RTT TECHNOLOGY TOPIC
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Smart Spectrum From Space

Huawei announced this month that they are launching two satellites later this year with China Mobile to test 'Terahertz' technology for delivering next generation mobile and fixed broadband to rural and urban areas.

Eutelsat announced this month that they are investing $550 million dollars for a 24% stake in One Web. $500 million dollars of the investment is financed from proceeds from the C band auction in the US.

It is ironic that the cellular industry is subsidising a new generation of competitive multi constellation (GSO/LEO) service offers from space. It is additionally ironic that auction incomes from RF C band will help finance the roll out of optical C band for optical cross connect in space and optical uplinks and downlinks.

The logical next step in this process would be for 5G operators to bid large amounts of money for satellite Ku and Ka band spectrum which would mean that satellite operators could replace their overworked Ku and Ka band uplinks and downlinks with yet more optical C band.

This highlights several underlying trends.

The asset value of telecommunication infrastructure in space is appreciating at a faster rate than terrestrial telecommunication infrastructure.

The asset value of terrestrial and space based optical infrastructure is appreciating at a faster rate than terrestrial and space based radio.

The 5G community is helping to finance this transition.

Is the investment by Huawei and China Mobile an early sign of a growing recognition of this shift in relative value?

If optical bandwidth is going to be so valuable should it be auctioned rather than given away for free? Optical free space communication is not immune to interference so broader optical spectrum regulatory intervention and oversight could be justifiable?

These are some of the subjects we analyse in depth on our 5 day workshop on LEO, MEO and GSO system and service integration being held on 14-18th June presented in association with the Continuing Education Institute.

To view the agenda and book a place on the workshop, follow the link
https://www.cei.se/course-820-leo-meo-and-gso-system-and-service-integration-group.html

Meanwhile, to this month's technology topic, Smart Spectrum from Space which as you might expect from the introduction looks at the relative value of space and earth telecommunication assets and the relative value of RF and optical assets.

We start by looking at how RF and optical wavelengths together have realised knowledge value from space and how this has acted as a precursor to realising commercial value.

In 1610, Galileo looked up at the stars through his latest invention, a prototype for the modern day refractor telescope.

In 1931 Karl Jansky accidentally discovered radio astronomy when investigating background static on Bell Labs short wave transatlantic radio phone service.

Radio astronomers explore the outer reaches of the known Universe and travel back to the beginning of time using radio frequencies from VHF to V band.

Optical astronomers explore the outer reaches of the known Universe and travel back to the beginning of time using space telescopes at infra-red, visible, ultra violet and X ray wavelengths.

Infra-red, visible and ultraviolet imaging is recovered from the Hubble telescope in low orbit (340 miles above earth) via NASA's Near Space Network using S band (2025-2110 and 2200-2290 MHz), X band (7190-7235 MHz and 8450-8500 MHz) and Ka band (22500-27000 MHz).

Infra-red mages from the James Webb Telescope due for launch in October this year will come back to earth (one million miles away) via the Deep Space Network at S band (2110-2120 MHz and 2290-2300 MHz), X band (7145-7190 MHz and 8400 MHz to 8450 MHz) and Ka band (32400-34700 MHz and 31,800 to 32300 MHz). Two optical ground stations have now been built by NASA to support broader bandwidth deep space communication.

Increasing our understanding of the Universe has quantifiable cost but unquantifiable value. It is effectively priceless.

Radio spectrum has delivered political and social value for over hundred years. Radio and TV broadcasting over terrestrial networks and TV from satellites in C band, Ku and more recently Ka band is essential to the political process and essential to education and entertainment. Radio and radar systems win wars and save lives.

Radio spectrum has always had economic value. Radio broadcasting in the 1920's triggered a tsunami of speculative investment not dissimilar to the New Space Industry today. Over the past forty years cellular radio has created a trillion dollar industry and paid hundreds of billions of dollars for spectrum previously used for broadcasting and or military radio. The industry has paid substantial tax as well.

Radio spectrum in space can also have environmental value. Sub metre imaging using Synthetic Aperture Radar in X band at 9 GHz means that illegal forestry and accidental or deliberate pollution can be tracked and prevented, ice sheets can be measured and animals counted.

It is therefore difficult but not impossible to estimate the additional value that space can deliver and difficult but not impossible to estimate this by frequency and wavelength. This means that we can calculate the additional value that 'smart spectrum from space' can deliver.

For example, companies such as Myriota and Hiber deliver low cost low power connectivity for agrarian and maritime IOT and energy and utility markets via LEO Cube SATs and the sub 1 GHz ISM bands. The final leg of the journey is to the farmer or fisherman's smart phone. This is multi network value, an example of space spectrum adding value to terrestrial spectrum and an example of unlicensed spectrum adding value to licensed spectrum.

In L band, GPS, Glonass, Galileo and Beidou provide an essential part of today's terrestrial smart phone experience.

In S band, the immediate adjacency of space spectrum to terrestrial Band 1 has commercial potential.

Spectral adjacency can however be problematic when an auction process is involved. The terrestrial broadcast community spent ten years resisting the sale of the 700 MHz band. The satellite TV community had similar reservations about being moved to the top of the 3.5 GHz band.

However as the announcement from Eutelsat shows, 5G clouds can have massive silver linings.

The satellite industry has an underlying problem that bandwidth in space is increasing faster than bandwidth to and from space. Space bandwidth is expanding exponentially due to the increasing number of satellites, earth observation sub metre imaging and sensing, deep space imaging, inter satellite and inter constellation switching and routing and other related traffic growth opportunities (cellular backhaul and subsea fibre by pass for example). Uplink and downlink radio bandwidth is at best increasing at a linear rate with interference noise floors creating a costly choke point.

The answer as discussed in last month's technology topic, Smart Fibre from Space, is to implement optical uplinks and downlinks coupled to optical cross connect in space. Fortuitously it seems that this will be paid for or at least subsidised by the terrestrial mobile operator community.

These links could theoretically be long wave infra-red (300 GHz to 3 THz) or medium wave infra-red (3 THz to 30 THz) but are more likely to be in the short wave infra-red band using optical C band between 191 and 195 THz (1530 to 1565 nanometres) to allow optimal matching into terrestrial and subsea fibre and to facilitate the use of active and passive optical components developed for fibre applications.

The recent US auction of 280 MHz of C band RF spectrum realised $81 billion dollars. The four terahertz of optical C band spectrum, potentially supporting one hundred and sixty 25 GHz DWDM channels, is free and lightly regulated.

Optical cross connect in space means that uplinks and downlinks can be multiplexed together and support multiple routing to reduce atmospheric fade margins. High altitude ground stations improve the link budget in both directions and minimise atmospheric perturbation. Adaptive optics help as well. Optimised optical downlinks therefore enable space generated value to flow down to earth and into terrestrial networks.

Smart Spectrum from Space therefore describes an emerging business model based on using RF and optical wavelengths to bring space value back to earth. Bidirectional links enable optimised inter-continental routing, adding value to terrestrial network services.

The model however requires collaboration between commercial entities who regard each other as competitors. Arguments over radio spectrum add to this enmity as do adversarial auction processes designed to maximise radio spectrum auction income.

Optical links to and from space and in space reduce these tension points and build touch points of common commercial interest. China Mobile and Huawei are making a tentative first move into space based integrated RF and optical networks, a smart use of RF and optical spectrum in space to enhance terrestrial telecom value. Others will follow.

Ends

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