Valuing 5G Spectrum: Valuing the 3.5 GHz and C-Band Frequency Range

The strategic, technical and valuation considerations associated with valuing 3.5 GHz spectrum

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Valuing 5G Spectrum: The 3.5 GHz Frequency Band

Introduction

Many will remember the initial euphoria, high spectrum auction prices and subsequent disappointment that greeted the introduction of 3G mobile broadband from around 2000. It was not until 2007 and the launch of Apple’s iPhone (“this changes everything”) that consumers began to appreciate the benefits of 3G. Sadly 3G did not deliver its initial promise in terms of data throughput right at the time when applications needing high download rates were starting to gain momentum. The subsequent auctioning and deployment of 4G spectrum saw an evolution, rather than a revolution, in mobile network performance and consumer behaviour. The all IP evolutionary nature of the transition meant that mobile operators were able to value 4G spectrum with a much higher level of confidence and were not swayed by the hype that accompanied the introduction of 3G. But now the mobile industry must contend with a new wave of expectation and hype as the era of 5G rapidly approaches. Mobile operators are already having to decide how much to pay for 5G spectrum despite uncertainty over standards, devices, use cases, business models and network performance. Spectrum in the 3.5 GHz and C-Band (4 GHz – 8 GHz) ranges are likely to be the first time that many operators have to value and bid for 5G spectrum. In this paper we explore some of the main challenges that operators will face in valuing these bands.

The 3.5 GHz and C-Band Frequency Range

The 3.5 GHz band (3GPP Bands 42 and 43) has been identified by the European Commission as a 5G “pioneer” band. There is considerable interest globally in this band as well as the so called C-Band, particularly in around the 5.9 GHz sun-band. The 3.5 GHz band has already been assigned in a number of markets including the UK, Japan, Spain, Hungary, Latvia, Slovakia and Ireland and future awards are planned in Switzerland and other markets despite a high degree of uncertainty over standards, spectrum availability, use case and business models. There are currently a small number of commercial Band 42 networks operational with the largest being in London and Tokyo. Globally, a large number of other markets will also be assigning these frequencies over the coming years.
These bands will play a critical role in the introduction of 5G for two main reasons. The first is that there is potentially a large amount of spectrum available - 400 MHz of Time Division Duplex (“TDD”) spectrum within Bands 42 and 43 - which will provide the wide, contiguous allocations necessary to deliver the high-levels of performance expected from 5G. The second is that compared to other pioneer bands such as 26 GHz (Europe) and 28 GHz (USA, Japan and South Korea), the lower frequency provides better propagation which means that it is likely to be deployed on existing operators’ networks rather than requiring the development of a new and expensive very small cell network. The spectrum therefore provides both coverage and capacity benefits and is envisaged to support the three classes of traffic typically associated with 5G, namely enhanced Mobile Broadband (eMBB), massive Machine Type Communication (mMTC) and ultra Reliable Low Latency Communication (uRLLC).

Exhibit 1: 5G revenue and traffic classes

### IMT 2020 (5G) Vision

<table>
<thead>
<tr>
<th>Low frequencies</th>
<th>eMBB</th>
<th>High frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide band B (Below 6GHz)</td>
<td>Enhanced Mobile Broadband</td>
<td>Extremely high data rates (e.g. 24.25 - 27.5, 37 - 43.5 GHz)</td>
</tr>
</tbody>
</table>

- **eMBB**: Enhanced Mobile Broadband
- **mMTC**: Massive Machine Type Communications
- **uRLLC**: Ultra Reliable and Low Latency Communication

**Source:** Recommendation ITU-R M.2083-0, 09.2015

### Supply and Demand

One of the key determinants of the value of 3.5 GHz will be relative levels of supply and demand. One of the challenges with the band is that in some markets it has already been assigned for use by Fixed Wireless Access providers particularly those operating WiMAX networks. Regulators will need to either wait for the expiry of the FWA licences as was the case in Ireland or reach an agreement with the incumbents to vacate the spectrum. Further complications may arise due to C-band Earth Satellite Stations which utilise part of the frequencies and in some markets the military are also making use of the spectrum. In the case of Ireland there was 350 MHz available which ensured that all operators were able to acquire sufficient quantities of contiguous spectrum to support new 4G / 5G radio. However, in other markets, the limited availability of sufficient spectrum may mean that demand outstrips supply and scarcity will create the potential for commercial and strategic sources of spectrum value leading to higher valuations and auction prices.

1 Commercial and strategic sources of spectrum value arise when a difference in relative spectrum holdings between operators provide a source of competitive advantage such as superior network performance, higher speeds, etc to which operators attach potentially significant value
Relative levels of supply and demand will also be influenced by the speed with which operators will be able to re-farm existing spectrum holdings. If one of the key factors influencing the speed of re-farming is the rate at which devices have these new spectrum bands on-board as standard and these devices diffuse through the market. The wealthier the economy, the higher the proportion of smartphones and the more frequently customers upgrade to a new device which will contain the chipset necessary to support 5G. Operators will therefore have to consider developments in the device ecosystem, the rate of device diffusion and the ability to re-farm in order to value 3.5 GHz spectrum – none of these are easy questions to answer.

**Standards and Strategic Choices**

3.6 GHz was initially, and in some markets still is, used by Fixed Wireless Access providers offering WiMAX based on the increasingly obsolete IEEE802.16 standard. The more influential 3GPP standards body has been successful in establishing Bands 42 and 43 for LTE-A which is the first all IP mobile standard to be produced by 3GPP and is fast becoming the de-facto global standard for FWA / NGA, Mobile, Fixed, V2x and PAN networks. LTE-A and its evolution to 5G will likely become a staple component of all future multi Gbps HETNET developments worldwide.

The merging of standards means that any wireless network can support any compatible device and, as with all other IP centric arrangements, services simply use the data channel as transport to the Internet. The net effect is that from an infrastructure and standards basis 5G networks will begin to look very similar to all other fixed and wireless networks. This raises an interesting question for the wireless industry when contemplating the value for 3.5 GHz spectrum – should it be treated as an enhancement of existing mobile broadband offerings or used to provide a combination of traditional mobile and fixed wireless access as an alternative to fibre Next Generation Networks. The service proposition to deliver high-speed broadband to fixed premises using external antennas is well suited to working extended ranges (below 5 Km) in this high frequency range at reasonable data rates (gross cell edge rate of 30Mbps DL). This option is particularly relevant in rural areas where the cost of deploying fibre is prohibitively high. As LTE-A technology develops further and carrier aggregation becomes common place to cell-edge, performance in the Gbps range becomes realistic which is currently being trialled commercially in Japan.
Device Availability and the Choice of Bands

3GPP and the ITU have released standardised bands for wireless networks and these are likely to be expanded / ratified in the forthcoming World Radio-Communication Conference in 2019 (WRC19). 3GPP has standardised Band 42 (3400 MHz to 3600 MHz) and Band 43 (3600 MHz to 3800 MHz) for use by any 3GPP TDD technology but currently these bands are only used for LTE-A networks. These are relatively new bands and while the infrastructure is generally available, devices are only now becoming available at scale and standard mobile handsets are only available in Band 42 (for example, Apple, Samsung Tab, Sony). It is expected that Band 43 handsets will become generally commercially available within 2 to 3 years. This raises interesting valuation challenges for operators. Device availability is a key driver of value and so operators may value Band 42 more highly if they intend to deploy for a mobile service. Band 43 may command lower auction prices but may push operators towards a FWA strategy initially only to then switch to a mobile strategy as handsets gain scale in this band. The strategy will complicate the valuation task.

National and Regional Assignments

The Irish regulator, ComReg, assigned the 3.5 GHz band (3.4 GHz to 3.8 GHz) on a regional basis whereas other regulators are basing their approach on a single national assignment. A regional approach creates greater uncertainty for incumbent operators as they may face niche new entrants in some areas. Regional valuations increase the complexity of the valuation exercise as separate customer, revenue and network models will have to be prepared for each region resulting in a more complex, challenging and time-consuming valuation exercise. Furthermore, if there is additional value in acquiring spectrum at the national level (in the language of game theorists and auction designers, regions are complementary) then this presents further valuation challenges. The value of one region will depend on whether the operator acquires another region. Not only does this make valuation more difficult it will usually result in the regulator preferring some form of package-based auction such as the Combinatorial Clock Auction which is known for its complexity, lack of transparency, governance issues and outcomes that may seem perverse. Some regulators are not imposing any minimum service area obligation but are instead issuing non-exclusive licences within a “non-interference” paradigm to prevent “spectrum banking” by operators but further complicates a sound spectrum valuation.
The 3.5 GHz band, with its attractive dual ability to provide both coverage and very high capacity, means that it will play a major role in supporting the three different categories of 5G use: eMBB, mMTC and uRLLC. This will require operators to develop at least three different subscriber, device, revenue and traffic forecasts when previously they typically only forecast a single class of traffic. Operators will have to define an appropriate “busy period” for different traffic types and also being carried on different spectrum bands/sub-bands. This has usually been a busy hour but in the world of 5G dimensioning may be based on a “busy 10 minutes” or some other time slice. They will also need to consider when these busy periods occur as they are likely to differ.

Developing appropriate revenue forecasts will be particularly challenging. Operators will have to ignore the hyperbole associated with 5G and such things as the “Internet of Things” and take a pragmatic and realistic view of the role they are likely to be able to play in the value chain and the revenues the various traffic types will yield. They will also have to explore whether differences in relative levels of 5G spectrum are able to deliver any potential sources of competitive advantage.

Use Cases, Revenue and Traffic Projections

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There is a huge amount of debate surrounding the potential use cases for 5G. Supporting different industry verticals such as health, logistics and transport are potential strategies for operators. They will need to consider whether they seek to specialise in and dominate a particular vertical in order to capture a greater proportion of value or simply to provide a pipe to serve all potential use cases. Success in the former strategy will require operators to “pick the winners” in terms of successful verticals for 5G and to place “big bets” to develop the skills, expertise, brand positioning and infrastructure necessary for success. Developments in network virtualisation mean that operators can now discuss network slicing – in effect providing a dedicated private network for clients. Slicing may be one way of implementing a specialist vertical strategy but then network slicing raises significant questions about net neutrality and whether such strategies will be acceptable under the relevant regulatory regime. The risk return profile for operators in a 5G world will be very different to preceding generations of technology.
Technical Valuation Challenges

Operators face considerable challenges in estimating the cost of rolling-out a 5G network. The key challenges from the technical perspective are:

- RAN infrastructure costs are highly variable based on the topology of the network. The traditional differences in macro and micro cells no longer apply when looking at BBU/RRU equipment with extended “front-haul” connectivity to multiple RRU's at different adjacent locations.

- Deployments of “common RAN” arrangements where the same infrastructure can be used by multiple operators each with separate spectrum allocations.

- The likely development of hybrid “HETNET” arrangements in high traffic density areas where any connection layer may be provided by separate “off load” operators.

These challenges are compounded when operators determine that 3.5 GHz will have to be deployed on a small cell basis. The key challenges in forecasting the costs of a small cell network are:

- All/most urban and suburban sites including in-building sites are likely to be shared by a number of operators as 5G roll-out completes and the extension of this sharing to “common-RAN” will further reduce individual costs. The split between shared sites and single operator sites to deliver competitive advantage will become critical to providing a sound RAN cost estimate. As cells become smaller and traffic concentration increases so the use of existing street furniture as a site for RRU equipment becomes possible. Recently various firms have signed agreements with city planners for wholesale leasing of street lights and other utility structures as a speculative venture for small cell roll-out.

Backhaul connectivity (downstream from the BBU) will quickly become a critical cost factor as well as a reliability factor for any small cell topology network. The point at which the backhaul path transitions to a fibre connection will also play a major role in capacity and latency. In 3G systems typically the transition to fibre was made after a maximum 4 cell “daisy chain”. In 5G systems this transition will need to be a maximum of a single microwave-hop to fibre chain to ensure latency conditions are met. Whilst 5G is a wireless technology, an operator will not be able to implement 5G without also investing significantly in fibre. Operators will have to invest in fibre transitions as close as one radio site back from the serving eNodeB and also deploy high-reliability bulk connection points from the core network (EPC) to the rest of the connected world in
order to support the traffic levels that will be generated by 5G customers. Many operators have already invested in fibre to support 4G and these will be treated as a sunk cost which will make the 5G business case more attractive. Those operators who have not yet committed to a major fibre roll-out will have to consider to what extent the 5G business case for 3.5 GHz spectrum should carry the costs of fibre given that the fibre investment will also support their existing 4G networks and improve the economics of future 5G bands.

Summary
Valuing 5G spectrum such as 3.5 GHz and the C-band is, in theory at least, straightforward. The value of 5G spectrum is simply the difference between the value of a business with the spectrum (the “with spectrum case”) and the value of the business without (the “no spectrum case”). The reality however is that operators will face significant challenges in valuing 5G spectrum and these challenges are likely to be encountered first in relation to the 3.5 GHz band. Mobile operators who see 5G as largely an evolution from 4G will find valuation challenging but those that regard 5G as the catalyst for a major change in strategy will find the valuation challenge even greater.

About Coleago Consulting Ltd
Coleago is a specialist telecoms strategy consulting firm and advises regulators and operators on issues relating to spectrum, regulation and network strategy. Coleago has worked with a number of operators on 5G spectrum valuation and has confronted many of the challenges discussed in this paper. For further information please contact our directors who are specialists in spectrum valuation.

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