Emerging Economies' Contributions to Space Activities and Legislation

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Abstract

Most if not all space activities require the use of the radio frequency spectrum (RFS); the RFS is essential for satellite and other wireless communications and scientific probes. Countries with advanced industries in the space sector obviously have more developed legislation than States that only aspire to participate in space activities. Even these, however, regulate space activities by which they are directly affected, primarily through their adherence to the International Telecommunication Union Radio Regulations (ITU-RR) and policies embedded in the space treaties. Thus, it can be said that most countries have some basic national legislation related to space activities.

Some emerging economies have changed the focus of their activities, from wanting to acquire a satellite for communications, to obtaining a remote-sensing /earth observation satellite. Regardless of the change in focus, they face similar issues: budgetary and personnel constraints, as well as policies of industrialized countries regarding transfer of technology. Despite these challenges, less developed countries have contributed to the expansion of space activities and their regulation, at the national and international level. They participate in ITU Study Groups, and in the UN COPUOS' sessions, bringing a different perspective to the deliberations of these entities.

This paper will focus on Emerging Market Economies (EMEs), 5G networks and satellite mega- constellations; it will provide an overview of some of their contributions to space law and space activities, while keeping in mind limitations they continue facing.

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Background

We talk of the 'global economy', of multi-national corporations investing in select countries, of global banking enterprises, usually with the emphasis on their 'global' aspect, and impact. At the same time, much talk surrounds the 'emerging economies' or 'emerging markets', with many descriptions given as to what constitutes or qualifies as an "emerging economy", or "emerging market". (Google alone has more than 180 million "results" or references to the terms). Some economists focus their definition on the GDP of the country, while others use other indices of development.

The World Bank defines the term as follows: "An emerging market economy (EME) is defined as an economy with low to middle per capita income. The term was coined in 1981 by Antoine W. Van Agtmael of the International Finance Corporation of the World Bank."[1] Another website provides a list of emerging markets: According to the Morgan Stanley Capital International Emerging Market Index, 24 developing countries qualify as emerging markets - including Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Qatar, Russia, South Africa, Taiwan, Thailand, Turkey, and United Arab Emirates. (Dec 31, 2018).[2]

It should be noted that many countries on this list have substantial industries and activities in the space sector. Should space-related activities be taken into account when defining "emerging markets"? If so, the list of 'emerging markets' or 'emerging economies' would be much shorter, since several of them - China, South Korea, India, Russia, have well-established space industries, and all countries benefit from space (satellite) communications. Perhaps a better definition or description of EMEs is called for, one based on their connections to the internet and other means of global communications, as Telegeography proposed and has being doing since 1989.[3] This company and the International Telecommunication Union (ITU) play important roles in tracking the growth of telecoms networks by country, by region, and at the international / global level. Their data present different pictures of EMEs, and their development.[4]

1 Reem Heakal. https://www.investopedia.com/articles/03/073003.asp. Updated June 25, 2019. Visited 5 Sept. 2019. [Emphasis in original].

2 https://www.thestreet.com/markets/emerging-markets/what-are-emerging-markets-14819803https://www.google.com/search? 8. [Emphasis in original].

3 TeleGeography is a telecommunications market research and consulting firm. www.telegeography.com.

4 *See* https://www.itu.int/en/ITU- D/Statistics/Pages/events/geneva2019/default.aspx.

Emerging Markets/Economies (EMEs), Telecommunications and the ITU: The case for 5G

According to adverts on Investopedia's website, among the 'stocks set to soar', and produce huge dividends to investors are 5G networks, or fifth generation technology, touted as the next generation of mobile internet connectivity, offering faster speeds and more reliable connections on smartphones and other devices than ever before.[5] "By 2021 alone there will be an estimated 29 billion devices hooked up to 5G, creating more than $1.46 trillion in market value for investors."[6] 5G networks will be used to enhance delivery of health services, super-fast IOT and mobile broadband connections, for autonomous driving vehicles, tele-medicine, among other benefits. You will be able to stay connected at high speeds, anywhere and everywhere- if you have the right equipment available. That is the upside of 5G. The downside of 5G is that until now, only a few cities in a few countries and a few carriers offer 5G services, and only to certain mobile phones.[7] Further, it's estimated that the cost of updating infrastructure to allow for 5G networks to flourish will be in the billions of dollars.[8]

The wireless world's equipment manufacturers are in competition with each other, the stakes are high, and further complicated by political considerations. One major concern is whether privacy laws and policies will be violated; whether 5G mobile phones will be used for surveillance, and whether the radiation they produce will be harmful to humans. These are only a few of the issues regarding 5G technology. A main issue is their access to the radio frequency spectrum (RFS).

The International Telecommunication Union (ITU) plays a major role in allocating limited natural resources, such as radio frequencies and orbits to different wireless/ satellite services. One big issue is radio frequency allocation to the 5G networks. A number of the ITU member Administrations have engaged in Study Groups, drafted reports and have conferred with other Administrations as to their position on 5G networks and technology. They all seem to concur that harmonization of radio frequency use across the globe is essential, particularly for certain services, such as driverless vehicles, and public protection and disaster relief (PPDR) operations.[9]

5 https://www.techradar.com/news/what-is-5g- everything-you-need-to-know.
6 https://breakthroughinvestors.com/5g-2019-2/.
7 Techradar.com news, note 5.
8 Ibid.
9 Bharat Bhatia, https://www.itu.int/en/itunews/Documents/2019/04/2 2019_ITUNews04-en.pdf, pp. 24-28. (ITU News Magazine, 04/2019.) Bhatia is President, ITU-APT foundation of India, *inter alia*.

5G and Satellite Mega-Constellations

5G proponents claim they will be bringing mobile broadband services to underserved and hard-to-reach areas, and new satellite constellation service providers make the same claims. In the last few years, several companies have received authorization from their respective Administrations to build and launch satellite constellations, ranging in size from 'nano'-satellites to spacecraft weighing at least 500 kg. The US's Federal Communications Commission (FCC) alone has authorized at least 10 satellite constellations to be launched within 6 years, SpaceX's Starlink among them.[10] Other companies that claim to provide internet access to underserved areas of the world and already have satellites in orbit are Iridium, O3b, and OneWeb. Are the FCC's authorizations examples of a new space race, of a "space gold rush"?[11] How many of the new consortia will end up providing services, and how many will fade away for lack of funding and clear business strategies? Perhaps a little bit of history may be useful to answer these questions.

In the early 1990s several corporations or consortia aimed to provide satellite personal communications via hand-held sets. Three of these were in competition with each other: Iridium, Globalstar and ICO Global Communications, all aiming to provide their services to the same markets. When Iridium first started promoting itself in the early 1990s, it boasted that it could connect users to even the most remote corners of the world via its 66 LEO satellite constellation. Globalstar promised connections via its 48+ LEO satellite constellation, and ICO via 12 satellites in Middle Earth Orbit (MEO). At the same time, mobile telephony, particularly GSM[12] expanded at an unprecedented rate, offering services to hand-held phones at much lower

10 SpaceNews, November 15, 2018. The U.S. Federal Communications Commission voted Nov. 15, 2018 to approve four proposed satellite constellations, authorizing nearly 8,000 small telecom satellites to serve U.S. entities from low Earth orbit. The new regulatory approvals set the stage for two companies, SpaceX of Hawthorne, California, and Telesat of Ottawa, Canada, to expand constellations already approved last year with more satellites in the rarely used V-band spectrum. Canadian startup Kepler Communications and LeoSat, a company licensed from the Netherlands, also received approvals, Kepler for 140 Ku-band satellites and LeoSat for 78 Ka-band satellites…The FCC's approval triggers a regulatory deadline whereby the companies must place at least half their constellations in orbit within six years, and the full systems in nine. At the end of nine years, the FCC freezes approval at the number of satellites in use. https://spacenews.com.

11 A "space gold rush" refers to many corporations seeking to mine extraterrestrial bodies such as asteroids for minerals, according to googlesearch.com. Other corporations see the gold rush in space as a means of securing the necessary radiofrequency bands they will need for their multi- satellite systems. *See* https://spacenews.com/signs-of- satellite-internet-gold-rush/.

12 Global System for Mobile Communications (GSM) is a standard developed by the European Telecommunications Standards Institute (ETSI) GSM is used in most of the world. https://www.google.com.

prices than any satellite service that Iridium or Globalstar could provide. (All three companies filed for bankruptcy protection in the late 1990s.) Mobile telephony continued to expand, overtaking landline connections in most countries, and especially in emerging market economies (EMEs).[13]
Mobile phones have been touted as key to economic development since the 1990s, although in some countries and regions of the world access to wireless communications is still lacking.[14] Ostensibly, the new satellite mega-constellations will provide coverage to the underserved populations /regions.[15] At least that is their promise, the same promise made earlier by Iridium and Globalstar. Will some of the new start-ups of mega-constellations meet the same fate as their predecessors? A look at a few of these systems follows.

The New Satellite Mega-Constellations: O3b, OneWeb, Starlink

O3b, established in 2007, is a satellite service provider now wholly owned by SES, which has 50+ satellites in geostationary orbit (GEO). O3b consists of 20 satellites in MEO, and has been operational since 2013. O3B claimed that it would provide communications to the "Other 3 Billion" people [hence its name] unconnected to any network. It provides communications to areas already covered by different satellite networks (SES?), to cruise ships and to the US Dept. of Defense. But is it providing services to those other 3 billion? According to its coverage maps, it has no 'points of presence' in Africa and only one in South America (Peru); O3b has 3 GEO gateways in Africa, and 2 in South America.[16] But according to its press release, SES's current O3b constellation is delivering services to customers operating in nearly 50

13 Mobile Connectivity in Emerging Economies | Pew Research. https://www.pewinternet.org. 2019/03/07. Mar 7, 2019 – Emerging Economies are middle- income countries as defined by the World Bank. [They] contain a mix of people with different sorts of devices. Many of these countries have notable variations in the share of their populations who have smartphones, more basic phones – or no phones at all. [They] offer country-level diversity and variety. *See* also ITU Statistics, note 4.

14 On 9 Sept. 2019 BBC News reported on research carried out by the Oxford Internet Institute (OII), showing that one-fifth of Britons do not use internet. 18% of the population- those living in rural areas, the elderly, and low-income households lack access to internet service. Another survey showed that there is a growing divide in experience and perception between those who use the internet and those who do not, which could lead to non-users potentially missing out on access to key services, widening the "digital divide". https://www.oii.ox.ac.uk/news/releases/new-survey-finds-majority-of-internet-users-have-a-positive- experience-online-but-potential-for-digital-divide-to- widen/. 9 Sept. 2019.

15 According to some researchers, more men than women have access to mobile phones in most countries. https://www.brookings.edu/blog/future-development/2019/04/10/mobile-phones-are-key-to-economic-development-are-women-missing-out/.

16 https://www.ses.com/our-coverage, a map with all the GEO, MEO gateways and points of presence.

countries, and is the only technically- operationally- and commercially-proven non-geostationary system for delivering low-latency data communications today.[17] Since SES owns and operates O3b, both entities benefit from each other, and are able to provide services worldwide.[18] If O3b's services were viewed independently from SES's, could it claim that it reaches at least some of the other 3 billion? One of O3b's founders, Greg Wyler, moved on from O3b and established a new satellite company, OneWeb.

OneWeb

OneWeb, founded in 2015, is one of several satellite manufacturers and eventual satellite broadband service providers aiming to cover the globe and underserved areas with a constellation of at least 650 to 900+ satellites in low earth orbit (LEO). OneWeb has opened a factory in Florida's Space Coast, to build some of the satellites, while its partner, Airbus Defence and Space, is building some of the satellites in Toulouse, France. The aim is to produce at least 15 spacecraft per week, each satellite having a mass of 150 kg.[19] It launched its first 6 satellites on 27 February 2019 from Kourou, French Guyana, in order to meet one of the authorization requirements, and ensure its access to the radio frequencies it will need to provide services.[20] Subsequent launches will take place mostly from Baikonur, and some from Virgin Orbit.[21]

In 2015 OneWeb sought to partner with Intelsat to provide services to underserved regions, while Intelsat, which invested $25 Million in OneWeb, wanted to have exclusive distribution rights to OneWeb's services.[22] SoftBank, which invested nearly $1Billion in OneWeb, had other ideas or plans and the arrangements between Intelsat- OneWeb-Softbank ran into problems with Intelsat's debt holders, and fell apart. Now, in 2019, Intelsat is suing OneWeb for breach of contract.[23] But OneWeb moves on: it is exploring an alliance with Iridium.[24] A MOU signed by the 2 entities is

17 https://www.ses.com/press-release/ses-enhance-and-expand-o3b-mpower-system-capabilities-dynamic-software-innovation, 5 Sept. 2019.
18 www.ses.com.
19 www.onewebsatellites.com.
20 Caleb Henry:" OneWeb's first six satellites in orbit following Soyuz launch." SpaceNews, 27 Feb. 2019. https://spacenews.com/first-six-oneweb-satellites- launch-on-soyuz-rocket/. Visited 20 Sept. 2019.
21 Ibid.
22 https://spacenews.com/intelsat-sues-oneweb-softbank/, Sept. 20, 2019. For background on this deal, *see* https://www.reuters.com/article/us-oneweb-intelsat-m-a/intelsat-says-it-expects-14-billion- oneweb-merger-deal-to-fail-id.USKBN18S4UY, June 1, 2017.
23 Ibid.
24 https://spacenews.com/leo-constellation-operators-oneweb-iridium-announce-collaboration/ Sept. 19/19.

expected to bring Iridium's L-band service and OneWeb's Ku- band service for a variety of applications, including heads of state communications, critical tactical services, disaster response and maritime, among others.[25] Will the other services include services to underserved populations or regions?
Perhaps Intelsat viewed its arrangements with OneWeb as a similar set-up and good competition to O3b's arrangements with SES. Both Intelsat and SES operate the largest fleets of GEO satellites, and would stand to benefit from having satellites in lower orbits. At present, the goal of serving the underserved regions of the world, rural and low-income populations seems to be an ephemeral aspiration, regardless of the massive investments in satellite / broadband systems made up to now. These systems appear to be small, compared to Starlink.

Starlink

Founded by SpaceX's Elon Musk, Starlink has already launched 180 of its multi- billion dollar, mega satellite constellation, and has been authorized by the US's FCC to launch up to 12,000 satellites. Starlink plans to launch additional satellites in early 2020, but will need to have 800 satellites in orbit to provide the internet services it envisions. Each satellite weighs 500kg, and will be in LEO (about 550 kilometers). Musk maintains that the satellites will not be creating much debris, as they will be burning up when they reach the Earth's atmosphere.[26]
While Musk is optimistic regarding the operations of this mega-fleet of satellites, much work remains to be done in coordinating the spacecraft and the frequencies used, in order not to cause harmful interference, let alone collisions between existing satellite systems and the hundreds or thousands of Starlink satellites. Although each satellite system plans on using different frequencies in the Ku, Ka, and V bands, the higher frequency bands are more prone to rain attenuation and signal degradation than the 'workhorse' C-band.[27]
The cost of new equipment to access the higher frequency bands needs to be factored in deciding which bands will be used, and according to some authors, planning has to be done far in advance. Cost will be a big challenge in terms of making these bands accessible. "The cost of components needs to be reduced and volume needs to increase before yields can become

25 Milbank Space Business Review, Sept. 2019. http://www.milbank.com.
26 Https://www.space.com/spacex-starlink-satellites-launch-just-beginning.html, May 24, 2019. Visited 25 Sept. 2019. But one commentator noted that "SpaceX is a disaster in making: DNA damage, Cancer, ignoring biological impact proven through thousands of studies, which a crooked wireless ignores." www.emfcrisis.com.
27 C Band is the original frequency allocation for communications satellites. C-Band uses 3.7-4.2GHz for downlink and 5.925-6.425Ghz for uplink. The lower frequencies that C Band uses perform better under adverse weather conditions than the Ku band or Ka band frequencies. www.tech-faq.com› c-band.

predictable."[28] Further, "there is unease within the satellite industry, and great concern that satellite may not be given the best deal in the Q/V bands. After the fight for C-band at the World Radiocommunication Conference in 2015 (WRC-15), there is concern that the industry may have to fight yet again."[29]

François Rancy, director of the ITU's Radiocommunication Bureau, stated in 2015 that the added push for terrestrial networks in the 3.4-3.6-gigahertz bands in the Americas, Europe and Africa, plus individual Asia-Pacific nations' statements at WRC'15, resulted in a "nearly global allocation" for terrestrial networks.[30] In the meantime, in search for more bandwidth, satellite networks have moved from the lower C- Band, to Ku- and to Ka-band.[31] This move was hastened when it became clear that satellite and terrestrial networks could not coexist. Thus, WRC-15 opened the whole of the 3.4-3.6 gigahertz band to terrestrial networks in the Americas and both Europe and Africa.[32]

The C-Band frequencies remain important to the satellite providers, as evidenced by the "C-Band Alliance" that Intelsat, SES, and Telesat formed to repurpose 200 MHz globally, to be used by 5G providers.[33] Eutelsat, the European satellite communications provider, originally was a member of the "C-Band Alliance", but has dropped out of the Alliance.[34]

The C-Band Alliance has proposed the sale/ auction of 200 megahertz of C-band spectrum to companies and organizations who want to use it for high-speed 5G wireless networks in the United States, but the FCC wants 300 Mhz for cellular 5G rollout, with the 3 remaining members of the C-Band Alliance in charge of the auction.[35] But if the Alliance cedes more spectrum, this would mean that many customers would need to upgrade broadcast equipment to continue services, and these upgrades cost money.[36]

While some critics pointed out that none of C- Band Alliance companies are US companies, it would seem that their bigger concern relates to who would reap the financial benefits from the auction, which could run into the millions

28 Helen Jameson, Via Satellite, January 2017. http://interactive.satellitetoday.com/via/january-2017/beyond-ka-supporting-future-telecommunications/.

29 Ibid.

30 Peter de Selding,"Satellite Industry Held its Ground at Global Spectrum Conclave." SpaceNews.com, 27 Nov. 2015.

31 Ibid.

32 Ibid.

33 https://spacenews.com/fcc-commissioner-defends- c-band-alliance-but-renews-call-for-more-5g-spectrum, 24 Sept. 2019.

34 https://spacenews.com/eutelsat-leaves-c-band-alliance-as-spectrum-decision-looms/, 3 Sept. 2019.

35 Ibid.

36 https://spacenews.com/eutelsat-leaves-c-band-alliance-as-spectrum-decision-looms/, 3 Sept. 2019.

or billions of dollars. The FCC was expected to make its decision later in 2019, on how to open up satellite C-band spectrum for 5G cellular services.[37]
The proponents of the mega satellite constellations and their ability to use the 5G bands face several issues. One, there is no way of knowing how well any particular fleet of constellations will work until a large number of the satellites are in orbit, which might take several years. Secondly, global harmonization for the use of the frequency bands is still in progress. Thirdly, the cost of upgrading the current infrastructure is extremely high, and new terminal equipment needs to be installed, or in the case of the individual users, they will have to acquire 'smartphones', which at present may be beyond the financial means of many users.
In regard to the infrastructure, who should pay for the upgrades needed- the governments, the satellite fleet operators, or the service providers? Should these costs be shared, and how much should be passed on to the end user? Do all people need super-fast, low latency satellite communications, or only certain sectors, such as banking, and security forces? While these issues need to be addressed by the regulators authorizing the mega-constellations, (most if not all in industrialized European and or North American countries), other countries in other regions are also concerned about access to 5G networks and associated costs. But they are also working on deploying 5G networks, often with the help of Huawei, the Chinese telecom firm.[38] "Like many developing regions throughout the world, Latin America is quickly becoming a mobile-first region, raising the importance of mobile broadband for internet access."[39]
Even though the 5G networks and their need for more frequencies in the C-Band was not on the 2019 WRC's agenda, (it will be on 2023 WRC agenda) it is likely that it will be discussed anyway, as 5G is being implemented in more countries. (Preserving C-Band for wireless services has been under discussion since the early 2000s).[40]
One author notes, however, that connectivity to satellite-based networks is vital.[41] She reminds the reader that there are millions of people around the world, even in developed countries, that don't have access to broadband

37 According to Monica Alleven, FierceWireless, Pai chooses public auction of C-band spectrum by end 2020. https://www.fiercewireless.com/wireless/pai-280-mhz-c-band-spectrum-to-be-auctioned-by-fcc. 18 Nov. 2019.
38 Huawei, the Chinese telecom corporation is developing several projects in Ecuador, Peru, Uruguay, Mexico, Brazil, among other countries in Latin America. *See* also "Huawei Head South", in Foreign Affairs Magazine, 10 May 2019. https://www.foreignaffairs.com/articles/brazil/2019-05-10/huawei-heads-south.
39 "5G in Latin America: A region's global competitiveness at stake." A White Paper from Frost & Sullivan and Principal. https://www.principalglobal.com/knowledge/insights/.26 Feb. 2017. Visited 27 Sept. 2019.
40 *See* SpaceNews, "Countries Preserve Options for C-Band Use", 29 June 2004.
41 Jennifer A. Manner, SpaceNews, September 24, 2019. http://spacenews.com.

communications, and that the most economical means of supplying such access is via satellite, rather than through terrestrial systems. She recommends that "regulators should not focus solely on ensuring there is spectrum available for terrestrial mobile technologies… [with such a narrow focus] there will not be adequate spectrum available to support other technologies, including satellite and Wi-Fi, which are critical for ensuring that everyone has access to broadband."[42]

The EMEs and Space Activities

The Morgan Stanley Capital International Emerging Market Index regards 24 developing countries as "emerging markets."[43] Yet, the majority, if not all these countries have national space agencies, and are active in space, from manufacturing satellites, rockets and other hardware, to launching them to orbit.[44] Thus, if their activities in these sectors were taken into account, perhaps they would no longer qualify as Emerging Market Economies (EMEs). Several of these countries- China, Japan, Korea- are exporters of telecoms equipment to other EMEs, and through loans, have helped them develop their infrastructure (wireless telecoms, roads), and consequently grow their local economies.

Many of the EMEs are located in the southern hemisphere, while the space sector is more developed in the northern hemisphere. Do the north-south relationships put the EMEs at a disadvantage, or do they help foster development in the southern hemisphere? How many "pilot" programs from the north (ESA/European Union, USA/NASA, the Asia-Pacific Space Cooperation Organization (APSCO)) take place in the southern hemisphere and subsequently develop beyond the 'pilot' stage? While an in-depth analysis of these relationships is beyond the scope of this paper, some generalities and a select overview focused on South America follow.[45]

China, for example, has built and launched communication and/or remote-sensing satellites for Bolivia, Venezuela, Nigeria, Pakistan, inter alia. China has cooperated with Brazil since the 1980s, on the China - Brazil Earth Resources Satellite (CBERS) program, and offers the images obtained from

42 Ibid.

43 *See* note 2, https://www.thestreet.com/markets/emerging- markets/what-are-emerging-markets-14819803https://www.google.com/search?q=list+of+emerging+markets+2019&rlz=1C1OKWM_enUS782US782&oq=list+of+emerging+markets&aqs=chrome.1.69i57j0l5.7943j0j7&sourceid=chrome&ie=UTF- 8.

44 https://en.wikipedia.org/wiki/List_of_government_space_agencies.

45 For longer accounts, *see* S.Ospina, "Latin American Space Activities In The 21st Century: To What Musical Beat: Samba Or Salsa? IAC-IISL, Guadalajara, Mexico, 2016; Journal of Aeronautical History: Review of Space Activities in South America; paper 2018/08. Bruno Victorino Sarli, SGAC, Brazil, Editor. https://www.aerosociety.com/media/9320/review-of- space-activities-in-south-america.pdf.

these remote sensing satellites free of charge to both countries and 20 other nations in South America, Southern Africa, and Southeast Asia.[46]

China has also partnered with Argentina for the construction of an earth station in the Patagonia, ostensibly to monitor the Moon's far side, and as part of China's deep space exploration programs. It has been operational since March 2018. China has insisted that the aim of the facility is peaceful space exploration and observation, and it claims it played a critical role in China's landing a spacecraft on the dark side of the moon in January 2019. However, some locals and the US government are wary and concerned of the growing Chinese influence in Latin America.[47] Chinese influence on and in space activities in Latin America is substantial, and likely to grow with its involvement in the deployment of the 5G networks, to the consternation of the United States.[48]

Although Argentina is not on Morgan Stanley's list, and while the overall economy in Argentina may not be the best, it has a fairly well developed space sector. It has built 2 communication satellites, ARSAT1 and 2, respectively, activities that have helped this country stand out. Argentina has also been influential in space policies, cooperating closely with Brazil in the drafting of several policy documents /resolutions, usually under the auspices of the International Law Association (ILA) and the Brazilian Space Agency (AEB).[49] Further, Aldo Armando Cocca, diplomat and lawyer, served as his country's ambassador to the United Nations, participated in COPUOS, and contributed to the drafting of the Moon Agreement, among other activities. His legacy lives on in his many writings, inspiring many lawyers in Argentina and other countries to study Space Law.

Colombia is another country that has challenged certain concepts of space law /space activities. The 1976 Bogotá Declaration[50] challenged the status quo of space activities, claiming that parts of the geostationary orbit were part of Colombia's national sovereign territory. Its position was based on certain physical attributes of outer space, and the fact that there was, and still isn't, a delimitation of air space from outer space. Colombia argued that this lack of delimitation allowed it to claim these sovereign rights, contrary to the 1967 Outer Space Treaty (OST), Art. II, which states that outer space is not

46 http://agenciabrasil.ebc.com.br/en/internacional/noticia/2018-08/brazil-china-celebrate-30-year-old- satellite-cooperation (2018 press release).

47 U.S. Military Warns of Threat From Chinese-Run Space Station in Argentina, 8 Feb.2019. https://foreignpolicy.com/2019/02/08/us-military-warns-of-threat-from-chinese-run-space-station-in-argentina/.

48 *See* note 38.

49 *See* writings by Jose Monserrat Filho (Vice President, AEB, Brazil) and Prof. Maureen Williams (ILA Space Law Committee).

50 https://bogotadeclaration.wordpress.com/declaration-of-1976/.

subject to national appropriation by claims of any kind.[51] Although Colombia signed the 1967 OST, it has yet to ratify it.

Even though few countries agree with the Colombian position, the lack of demarcation between air and outer space will become significant as sub-orbital flights with paying passengers are undertaken. Should air law or space law govern sub-orbital flights? The issue will be important in the event of an accident, and insurance claims that could result, despite waivers or disclaimers on the part of the companies providing the flights. Further, the issue of national appropriation of space resources will become important when space mining begins, as Art. II of the OST also prohibits claims of sovereignty of outer space and celestial bodies, such as asteroids and the planets.[52]

It seems that the ability to manufacture space objects, such as satellites and launch vehicles, is reflected in national legislation and policies regarding outer space. Thus, the industrialized (northern hemisphere) countries have more developed national regulations and laws than the countries in the southern hemisphere, which depend on their northern neighbors for much of the technology and access to outer space.

Despite this dependence, several countries- Argentina, Brazil, Colombia, Peru, inter alia- have created small industries to build cubesats, which are then launched by entities in the northern hemisphere.[53] Although they want to grow their satellite manufacturing capability, some of the South American countries often lack the support of their governments.[54] They have been struggling for decades to create a Regional Space Organization, but due to many economic and political factors, it remains an aspiration of, as well as an inspiration to the national governments.

Conclusion and Recommendations

Whether the focus is on 5G networks or on the satellite mega-constellations, one issue stands out: their cost. One author calculates that the Latin American deployment of 5G and upgrading the necessary infrastructure will cost between $50 to 60 billion, and will take more than 5 years.[55] Since operators need to monetize their investment, they will provide high-speed, low latency services to corporations (and governments?), rather than to

51 Art. II, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. Entered into force Oct. 1967. [Cited as the OST hereinafter].

52 Ibid.

53 One example is the nanosat built in Colombia with Colombian components, launched by NASA in January 2014. https://colombiareports.com/1st- satellite-made-colombia-launched-nasa/.

54 Fernando Garcia, as quoted in https://www.mexicanist.com/l/a5g-in-latin-america/, 07/09/19.

55 Ibid.

individual consumers. The same financial calculations will likely influence the deployment of the mega constellations: how, and from whom will they recuperate their investments? At the end of the day, the rural and low-income populations are likely to remain underserved, waiting for any kind of access to the internet, at slower speeds than what 5G promises.

Could the supporters of 5G networks and the promoters of the satellite mega-constellations be persuaded to shift some of their investment, e.g., a few million dollars, to provide communications and internet services in and to the underserved regions of the world? If they were to launch fewer satellites, the repurposed monies could be used toward that goal. These mega-projects, whether terrestrial or in orbit, face financial and regulatory challenges and deadlines, and will need the support of regulators in the Emerging Market Economies (EMEs) as well as at the ITU and other UN agencies.

Offering low-speed internet and other communications services to the other billions of people in EMEs might improve their chances of receiving the necessary governmental approvals. After all, isn't providing services to the unconnected and underserved one of the basic premises of the developers of the satellite mega- constellations, like OneWeb, O3b and Starlink, *inter alia*?

All economies benefit from space-based (satellite) communications, which in many countries are **their onl**y link to outer space activities. These links often form the basis of their national space policies and/or space legislation, which need to be further developed for the success of their nascent space industries, and help them expand their emerging economies.