RTT TECHNOLOGY TOPIC
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CIRCULAR ARGUMENTS

In this month's Technology Topic we explore the inherent tension between the NEW LEO satellite operators and existing LEO, MEO and GSO constellations, the related technical, commercial and regulatory issues and the implications for the 5G operator community.

From a regulatory perspective, satellites are divided into geostationary (GSO) and non-geostationary (NGSO). The ITU specifies that GSO satellites have priority over MEO and LEO (NGSO) satellites with regard to frequency usage. LEO satellites in (more or less circular) polar orbits between 160 and 2000 kilometres pass regularly between users and gateways on the ground and MEO and GSO satellites and therefore have to prove that they meet agreed coexistence criteria.

Over the past twenty years Iridium and Globalstar have shown that it is eminently possible for LEO and MEO and GSO constellations to coexist but this is on the basis of narrow band (10+10 MHz) user links in L band.

Iridium mitigate gateway interference in Ka band by using inter satellite switching (between 23.187 GHz and 23.387 GHz). LEOSAT are proposing a similar approach using the same Thales based platform as Iridium. Some of the proposed new LEOS such as the Space X constellation propose to inter satellite switch using optical transceivers.

The substantive difference between Iridium and NEW LEO operators such as Space X, One Web and LeoSat is the use of Ku-band for ground to space and space to user links.

OneWeb acquired the spectrum and access rights owned originally by Skybridge Incorporated, a US entity established in the 1990's to roll out a high satellite count LEO constellation. The Ku pass band for the downlink is between 10.7 and 12.7 GHz and the uplink is 12.75-14.5 GHz. The gateway downlink pass band is 17.8-20.2 GHz with the downlink at 27.5-30 GHz.

In the original FCC filing, Skybridge proposed to meet the US Ku-band EIRP and flux density limits and protection ratios to the shared services supported in and adjacent to the pass band by using progressive pitch angular power separation.

This means that as the satellites move towards the equator they deliver their power at a progressively more inclined angle to avoid sending power into GSO satellite receivers pointing directly upwards. As they move away from the equator the power is delivered more directly downwards on the basis that GSO satellite dishes will be pointing at a progressively lower elevation.

This is achieved by slowly rolling the satellite to alter the pitch as the satellite approaches the equator and handing off transmission to another satellite when directly overhead. Given that the orbit time is 110 minutes this happens every 55 minutes. Reaction wheels also known as momentum wheels are used to manage the roll rate and spin direction. These are powered from the solar panels on the satellite.

The FCC was subjected to significant lobbying from other incumbent users in the Ku user and Ka gateway pass bands with the methodology used to calculate interference levels from these satellites cited as a major concern.

Twenty years on these arguments continue. OneWeb, Space X and LEOSAT stress that their progressive pitch approach coupled to adaptive power control and in some case fractional beam width adaptive antennas is significantly more effective than the original Skybridge (and Teledesic) proposals but the modelling is significantly complex, particularly when multiple constellations sharing the same pass bands have to be taken into account. There are also a wide range of potential victim receivers ranging from high definition and UHD satellite TV, very small aperture terminals and a wide mix of civilian and military two way radio systems.

Conversely if relatively extreme inclination angles are imposed on the NEWLEOS, there will be a directly adverse impact on the link budget, additional latency and a capacity cost all of which will subtract value from the NEWLEO business model.

This brings us to the regulatory and competition policy arguments.

LEOSAT has a distinctive business model based on the proposition that radio waves move faster in free space than light in fibre. Combined with inter satellite switching, this means that over distances of more than 5500 kilometres, LEOSAT can demonstrate a latency gain which can potentially realise high value from applications such as high frequency trading and other time critical financial services. Complete control of the end to end channel also minimises jitter and maximises security.

By contrast, OneWeb and Space X in their FCC filings stress their potential role in connecting the unconnected or under connected. Depending on how you count them this amounts to about 35 million people in the US and 3 to 4 billion people globally.

Greg Wyler, the founder of 03b, (the **O**ther **3 B**illion) successfully used this argument to gain regulatory approval for the O3b MEO constellation in 2008 having acquired Ka band spectrum from Teledesic when it stopped constellation development in 2002. This provided O3b with access rights to the downlink pass band between 17.7 and 20.2 GHz and an uplink between 27.5 and 30 GHz, the same bands that are proposed to be used for the NEWLEO Ka band gateway uplinks and downlinks and already used by Iridium and a number of GSO operators.

03b inconveniently had to raise capital in the year that Lehmann brothers went bankrupt and it is a tribute to the persuasive skills of the Wyler management team that the constellation launched and more or less met its business plan objectives. However it achieved this by substantially changing the market focus of the business which now supplies internet connectivity to cruise ships 40 degrees either side of the equator.

This highlights the problem that many of the presently disconnected are low income or no income customers so making any comprehensive inroads into the digital divide is likely to require substantial government subsidy on a country by country region by region basis.

This already happens with terrestrial fibre subsidies or via universal service obligations imposed with various financial incentives. The amount of digital divide subsidy going to the satellite industry is relatively small (of the order of 1.5% in the US market) and the NEW LEO contenders including Space X make a persuasive argument that these dollars would be more effectively spent with them rather than on terrestrial system subsidies.

Whether this is the case depends on the fine detail of the final agreements on coexistence with the agreement process now made more complex by the ambitions of the 5G community to share or acquire Ku and Ka band spectral assets.

This includes a growing recognition by aspiring 5G operators that the principle of angular power separation could be applied to support co sharing between terrestrial 5G and LEO, MEO and GSO networks, a combination which would provide superlative global coverage and capacity gain

achieved through spatial frequency reuse. This could include the 28 GHz band though the satellite operators remain resolutely opposed to this.

There are substantial regulatory barriers that need to be overcome before spectrum sharing becomes a practical proposition. The failure of the proposed Intelsat and OneWeb merger provides a case in point. It may have been that the Intelsat bond holders were wary about increasing their gearing ratios, already stratospherically high. It may also have been influenced by a nagging worry that Intelsat's spectrum and international landing rights, patiently negotiated over 50 years, could have been open to legal challenge if the merger had gone ahead.

It may be that this particular log jam will be unlocked by Google or Facebook. Google already has a 10% stake in Space X in return for a $1 billion dollar investment and both companies have enough spare cash to buy a large part of the satellite industry at present enterprise value. They also have substantial regulatory influence.

In the meantime it is important that the NEW LEOS do not shoot themselves in the foot by disputing each other's interference models and offer a unified vision to regulatory authorities around the world based on the thesis that high count low earth orbit satellite constellations have a critical and economically compelling role to play in future internet connectivity and can and should be seamlessly integrated with MEO, GSO and terrestrial 5G networks.

Ends

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5G and Satellite Workshop- Sydney and Singapore

We are delighted to be working again with Niche Markets Asia presenting a 5G and satellite and local area connectivity workshop in Sydney on Monday and Tuesday 30 and 31 October. We will also be speaking at **Radcomms 2017**, the leading spectrum management conference organised by the Australian Communications and Media Authority (ACMA) on Tuesday and Wednesday 1 and 2 November and then running the two day workshop in Singapore on Monday and Tuesday 6 and 7 November. **The workshops explore the positive technology and commercial touch points between the 'new space' satellite industry and 5G operator and vendor community.**

More details here

5G BOOK – 5G Spectrum and Standards – Geoff Varrall
Published by Artech House

The spectrum, band plan and standards choices for 5G and satellite mobile and fixed broadband, the technology and the economic impact of these choices on the mobile broadband and satellite industry supply chain, operator community and target vertical markets.

£119.00
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Making Telecoms Work - Geoff Varrall
Published by John Wiley

The technology economics of wireless versus fibre, cable, copper and satellite connectivity and the changing business dynamics of the telecommunications industry.

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RTT, The Mobile World and Policy Tracker are working on a new book project on 5G and Satellite Spectrum and Standards and related regulatory and competition policy issues prior to WRC 2019. The book will be published by Artech House next year.

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