

East Wind, West Wind

Avoiding a technological cold war

Abstract

Currently we are living in a context of growing geopolitical tension, with the creation of two blocks, one around China and one around the United States. This is very relevantly altering the global supply chains, the location of the digital companies, the multilateral laws of commerce, and in general, the structure and government of the digital ecosystem.

The main objective of this paper is to analyse the European position with respect to the United States and China, highlighting the main European strengths and opportunities to harness the potential of the digital ecosystem and more in particular of the key digital enablers, with the ultimate goal of achieving digital sovereignty.

First, we highlight the different approaches towards the development of the digital ecosystem in the three regions, where Europe is heavily relying on regulation to control the companies that are currently dominating its market, the US relies on their economic power and business dynamism with very little intervention from the state, and China that relies on a handful of companies that operate without competitors in the country's market due to the government blocking third country's big tech from entering.

On the other hand, the increasing geopolitical tensions are arising mistrust in an environment that had grown "freely" since the end of the cold war in the 90s. This is causing blockades from one region to another, with the US and its allies blocking China's companies from their networks out of security concerns, which have later followed in a complete blockade of digital trade with the country, with the most recent ban from selling AI chips to Chinese manufacturers. This has been quite beneficial for some European companies, like Nokia and Ericsson that have become leaders in development of 5G technology. Nonetheless, despite their efforts, China is still expanding towards emerging economies, especially Africa and South America, giving them access to a highly growing market that can be dominated at the country's will.

In the meantime, European countries are in search for their digital sovereignty, putting forth a set of strict measures to promote the creation of their own digital platforms that can compete fairly with the Big Tech. However, in the current geopolitical context, are these policies contributing to the fragmentation of the Internet?

Key Words

Digital Sovereignty, Digital Economy, Internet Fragmentation, 5G, AI, Blockchain

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Chapter I

Objective, Methodology, and Definitions

Article 1 *Objective of the Research*

The Objective of this research is to analyze the European digital position with respect to the United States and China, highlighting the main European strengths and opportunities to harness the potential of the digital ecosystem and more in particular of the key digital enablers, with the ultimate goal of achieving digital sovereignty.

Article 2 *Methodology*

In order to evaluate the development of the digital ecosystem we begin by making an analysis of the environment using a PESTLE tool. Next, we have made an internal analysis to evaluate the European position compared to both the United States and China focusing on their contribution and control of the digital ecosystem. To do this, we have made use of indicators that measure different market, technological, and regulatory aspects of the ecosystem in the three regions, in particular:

- To evaluate the degree of technological development we have decided to use the number of ICT patents, the investments in Research and Development, the number of start-ups, etc. that have been identified by the OCDE as the most relevant to measure innovation. Each of these contributes in a different way to the global digital ecosystem value chain.
- To evaluate the regulatory environment, we have analyzed the legal framework and governance models existent in each of the considered regions.
- In order to dig deeper in the dynamics of the digital ecosystem, we have opted for expanding our previous analysis focusing on the new digital enablers that are modelling the new digital world: 5G, Artificial Intelligence, and Blockchain.

As a result of our analysis, that we have presented in a SWOT matrix.

Article 3 *Definitions*

- 1) «Digital Ecosystem»: The Digital Ecosystem is a set of different economic actors that compete and collaborate from sophisticated technological platforms to produce goods and services necessary for digitalization.
- 2) «Digital Sovereignty»: A country's capability to have control or significant influence over their digital ecosystem to defend the rights and interests of their citizens and companies.
- 3) «Gatekeeper»: A provider of core platform services shall be designated as gatekeeper if: (a) it has a significant impact on the internal market; (b) it operates a core platform service which serves as an important gateway for business users to reach end users; and (c) it enjoys an entrenched and durable position in its operations or it is foreseeable that it will enjoy such a position in the near future. (Source: European Commission)
- 4) «Globalization»: Economic, Technological, Social, and Cultural process that consists in the increasing communication and interdependency between countries, joining their markets, societies, and cultures through a series of societal, economic, and political transformations (Source: VETIC)

Chapter II

General Analysis of the Digital Ecosystem

In order to analyze the environment, we performed a PESTLE (Political, Economic, Social, Technologic, Legal, and Environmental) analysis. Thanks to this tool we can classify inside six areas the environment's variables that condition the digital ecosystem of the three regions we are going to analyze: the European Union, the United States, and China

Article 4

PESTLE Analysis of the Digital Ecosystem in Europe

In the following table we can see the PESTLE analysis of the digital ecosystem in Europe

Table 1: PESTLE analysis of the digital sector in the EU

Factor		Description	Impact
Political	The European Single Market	Europe is currently in a process of political, economic, and digital integration, which seeks to eliminate borders within the European Union to create the European single market, in which goods and services flow freely and are available to companies and citizens who are located within the Union without being limited by international borders. However, there are still large differences between the countries that break the single market, as we can clearly see in per capita incomes or the digitalization index. This is because despite belonging to the EU, each of the Member States is an independent country, looking out for its own competitive interests within the global market.	Negative /Positive
	Support from the institutions	The European digital strategy seeks to improve European digital sovereignty based on two areas of action: the European digital decade, which sets the digital goals for Europe in 2030 through the European digital compass; and building Europe's digital future, which is based on three pillars, a technology that works for people, a fair and competitive digital economy, and an open, democratic, and sustainable society. [1]	Positive
Economic	The impact of the COVID crisis	The COVID crisis has not only influenced inflation rates. Travel restrictions and periods of confinement have had a very negative impact on the economies of countries around the world. To combat the crisis, the European Commission has created the recovery and resilience funds with a total budget of €723.8 trillion. Member states had to submit to the European Commission their recovery plans, which must include environmental and digital policies aimed at meeting the objectives set by the Commission in the digital compass and in the European green deal. The Commission has published a Scoreboard in which progress can be seen, at country level, towards the implementation of recovery and resilience policies. However, despite the aid that is being received from the institutions, the return to normality has seen a fall in the demand for digital services that we saw during the year of confinements. This drop in demand is reflected in a lack of return on investment	Positive/ Negative

		that in turn impedes investment by private institutions. [2]	
	Slowing economic growth and rising inflation rates	In February 2022, the inflation rate in the European Union was 6.2%. The largest price increases are being seen in Lithuania, with an inflation rate of 14%, while France has the smallest with 4.2%. The current inflation rate in the European Union is the highest on record, surpassing the previous one in July 2008, when prices rose an average of 4.4% per year. Between the two crises, the inflation rate had remained below 3%. There are several reasons why we are seeing these price increases, supply chains have not yet recovered following the COVID crisis, and energy costs continue to rise. [3]	Negative
	The impact of the Ukraine crisis	Western countries continue to impose sanctions on Russia for its recent invasion of Ukraine. Some of these sanctions are having a very negative impact on the European economy, such as banning exports of gas, coal, and oil that are leading to an energy crisis throughout Europe, increasing gasoline and electricity prices, which are also reflected in increases in inflation rates and business closures. In addition, more and more companies are disrupting their services in Russia, which is reflected in huge revenue losses.	Negative
Social	Demand for digital content	Europe is one of the main consumers of digital content, which favors investment by private companies in the construction of data centers, and better international connections.	Positive
Technological	Low R&D	According to OECD data [4] we can see how the European Union is below the OECD average with an investment in R&D of 2.204% of GDP compared to 2.681%. The problem increases when compared to China (2.401%) and United States (3.45%). However, we can find some European countries among the most innovative in the world, such as Sweden, which ranks third on the world scale with an investment of 3.527%, only surpassed by Israel and Korea, while Latvia and Slovakia are among the bottom five. As we have already anticipated, these differences produce natural ruptures within the single market and mean that the EU cannot be placed among the leaders. [4]	Negative

Environmental	European Green Policies	One of the European objectives is to ensure that Europe is climate neutral by 2050, for which the European Union has developed the European Green Deal, within which we find a series of <i>milestones</i> that member states must meet to achieve the climate goal. [5]	Neutral
Legal	New European regulations	Europe is updating its regulatory framework to address digital challenges. To this end, the European Commission has published a series of proposals for regulations that seek to control the power of large digital platforms (DMA), protect online users (DSA), establish the rules for the use of new emerging technologies (AI, Edge computing, Cloud, etc.), and encourage the creation of European companies in a competitive and fair market.	Neutral

Article 5

PESTLE Analysis of the Digital Ecosystem in the US

Once the European context has been analyzed, we can move on to the United States, who together with China is the main driver of the digital ecosystem. The United States bases its innovation on private companies, with little intervention from the state.

Table 2: PESTLE analysis of the digital sector in the US

Factor		Description	Impact
Political	The American Single Market	Unlike the European Union, the United States can act coordinately within the entire territory, from a central office and without border restrictions. However, when looking deeper we can see clear differences between the states, being the innovation hubs the two coasts, and recently Texas for its low electricity prices.	Positive
Economic	Headquarters of the most innovative companies in the world	The United States is home to the world's largest multinationals: Microsoft, Amazon, Google, Meta and Apple. This gives it a much higher advantage over other countries in terms of Innovation. In turn, it is also home to the main Western chip manufacturers: Qualcomm and Intel.	Positive
	Rising inflation costs	The inflation rate has risen 7.9% since last year due to increases in gas, food, and housing costs. This is the largest rise seen in the United States since 1982 [6]	Negative
Social	Increased consumer demand	As in the case of Europe, the new applications of VoD, virtual and augmented reality and social networks are increasingly causing the demand for bandwidth by consumers to rise exponentially.	Positive
Technological	High investments in R&D&I	According to the OECD [4], the United States is the fourth country with the highest R&D spending as a percentage of its GDP, with a value of 3.45%, below Israel (5,436%), Korea of the South (4,815%) and Sweden (3,527%). However, we must bear in mind that these three countries have populations much lower than the American one, in addition to having very aggressive digitization policies, since it is one of their main resources. Regarding its competitors, the US are well above, China with 2.4% and Europe with 2.2%.	Positive
Environmental	Inflation reduction Act	As part of the inflation reduction act, the US is proposing a set of measures to increase clean energy in the country and to reduce harmful pollution. We highlight their	Positive

		commitment to reduce greenhouse gas emissions by about 1 gigaton in 2030 [7]	
Legal	Reduced central regulation	Despite the fact that it is a single market, the central regulator has very little involvement in the development of regulations that affect the entire territory, delegating mostly to the specific regulations of the states, which hinders in some cases the expansion of companies that have to adapt to specific regulations.	Negative

Article 6
PESTLE Analysis of the Digital Ecosystem in China

Finally, we assess the state of the digital sector in China, the second most innovative country within the digital sector. However, unlike its American competitor, it relies on state intervention and a limited number of tech companies.

Table 3: PESTLE analysis of the digital sector in China

Factor		Description	Impact
Political	Centralized market	China is one of the most centralized markets, leaving all power in the hands of the central government, which regulates companies in a completely coordinated manner. This implies a great deterioration to market competition, however, making it easier for public-private companies to focus their efforts on very specific areas that the regulator imposes on them.	Positive/ Negative
Economic	The Ukrainian War	For the time being, China has remained neutral to the conflict, continuing its trade relations with both countries and declaring that it does not want sanctions to affect the country. On the other hand, Huawei is one of the main suppliers of equipment for the deployment of mobile networks in Russia since 2019, which together with Western sanctions, will encourage the creation of two global blocs. [8] [9]	Neutral/ Positive

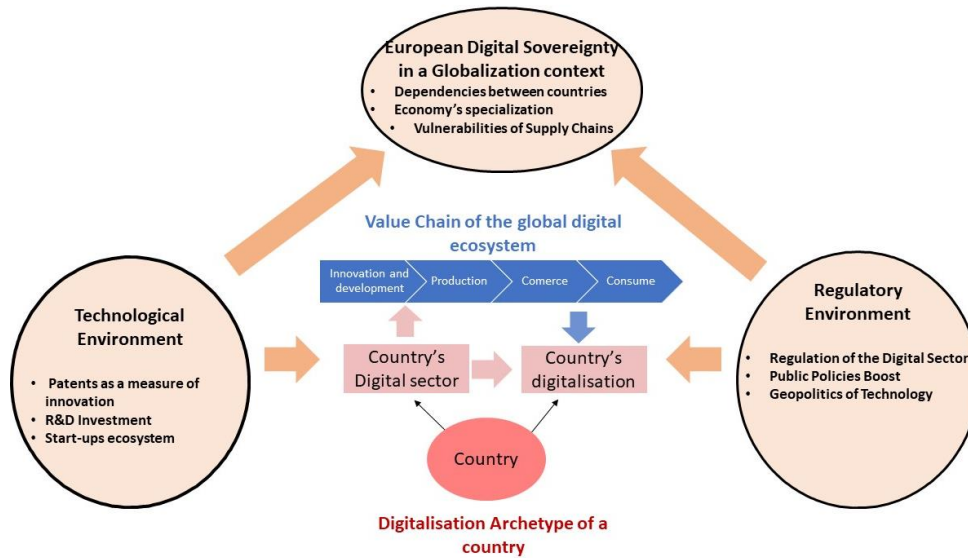
	The COVID crisis	China has not been excluded from the impacts of the COVID crisis and is still in the recovery phase after the impact that the lockdown has had on production chains and deployments.	Negative
Social	Early Adopters	China is one of the earliest adopters and biggest markets for new technologies, they hold the first place in deployment for 5G, and are estimated to be among the most promising countries in the development of these technologies [10]	Positive
Technological	The Firewall China	For years, China established its own internet network, in which the government establishes what content citizens can see and blocks a large number of American companies including Google, Facebook, Twitter, Dropbox, Printest, and many others. [11]	Negative
Environmental	Replacing coal with renewable energies	Although most of the energy in China continues to come from thermal sources, the country is becoming aware of renewable technologies, with a particular focus on solar photovoltaics of which it accounts for 70% of global generation; hydropower and wind energy. [12]	Positive
Legal	Extensive legal framework	Despite not having as many regulations as their counterparts, China has a very extensive digital legal framework that started developing in the 2010s. However, they are still in need of much advancement in the regulation of new technologies	Neutral

Chapter III

Internal Analysis of the Digital Ecosystem

With the internal analysis we will assess the European position with respect to its two competing regions. To do this, we have made use of variables that measure the development of the ecosystem from different perspectives: The techno-economic perspective with which we evaluate the degree of innovation and technological development of the countries; the regulatory perspective in which we evaluate the legislative initiatives that contribute to the governance of the ecosystem; and digital sovereignty in an environment of globalization.

Figure 1: Model for Analysis. The Digital Sector



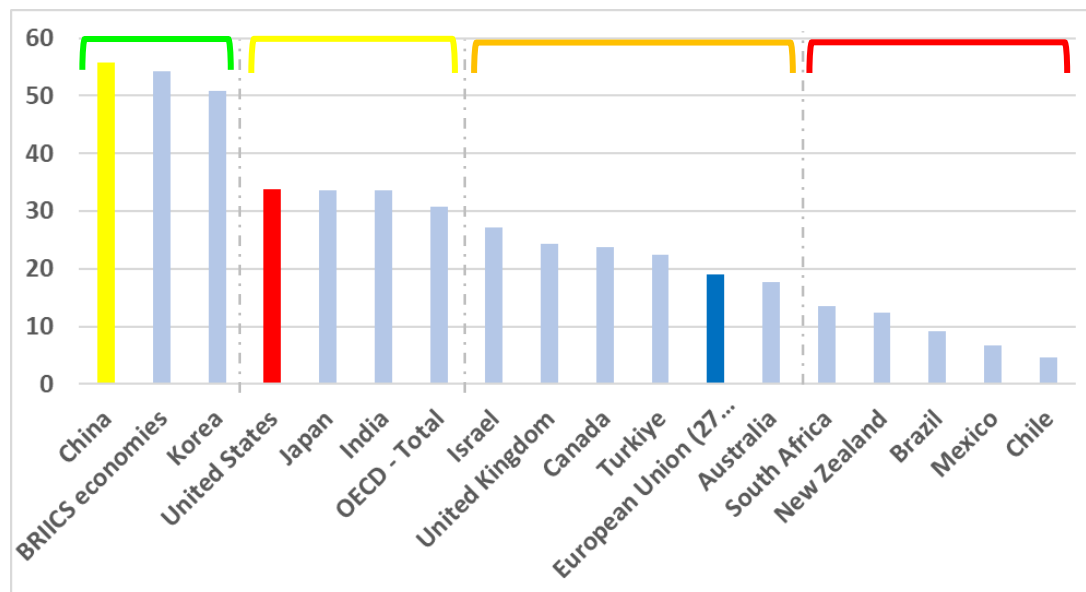
Source: VETIC, ETSIT UPM

Article 7

Technological Environment

One of the proxy variables that we can use to measure the degree of innovation of the regions are ICT patents. Below we can see the ICT patents in the main economies of the world, where we have highlighted the three that we are studying.

Figure 2: Patents in ICT-related technologies, as a percentage of total IP5 patent families, 2021



Source: OCDE Going Digital Toolkit

We can see how depending on the patents in ICT technologies, we can divide the countries into four groups: the Innovators, those countries that actively contribute to the creation of the digital ecosystem and that base their economy on the export and consumption of their own digital products, among which is China; all-doers, those countries that have a high degree of digitalization, but have not specialized their economy only in the production of digital products, but opt for greater diversification in their exports and domestic consumption, among which we find the United States; consumers, those regions that contribute to the digital ecosystem by importing digital products, but that do not specialize in the digital field, among which we find Europe; and digital novices, who consume digital products, but are still in the process of creating a digital economy.¹

Although at first it may seem that Europe is in a very bad position compared to its competitors, it is necessary to emphasize that several European countries, including Finland and Sweden are among the first group of innovators. However, because we treat Europe as a single region, and perform an arithmetic average of all its countries, its contribution is significantly reduced.

On the other hand, although it may seem that both Europe and the United States are far behind China, we must bear in mind that being a standardized indicator is showing us the percentage of digital patents with respect to total patents, so a diversified economy such as the United States, who is also headquarters of the companies with the largest number of ICT patents in the world, may appear delayed since it does not rely solely on digitalization to maintain its economy.

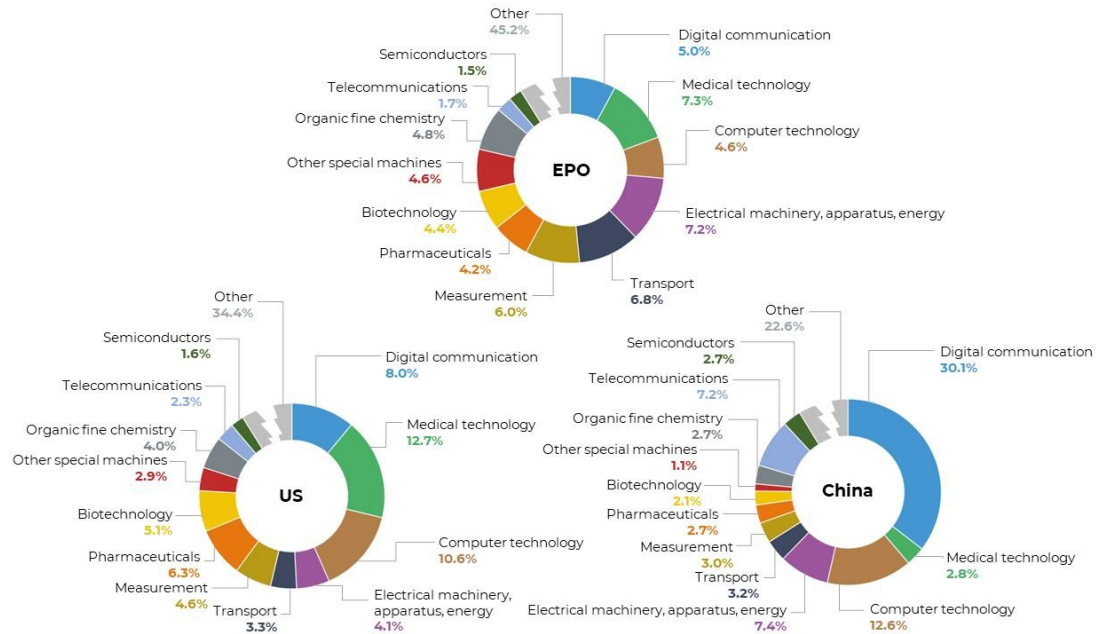
To be able to look at this phenomenon in more detail, we can see the decomposition with respect to the technological area in each of the regions, which we have included Korea and Japan, since as we have seen above, they are an oriental reference of technological innovation. We can also see the patents depending on the technological area². In this case, we see how China seems to have a clear commitment to digital communications technologies, in particular 5G, hand in hand with Huawei. For its part, the United States seems to bet on medical technologies, computer

¹ See: Huawei, Arthur D. Little. *Think Different. Think Archetype. Your Digital Economy Model*. https://www-file.huawei.com/-/media/corp2020/pdf/public-policy/adl_huawei_digital_transformation_main_report.pdf?la=en

² For this study we have taken the 12 technological areas highlighted within the *Patent Index Report 2021*

technologies, digital communications, and pharmaceuticals, with the help of Raytheon Technologies Corporation, Qualcomm, Microsoft, and Alphabet respectively. Finally, Europe is relying on medical technologies, electrical machinery, and transportation by Ericsson, Siemens, and Royal Philips respectively. [13]

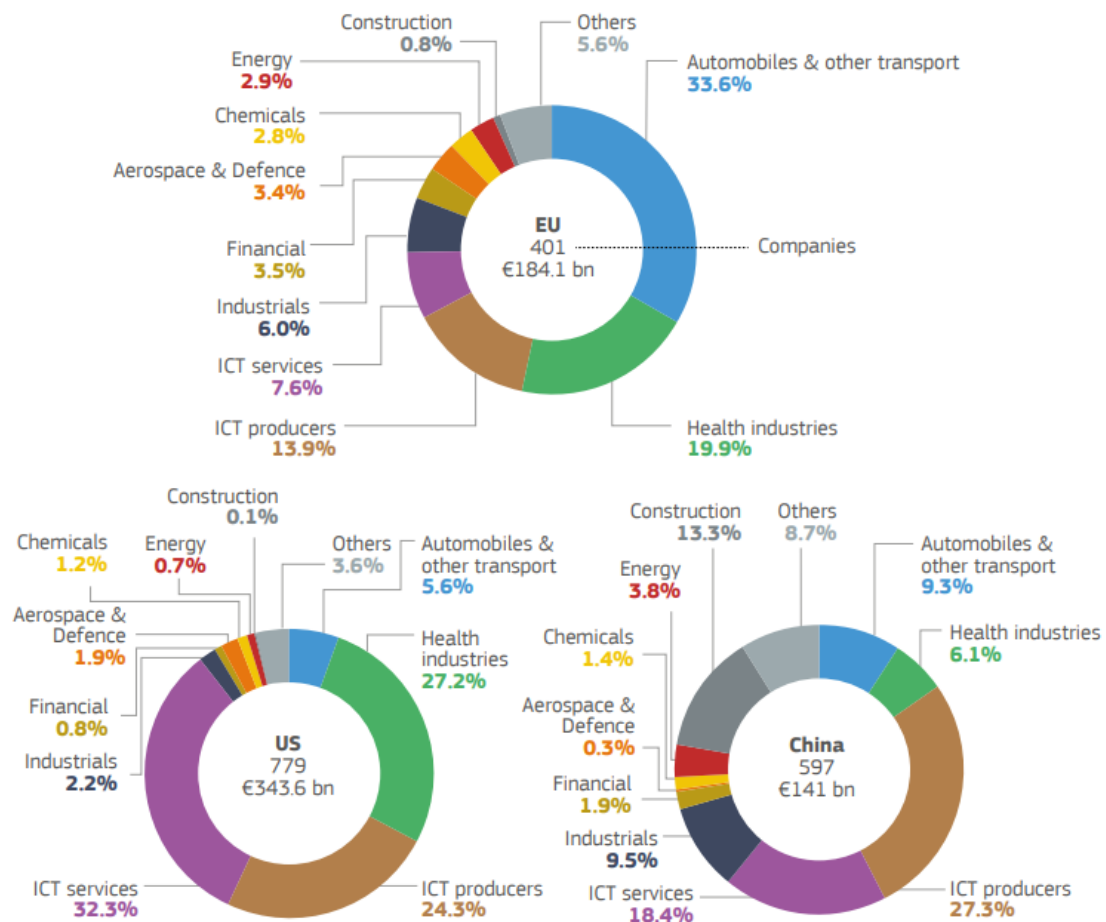
Figure 3: Patents by technological area, 2012-2021



Source: Own elaboration based on data from the European Patent Office. Statistics and Trends Centre

On the other hand, we can see the investments in R&D. In the following figure we can see the different sectors of the economy and R&D investments in each of them divided by region. We highlight how while investments in ICT represent more than 50% in the United States, with China approaching these figures, in Europe it barely represents only 20%, giving more priority to other industries such as automotive or health. On the other hand, we can clearly see represented the most powerful companies in each of the regions, in the United States the large platforms, Google or Facebook that offer ICT services, in China the large ICT producer Huawei that has positioned itself as the second most innovative company and with the largest investments in R & D in the world, and Europe with Volkswagen seventh in the list of innovators.

Figure 4: R&D investments by region and sector, 2021



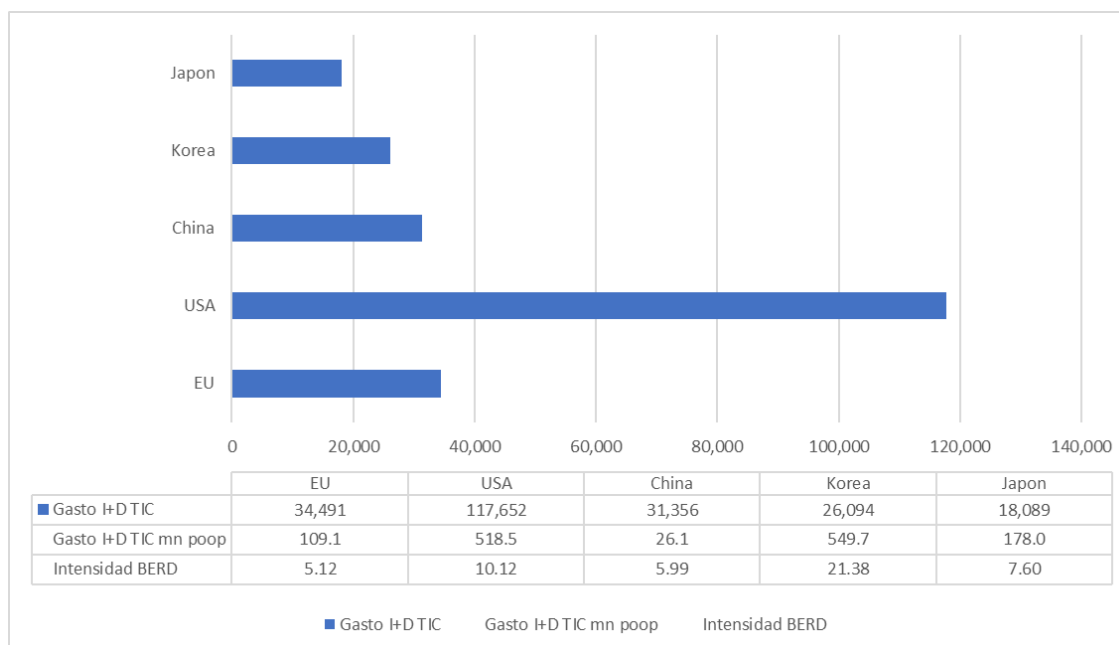
Source: The 2021 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG RTD.

On the other hand, we can see the variations in investments in the last 10 years. We see how the Sino-American trend towards ICT services and products follows a sustained growth, while in Europe there has been hardly any growth in this area. In his view we see how China has managed to increase its digital presence from around zero investments in ICT services to almost € 15 billion, with a growth slope similar to the American one.

As we have seen, the ICT sector is one of the most active sectors worldwide, characterized by its high intensity in R & D [14]. Analyzing the ICT subsectors, we can identify that the service sector is the most dynamic, while Computing and related activities have the largest BERD³; on the other hand, sectors such as manufacturing have been experiencing reductions since 2007.

³ Business Expenditure on Research and Development

Figure 5: BERD effort in the digital sector by region, 2020



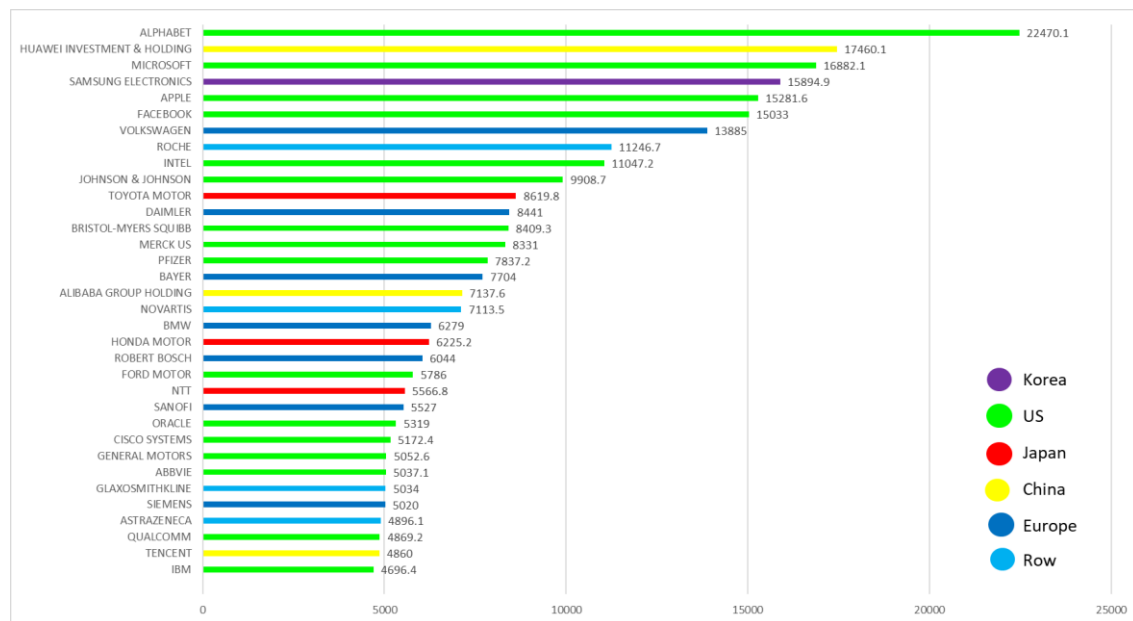
Source: Own elaboration based on data from 2020 Prospective Insights on R&D in ICT

In the figure we can see how despite having a high total expenditure, as soon as we normalize the variable, the European Union is very behind its competitors, surpassing only China. If we look at the EBRD intensity (EBRD/VA) we have the clear dominance of Korea, followed by Taiwan (12.56), the United States, Norway (10.04) and Japan. On the other hand, taking the ICT subsectors, we can see how the strengths of these first two are in the manufacture of electronic components, while the rest of the countries, including the US and Europe are more aware of computing and related activities. With all this we can observe how the center of gravity of ICT is slowly moving eastward. Despite not yet being a great threat, China and India have been showing a very dynamic behavior in all variables for 10 years, leaving behind their traditional role of global factories and betting on the ICT production sector. However, the European Union is not improving its global position which leads us to consider the future of the ICT sector within the Union.

On the other hand, we can look at private investments. In this case, the United States is a clear dominant market, with 16 companies within the top 30, while the rest of the regions have much smaller representation, Korea, China and Europe with 4 companies, and Japan with 2.⁴

⁴ In the figure we have added companies like TSMC as Korean following the indications of the IRI

Figure 6: Ranking of companies operating in the digital sector depending on the R&D expenditure, 2021



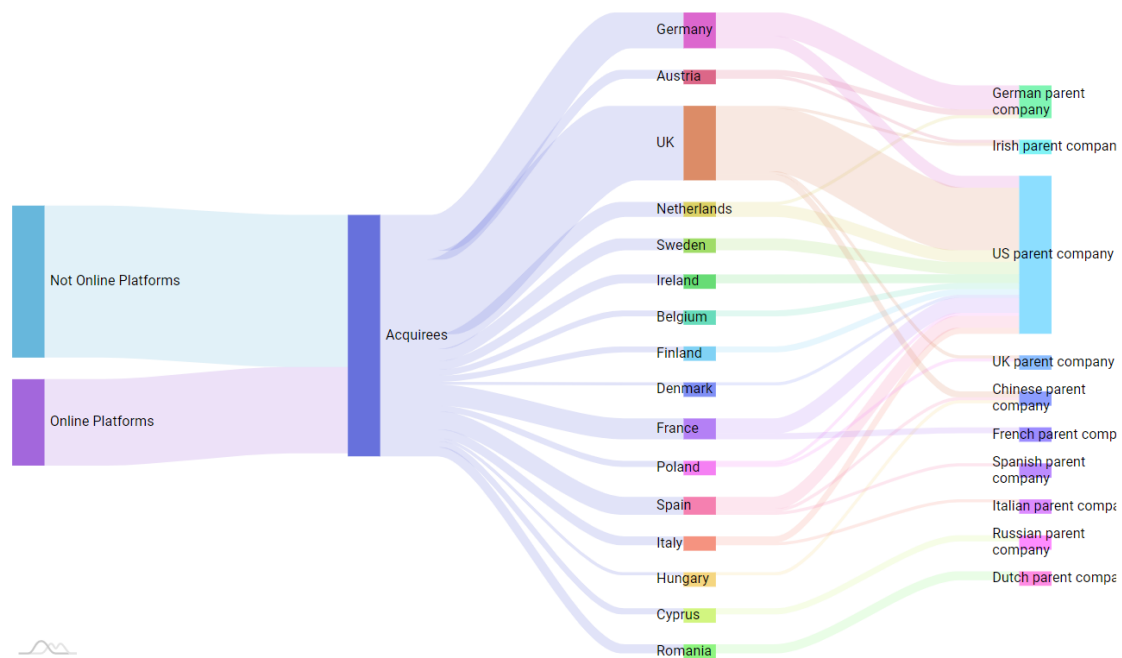
Source: Own elaboration with data from The 2021 Eu Industrial R&D Investment Scoreboard

The main European companies are located in 18 of the 27 European countries, with the majority of investments coming from Germany representing 47.2% of R&D investments, France, with 17.4% and Denmark with 10.3% [15]. In addition, when we look at the top 10 European companies by R&D we see how half belong to the automotive sector, two to the health sector, two to ICT producers and one to ICT services. Despite continuing to grow, ICT services still account for a very small share of Europe's R&D expenditures⁵. With this we can see the European weakness when we compare it with the main ICT innovators, such as the United States, where 5 of the top 10 companies belong to the ICT industry (Apple, Microsoft, Alphabet, Facebook, and Intel), this sector accounting for 30% of R&D investments; or China, with two ICT producers (Huawei and ZTE) and three ICT services companies (Alibaba, Tencent and Baidu). In short, Europe is increasingly resembling Japan, a prosumer with a prominent auto and health industry.

Finally, we can take the number of startups as an indicator of business dynamism. In the next figure we can see the European start-ups acquired during the period 2013-2020, out of which 35% are classified as online platforms. Over 30% of these companies are from the UK, 15% from Germany, 9% from France, and 7% from Spain. The major acquirer is the United States, that represents over 65%, the next biggest buyer is Germany with 14%.

⁵ ICT services account for 7% of spending while cars account for 34.8%

Figure 7: Mergers and acquisitions of EU start-ups (2013-2020)



Source: Observatory on the Online Platform Economy

We can see that one of the biggest problems with the European Start-up ecosystem is that very few of these companies reach beyond the start-up stage, and the majority sell to the big platforms in the US, particularly Google, Meta and Verizon.

Article 8 Regulatory Environment

The regulatory environment plays a very important role in Europe, who in the past few years has been updating its framework to keep up with the technological innovations. In the following table we show the comparison of the different regulatory initiatives that Europe is pushing forward compared to the US and China, where dark blue means a passed law, light blue means a proposal, and green means an announced project.

Out of these we highlight the digital services package that includes the Digital Services Act and the Digital Markets Act. It is composed of a set of rules companies, especially large online platforms, must follow to ensure that the rights of the European citizens are upheld, as well as ensure that there is fair competition inside the digital single market.

Table 4: EU, US, China regulation comparative

EU	US	China
Proposal for a Regulation of the European Parliament and of the Council on a Single Market For Digital Services (Digital Services Act) and amending Directive 2000/31/EC COM(2020) 825	S.1957/ H.R.5792 - State and Local Digital Service Act of 2021	
	S.1896/H.R.3611 - Algorithmic Justice and Online Platform Transparency Act	
	H.R.6796 - Digital Services Oversight and Safety Act of 2022	
Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act)	S.2992/ H.R.3816 - American Innovation and Choice Online Act	Electronic Commerce Law of the People's Republic of China (Effective Aug 31, 2018)
	S.3197 - Platform Competition and Opportunity Act of 2021	
Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act) COM(2022) 46	CHIPS and Science Act	
	H.R.4521 – United States Innovation and Competition Act of 2021	
Proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937 COM(2020) 593	H.R.2211 - Central Bank Digital Currency Study Act of 2021	
	H.R.5101 - U.S. Virtual Currency Market and Regulatory Competitiveness Act of 2021	
Regulation (EU) 2022/1925 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 (Data Governance Act)	S.4200 - Secure Research Data Network Act	Data Security Law of the People's Republic of China (Effective June 10, 2020)
Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on harmonised rules on fair access to and use of data (Data Act)	S.1477 - DATA Act	Cybersecurity Law of the People's Republic of China (Effective June 1, 2017)

COM(2022) 68		
Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act)	S.3600 - Strengthening American Cybersecurity Act of 2022	
	H.R.1668 - IoT Cybersecurity Improvement Act of 2020	
Proposal for a Directive of the European Parliament and of the Council on measures for a high common level of cybersecurity across the Union, repealing Directive (EU) 2016/1148	S.2520 - State and Local Government Cybersecurity Act of 2021	
COM(2020) 823	S.1917 - K-12 Cybersecurity Act of 2021	
Directive (UE) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union [under revision]	S.402 - Network Security Trade Act of 2021	
Regulation (UE) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC [under revision]	H.R.4258 - Improving Digital Identity Act of 2021	

Article 9
European Digital Sovereignty in a globalization context

Globalization has led to certain countries specializing in the production of certain goods, making them dependent on other countries and these on them. We find many benefits derived from this process, such as the growth of world trade and the reduction of labor costs due to outsourcing. However, we can also find a decreasing distrust in public institutions and a shortage of suppliers.

The U.S.-China trade dispute has caused companies to re-examine their supply chains. Priorities are shifting from efficiency and "on time" to resilience, redundancy of supplies and regionalization. In addition, the United States is leaving aside China as a producer, opting for other countries such as Mexico or suppliers from other Asian countries where costs are lower.

The trade war has led to Huawei being removed from the 5G networks of the United States and their allies. These restrictions have represented a great opportunity for European companies such as Ericsson or Nokia. [16]

Another of the vulnerabilities of the production chains can be seen reflected in the recent semiconductor crisis, which has paralyzed numerous sectors of the economy (automotive, mobile phones, 5G infrastructures, etc.) This lack of supplies has led Europe to mobilize its funds for the creation of European chips under the new European Chips Act. [17]

Article 10
5G Analysis

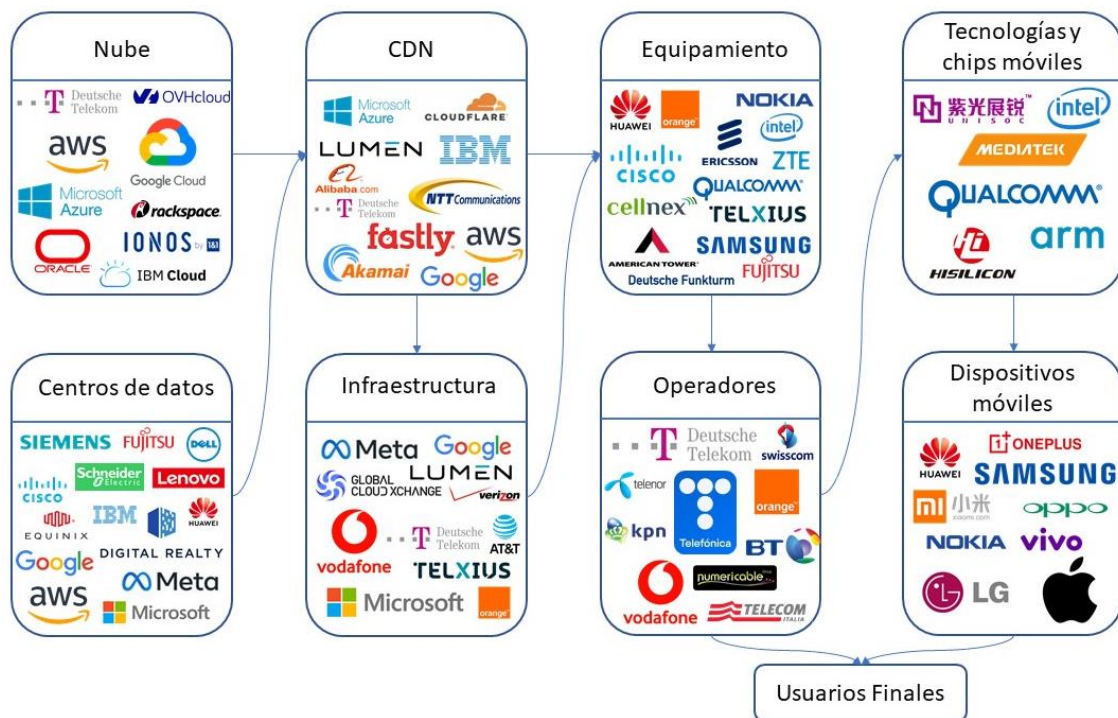
For some years, 5G has taken on great importance as the future of global mobile communications. All operators are deploying networks in record time to be able to offer their users the capacity they demand. New immersive reality applications, telecommuting and *Video-On-Demand* are putting operators' networks to the test. However, it is not only ordinary citizens who require the benefits of 5G, developments in Industry 4.0 and IoT will be the largest source of data circulating on the network, generating 79.4 ZBytes of data in 2025. [18]

Europe has recognized the potential of this new technology, as well as the importance of the technologies that surround it: Artificial Intelligence, *Cloud Computing* and *Edge Computing*. To this end, it has developed an extensive regulatory framework in addition to making extensive investments through the *Next Generation Fund* and Horizon Europe.

However, Europe is far behind the main global 5G powers: the United States and China. That lead in 5G adoption rate, and are estimated to be the biggest markets for this technology in the near future [10]

When we look at the 5G value chain, we can identify most of the companies belonging to these countries are in the most critical steps, that is cloud, infrastructures, and the mobile technology development.

Figure 8: 5G value chain

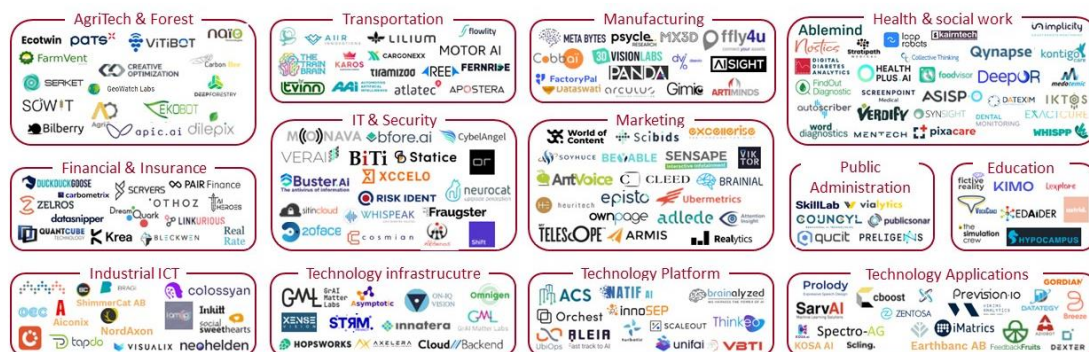


Article 11 AI Analysis

AI has become in a few years one of the main enablers to gain control of the new digital ecosystem. However, countries try to achieve their sovereignty from different areas, Europe focused on the creation of a reliable Artificial Intelligence, which works with and for people always putting the well-being and security of the latter at the center; The United States, which sees an Artificial Intelligence very driven from the business world and with a great capacity for innovation but also with a great potential for damage if it is not correctly monitored; and finally China, which from a state protectionism seeks to compete with its American rival both in a business field and from the state level. [19]

In the following figure we can see the AI start-up landscape in Europe.

Figure 9: AI start-up landscape in Europe

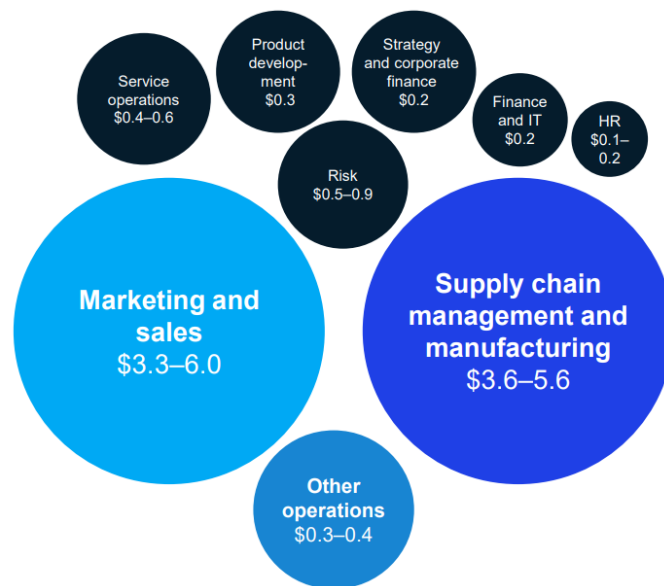


Source: Own elaboration based on data from <https://www.ai-startups-europe.eu/>

It is important to highlight the importance of AI in the marketing and supply chain management sectors. According to the Technology Trends Outlook by McKinsey, the potential value at stake

form AI is \$10 to \$15 trillion, with leaders adopting AI exhibiting a stronger financial performance.

Figure 10: Global annual potential, forecast. Value at stake, \$ trillion



Source: McKinsey Technology Trends Outlook 2022. August 2022

Article 12 Blockchain Analysis

Blockchain is a technology that allows information to be recorded in a decentralized manner. The core of the Blockchain is a shared database, of which all users have their own copy, so if a user wants to change their copy, it would be different from the rest, and the action would not be considered valid. Thanks to this, the Blockchain can be used as a secure way to store information on which all parties involved agree. [20]

Although there are variants of the technology, we can find some common features: they have a means of communication between the nodes of the network, they have a mechanism so that each node can send a transaction to be accepted, and they have a mechanism for the rest of the nodes to accept the transaction and incorporate it into the database. The Blockchain gets its name from the fact that the information is stored in blocks, which once accepted are joined to the previous ones by cryptographic techniques, creating a chain. The United States is expected to get the most revenue from Blockchain technology, particularly since one of its most notable applications was banned in China: Bitcoin. [20]

Chapter IV

Internet Fragmentation

According to ICANN, Internet Fragmentation *is the idea that the Internet may be in danger of splitting into a series of cyberspace segments, endangering its connectivity* [21]. It has been a growing concern in the Internet governance community since 2015, after the Snowden Revelations (2013), the creation of the Chinese Firewall (2008), and the problematic transition from IPv4 to IPv6 (starting in 2011) however, during those times, there was not a widespread consensus of what the term fragmentation did or did not entail. In 2020, the issue began to surface again, as governments began to search for their Digital Sovereignty in regulation, from Europe

with the Digital Services and Markets Act (Dec 2020), the General Data Protection Regulation (Entered in May 2016, applied since May 2018), and the new DNS4EU project under the Connecting Europe Facility program [22]. And it has reached its peak now, with the geopolitical tensions that are growing between the east (China and Russia) and the West (US and Europe).

It was the idea of a network that breaks into splinters that gave birth to the term “splinternet”. First used in 2001 by the Cato Institute [23], where they propose the division of the internet as a solution to the increasing fragmented regulations that were appearing and proposing “*To escape the regulation trap of the commons, the Internet should splinter and go private. [...] Instead, owned Internets-proprietary “Splinternets” where prespecified ground rules regarding privacy and other governance issues replace regulation and central planning-may be superior*”. Since then, the term has gotten increased bad connotations, turning from solution to issue. The Internet Society (ISOC) has since redefined the term as “*the idea that the open, globally connected Internet we all use splinters into a collection of isolated networks controlled by governments or corporations*”, where sites and content are blocked depending on the geographical situation of the users [24].

According to the World Economic Forum (WEF), Internet Fragmentation can appear in three forms: Technical, Governmental, and Commercial [25].

- Technical Fragmentation: conditions in the underlying infrastructure that impede the ability of systems to fully interoperate and exchange data packets and of the Internet to function consistently at all end points. It can come from network addressing, firewalls, DNS splitting, private network isolation, etc.
- Commercial Fragmentation: Business practices that constrain or prevent certain uses of the Internet to create, distribute, or access information resources. It can come from peering and standardization, network neutrality, geo-localization and geo-blocking, etc.
- Governmental Fragmentation: Government policies and actions that constrain or prevent certain uses of the Internet to create, distribute, or access information resources. It can come from Digital protectionism, “cybersovereignty”, data transborder movement prohibitions, etc.

However, fragmentation usually comes from political decisions that have consequences in these three areas, so there are times when the same action can appear on different forms of fragmentation.

Technical Fragmentation

One of the main principles of the internet relies on interoperability, that is, any connected device can exchange packets with any other device, regardless of their geographical position or their manufacturer. This is thanks to a global system of internet addresses and domain names, and a global DNS standard, always relying on a basic connectivity.

Currently, we can find many countries that are distancing themselves from the unity of the Internet, beginning in China, where since 2008, its Firewall has been blocking certain content from reaching users. One of the turning points in the process was in 2009, after riots in the western region of Xinjiang led to government blocking of many sites, mostly run by American companies, such as Twitter, Facebook, and Hotmail [26]. Since then, we have seen tighter restrictions around the Big Tech companies, including the Google search Engine and Wikipedia. More recently, we are seeing the same restrictions being applied in Iran, where the Government has begun restricting internet access, with long blackouts [27], after protesters took to the street to protest against the death of Mahsa Amini, a 22-year-old woman in police custody. The move is not new in the country, where in 2019 users experienced a four-day internet blackout as a response to the riots that have since become the bloodiest in the country’s recent history [28].

Also distancing itself from the global internet is Russia, who in 2019 approved the "sovereign internet" law introducing new controls on the Internet and giving officials and giving wide-ranging powers to restrict traffic on the Russian web. Similar to the US section 706 of the communications act, although less restrictive, the Russian president can disconnect the country's network from the global internet in cases of emergency. The law also demanded service providers to install equipment capable of filtering and sourcing the information going through the nodes [29]. Also, as part of these policies, the Russian government began testing in February 2019 unplugging the country's internet as part of a test of its cyber-defences, primarily after NATO began to consider sanctions due to the continuous cyber-criminality seen in the country. Under the Digital Economy National Program, Russian networks need to continue operating even after foreign powers act to isolate the country, meaning that Russia would have to build its own version of the net's address system (DNS) [30]. The tests concluded in December that year, with successful results [31]. However, after the war in Ukraine began, the Russian internet was left undisrupted, with the US and Europe agreeing that sanctions should not interfere with the functioning of the country's networks. Despite these statements, many online companies have left the country, including Meta, Google, and Apple [32]. Lastly, Ukraine asked ICANN, the Internet Corporation for Assigned Names and Numbers, to revoke domain names (.ru) and shut down primary DNS servers in the country, however, ICANN refused the move, arguing that *"our mission does not extend to taking punitive actions, issuing sanctions, or restricting access against segments of the Internet – regardless of the provocations. [...] Essentially ICANN has been built to ensure that the Internet works, not for its coordination role to be used to stop it from working."* [33]

Europe is also trying to create their own digital ecosystem that doesn't rely on these countries. Therefore, under the Connecting Europe Facility programme, they are developing the European DNS System. The DNS *will be transparent, conform to the latest security, data protection and privacy by design and by default standards and rules, and form part of the European Industrial Alliance for Data and Cloud* [34]. One of the main issues around DNS diversification is the compliance with all protocols that conform it, and the inability of institutions to confirm if the protocols are being upheld, having to rely on measured parameters.

Commercial Fragmentation

Commercial fragmentation may appear as a result of certain practices by digital companies. One of the most important issues is net neutrality and technical standardization.

Net neutrality consists in Internet Providers treating Internet traffic equally [35]. The most recent issues concerning net neutrality is the recent fight between telecom operators and internet platforms. We have witnessed this fight in Korean ground, where SK Broadband demanded Netflix to pay for infrastructure usage, after the broadcasting of the popular series "The Squid Game" pushed the network to its limits. Netflix tried to ease the burden by installing new cache servers, however, the Korean operator took legal action against the platform that resulted in Netflix having to pay for the usage of the Korean network [36]. The European Commission had stayed "neutral" to this fight, but that is no longer the case. According to the highly influential and well-informed POLITICO newspaper, the European Commission will set forth a proposal for the "Connectivity Infrastructure Act", where the Big Tech could be forced to contribute to the deployment of the European 5G network. We've had hints of a new legislation for quite some time, Thierry Breton had previously said that legislators would see a fair return for telecom's investments in infrastructure by the end of 2022 [37], not too long afterwards the European Council also hinted at an additional tax by saying that *"all market actors benefiting from the digital transformation" should assume their social responsibilities and "make a fair and proportionate contribution to the costs of public goods, services and infrastructures,"* [38], so the arrival of a new legislation seems only the next natural step. Europe had set very ambitious

connectivity goals in their digital compass, including a connectivity goal of “*gigabit for everyone and 5G everywhere: All European households will be covered by a Gigabit network, with all populated areas covered by 5G*” by 2030 [39]. However, the deployment seemed slower than anticipated, and the goal began to look unachievable, with telecom operators struggling to pay for spectrum licenses and complete deployment of infrastructure. The proposal could include putting into law the guidelines set in the Connectivity Toolbox by the European Commission, a recommendation on Very High-Capacity Networks, and a revision of the broadband state aid guidelines [40].

On the other hand, we have technical standardization, and the problems arriving from proprietary solutions. This problem becomes critical when a massive number of devices is introduced into the network as in the case of IoT. One of the most critical fights we have witnessed over the years was between Ios and Android for the phone market, however, recently we are seeing companies in the area of IoT that are creating the same proprietary solutions, such as LoRa and Zigbee.

Finally, we have issues deriving from geo-blocking, that is, personalizing the user experience depending on their geographical location.

Governmental Fragmentation

Regarding governmental fragmentation, it is important to first clear the concept of digital sovereignty, for we can find many definitions depending on the source. For our case Digital Sovereignty is *A Country's ability to act independently in the digital world* [41]. However, there is a very thin line between Digital Sovereignty and Digital Protectionism, a country's ability to censor certain sites and data movements to undercut foreign competitors and boost local companies [42]. One clear example of this practice is China, who besides technically blocking certain content through their firewall, they have also been blocking certain platforms to boost the growth of their own digital giants, a clear case is the blocking of Amazon to allow the growth of Alibaba or blocking Facebook and Twitter to feed WeChat.

Those countries that have not performed these practices are seeing their local digital companies unable to compete with the Big Tech; therefore, they rely on regulation to restrict certain practices that do not adhere to their principles and values. In Europe, the most recent example is the Digital Services Act and the Digital Markets Act, however, one of the most controversial regulations was the GDPR. The GDPR gives consumers more control over their personal information and has been the cause of some of the largest fines imposed on the Big Tech in Europe.

Another form of governmental fragmentation is the content censorship, as has happened in Russia, where the Big Tech companies Google and Meta face multi-million-dollar fines for not deleting content deemed illegal in the country [43], one of the latest was in the 18th July when Roskomnadzor fined Google LLC 21.077.392.317,8 rubles for not removing content regarding “the military operation in Ukraine”, becoming the largest fine to a tech company in the country's history.



Another issue coming from the geopolitical war between eastern and western countries is the recent US barring tech firms that receive federal funding from building factories in China in the next ten years [44]. Showing the country's determined position to remain a technological leader in the next years.

Chapter V

SWOT Analysis

Finally, we can summarize all our findings in a SWOT matrix. Beginning with Europe, we can highlight as one of the main European Weaknesses the lack of leader companies that contribute to the creation of a private-lead innovation environment; as one of the main Threats their tend to base their digital sovereignty on a very strict regulation of the digital platforms that can lead to a deceleration of the innovation on European ground and lack of stimulation for small companies to grow in fear of being subjected to a very close scrutiny; as one of the main Strengths we have that the two main European companies, Nokia and Ericsson, have risen to the role of European digital suppliers; and finally, as one of the main Opportunities we have the huge investments form the Commission aiming to create this ecosystem, now with the distribution of the new funds, Horizon Europe and Next Generation.

Table 5: SWOT Matrix of the Digital Ecosystem in Europe

 Weaknesses	 Strengths
There is a great dependence on third country companies, specially from the US. We can see these companies dominate the main bottlenecks, including cloud and data centers. This is particularly worrying when we look at the exploitation of data stored in these facilities.	Europe is one of the biggest markets for the development of new digital technologies. With its high living standards and high GDP per capita it has become the most relevant market for the deployment of innovation like the metaverse.
Europe is the only country where telecom operators have declining revenues. This becomes a great disadvantage when competing with the other two economies. However, we must bear in mind that while the telecom operators in both the US and China have access to the entire population and territory, in Europe we have hundreds of operators, as each country has three or four working in their territory, meaning that the European operators work on a much smaller territory and market.	The two most important European companies, Nokia and Ericsson have become very relevant in the deployment of next generation networks, most importantly 5G.
Europe not only has a huge dependency with the American online platforms (Google, Amazon, Microsoft, Apple, Meta, etc.) but is also missing from the top company's list, where we find the US, China, South Korea, and Japan.	



Threats

The economic, social, and digital differences between countries cause a rupture in the digital single market. These differences exist because each country keeps pushing to achieve their own interests in the global market.

There exists a great threat of overregulating the environment searching for digital sovereignty. This overregulation could lead to companies exiting the environment and reflect on a decrease in innovation and business dynamism. It is critical for Europe to ensure the level playing field while making sure that it is still attractive to companies.







Opportunities

It is home to some of the most innovative countries in the world: Finland and Sweden through Nokia and Ericsson respectively. However, Europe is very strong in many other sectors such as textile and automotive, as it is home to the biggest companies in these areas, with Inditex, Louis Vuitton, and Volkswagen. This represents a great opportunity of growth for Europe, as these companies are digitalizing at a great speed and could soon become digital leaders in their areas.

The European Commission is pushing forth their digital policies with huge amounts of funding that, if well spent, could place Europe among the technological leaders.

Next, we show the SWOT matrix for the US. We can see how in this case we have as the main strength the huge business dynamism, as weakness the fragmented regulation existent between states, as main threat the increasing relevance of Asian markets that is threatening the “empire” created around American companies, and as main opportunity the new funding sources for innovation and research that the government is setting forth.

Table 6: SWOT Matrix of the Digital Ecosystem in the US

 Weaknesses	 Strengths
<p>There is a very relevant fragmentation between states regulations, that can vary very quickly in time, giving companies very little time to adjust to the changes, and becoming a great disadvantage when compared to a truly united region like China.</p>	<p>It is home to the most innovative companies in the world, leading in R&D with a huge gap with respect to its competitors.</p>
	<p>It dominates the critical bottlenecks in the digital ecosystem chain, being for instance one of the main nodes in global internet traffic, as we can see in the network of submarine cables. This gives them great advantage when it comes to on one hand controlling certain traffic from one region to another, and on the other hand</p>
 Threats	 Opportunities
<p>It is in a great battle with the Asian economies, especially China, that is currently expanding to the growing markets, taking away the American advantage in these areas.</p>	<p>The government is starting to involve itself more on the research and development of digital technologies, increasing federal funding and giving American companies more advantages in their market.</p>
<p>The new policies include bigger bans on trade with China, not only reducing the market for companies, but also creating a risk to supply chains.</p>	

Finally, we can see the analysis for China, from which we highlight as main strength the market size, as main weakness we have the close relationship between government and companies that has led to a lack of competition in the market and the creation of monopolies; as main threat we have the increasing geopolitical tension with the US and its allies, and as main opportunity we have their expansion towards emerging economies.

Table 7: SWOT Matrix of the Digital Ecosystem in China

 Weaknesses	 Strengths
<p>Their closed protectionism has led to a great development of their own companies that have thrived in their own environment, however, their reluctance to accept other companies in their market has led to a lack of competition, where we can see for instance Alibaba as the sole proprietary of the cloud services in the entire country.</p>	<p>Their market size and access to pool of workers at very little price, gives them a huge advantage with respect to their competitors. However, by trying to leave their “world factory” role behind, China is starting to prioritize the development of high skills among the workforce.</p>
	<p>They are among the most important chip exporters in the world, making many countries dependent on their technology for their own digital development.</p>
 Threats	 Opportunities
<p>The growing concerns in western countries towards the Chinese expansion in emerging economies and the security concerns arriving from the close relationship between companies and the public sector has led to many western allies blocking Chinese products and services.</p>	<p>Their cheap prices have made them the preferable option for digital growth in emerging countries, which not only gives them access to a huge market and data pool but also a dew source of allies.</p>
<p>After the pandemic, the country entered a zero-covid policy that has led to a closure of frontiers and trade. This could have devastating consequences for the economy and for their growth as a digital super-power.</p>	

Chapter VI

Conclusions and Recommendations

The geo-politization of the economy is causing a disruption in the competition laws of the market, as companies and countries are looking to protect their interests and remove competitors. The control of production chains and the use of new digital technologies have become key in controlling the global digital ecosystem. Digital transformation will become the main source for economic development and competitiveness among nations, with data becoming the new enabler for economies and companies.

Innovation and Digital Development in the EU is weak when compared to the US and China, the main reasons are:

1. Lack of big tech companies (Unicorns) that compete across the different areas of the digital ecosystem.
2. Lack of digital industry drive, reflected in small investments in R&D, low generation of ICT patents and lack of development of start-ups.
3. Digital concentration, where a handful of European companies drive the European digital transformation, from the R&D in Sweden and Finland to the Mechanical industry in Germany.

The EU needs to implement an efficient public policy for the development of digital technologies, first solving the breaches existent in the single market to ensure that the European companies have the same opportunities as their American or Chinese counterparts. In order to achieve this we must:

1. Eliminate internal trade barriers that impede technological trade among the Union
2. Promote R&D&I (Research, Development and Innovation) in both the public and private sectors.
3. Make use of the potential of open innovation.

Europe is aware of the weaknesses in its digital economy compared to the technological leaders and is investing to improve its technological capabilities and remove those barriers that prevent this development. Europe has great strengths in many other sectors outside the digital areas, retail, health services, transport, and car manufacturing are a clear example of the European potential. Europe needs to push these sectors and ensure that the digitalization policies are bringing the expected revenues.

Chapter VII

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