The emerging ecosystem for LTE TDD networks at 3.5/3.6 GHz

Global TD-LTE Initiative

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Global TD-LTE Initiative

August 2013

The market for LTE TDD networks in spectrum bands 42 and 43

Produced for the 3.5GHz Interest Group by Innovation Observatory

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Executive summary

3GPP spectrum bands 42 and 43 are set to become important global spectrum bands, used worldwide for the delivery of mobile broadband services based on LTE TDD. Bands 42 and 43 have the potential to become some of the most widely available bands.

There will be two **major drivers of deployment** of LTE TDD in bands 42 and 43.

The biggest driver will be **capacity exhaustion in mobile networks**. As the number of customers using mobile broadband services increases, and as the volumes of traffic they consume continue to grow, mobile operators worldwide will find their networks under increasing pressure. Operators will find themselves constrained by the amount of spectrum they can use for the delivery of services. Even with technology improvements that deliver better spectral efficiency, the resources they have already been allocated (typically a mix of bands of spectrum between 700MHz and 2.6GHz) will be insufficient to deliver customers' traffic. As this happens, mobile operators will start to turn to capacity in new spectrum bands. One of the first of these will be spectrum at 3.5GHz. Operators are already starting to seek spectrum in bands 42 and 43 so they are prepared for when more capacity is needed, and as one operator told us: "even if mobile operators don't think they need more capacity now, they are unlikely to be saying the same in six months' time."

Another, smaller but more immediate driver for the growth of the market will be the **desire of WiMAX operators to migrate their networks to LTE**. The main reason they want to do this is to take advantage of the ecosystem that has developed, to access an improved range of devices for their customers, and wider choice of network access technologies. A number of WiMAX operators told us that they view WiMAX technology as being a dead-end technology (although this view is not universal). The largest WiMAX operators have already started migration to LTE – but these early movers have all held spectrum in other frequency bands. The first WiMAX migrations by players with spectrum in bands 42 and 43 are being planned now. Operators have been engaging in technical trials, and some expect to begin their migrations before the end of 2013.

Some significant **barriers to market development have been lowered** in recent months.

LTE TDD technology has been proved: there have been large scale deployments in several frequency bands, and at least one operator (UK Broadband) now has a commercial LTE TDD network operating at 3.5GHz, which is capable of delivering download speeds that significantly exceed typical ADSL and E1/T1 services. Its network has been configured for full mobility too, showing that from a technology perspective TDD LTE at 3.5GHz is not limited to delivery of fixed broadband. Several other operators are now deploying, planning and trialling LTE TDD at 3.5GHz, with the intention to launch services. Any lingering doubts about LTE TDD technology should be dispelled.

A couple of major global markets have signalled their intention to make spectrum in bands 42 and 43 available: in the US, this spectrum is likely to be available in large parts of the country for deployment of small cells; in Japan, 3.5GHz spectrum is being cleared for mobile broadband delivery. Even taking into account the likely limited geographic availability of this spectrum in the US, these moves could ultimately give several hundred million people across the two countries the ability to benefit from devices capable of supporting LTE TDD at 3.5GHz.

Chipsets, network equipment, and fixed and mobile devices are now available; and while the choice is not yet wide, vendors' roadmaps (privately shared) show that more CPE, dongles, and MiFi devices will appear within the next few months, with phones to follow.

Technology costs have come down fast, with operators reporting 40-50% reductions over the last twelve months in the cost of CPE supporting LTE TDD at 3.5GHz; they expect further price reductions. The cost of base stations has also been in sharp decline. These cost reductions make the business case for deployment of LTE TDD at 3.5GHz easier to justify.

Though there has been progress, the key players in the LTE TDD ecosystem have a real **opportunity to drive the 3.5GHz market faster**, and in doing so to improve services for customers, open up new equipment markets, and help telecoms operators to develop new business models.

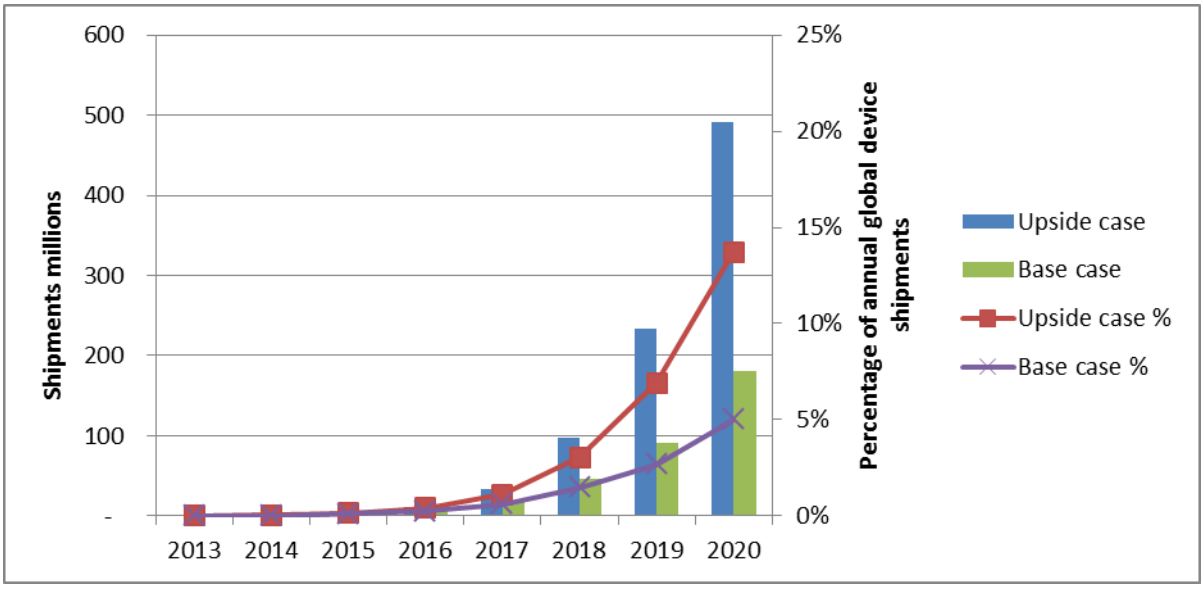
Regulators must facilitate use of bands 42 and 43 for LTE TDD and for the delivery of both fixed and mobile services. Regulators must facilitate access on a technology-neutral basis, for the delivery of a full range of telecoms services. Any hurdles to voice or mobile service provision should be removed.

A critical aspect of the regulation and management of bands 42 and 43 is not only that the spectrum is made accessible for the launch of LTE TDD services, but also that the spectrum is made available – as far as possible – in sub-bands or blocks which are internationally available, and which are wide enough to support effective service delivery. Some operators are asking for 40MHz channels and also the ability to refarm spectrum so that multiple services can be provided, and it would be helpful it there was a secondary market to help enable defragmentation. Regulators should also treat bands 42 and 43 equally. By opening up both bands regulators will help to solve the spectrum fragmentation that has occurred globally in these bands so far, will support improved global roaming for data services, and will help to bring down equipment costs.

By signalling definite intentions to make bands 42 and 43 available for mobile broadband services, regulators will give vendors greater confidence to invest in chipsets and devices.

Device vendors must realise that there is a significant market to serve. In the short term the LTE TDD market at 3.5GHz is not going to be as large as the market for LTE TDD devices serving other frequency bands. Nonetheless, demand from mobile operators to use 3.5GHz as an expansion band for mobile data offload services has by 2020 the potential to create annual demand for between 180 million and 500 million TDD LTE devices capable of supporting bands 42 and 43. This market will begin to emerge from 2014.

Figure 1: Forecast global annual shipments of 3.5GHz-compatible devices



Source: Innovation Observatory

In the short-term, we forecast that the market will be driven by use of LTE TDD in bands 42 and 43 for delivery of fixed broadband services, with market growth starting in 2013, and with the potential to reach 6.3 million fixed wireless subscribers on LTE TDD 3.5GHz networks globally by 2020. Within a few years though, it will be usage of spectrum at 3.5GHz for mobile data services that will dominate infrastructure deployment, device development and service revenues.

In order that they can most effectively open up these opportunities, operators report requirements for:

- Multi-generation, multi-band devices
- Mobile devices (including dongles and phones)
- Dual mode WiMAX/LTE TDD devices
- Clear timetables for device availability.

Equipment and chipset vendors must also move faster to support LTE TDD at 3.5GHz. There are a few pioneers developing chipsets and devices, but operators will benefit from a broader ecosystem. Network and service planning is now at the stage where base stations and devices are needed in significant volumes: there is a critical mass of operators behind LTE TDD in 3.5GHz bands. Operators with significant spending potential express desire for faster development of:

- Chipset choices
- Amplifiers which can match the performance characteristics of LTE in other spectrum bands
- Support for advanced antennas (e.g. 8T8R) at 3.5GHz, and multi-band antennas supporting 3.5GHz
- Timetabled commitment to support 3.5GHz from vendors currently stating that their technologies are '3.5GHz-ready'.

Mobile operators must signal their clear desire to use LTE TDD in bands 42 and 43, even where their plans are not immediate. This will give vendors more confidence that a substantial market for devices and network equipment is going to emerge, and encourage regulators to open up access to the spectrum where this is needed.

WiMAX operators and new entrant fixed broadband providers wanting to deploy LTE TDD at 3.5GHz should present collective orders for base stations and CPE supporting bands 42 and 43, if at all possible. Fragmentation in their demand serves to reduce the attractiveness of the market for equipment and device vendors, and sustains kit prices. Our analysis suggests that collectively they can present order sizes that will be attractive to a variety of vendors, and that will serve to tempt more suppliers into the marketplace.

Introduction

LTE-based mobile services have arrived, and customer numbers are growing rapidly. There were more than 100 million LTE customers worldwide by mid-May 2013[I], and the global number of mobile users on LTE networks is expected to reach more than a billion within the next five years.

LTE networks are being deployed using a range of frequency bands. Operators have most commonly focused on spectrum bands in the 700 MHz to 2.6GHz range. Where possible they are using the lower frequency spectrum bands to deliver widespread coverage, and using the higher frequency spectrum bands to add capacity in key, high traffic locations.

LTE has been deployed in both FDD (frequency division duplex) and TDD (time division duplex) modes. Both have been shown to work effectively, and although LTE FDD has been much more widely adopted so far, both LTE modes have a critical mass of supporting operators.

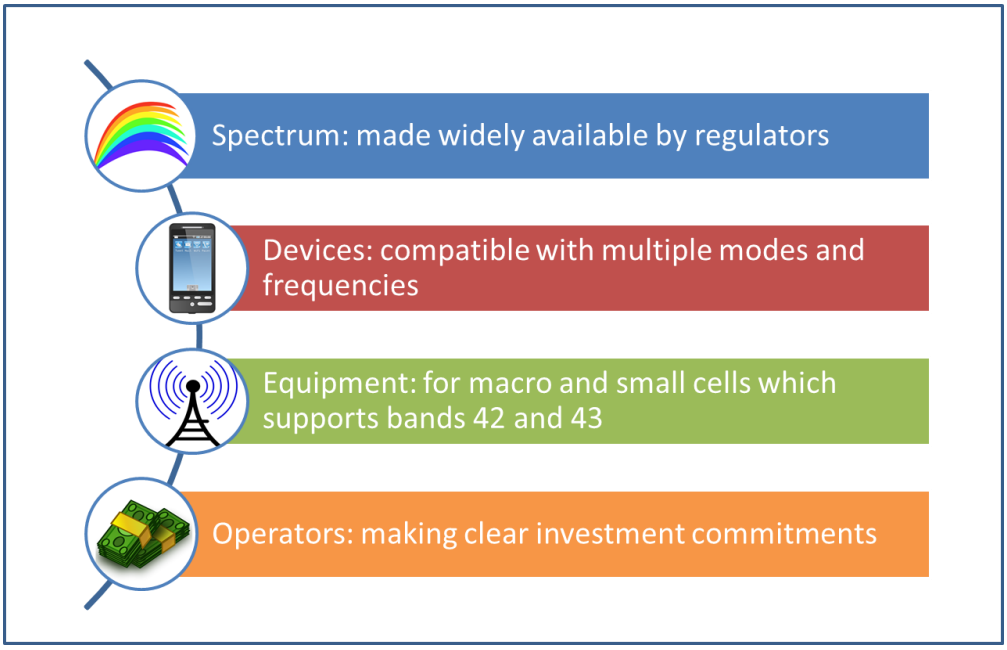
The device ecosystem is now supporting the common spectrum bands and both FDD and TDD modes with a wide range of devices including modems, routers, dongles, MiFi devices, tablets and mobile phones. Operators and their customers have an increasingly attractive range to choose from, often able to support multiple modes and multiple frequencies, and operators are beginning to enjoy the economies of scale benefits delivered by large-scale chipset and device production.

However, further work is needed to improve support for two important spectrum bands: 3GPP bands 42 and 43, which are capable of carrying LTE TDD services on spectrum in the 3400MHz to 3600MHz and 3600MHz to 3800MHz ranges (hereafter referred to as spectrum at 3.5GHz). The market for LTE TDD services delivered in bands 42 and 43 is poised to emerge. Commercial services have now been introduced in the UK, and elsewhere operators are testing services and report plans to switch on networks imminently. However, 3.5GHz is not yet well supported by device vendors, and many national regulators have yet to facilitate technology and service-agnostic usage of this spectrum.

This report has been commissioned by UK Broadband, on behalf of the 3.5GHz Interest Group, to raise awareness of the global prospects for LTE TDD in bands 42 and 43. Based on a survey of the Interest Group's operator members, a survey of device vendors, and fresh market analysis, it reviews the current status of LTE TDD in bands 42 and 43, looking at device availability, regulation and operator activity. It also looks at the future of LTE TDD in these bands, forecasting equipment and service markets, identifying the key triggers that will kick start the market and move it from a state of poise to a state of momentum. It provides a roadmap to give device vendors, operators and regulators confidence to accelerate LTE TDD at 3.5GHz.

Status of the LTE TDD ecosystem at 3.5/3.6GHz

The rapid development of the market for LTE TDD in bands 42 and 43 will depend upon a number of factors all coming together:



Until now the market has been hindered by a state of inertia: operators waiting for devices and equipment; operators waiting for regulators; and vendors waiting for operator commitments. However, the market is beginning to move. This section reviews the current state of the ecosystem.

Availability of spectrum

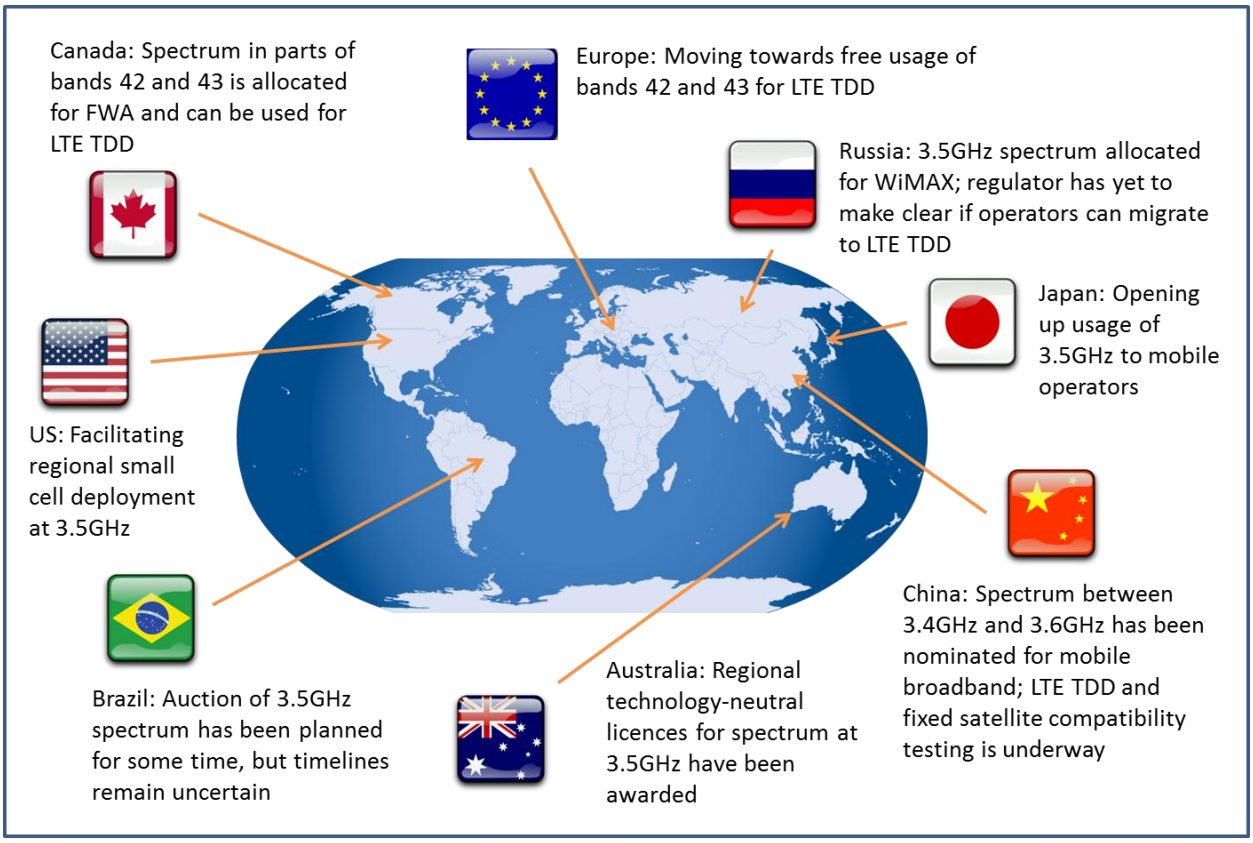
Regulators worldwide are recognising the need to make more spectrum available to support mobile services. The ITU's report of 2006 forecast potential national spectrum requirements of between 1280MHz and 1720MHz[II] by 2020 to cover the needs of IMT and IMT-Advanced networks. And as key bands identified for mobile broadband, bands 42 and 43 are major resources that can be used to limit spectrum shortfalls, between them offering 400MHz of potential spectrum. Moreover, bands 42 and 43 are well suited to support asymmetric broadband services requiring much higher downlink capacity than uplink capacity.

Regulators around the world have so far taken a fragmented approach to awarding spectrum in bands 42 and 43 for use in LTE TDD networks. Most spectrum in bands 42 and 43 that has been allocated for widespread commercial use has been distributed for regional or national fixed wireless services – typically to support the increased availability of fixed broadband services. Licences have been used by service providers to roll out WiMAX networks (or in some cases have remained unused).

Some regulators are happy to support the refarming of this spectrum for use by any technology, and for the delivery of any type of telecoms service (including broadband access, fixed voice and mobile voice). Others are much more restrictive. In some countries spectrum at 3.5GHz is protected for use by satellite services, for point-to-point wireless services, or reserved for governmental organizations – this makes access for delivery of broadband wireless services problematic until the users in those bands can be migrated, or persuaded to share the spectrum they are occupying.

There are signs though that some of the biggest markets are moving towards making bands 42 and 43 (or parts of them) available for LTE TDD networks. Figure 2 below shows the status of 3.5GHz licensing in selected markets.

Figure 2: Availability and use-ability of spectrum in bands 42 and 43, selected countries and regions



Source: Innovation Observatory

In **Europe** there are relatively few official regulatory hurdles to the use of spectrum at 3.5/3.6GHz for TDD LTE. Frequency at 3.6GHz is set aside by CEPT for Band 43 (TDD) usage. Meanwhile, 3.5GHz is technology neutral, i.e. both Band 42 (TDD) and Band 22 (FDD) are permitted, although in fact a preference for using TDD at 3.5GHz has been identified (to be reconfirmed later this year). Nonetheless, even in Europe, where common regulation applies at a supra-national level, there are big differences in the availability and actual usage of spectrum. EC Decision 11(06)[III] specified that national regulators should designate bands 42 and 43 on a non-exclusive basis to mobile/fixed communications networks, without prejudice to the protection and continued operation of other existing users in those bands (including FWA and satellite users). It also stated that regulators should aim by the end of 2013 to choose a preferred harmonised spectrum frequency arrangement (based on TDD or FDD and in blocks as defined in the Decision), and should consider migrating existing users towards those harmonised arrangements.

In the meantime, spectrum in these bands has commonly has been licensed for FWA and WiMAX services, and regulatory approaches in general favour technological neutrality and competition in the supply of both voice and data services, although a number of countries (and particularly in Central and Eastern Europe) have yet to officially mandate support for usage of 3.5GHz for mobile services. Not all countries have allocated the spectrum (for instance Band 43 remains unused in some places) and significant blocks of frequency in these bands are occupied by other users (such as satellite providers). Regulations do not require that these users be relocated to new spectrum bands.

One operator with firm plans to offer mobile services using LTE-TDD at 3.5GHz said

> ***Some national regulators are less happy than others to designate Band 43 for mobile data use, perhaps because they have a lot of satellite use of that band at the moment … but we expect both bands 42 and 43 to be cleared for mobile data service use in most countries [as well as for fixed wireless access].***

European operators we spoke to expected that bands 42 and 43 would be a key part of efforts to meet the requirement of the EC for national regulators to identify 1200MHz of spectrum for mobile data services by the end of 2015.

Africa and the Middle East are key regions in terms of 3.5GHz usage as they are home to some of the biggest, fastest growing WiMAX operators holding spectrum at 3.5GHz. However, licensing regimes are much more constraining than in Europe, and holders of spectrum in bands 42 and 43 are often not permitted to use that frequency for delivery of voice or fully mobile services. There are also questions in some countries about permission to launch LTE networks – frequency allocations have often been technology specific.

The **Asia-Pacific** region is fragmented as far as use of 3.5GHz for LTE TDD is concerned. In Japan the regulator is in the process of clearing the spectrum in bands 42 and 43 so that it can be used for the delivery of mobile broadband services. That process is continuing during 2013, and it is anticipated that mobile operators will start to use this spectrum from 2014 onwards. In South Korea although some of the capacity in the 3.5-3.7GHz range is used for fixed satellite services, the government plans to release 160MHz of capacity at 3.5GHz for mobile broadband services by 2016 as part of its Mobile Gwanggaeto Plan (which involves freeing up an extra 600MHz of spectrum for mobile broadband by 2020). Fixed satellite services are also occupying extensive spectrum assets between 3.4 and 3.8GHz in India and Vietnam. Meanwhile, spectrum has been licensed between 3.4GHz and 3.5GHz in Australia on a city-wide and regional basis for broadband fixed wireless services. Spectrum in band 43 is used for point-to-point and satellite services. China has committed to making the spectrum between 3.4GHz and 3.6GHz available for mobile broadband, and it is recognised that this frequency is suitable for TDD-based services. Field tests are underway to ensure the compatibility between LTE TDD and fixed satellite services. It is not yet clear how the spectrum will be allocated. In the meantime, portions of the spectrum in bands 42 and 43 are used for satellite, FWA and microwave services. If China starts using band 42 or 43 for LTE TDD soon, it will have a dramatic impact on the potential of the market.

In **Latin America**, licences in the relevant spectrum bands (at 3.5GHz) are often awarded for fixed access services only – not for mobile services – and the status of the licence terms for the provision of voice services is also somewhat often vague. In Brazil, auctions of spectrum at 3.5GHz have been expected for a couple of years (with 3.4–3.6GHz set aside for broadband fixed wireless access (BFWA)), but timetables for those auctions remain uncertain. In Uruguay, LTE TDD has been allocated band 42, and in Argentina, Mexico and Peru use of spectrum at 3.5GHz has been allocated for BFWA and nomadic operation has been introduced in some markets. In Argentina use of this band for LTE is permitted.

In **North America**, spectrum in bands 42 and 43 is looking increasingly accessible, and changes here have the potential be a major driver of change for the market as a whole. The United States has issued a Notice of Proposed Rulemaking and Order (NPRM) about making 100MHz of spectrum which straddles bands 42 and 43 (50MHz at the top and bottom of each band respectively) available for small cell networks. This will open up a lot of potential spectrum covering many parts of the US. The small cells can only be used in areas where there will be no interference with important government or national users, but estimates suggest it will be

possible to deploy small cells using these frequencies across around 60% of the landmass, home to around 40% of the population.

Canada auctioned 175MHz of spectrum for fixed broadband access (WiMAX) crossing bands 42 and 43 in 2004/5 in four blocks (three paired 25MHz blocks and one unpaired block). A shared licence band is available at 3.65GHz which is being used for broadband wireless and backhaul. Note that that the Canadian band plan at this frequency does not align entirely with other international markets, with 3475-3650 MHZ set aside for FWA, mobile given a co-primary allocation from 3650 to 3700MHz, and radiolocation given primary usage between 3400 and 3450MHz.

Availability of chipsets and devices

Chipsets are now available that support LTE TDD at 3.5GHz. Indeed chipsets supporting TDD LTE at 3.5GHz have been commercially available since 2012, as have chipsets supporting both TDD LTE and WiMAX in bands 42 and 43. Vendors with compatible chipsets report that it is possible to hand over from any other commercially developed TDD LTE or FDD LTE or WiMAX frequency band to LTE TDD at 3.5GHz. Chipset vendors that are known to have 3.5GHz capability for their LTE-TDD chipsets include Sequans (SQN3140 RFIC, supporting bands 38, 40, 41, 42 and 43, as well as WiMAX at 2.3, 2.5 and 3.5GHz), and Huawei / HiSilicon (Balong 710). Altair Semiconductor has also reported its chipsets now support bands 42 and 43, and that it is sampling to customers. Other silicon providers will have 3.5GHz LTE TDD chipsets ready in 2014.

Availability of devices that can support LTE TDD remains limited, although the situation is improving. The earliest devices available to operators are indoor and outdoor CPE to support fixed wireless broadband applications. Most early equipment has been LTE-only, although one vendor has introduced dual-mode WiMAX and LTE devices that can support bands 42 and 43, and one device offers DC-HSPA+ fallback. In total we can identify 16 devices in the market (or close to being commercially available). Details are presented in the following table. Operators and vendors report that devices either are, or are becoming, available from other OEMs, although those vendors have declined to confirm the reports.

Table 3: Devices supporting LTE TDD in bands 42 or 43

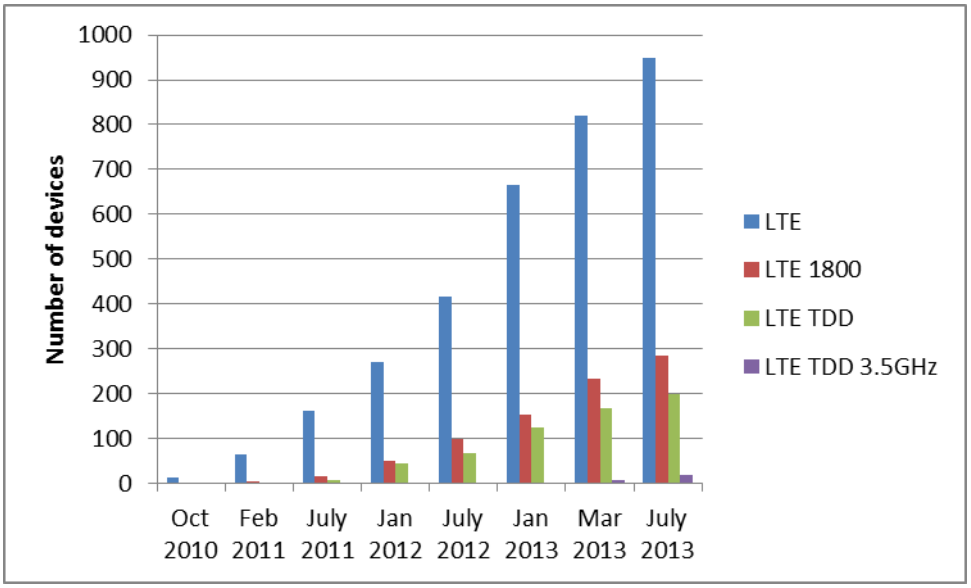
Vendor	Device type	Device name	Frequency bands supported	Fallback options
Airspan	Industrial / vehicle terminal	MRT	Includes **42, 43**	
Gemtek	USB Modem	High Gain LTE USB Modem[IV]	Known to contain Sequans' SQN3140 RF chip that operates in the TDD LTE bands **42** and **43**	
Greenpacket	Indoor CPE	DB-350*	**42, 43**	USB 2.0 port for 3G dongle
Greenpacket	Outdoor CPE	OD-350*	**42, 43**	
Huawei	Router	B222s-42	TDD 3500 b**42**, **43**	
Huawei	Router	B222s-42A	TDD 3500 b**42**, **43**	
Huawei	Router	B222s-42E	TDD 3500 b**42**, **43**	
Huawei	Router	B593s-42	TDD 3500 b**42**, **43**	
Huawei	MiFi device	E5776s-420 Cat 4 personal hotspot	TDD 3500 b**42**, **43**	DC-HSPA+

Huawei	Router	B5268w Cat 4 device	TDD 3500/2600/2300/1900	
Huawei	Router	B5268 Cat 4 device	TDD 3500/2600/2300/1900	
Huawei	Router	B2268A Cat 4 device	TDD 3500/2600/2300/1900	
Huawei	Router	B2268S Cat 4 device	TDD 3500/2600/2300/1900	
Huawei	Router	B2268H Cat 4 device	TDD 3500/2600/2300/1900	
ZTE	Router (indoor CPE); outdoor CPE available Q3 2013	Indoor CPE MF280 Others to be determined	**42, 43**	
ZTE	MiFi available Q4 2013	USB modem MF812	**41,42,43**	LTE TDD B41

** Due for launch before end July 2013*
Source: All data confirmed by equipment vendors, except where stated; GSA (Global mobile Suppliers Association: http:/www.gsacom.com) data used as starting source for the research

Device availability for LTE TDD in bands 42 and 43 is lagging device support for LTE TDD bands 38 and 40 by around two years and comparison with the timelines for the development of LTE device ecosystem support at other frequencies suggests it will be 2015 before a significant number of devices supporting LTE TDD in bands 42 or 43 become available.

Figure 4: Historical growth pattern of the LTE device ecosystem

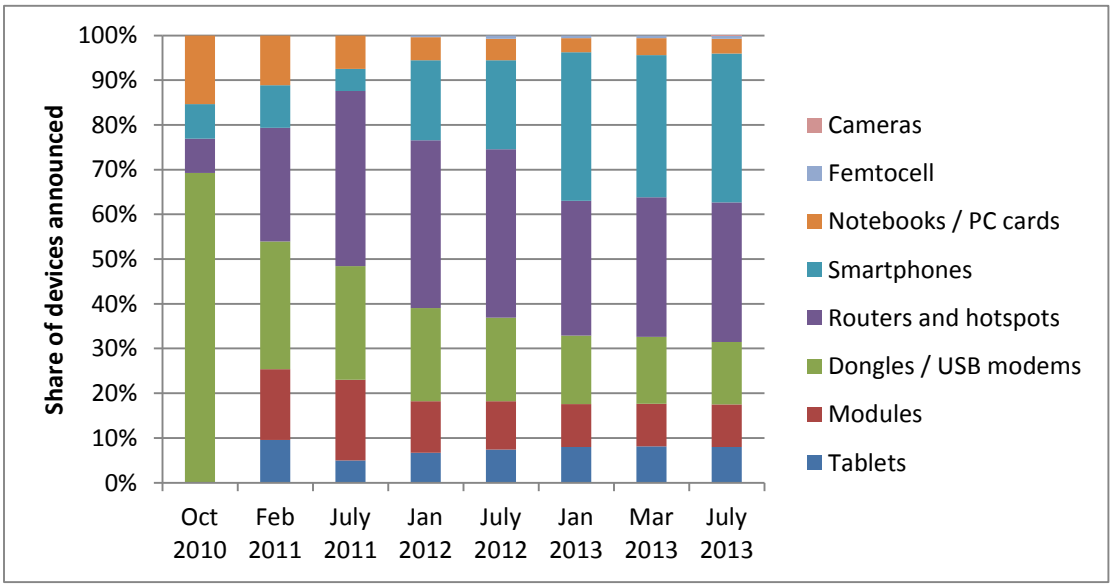


Source: Compilation based on data published by the Global mobile Suppliers Association (GSA), based on product announcements. Devices only counted where support definitely confirmed.

Analysis of device-type evolution is also instructive. As Figure 5 below shows, the ecosystem for the LTE market as a whole was dominated by routers and dongles for the early years, with phones and small cells only coming to play a significant role at a later date. A similar pattern is emerging for LTE TDD at 3.5GHz. Vendors have indicated the imminent arrival of dongles, datacards and MiFi devices supporting bands 42 and

43, although routers and CPE will be much more common throughout 2013/2014. Our conversations with vendors suggest tablets and phones that support bands 42 and 43 are likely to start to appear in 2014.

Figure 5: Growth pattern of the LTE device ecosystem, by device type



Source: Compilation based on data published by the Global mobile Suppliers Association (GSA), based on product announcements. Devices only counted where support definitely confirmed.

Availability of network equipment

The status of the network equipment market is similar to the status of the device market: improving. A number of vendors of radio network equipment are making available eNodeB base station equipment to support bands 42 and 43. These include vendors of WiMAX kit and those from the LTE ecosystem. The table below summarises known equipment at the end of June 2013.

Table 6: network equipment supporting TDD LTE in bands 42 or 43

Vendor	Device description	Device name	Frequency bands supported	Network technologies supported (eg LTE TDD, FDD, WiMAX, WCDMA, GPRS etc)
Accelleran	Small cell base station	M101 TD-LTE eNode B[V]	38, 39, 40, 41, **42, 43**	LTE TDD and WiFi
Airspan	Pico base station	AirSynergy 2000	Bands 1, 3, 4, 5, 7, 12, 12, 14, 17, 20, 25, 40, 41, **42, 43,** 44	LTE (TDD and FDD) and WiMAX
Airspan	Femto base station	AirSynergy 1000	Bands 1, 3, 4, 5, 7, 12, 12, 14, 17, 20, 25, 40, 41, **42, 43,** 44	LTE (TDD and FDD)
Airspan	Outdoor base station	Air4G*	Multiple bands (software defined) including 42, 43	LTE (TDD and FDD) and WiMAX
Huawei	Macro: Distributed base station	DBS3900	Bands 38,39, 40, 41, 42/43 (3.4GHz-3.7GHz)	LTE TDD/FDD, UMTS, GSM, TD-SCDMA, WiMAX, CDMA

	(eNodeB)			
Huawei	Small cell: indoor	Lampsite	Currently supports Band 38/40/41; other bands can be customized	Huawei
Huawei	Small cell: outdoor	Micro BTS3205E	Currently supports Band 38/40/41; other bands can be customized	Huawei
Nokia Siemens Networks	Flexi 10 multimode base station	To be determined - supporting products not yet shipping	Its multimode base stations are band **42 and 43** ready	To be determined - supporting products not yet shipping
Radisys	Small cell base station	Trillium TotaleNodeB	Programmable for multiple bands and frequencies including **42** and **43**	LTE TDD
Runcom	eNodeB	RNU5001	38, 40, 41, **42, 43,** 44	LTE (TDD and FDD)
Telrad Networks	Base station	4Motion family: BreezeMAX (distributed) and Compact (outdoor)	Multiple, from 2.3GHz-3.8GHz (software-defined): 2.5GHz and 3.5GHz TDD tested 2011	LTE-TDD and WiMAX
ZTE	Distributed eNodeB	BBU ZXSDR B8200 and B8300 (baseband units) and ZTE RRU R8964	**42, 43**	LTE TDD/FDD/WiMAX/G/U /CDMA

** Airspan says a micro base station LTE TDD-only version (Air4Gs) will be available shortly*
Source: All data confirmed directly by the equipment vendors, except where indicated

As shown in the table, some vendors' solutions offer software defined radio functions so that radio access networks can be upgraded / migrated from WiMAX to LTE with a software upgrade only.

Operator commitments to invest in LTE TDD at 3.5GHz

Operator commitments to LTE TDD at 3.5GHz are growing steadily. At the end of June 2013 there was one live commercial LTE TDD network operating only in bands 42 and 43; that had been launched by UK Broadband, which is providing fixed wireless broadband access – and soon fully mobile data services – in the UK.

However, a number of other operators have announced plans to launch services using LTE TDD in bands 42 or 43. These include players from all parts of the world.

Table 7: Operator progress to LTE TDD in bands 42 / 43

Operator	Country	Fixed / mobile	Details
AFT-Linkem[VI]	Italy	n/d	Planned, trials confirmed in news interview
AxTel[VII]	Mexico	Mobile	Plans reported
B-lite[VIII]	Belgium	n/d	Planned deployment
Bollore Telecom[IX]	France	Mobile	Planned
Dedicado[X]	Uruguay	n/d	Combined WiMAX / LTE network in deployment (Telrad, formerly Alvarion)
Enforta** [XI]	Russia	Fixed	Trials reported
Entel[XII]	Chile	Fixed (business services)	Has been testing
E-Plus*	Germany	Mobile	Currently running a trial
Imagine Group* [XIII]	Ireland	Fixed	Planned; has made pilot deployments
Menatelecom[XIV]	Bahrain	Fixed wireless including mobility	Deployment started (but in dispute with regulator over right to enter auction for a 4G licence)
Milmex[XV]	Poland	n/d	Network deployed capable of dual mode WiMAX / LTE TDD operation (Airspan)
Sazz* [XVI]	Azerbaijan	Fixed and nomadic	Plans migration. In trials
Smoltelecom**	Russia	n/d	Planned or in deployment
Softbank Mobile[XVII]	Japan	Mobile	Considering using 3.5GHz in its AXGP network; currently conducting trials
TransTeleCom[XVIII, XIX]	Russia	Fixed	Plans / trials reported
UK Broadband*	UK	Fixed/Mobile	Launched 2012; mobile service demonstrated
VelaTel[XX]	Croatia, Serbia, Montenegro	n/d	Deployment started Q2 2012 (ZTE)
Xplornet*	Canada	Fixed	Have been conducting trials

*Sources: * Confirmed directly by operators, ** Global mobile Suppliers Association (GSA); otherwise as indicated*

In addition to these, the research for this report has identified some other large network operators who intend to launch significant LTE TDD networks at 3.5GHz, but who have not yet announced their plans publicly. Innovation Observatory expects half a dozen additional trial launches by the end of 2013, and steady growth in the number of operational networks from that point onwards.

Operator service plans for LTE TDD at 3.5GHz

As at May 2013, only fixed and nomadic broadband access was on offer commercially over LTE TDD at 3.5GHz. However, LTE TDD at 3.5GHz is well-suited to the provision of several services tried and tested in the WiMAX environment at 3.5GHz, and also new service ideas. We have spoken in-depth with operators planning to deploy LTE TDD at 3.5GHz, and it is clear they are planning to introduce a wide variety of services. Table 8 below summarises the most important of these, focusing first on those that will have the greatest impact on the LTE TDD 3.5GHz ecosystem in terms of device requirements, and the number of customers using them.

Table 8: Operator plans for 3.5GHz LTE TDD networks

Use case	Details
Capacity improvement	Not a service in its own right – rather a complement to existing mobile data services. Involves deploying an overlay capacity network to complement lower-frequency coverage bands for mobile operators; and deployment of cells in the areas of greatest capacity demand density, where spectrum in traditional LTE bands is limited. No mobile operator has officially done this yet, although a number have indicated privately that they will need to use spectrum at 3.5GHz as a capacity expansion band. Spectrum at 3.5GHz is particularly attractive because there is sufficient spectrum (depending upon how it is allocated) to support carrier aggregation (CA) and hence to take advantage of the higher bandwidths that CA can deliver. 3GPP has an on-going programme of work to develop advanced carrier aggregation including FDD-TDD inter-band CA. Network tests have shown that when they are configured for higher traffic loadings, cells based on 2.6GHz and 3.5GHz approximate to more or less the same cell size. This means the total cost of ownership for overlay networks deployed at 3.5GHz can in some instances actually be lower than the total cost of ownership for overlay networks at 2.6GHz, because of the much lower spectrum outlay.
Small cell networks	Complementing existing large-cell networks in other bands (as for the capacity and coverage improvement cases above), but using low powered cells, particularly for indoor areas such as shopping malls and stadiums to give improved service quality (including in terms of throughput and device power demands), and within homes – potentially with capacity shared between subscribers and other nearby nomadic or mobile users. Spectrum at 3.5GHz is well suited to small cell deployments: it offers high capacity potential and minimal interference with other small cells (unless deployments are extremely dense), and interference with other LTE services at lower frequencies is limited. Using 20 or 40MHz of capacity in hotspot zones through the use of small cells will enable LTE operators to improve quality of services for their own customers by reducing access congestion and raising average speeds. These small cells can also be used to provide wholesale offload or roaming services to other LTE operators in need of capacity. Operators all around the world are already deploying small cells. The Small Cell Forum reported over 11 million small cells deployed by February 2013[XXI]. No operator has yet deployed small cells using TDD LTE at 3.5GHz. However, initiatives by the FCC in the United States could drive small cell deployment at 3.5GHz in that market. Open neighbourhood small cell approaches take the idea of small cells one step further, and enable public users outdoors to access small cells that have been deployed indoors by private individuals. The model has already been used in a WiFi context: in the UK, BT's broadband users can share their home WiFi capacity with other BT WiFi (Openzone) users in the vicinity.

	By employing an open neighbourhood approach an operator might offer consumers home devices that act as small cell LTE hotspots. These might use any combination of spectrum bands, but bands 42 and 43 are particularly useful because they offer high capacity and a low range (hence cause less disruption to other networks and cells). Moreover, in contrast to WiFi deployments – where traffic typically goes off-net to the Internet – small cell LTE deployments would enable operators to retain control of the traffic. Again, discussion of this business model for LTE TDD at 3.5GHz is conceptual at this stage.
Wholesale data offload / roaming	A number of operators deploying or planning to deploy LTE TDD at 3.5GHz are looking at the potential to offer wholesale data offload services. As yet no operator is offering this over an LTE TDD network at 3.5GHz, but a precedent for the wholesale business model has been set. Clearwire in the US, for instance, offers Sprint unlimited wholesale access to both its WiMAX and LTE TDD networks at 2.5GHz. Sprint has agreed to pay a fixed fee for unlimited 4G WiMAX services for its customers in 2012 and 2013, with usage based fees to follow after 2013; and usage based fees for its LTE network (which had 1300 sites commissioned by end March 2013) from 2012. These wholesale services generated around US$57 per wholesale subscriber per year for Clearwire in 2012. As it becomes more widely deployed, LTE TDD at 3.5GHz also offers potential as an international roaming capacity band. Mobile operators want to encourage their roamers to use high quality, sustained high speed services without losing them to third-party WiFi service providers. So where 3.5GHz network operators are already offering wholesale offload to mobile operators within their own national market, it also makes sense for them to offer wholesale roaming to support international travellers.
Fixed access broadband services	This business model involves using the network to deliver fixed wireless broadband access services for residential and business customers. It has been proved in a number of countries worldwide using WiMAX networks, and works well where there is no competitive alternative source of broadband Internet access for customers. Services can be delivered in both urban and rural locations. All WiMAX operators planning to migrate to LTE TDD are intending to offer this service. Many also aim to add nomadic services using MiFi devices or dongles. Services can support potentially high broadband access speeds, with service redundancy where required for business customers.
Fully mobile services	LTE TDD networks operating in bands 42 and 43 can be used to offer fully mobile services. UK Broadband's network has been configured to support this, for instance. Given that – in comparison with deployments at much lower frequencies – band 42 and 43 spectrum provides low coverage per cell when configured for fully mobile services, these bands would not be used to provide a full national network on their own. The use of these frequency bands makes most economic sense when deployed as a contiguous metropolitan network in dense urban areas, where the network can be used to effectively serve a high concentration of mobile data users. No operator is yet offering fully mobile services on a commercial basis, but some 3.5GHz WiMAX operators we spoke to are expecting to develop mobile services when device availability and cost allow – and some have always intended to use their 3.5GHz spectrum holdings for this – particularly in markets well served by fixed broadband infrastructure and where the FWA business case is harder to make. This would enable a

	defence against mobile operators developing high-capacity wireless access services themselves: fully mobile broadband is a threat to FWA offers.
Wireless backhaul	LTE TDD networks at 3.5GHz can be used to provide backhaul from small cell sites for mobile operators, or for ISPs. One example of a commercial deployment is that of Bahamas Telecom, which commissioned Huawei to deploy its eRelay solution for this purpose. This will be used for low cost backhaul – initially to support transport of video images for Bahamian police surveillance. LTE TDD at 3.5GHz can support backhaul in non-line-of-sight scenarios by using directional antennas.
Enhanced business services	LTE TDD networks at 3.5GHz can support prioritised broadband access for emergency services and enterprise use, at premium prices. The business case has already been proven to work for WiMAX at 3.5GHz. For instance SuomiCom in Finland offers video surveillance, uncontended broadband access for TV production, and prioritised business broadband services with monthly ARPUs well in excess of standard broadband access services[XXII]. WiMAX operators can be expected to continue with such services if and when they migrate to LTE TDD at 3.5GHz.

Source: Innovation Observatory

The business justification for each of these potential use cases, and how they might be combined, depends on a number of factors that are specific to each operator, within its own market.

Market forecasts

Given the increasing number of operators investigating the potential of LTE TDD at 3.5GHz, the growing vendor support for LTE TDD at 3.5GHz, moves by regulators to facilitate greater usage of bands 42 and 43, and evident potential for the capacity these bands offer in terms of service development and delivery, there is good reason to be optimistic about the potential of the market for LTE TDD-based services delivered in these bands.

The primary determinants of how fast the market will grow will be the:

- Rate of capacity exhaustion
- Timescales within which regulators remove regulatory barriers
- Speed of WiMAX operator migration to LTE, and how they migrate
- Size of equipment price declines.

Rate of capacity exhaustion in mobile networks

As mobile operators use their allocated spectrum resources they will need to find new ways of adding capacity to their LTE networks, and they will turn to the capacity available in bands 42 and 43, which is widely available, and low in cost relative to spectrum in other bands. Bands 42 and 43 offer up to 400MHz of spectrum that can be used to deliver mobile services.

We expect that capacity increase for mobile operators will ultimately be the biggest driver of the LTE TDD 3.5GHz technology and service markets. One large European mobile operator we spoke to told us…

> ***We will start using 3.5GHz bands for LTE when demand requires it … we see LTE in this band as a proper part of the LTE family***

…and holders of 3.5GHz spectrum used for other services have told us they are in talks now with mobile operators to provide capacity overlays using LTE TDD.

Our research has shown that mobile operators are well aware that spectrum at 3.5GHz could be used to satisfy some of their future capacity requirements, and that they are already moving to either acquire, or to protect spectrum in bands 42 and 43. Where once they might have traded spectrum in these bands, as one WiMAX operator put it, the typical response now to a request for a spectrum trade is: "Out of my cold dead hands".

Timescales within which regulators remove regulatory barriers

If regulators for the biggest national telecoms markets all start to clear the way for LTE TDD usage in bands 42 and 43, even if allocation of frequencies in the bands is not harmonised, and most of those regulators markets support technology-neutral approaches to bands 42 and 43, then the market will grow quickly.

We have presented two scenarios for our forecasts, and these primarily differ in terms of the number of major global markets in which the regulators facilitate use of bands 42 and 43 for LTE TDD mobile services. Our base case forecasts assume that European regulators continue to clear the way for LTE TDD usage in bands 42 and 43, where practical, throughout 2013/2015. They assume that the US and Japan will both continue their current initiatives to make spectrum in bands 42 and 43 accessible for LTE TDD network operators kick starting widespread adoption in those countries. The base case forecasts do not assume that usage of the bands will be harmonised in terms of frequency allocations. They are based on the premise that there will be a mix

of FDD and TDD allocations, and fragmentation of the spectrum allocations (with the US for instance only releasing parts of those bands). They do assume many countries will support technology neutral approaches to usage of bands 42 and 43, although this will not be universal.

The upside case forecasts assume in addition to this that either China or India also provides regulatory clarity and opens the door for use of bands 42 and 43 for fully mobile LTE TDD services, or that both Brazil and Russia do this.

Speed of and strategies for WiMAX migration to LTE

Many WiMAX operators already operate networks at 3.5GHz, covering around 4 million customers worldwide. A significant number of those are comparing the likely future technology capabilities of WiMAX and LTE and are questioning whether they should migrate to operate LTE TDD networks at 3.5GHz. Proponents of this approach generally argue that in the longer-term the LTE ecosystem offers better technology potential, that economies of scale will be better in the LTE ecosystem than in the WiMAX ecosystem, and that there will be a broader range of vendors to work with. As one WiMAX operator put it:

> ***It is about the ecosystem cost per bit … in the longer term this will be much better on LTE. WiMAX is stable, and mature. No one is improving it. No one will give me more bits/Hz on WiMAX, but LTE technology is at its infancy. There is a path to the future.***

Aside from a perception that long-term performance of LTE networks will outstrip the performance capabilities of WiMAX networks, some operators are also starting to migrate because their networks are running out of capacity, and they perceive the immediate potential to deploy 20MHz carriers on LTE TDD; others are concerned that their WiMAX technology providers are under-investing in technology improvements, and others still are concerned that the WiMAX deployments are becoming too proprietary and locking them into individual suppliers.

Our forecasts assume a steady migration of WiMAX networks to LTE TDD in bands 42 and 43 over the next ten years. The first migrations are likely to take place towards the end of 2013 / early 2014, with the bigger WiMAX operators likely to make the first moves. It will not be the case that all WiMAX operators will immediately migrate to LTE TDD at 3.5GHz. A significant base of WiMAX providers plan to continue running the networks they have paid for, and that are still serving their needs. They will milk these assets as long as possible. The upside scenario in our forecasts assumes a faster migration rate between 2013 and 2020.

WiMAX operators are planning various approaches to migration, and these will have differing impacts on the prospects for network equipment and device vendors. Key technology strategies include:

- Software upgrades to existing equipment
- Full new network deployment

The first approach is to upgrade an existing WiMAX network using a software-upgrade. This is only possible where the WiMAX vendor has supplied LTE TDD-ready technology that is capable of software upgrade, and not all vendors support this. However several significant WiMAX operators using 3.5GHz, and who are planning long-term migration, have been assured by their vendors that their networks can offer this migration path.

The other approach involves deploying a completely new LTE network, with new cell site equipment and new IT systems. Our interviews show that a number of key operators plan to use this approach. These operators

typically tend to be more advanced in their migration plans (driven by greater dissatisfaction with current network vendors).

Migration strategies also vary between running WiMAX and LTE side-by-side, and a big bang migration. Running WiMAX side-by-side with LTE (phased migration) is a strategy that has been used by WiMAX operators with spectrum in other bands. Saudi Arabia's Mobily, for instance, deployed an LTE network alongside its existing WiMAX network, which was running to capacity and too dense to easily upgrade through the addition of extra sites. It deployed its LTE network in three geographic areas, in stages, using a single RAN WiMAX/LTE solution. Its approach was to split its spectrum between WiMAX and LTE, with a strategy to turn off the WiMAX customers as their contracts expired. It gained significant extra capacity (three times the throughput for the spectrum used) through its move to LTE TDD.

In contrast to this strategy Russia operator Yota (also operating WiMAX in other spectrum bands) employed a big bang approach; simply turning off networks in defined geographic areas (starting with Moscow) as it turned on its LTE network.

The phased migration approach could theoretically lead to demand for more dual mode WiMAX/LTE CPE devices, although operators spoken to for this report expressed a preference for simply allocating new customers with LTE-only CPE. The big bang approach requires greater upfront investment in LTE CPE. WiMAX operators are understood to be planning both approaches to migration.

Availability and cost of 3.5GHz compatible LTE TDD CPE

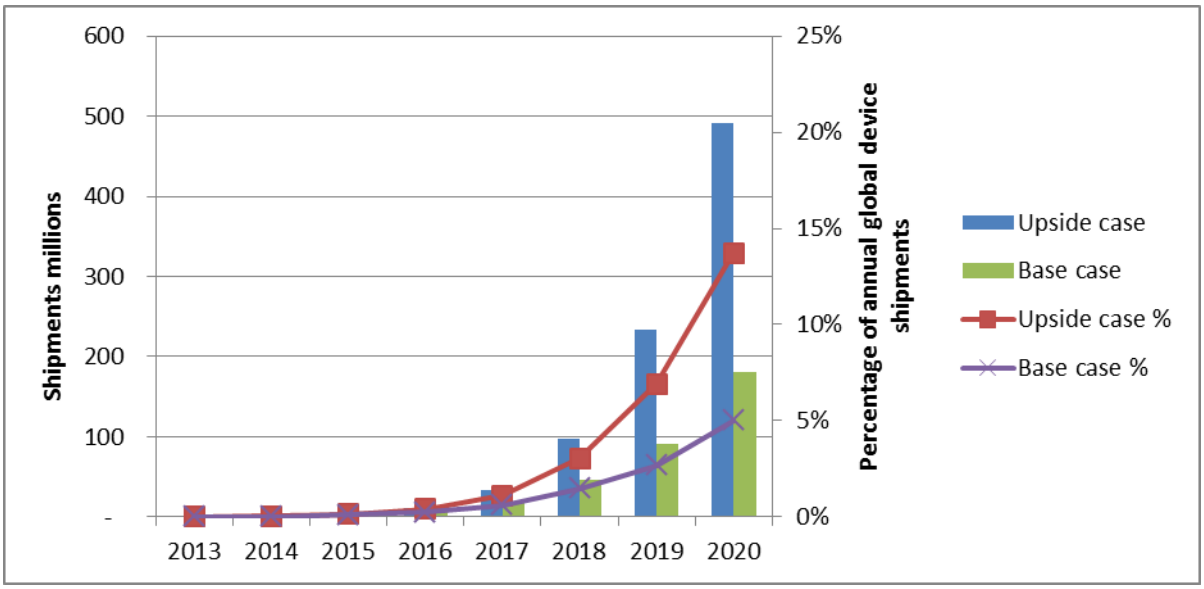
Whilst costs for LTE TDD 3.5GHz compatible devices have come down a long way in the last 12 months, WiMAX operators have been waiting for them to fall further so that they are much closer to WiMAX CPE prices. This process is expected to take 12 to 18 months, and until that time the speed of WiMAX migration will be held back by the cost differential.

WiMAX operators are not at this stage typically planning mobile strategies – the lack of handsets is a major hurdle. This will not change until 2014/2015 when the first handsets start to trickle onto the market. By 2016 WiMAX operators are assumed to take advantage of new device availability, to develop fully mobile services, using roaming agreements or MVNO arrangements to fill in their capacity gaps.

Device forecasts

Taking the various drivers into account Innovation Observatory forecasts that shipments of LTE TDD devices supporting bands 42 and 43 will grow substantially. The forecast number of shipments under the base case scenario and an upside scenario is shown in the chart below. By 2020 it is forecasted that the total number of devices shipped annually has the potential to grow from just over a hundred thousand to between 180 million and 490 million device shipments per year, depending upon whether one or more of the BRIC economies opens up use of LTE TDD at 3.5GHz for mobile services. These figures equate to around 5% and 14% of global mobile device shipments respectively.

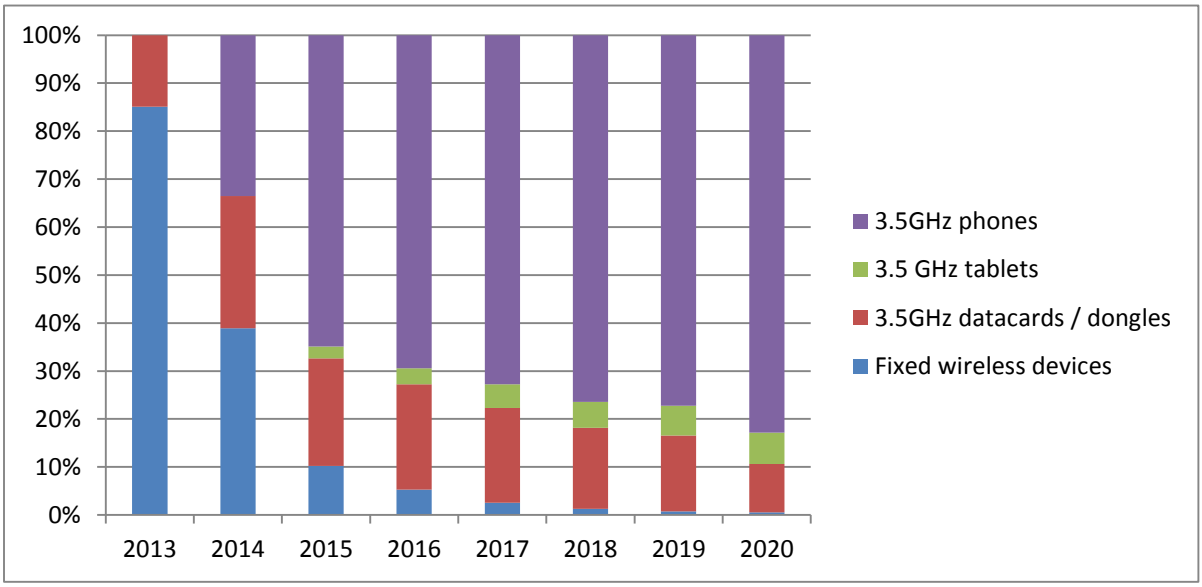
Figure 9: Total annual shipments of 3.5GHz-compatible devices



Source: Innovation Observatory

CPE for broadband fixed wireless deployments will account for the majority of shipments in 2014/2015, but these volumes will quickly be overtaken by shipments of devices (including MiFi devices and dongles, phones and to a lesser extent tablets and other computing devices) designed to support nomadic or fully mobile services. By 2020 only 1% of all 3.5GHz compatible devices shipped are expected to cater for broadband fixed wireless services over LTE TDD at 3.5GHz. The vast majority of devices will be mobile phones bought by mobile operators keen to support data services and roaming for their customers. These phones will support multiple mobile generations, modes and frequency bands.

Figure 10: Annual shipments of 3.5GHz-compatible devices, by type, as % of total, upside case scenario



Source: Innovation Observatory

Fixed wireless devices in contrast will be mostly single band. The range of dongles and MiFi equipment on offer will include single mode, single band devices, and multi-mode, multi-band devices.

User forecasts

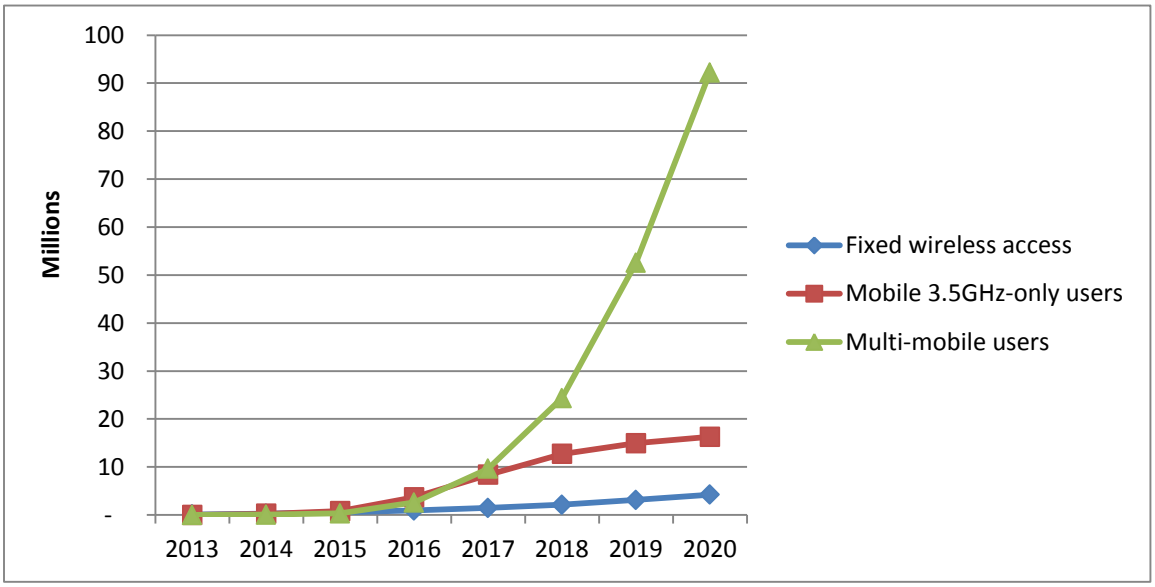
The number of users of TDD-LTE services in bands 42 and 43 will naturally lag device shipments, and only a proportion of all TDD-LTE capable devices shipped will actually be activated for LTE services, and then used on TDD LTE 3.5GHz networks.

Our growth assumptions for the number of active TDD-LTE 3.5 GHz network users between 2013 and 2020 include three categories of user:

- Users whose home networks[1] have been configured for broadband fixed wireless services ("fixed wireless access" in the chart below)
- Users whose home networks have been configured for mobile services, using TDD-LTE at bands 42 or 43 exclusively ("mobile 3.5GHz only users")
- Users whose mobile services are delivered using TDD-LTE at bands 42 or 43, in combination with other mobile modes and spectrum bands. This covers situations where this is enabled in the home network; and also where the home network does not use bands 42 or 43 but the service provider has enabled wholesale carriage on a third party network over bands 42 or 43 ("multi-mobile users").

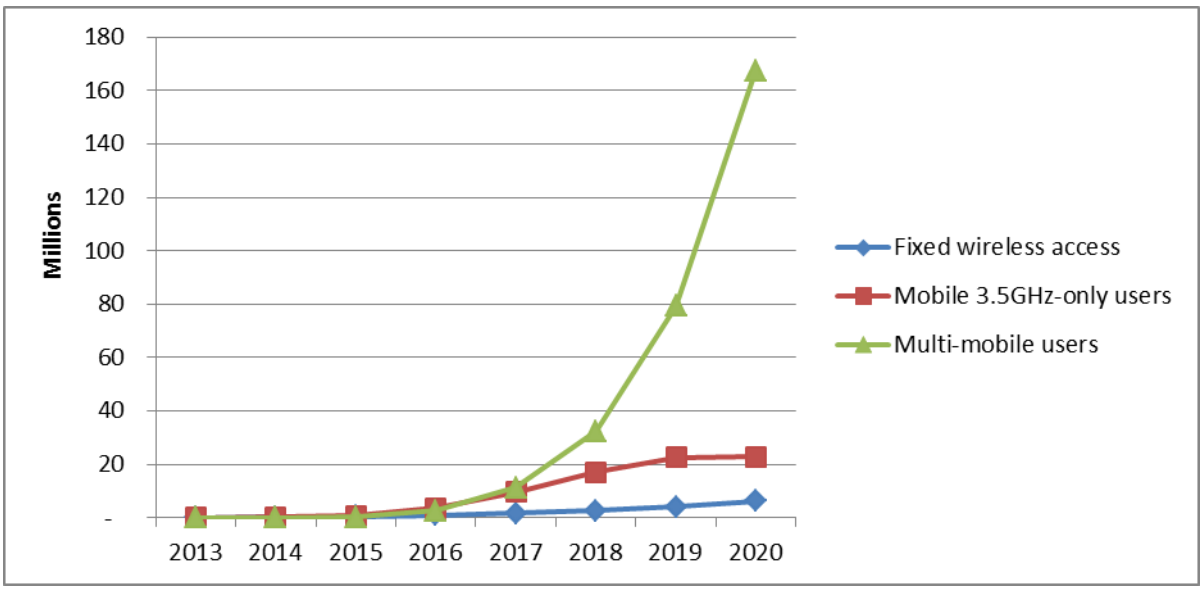
1 i.e. the network whose services they use, not the home area network

Figure 11: Forecast users of LTE TDD 3.5GHz services, base case scenario



Source: Innovation Observatory

Figure 12: Forecast users of LTE TDD 3.5GHz services, upside case scenario



Source: Innovation Observatory

The number of users whose networks have been configured for broadband fixed wireless services are expected to grow the fastest in the 2013 to 2014 time frame. Beyond that point users on mobile networks incorporating 3.5GHz cells, or with agreements to roam or offload onto 3.5GHz cells, are expected to become the bigger group. By 2020 it is forecasted that there will be between 4.25 million and 6.3 million active users on LTE TDD fixed wireless networks operating in bands 42 or 43, depending upon the scenario. In contrast by 2020 we expect there to be between 16.3 million and 22.8 million users on mobile networks whose services are configured exclusively to use LTE TDD at 3.5 GHz (for instance using dongles for high speed data in urban areas). This group will be smaller though than those we have defined as multi-mobile users. This, the biggest group of users, will be those whose services have been configured for mobile services using TDD-LTE at

bands 42 or 43, in combination with other LTE modes and bands, and 3G and even 2G networks. It is forecast that there will be between 92 million and 167 million such multi-mobile users by 2020 depending upon whether one or more BRIC markets fully enables use of LTE TDD at 3.5GHz for mobile services. These users will not be on LTE-TDD at 3.5GHz all of the time. In fact some may never use the LTE TDD 3.5GHz capacity that is theoretically available to them. However most operators will simply see they need to provide offload to / roaming across other infrastructures to make services attractive and viable in the long-term.

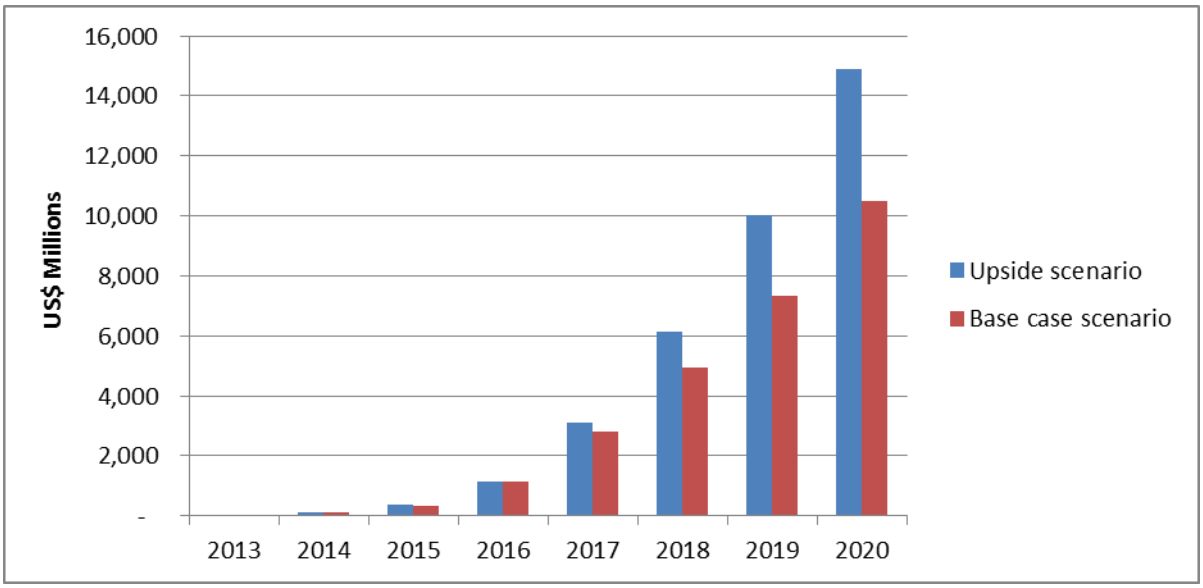
Revenue forecasts

The forecasts for revenue include several key categories of revenue:

- Broadband access and associated service revenues generated by serving customers on broadband fixed wireless networks
- Retail mobile broadband revenues generated by providing customers with fully mobile data services
- Wholesale revenues generated by providing third party operators with traffic offload to 3.5GHz cells.

Total annual global service provider revenues from LTE TDD 3.5GHz services are forecast to grow to US$10.5 billion in the base case scenario and to US$14.9 billion in the upside scenario.

Figure 13: Forecast global service provider revenues from LTE TDD 3.5GHz services



Source: Innovation Observatory

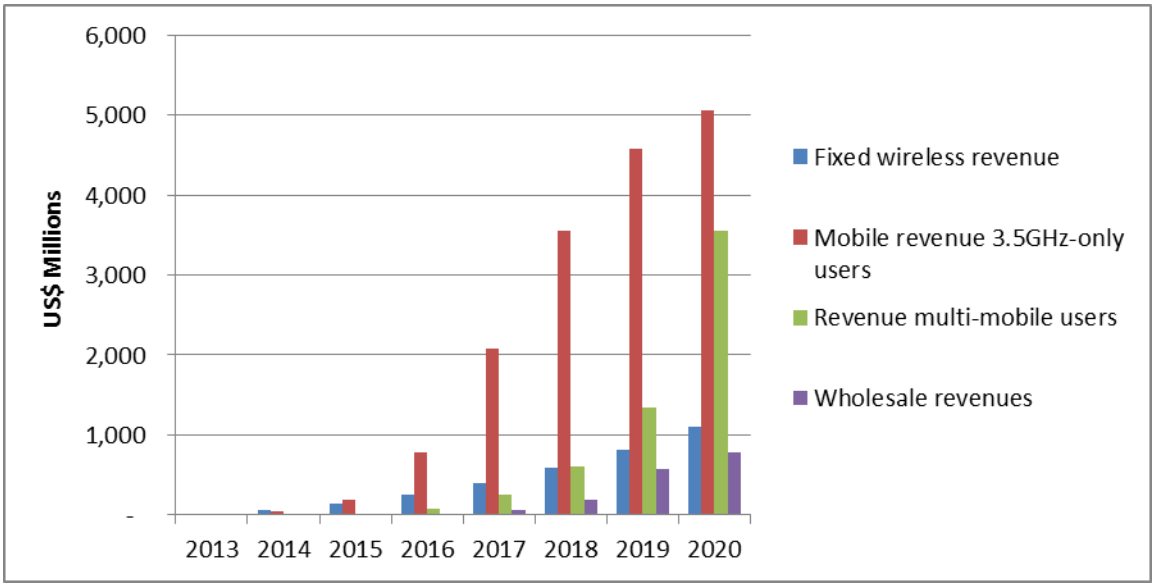
Broadband access and service revenues associated with delivery of broadband fixed wireless services will drive early market growth, and ultimately offer a potential market opportunity much larger than the current public 3.5 GHz WiMAX market. In the 2013 to 2020 period, though, the market will still be in its early growth phase. In the base case we forecast that annual revenues from these services will reach US$1.1 billion in 2020. In the upside scenario service provider revenues reach US$1.6 billion per year. In the earlier part of the forecast period ARPU is expected to be equivalent to current WiMAX ARPU, but later on-going competitive pressure in broadband markets worldwide will off-set inflationary price growth and is forecasted

to lead to ARPU reductions. We have forecasted a global average ARPU decline to around US$25 per customer.

The market for mobile broadband revenues generated by customers with access to fully mobile data services will initially be a smaller market, but will grow to US$9.4 billion by 2020 in the base case and US$13.4 billion in the upside case. This includes revenues from customers whose primary network is operating at 3.5GHz, as well as revenues from mobile operators whose networks include a combination of network generations, modes and frequency bands ("multi-mobile users"). It includes retail and wholesale revenues. Where TDD LTE at 3.5GHz is not the primary band for the mobile service, we have counted only a percentage of each user's ARPU, in proportion to the estimated volume of traffic traversing 3.5GHz infrastructure.

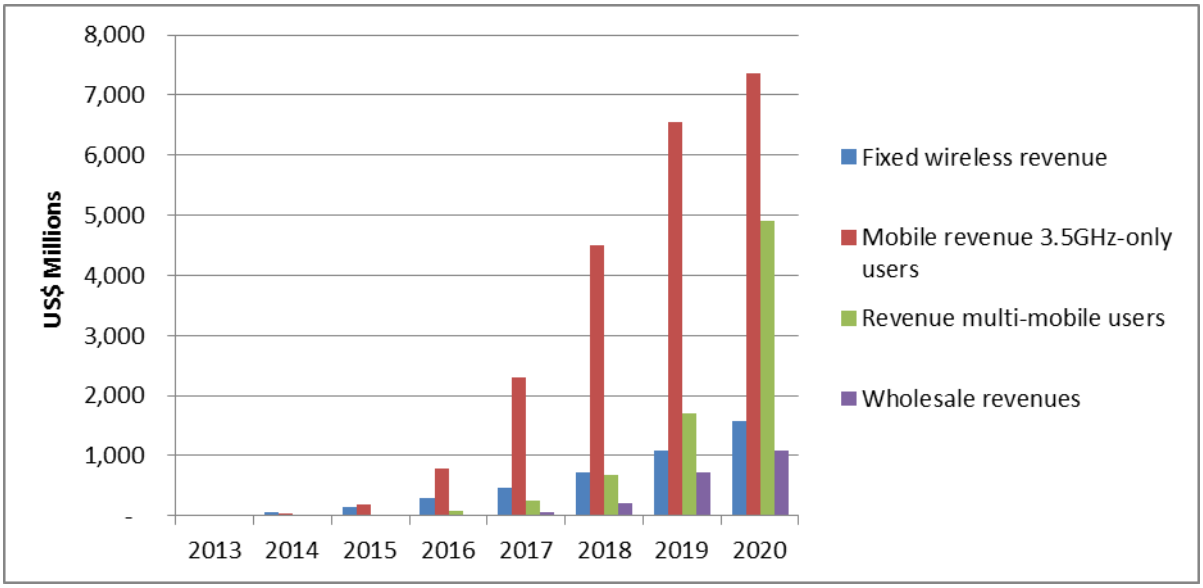
Wholesale revenues are expected to be derived from operators with 3.5GHz infrastructure providing hotspot offload to mobile operators needing additional network capacity (in national roaming-type arrangements). This revenue stream is not expected to be strong over the next couple of years. Mobile operators will not buy this type of service until they are exhausting their own network resources. Providers of wholesale services will vie with providers of wholesale WiFi offload services for this traffic, and so services will need to be competitive. Nonetheless it is forecast that this revenue stream will grow to US$782 million globally by 2020 in the base case, and to US$1.1 billion in the upside case, and that this market will have a long way further to grow beyond that point.

Figure 14: Forecast revenues from LTE TDD 3.5GHz services, by service type, base case



Source: Innovation Observatory

Figure 15: Forecast revenues from LTE TDD 3.5GHz services, by service type, upside case



Source: Innovation Observatory

Recommendations

Though there has been progress, the key players in the LTE TDD ecosystem have a real **opportunity to drive the 3.5GHz market faster**, and in doing so to improve services for customers, open up new equipment markets, and help telecoms operators to develop new business models.

Regulators must facilitate use of bands 42 and 43 for LTE TDD and for the delivery of both fixed and mobile services. Regulators must facilitate access on a technology-neutral basis, for the delivery of a full range of telecoms services. Any hurdles to voice or mobile service provision should be removed.

A critical aspect of the regulation and management of bands 42 and 43 is not only that the spectrum is made accessible for the launch of LTE TDD services, but also that the spectrum is made available – as far as possible – in sub-bands or blocks which are internationally available, and which are wide enough to support effective service delivery. Some operators are asking for 40MHz channels and also the ability to refarm spectrum so that multiple services can be provided, and it would be helpful it there was a secondary market to help enable defragmentation. Regulators should also treat bands 42 and 43 equally. By opening up both bands regulators will help to solve the spectrum fragmentation that has occurred globally in these bands so far, will support improved global roaming for data services, and will help to bring down equipment costs.

By signalling definite intentions to make bands 42 and 43 available for mobile broadband services, regulators will give vendors greater confidence to invest in chipsets and devices.

Device vendors must realise that there is a significant market to serve. In the short term the LTE TDD market at 3.5GHz is not going to be as large as the market for LTE TDD devices serving other frequency bands. Nonetheless, demand from mobile operators to use 3.5GHz as an expansion band for mobile data services will by 2020 create annual demand for over 180 million TDD LTE devices capable of supporting bands 42 and 43, and potentially as many as 490 million devices annually by that date.

In order that they can most effectively open up these opportunities operators report requirements for:

- Multi-generation, multi-band devices
- Mobile devices (including dongles and phones)
- Dual mode WiMAX/LTE TDD devices
- Clear timetables for device availability.

Equipment and chipset vendors must also move faster to support LTE TDD at 3.5GHz. There are a few pioneers developing chipsets and RAN equipment, but operators will benefit from a broader ecosystem. Network and service planning is now at the stage where base stations and devices are needed in significant volumes: there is a critical mass of operators behind LTE TDD in 3.5GHz bands. Operators with significant spending potential express desire for faster development of:

- Chipset choices
- Amplifiers which can match the performance characteristics of LTE in other spectrum bands
- Support for advanced antennas (e.g. 8T8R) at 3.5GHz, and multi-band antennas supporting 3.5GHz for devices and wireless access networks
- Timetabled commitment to support 3.5GHz from vendors currently stating that their technologies are '3.5GHz-ready'.

Mobile operators must signal their clear desire to use LTE TDD in bands 42 and 43, even where their plans are not immediate. This will give vendors more confidence that a substantial market for devices and network equipment is going to emerge, and encourage regulators to open up access to the spectrum where this is needed.

WiMAX operators and new entrant fixed broadband providers wanting to deploy LTE TDD at 3.5GHz should present collective orders for base stations and CPE supporting bands 42 and 43, if at all possible. Fragmentation in their demand serves to reduce the attractiveness of the market for equipment and device vendors, and sustains kit prices. Our analysis suggests that collectively they can present order sizes that will be attractive to a variety of vendors, and that will serve to tempt more suppliers into the marketplace.

Notes

[I] Announced by Wireless Intelligence in Mobile World Live: http://www.mobileworldlive.com/global-lte-connections-hit-100-million

[II] ITU-R M.2078 at http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2078-2006-PDF-E.pdf

[III] http://www.erodocdb.dk/docs/doc98/official/pdf/ECCDec1106.pdf

[IV] http://www.sequans.com/2012/02/sequans%E2%80%99-second-generation-lte-semiconductor-technology-adopted-by-gemtek-for-new-lte-device/

[V] http://www.accelleran.com/AccelleranM101.html

[VI] http://www.corrierecomunicazioni.it/tlc/21697_rota-digital-gap-dal-wimax-ottimi-riscontri.htm

[VII] http://www.maravedis-bwa.com/templateemail/newsletters/022013/td-lte-continues-to-gain-momentum-across-the-globe.html

[VIII] http://lteworld.org/press-release/b-lite-be-first-introduce-4g-european-capital & http://campaign.plantaflag.com/t/r-D76BBEF46D7258B22540EF23F30FEDED

[IX] http://www.fiercewireless.com/europe/story/wimax-go-nationwide-2010-lte-future/2009-12-02 & http://blogs.lexpress.fr/tic-et-net/2012/05/02/wimax-bollore-telecom-saisit-le-conseil-detat/

[X] http://www.alvarion.com/news-center/global-press-releases/1844-dedicado-a-leading-private-telecom-operator-in-uruguay-selects-alvarion-to-expand-4g-network-capacity

[XI] http://www.1prime.biz/news/0/%7BBF95A1ED-3B54-4920-AE5A-31724F319107%7D.uif?layout=print

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