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I. Introduction

Despite its sector-specific nature, telecommunications are the basis of the world economy's digital transformation, as well as numerous applications that impact our daily lives. Without a well-functioning telecom industry, humanity's endeavors to use technology – from Internet of Things ("IoT") devices and Cloud data storage to management of renewable energy smart-grids – become more costly and less accessible for businesses and consumers.

Indeed, the telecom sector now faces major challenges in achieving those socially desired goals: Telecom operators big and small realize that expanding network infrastructure is expensive; new generation mobile technology (such as 5G) has lower indoor reach (thus demanding more antennas per area);[4] big tech platforms have increased the demand of telecom networks to an unprecedented level due to the growing use of data; and natural resources required for the provision of telecom services (radio frequency) is already scarce and highly exploited. Putting it simply: supplying telecom services (and competing in this market) is becoming both growingly burdensome, and in demand.

However, the telecom industry is about to experience an unprecedented and seldom discussed transformation that will bring new market conditions of which regulatory and competition agencies must be aware. This transformation is defined by potential new ways of providing telecom services through space infrastructure, thanks to the many space exploration projects currently in progress. The field, often associated with sci-fi geeks and high-end scientists, is now of growing importance for regulators and antitrust enforcers.

The scope of this article is limited to the impact of space exploration projects on telecom competition, leaving other important new traits of this sector aside. Space exploration projects ("SEPs") are herein understood as any attempt to use space, more than 80km above sea-level, for commercial purposes.[5] The intersection between space and law is not unprecedented, but, as technology and business initiatives advance into this realm, so does the demand for greater legal certainty, including in competition law.

II. Overview of SEPs

On one hand, SEPs involve high risks for investors – e.g. it is not uncommon to see failed attempts at rocket launches and loss of contact

[1] All views expressed in this article are from the authors and do not necessarily reflect the position of institutions to which they are or were related to. The authors are deeply grateful to Prof. Dr. Andreas Heinemann (Universität Zürich – UZH) and Michael Gschweitl (European Space Agency/ETH Zürich) for sharing their insights about this subject.

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[4] In 5G technology, the bandwidth of radio frequency waves is higher, meaning the capacity to transmit data is bigger, but the geographical reach of the waves and the capacity to penetrate through physical barriers (indoor) are lower. OECD, *Developments in Spectrum Management for Communication Services*, 8 (2022), https://doi.org/10.1787/175e7ce5-en.

[5] This article, therefore, uses a broad concept of SEPs, encompassing the Earth's orbit and not being limited, e.g. to beyond-the-moon projects. However, it is worth highlighting that a precise definition of outer space is not subject to consensus in the scientific field, given that atmosphere force (i.e. the pull towards the center of the Earth) becomes gradually lower as altitude increases and, therefore, there is no exact point in which Earth's gravity suddenly vanishes in favor of orbital dynamic forces. Traditionally, the imaginary line that separates Earth from space is called "the Karman line," set at 80 km above sea level.

with space exploration probes in the last few decades. On the other hand, SEPs demand high investments, many of which have insufficient capital return – i.e. for every $1 invested, investors have a chance of receiving less than $1. These two aspects combined mean that SEPs are traditionally not self-sufficient businesses – i.e. if private companies explored space alone, they would have high chances of bankruptcy.

This economic element, in addition to the geopolitical interests in space exploration – as illustrated by the Cold War's space race – helps us understand why SEPs are historically State-funded. Most SEPs that involve private companies have received some support from public funds and are commonly a result of public-private partnerships ("PPPs").[6] In other words, space exploration as a business is viable when the risks are shared between private investors and the State.

However, this scenario has been changing. Once an industry overwhelmingly defined by private companies serving as sub-contractors to provide equipment for missions primarily funded by State institutions, we now see a growing participation of private-headed space initiatives and services in the overall number of SEPs.

This is mainly derived from the rise of companies like SpaceX, Boeing, Blue Origin, and Virgin Galactic, entities spawned from private owners with multi-billion-dollar wealth to support their projects and the associated risks behind them. As a result of the available capital and access to technology for construction of their own spacecraft, the scope of these businesses is on a much larger scale than the private companies that provided equipment for State-led space missions decades prior.

With these new players in the market, private companies have been able to provide transportation services (including to NASA)[7] and are even aiming to establish a new market for space tourism in the future. This phenomenon is similar to what happened to GPS services ("Global Positioning System"), which began as restricted products under strong State incentives due to its initial military purposes, and advanced into a consumer-oriented market driven by free enterprises, now widely accessible.[8]

When it comes to telecom services, although the use of space infrastructure is not *per se* new, this shift in the presence of private companies has brought new forms of provision of telecom services. For example, it allowed for the ascension of a market dedicated to Low-Earth Orbit ("LEO") internet services using satellite constellations built primarily by those private companies.[9] Said market is comprised of players like SpaceX's Starlink, Amazon's Project Kuiper, and Oneweb, providing high-speed internet to remote areas not covered by standard internet providers. This scenario contrasts with the old telecommunication infrastructure of geostationary satellites put in place mainly by the State with third-party support, including governmental agencies.

III. Impact over Telecom Competition

Network infrastructure is commonly seen as a barrier to entry in the telecom sector. This barrier is a negative for competition either because the cost itself reduces entrance of new competitors – as illustrated by the alleged poor competitive pressure of mobile virtual network operators ("MVNOs"), who do not own network infrastructure, over established operators in some jurisdictions – or because it can serve as a pathway for established players to harm entrants. Therefore, network infrastructure is

[6] Examples of PPPs date back to the Project Mercury, the first American spaceflight program, where private companies like Garrett AiResearch and McDonnell Aircraft collaborated with NASA to produce the spacecraft and its internal systems.

[7] Most recently seen in NASA's Commercial Crew Program, where the American space agency hires companies like SpaceX to transport NASA's personnel to the International Space Station on demand.

[8] A known landmark to civilian use of GPS was 1983, when then U.S. President Ronald Regan authorized the use of GPS by commercial airline companies. Aerospace, *A brief history of GPS,* (undated), https://aerospace.org/article/brief-history-gps.

[9] This is an infrastructure built by multiple satellites stationed at a set height around the orbit to compensate for the absence of a geostationary source and maintain consistency in signal reception.

itself a barrier, but it can also facilitate further anticompetitive practices.

Such practices by telecom operators can take different forms, such as, in wholesale services (upstream), overcharging a competitor who needs access to local infrastructure (so-called last-mile network) to provide retail services (downstream), or by executing overly broad exclusivity agreements with "towercos" (dedicated providers of network infrastructure) to foreclose competitors' access to these firms.

Concerns over undue use of network infrastructure is neither new nor hypothetical. Competition cases in the telecom sector commonly deal with behavior by telecom operators who have allegedly abused their dominant position in the market by using their own network infrastructure to discriminate and "margin squeeze" competitors and potential entrants. Despite their different outcomes, examples from different jurisdictions include the *Trinko* case in the US,[10] the *Deutsche Telekom* cases in the EU[11] and the *Vesper* and *BT* cases in Brazil.[12]

In this scenario, new forms of infrastructure and new ways of providing telecom services are potential game-changers. This is where SEPs come in, expanding the possibilities of using space as additional or alternative infrastructure for telecom networks. Among the most promising such breakthroughs in the field, and which will help illustrate these changes in the industry, is the use of laser satellite systems[13] as the new backbone for internet services.

Currently, development of laser-based telecommunication is primarily directed towards military use and space communication (often between an Earth-based station, the International Space Station, and probes present far beyond the Moon). This is because of the higher speed of data transmission and the better data security in laser usage as compared to radio frequency ("RF") communication in space, given that laser beams are harder to detect and intercept. However, recent efforts by ETH Zürich scientists have shown that a laser satellite system can also become a viable future replacement for the optical fiber infrastructure used for internet services.[14]

The team at Zürich managed to demonstrate successful transmission of a terabit ("Tbit") of optical data through the air over a distance of 53km, dealing with air turbulence around the environment that causes signal distortions (which are corrected by the signal receptor). In other words, they were able to emulate laser communication in worst-case scenario conditions that could affect LEO transmissions and receive accurate data. Using current technology, the system designed for this demonstration could be scaled up to transmit as much as 40 Tbit/s of data.[15]

While optical fiber cables can transmit higher rates of data (*ca*. 100 Tbit/s) and RF satellite infrastructure is currently more advanced, the implementation of laser technology could provide numerous advantages, making it a potential game-changer for telecom.

The construction of laser satellite infrastructure involves smaller and lighter equipment than RF satellites, while also not having spectrum licensing fees that pertain to RF communication. In fact, with modulation being applied to optical laser transmission, laser communication brings a lot more available space for usage in competition than RF offers. Finally, laser infrastructure is cheaper to build and maintain than deep-sea and underground fiber cables, as

[10] *Verizon Communications, Inc. v. Law Offices of Curtis V. Trinko, LLP*, 540 U.S. 398 (2004).

[11] COMP/C-1/37.451, 37.578, and 37.579 (2003).

[12] Administrative Proceeding nº 08012.003918/2005-04 (2016) (*Vesper* case) and Administrative Proceeding nº 08700.011835/2015-02 (2023) (*BT* case).

[13] In this case, laser is used as the conduit of data instead of radio signals, carrying much more data rates due to its higher wave frequency. It also has the advantage of requiring less power to transmit and receive data, making it an energy-efficient alternative.

[14] Yannik Horst, Bertold I. Bitachon et al., Tbit/s line-rate satellite feeder links enabled by coherent modulation and full-adaptive optics, 12 Light Science Application 153 (2023). https://doi.org/10.1038/s41377-023-01201-7.

[15] Daniel Meierhans, *Lasers enable internet backbone via satellite*, ETH Zürich (June 20th, 2023), https://ethz.ch/en/news-and-events/eth-news/news/2023/06/lasers-enable-internet-backbone-via-satellite.html.

well as providing faster connections with the use of dedicated satellite constellations.

Considering the above, one can argue that space infrastructure can reduce barriers to entry in the telecom sector, because entrants would be less dependent on the incumbent's current infrastructure to compete. Furthermore, countries where complex legislation and strict requirements for establishing new infrastructure serve as a barrier to entry, could minimize these constraints in space, where occupation is not currently subject to regulation.[16]

Enjoying the outcomes of SEPs and establishing space infrastructure is not expected to be zero-cost, however, so space will have its own barriers for competition. An example of this is the limited space available for use of satellite constellations at a set height and how the height of said constellations dictates the latency in connection for internet services (the lower the height, the lower the latency). Additionally, telecom entrants would decide between bearing the high costs of launching their infrastructure into space or hiring firms specialized in this segment.

IV. Challenges and Lessons for Competition Agencies

Considering the scenario above, there are at least three main elements of which competition agencies worldwide should be aware.

A. Market Definition

As is known among competition experts, to assert whether a business practice or transaction is unlawful under competition law, the enforcement agency must first define the relevant market, which has a product dimension and a geographical one.[17] Simply put, this is the environment where competition takes place, and the agency must first identify the boundaries of this environment – based on market tests and other available evidence – to determine which elements influence competition and the investigated facts.

Despite decades of competition law enforcement and recurrent use of methods provided by Economics, defining the market is not always an easy task. Difficulties happen when the market is highly complex, when the enforcement agency lacks sufficient information about the market's functioning, or when a market is undergoing a transformation process due to recent innovation. This potentially applies to SEPs' outcomes in the telecom sector.

The new ways of providing telecom services based on space infrastructure will not necessarily compete with services currently in the market. This will depend on, e.g. the level of substitutivity of the space-based services (both on the supply and demand sides) in comparison to current services. New services may be considered as a separate market, even if some indirect pressure is felt in current services. If so, this would be just another chapter in the history of the telecom sector's development, where the type of infrastructure differentiates the markets.[18]

Competition agencies have the challenge of defining the market after or during disruptive innovation. To address this, two lessons seem important. Firstly, agencies should seek a wide and diverse pool of information, reaching out to different players in the supply chain of space-based telecom services (from equipment manufactures to telecom operators) and different sizes of stakeholders (from small start-ups to major enterprises). Secondly, agencies should keep in mind that so-called pipeline products or services (near-the-end projects still in research and development that have not yet been marketed) can be included in the relevant

[16] Using space would minimize, not necessarily eliminate, the burdens of local legislation because, to use space infrastructure by Earth-based operators and for Earth-based clients, Earth infrastructure is still expectedly necessary to generate a network between Earth and space.

[17] As established in at least most jurisdictions, defining the relevant market is not necessary only when an assessment is being made of a *per se* infringement or an infringement by object, such as a hardcore cartel.

[18] Competition agencies worldwide were challenged to define a relevant market for broadband internet services, when networks based on copper cables were advanced into optical fiber cables (FTTH). OECD, *Defining the relevant market in Telecommunications*, 19 (2014), https://www.oecd.org/daf/competition/Defining_Relevant_Market_in_Telecommunications_web.pdf.

market, to prevent a quickly outdated competition assessment.[19]

B. National Champions

As seen in section II above, despite the changing scenario of privatization in space exploration, States still play a major role in it. In such frameworks, competition agencies must be alert to the negative influences of State intervention in competition, especially when space exploration moves towards self-sufficiency as a business. State intervention can promote the so-called "national champions" (domestic players that stand out in the global market), which, despite benefits for the country in the short-term, can hinder competition in the medium and long-term.

Defining whether State intervention is good or bad is controversial. In addition, even if the net effects are negative for competition, in some jurisdictions, competition agencies cannot sanction the State unless it has acted as a market player. The one remaining tool for competition agencies is advocacy: working in public forums to promote competition awareness and mitigate the harmful effects of State intervention in SEPs or telecom services.

C. Old Risks in New Places

Even if space serves as a broader alternative for telecom infrastructure, the winners of this new environment can still pose antitrust risks, be they new players or incumbent operators. As mentioned in section III above, space has barriers of its own, so whoever gets the front run of space infrastructure can also, in theory, discriminate against competitors and exploit vertically-related customers and end-consumers. This simply means that competition agencies will have to monitor space-related markets more closely than they do today, with the already existent enforcement tools. Given the lack of reports and other advocacy-related products by competition agencies about space exploration, this is an industry to keep a closer look in competition policies.

V. Concluding Remarks

As technology advances, so does the reach of economic interests in space. This tends to bring unprecedented benefits to businesses and consumers, as illustrated by projects aimed at expanding internet access in remote and less developed areas. However, like every arising market, this phenomenon also poses potential antitrust risks.

The potential effects of SEPs in the telecom industry are ambiguous. On one hand, developments in space infrastructure enable new forms of providing telecom services and can potentially allow entrants to bypass the cost of accessing incumbents' network infrastructure. The use of LEO satellite constellations and optical laser technology illustrate this. On the other hand, space infrastructure has costs of its own and whoever dominates this field will inevitably invite some antitrust scrutiny, while competition agencies themselves will have to face issues such as market definition, the impact of State incentives on national champions, and surveillance of space-related practices.

In a moment when artificial intelligence is in the spotlight, competition policies risk overlooking SEPs' impact on competition in this vital sector.

[19] This standard has been adopted by the European Commission in its 2024 revised Notice for market definition (section 4.3). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AC_202401645.