Report on BEREC
International Mission to USA

11 June 2020

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1. Introduction and acknowledgements

BEREC Chair 2020 Mr Dan Sjöblom (PTS) and the Vice-Chairs Mr Jeremy Godfrey (ComReg, Mr Van Bellinghen (BIPT), Dr Monika Karas (NMHH), Mr Tonko Obuljen (HAKOM) accompanied by Mr Sasho Dimitrijoski (AEC), Mr Ola Bergstrom (PTS), BEREC CN Chair 2020 and Mr Tom Boyce (ComReg), travelled to the West Coast of the United States of America (USA) to meet senior policy makers, technical and project leads from global industry stakeholders as well as academics that are leading research into self-programming networks.

The meetings were held in Silicon Velley, San Diego and Los Angles and covered a wide range of topics. The BEREC delegation was interested in topics that would previously have been considered "adjacent to" the telecommunications sector and, therefore, outside BEREC's remit but in a converging world are becoming more relevant, including: insights from large players of the digital economy, standards in telecoms including joint standards for 5G networks, new network deployments, Internet governance, convergence between content and telecoms providers as well emerging technologies and developments in telecoms network.

We would like to warmly thank all the people we met in the USA for their generosity of time and hospitality.

About BEREC

The Body of European Regulators for Electronic Communications (BEREC) was initially established by Regulation (EC) No 1211/2009 as part of the Telecom Reform package. On 11 December 2018, the European Parliament and of the Council adopted Regulation (EU) 2018/1971, establishing BEREC and the Agency for Support for BEREC (BEREC Office), repealing Regulation (EC) No 1211/2009.

BEREC is an independent EU body composed of the National Regulatory Authorities (NRAs) for the electronic communications sector from the Member States and the European Commission, to which participation is open to NRAs from European Economic Area States and third countries, in particular candidate countries which facilitates the consistent application of the electronic communication framework throughout the European Union. BEREC's mission is to contribute to the development and better functioning of the internal market for electronic communications networks and services. In particular, BEREC develops and disseminates among NRAs regulatory best practices, such as common approaches, methodologies or guidelines on the implementation of the EU regulatory framework. BEREC also assists the European Commission and the national regulatory authorities (NRAs) in implementing the EU regulatory framework for electronic communications. It provides advice on request and on its own initiative to the European institutions, and complements at European level the regulatory tasks performed at national level by the NRAs.

BEREC has a system of rotating Chairmanship and the BEREC Chair of 2020 is from PTS, the Swedish NRA. The Board of BEREC, the Board of Regulators (BoR) is composed of one member per Member State, who is the head or a member of the collegial body, appointed by the NRA that has primary responsibility for overseeing the day-to-day operation of the markets for electronic communications networks and services

BEREC's annual study trip

Each year, BEREC organises a visit to a non-member country to gain insights from the local electronic communications markets and digital ecosystem. During a typical study trip, the BEREC delegation meets representatives of the NRA, the relevant ministries, as well as incumbent operators, new entrants and other stakeholders in the industry. Past destinations include Japan, Canada, India and China.

2. General area visited

The West Coast of the USA has for many decades been a centre of innovation and companies based there are often world leaders in their field. California was recently ranked in a 2019 Blomberg analysis as being the most innovative economy in America. This analysis was based on six equally-weighted metrics: research and development intensity, productivity, clusters of companies in technology, "STEM" jobs, populous with degrees in science and engineering disciplines, and patent activity.

For these reasons, it was decided that the West Coast was a prime location to meet with key ICT companies, to see what is "hot" in their areas of interest. These companies operate in what may previously have been considered as adjacent sectors but are increasingly becoming of interest to BEREC in the context of the forthcoming legislative initiatives from the Commission. The trip spanned the week Monday 20 January to Friday 24 January 2020 and included visiting Silicon Valley in the San Francisco area along with visits to San Diego and Los Angeles.

2.1. General information about Silicon Valley

Silicon Valley is a region in the southern part of the San Francisco Bay Area in Northern California that serves as a global centre for high technology, innovation, venture capital, and social media. It corresponds roughly to the geographical Santa Clara Valley. San Jose is the Valley's largest city; other major Silicon Valley cities include Sunnyvale, Santa Clara, Redwood City, Mountain View, Palo Alto, Menlo Park, and Cupertino.

Silicon Valley is home to many start-up and global technology companies. Apple, Facebook and Google are among the most prominent. It's also the site of technology-focused institutions centred on Palo Alto's Stanford University.

2.2. San Diego

The economy of San Diego is influenced by its deep-water port, which includes the only major submarine and shipbuilding yards on the West Coast. It is therefore not surprising that the largest sectors of San Diego's economy are defence/military, tourism, international trade but San Diego also has a thriving research/manufacturing sector. San Diego hosts several major

producers of wireless cellular technology. Qualcomm was founded and is headquartered in San Diego, and is one of the largest private-sector employers in San Diego. Other wireless industry manufacturers headquartered here include Nokia, LG Electronics, Kyocera International, Cricket Communications and Novatel Wireless.

2.3. Los Angeles

Los Angeles is a sprawling Southern California city with a population of nearly four million people, making it the country's second most populous city after New York City. It is famous as being the centre of the nation's film and television industry, with studios such as Paramount Pictures, Universal and Warner Brothers located in the Hollywood and Burbank areas.

Los Angeles also has a long association with the aviation industry and the presence of research universities like USC, an engineering powerhouse, along with UCLA and Caltech, built impressive graduate programs, which fed this sector. Aeronautical companies such as Lockheed, Douglas, Northrop and Hughes Helicopters were all established in the Los Angeles suburbs and aerospace in Los Angeles was born out of this aviation industry.

3. Overview and summary of meetings held by the BEREC delegation

3.1. Apple Inc.

Apple Inc. is a multinational technology company headquartered in Cupertino, California, that designs, develops, and sells consumer electronics, computer software, and online services.

Initially Apple Inc., was known for manufacturing and selling Apple I, Apple II and iMac personal computers in competition with Microsoft Windows-based rivals. However, rivals, since the launch of the iPhone in to great critical acclaim and financial success in 2007, Apple Inc. is now known as a world leader that designs, develops, and sells consumer electronics, computer software, and online services.

The company's hardware products include the iPhone smartphone, the iPad tablet computer, the Mac personal computer, the iPod portable media player, the Apple Watch smartwatch, the Apple TV digital media player, the AirPods wireless earbuds and the HomePod smart speaker. Apple's software includes the macOS, iOS, iPadOS, watchOS, and tvOS operating systems, the iTunes media player, the Safari web browser, the Shazam acoustic fingerprint utility, and the iLife and iWork creativity and productivity suites, as well as professional applications like Final Cut Pro, Logic Pro, and Xcode. Its online services include the iTunes Store, the iOS App Store, Mac App Store, Apple Music, Apple TV+, iMessage, and iCloud. Other services include Apple Store, Genius Bar, AppleCare, Apple Pay, Apple Pay Cash, and Apple Card.

Its worldwide annual revenue totalled $265 billion for the 2018 fiscal year. Apple is the world's largest technology company by revenue.

Senior executives from Apple Inc. told the BEREC delegation about the key role that privacy plays in the company and is adopted as one of its core values. They explained that four operating principles reflect the importance of the company's privacy programme:

- Data minimisation - to only collect personal information where it makes sense to do so. The executives explained that the company does not collect or retain identifiable information about individuals.

- On device processing – this involves using machine learning to enhance privacy so others do not see the users data. This results in algorithms in the cloud being pushed to devices, where the processing occurs, rather than uploading data to the cloud for processing.

- Transparency and choice – Apple executives explained that GDPR sets the standard for Apple and the company's approach is that the burden is on Apple to prove that a person actually consented to have their data accessed/processed.

- Security – is of critical importance, considering that health data and payment data is held on devices. Apple has a privacy engineering group, which depends on the high quality radios, sensors and computing power to ensure the necessary level of security on Apple devices.

There was discussion among the parties about the impact that the European Electronic Communications Code (EECC), which will introduce a new definition of electronic communications services (ECS), may have on services such as Facetime and iMessages in the context of lawful intercept request.

Apple executives gave some insights into the envisaged features of Next-Generation 112, which may include; 2 and 3 way video, the ability to send photos and video and the location of the phone along with location-based calling allowing for the routing of calls to the correct PSAP.

Before the meeting concluded, there was a general discussion on a broad range of topics, including, security in 5G networks, AI in the context of the Commission's stated objective to initiate AI legislation within 100 days of taking office.

3.2. Stanford University

Stanford University is a private research university in Stanford, California. It is known for its academic achievements, wealth and location within Silicon Valley; it ranks as one of the world's top universities.

Stanford University today comprises seven schools and 18 interdisciplinary institutes with more than 16,000 students, 2,100 faculty and 1,800 postdoctoral scholars. Stanford is an international institution, enrolling students from all 50 U.S. states and 91 other

As of March 2020, 83 Nobel laureates, 28 Turing Award laureates and 8 Fields Medallists have been affiliated with Stanford as students, alumni, faculty or staff. In addition, Stanford University is particularly noted for its entrepreneurship and is one of the most successful universities in attracting funding for start-ups. The university is described as having a strong venture culture in which students are encouraged, and often funded, to launch their own companies. Stanford alumni have founded numerous companies including Alphabet Inc., HP Inc., Cisco Systems, and Netflix. In addition, Stanford students and alumni have won 270 Olympic medals including 139 gold medals.

The BEREC delegation met with:

- Professor Nick McKeown, Professor in the School of Engineering and Professor of Computer Science

- Professor Barbara van Schewick, who is a Professor of Law and Helen L. Crocker Faculty Scholar at Stanford Law School, Director of Stanford Law School's Center for

Internet and Society, Professor by courtesy of Electrical Engineering in Stanford University's Department of Electrical Engineering, and

- Yiannis Yiakoumis, PhD graduate from Stanford University (EE), working with Professor McKeown and a co-founder and CEO at Selfie Networks.

Discussions were initially focussed on Professor McKeown's work on Self-Programming Networks, which is a project intended to allow network operators cope with the challenges of managing networks that continue to get bigger, faster, and more complex and must connect to everyone and everything and support diverse applications with varying workloads. Professor McKeown explained that a self-programming network will do its own configuration, maintenance and verification, maximise its resource utilisation, provide differentiated and deterministic SLAs to applications and users, support varying workloads and provide an interactive dashboard for users and operators in accordance with the operators high-level policies.

Professor McKeown highlighted that 80% of the worlds switches and routers are owned by cloud providers, and 7,000 RFC standards are mainly owned by equipment vendors, so self-programming networks will, like SDN (which came from Stanford), introduce fundamental business change for network operators to control their networks.

Yiannis Yiakoumis outlined the work his company undertook over the period of one year to assist a content and application provider (CAP) to become a participant in only 10% of eligible zero-rating programmes in Europe.

Professor van Schewick outlined her into the introduction of user-paid, user-controlled quality of service (QoS) internet access. This is an area that Selfie Networks is involved in, to enable innovative network services in the presence of net neutrality regulations. Professor van Schewick outlined that such user-controlled QoS can be offered and operate within the framework of Europe's open internet regulatory framework.

3.3. Microsoft

Microsoft Corporation is an American multinational technology company with headquarters in Redmond, Washington. It develops, manufactures, licenses, supports, and sells computer software, consumer electronics, personal computers, and related services. Its best known software products are the Microsoft Windows line of operating systems, the Microsoft Office suite, and the Internet Explorer and Edge web browsers. Its flagship hardware products are the Xbox video game consoles and the Microsoft Surface line-up of touchscreen personal computers. In 2016, it was the world's largest software maker by revenue (currently Alphabet/Google has more revenue). The company also produces a wide range of other consumer and enterprise software for desktops, laptops, tabs, gadgets, and servers, including Internet search (with Bing), the digital services market (through MSN), mixed reality (HoloLens), cloud computing (Azure), and software development (Visual Studio).

In April 2019, Microsoft reached the trillion-dollar market cap, becoming the third U.S. public company to be valued at over $1 trillion after Apple and Amazon respectively.

The Microsoft executives that welcomed the BEREC delegation began the meeting by presenting the features of Microsoft Translator. Microsoft Translator is a multilingual machine translation cloud service that is integrated across multiple consumer, developer, and enterprise products; including Bing, Microsoft Office, SharePoint, Microsoft Edge, Skype Translator, Internet Explorer, and Microsoft Translator apps for Windows, Windows Phone, iPhone and Apple Watch, and Android phone and Android Wear and the Microsoft Translator Apps for iOS and Android.

The Microsoft executives delivered a presentation about AI, initially showcasing seeing-AI, which brings significant benefits for the blind and visually impaired. Then then presentation broadened to matters related to the ethics and transparency of AI. Microsoft's position is that companies/organisations should be transparent by allowing individuals the opportunity to opt out of having their data captured and processed. In this regard, the hosts highlighted their position calling for government regulation and responsible industry measures to be introduced to address advancing facial recognition technology. While this technology brings important and even exciting societal benefits but also the potential for abuse.

The executives explained the features of Microsoft's Azure Cognitive Services (and container support), which allows developers to use the same APIs that are available in Azure, and allows service providers flexibility in where to deploy and host the services that come with "containers", including:

- Computer Vision - The Read container allows service providers to detect and extract printed text from images of various objects with different surfaces and backgrounds, such as receipts, posters, and business cards. Additionally, the Read container detects handwritten text in images and provides PDF, TIFF, and multi-page file support.

- Face - Cognitive Services Face provides a standardized Linux container that detects human faces in images. It also identifies attributes, which include face landmarks such as noses and eyes, gender, age, and other machine-predicted facial features. In addition to detection, Face can check if two faces in the same image or different images are the same by using a confidence score. Face also can compare faces against a database to see if a similar-looking or identical face already exists. It also can organize similar faces into groups by using shared visual traits.

Before concluding the meeting there was a discussion between the parties about emergency calling obligations in the EECC as well as aspects of law-enforcement authorities seeking intercept of electronic communications.

3.4. Cisco

Cisco Systems, Inc. is headquartered in San Jose, California, in the centre of Silicon Valley. Cisco develops, manufactures and sells networking hardware, software, telecommunications equipment and other high-technology services and products. Through its numerous subsidiaries, such as OpenDNS, Webex, Jabber and Jasper, Cisco specialises in specific tech markets, such as the Internet of Things (IoT), domain security and energy management.

Cisco was founded in 1984 by Len Bosack and wife Sandy Lerner, at the time two Stanford University computer scientists, who had been instrumental in connecting computers at Stanford. They pioneered the concept of a local area network (LAN) being used to connect geographically disparate computers over a multiprotocol router system.

The company has grown over the decades and today Cisco provides solutions according to three business types; Small business, Midsize Business and Service providers. These solutions are provided by a broad range of technologies, including; Analytics and Automation, Artificial Intelligence, Cloud, Critical Network Infrastructure, Data Centre, Internet of Things, Wireless and Mobility, Security and Software-Defined Networking.

The Cisco representatives gave an overview of the company and its philosophy to support permissionless innovation, which will allow networks to grow. They explained that Cisco is not involved in mobile network radio access network (RAN) and as such its role in cybersecurity of 5G networks is limited – once the signal is passed from the RAN then Cisco is involved. The representatives added that cybersecurity of 5G networks is a matter of trust, constant oversight and technical assessment.

There was a discussion between the parties on the future of telecoms networks and the possibility that very large content providers ("hyperscalers") will seek to position their apps and services closer to the edge and therefore will start to collaborate with network operators. There was further discussion about the potential merits of Wi-Fi 6 and how these might measure up against 5G. After the discussions, the BEREC delegation was given a demonstration of Cisco's solutions for:

- Connected Manufacturing, and

- Connected Public Sector

3.5. Google

Google LLC is an American multinational technology company that specializes in Internet-related services and products, which include online advertising technologies, a search engine, cloud computing, software, and hardware. It is considered one of the Big Four technology companies, alongside Amazon, Apple, and Microsoft.

Google was founded in September 1998 by Larry Page and Sergey Brin while they were Ph.D. students at Stanford University in California.

By 2011, Google was handling approximately 3 billion searches per day. To handle this workload, Google built 11 data centers around the world with some several thousand servers in each. These data centers allowed Google to handle the ever changing workload more efficiently. On January 26, 2014, Google announced it had agreed to acquire DeepMind Technologies, a privately held artificial intelligence company from London. The purchase of DeepMind aids in Google's recent growth in the artificial intelligence and robotics community.

On August 10, 2015, Google announced plans to reorganize its various interests as a conglomerate called Alphabet. Google became Alphabet's leading subsidiary, and will continue to be the umbrella company for Alphabet's Internet interests. Google's stated mission is "..*to organize the world's information and make it universally accessible and useful.*"

The BEREC delegation received a presentation from Google's Vice-President of Engineering Networking, who explained that Google is constantly working to become carbon-neutral in its operation and will invest €3 billion to expand data centres in Europe over the next 24 months.

The Google representatives also presented information on the Open Network Foundation (ONF) in which Google is an active member. ONF is a non-profit operator led consortium that aims to drive transformation of network infrastructure and carrier business models. It serves as the umbrella for a number of projects building solutions by leveraging network disaggregation, white box economics, open source software and software defined standards to revolutionize the carrier industry. The ONF works closely with network operators and other stakeholders and its projects are being used to build the next generation broadband infrastructure and services, to create open source solutions in the rapidly evolving mobile infrastructure space, to deliver advanced cloud-native edge platforms that provide the foundation for supporting new edge services as well as creating and evolving the Software Defined Networking (SDN) movement, which provides network operators with the freedom to build networks that are dynamic, cost effective, flexible and secure.

The Google representatives also outlined that Google provides servers/caches to ISP (content delivery network (CDN)), which handle over 1 Tb/sec of traffic. These caches will serve up to 80% of all data requests, thereby reducing the need to query Google's main data centres. They also explained Google's role as an infrastructure partner, which includes laying underwater cables between North and South America.

The Google representatives delivered a presentation on Google's suite of products and services for Citizen Band Radio Spectrum (CBRS), which is intended to address the rising demand for bandwidth. The CBRS project sees the FCC working with industry players to create a set of CBRS rules for shared spectrum as a new model for adding capacity at a low cost in the 3.5 GHz band. Google's Spectrum Access System (SAS) controls fundamental access to CBRS and the SAS is designed to support dense networks across operators and to scale on-demand. The SAS is supplemented by Google's Network Planner, which provides an accurate, easy-to-use planning over a web browser using integrated Google geospatial data, and running advanced propagation models in the Google Cloud.

There was an open discussion on regulation of AI, where the Google representatives referred to a recent op-ed in the Financial Times, where Google and Alphabet CEO Sundar Pichai set out his case for greater regulation of artificial intelligence. The Google representatives informed the BEREC delegation that Google employs and in-house ethicist and similar AI principles to Google's are being developed and published in Silicon Valley.

3.6. Facebook

Facebook, Inc. is an American social media and technology company based in Menlo Park, California. It was founded by Mark Zuckerberg, along with fellow Harvard College students, originally as TheFacebook.com—today's Facebook, a popular global social networking website. Facebook is one of the world's most valuable companies. It is considered one of the Big Five technology companies along with Microsoft, Amazon, Apple, and Google.

Facebook offers other products and services beyond its social networking platform, including Facebook Messenger, Facebook Watch, and Facebook Portal. It also has acquired Instagram, WhatsApp, and Oculus, and has a 9.9% stake in Jio, an Indian mobile telecommunications company that operates a national LTE network. It does not offer 2G or 3G service, and instead uses only voice over LTE to provide voice service on its 4G network.

The BEREC delegation were given a demonstration of Facebook Portal; a brand of smart displays developed in 2018 by Facebook. The product line consists of four models (Portal, Portal Plus, Portal Mini, and Portal TV) that provide video chat via Facebook Messenger and WhatsApp, augmented by a camera that can automatically zoom and track people's movements. The devices are integrated with Amazon's voice-controlled intelligent personal assistant service Alexa. Facebook uses some types of data collected from Portal devices for targeted advertising though the company later clarified that it analyses the metadata, not the content, of video calls made through Portal devices.

The BEREC delegation were also given demonstrations of Facebook's Oculus Quest and Oculus Rift virtual reality headsets, where the user could select the location (including the environs of the Berlaymont building in Brussels) in which their virtual journey would take place.

After the demonstrations of Facebook's hardware, there was a general discussion between the two parties on a broad range of topics. Facebook representatives, which included its Director of Public Policy, explained that 90% of Facebook users are outside the USA and while Facebook is interested in connectivity issues, it has no plans to become a telecoms service provider. Instead, Facebook is interested in "high-altitude" platforms, it advocates for addition spectrum to be allocated in the 6GHz band for enhanced Wi-Fi and is a member of the ITU and the GSMA. The Facebook representatives also explained that Facebook is an active member of the Telecom Infra Project (TIP), which aims to accelerate innovation in the telecoms industry, coupled with new business approaches and cost efficiencies. They also informed the BEREC delegation that Facebook invests billions of dollars in infrastructure projects, including the laying of sub-sea cables. This fibre is primarily to connect data centres to each other and Facebook is making dark (unused) fibre available to any telecoms operators that the cables pass and who wants capacity.

There was a discussion about the potential regulation of content and the moderation of election material on Facebook's platform. The Facebook's representatives stated clearly that Facebook would welcome regulation in these areas and it is not for companies to decide these matter. They referred to a recent call by Nick Clegg, Vice-President for Global Affairs and Communications at Facebook, for such government regulation – essentially that online companies needed more help to police what is featured on their sites, most notably harmful content and political advertising.

3.7. Qualcomm

Qualcomm is a public multinational corporation established in 1985 and headquartered in San Diego, California. Qualcomm develops software, semiconductor designs, patented intellectual property, development tools and services, but does not manufacture physical products like phones or infrastructure equipment. The

company's revenues are derived from licensing fees for use of its intellectual property, sales of semiconductor products that are based on its designs, and from other wireless hardware, software or services.

The Qualcomm representatives explained that their business philosophy is to be an enabler, with a neutral disposition to all, for operators and device manufacturers. They added that Qualcomm is also pushing AI technology and see the automotive industry as being very important, not just from a connectivity perspective but also from an infotainment approach.

The representatives explained that Qualcomm is central to the activities son how 5G is developed as the company develops the core technology and licences it to network operators and handset manufacturers – Qualcomm makes the chips that goes into 5G technology. In addition to mobile handsets, Qualcomm is also very interested in Industrial IoT.

The BEREC delegation was informed that from Qualcomm's engagement with network operators, there are aggressive plans to roll out 5G networks, not only in the sub 6GHz bands but also in the mm Wave. There are currently 45 network operators rolling out 5G, with 230 further network operators expected to follow in 2021. In Qualcomm's view handset manufacturers are currently running ahead of network operators and they expect that all handset launches n 2021 will be 5G enabled, with mmWave capability being mandatory for the handsets, where mmWave is deployed in the region. As such, the first generation of 5G smartphones will have sub 6 GHz capability but the second generation will have 700 MHz and mmWave capability. Qualcomm expected that there would be 200 million 5G devices purchased in 2020 but that this would increase to 750 million devices in 2022.

As regards network operators, Qualcomm officials noted that 2017-2019 the focus was on a new RAN – this is a once-in-a-decade/15 year event – and 5G rollout is on traditional cellular connectivity services i.e. non-stand-alone 5G, anchored on 4G/LTE technology but new markets will evolve more slowly when the networks move to stand-alone 5G.

The Qualcomm representatives also informed the BEREC delegation that, in their opinion, cloud providers are interested in 5G because it offers the opportunity for latency to be monetised and cloud providers are interested to see how they can be involved. There was a short discussion out the overlap between Wi-Fi and 5G as Release 16 of the 5G standards provides for cellular communications in unlicensed spectrum. Qualcomm representatives believed that while both will be used extensively, cellular communication is seen as more secure compared to Wi-Fi, which uses unlicensed spectrum and in subject to interference and primarily because 5G will be 3-5 times faster than Wi-Fi.

After the discussions, the BEREC delegation was given a demonstration of a 5G handset achieving 1 Gb/sec download speed. The demonstration also highlighted that handset could achieve this type of speed without line-of-sight, as it was able to effectively pick up reflected waves from buildings in the area.

3.8. ICANN

The BEREC delegation met with representatives from the Internet Corporation for Assigned Names and Numbers (ICANN), including its CEO and President, Göran Marby, who is a former Director General PTS as well as being a former BEREC Chair.

Mr Marby and his senior staff outlined ICANN's role and function to the BEREC delegation. ICANN is an American multi-stakeholder group and non-profit organization responsible for coordinating the maintenance and procedures of several databases related to the namespaces and numerical spaces of the Internet, ensuring the network's stable and secure operation. The "multi-stakeholder model" is a community-based consensus-driven approach to policy-making. The idea is that Internet governance should mimic the structure of the Internet itself- borderless and open to all.

ICANN plays a unique role in the infrastructure of the internet. Through its contracts with registries (such as dot-com or dot-info) and registrars (companies that sell domain names to individuals and organisations), ICANN helps define how the domain name system functions and expands.

Much of its work has concerned the Internet's global Domain Name System (DNS), including policy development for internationalization of the DNS system, introduction of new generic top-level domains (TLDs), and the operation of root name servers. The numbering facilities ICANN manages include the Internet Protocol address spaces for IPv4 and IPv6, and assignment of address blocks to regional Internet registries. ICANN also maintains registries of Internet Protocol identifiers.

ICANN's primary principles of operation have been described as helping preserve the operational stability of the Internet; to promote competition; to achieve broad representation of the global Internet community; and to develop policies appropriate to its mission through bottom-up, consensus-based processes.

Before the establishment of ICANN, the Internet Assigned Numbers Authority (IANA) function of administering registries of Internet protocol identifiers (including the distributing top-level domains and IP addresses) was performed by Jon Postel, a Computer Science researcher who had been involved in the creation of ARPANET[1], first at UCLA and then at USC-Information Sciences Institute. The Information Sciences Institute was funded by the U.S. Department of Defence, and Postel's role had come about as a "side task" to this research work.

As the Internet grew and expanded globally, the U.S. Department of Commerce initiated a process to establish a new organization to perform the IANA functions. After consulting widely, it was decided to privatise the management of Internet names and addresses in a manner that allows for the development of competition and facilitates global participation in Internet management. ICANN was formed in response to this policy and ICANN was tasked with managing the Internet Assigned Numbers Authority (IANA) under contract to the United States

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[1] The Advanced Research Projects Agency Network (**ARPANET**) was the first wide-area packet-switching network with distributed control and the first network to implement the TCP/IP protocol suite

Department of Commerce (DOC) and ICANN's formally came into being on September 30, 1998, incorporated in the U.S. state of California. On July 26, 2006, the United States government renewed the contract with ICANN for performance of the IANA function and on September 30, 2009, ICANN signed an agreement with the DOC that confirmed ICANN's commitment to a multi-stakeholder governance model, but did not remove it from DOC oversight and control.

On March 10, 2016, ICANN and the DOC signed a historic, culminating agreement to finally remove ICANN and IANA from the control and oversight of the DOC.

ICANN representatives explained the difficulties that arose in 2019 when hackers hijacked the top level domain (TLD) of several companies and even complete countries. In doing this they were able to interfere with the fundamental address book of the internet. The matter was eventually resolved and ICANN urged TLD registrars to increase security of their systems.

3.9. SpaceX

SpaceX, is a private American aerospace manufacturer and space transportation services company headquartered in Hawthorne, California. It was founded in 2002 by Elon Musk with the goal of reducing space transportation costs to enable the colonization of Mars.

SpaceX is the only private company capable of returning a spacecraft from low Earth orbit, which it first accomplished in 2010. The company made history again in 2012 when its Dragon spacecraft became the first commercial spacecraft to deliver cargo to and from the International Space Station.

SpaceX successfully achieved the first re-flight of an orbital class rocket in 2017, and the company now regularly launches flight-proven (i.e. previously used) rockets.

During the BEREC Miniboard's visit to SpaceX's rocket assembly facility in Hawthorne California, SpaceX's executives gave a presentation about SpaceX's Starlink project, which will see a constellation of low-earth-orbit (LEO) satellites – approximately 500 km altitude - providing broadband Internet access. SpaceX's plan will see an initial constellation of 3,200 satellites, growing to 4,400 over the coming years. Starlink is targeting service in the Northern U.S. and Canada in 2020 and would hope to rapidly expand to near global coverage of the populated world by 2021. SpaceX can launch 60 satellites at a time using its Falcon reusable rocket.

In response from a member of the BEREC delegation about the increasing issue of space debris, a SpaceX representative informed the group that at end of life, Starlink satellites will utilize their on-board propulsion system to deorbit over the course of a few months. In the unlikely event the propulsion system becomes inoperable, the satellites will burn up in Earth's atmosphere within 1-5 years, significantly less than the hundreds or thousands of years required at higher altitudes

The BEREC delegation was shown a prototype of the Starlink consumer premises equipment (CPE), which will marketed as a complete "DIY-installation". The CPE is comprised of a Starlink antenna, combined with a Wi-Fi router, power supply, mount and installation accessories. The antenna is flat and approximately the size of a large pizza and will self-orient to find the best satellite reception from the Starlink constellation. It is expected that the CPE will be in view of 20 satellites at any time and Internet speeds of 100 Mb/s download and 10 Mb/s upload are envisaged. Speeds will be depended on the density of subscribers in a particular area and the capacity of the backhaul node which serves them.

SpaceX user terminals receive signals in the 10.7 - 12.7 GHz frequency range and transmit to the satellites in 14.0 - 14.5 GHz frequency range to Starlink satellites and the use of those frequency ranges is addressed by ECC Decision (17)04. SpaceX user terminals are awaiting approval for deployment in Europe once a revision to ETSI standard EN 303 980 is adopted and published. This matter is still in progress.

After discussions about the Starlink project, the BEREC delegation was given a guided tour of the rocket assembly facility, during which they heard that 60-70% of all satellites are carried into space by SpaceX rockets. In addition to the Starlink project, SpaceX has a separate contract with NASA to send astronauts to the International Space Station (ISS). The Falcon rockets are reusable and can be turned around for re-use within two weeks. They are designed for up to ten-times reuse – currently rockets are used up to four times but this is likely to go to five times in 2020. SpaceX had over forty launches in 2019 and the rockets use liquid oxygen and methane as fuel as this is considered more environmentally friendly.

3.10. AT&T

AT&T Inc. is an American multinational conglomerate holding company headquartered in Dallas, Texas. It is the world's largest telecommunications company, the largest provider of mobile telephone services, and the largest provider of fixed telephone services in the United States through AT&T Communications. Since June 2018, it is also the parent company of mass media conglomerate Warner Media, making it the world's largest media and entertainment company in terms of revenue.

AT&T traces its origins to the Bell Telephone Company, founded by Alexander Graham Bell, after Bell's patenting of the telephone. One of that company's subsidiaries was the American Telephone and Telegraph Company (AT&T), established in 1885, which acquired the Bell Company on December 31, 1899, for legal reasons, leaving AT&T as the main company.

On October 22, 2016, AT&T announced a deal to buy Time Warner in an effort to increase its media holdings. The United States Department of Justice Antitrust Division launched a case to block the merger with Time Warner, saying it "will harm competition, result in higher bills for consumers and less innovation. In order for AT&T to fully acquire Time Warner, the Department of Justice stated that the company must divest either DirecTV or Turner Broadcasting System, two of its existing media businesses. On June 12, 2018, AT&T was given permission by the US courts to proceed with its deal for Time Warner and subsequently Time Warner became a wholly owned subsidiary and division of AT&T with a new name, WarnerMedia.

Three months after completing the acquisition, AT&T reorganized into four main units: "Communications", including consumer and business wireline telephony, AT&T Mobility, and consumer entertainment video services; "WarnerMedia", including Turner cable television networks, "Warner Bros." film and television production, and "HBO".

The BEREC delegation met with AT&T executives, including executives from WarnerMedia at the Warner Bros studios in Burbank, Los Angeles. The discussion centred on the merging and overlap between media and telecoms companies and the insights from the Executive Vice President at Warner Bros. Entertainment Group of Companies were particularly informative. He explained that Warner Bros. film and television is open to licensing all its content, linear and streaming to all platforms – it is platform agnostic. HBO, WarnerMedia and Warner Bros have approximately 100,000 hours of television content and six thousand films – with Warner Bros. having twice the content of HBO and Turner combined.

Warner Bros. intend to roll out its content offerings to the US and Latin America, then Europe and finally Asia. This is in the context of the launch of Disney+, which will see increased competition of streaming platforms. Warner Bros. executives expected that with the increase of subscription TV platforms (e.g. Apple TV, Disney+, Netflix, Amazon Prime…) it is expected that three or four will become dominant players or, alternatively, someone will bundle the three or four most popular and offer these as a combined package.

In response to questions from the BEREC delegation, the AT&T/Warner Bros. executives consider that linear TC will remain relevant forever, particularly for news feeds, but less so for scripted drama and comedy. The BEREC delegation was also informed that AT&T will not share customers data, however gathered through the various channels, with other entities.