Korea Telecom showed off 5G media services at the U-20 FIFA World Cup in Korea in May-June 2017

PRICING AND POLICY IN A 5G WORLD

In future, the revenue per MHz of spectrum used will decline dramatically as we move to 5G, writes **STEFAN ZEHLE**

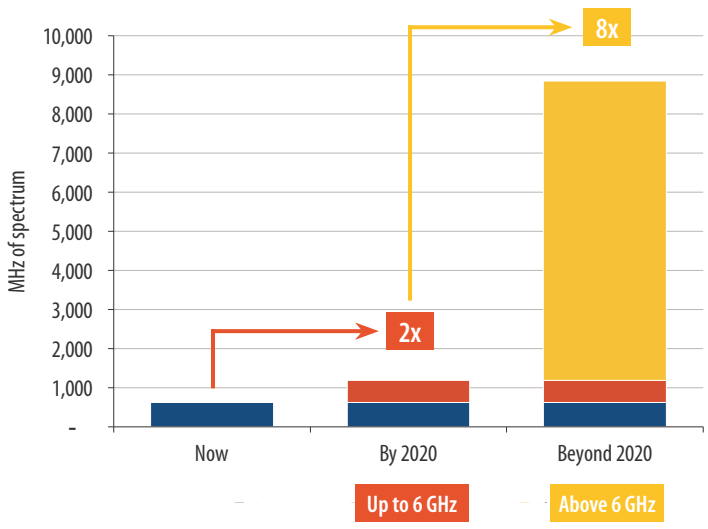
Spectrum has always been the essential ingredient in a mobile business. The evolution of mobile networks from voice and narrow band data to mobile broadband in the form of 4G sharpened the focus on spectrum. What matters in a mobile broadband market is to deliver the best mobile broadband experience, which is a combination of geographic coverage, probability of coverage (notably indoor coverage), speed and consistency of speed. In a mobile broadband world, the term coverage is to be understood as 'application coverage'. Put simply, what people want to do has to work wherever and whenever.

The evolution from 4G to 5G accentuates the focus on the user experience and application coverage. Enhanced mobile broadband (eMBB) is one of the key requirements for 5G, as are massive machine type communications (mMTC) and ultra-reliable and low latency communication (uRLLC). And three use cases drive overall demand for spectrum:

- More sub-1 GHz spectrum is needed for wide area coverage – the original GSM 850/900 MHz band, depending on ITU region, as well as the first digital dividend in the 700/800 MHz band. The second digital dividend has more spectrum at 600/700 MHz.
- Spectrum between 1 GHz and 5 GHz is required to provide capacity in high traffic density areas. Existing assignments include the familiar 1800/1900 MHz, 2100 MHz, and 2500/2600 MHz bands. Depending on the region, new bands include 1500 MHz, 2300 MHz and the C-band, i.e. 3400 to 3800 MHz which, if available for mobile, provides a massive 400 MHz of spectrum.
- Above 5 GHz, several GHz of spectrum have been identified for 5G. Nominated bands for ITU WRC-19 studies fall in the range 24.25 to 86 GHz. The spectrum is also referred to as millimetre waves. The amount of spectrum to be allocated to mobile is measured in multiples of GHz rather than multiples of tens of MHz. For example, in 24 GHz the aim is to allocate 24.25 to 27.5 GHz to mobile, a massive 3 GHz, i.e. 3,000 MHz.

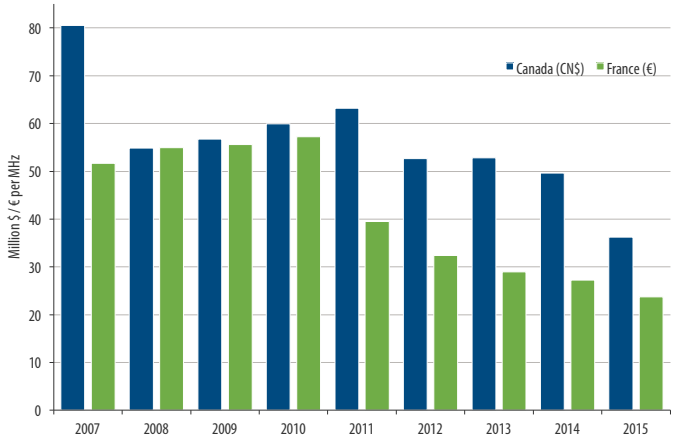
In summary, depending on the market up to the year 2020, the amount of spectrum assigned to mobile operators will increase by a factor of 1.7 to 2 times and beyond 2020 by a further 8 to 10 times (see figure overleaf). But current thinking about spectrum pricing and assignment needs to be revised to solve the economic equation to allow 5G to happen.

TYPICAL INCREASE IN MOBILE SPECTRUM, EUROPE



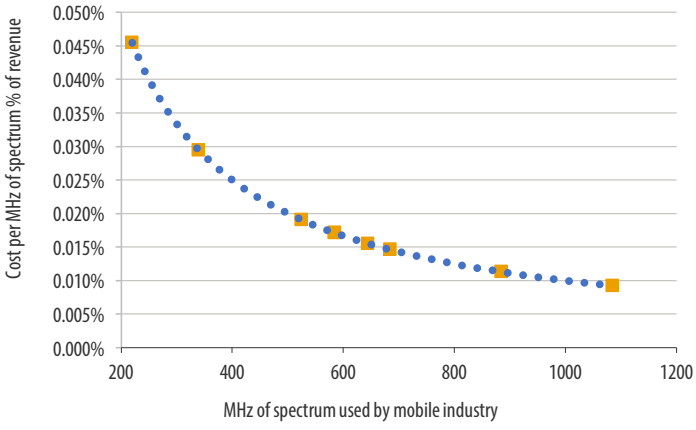
Source: Coleago Consulting

MOBILE INDUSTRY REVENUE PER MHZ OF SPECTRUM DEPLOYED (CANADA/FRANCE)



Source: Coleago Consulting

ANNUALISED COST PER MHZ OF SPECTRUM AT 10% OF REVENUE



Source: Coleago Consulting

THE FUTURE OF SPECTRUM PRICING

Infrastructure-based competition in mobile delivered huge societal benefits. Competing operators rolled out their network as fast and as far as economically feasible using their licensed spectrum because coverage was a key differentiator. The licensing of new third and fourth entrants using primarily 1800/1900 MHz spectrum added to the competitive mix, driving down prices and allowing mobile to grow into a mass market.

The emergence of 3G and assignment of spectrum in 2.1 GHz in ITU regions 1 and 3 and AWS spectrum in region 2, primarily through auctions, brought to everyone's attention that spectrum is a scarce resource and that mobile is about more than just voice and messaging.

The logic of assigning spectrum through auctions had nothing to do with raising revenue for the state. Auctions were used as a mechanism to assign the scarce resource that is spectrum to those that could generate the most value from it. This would ensure spectrum was used efficiently. As New Zealand's Ministry of Business, Innovation and Enterprise said in May 2013: "The key goal of any auction is to guide goods to those who value them the most. Spectrum auctions help identify the highest value use and users."

Since the assignment of 3G spectrum (2.1 GHz in Europe), auctions became the default mechanism for assigning spectrum, relying on what is a market-based approach to achieve the best outcome. However, in many jurisdictions governments forgot that the purpose of a spectrum auction was not to raise money but to serve as a mechanism for efficient spectrum assignment. Many countries in Europe, Asia, Africa and Latin America drove up auction reserve prices to extremely high levels, including for the renewal of expiring licences.

The socioeconomic rationale for this is questionable and we are witnessing an increase in auctions where reserve prices are so high that operators no longer have a business case. As a consequence, there are more auctions where spectrum remains unsold, as was the case in Argentina, Australia, Bangladesh, Brazil, Ghana, India, Korea, Mexico, Mozambique, Thailand and some other markets.

While six or seven years ago spectrum auctions were carried out against a background of mobile market revenue growth, since 2015 mobile operator revenues worldwide show little or no increase, while investment in 4G capacity is ramping up and 5G investment is about to start. Due to ever larger amounts of spectrum used by mobile operators, mobile services revenue per MHz of spectrum deployed is declining across all markets. For example, in Canada the mobile market revenue per MHz declined from CN$81 million in 2007 to CN$36 million in 2015 – a 55% decline – and in France over the same period revenue per MHz dropped from €52 million to €24 million – a 54% decline.

While cash flow is being squeezed, governments are now looking at assigning more spectrum to mobile operators for future 5G deployment. In Europe auctions for 3 GHz and 700 MHz spectrum

are underway and in the US the 600 MHz auction concluded in March 2017. In contrast, many emerging markets have yet to assign the first digital dividend as well as spectrum at 1.5, 2.1, 2.3 and 2.6 GHz. Many governments still see the sale of spectrum as an opportunity to raise revenue for the state. With high licence fees, the business case for investment in further spectrum assets looks shaky even before considering 5G.

The trend for a declining amount of revenue per MHz of spectrum deployed is set to accelerate. Depending on the market, up to 2020 the amount of spectrum assigned to mobile operators will increase by a factor of 1.5 to 2 times and beyond 2020 by a further ten times. This calculation includes millimetre wave spectrum at 24, 30 and 40 GHz. This means in future the revenue per MHz of spectrum used will decline dramatically – and government expectations of how much revenue can be raised from the sale of spectrum must be revised downwards in a similarly dramatic fashion. This must be the clear message to governments in countries which drove up spectrum prices and includes some European countries such as Greece and Italy as well as many emerging markets in Africa, Asia and Latin America.

Ultimately the cost of spectrum is borne by the users of mobile services. Looking at the cost of spectrum as a percentage of mobile operator revenue enables a regulator to set spectrum prices that result in a successful auction. The annual equivalent cost of an up-front spectrum fee can be calculated using an annuity formula. For example, in Germany the annualised cost of spectrum stands at around 6% of industry revenue and in the US the figure is similar.

In 2015, Credit Suisse noted that European mobile industry returns on total investment had fallen to cost of capital. And in some other markets it is below the cost of capital and we have seen write-downs, such as in India. This implies that the annualised cost of spectrum cannot increase any further and hence the cost per MHz of spectrum has to decline as more spectrum is assigned to mobile. The graph (opposite) shows an example of the evolution of annualised cost per MHz of spectrum if an overall cost of spectrum at 10% of revenue is targeted.

INTERNET OF THINGS: NOT A MAJOR FACTOR

There are expectations of additional revenue from providing connectivity from machine to machine (M2M), or the internet of things (IoT). The reality of making revenue from connecting things is rather sobering. Statistics published by the French telecoms regulatory authority, ARCEP, show that while M2M SIMs increased to account for 14% of all SIMs by 2016, M2M revenue accounted for less than 1% of total revenue.

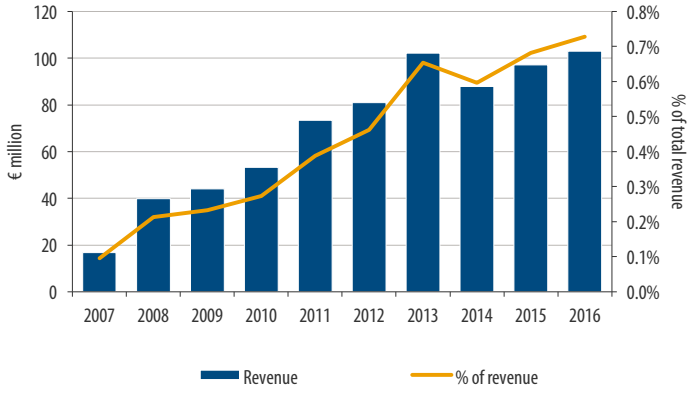
The evidence from France is corroborated by our work with operators: M2M revenue is unlikely to generate significant increases in revenue. Yet, we keep hearing rather large figures of future IoT revenue, i.e. in the mMTC and uRLLC use cases for 5G. Perhaps analysis from Informa explains this paradox: its research shows that in 2015, communications services (hardware, connectivity management) accounted for 80% of IoT revenue; by 2020 this will drop to 40%. This 40% includes not only communications services but also hardware and connectivity management; only a small portion is accounted for by revenue from mobile data traffic.

In other words, an IoT mobile data traffic revenue bonanza is unlikely. In any event right now the focus is on narrowband IoT (NB-IoT), which – as the name implies – does not require a lot of spectrum.

THE VALUE OF MILLIMETRE WAVE SPECTRUM

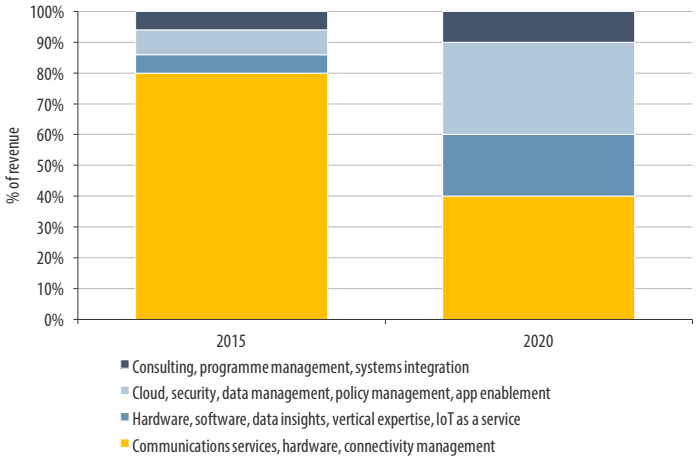
While the amount per MHz operators will pay for spectrum above 5 GHz will be relatively small compared to prices paid for spectrum up to 2.6 GHz, millimetre wave spectrum at 24, 30, 40, 60 and 80 GHz does have value to mobile operators. Nowhere is this more in evidence than in the US where the race to secure millimetre wave spectrum through acquisitions is well under way. In May 2017, Verizon made the boldest move, outbidding AT&T by paying US$3.1 billion for Straight Path, which holds 620 MHz in 28 GHz and 39 GHz. This translates into an estimated 0.017

M2M REVENUES IN FRANCE



Source: ARCEP

IOT REVENUE OPPORTUNITY



Source: Informa

US$/MHz/pop(population). While this seems rather low compared with the 0.81 US$/MHz/pop operators paid for the 600 MHz spectrum in the incentive auction that concluded in March 2017, it is still a large amount.

As part of Verizon's acquisition of XO in February 2017, Verizon also leases available XO wireless spectrum at 28 GHz, with an option to buy that spectrum by year-end 2018. In February 2017 AT&T acquired FiberTower for its 24 and 39 GHz spectrum. Also in February 2017, Dish agreed an asset swap with EchoStar to acquire 28 GHz spectrum. Globalstar is seen as an acquisition target for its spectrum and its shares went up by 60% between March and May 2017.

But given that the early pre-standard 5G activity in the US focuses on fixed wireless access rather than mobile, the business case for acquiring the millimetre wave spectrum will not have been driven by mobile alone and it would be unwise to use the prices paid in the US as a guide to what value operators might attach to millimetre wave spectrum in other countries.

THE SMALL CELL CHALLENGE

So far, I have considered only the cost of spectrum. Of course, catering for increasing 4G mobile broadband traffic and subsequently 5G requires the deployment of cells using spectrum above 3 GHz. High-band spectrum, and particularly spectrum above 5 GHz, is only really useful in a small cell deployment – 5G is associated with the deployment of many thousands of small cells. While operators are looking towards a reduction in the cost (both capex and opex) of small cells (hardware, power, maintenance, backhaul, rent) by a factor of ten, even if this is achieved, the extreme densification in urban areas including indoor installations in shopping malls, public transport hubs, stadiums, large office buildings and similar spaces means the number of sites will grow by ten times and more.

While millimetre wave spectrum for 5G will also be used for fronthaul and backhaul and so help to reduce connectivity costs, operators are confronted with challenging economics. It is clear that it is not economically feasible to deploy small cells within a macro site cost structure. Throwing high spectrum prices into the mix would turn 5G into a non-starter.

To make the economics of small cell deployments work, operators are opting for new models. For example, Vodafone in the Netherland has identified 'performance zones' where it delivers speeds of 5-10 Mbps for every customer. This requires partnership models with landlords. The use of unlicensed 5G spectrum in 5 GHz, aggregated with licensed spectrum, is being explored.

Small cell deployment is both outdoors and indoors. Outdoors, lamp posts, bus shelters, bill boards, CCTV columns, sign posts and other street furniture provide the physical support. The issue is that it is not physically possible for competing operators to install their own equipment and the owners of such sites may not wish to deal with multiple operators. As a result, we are already seeing the emergence of neutral host small cells, also referred to as small cell as a service, provided by companies such as Arqiva in the UK.

The high data rates and traffic density requirement for 5G means it is unlikely that this can be provided inside buildings from the outside. In many countries, mobile operators have installed distributed antenna systems (DAS) in buildings. Not only is this expensive, but building owners do not like the disruption of installation. The use of millimetre wave spectrum to fronthaul small cells may ease small cell in-building deployment.

> **Aside from pricing, 5G requires a more nuanced approach to spectrum assignment.**

LICENSED SHARED ACCESS AND UNLICENSED SPECTRUM

Aside from the issue of spectrum pricing, the evolution to 5G requires a more nuanced approach to assigning spectrum. While the assignment of exclusive spectrum rights has been highly beneficial to stimulating investment, in future sharing is likely to play a bigger role.

The European Commission (EC) is exploring 5G and moving away from traditional forms of exclusive licensing. At a public workshop held in March 2017 to assist with a study on spectrum assignment, the EC focused on the question of whether moving from 4G to 5G would change the status quo and whether a more harmonised approach among member states was required. The following points emerged:

- New partnerships will drive the change – aggregator or 'mega' virtual operators
- What approaches are needed to speed up access to spectrum for all users?

- There are more ways spectrum could become available; governments do not have to hold auctions
- There is the potential to adapt the 'sharing economy' idea to spectrum
- Current regulatory and technical tools can improve access to spectrum.

A survey conducted by VVA Consulting found that mobile operators are still wedded to traditional exclusive ownership licensing, arguing that licence conditions for 5G need to be structured in a manner conducive to optimising the potential for private investment. But users are more concerned with ensuring deployment by means of 'use it or lose it' provisions in licences.

Clearly, the fact that the EC is conducting this study highlights the concern for innovation, competition, investment and user benefits. One of the outputs from the workshop was that licensing the so-called 5G bands, especially above 5 GHz, represents a challenge for regulators and operators. There is a high risk of failure.

From a regulatory standpoint, failure could come in various forms: unsold spectrum because reserve prices are too high or there are inappropriate deployment rules; spectrum is assigned but not brought into use; or there may be negative competitive outcomes. From an operator standpoint getting the valuation of 5G suitable spectrum right presents a challenge.

To mitigate these risks flexibility is required. Flexibility can be created by allowing operators to share and trade spectrum, and by exploring licensed shared access (LSA). In the EU, most countries do not have regulatory barriers against spectrum sharing but uptake is limited. Trading is allowed in most countries, but there is also very limited uptake, for example due to competition issues. LSA is not widely used and is viewed with scepticism.

Depending on the country, rules attached to spectrum rights may make it very difficult for operators to trade and/or share spectrum. For example, India imposes additional fees on shared spectrum. For these jurisdictions, raising revenue from the sale of spectrum is still the main issue and this is achieved by setting high reserve prices and holding auctions to assign exclusive rights to operators for 15 years or more. This approach is not conducive to facilitating investment in 5G. In contrast, the early 5G style deployments in the US may be due to the market-driven approach which allows US operators to play a pivotal role in shaping the 5G technology ecosystem.

DEPLOYING 5G INFRASTRUCTURE

The massive deployment of small cells moves the spotlight to another scarce resource: suitable sites – in dense urban environments spectrum is not the only scarcity. Access to sites has become a bottleneck for operators; regulators and cities must establish the ground rules that ensure competitive service and minimise the cost to operators.

A cash-strapped city may auction access to lamp posts and other street furniture. If, as seems likely, there is only room for one operator to install its radios this would have negative implications for competition. This points to access network sharing among operators.

With its high density of access points, 5G resembles a fixed network. Fixed network operators tend to benefit from 'wayleave' rights or have such agreements with landlords. The importance of the wayleave issue is recognised by cities. For example, the City of London has a 'digital infrastructure toolkit' that includes standardised wayleaves. As stated: "The standardised wayleave toolkit will improve connectivity for business and speed up the installation of broadband. All parties will benefit from lower costs and more efficient ways of working." But it also states: "This document relates to individual tenant fixed line and wireless (not mobile) telecoms service connections and does not extend to cover public network infrastructure apparatus."

> **"The deployment of small cells highlights another scarce resource: suitable sites."**

The UK's electronic communications code confers certain rights on 'code operators' to install and maintain electronic communications apparatus on public land. The UK regulator, Ofcom, is consulting on a new code[1] that will also address wholesale infrastructure providers (WIPs) that may not necessarily be operators, such as Arqiva and the Wireless Infrastructure Group. The provisions of the new code will impact the deployment of spectrum, particularly above 5 GHz and also in the 3 GHz band. In other words the new code will impact the business case for 5G and value of spectrum.

As markets prepare for the assignment of spectrum above 2.6 GHz, it is worth looking in parallel at the issues relevant to the deployment of 5G infrastructure: spectrum licence conditions, the rules for infrastructure and spectrum sharing, the role of WIPs, and ensuring reasonable conditions under which access to sites is granted.

APPROACHES TO SPECTRUM AUTHORISATION, ASSIGNMENT AND USAGE CONDITIONS

Sources: LSTelecom, VVA, Policy Tracker

REFERENCE

1 Ofcom (2017). Electronic communications code. Digital Economy Bill: proposed code of practice, standard terms of agreement and standard notices and communications. bit.ly/2nw5aXq

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