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Space Based Connectivity in a Post Pandemic World

Over the last few weeks Space X has delivered two astronauts to the International Space Station and added 64 satellites to their Starlink Mega LEO constellation with their in orbit satellite count now at 538. Given that he also has a car company to run, Mr Musk must be a busy man. In the same month, OneWeb and Intelsat went into administration highlighting the challenges of managing investor confidence as the pandemic progressed.

As always, the challenge is to persuade investors to take a longer view which also means looking at what the world will need to recover economically from an extended and potentially recurring lockdown process.

The alternative is government intervention which for OneWeb has meant giving the UK government a 20% stake in return for £500 million of funding. Industry commentators have criticised the deal, saying the constellation is not an adequate alternative to Galileo. This misses the point. Any of the new mega LEO constellations come with inherent in built location and positioning based on their doppler signature (stronger than existing GNSS) and RF flux level (stronger than GNSS). Positioning from mega LEOs is therefore harder to jam but it is also easier to add two way messaging, already offered from the Chinese BeiDou constellation and integrated broadband (not available from BeiDou). Think of it as connectivity plus positioning and it becomes a compelling proposition, already proven by other operators (Iridium for example).

More broadly for the UK government, a stake in OneWeb strengthens their negotiation position in US trade talks (OneWeb has a factory in Florida), protects a national satellite and rocket industry built up over 60 years (anyone remember Blue Streak?) and potentially becomes a part of an integrated overseas aid and trade programme. By comparison, the proposed investment of £5 billion in a British alternative to Galileo would have been a monumentally bad idea.

In this month's technology topic we explore the role that universal low cost connectivity and positioning services from the mega LEOS (Starlink, Project Kuiper, and OneWeb) and other constellations could play in the process of global post pandemic recovery but also highlight regulatory changes that will need to be made.

The existing regulatory environment is designed to work in a pre-pandemic world in which sovereign nation interests determine regulatory policy. Regulation is traditionally viewed as a mechanism for controlling competition. The flip side is that it can also be structured to mitigate investment risk.

Sovereign nation regulation has also increased the cost base for terrestrial cellular operators making it commercially difficult to connect the unconnected. It is possible that universal connectivity could be delivered from space at a lower cost per bit than terrestrial networks but caveats apply.

The economics of space based connectivity are dependent on rocket launch costs. These are halving every 18 months when measured per kilogramme of payload. Satellites are also proving to have longer life spans than anticipated with station keeping managed by solar powered ion thrusters instead of expendable hydrazine. Satellite constellation costs are decreasing over time.

Terrestrial cellular network costs are increasing over time with capex and opex costs compounded by regulatory and competition policy.

The earth bound regulatory story starts in the 1980's with the breakup of AT&T and the decision by the FCC to establish regional licenses based on rural statistical areas (RSA's) and Metropolitan Statistical Areas (MSA's). The 800 MHz cellular band was divided into 734 market regions also known as Cellular Market Areas with the spectrum allocated as A and B blocks with A block awarded to non-wireline carriers and B block awarded to the local wireline carriers. This approach was replicated in Argentina, Brazil, Canada, Columbia, India, Indonesia, Japan, Mexico, Peru, Russia and Iraq though with differences in implementation.

In 1993 the FCC had to decide how to regulate the newly available spectrum at 1.9 GHz described as the PCS (Personal Communication Service) band. The PCS licenses were divided into 487 major trading areas sub divided into Basic Training Areas with the spectrum divided into six blocks, A to F. The intention was that this would support up to 8 operators per market, two on the 800 MHz band and six in the new PCS band.

This policy of band fragmentation was closely linked with a realisation that a bidding pool of at least five operators per license would maximise auction income.

And so it came to pass. Bear in mind that we are talking about the heady days in the late 1990's when stock values were soaring and spectrum was seen as an investment that could only possibly increase in value with the cost of bidding for multiple licenses with multiple conditions hidden in the noise floor.

In parallel, companies with national footprints such as Vodafone realized that building a business across multiple countries could add customer value, better integrated roaming for example, and that share value could be increased on the basis that economies of scale could be achieved.

This all seems like momentous stuff but the satellite industry was also going through a major structural change with Inmarsat leading the charge towards privatisation with a public listing in 1999.

Regulatory and competition policy in the terrestrial telecom and mobile industry and satellite industry are often regarded as being different but there are similarities. Terrestrial operators borrow money on the basis of investment sentiment based on the perceived value of the spectrum that they own and their relative capability to extract value from their spectral assets. This is similar to investing in a mining stock or oil stock with exploration and extraction rights.

Contemporary valuations also need to accommodate other obligations that might be added to the auction or license conditions, for example a requirement to provide rural connectivity and or emergency service coverage.

Satellite operators have similar constraints. Rather than bidding for spectrum, they have generally been gifted spectrum and orbit rights in return for coverage or service obligations. These obligations may include military payloads.

For the past thirty years (and before) the satellite industry has been constrained by a supply chain focused on delivering cost plus contacts to military clients rather than delivering consumer cost friendly networks.

This proved problematic for companies such as Inmarsat or Intelsat tasked with delivering shareholder value within a relatively short shareholder investment time scale. High debt ratios could be serviced by high pricing but the high gearing encouraged by high margins was always going to make these companies intrinsically vulnerable to take over or forced administration as soon as margins became squeezed.

The FCC initiative to get 5G operators to pay $9.6 billion dollars for C band spectrum will however be helpful. Whether this represents good value for the 5G community depends on the time scale over which the investment is viewed. Twenty years ago, European terrestrial cellular operators were busy spending over $100 billion dollars on 3G spectrum, setting global expectations for future spectrum auctions.

The spectrum cost was compounded by the roll out cost of a network technology that was to prove to be power inefficient and expensive. To make things worse, realised value shifted away from the operator community to other parts of the value chain with Apple as a beneficiary. Twenty years on, Apple has a market valuation of a trillion dollars; Vodafone has a market valuation of less than $40 billion.

It could be argued that this shift in shareholder value is the unintended outcome of well-intended regulatory and competition policy. The idea of multiple operators per market is sound in terms of competition policy but results in significant network duplication and high market support costs.

Additionally, differences in regulatory and competition policy between markets and regions make it difficult for companies like Vodafone and Telefonica to realise global scale economy. Different planning regimes on a country by country and often city by city basis can be irksome. It is also difficult to make money from terrestrial networks in low income countries; Vodafone's painful experience in India is an example.

Sovereign nations have the right to set the rules of engagement for their local terrestrial wireless and wireline providers and regulatory and competition policies are influenced by local social and economic considerations.

This includes a political need to improve rural connectivity. It makes minimal economic sense for terrestrial operators to provide rural coverage particularly for low ARPU markets. Infrastructure costs per subscriber are high relative to the income available.

By contrast, the cost of providing connectivity from space from a LEO mega constellation is the same for everyone irrespective of where they are on the planet.

Similarly most countries need to demonstrate that they are making progress towards specific environmental goals. While it might be counter intuitive to regard a LEO mega constellation as environmentally friendly, it is effectively a solar powered substitute for terrestrial wireless and fibre with the capability to deliver added value for agrarian green IOT and other green friendly initiatives with integrated location and positioning adding particular value.

Crucially, mega constellation operators avoid most of the costs incurred by sovereign nation fragmentation. There are local planning constraints for earth stations but the number of stations can be minimised by inter satellite and inter constellation switching. Sovereign nations can refuse to allow satellite operators to provide services to their country provide but they cannot stop a satellite from flying over their air space.

The satellite industry seems to be winning the regulatory argument for protecting their existing Ku and Ka band spectral assets and it looks as though there is an expectation that any transfer of assets to terrestrial operators would be coupled to generous compensation.

C band is an early test of this policy but also highlights that sovereign nation fragmentation cost is likely to increase rather than decrease over time for the terrestrial operator community. C band spectrum is being auctioned in myriad different configurations including different flavours of FDD and TDD, different pass bands and EMC limits. This technical complexity will introduce additional terrestrial cost.

The satellite industry can literally rise above these issues particularly if the operators can harmonise space sector spectrum and standards for super sovereign connectivity and positioning services. Nearly $10 billion dollars of cash from the C band sell off will provide useful resources for Ku and Ka band investment and has already resulted in a rush of orders for new satellite hardware.

It could be argued that entrusting global communications to a handful of mega constellation operators represents an unacceptable concentration of power and influence and as such should be subject to rigorous regulatory control.

The answer is to extend the principle of sovereign nation state universal service obligation to a global regulatory requirement where the right to deliver high value services to the developed world is balanced by a binding obligation to connect the unconnected or under connected.

This is hard to achieve with terrestrial networks but easier to achieve from space. It was the basis on which Greg Wyler argued the regulatory case for making spectrum available to O3B (The Other Three Billion) and OneWeb. If at first you don't succeed…..

Post script – A note on Mega Constellations

A Mega constellation is a constellation with hundreds and potentially thousands of satellites in either a low or medium earth orbit.

A constellation count of 20,000 means that there will always be a satellite nearly overhead. This maximizes RF flux density, minimises delay and minimises blocking from buildings and vegetation.

In FCC submissions, Starlink has increased the number of proposed satellites from an initial count of 12,000 to 42,000 at 273 miles, Project Kuiper is planning for 3236 satellites at three orbit heights (367, 379 and 391 miles), OneWeb initially filed for an orbit height of 750 miles with 720 satellites increased to 1980, now increased to 48,000.

While these numbers seem stratospherically high by legacy space standards, they are modest when compared to terrestrial base station numbers. Huawei for example plans to ship 500,000 5G base stations this year.

Simply stated, 20.000 satellites will provide global coverage with any increase in count justified on the basis of capacity though it would also be possible to scale satellites in terms of their size. A single Space X rocket carries 60 desk sized Starlink satellites into space each weighing 500 pounds (227 kilograms) but that rocket could carry one office sized satellite weighing 30,000 pounds (13,000 kilogrammes).

As any radio engineer will tell you, radio network economics are ultimately determined by link budgets including power budgets, receive sensitivity and interference resilience (selectivity). The numbers of base stations and /or satellites are therefore part of a complex technical and commercial calculation.

More information on this can be found in our most recent book

5G and Satellite Spectrum, Standards and Scale

Available from Artech House, you can order a copy on line using the code VAR25 to give you a 25% discount.

http://uk.artechhouse.com/5G-and-Satellite-Spectrum-Standards-and-Scale-P1935.aspx

The unintended consequences of regulation and competition policy and the rise and fall of Vodafone are discussed in detail in a newly published book A History of Telecommunications by John Tysoe and Alan Knott-Craig. If you are interested in ordering a copy, email

john@themobileworld.com

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