arcep

Smartphones,
tablets, voice assistants...

DEVICES,
THE WEAK LINK
IN ACHIEVING
AN OPEN INTERNET

Report on their limitations and
proposals for corrective measures

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Devices, the weak link in achieving an open internet

Content

1 Introduction

Since November 2015, the European Open Internet Regulation 2015/2120 has guaranteed users' right to access an open internet, in other words the right to freely access any content that exists on the internet and, in exchange, to be able to provide any content they want on the web. In October 2016, following the Regulation's adoption, the Digital Republic Law enshrined the principle of net neutrality into national law, and gave Arcep investigatory and sanctioning powers, to ensure its enforcement.

If most of the provisions contained in the Open Internet Regulation concern internet service providers' (ISP) obligations, Arcep believes that the internet access chain does not stop at access networks: other intermediaries have the power to hamper users' ability to access certain online content and services. This is true of devices (smartphones, tablets, computers, etc.), their operating systems and their app stores which are controlled by a small number of economic actors.

In other words, freedom of choice with respect to content, services and applications on the internet today is only guaranteed at the network level, and not at the device level. The right to internet openness is guaranteed only on one link of the user experience chain.

Arcep has worked to point up this partial approach to net neutrality for some time. In its earliest investigations into net neutrality, notably the report published in 2010[1], Arcep was already suggesting an increased oversight of the neutrality of devices and their operating software. The legislative developments that followed this period of observation, at the national and later European level, resulted in a legal framework that focuses on neutrality at the network level.

Today, now that the legal framework governing network neutrality has been established thanks to Europe's Open Internet Regulation, the regulator is calling for a serious examination of the influence that devices have on internet openness. In Article 3, Paragraph 3, the Regulation establishes users' freedom to choose their access device, thus suggesting that by dissociating the device from the ISP and from the internet access service, device market competition makes it possible to shield end-user devices from the temptation to impose limits on usage.

The conclusions of Arcep's work on the influence of devices, and those of this report, make it possible to establish that this competition in the device market has not been enough to prevent every type of restriction for end users. This is why Arcep is examining the question of whether to extend the principle of freedom of choice in providing and accessing content to devices.

After having laid the foundations of its analysis of internet access devices in its initial report published in May 2017, Arcep consulted with the sector's stakeholders on this issue in various ways, throughout the second quarter of 2017. A large number of companies and associations were interviewed at Arcep's offices. Three workshops, held in a more collective spirit, were hosted in creative venues around Paris, with the aim of working together with stakeholders to think about those restrictions that Arcep had identified:

- "Let's design the ideal app store!" – Arcep brought together developers to explore the limitations that both users and developers encounter in the applications universe.
- "Back to the future! Let's imagine tomorrow's devices, in light of past successes and failures" – aimed at a more varied group of stakeholders, and devoted to forward-thinking and

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[1] Arcep, *Net and network neutrality - Propositions and recommendations*, https://www.arcep.fr/uploads/tx_gspublication/net-neutralite-orientations-sept2010.pdf, September 2010

comparing the views of the sector's different experts, and exploring how these future developments are likely to impact internet openness.

- "Are we being held hostage by our operating systems? A round-up of available solutions" – Aimed at users and consumer associations, taking stock of data portability solutions and their impact on competition.

Lastly, in late 2017 Arcep held a public consultation on all of the questions to emerge from these workshops. Arcep departments received feedback from a number of stakeholders, which were examined and, when relevant, incorporated into this report.

This report serves several purposes.

First, it delivers a snapshot of internet access devices, whose variety has continued to grow over the past ten years. Ten years ago, when Arcep began investigating net neutrality, it was easy to list all of devices available to access the web. Since then, as the first part of this report reveals, mobile internet access has become the most common form of internet access, spurred by the growing adoption of smartphones, while new systems are now emerging as future points of network access. Game consoles and smart TVs have also become internet-ready and can serve as a hub for more and more services in the home, while cars are also going digital and can serve as a catalyst for a range of mobile applications. The long list of connected products also makes it possible to imagine that most of the items used in our daily lives will have an online purpose, while the ubiquity of artificial intelligence can be seen as a connectivity facilitator and integrator, notably with the development of voice assistants. Each of these paths to internet access brings its own software environment, shaped by technical and economic considerations, and creating a shifting balance of power between hardware suppliers, developers and end users.

Next, in its second part, this report maps out the ways in which devices can hamper users' freedom to choose their content and applications. Some of these restrictions derive from the very nature of the devices themselves, and their intrinsic technical properties. In other instances they derive from the devices' software, which has naturally evolved over time in the ever-changing digital universe. Certain players' business model or technological choices can also result in less internet openness. Through this mapping of restrictions, enhanced by the feedback received from the sector's stakeholders, Arcep seeks to demonstrate that, if certain restrictions are legitimate, or can result from incompatibilities between rival systems (e.g.: iOS vs. Android), others artificially restrict users' choices.

This mapping exercise largely takes the form of examples, with no claim to being exhaustive.

Lastly, Arcep wants to kick-off an investigation into the actions being taken with respect to certain devices, to ensure internet openness. In the third part of this report, the Authority thus analyses several possible courses of action to remedy the restrictions that have been identified. The aim in doing so is, first, to create more transparency around the sector's internet openness practices (by informing users and public policymakers), including the use of forms of feedback such as ratings, as part of a data-driven approach to regulation. The second aim is to simulate virtuous behaviour with respect to internet openness, by creating a more fluid switching between systems or making certain equipment compatible. Third is a plan for taking direct action to lift certain restrictions, through a dispute settlement procedure, concerning refusals to offer and access obligations.

The purpose of these proposals is to fuel public debate and, if public policymakers so decide, to lead to national or European legislative measures.

2 End-user devices' possible or probable evolution

2.1 Different development models for the main internet access devices

Analysing the recent history of devices makes it possible to determine the range of equipment that is currently the most likely to influence users' ability to enjoy internet openness in France. Looking beyond European borders and studying the organisation of a country such as China is an equally necessary exercise, and especially useful for testing the automatic assumption that the model we are familiar with is universal.

2.1.1 Increasingly mobile internet access in France, and in Europe, controlled by two main players

In 2017, 88% of people in France said they were internet users[2], a figure that rises to nearly 100% when looking at people between the ages of 12 and 39. So says the 17th edition of the Baromètre du Numérique, a study conducted by Arcep, CGE and French Digital Agency[3].

a) Shift in user behaviour towards increasingly mobile access

Over the span of 10 years, the internet became an integral part of the daily lives of most of the people in France. It is worth mentioning that in 2005, only 52% of people in France stated that they used the internet[4]. Today, more than three quarters of them use it every day. And they employ a range of devices to do so – computers, tablets and smartphones being the three most common. The smartphone is especially popular with internet users: 48% of them cite it as their main internet access device, ahead of the computer, which is the device of choice for 43% of internet users[5].

Smartphones' dominant role in providing internet access was by no means an obvious outcome in the early 2000s, however. At the time, computers were the only way to access the web. And each device had its own purpose. Fixed and, starting in the 1990s, mobile phones were used only to make calls and send text messages. It was not until the release of the first iPhone in 2007, and the iPad in the early 2010s, that behaviours were disrupted and mobile devices outfitted with internet access capabilities. Today, 73% of people in France have a smartphone, versus 17% in 2011[6]. Sixty four percent of them use their smartphone to access the web, compared to only 6% in 2007[7]. Meanwhile tablets continue to enjoy a growing popularity inside homes, and are now used by 44% of people in France, compared to a mere 4% in 2011[8]. Internet access has shifted from fixed to mobile systems, to such an extent that the percentage of French people who only have a mobile plan is increasing – 5%

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[2] CREDOC for the *Agence du Numérique*/French Digital Agency, Arcep and the Economic General Council/Conseil Général de l'Économie, *Digital Market Barometer 2017*, https://www.arcep.fr/uploads/tx_gspublication/barometre_du_numerique-2017-271117.pdf, June 2017: 88% of people in France say they use the internet "every day", "once or twice a week" or '"more seldom".

[3] *Ibid*.

[4] *Ibid*.

[5] *Ibid*.: Equipment that stated internet users employ most often to connect to the internet, 2017

[6] *Ibid*.

[7] *Ibid*.

[8] *Ibid*.

in 2017 compared to 3% in 2016 – while the percentage of those with only a fixed line plan is decreasing: 19% in 2017 compared to 28% in 2016[9].

b)   The advent of applications as new online content and service formats

Smartphones and tablets have not only rendered internet access mobile, but have also disrupted the traditional browser model, the interface for accessing web pages. Providing simplified and more user-friendly access to the internet, applications are now very popular ways for searching for online content and services. Fifty five percent of French people downloaded apps to their phone in 2017, compared to 7% in 2010[10]. But this is not only true in France: on average, every smartphone user around the world uses 40 applications a month[11], and has installed around 80. The extent of users' adoption of applications can also be seen in the time they spend on them every day: the global average is three hours a day[12].

c)   A myriad of devices, but still very few operating systems

Users today have a vast array of physical devices to choose from. For both fixed and mobile devices, a plethora of suppliers are working to secure a share of the market by continually revamping their products. When it comes to operating systems, however, users have a far more restricted choice.

This is true of the smartphone market where competition lies chiefly on the hardware layer, with a large number of suppliers competing for market share. However, two players currently share virtually full control of the mobile operating systems (OS) segment: Apple, whose iOS leads the way in terms of per-user revenue, and Google whose Android OS leads the way in volume.

Global market share, in volume, for smartphone suppliers in Q3 2017
Source: IDC

Global market share, in volume, for mobile OS in Q3 2017
Source: IDC
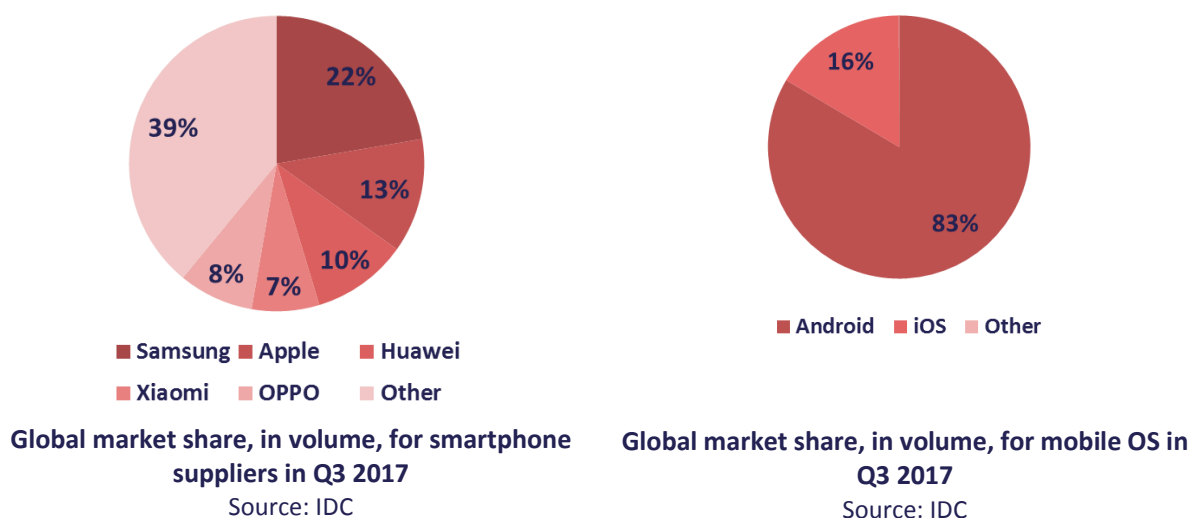
Through its devices, Apple has opted for an "integrated" approach to related services, to guarantee as fluid a user experience as possible for its customers. Its business model is based on selling devices and promoting its services. To this end, Apple guarantees continuity between its products, all its services being consistent in terms of quality, security, design, performance and protection of

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[9] *Ibid*.

[10] *Ibid*.

[11] App Annie, *2017 Retrospective report on mobile apps*, https://www.appannie.com/en/insights/market-data/app-annie-2017-retrospective/#unique-identifier, January 2018

[12] *Ibid*.

personal data. In practice, this means that Apple has exclusive control of its devices, at both the hardware layer, with the iPhones and iPads, and the software level with the use of the single, iOS operating system and the App Store. Apple controls content and service providers' access to its devices by requiring that developers use its development kit (Xcode, available on Macintosh only), applying a strict editorial policy, and deciding to maintain only a limited number of versions of iOS. However, the development languages for iOS applications, Objective-C and Swift, are both Open Source.

With Android, Google has adopted an online services approach based mainly on Open Source code, to ensure that its operating system is compatible with as many devices as possible: smartphones and tablets, but also watches, televisions and connected products. Because Google's business model is based on online advertising, and especially contextualised advertising, the purpose in making Android available is to increase internet usage. By making its operating system freely available to device manufacturers Google is, in the short term, seeking to make its search engine available on all devices and, in the longer term, to make all of its applications and services available, in particular its Play Store[13]. Device manufacturers and operators can modify the basic Android system by adding overlays or by creating "forks", i.e. derivative systems that evolve independently. Twenty percent of Android devices in 2016 were forks[14]. On the other hand, Google favours making these derivatives of its operating system compatible with as many services as possible and especially with the applications that it develops itself, by having device manufacturers sign a "Compatibility Commitment".

What is the Android Compatibility Commitment?

Since the Open Handset Alliance was created in 2007, Android code has been Open Source, in other words available to anyone with no (pricing or other) conditions imposed by Google. This means that anyone can download it from the Android Open Source Project website and do what they want with it. Device manufacturers can thus use the source code as it is (e.g. Nexus smartphones) or modify it to customise their devices' operating systems (OS) (e.g. the Samsung Galaxy, OnePlus smartphones and Amazon Fire tablets). By opting for an Open Source code, which means a significant decrease in OS development costs, Google wants to enable the development of a plethora of applications and the availability of an increasingly wide selection of devices, in a way that benefits users, device suppliers and developers.

Because this Open Source format can lead to a fragmentation of the Android universe, with the emergence of derivative systems, Google encourages the different versions of Android to meet those specifications that ensure their compatibility with the broad universe of Android apps. It is to this end that Google requests that device suppliers that are members of the Open Handset Alliance sign an Android Compatibility Commitment. Suppliers that sign this contract make the commitment to only supply devices whose OS meets Google specifications. In exchange, they benefit from the integration of all of the latest features developed for Android. For its Galaxy line, Samsung provides an Android OS that it has customised while continuing to comply with Google specs. By the same token, OnePlus devices run on the "compatible" OxygenOS. On the flipside, for its line of tablets, Amazon has developed the "non-compatible" Amazon Fire system. It should be noted that signing the compatibility agreement does not prevent manufacturers from also producing non-compatible devices, under other brands.

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[13] There are nevertheless a number of alternative operating systems, notably those based on a Linux Open Source kernel.

[14] 272.9 million smartphones running on forks were sold worldwide in 2016, according to ABI Research.

Device manufacturers that have signed the compatibility agreement can also agree to the terms of a specific, non Open Source, licence, to embed "Google Play Services" and access the Google apps universe, which encompasses the Play Store and a suite of applications including Google Maps and Gmail, provided they satisfy the criteria listed in the Mobile Application Distribution Agreement (MADA), which is not publicly available. Google states that this agreement applies to the entire suite, but does not give exclusivity: on the one hand, the equipment supplier keeps the option of offering its own suite or other applications for which it has agreements. On the other hand, users can deactivate or delete these apps from their home screen. Lastly, Google stipulates that it offers product placement deals to allow device suppliers to have its suite of applications, notably its search engine and app store, appear on the home screen, against remuneration. Contrary to the compatibility agreement, which applies brand by brand, those licences for apps apply on a case-by-case basis, according to the device

If the mobile OS market has evolved into a market concentrated largely around Android and iOS, there were more than five mobile operating systems in existence when smartphones were first launched, including those developed by Windows, BlackBerry and Nokia. There are two reasons for this concentration in the operating system market. First, there are club effects: having a small number of operating systems is an advantage for developers who want to optimise their resources and benefit from high standard solutions. Second, the concentration of the operating systems market is further reinforced by the network effect on app stores: from the users' point of view, the number of available apps is a criterion when choosing their device, and therefore the operating system. Thess club effects can explain the failure of later arrivals such as Firefox OS, as they were unable to attract a large enough community of developers and users.
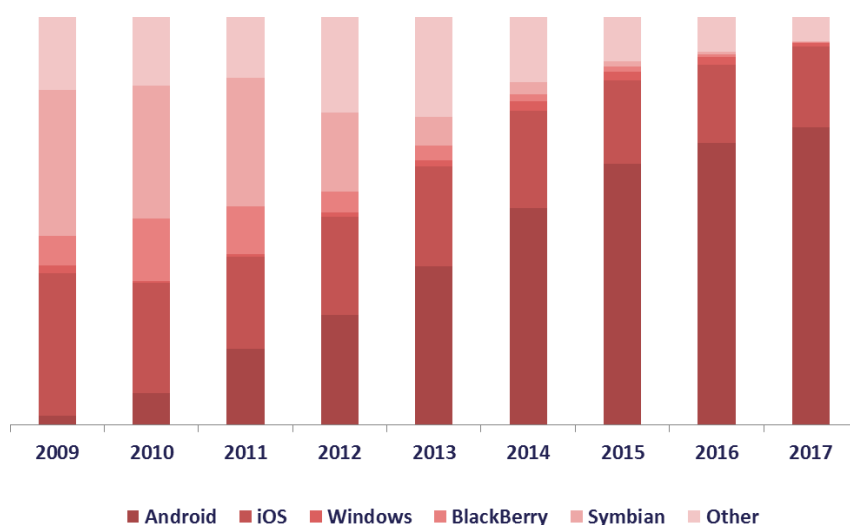
Global market share, in volume, of smartphone OS between 2009 and 2017

Source: StatCounter

The diversity of physical equipment can also be seen in fixed devices, and especially in the modem-computer duo. Users have the choice of a plethora of computer manufacturers such as Lenovo, HP, Dell, Acer, Asus and Apple. However, as with mobile equipment, the fixed operating systems market is now concentrated around two main players which, in the computer world, are Microsoft with its different versions of Windows and Apple with its Mac OS.

Global market share, in volume, for PC makers in Q4 2017

Source: IDC

Global market share, in volume, for fixed operating systems at the end of 2017

Source: IDC
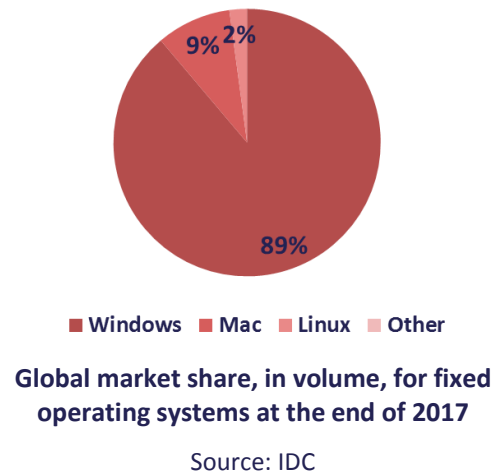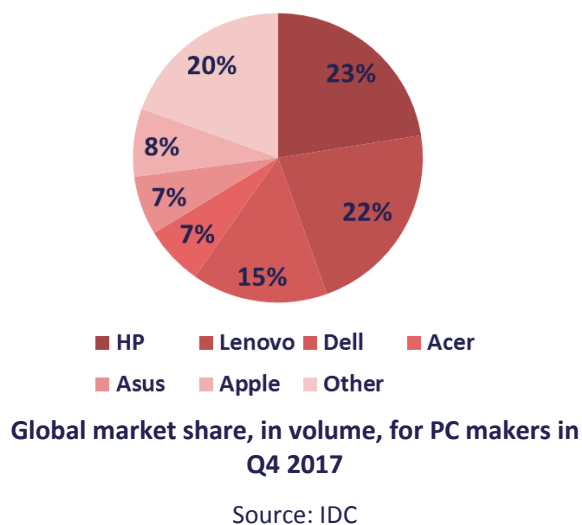
Apple applies the same strategy to its computers as it does to its mobile devices: all of its computers run on its own Mac OS operating system and a software suite developed in-house.

Microsoft, meanwhile, is focused on its software products which are compatible with a very large number of brands of hardware products. Microsoft products developed for PCs, for both consumers and businesses, include the Windows operating system, of which many versions are available, the Microsoft Office software suite, the Internet Explorer and Microsoft Edge browsers, the Bing search engine and apps from the Microsoft store. If Microsoft associates its operating system with its Microsoft Office software suite, alternative app stores and browsers can be installed and used. On this last point, the latest version of the company's OS, Windows 10 S, stands out from the previous ones by promoting itself as an all-in-one package for users looking for simplicity. Its singularity comes from the fact that users can only install the Microsoft Store, which the company justifies as being for security reasons.
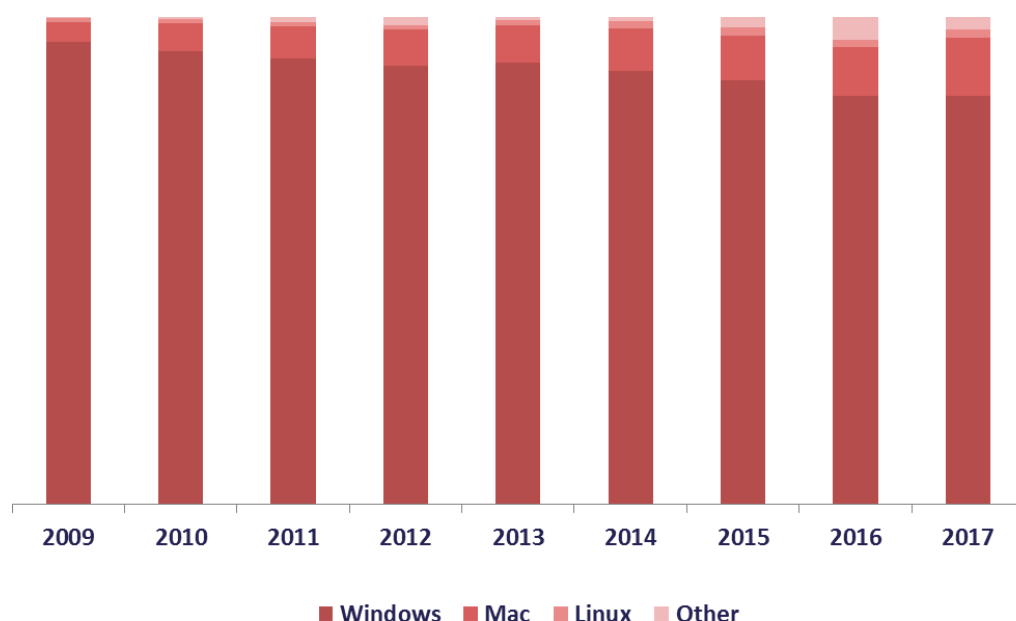
Global market share, in volume, of computer OS between 2009 and 2017

Source: StatCounter

Contrary to the evolution of smartphones, the computer operating system market has always been highly concentrated: Microsoft established itself with Windows at the outset as the market reference, while Apple arrived on the scene as a small-scale troublemaker, targeting the high-end market, and Linux satisfied the needs of a fringe population of more tech-savvy users.

2.1.2 In China, mobile internet access from the onset, with a larger selection of smartphones

It can be an interesting exercise to observe the particular properties of the devices that provide internet access in other parts of the world that differ significantly from the West, in terms of both how devices and the internet are used, and how open internet is. This is especially true of China where users access the internet primarily via smartphones. Of the country's 750 million fixed and mobile subscribers[15] – following an increase of close to 20 million in the first six months of 2017 – more than 724 million are mobile internet users. China's internet population could climb to more than 1.4 billion by 2019.

National brands dominate China's device market, of which the top four are Huawei, Oppo, Vivo, and Xiaomi. Together they controlled close to two thirds of the market, as of April 2017. While Apple represents more than 10% of handset sales in China, Samsung has a less than 3%[16] market share.

As concerns mobile operating systems, in keeping with the global trend, Google's Android became the most popular OS in China in March 2012, with a 36% market share, compared to 19% for Nokia's Symbian[17] and 16% for Apple's iOS. In the months that followed, the rate of growth for Android was such that it accounted for close to two thirds of the market at the end of 2012. In January 2018, close

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[15] China Internet Watch, *"Whitepaper: China Internet Statistics 2017"*, 2017

[16] China Internet Watch, *"Top 10 smartphone brands in China in April 2017"*, 2017

[17] StatCounter, http://gs.statcounter.com/os-market-share/mobile/china/#monthly-201201-201801

to 80% of smartphones in China were running on Android, while Apple's iOS had a roughly 20% share of the market.

If the vast majority of mobile devices run on Android source code, one feature of the Chinese market is the considerable presence of Android derivatives (aka forks). Device manufacturers Oppo, Vivo and Xiaomi power their devices with their own Android derivative OS (respectively Color, Funtouch and MIUI, which meet the specifications listed in the Android compatibility commitment document). Huawei uses the Android OS while integrating its own EMUI interface. Meanwhile, Baidu, which operates China's most popular search engine, had developed its version of Android for smartphones and tablets, Baidu Yi, in the early 2010s, in particular thanks to a partnership with hardware supplier, Dell. This enabled Baidu to market its own services, rather than Google's, such as its Baidu Tieba search engine, Baidu Maps and the Baidu Baike encyclopaedia. In 2015, however, it decided to stop selling smartphones powered by this modified version. Lastly, in 2011 local e-commerce giant Alibaba wanted to develop its own OS, Yun or AliYun, built on the Linux Open Source kernel. It stands out for its use of the cloud for storing data, and the use of *yu* – which means cloud in Chinese – apps. This approach reduces the importance of hardware, which explains why it is used for some of the cheapest handsets. It should nevertheless be pointed out that, even if Alibaba states that it is an independent project, Google considers AliYun a non-compatible Android derivative. Which is why Acer, a member of Open Handset Alliance, decided against selling phones that run on this OS back in 2012. According to estimates from Canalys and Counterpoint analysts, only 2.2% of the smartphones sold in China ran on this OS[18] at the end of 2016. Alibaba disputes this figure, and has set a target shipment of more than 100 million smartphones powered by AliYun, or 14% of the Chinese market.

Another particular feature of the Chinese market is the use of home-grown app stores and search engines. This can be attributed to the strained relationship between the Chinese government and Goole parent company, Alphabet. In February 2006, Google had agreed to adopt a policy of self-vetting content control, sometimes referred to as the "Great Firewall of China", in exchange for the ability to install its equipment in that country. Google thus blocked sites that the Chinese government considered illegal using a self-censored version of its search engine. In 2010, however, following a series of cyberattacks against Google, which targeted Gmail data in particular, the company decided to shut down its google.cn search engine and reroute all of the traffic to the version of the site based in Hong Kong, whose results were not censored. Between 2010 and 2014, China decided to block Google services intermittently. Today, Gmail, Google News, Google Search and most Google services are still blocked. From a broader perspective, the consequence of the content monitoring policy imposed on ISPs and content and application providers is tantamount to a ban on the sale of certain services and applications, and so resulting in less international competition in China's online services market. Meanwhile, to keep a foot in the Chinese market, Apple has elected to bend to local restrictions. First, the company removed all of the apps that are banned in China from its local app store, such as those tied to VPN (virtual private network) services, which enable users to circumvent the government's content monitoring policy, along with those tied to social media sites. Second, Apple agreed to store its users' (encrypted) iCloud data in China Telecom datacentres. This did not prevent certain iPhone services, such as iBooks and iTunes Movie from being blocked, and so benefitting local players such as Huawei, Alibaba and Tencent – the Chinese giant best known for its WeChat application.

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[18] Bloomberg, Alibaba Stumbles in Bid to Wrest Mobile Control From Tencent, https://www.bloomberg.com/news/articles/2017-06-06/alibaba-falters-in-bid-to-take-mobile-phone-control-from-tencent, 7 June 2017

2.2 Features that could prove decisive in users' choice of an internet access device

If the smartphone houses several functions from several different pieces of equipment (telephone, video, gaming, multimedia player, personal assistant) into a single device, it also enabled the emergence of new uses thanks to new features. First viewed as attractive, some of these features could become deciding factors when choosing an internet access device.

2.2.1 Artificial intelligence, an additional level of intelligence in devices

Services that make use of machine learning or artificial intelligence[19], are found more and more in devices. One of the best known and telling uses is perhaps facial recognition which, when used in photo management applications, serves to group photos based on the people in them. Today, artificial intelligence underpins a large number of services, and is used in a variety of features, notably for promoting services and content, without users necessarily being aware of it:

- Google's latest photo app employs artificial intelligence to recognise silhouettes in photos and blur out background elements by choosing the area of focus. To simulate blur effects resulting from lens focus, and highlight the subject being photographed, the smartphone needs to be able to distinguish the area of the scene where the photographed subjects are located, and slightly blur all the other areas. This means having to identify those people's silhouette to be able to then highlight them. This identification needs to occur the moment the photo is taken, and cannot withstand a transmission to server delay. Google thus made use of intelligence to recognise human silhouettes, and then embedded it in its smartphones.

- Artificial intelligence is already capable of estimating how to edit a photo so that the final rendering is as pleasing to humans as possible. In addition to knowing *which* photo to take, it can decide *when* to take it. So the Google Clips camera would be capable of recognising its owners, the family environment and even the expressions of loved ones. When in sleep mode, it could wake up only to take a photo at an opportune moment, e.g. when the artificial intelligence detects a "happy" expression, in the right light and setting.

- Browsers use artificial intelligence to distinguish between content that internet users interact with and trackers, notably cookies[20], used to track them on different websites. Artificial intelligence also makes it possible to counter possible attempts by companies deploying trackers to circumvent the system. So, based on web users' browsing habits, the intelligent tracking protection deployed in the Safari browser learns to recognise the elements tracking them.

- Voice assistants use artificial intelligence to recognise the elements captured by a camera, and to supply relevant information and suggest content to the user. For instance, the Google

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[19] The OED defines artificial intelligence as "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages." In this report, the term artificial intelligence is used to refer to a programme that self-trains to classify entities based on the examples it is given. For instance, for smile recognition, without artificial intelligence, the developer will list the criteria based on which a smile can be detected (position of the mouth, lines on the face, etc.), whereas to programme an artificial intelligence, the developer will use examples of annotated photos on which some people are smiling and others are not. In the second instance, it is the artificial intelligence itself that will determine the relevant criteria for recognising a smile.

[20] Electronic Frontier Foundation (EFF), *"Safari in Arms Race Against Trackers - Criteo Feels the Heat"*, https://www.eff.org/deeplinks/2017/12/arms-race-against-trackers-safari-leads-criteo-30, 21 December 2017

Lens visual search interface can identify objects or locations filmed on a smartphone, so that the assistant can provide corresponding information and personalised recommendations.

By automating certain tasks, artificial intelligence will often support the user once she has made a choice. In some instances, artificial intelligence will consist of making a recommendation to the user; in others artificial intelligence will make the decision for the user, without necessarily informing her of the other options available.

If only a minority of today's smartphones are outfitted with artificial intelligence, Gartner forecasts that 80% of those sold in 2020 will be[21]. The firm also expects new applications to derive from the use of these AI features – predicting users' wants and solving problems in their stead, choosing the applications to launch based on an analysis of past behaviour, automatically detecting the content to censor, etc.

2.2.2   Voice assistance, a feature designed to simplify commands

Voice recognition is a relatively old function, since the first tools of their kind were designed in the 1950s at Bell Labs, and in the 1970s at IBM. The first commercial voice-controlled assistant was launched in 1971[22]: the "Voice Command System" designed by J.J.W. Glenn and M.H. Hitchcock, which could recognise 24 separate words after a learning phase. Since then, voice assistants have evolved and began to gather real momentum in the 1990s as they were integrated into IBM consumer PCs, and again in 2007 with the Microsoft operating system, Windows Vista. But it is especially since 2011, the year that Apple's voice assistant, Siri, was first launched with the iPhone 4S, that voice assistants began to really catch on, and became widely used.

Voice is currently used to interact with a search engine or a digital assistant that performs multiple tasks. There are four main players in today's market: Apple (Siri), Google (Google Assistant), Microsoft (Cortana) and Amazon (Alexa). Other initiatives do exist, and a number of assistants are being developed, by Facebook (M), Orange and Deutsche Telekom (Djingo) and Samsung (Bixby). This is a market that could be worth more than 10 billion dollars by 2020[23].

This new type of interaction between users and their devices appears to also be more practical in many cases: when driving, or travelling or when the user is busy doing something else. However, using voice-based devices in public, at work or on public transport is still a delicate matter for many users who do not want their internet searches exposed in public. To win over all users, these assistants may therefore evolve or diversify towards conversational interfaces such as chatbots.

2.2.3   Mobile payment: an indispensable feature for smartphones?

Mobile payment refers to all of the transactions made on a mobile device, and debited from a debit or credit card, phone bill or e-wallet, which can be recharged by topping up one's credit.

The idea of mobile payment encompasses several categories: remote payment via applications or on e-commerce sites, proximity payment via a terminal, and mobile-to-mobile money transfers.

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[21] Gartner, *Gartner Highlights 10 Uses for AI-Powered Smartphones,* https://www.gartner.com/newsroom/id/3842564, 4 January 2018

[22] Clubic, *La reconnaissance vocale: mythe ou réalité ?*, http://www.clubic.com/article-161030-2-clubic-test-solutions-reconnaissance-vocale.html, 12 September 2008

[23] Wavestone, *Essor des voice assistants intelligents: Nouveau gadget pour votre salon ou fenêtre d'opportunité pour rebattre les cartes de l'économie du web ?*, https://www.wavestone.com/app/uploads/2017/09/Assistants-vocaux-04.pdf, 2017

In Africa and Asia, where a large percentage of the population is unbanked, mobile payment is very well developed. In France, to become widely used for daily purchases it needs to be distinguished from contactless payments using a credit card[24].

There are several potential advantages to mobile payment. Security levels are high since an ID code or digital fingerprint is used, while biometric payment cards are only in the trial stage[25], and because banking data are not stored in users' phones. It can also allow users to benefit from partner shops' loyalty programmes, centralise their debit/credit cards, etc.

The various mobile payment practices are starting to be widely used in France, according to the 2017 edition of Visa's annual report[26].

Lack of "interbanking" due to a combination of three factors

Fragmented solutions – In the marketplace we find both applications developed directly by banks (Paylib, the solution designed by seven major French retail banks[27] and which can be used after downloading the dedicated app for one of the partner banks, Kix for BNP Paribas, etc.), by OS providers (Apple Pay, Android Pay), equipment suppliers (Samsung Pay), mobile operators (Orange Cash, M-Pesa) or app developers (Lydia, Lyf Pay, PayPal, *etc*.).

Exclusivity deals and partnerships – Certain applications are not compatible with every device or OS. Apple Pay and Samsung Pay, for instance, are only available on and compatible with Apple and Samsung devices. By the same token, Android smartphone owners can use Paylib and Google Pay solutions. Moreover, the development of mobile payment solutions often means joining forces with partner banks to ensure the service is efficient. For instance, a number of French banks, such as BNP Paribas, le Crédit agricole, LCL and Crédit mutuel have refused to adopt Apple's solution. The financial terms and conditions imposed by the company (a percentage of the bank's commission on each transaction performed using Apple Pay)[28] could explain why. Similarly, partnerships with retailers can help secure the success of a mobile payment solution.

Lack of interoperability – As an intermediation service, mobile payment reaches maximum efficiency when its network effects are also maximised, i.e. if interoperability between different platforms is possible: the arguments in favour of interconnected mobile payment systems are the same as those given for telecom services where interconnection is a growth catalyst. Today, private sector players are not implementing this interoperability voluntarily, as the market leaders do not want to lower the barriers to entry for newcomers. Which is why there need to be discussions between government bodies and the private sector. In particular, the level of interoperability (between platforms, agents or clients) and its scope, in other words the list of interoperable services (money transfers, payments, opening accounts, etc.) needs to be determined to ensure that innovation is not curtailed.

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[24] Futurthinking, *observatoire du paiement sans contact*, https://www.futurethinking.fr/wp-content/uploads/2017/12/LOBSERVATOIRE_DU_PAIEMENT_SANS_CONTACT_2017.pdf, 2017

[25] Les furets, *Carte bancaire: bientôt un lecteur empreintes digitales intégré*, https://www.lesfurets.com/credit-conso/actualites/carte-bancaire-empreintes-digitales, 3 November 2017

[26] Visa, *What does the Mobile Payments user in Europe look like?*, https://www.visaeurope.com/media/images/v2%20visa%20digital%20payments%20european%20fact%20sheet%2010.10.16-73-40177.pdf, 2016

[27] Le Crédit Agricole, BNP Paribas, La Banque postale, La Société Générale, La Banque Populaire, La Caisse Épargne and Le Crédit Mutuel Arkea

[28] Le Monde, *Les banques résistent au grand méchant Apple,* http://www.lemonde.fr/economie/article/2017/05/04/les-banques-resistent-au-grand-mechant-apple_5121952_3234.html, 4 May 2017

Alongside the NFC system found on a great many smartphones[29] and credit cards is the system based on QR codes. In France, applications such as Lydia or LyfPay use this technology. Retailers need to install compatible scanners for it to be widely adopted for proximity payments, which is hampering the system's development. This method for in-store payments is very popular in certain countries, such as China, where more and more users are paying for goods in shops using applications such as WeChatWallet or Alipay.

Regardless of the technology chosen, the emergence of the different mobile payment innovations on user devices depends in part on device manufacturers' and OS providers' policies. Available mobile payment services could become a criterion when choosing a mobile device, or become an impediment to switching brands.

2.2.4   Virtual reality and augmented reality, mere goodies or future must-haves for devices?

If augmented reality and virtual reality are not new concepts, their practical implementation has often come to a halt at the prototype stage and, up until now, very few consumer applications have managed to showcase them.

Augmented reality makes it possible to add a layer of information on top of an image taken in real time by a device's camera. It is used by applications such as Pokemon Go and AR Stickers to display virtual elements, respectively Pokémons and Stormtroopers, by superimposing them on the picture captured by the phone. Augmented reality applications began to appear with the first generation of smartphones, and today's devices are providing greater support: Apple deployed its augmented reality environment (ARKit) with iOS 11 and Google offers its ARCore environment on Android. Dedicated AR equipment, such as HoloLens and LightWear headsets, should pave the way for more complex augmented reality solutions down the road.

Virtual reality enables full immersion in a computer-generated environment or simply a remote environment, e.g. to simulate a user's presence in a different location from where she is. It can be used in video games to create a more realistic experience, or in films to immerse the viewer in the action. We can also imagine it could be used in semi-autonomous cars, so that a human driver can take over during situations that require human intervention, even if they are not in the car.

As with the camera that is now an integral part of all smartphones, augmented reality and virtual reality utilities could become vital features on future devices. The integration of virtual reality in consumer electronics products, such as Sony game consoles or smartphones (e.g. with the Google Daydream headset)[30] does seem to foreshadow wider adoption in the coming years.

2.2.5   Advent of thin client devices: giving the cloud a bigger role?

As connectivity improves across the country, the evolution of hardware is also being shaped by the advent of increasingly thin devices, i.e. devices on which certain functions are not executed locally, on the physical device, but rather in the cloud. Some smartphones, for instance, offer users the option of locating certain services in the cloud, such as storage capacity, which are supported by additional services such as automatic back-up and file sharing with third parties. A more drastic

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[29] Association Française du Sans Contact Mobile (French mobile contactless payment association), *Key data on NFC and contactless payment*, as of 30 June 2016 in France, there were 90 NFC-compatible models of mobile phone and 11.5 million owners of NFC-compatible handsets, http://www.afscm.org/le-nfc-en-chiffres/, June 2016

[30] Unlike Facebook's Oculus Go headset which is a standalone piece of gear, these products can be seen as peripherals for a device that has a different core purpose.

solution emerging today is the ability to build a complete computer using components in the cloud, such as the processor, graphic card and hard drive, and centralised in a remote datacentre. So users of Blade's Shadow PC[31] only require a screen capable of processing video streams – whether a computer display or a television – to be able to access PC functions.

In contrast, other functions continue to reside physically on the device. This is especially true of storage for sensitive data such as identification and authentication data for the device, which the OS provider cannot access, and certain artificial intelligence modules. The lack of network connectivity, or overly long latency, along with privacy protection obligations, which suppose giving users local control over processed data, led smartphone manufacturers to move some machine learning to the devices.

It nonetheless remains that the growing prominence of the cloud could reduce the influence that certain devices have over the internet's openness. For instance, a device that enables access to a work space in the cloud using a mobile app or browser can run on any operating system it wants, using the Shadow Blade service. Here, using cloud services could allow end users to free themselves of certain internet access restrictions that derive from their device's software layer.

2.3   Various models for other internet access devices

If computers and smartphones are currently the devices most commonly used to access the internet and, and although they continue to develop, other older devices such as game consoles and more recently televisions, smart watches and smart speakers, have become ways to access the internet whose evolution warrants analysis.

2.3.1   Are consoles a viable alternative to the modem-computer duo?

The video game industry has been deeply affected by the digital revolution, with the development of increasingly connected consoles. Today, gamers need an internet connection to get the full gaming experience on virtually all of their equipment. Whether fixed or handheld, consoles regularly update their content, gather information on gamers' habits (the collected data are analysed to continually configure and improve the games) and allow gamers to interact online, which makes internet access vital.

If consoles use the internet to enhance the user experience, and offer a vast array of add-on content, users do not really view them as a device for accessing the internet. Every console has a built-in browser, but its user-friendliness is hampered by the design of the gamepads. And, in general, very few of a computer's functions can be used on a console. As a result, the internet access provided by consoles remains very targeted.

Consoles nevertheless stand out less and less for their library of games. With mobile devices (smartphones and tablets) resembling handheld game consoles more and more, the past differentiation that lay in the games on offer now lies more in the additional content on offer (films, videos, music, apps, media, etc.). So consoles today now provide access to third-party apps and services, such as Netflix, MyCanal, YouTube or AlloCiné, in the same way that app stores do for smartphones.

Video game consoles, which now have their own app stores, could be likened to internet access interfaces.

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[31] Shadow is a cloud computer developed by Paris-based start-up, Blade: https://shadow.tech/.

Changes in the video game universe: challenging the console segment's silo organisation?

The first video game that was designed, called Nim, appeared in the early 1950s in a version available on the Nimrod computer. It was not until the early 1970s that the first home consoles came on the market, with the advent of the Odyssey console. Since then, there has been a steady stream of new generations of consoles.

Home consoles differ from computers and other PCs in the small size of the manufacturer population. Up until the late 1990s, a sizeable number of console makers were competing for market share (Sega, Atari, Nintendo, Sony, etc.), but their numbers had shrunk since the 2000s, parallel with the arrival of the Xbox, down three major vendors: Microsoft, Nintendo and Sony. Unlike with PCs, where video games were generally compatible with every brand of computer, console games were often developed for specific hardware. Game publishers were thus forced to choose between the three main platforms, which belonged to companies that were also game publishers themselves. The predominant model was the proprietary model, with games available on different physical media (cartridges, CD-ROM, mini DVD, DVD, Blu-Ray) and a great many exclusivities attached to each console. The use of physical media for games required the intermediation of physical retail outlets for distribution.

The video game distribution model has evolved since then, which has partially challenged content distribution in silos, and changed the conditions for accessing games for users.

First, because the PC has become an alternative to game consoles for accessing video games. The better performance that a gaming PC can deliver in terms of power and graphics, combined with the incorporation of innovations such as virtual reality, spurred gamers' growing adoption of computers. In addition to their technical properties, PCs also give users the ability to access games from a multitude of publishers on a single device, which also helps secure gamers' loyalty. The advent of superfast access networks has given video game publishers the ability to self-publish their products on mobile app stores, and on platforms that aggregate PC games, such as Steam which is open to developers big and small. Today, if consoles continue to sustain the video game market (they represented 63% of revenue in France in 2016), PC games represent a growing percentage of value (29% in 2016 vs. 16% in 2015[32]).

Next, because digital games took over from physical games, and made it possible to increase the array of available titles. Platforms became internet-ready and allowed gamers to buy their games directly online, rather than having to go to a physical shop, and so circumvent the restrictions weighing on retro-gaming[33] for instance. France's Entertainment software publishers trade organisation (SELL) reports that, at the end of 2016, digital video game sales outweighed physical sales in terms of value[34]. Despite which, the end of the physical medium was not enough to eradicate the partitions between consoles.

Lastly, because the democratisation of mobile games underscores users' appetite for community spaces. The advent of smartphones and tablets, outfitted with graphic processors that rivalled consoles' more and more, could have been a disruptive element in the video game market. Console-makers' usual business models were challenged; the virtual absence of exclusivity deals on mobile devices indeed enabled gamers to play together using different platforms.

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[32] SELL., *Video game market snapshot – market , consumption, usage,*
http://www.sell.fr/sites/default/files/sell_ejv_octobre17_pdf_numerique_03.pdf, October 2017

[33] The practice of playing old video games.

[34] SELL, *Video game market snapshot – market , consumption, usage,*
http://www.sell.fr/sites/default/files/sell_ejv_octobre17_pdf_numerique_03.pdf, October 2017

Even if the video game console universe still prevails, and is still organised in silos, the growing popularity of computers has made it possible to limit the publication of games that are exclusive to a single console. By the same token, aware of gamers' appetite for community spaces, console manufacturers have developed platforms where gamers can meet and play. Despite these developments, game compatibility on different consoles remains impossible and even backwards compatibility between an old game and a new console is not always on the menu, which can erase the ability to use old content. Similarly, multiplayer online gaming, enabled by consoles' internet connection, is primarily available to gamers using the same platform, even if some console-makers such as Nintendo and Microsoft are developing cross-platform games. For instance, two aficionados of the same game will not be able to play it together online if one uses an Xbox and the other a Playstation. This restriction does not appear to be a technical one, however, since a bug introduced into the Fortnite[35] game temporarily allowed gamers using these different platforms to play together online.

2.3.2 Will set-top box or smart TVs become the home's internet access hub?

More and more users have adopted smart TVs over the past several years, replacing old televisions that served only to display images coming from another piece of equipment (ISPs' box, DTT signal, game consoles, etc.). Today, TVs are more sophisticated, and coming to resemble computers or smartphones thanks to the addition of a processor and Wi-Fi connectivity, which allows them to be connected directly to the internet. What had previously been managed by the box or a game console – e.g. applications, games and videos – can now be managed on the TV: intelligence has thus moved to the television itself.

At the same time, service providers' set-top boxes, which served as internet access devices when connected to the TV screen, continue to evolve, and today allow users to do more than simply manage their TV services. They also provide access to a world of applications, through an app store, and to the web thanks to a browser.

At the end of Q2 2017, close to 65% of households in France had an internet-ready TV, and 92% of them had their television connected to the web. Connection methods vary on this type of equipment, and in some cases overlap: more than 8 out of 10 TVs are connected through an ISP's set-top box, and close to 3 out of 10 are smart TVs[36] – a percentage that is expected to continue to climb, as is the percentage of people in France who own a smart TV. Indeed, in Q2 2017, 26% of TV owners in France had a smart TV, compared to 22% one year earlier[37].

Ubiquitous smart TVs and watches: an opportunity for new operating systems to take hold?

The two dominant mobile operating systems both have their equivalents in the TV universe. Android TV is integrated directly into certain brands of television, or accessible through a peripheral device (Android TV on third-party devices or ISPs' box). The version of iOS designed for television, tvOS, is *only* available through a plug-in peripheral, the Apple TV, as Apple did not want to market its own televisions or create a partnership with a television manufacturer.

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[35] 01 Net, *Des joueurs PS4 and Xbox One ont enfin pu jouer ensemble... grâce à un bug,* http://www.01net.com/actualites/des-joueurs-ps4-et-xbox-one-ont-enfin-pu-jouer-ensemble-grace-a-un-bug-1259436.html, 19 September 2017

[36] A smart TV is a television with built-in internet access capabilities.

[37] CSA, *Observatory of audiovisual equipment in households in Metropolitan France. Findings for Q1 and Q2 2017 for television",* http://www.csa.fr/Etudes-et-publications/Les-observatoires/L-observatoire-de-l-equipment-audiovisuel-des-foyers/L-equipment-audiovisuel-des-foyers-des-1er-et-2eme-trimestres-2017-pour-la-television, 20 October 2017

Choosing to market a TV operating system via an external device is an advantage when the life cycle of a television is quite long (around seven years[38]): it makes it possible to plan for its more regular replacement, as with smartphones and tablets, and regardless of how old the television is.

If most manufacturers have integrated Android TV into their televisions, it is interesting to note that the market's top two brands[39], Samsung and LG, operate their own OS, both based on a Linux kernel: respectively Tizen and Web OS. Both of these manufacturers also led the way in sales in Europe in 2016, with a 31% and 13% market share, respectively, compared to 11% for televisions powered by Android TV[40].

In the smart TV universe, a manufacturer can still stand out from its rivals and control the software aspect of its products, to be able to provide its customers – who have a growing appetite for connectivity and access to OTT services – with a rich and fully secure experience. The ability to develop alternative operating systems remains easier in a market that is not yet dominated by a key player, within a still relatively small applications environment.

The development of smart watches offers a similar example to smart TVs, and one where Apple and Google are present in the same way, Apple via its watchOS that is available only on the Apple Watch and Google via Android Wear. Both of these operating systems designed for smart watches are derived from parent OS, iOS and Android. Samsung uses its own Tizen Open Source OS, as it does for its televisions. Apple is by far the smart watch market leader, with a close to 50% share of sales, and well ahead of Android Wear and Tizen which each have a roughly 15% share of the market[41].

Most smart watches remain dependent on smartphones, and if Apple has made its Apple Watch only compatible with the iPhone, Google and Samsung are making their smart watch OS iPhone-compatible as well.

2.3.3 Smart speakers with voice assistants: future frontrunners in the galaxy of smart home equipment?

The emergence of voice assistants paved the way for the arrival of a new type of equipment, where voice replaced touch to communicate.

After having originally been used in mobile devices (smartphones and tablets), this new form of voice-controlled interaction is now being used by fixed devices as well, namely smart speakers. They are used inside the home and rely on Wi-Fi connectivity combined with a speaker outfitted with microphones and a speaker which, thanks to built-in artificial intelligence, interacts with users' voice.

These devices were designed to satisfy all of users' oral questions and commands: for instance, the speaker can play music or search for an Italian restaurant to dine in. The speakers can also interact with all of the home's connected devices, provided they are compatible. So a speaker could turn on a light when the user enters the room, or send videos to the TV screen. Partnerships have thus been formed between the makers of home appliances and smart speaker manufacturers. To be heard, the user needs to use a predefined expression, such as "Ok Google", "Alexa" or "Hey Siri" depending on

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[38] Audio Video HD, *We replace our TVs every seven years, on average,* http://www.audiovideohd.fr/actualites/8750-NPD-DisplaySearch-nous-changeons-de-TV-bien-plus-souvent.html, 13 June 2012

[39] Statista, *Global market share held by LCD TV manufacturers from 2008 to 2016,* https://www.statista.com/statistics/267095/global-market-share-of-lcd-tv-manufacturers/

[40] Statista, *Share of smart TV sales in Europe by operating system in 2016,* https://www.statista.com/statistics/660850/smart-tv-operating-system-market-share-in-europe/

[41] Neowin, *IDC: Smart watch shipments fell 32% in Q2, with Apple Watch crashing by 55%,* https://www.neowin.net/news/idc-smartwatch-shipments-fell-32-in-q2-with-apple-watch-crashing-by-55, 22 July 2016

the model. The speaker then answers the request by analysing the user's habits, among other things, to deliver relevant responses.

Users' adoption of smart speakers appears to already be well underway in the United States, and will likely become so soon in France; in late 2017 Google rolled out its Google Home speaker, while Apple and Amazon have announced the launch of their respective products, the HomePod and Amazon Echo, for spring 2018.

Smart speakers, already a success in the United States

Using a voice assistant to perform searches or view information through a conversation with a device is catching on, especially in the United States which has been a pioneer in this area. In 2010, Google CEO Eric Schmidt reported that 25% of queries made in the US were voice searches. Although Google provided a revised figure of 20% in 2016[42], voice assistants are still a fast-growing market, with the development of smart speakers that have this function built-in.

Amazon, Apple and Google are spearheading the sector. In the United States, Amazon enjoys a substantial lead over the competition in the smart speaker market as, according to research firm CIRP, it boasted a 69% market share in December 2017, with 31 million Echo speakers sold, compared to 14 million for Google and its Google Home[43] speaker. US retail giant Walmart has formed a partnership with Google to compete with Amazon for online sales, allowing Google speaker users to do their shopping via the voice assistant. Meanwhile Apple, which currently trails behind, has begun taking pre-orders for its HomePod in the United States, with the first shipments due in February 2018.

This fast-growing market has real potential. According to market research firm Forrester, more than two out of three households in the US will have a smart speaker in 2022[44].

2.3.4 Connected cars: the ordinary way to access the web in future?

The use of technological innovations in connected cars tends to be aimed at satisfying safety requirements, above all, to make transportation more efficient and driving easier. Here, it is worth remembering that every car will be equipped with a SIM card, following the implementation of the eCall[45] system. But providing cars with internet access capabilities is also designed to provide drivers and passengers with information and entertainment.

This includes giving passengers access to their mail and messages, to multimedia content, their calendars, etc. The dashboard could eventually become one of the most viewed displays. The driver and passengers would be able to access the web and certain applications using one of three formulas, depending on the car-makers' chosen strategy:

- On-board system: built-in computing capabilities and connectivity, thanks to a SIM card and a dedicated telecoms plan for the vehicle;

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[42] Search Engine Land, *Google says 20 percent of mobile queries are voice searches*, https://searchengineland.com/google-reveals-20-percent-queries-voice-queries-249917, 18 May 2016

[43] Geek Wire, *New data: Google Home faring better against Amazon Echo, grabbing 40% of U.S. holiday sales* https://www.geekwire.com/2018/new-data-google-home-faring-better-amazon-echo-40-u-s-holiday-sales/, 26 July 2018

[44] Forbes, *22 Million Amazon Echo Smart Speakers To Be Sold In 2017, Driving US Smart Home Adoption* https://www.forbes.com/sites/gilpress/2017/10/29/22-million-amazon-echo-smart-speakers-to-be-sold-in-2017-driving-us-smart-home-adoption/#e32b106481a2, 29 October 2017

[45] Starting on 31 March 2018, a European regulation (http://eur-lex.europa.eu/legal-content/FR/TXT/HTML/?uri=CELEX:32015R0758&from=FR) requires an eCall system (on-board emergency call mechanism) and hence connectivity, in all cars.

- Hybrid system: intelligence integrated into the car, but the smartphone serves as the modem[46];
- Smartphone integration system: the smartphone screen is replicated on the dashboard or on-board computer, and connectivity is supplied by the smartphone.

Automotive manufacturers naturally focus heavily on safety, and want to avoid any activity that could distract the driver or threaten their safety. This is why in cases where the driver's smartphone would be used in the connected car, only a small selection of apps and features would be replicated in the car's multimedia system. Agreements between OS providers and car-makers will need to be established. And the use of voice-controlled assistant systems is expected to provide a solution to the need for safety. At the same time, with the looming prospect of ubiquitous autonomous cars, infotainment will no doubt grow in popularity, and the restrictions applied in the OS for the sake of driver safety will no doubt gradually disappear.

The connected car takes off: alliance or opposition between digital giants and leading car-makers?

Car-makers and equipment suppliers, top internet companies, and especially OS providers, and start-ups alike all want a piece of this fast-growing market. Hence the power struggles and alliances we are seeing between the two industries. Google, for instance, created the Open Automotive Alliance with four top automakers (Audi, General Motors, Honda and Hyundai), to have its Android OS integrated into cars, with the Android Auto solution. Apple has developed CarPlay, an embedded iOS for vehicles that allows drivers to obtain driving instructions, make calls, exchange message, listen to music and use Siri directly from the car's dashboard[47]. The Mirrorlink system from the Car Connectivity consortium – which according to its members[48], brings together 70% of the world's car manufacturers and 70% of its smartphone-makers (Huawei, Samsung, Sony, HTC, LG) along with a great many leading consumer electronics suppliers – allows users to see smartphone apps on their dashboard display and listen through the car's speakers. Some carmakers, however, do not want digital industry players to gain the upper hand, and are working to develop their own solutions. Examples here include Renault with Easy Connect and the SmartDeviceLink consortium whose members include Ford, Toyota, PSA, Mazda, Subaru and Suzuki, which are pushing for the adoption of the Open Source SDL platform developed by a Ford subsidiary.

2.3.5 The "kindle-isation" of devices: creating a specialised internet?

Users today have adopted the smartphone as their device of choice for accessing the internet. But they also watch online videos on their TV, get music from their voice assistant, ask for traffic information from their car, download new games onto their home console, and buy books off their e-book reader. So users have a host of devices that provide them with access to the internet, and allow them to satisfy all of their daily needs. This trend, which could be called the "kindle-isation" of internet access, could encompass two phenomena.

First, it could correspond to the natural evolution of uses, which would require a specific type of device for each purpose. The device's design could explain why users employ a dedicated device for each type of content they want to access. A good example is the e-book reader, which connects to the web mainly to access digital versions of books. If, today, very few devices offer limited access to the internet, the expected explosion of the number of connected objects could mean that this type

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[46] Given the above-mentioned regulation, this strategy does not appear to have much of a future.

[47] Apple, https://www.apple.com/fr/ios/carplay/

[48] Car Connectivity Consortium, https://carconnectivity.org/about/

of limited access will become commonplace. While access through a single device, such as a smartphone or a computer, in theory gives the user access to the full range and wealth of content and services available online, the growing specialisation of devices does not make it possible to tap into the web's diversity. So we are seeing internet access being divvied up between a group of intermediaries offering specialised connections.

Second, this "kindle-isation" could reflect the approach of certain content and service providers that sell devices designed to access their own services. This is apparently the case with HomePod speakers: the first announcements seem to imply that they will only give users access to Apple Music and iTunes[49] and not to competing online music services, such as Spotify[50]. This model whereby, from its physical to its software layers, a device is associated with a single player, and often an online platform, could be adopted by other players as well. In future, a social network could market a device whose internet access would be confined to partner applications; a connected car's GPS could choose driving routes that are likely to increase traffic to businesses that have deals with the car-maker.

When this is the result of a corporate strategy, equipment specialisation could go hand in hand with a dedicated internet access service, which is invisible to the end user. Certain connected products are *de facto* sold with a connectivity service, such as the cellular version of the Apple Watch Series 3[51].

Regardless of its origin, there are real concerns attached to seeing this model extend to all devices, and lead to a fractioning of internet access. Conversely, it is likely that this "kindle-isation" of internet access will not become widespread and that a device, such as the smartphone or today's modem-computer duo, will continue to deliver access to the entirety of the internet. This is why these devices will be the subject of a more in-depth analysis in the subsequent chapters of this report.

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Devices continue to evolve while other types of equipment, enhanced with new features, are also providing an internet connection – including game consoles, televisions, smart speakers and cars.

If we look at all of these segments together, there is a plurality of operating systems. On top of veteran console-makers, in the smart TV market there is Samsung which has outfitted all of its devices with its own Tizen operating system, providing an alternative to Apple TV and Android TV systems. In the voice assistant segment, Amazon is competing with Apple and Google with its Alexa products, integrated into the Echo smart speaker while, over in the car segment, manufacturers are working together to design new connectivity solutions.

Apple and Google nevertheless continue to dominate the smartphone market, which today is the main device used to access the internet in France. Although a number of suppliers are vying for a share of the hardware market, the club and network effects of the platforms themselves have ultimately concentrated the market around only two operating systems: iOS and Android.

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[49] 9to5Mac, *HomePod can play purchased iTunes music, podcasts and stream Beats 1 without Apple Music subscription*, https://9to5mac.com/2018/01/23/homepod-can-play-purchased-itunes-music-podcasts-and-stream-beats-1-without-apple-music-subscription/, 23 January 2018

[50] Business Insider, *Spotify won't work with Siri on Apple's HomePod*, http://www.businessinsider.fr/us/apple-homepod-spotify-2017-10/, 30 October 2017

[51] In France, Germany and the UK there is as yet no provider of connectivity for this equipment, https://www.apple.com/fr/watch/cellular/

3 Current impediments to internet openness, and risks for tomorrow's internet

3.1 How devices fit into the internet access equation

Devices play an essential role in providing internet access. They deliver potentially very different features, and are partially controlled by a small group of economic actors. This is why they need to be taken into consideration when evaluating how the internet operates. It nevertheless appears that, despite the ambitious goals it sets forth, the European Open Internet Regulation overlooks this link in the chain that runs from users of internet access services to news, information, content, applications and services.

3.1.1 Spirit of the Open Internet Regulation

With Regulation 2015/2120 of 25 November 2015, which establishes measures regarding internet openness, European lawmakers expressed their position on the shared asset nature of the internet, by underscoring that it had become "*an open platform for innovation with low access barriers for end-users, providers of content, applications and services and providers of internet access services.*". In addition, France's Constitutional Council has stated that, "*given the current state of the means of communication, and in light of the widespread development of public online communication services, and the importance that these services have gained in the ability to participate in democratic life and to express ideas and opinions,*" the constitutional right to free expression and communication, "*implies freedom to access these services*".[52]. This resource, whose value today derives largely from the fact that it is easily shared, should not be monopolised by a few people or legal entities.

The regulation recognises that end users have rights.

It should be stated that these rights pertain not only to incoming streams on ISPs' networks, but to outgoing streams as well. Indeed, "*irrespective of the end-user's or provider's location or the location, origin or destination of the information, content, application or service, via their internet access service,*" end users must be able to:

- first, "*access information and content*" and "run […] *applications and services*";
- second, "*provide information and content*" and "*provide applications and services*".

To ensure this, the regulation recognises users' right to "*use terminal equipment of their choice*".

While setting out ambitious objectives for safeguarding internet openness, the regulation nevertheless focuses on internet service providers (ISP), imposing supervisory measures on their traffic management practices and their transparency, in addition to prohibiting restrictions on the use of terminal equipment connected to the networks.

However devices, which have attachments to access networks, are at the very heart of the technical chain of internet access. They are essential links that warrant examination when gauging the principle of an open internet.

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[52] Decision No. 2009-580 DC of 10 June 2009, Act promoting the dissemination and safeguarding of creation on the internet

3.1.2   Terminal equipment in the technical chain of internet access

These links are, first, physical links. In addition to ISPs, other players come between the end user and online content and services. They include data hosting centres, transit operators and devices.
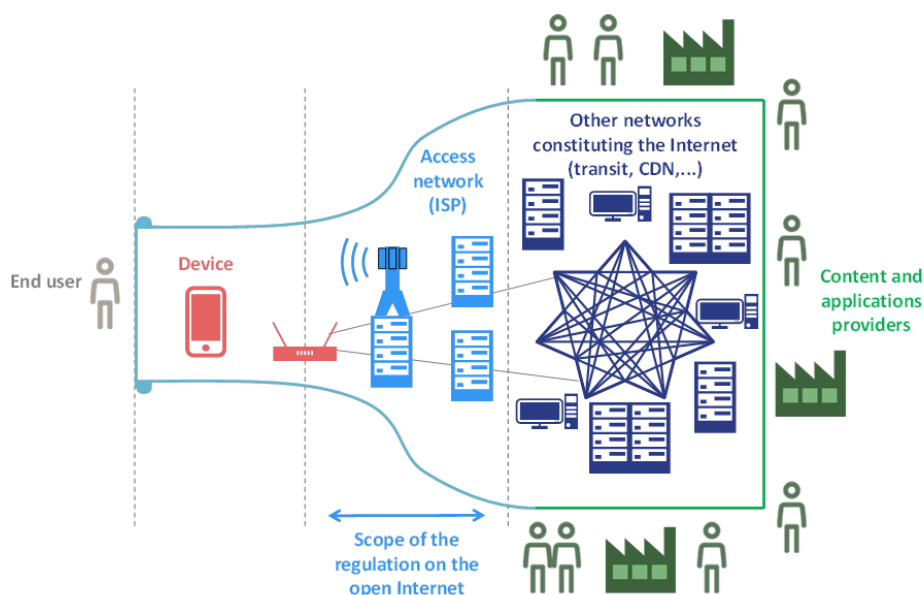
Physical links between the end user and the internet

These links between the end user and online content and services are also software links. Several players enjoy a position of power over the internet's data traffic. They include online platforms, as well as app stores and applications. Operating systems are also a necessary point of passage for data on the internet.

Software links between end users and content

3.1.3   Particular features of the links formed by devices

End users are not necessarily in a position to assess their devices' characteristics: first, the people buying terminal equipment are usually not industry professionals. Second, when an end user has

chosen her device, she will typically be the only one to use it (it is rare, for instance, for several mobile devices to share the same internet access plan), and will not be trading it in immediately (according to market research firm, Kantar, in 2016 European smartphone owners changed their equipment, on average, every 22 months). Lastly, the manufacturers of certain terminal equipment, and especially mobiles, currently enjoy an especially strong competitive position. Impediments to internet full openness could come from this equipment, however, whether for technical or commercial reasons. As the guarantor of net neutrality, Arcep is investigating terminal equipment and their operating systems, which have attachments to the networks.

If the European Open Internet Regulation enshrines users' freedom to choose and use any device, it does not impose any specific obligations on device manufacturers and suppliers, nor on other software links in the technical chain illustrated above. Arcep believes that to be able to fully grasp the concept of an open internet in its broadest sense, the influence that devices have on this openness needs to be investigated.

3.1.4   Analytical scope

In the context of this investigation, devices are examined with respect to how much capacity they give end users to access all of the information and services available on the internet, and to provide content.

With this in mind, the main devices being analysed are as follows:

- mobile communication devices (smartphones and tablets),
- telecom carriers'/ISPs' internet boxes[53],
- alternative providers' or players' TV devices (Apple TV, Roku, etc.),
- computers,
- voice-controlled devices,
- video game consoles,
- smart TVs,
- other connected products that provide internet access (smart watches, e-book readers, etc.).

However, other devices, such as the majority of connected products (smart sensors, smart meters, connected furniture, etc.) does not fall within the scope of this report, as they do not allow users to connect to the internet.

Situations can vary dramatically amongst the different equipment being analysed, and create more or less severe impediments for users. It is important, however, to keep in mind the size of each category's role in providing internet access. Therefore, even small impediments that may come from smartphones will not have the same influence as theoretically greater impediments that derive from more marginal and more specialised equipment.

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[53] It is interesting to note that, if ISPs' approach is unwavering with respect to the definition of the "network termination point" for mobile access, it varies for fixed access. Some operators indeed posit that internet boxes are part of their network; and so believe that users' freedom to choose their terminal equipment does not apply, as it could undermine the integrity of their network.

The purpose of this report is not to determine the precise location of the "network termination point". As a result, for the sake of thoroughness and in keeping with a functional approach, ISPs' internet boxes have been included in the scope of the devices being analysed.

3.2 Limits due to the nature of the device

When end users buy a device, their choice is influenced above all by how they plan to use it: fixed or mobile, simple or sophisticated, dedicated or not. This choice has a direct effect on the scale of possibilities in terms of accessing the internet and providing content online.

3.2.1 The modem-computer duo: the ideal way to access services and provide content online?

Still today, even if some users have told Arcep of the difficulties created by the lack of technical documentation made available by certain box providers and, in general, the restrictions on use (e.g. on self-hosting, VPN, remote desktops, certain online gaming features, etc.) tied to the integrated router in certain boxes, the development of any minimally complex online service will necessarily require a modem and a computer (not only to ensure a user-friendly experience, but also for reasons of compatibility and availability of development tools).

Looking at computers, some believe that even a desktop computer, and specifically a PC is the multi-purpose device *par excellence*, since it can be upgraded by writing new programmes or adding new components. Physical and software interfaces make it possible to add new features to it.

Jonathan Zittrain[54] thus points up similarities in the how PCs and the internet are used: "*Both the Internet and the PC are on a similar trajectory. They were designed by people who shared the same love of amateur tinkering as the enterprising Coyote. Both platforms were released unfinished, relying on their users to figure out what to do with them—and to deal with problems as they arose. This kind of openness isn't found in our cars, fridges, or TiVos. Compared to the rest of the technologies we use each day, it's completely anomalous, even absurd*".

However, generally speaking, only the most technologically savvy are capable of upgrading a PC. For less savvy users who are concerned about the integrity of their hardware, the PC's possibilities do not outweigh its drawbacks in terms of ease of ease and security. It appears that users need to choose between freedom and convenience. Jonathan Zittrain himself speaks of the clash between PC's "open" model and the safer model of walled garden computers.

Besides, this walled-garden computer model is close to that of smartphones, with a tendency to deliver content through proprietary app stores. Such is the case, for instance, with computers that run on Windows 10 operating systems.

Moreover, certain features that are now an integral part of internet access, are often not available on computers. For instance, certain applications like WhatsApp require a device with a SIM card to validate the user's ID, to be able to use them.

Other components are not likely to be widely deployed in computers, such as cameras, GPS, motion sensors, QR code scanners, NFC chips or gyroscopes (used by compass apps).

This explains why certain applications were developed solely for smartphones. As a result, if the computer remains the best device for making content available on the internet, it can no longer be considered a device that enables full access to the internet.

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[54] Jonathan L. Zittrain, *The Future of the Internet and How to Stop it*, http://blogs.harvard.edu/futureoftheinternet/files/2013/06/ZittrainTheFutureoftheInternet.pdf , June 2013

3.2.2 Other devices, designed to use services

Where connecting to the internet was once specificity of the desktop computer, the market today has largely shifted to new devices, and primarily the smartphone. Although multi-purpose, this device does not offer all of the facilities of a computer, notably in terms of plug-in peripherals and data processing. It is designed to streamline the user experience on the web.

With the miniaturisation and decreased cost of modules enabling electronic devices to connect to the web, the range of internet-capable devices expanded considerably, as did connectivity products. This led to a very disparate range of experiences, and users' demands with respect to access to online content is not necessarily the same, depending on the scale of the features that each device can deliver.

For instance, smart watches have inherent limitations due to their design: small display, which naturally means a drastic selection of what can be seen, and few interaction options (touch screen, small number of buttons). Here, we understand that smart watch owners do not demand full connectivity to all of the content available online, but rather expect more selective and thoughtfully adapted access.

The same phenomenon can be seen with other emerging devices, such as connected game consoles, connected cars and smart speakers. The display features (small or no screen) and having largely audio-based interaction limits the ability to access exhaustive information, and leads to a selection of the information delivered by the content provider.

This means that new devices, whether smartphones, smart watches or smart speakers, are essentially geared to consuming services and applications (even if, within them, a user may produce and provide content): users can absorb everything that is going on around them, or dictate texts, but cannot write programmes or draft texts of any great length. As they are more and more connected, these devices require less and less local storage space.

These limitations are not worrisome in and of themselves, since they derive from the nature of the object itself, and the customer expects them. However, by extrapolating this trend of ever more numerous connected products, it is possible to consider that there is a risk of fragmenting users' internet access, which could eventually consist of just a host of specialised silos, or sub-internets. If it is still far from complete – as there are still multipurpose devices – this "balkanisation" of the web could threaten the existence of a fully open internet, as some users may not have all of the equipment required to be able to make available and access all of the content that exists on the internet.

a) Smartphones and tablets, devices that provide broad access to content and could be used to design services

In less than a decade, smartphones have taken hold as the device of choice for accessing the internet. As with tablets, smartphones are multi-purpose, to the extent that France's *Commission d'enrichissement de la langue française* recommends they be qualified "multipurpose mobiles". Theoretically, they allow users to access all of the content available on the web.

In addition, the somewhat limited nature of their interface (a touchscreen is not ideal for writing content, such as code) diminishes with the advent of smartphones that can be used as a desktop (e.g. with Samsung's DeX dock[55] and Microsoft's Display Dock [56]): thanks to these new devices, users can

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[55] The register, *DeX Station: Samsung's Windows-killer is ready for prime time*, https://www.theregister.co.uk/2017/05/15/samsung_dex_deep_dive/, 15 May 2017

have all of the functions of a smartphone and a PC at their fingertips. This development is nevertheless confined to a handful of devices, and they are still too new to be able to predict their future popularity.

It should also be noted that smartphones and tablets, whose versatility is a major selling point in their adoption by consumers, are naturally less well suited than other devices to meet specific needs. E-book readers are better for reading e-books, televisions are still the screen of choice for watching video content, and game consoles and PCs provide a better gaming experience.

b)   E-book readers: good for reading, but light on features

E-book readers stand out from tablets, first, with a screen that offers a more enjoyable reading experience. Designed for reading, these devices cannot run many applications, and in many cases can only be used to read e-books. This can be attributed in particular to the use of e-ink technology that provides a much slower refresh rate than the technology used by other displays, as well as a typically two-colour display, which makes it impossible to render most of today's web pages properly.

But the customer buying an e-book reader is probably not hoping for a complete multimedia experience, which they could get by buying certain hybrid tablets whose format is similar to e-book readers but offer a wider range of features.

E-book readers also stand out from tablets through the internet access they provide. Their connectivity is used chiefly to provide access to libraries of e-books. If they can be connected to a computer, and thereby access any available e-book, in practice it is impossible to connect one directly to an e-book shop other than the one configured by the device's manufacturer[57].

c)   Game consoles, harnessing power

If mobile phones initiated a new clientele to gaming (and especially casual gaming), dedicated consoles are still the main devices used to play video games, especially since they have also evolved towards an internet-centric model. It is by now virtually indispensable for a game console to be internet-capable, as much from the manufacturers' viewpoint (to be able to manage updates and fight against piracy), as from users' (to be able to play online).

Thanks to this internet connection, some consoles now also contain apps (particularly for playing media content) and browsers (combined with the necessary peripherals – keyboard, mouse – to emulate a computer). Despite which, consoles are not sold as multipurpose devices. Their core interface is still the joystick or controller, which is designed to allow users to react quickly when gaming, but does not provide an evolved typing mechanism. And this to the point that console-makers often offer smartphone applications so that a gamer's phone can act as a companion screen. It is often true that users can buy a game from the online store more quickly by ordering with their smartphone than with their console.

Furthermore, some console-makers are still very much focused providing a game-centric machine. Although Nintendo consoles have a touchscreen and an OS that provides the same possibilities as a smartphone, the manufacturer chose to block the browser so that it can only be used to configure the console. Users are therefore forced to go through the app store to access content.

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[56] Microsoft, *The phone that works like your PC*, https://www.microsoft.com/fr-fr/mobile/accessoire/hd-500/

[57] This limitation does not appear to be justified by the device's technical capabilities (contrary to the rendering of websites). If e-book readers in any event only allow users to access a limited selection of online content, it is less for the sake of protecting internet openness as for the need to oversee the associated sales practices that this could be criticised.

d)   Smart TVs: poised to be untethered media devices?

Operating systems that are comparable to those that power smartphones are starting to be deployed in televisions, and currently with some variety. They allow users to install apps and services to be able to access content via the internet. if the operating systems are similar, televisions do not provide a fluid user experience when inputting text or scrolling through menus, for instance, which considerably dampens users' desire to use them to search for content. In reality, suitable input peripherals (keyboards or cursors) could be connected to a smart TV, but most users do not view their television as a way to surf the web, and do not typically outfit their home equipment to this end. The main physical interface for controlling the TV is therefore still the remote control[58]. Even when made "smart," TVs are used chiefly to access media content apps or content that the user already selected on her smartphone. The advent of voice assistants on televisions could help enhance the content viewed on the TV.

e)   Voice assistants and smart speakers: creating an intelligent but internet-centric experience

Today, voice assistants are being developed for all manner of machine (computers, smartphones, televisions, connected cars, etc.). What sets smart speakers apart is that they rely entirely on voice-controlled interfaces and, by nature, cannot provide access to any visual internet content (text, images, videos, video games) except on a companion screen (smart TV, computer screen, smartphone).

When confined to replying orally, smart speakers often given only a single result to a query, which is chosen by the ranking algorithm. If algorithm developers need the results delivered by their tools to be relevant, it nevertheless remains that the need to supply a single response constitutes a structural impediment to internet openness.

It should also be noted that, generally speaking, a voice assistant that is configured by default on a device cannot be replaced, as it is tied to the operating system. Moreover, certain voice assistants cannot be configured to switch search services. So the only sources of information that can be queried to answer users' questions are the ones that the device's manufacturer has selected.

In addition, if it is true that content providers can design apps that can be queried by the speaker, the speaker itself is not open to app developers: it is the intelligent assistant service that is. There are APIs that allow developers to interface their service with the speaker, but online content providers do not have ability to install their app on the speaker, for instance to interact directly with the microphone. It is therefore impossible, for developers wanting to deliver their apps through voice assistants, to circumvent the device's web interfaces. Also worth noting is that voice assistants' storage space is only used as a buffer memory, not as a space where apps can be installed or content stored.

If voice assistants' limitations can create problems on every platform, the issue is more critical when it comes to smart speakers. First, because the voice assistant is their only internet access interface. Second, because voice assistants' limitations can have repercussions on all of the devices that interact with them. Some of the services and content to which the speaker provides access are not designed to be used on the speaker (especially since it often has no screen), but rather on other devices. These assistants use the speakers to route the consumption of content and services to most of the home's connected peripherals.

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[58] Here, it is possible to note that, instead of trying to get users to connect new peripherals into their TV, a service provider like Netflix has opted to have access to its service incorporated into the remote control.

What is an API?

For a third party to be able to provide applications, they need to be given access to devices. For instance, a messaging app might want to access users' contacts, and a photo app will need access to a device's camera. The advent of app stores thus went hand in hand with giving developers access to devices through the Application Programming Interfaces, or API, made available by operating systems. In the case of a messaging app, the API will provide a function that the application will use to obtain a contact list. For a photo app, it will be a function that can send back a picture taken by the camera. If there are a great many smartphones that run on the Android OS, and several versions of the iPhone, defining APIs for each universe prevents developers from having to write dedicated programmes for each model of smartphone. As long as app developers use the API made available by the operating systems, it is the OS that will serve as the interface between their programmes and the different devices. However, because APIs evolve over time, some apps may not work with older versions of an operating system.

By the same token, web APIs make it possible to use web services without having to worry about their inner workings. This means that developers can use the web API supplied by Facebook, Google and others to integrate their services into applications. On certain devices such as smart speakers, operating systems do not supply APIs, but it is still possible to develop apps for these devices if they make use of web services. With smart speakers, then, even though it is not possible to install applications on the device, users can "call up" applications through intelligent assistant services.

f)   Connected cars, from assisted driving to infotainment

As stated earlier, the purpose in making cars connected can be threefold: the first is to provide greater safety, the second to make driving easier, and the third is to provide passengers with entertainment.

In its primary purpose, we can expect connected cars not to have a well-designed interface that enables access to a wide variety of content. On the one hand, car-makers are not inclined to want to change the dashboard so as to prevent certain driving-related functions from being used improperly. On the other, the connected car is no doubt the only device that eschews attracting the attention of its main user, i.e. the driver, too heavily. Drivers must not be distracted when at the wheel, and will generally have little time to devote to any applications that demand their attention. So only a small selection of apps need to be available.

For safety reasons, very few applications are allowed in connected cars. They need to receive prior approval from app stores[59] and need to be isolated from the system that manages the vehicle's main functions. This requirement is all the more imperative when looking forward to the development of cars that are not only connected, but self-driving.

In its secondary purpose, however, nothing would seem to indicate that a connected car would not provide access to an internet that is any less rich than on any other device, such as a smartphone or tablet.

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[59] The app stores associated with the embedded operating systems in cars limit the different types of application that are permitted. In most instances, only messaging, music playback and dashboard apps are allowed. One explanation given is that apps must not distract the driver.

3.3   **Limits** derived from the evolution of devices' software and OS

A great many physical devices, and particularly smartphones, are sold with a default operating system which, in some cases, users cannot change. A device can be designed using one of two models: a fully integrated design, whereby the OS and hardware are developed by the same entity, and the other where the OS kernel and the hardware are developed by different entities.

As a result, any software upgrades that OS creators want to make will affect how the device functions, and notably the internet access it enables. It should be noted that OS-related impediments may also occasionally derive from the obsolescence of the physical side of devices, which no longer have all of the properties required to deliver certain features.

3.3.1   On the application side

a)   A method for accessing the internet in which developers are challenged by having to manage the obsolescence of certain operating systems…

Operating system providers may want to limit the number of versions of their OS in circulation, for instance to increase security levels on the platform, limit costs or to encourage users to upgrade to the most recent versions of their products.

To hasten the extinction of the oldest versions, an operating system's developer may, when updating it, decide to no longer give app developers access to APIs that were previously available to them. As a result, an application that is available on an older version of an operating system may disappear when that version is no longer supported, if its provider is no longer able to assume the investment needed to recode its base functions.

So users who have downloaded the most recent versions of an operating system may lose access to some of their apps, or no longer be able to update certain ones.

b)   … and the fragmentation of others

By the same token the fragmentation, or proliferation, of derivatives of the same operating system can also create impediments to end users' ability to access content. If versioning is something that exists with every OS, fragmentation levels are especially high with operating systems that are mainly Open Source, in other worlds those whose source code is, at least in part, made available to developers: users can develop and enhance these operating systems by providing overlays, or by making radical modifications by creating forks.

This situation can limit certain content providers' ability to deliver their products on every device. Although emerging solutions designed to help developers provide cross-platform applications, a great deal of development work still needs to be done to ensure that content is compatible with all available devices.

3.3.2   On the website side

a)   The browser: a method for accessing an abundant internet…

Competition between the different browsers pushes them to rapidly adopt the most popular and standardised features being offered by their rivals. It was a European Commission investigation in particular that made it possible for this competition to thrive. On 21 December 2007, following a complaint from the Opera browser, the Commission launched an investigation into the tying practices between Windows and Internet Explorer. This practice allowed Microsoft to use its dominant position in the operating system market to access a dominant position in the browser market. In December 2009, this investigation resulted in an agreement whereby Microsoft

committed to creating a choice, or ballot screen that allowed users to choose their browser. Microsoft also committed to uninstall Internet Explorer. The ballot screen allowed browsers to all be on an equal footing. To ensure that none enjoyed a particular advantage, even the order in which they were listed was random.

The ballot screen was made available from 2010 until the end of 2014, but it would be an exaggeration to attribute real competition between the different browsers to a single measure. Internet Explorer began to fall out of favour even before the measure came into effect[60], following the arrival of Firefox and later Chrome. The internet is not only the web, but a large percentage of the services available on the internet have a web version. Because browsers are a longstanding method for accessing the internet, they are present on the main connected devices, and providing a web service allows them to ensure that a large number of people can access these services under relatively homogeneous conditions.

b)   … though still deprived of certain features…

When a device is equipped with a browser, it gives users the ability to access most web services.

However, websites also have several limitations compared to applications.

- These limitations may be imposed by the browser. Such is the case with certain web functions which, although standardised, are not supported by certain browsers. So, if standardisation is often necessary for a function to be deployed on all browsers, it is not in itself enough. Some functions that have been standardised by the W3C[61], such as web notifications, are not fully supported by every browser (some support only a limited version).

- These limitations can also be imposed by the operating system. For instance, it is not possible for web services to access devices' identifiers, which are often what makes it possible to monetise an app by sharing data with advertising networks, and by giving them the ability to display personalised ads. Operating systems impose these restrictions to protect users' privacy. Online ad tech company Critéo points out that certain measures make it easier to monetise apps compared to web content[62].

- These limitations can also be imposed by the operating system or the browser. It is impossible to configure certain aspects of mobile browsers (e.g. choice of the default search engine[63]), and certain functions available on computers are absent or simplified on a mobile device (e.g. the ability to install extensions such as ad blockers may be blocked either by the operating system – iOS blocks this feature on every third-party browser – or by the browser: Android allows ad blockers since Firefox uses them, but Google's Chrome blocks them).

Lastly, browsers do not offer an offline mode, and are not able to download data when running in the background. As a result, web pages have a longer response time and, naturally, a slower load time. From the users' perspective, this can put browsers at a disadvantage compared to applications.

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[60] W3Counter, *Web Browser Usage Trends*, https://www.w3counter.com/trends

[61] W3C stands for the World Wide Web Consortium, an international standardisation body created in 1994 and responsible for promoting compatibility between web technologies, such as HTML5 and CSS.

[62] The Wall Street Journal, C*riteo's Shares Plummet on Revenue Forecast*, https://www.wsj.com/articles/criteos-shares-plummet-on-revenue-forecast-1513279308, 14 December 2017

[63] Next Impact, *Windows 10 S: questions and answers on a very strange system*, https://www.nextinpact.com/news/104187-windows-10-s-questions-et-reponses-autour-dun-systeme-bien-etrange.htm, 3 May 2017

c)   … but that could change

There are nevertheless developments happening today that make it possible to eradicate the differences in the user/client experience between browsers and applications. Progressive Web Apps are web pages that employ browsers' advanced features to deliver a user experience more akin to what native apps (i.e. those developed specifically for smartphone*s*)provide: the launcher on the home screen, full screen display, refreshing content even when the page is not active, and the ability to send user notifications. Progressive Web Apps enjoy the advantages of web pages, such as indexing by search engines and the ability to be shared using a simple URL. They also make it easy to turn websites into hybrid apps that are better integrated into the mobile environment, and more rapidly accessible than applications.

However, even if Progressive Web Apps take on some of applications' key functions, they do not benefit immediately from the latest smartphone innovations. For a function to become part of Progressive Web Apps, it first needs to be part of a common set of functions supported by the main operating systems and then by their browsers. This will often suppose standardisation by the W3C. In the case of Service Workers, one of the key functions of Progressive Web Apps, close to four years elapsed between the first working draft from the W3C[64] and the function being supported by Edge and Safari browsers. Other standards that could benefit Progressive Web Apps are still being standardised, notably Push API (for displaying notifications), on which work began in 2012[65]. As a result, while developers of native apps can update their applications as soon as the feature is available on the device, they need to wait for it to be supported by the browser before they can offer the service in the form of a web page. Given the current state of the market and technical developments, it does appear that the smartphone universe leans in favour of content delivered through applications, giving both customers and providers greater possibilities, and greater exposure through the smartphone's app store. As long as this situation continues, browsers will not be able to fully play the role of effective gateway to the internet on smartphones.

Lastly, it is worth remembering that if browsers can, to a certain extent, offer an alternative to app stores, they do not replace operating systems. Browsers are not directly integrated into devices and need to be installed on an operating system. For instance, they do not have access to the device's key functions (e.g. communication ports), as much for security reasons as for the sake of Digital Rights Management (DRM), in other words the technical measures in place to control how digital works are used.

3.4   Limits derived from the editorial policy of the operating systems and app stores

When choosing a device, end users are not making a solely technical choice. They are leaving it up to the operating system's provider – and, if they choose to buy an "integrated" device, to the provider of the app store – to determine the criteria used for selecting and sorting the suggested content sent back in response to their queries. These criteria – which can represent a guarantee of quality (notably in terms of security, privacy and reliability) for some users, but remain imperceptible to others – can influence how open users internet access truly is.

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[64] The World Wide Web Consortium (W3C), *Service Workers, W3C First Public Working Draft 08 May 2014*, https://www.w3.org/TR/2014/WD-service-workers-20140508/

[65] The World Wide Web Consortium (W3C), *Push API, W3C Working Draft 18 October 2012,* https://www.w3.org/TR/2012/WD-push-api-20121018/

3.4.1   Anti-virus protection measures: to what extent do they justify the OS provider's interference?

To facilitate the use of devices while minimising the risks, OS include certain default protections that only allow users to install software that is authenticated and recognised by the operating system's developer. So only apps acquired from the device's official app store can, in theory, be installed. Some devices nevertheless allow users to override this protection, to give them more freedom of choice. But this freedom also exposes users to greater risks, since the apps are no longer filtered before being installed.

To limit these risks, Google regularly scans all of the apps installed on devices with Google Play Services. This analysis makes it possible to flag up any malware to users, as well as apps that do not meet basic security rules. This applies to apps that are downloaded off alternative app stores, as well as those obtained from the Play Store. Some malwares are identified after having been made available on the Play Store, which shows how difficult it is for app stores to remain open to developers while guaranteeing the security of their system. One alternative consists of limiting the selection of available apps by only offering those that have been validated through an in-depth process, as Uhuru Mobile does.

If we welcome the availability of tools that help limit the risks associated with applications from the Google Play Store and those downloaded from alternative app stores, we can still wonder about the security alerts that are displayed when users download content from alternative stores. They seem especially inappropriate in the case of an app store such as F-Droid which is well known for the detailed verification it makes of all of the apps it carries[66].

3.4.2   Preinstalling apps on devices: choices imposed on customers

Devices are typically sold with set of key, preinstalled applications. This usually includes a search engine, a messaging service, cloud storage, a video service, map service and browser, for instance. This system that favours the services that are tied to the operating system naturally tends to steer end users away from other services, even when they offer new, innovative features. In its analysis, the European Commission concluded that users rarely download apps that provide the same features as a pre-installed app (except when the latter is particularly mediocre). However, the fact of pre-installing apps may also align with the expectations of end users who want to be able to use their device as soon as they switch it on for the first time.

In some instances, however, these apps can neither be deactivated nor deleted. In other cases, they can be deactivated but not deleted as the device's manufacturer want to be sure that users can revert to factory settings if necessary. On some Android smartphones, for instance, users can neither deactivate nor move the search bar. If Google does not oblige handset suppliers to make it impossible to uninstall its apps, the financial incentives that the company gives to partner suppliers factors in the devices' use of some of its branded services, which may encourage them to promote a service in a way that makes it more complicated to use rival services. For instance, Lenovo/Motorola blocks the ability to uninstall and modify the Google Search bar, which is displayed on the home screen, and iOS does not allow users to change the search engine used by Spotlight.

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[66] Wired, *Android Users: To Avoid Malware, Try the F-Droid App Store*, https://www.wired.com/story/android-users-to-avoid-malware-ditch-googles-app-store/, 21 January 2018

Preinstalling applications, as viewed from elsewhere

Users' relative lack of control over the apps that cannot be modified on their devices has already provoked reactions in places other than France.

In 2015, the European Commission launched an inquiry into Google and its operating system for mobile devices. In its preliminary conclusion on Google's possible abuse of a dominant position, the Commission stated that Google had employed a strategy with respect to mobile devices that sought to protect and strengthen its dominant position in the general online search sector. To reach this verdict, the Commission concluded that Google was in a dominant position in three markets: search engines, licensed mobile operating systems and Android app stores. The Commission expressed concerns about three of Google's practices:

- obligating manufacturers wanting to provide access to Google Play to pre-install Google apps. The Commission's investigation showed that it is commercially important for manufacturers of devices using the Android operating system to pre-install the Play Store on those devices, which makes it possible to access Google Play Services and take advantage of certain features such as the GPS service.

- The terms and conditions of the "compatibility commitment". A manufacturer that wants to install a proprietary Google app on its devices, such as Google Play Store and Google Search, no longer has the option of selling device powered by non-compatible Android forks.

- Financial incentives to pre-install Google Search exclusively as the search engine. According to the Commission, these incentives influenced whether or not certain device suppliers and certain mobile network operators developing overlays for the Android OS pre-installed rival search services.

In South Korea, in 2014 the Ministry of Science and ICT (MSICT) published a recommendation to allow users to uninstall pre-installed apps on smartphones. On both Android and iOS devices, some apps deemed "indispensable" by the operating system cannot be deleted. Added to those are certain apps preinstalled by the devices' manufacturer or by operators. Since 2017, it is forbidden by law to unduly block the deletion or installation of any apps.

In Japan, the Fair Trade Commission (JFTC) and the Japanese Ministry of the Economy, Trade and Industry (METI) conducted a study of the device market, and concluded with a call for vigilance over the lack of development of rival OS to Android and Apple, but also over the pre-installation and overt promotion of certain applications. In late 2017, it was announced that study groups would be created to examine possible responses.

In Italy, MP and entrepreneur Stefano Quintarelli proposed a law that would also allow users to delete apps that are installed by default, and to ban the practices of certain device suppliers that made certain applications exclusive to their devices even though it is not justified by technical incompatibility. Introduced in 2017, the bill is currently before the Italian Senate.

Looking beyond smartphones, device manufacturers' choice to promote certain content can be all the more blatant when it comes to smart speakers. Certain partnerships that smart speaker suppliers have formed appear difficult for the competition to get around: Google Home's partnership with the TuneIn streaming app, an American company that provides internet radio services and other audio content, makes it hard for Google smart speaker users to access any other internet radio services. The inherently limited nature of the speakers' content selection interface makes the manufacturer's initial choice all the more decisive.

3.4.3 Handling sensitive content: an imperative that challenges impartiality and can be over-interpreted

When not dictated merely by law, an app store may limit access to certain content that is deemed sensitive, if the company is concerned about protecting its brand image. In 2013, for instance, Apple removed the *500px* photo app from its app store as it allowed users to view nude pictures. In 2015, it was the France Musique radio app that was censored by Apple because it used a Manet nude as its illustration. These examples reveal that, even when based on the argument of protecting the public good, an editorial policy can create misunderstanding, as interpretations of what constitutes "sensitive" material greatly vary.

Depending on the app store's editorial policy, and its terms and conditions of use, it may be impossible for end users, in a walled garden system, to access certain content: these users have no option other than to use the app store available on their device.

3.4.4 App stores' content indexing and display policies: subjectivity and a lack of transparency in operating systems' terms and conditions

In addition to the issue of how to handle sensitive content, app stores today play a dual role when making content available to smartphones. First, they have the role of indexing, a process during which they can make a selection, applying different reasons for restrictions (anti-fraud, copyright protection, protecting the integrity of the hardware, etc.) – some of which may be entirely legitimate. Second, within the indexed content, stores offer search engine features, which means they inevitably apply rankings. There is invariably some degree of subjectivity to any ranking, even the best intentioned, which makes it practically incompatible with the goal of neutrality. As a result, internet openness will be challenged by devices if it is impossible to circumvent app stores tied to the operating system since, when choosing the apps they want to download, users can only view their choices through the prism of the search engine included in the store.

Generally speaking, app stores' content indexing and display policies may lack transparency. App stores' editorial policies are not always available in writing, and could be based on criteria that are not compliant with the objective of the open internet. The potential effects of such policies may be especially critical when the device's operating system does not allow users to install an alternative app store, and only apps to be downloaded from the app store. This type of impediment is particularly obvious in walled garden environments such as Apple's[67] or those of certain game consoles.

In addition to the technical justifications that are given, such as the device security and integrity, or protecting personal data, it is possible that some impediments derive in reality from business choices: app stores may favour vertically integrated services by impeding the proper running of rival applications, whether music, video or print media apps. This impediment may not necessarily take the form of actually blocking the targeted applications: rather it could involve an unduly long approval process for certain apps applying to be listed on an app store.

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[67] TechCrunch, *App Store bug boosts paid apps over subscriptions in the top charts*, https://techcrunch.com/2017/02/20/app-store-tests-favoring-paid-apps-over-subscriptions-to-rebalance-its-top-charts/?ncid=rss, 20 February 2017

Medium, *Apple App Store Top Grossing Ranking Algorithm Update,*https://medium.com/@incipiagabe/apple-app-store-top-grossing-ranking-algorithm-update-2-17-17-cadf07edc1f1, 17 February 2017

Arcep, which helps to finance an app called *Wehe* that detects net neutrality violations, and which was developed by Northeastern University, was itself confronted with an indexing issue. The first version of the app was submitted for listing on the Apple App store in January 2018, but was refused admission, without being told which point of the App Store's terms of use the application violated[68]. If the application was ultimately listed on the App Store following an appeal, the case illustrates the challenges that a simple developer can face, and who does not have the same means that Arcep does to assert its rights.

a) Algorithms and machine learning: will they forever remain black boxes?

To be as effective as possible, content and service ranking is often performed by an algorithm that chooses to spotlight services according to either general parameters or parameters that are proper to the user. The systematic nature of algorithms does not prevent them from possibly being biased, and their opacity prevents any outside monitoring of the sorting rules they employ.

Moreover, this opacity is in danger of becoming even greater: less and less, algorithms are being written directly by developers, but are instead the fruit of machine learning. This means that it is the method of learning, the objectives by which it is evaluated, and the data used for training that define the algorithm. If some learning methods do make it possible to know the criteria used to sort the elements, others provide no visibility[69]. It can therefore be challenging for both third-parties and those implementing the algorithmic ranking, to know which criteria will be used to spotlight content.

Consensus on the algorithm transparency issue

Following the adoption of the Digital Republic Law in France, in 2016, the General Council for the Economy (CGE) commissioned a report on the methods used to regulate content processing algorithms, a sign that public authorities had identified the risks associated with algorithms' overly great opacity. One of the report's recommendations was to create a collaborative scientific platform to foster the development of software tools and methods for testing algorithms. Called "Transalgo", this platform is currently being maintained by the French Institute for Research in Computer Science and Automation (INRIA) and marks the first milestone in government action in support of increased transparency for algorithms.

b) Browsers' predictive algorithms: another way of favouring certain content

If browsers appear to be a relatively unbiased gateway to the internet, it nonetheless needs to be emphasised that content can enjoy preferential treatment from the browsers' embedded features and optimisations. One case in point is pre-loading functions.

To improve the user experience, browsers are optimised to reduce the time it takes for web pages to be displayed. To accelerate content loading, browsers have pre-load features that can range from DNS prefetching (the IP addresses of the websites that users can visit are logged ahead of time so that they can connect them more quickly) from loading the full page and sources it contains, by way a page outline load. Therefore different browsers will preload different resources: Firefox, for instance, only loads page outlines, whereas Edge and Chrome could pre-load all of the resources for

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[68] Ars Technica, *Apple rejects net neutrality testing app, says it offers "no benefits to users"*, https://arstechnica.com/information-technology/2018/01/apple-rejects-app-that-claims-to-detect-net-neutrality-violations/, 18 January 2018

 Ars Technica , *The net neutrality testing app that Apple rejected is available now*, https://arstechnica.com/tech-policy/2018/01/the-net-neutrality-testing-app-that-apple-rejected-is-available-now/, 19 January 2018

[69] Defence Advanced Research Projects Agency, *Explainable Artificial Intelligence*, https://www.darpa.mil/program/explainable-artificial-intelligence

the page that the user is likely to visit next, so that it will be immediately and fully displayed when the user wants to view it.

It is browsers' prediction algorithms that determine which content to pre-load on users' devices. In Chrome, the heuristics used to determine the content to pre-load changed in 2017. Initially, following a Google search, Chrome often pre-loaded the page corresponding to the first search result, as Google estimated that there was a very high likelihood that users would click on it[70]. Now, Chrome employs several indicators: the user's browsing history, as well as the content that the site's publisher recommends to download, and the content's format.

Pre-loading nevertheless consumes a great deal of bandwidth and memory, both of which are finite resources, especially on mobile devices. This is why on Chrome Mobile the feature is only activated for AMP[71] (Accelerated Mobile Page) format, a Google-supported format optimised for mobile browsing. When a Chrome Mobile user performs a Google search, the browser pre-loads several search results that are in AMP[72] format (recognisable thanks to the logo above the URL) while results in standard web format are not pre-loaded. But pre-loading heavily influences the speed at which a page is displayed[73][74] and even when they are heavier than classic web format pages, AMP format pages could be displayed more rapidly in the browser[75].

According to Google, users will favour pages that load more quickly[76]. This means that, independent of any other load speed or content quality factor, Chrome's choice to only pre-load AMP format pages could encourage internet users to give priority to pages bearing the AMP icon over other search results.

3.5 **Limits** resulting from competition models between systems

Generally speaking, choosing a device means entering into the universe designed by a hardware manufacturer and an operating system creator, whose business models can be reflected in the quality of the internet access they provide. A hardware manufacturer may therefore want to monetise technological innovations by demanding payment from content providers wanting to use them. Similarly, an operating system provider might promote the method for accessing the internet that gives it the best monetisation prospects, by integrating complementary business activities.

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[70] Google Fellow, *Knocking down barriers to knowledge*, https://googleblog.blogspot.fr/2011/06/knocking-down-barriers-to-knowledge.html, 14 June 2011

[71] Since version 58, cf. Google, *Intent to Deprecate and Remove: Prerender*, https://groups.google.com/a/chromium.org/d/msg/blink-dev/0nSxuuv9bBw/PKu8Nv3yCAAJ

[72] Google, *White paper on privacy in Google Chrome*, https://www.google.fr/chrome/browser/privacy/whitepaper.html#netpredict, version of 5 December 2017

[73] AMP, *Measuring AMP Performance*, https://amphtml.wordpress.com/2018/01/17/measuring-amp-performance/, 17 January 2018

[74] Medium, *Why AMP Caches exist*, https://medium.com/@pbakaus/why-amp-caches-exist-cd7938da2456, 13 January 2017

[75] Search Engine Land, *The AMP is a lie*, https://searchengineland.com/the-amp-is-a-lie-278401, 13 July 2017

[76] Think with Google, *The need for mobile speed: How mobile latency impacts publisher revenue*, https://www.thinkwithgoogle.com/intl/en-154/insights-inspiration/research-data/need-mobile-speed-how-mobile-latency-impacts-publisher-revenue/, September 2016

3.5.1 Monetising a device's auxiliary functions

Sometimes, developing certain content and services requires access to a device's auxiliary functions. The terms and conditions for accessing these functions may be such that, directly or indirectly, end users ultimately have only limited access to content and services.

This type of situation can result from the financial incentives offered to content and service providers that access certain devices' functions.

So it can be costly for the users of these devices to access certain content if their provider chooses to carry over access costs – which vary depending on the app store – to the user. Such is the case with iPhones, when Apple makes access to for-pay multimedia content contingent on using its app store's built-in payment system, and so earns a commission on each sale. Such is also the case on iPhones when payment services, such as contactless payment, have access to the phone's specialised components (e.g. the device's NFC chip) and when this access is contingent on using the Apple Pay, paid payment platform[77].

This type of situation can also result from the terms and conditions governing the use of payment data generated when users purchase content. Although far from being the service provider's core business, these data can help strengthen their customer loyalty strategy and threfore the success of their products. When an app store operator such as Apple requires content providers to use its online subscription service, it deprives them of access to these user data.

Taken to their extreme, the conditions imposed on content providers could also result in content libraries drying up, as content providers' economic viability could be compromised.

3.5.2 Promoting applications as internet access method, and policies for making API available

Accessing the internet through applications offers obvious advantages in terms of user-friendliness for mobile device owners. Besides, mobile internet users tend to favour apps over browsers.

But the internet access provided by apps is naturally more restrictive than through a browser, because it is more specialised: app developers design their apps to deliver a specific service. If this specialisation streamlines the user experience, it also means less control over the information that the user has access to, and less control over the criteria used to select the content that is given prominence.

In addition, to make use of these functions, developers employ the APIs provided by operating systems. Some of these APIs may be restricted, however, or subject to certain conditions, which is not without incidence on content developers' ability to market their products.

a) Conditions attached to accessing the APIs made available by operating systems: a direct restriction on developers

Some of the operating system's APIs make it possible to activate the device's sensitive features, and only the operating system's integrated applications, or those deemed reliable, can access them. On iOS, for instance, an entitlement is required to use certain APIs, which is typically only attributed to applications developed by Apple. In 2017, it was nevertheless revealed that Apple have given Uber an entitlement to use an API that allowed the app to record the iPhone user's display at any time.

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[77] A platform that acts as the interface between banking establishments and traditional payment system players, developed by the manufacturer of the device that houses the NFC chip.

Similarly, some Android API, such as those that made it possible to modify web proxies[78], access geo-locating hardware, or to uninstall certain software, are not open to third-party developers. Installing certain apps supposes having rooted one's smartphone to disable the software locks on APIs. Such is the case with certain back-up apps[79], third-party audio streaming apps[80], certain ad blockers[81] and apps that allow users to delete applications that are installed by default[82].

These restrictions are justified by the sensitive nature of the functions that could be exploited to compromise the device's security. In some cases, however, the operating system's developer uses these functions for its services and applications. For instance, Google was able to take advantage of its privileged access to certain Android functions to obtain the list of the relay towers in smartphones' vicinity[83]. These data could help improve location-based services, but third-party apps do not have access to them.

Moreover, the Android operating system does not provide the same APIs on devices that run Google Play Services (that comply with Google's terms and conditions) and on devices that only use the Open Source version of Android. Google Mobile Services are described as "a collection of Google applications and APIs that help support functionality across devices"[84]. On devices that house Google Play Services, the geolocation API is described as simpler, more accurate and less energy-consuming that the version available on the Open Source version of Android. In addition, several innovative functionalities described in Part 2 of this report (augmented reality, embedded AI) use APIs that are, at least for a time, exclusive to Google services.

As a result, the conditions under which APIs are made available to third parties are not or little known to the public at large, but can affect developers' ability to offer their content online.

b)   Conditions for making web APIs available: another direct restriction on developers

When it is not possible to take direct advantage of a device's functions via their APIs, in some cases it nevertheless remains possible to go through associated services' (e.g. voice assistants) web APIs. Here again, the applications must comply with service providers' terms and conditions of use.

To make use of these web APIs, developers typically need to register with the service provider to obtain a user ID that will allow them to access the application programming interfaces. These user IDs allow the service provider to exercise more consistent control over the app developers who are likely to access their services. A service provider can at any moment revoke highly targeted access by disabling an app developer's access key. While on a smartphone, app stores can remove certain apps from their catalogues without it affecting the devices on which they are already installed, apps that use web API may be disabled even on devices that already installed them. This means that the device's user can no longer access the content (or at least not under optimal conditions).

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[78] Network elements that provides the interface between the device and the web.

[79] For instance Titanium Backup, https://play.google.com/store/apps/details?id=com.keramidas.TitaniumBackup&hl=fr

[80] For instance AirAudio, https://play.google.com/store/apps/details?id=eu.airaudio&hl=fr

[81] For instance AdAway, https://adaway.org/

[82] For instance System App Remover, https://play.google.com/store/apps/details?id=com.jumobile.manager.systemapp

[83] Le Monde, *Google a collecté des données de localisation sur les utilisateurs d'Android à leur insu*, http://www.lemonde.fr/pixels/article/2017/11/22/google-a-collecte-des-donnees-de-localisation-sur-les-utilisateurs-d-android-a-leur-insu_5218680_4408996.htm, 22 November 2017

[84] Google, *The best of Google, right on your devices*, https://www.android.com/intl/fr_fr/gms/

The disparity between the two versions of Android APIs for fundamental telephone services undermines the relevance of rival Android fork OS. An entire set of applications works less well (or not at all if the developer did not think about compatibility with devices that do not provide Google Services) on hardware that powered by these operating systems, even when they have a manufacturer's support: if a manufacturer can easily develop APIs that correspond to its hardware's components, they still need to be perfect substitutes for Android APIs to ensure that Android apps can also run on the fork OS. As a result, despite the Android platform's Open Source kernel, the success of new derivative operating systems is an apparently complicated affair.

By the same token, alternative operating systems are still attempting to gain traction, particularly Open Source ones, but they can be hemmed in by the APIs of non Open Source hardware components, which can lead to development delays that are too often prohibitive for doing business with consumers or app developers.

In addition to the barriers to entry resulting from the club effects that characterise platform markets in general, the success of any OS wanting to compete with Android and iOS therefore seems compromised. Without the spur of lively competition, the providers of existing OS could adopt behaviour that could undermine internet openness.

3.5.3 Development of voice-controlled assistants as a method for accessing the internet

As with applications that channel online content to end users, the proliferation of voice assistants in the home and in connected cars could further restrict internet access in a growing number of configurations.

If these devices offer the advantage of allowing users to access certain online content in an extremely fluid and personalised way, using them could also involve a trade-off in end users' ability to choose. Business considerations could bias voice assistants' responses, whose effects will grow as these devices become more skilled (they are already capable of ordering goods and services directly for the user, in some cases in exchange for a commission on the transaction).

But exclusion and promotion are harder to gauge on these devices. For instance, some players may be on the winning side of the equation if they are also active in the retail sector, and prevent users from changing the shop they use for their purchases. For instance, it has not been possible to buy Chromecast dongles on Amazon since 2015[85], but this omission is hard to see for a user who simply asks their (Amazon) Alexa smart speaker to order a "streaming media player": in any event the user will only be given a few choices. To become aware of this omission, the user would need to ask the assistant to buy a Chromecast, to then have Alexa suggest equivalent products from Amazon or other brands, but not Google products.

3.5.4 Monetisation practices for other products and services sold by the handset's manufacturer

To be able to capitalise on the innovations introduced by a device manufacturer, it may be necessary to have several compatible devices, which locks users into a single manufacturer's universe.

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[85] Amazon decided to list only those streaming media players that provide an app com compatible with its Amazon Prime Video service. The Verge, *Amazon will ban sales of Apple TV and Google Chromecast,* https://www.theverge.com/2015/10/1/9434115/amazon-banning-apple-tv-chromecast, 1 October 2017

To wit, some Android OS overlays are only interoperable with other specific devices – not for any particular technical reason, but rather for business reasons. For instance, only Sony smartphones can use the Remote Playstation application that enables remote gaming with a Sony console. Similarly, Samsung only offers an app for controlling Samsung brand smart home equipment. Playstation console owners are thus induced to buy Sony mobile devices, as Samsung product users may find it more convenient to buy a smartphone of the same brand.

Another example is the link between the Apple Watch and fitness equipment[86].

Aware of the risks that exclusivity deals can carry, some manufacturers are working to minimise their impact. For instance, BMW, which offers a "CarPlay" option, now does so in the form of a subscription[87] so that users with non-compatible devices can cancel it.

In the same vein, the proliferation of uses for and sometimes the increase in screen resolution led to a situation where devices' did not have enough storage capacity to be able to store all of their users' content. Device manufacturers now couple their operating systems with cloud solutions that expand devices' storage capacity. This expansion of storage space, which is often subject to payment beyond a certain allowance, further increases the difficulty that users can have in switching ecosystems.

The conflict between Amazon and Google that was mentioned earlier offers a good illustration of the way in which, through a ricochet effect, exclusivity deals between content providers and device manufacturers could undermine internet openness. In retaliation for having its products pulled from Amazon, Google announced that YouTube would no longer be available on Amazon Fire TV Stick and Amazon Echo Show devices (rivals to the Chromecast and Google Home) starting on 1 January 2018[88].

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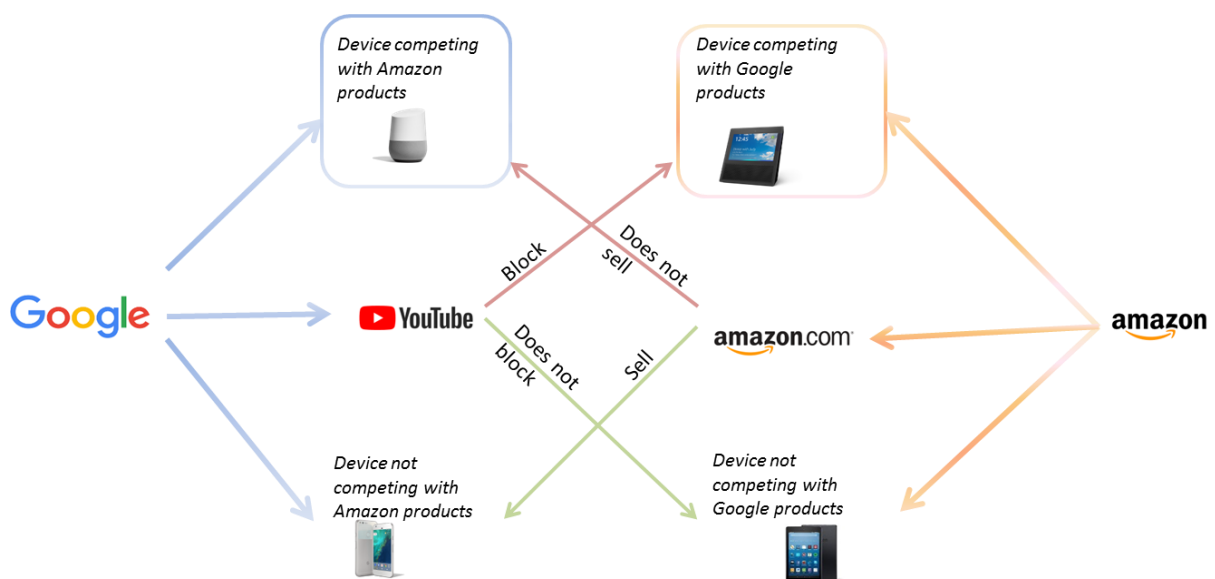
[86] Business Insider, *The best new feature for the Apple Watch proves Apple is serious about fitness tracking*, http://www.businessinsider.fr/us/apple-watch-gymkit-watchos-4-2017-6/, 6 June 2017

[87] The Verge, *Is BMW going to make you pay for Apple CarPlay every year?*, https://www.theverge.com/2018/1/16/16897326/bmw-apple-carplay-subscription-google-alexa-detroit-auto-show-2018, 16 June 2018

[88] Tech Crunch, *Google is pulling YouTube from Echo Show and Fire TV, as feud with Amazon continues*, https://techcrunch.com/2017/12/05/google-is-pulling-youtube-from-echo-show-and-fire-tv-as-feud-with-amazon-continues/, 5 December 2017

Taken to their extreme, the mechanisms at work in this affair could lead to the emergence of a "TriNet"[89], wherein all of the leading platforms would only offer an optimal version of their services to people using their brand of device. Because it is neutral, the web would therefore only be able to provide access to lesser services, and users would gradually turn away from them, attracted instead by the higher standard services that are exclusive to certain devices.

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What emerges from the analysis provided in this section is that devices create a considerable number of impediments to internet openness. There are several possible types of impediment: those resulting from the nature of the device being used, those that can be attributed to devices' software and OS developments, those resulting from the editorial policies of the devices, the operating systems and app stores and, lastly, those resulting from device suppliers' and OS providers' business models with respect to innovation.

Arcep recognises that some of these impediments cannot be attributed to a desire to diminish the open nature of the internet, particularly when they depend on technical constraints over which device manufacturers have no control. This is true of those impediments that derive from the nature of the devices. It can be presumed that users are aware of these restrictions, and base their choice of equipment on the way they plan on using the internet.

Other impediments are more deliberate, such as those resulting from editorial policies or models of competition between systems.

Some of these may be beneficial for end users. So, despite their limitations, walled garden systems can be seen as offering greater security, greater privacy guarantees or an ease of use and a continuity in the user experience. By the same token, the fact of pre-installing apps, which has the drawback of steering internet users away from certain content, can also make a new device easier to use straight out of the box.

In other instances, these impediments imposed deliberately by device manufacturers or OS providers constrict the distribution of access to certain online content and services – without there always being an objective justification or employing disproportionate methods – and could be at users' expense. An app store's refusal to carry an app could fall under this heading, as could the untimely warnings flashed at users choosing to install an app from an alternative app store, which nothing suggests is faulty.

Arcep believes that this observation should lead public policymakers to undertake an examination of the responses to be brought to ensure internet access remains open, including at the service level.

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[89] A heavily commented blog post by André Staltz, in 2017, gave birth to this concept: https://staltz.com/the-web-began-dying-in-2014-heres-how.html, 30 October 2017.

4 Courses of action to ensure internet openness and freedom of choice for users

In its work towards an open internet, as part of its mandate to protect neutrality at the network level, Arcep wants to ensure that terminal equipment in no way undermines this openness: as with the choice of internet service provider, end-users should be able to choose their device separately from the choice of content and services they want to use. If this is not the case, it could result in two problematic situations: end-users could be deprived of the internet's full bounty if they chose their equipment based mainly on criteria that are separate from the content and services they will be able to access. Others, who are more sensitive to the content and services they want to be able to access from their device, could find they have a smaller selection of devices to choose from.

Arcep thus sought to examine solutions to remedy the impediments to internet openness induced by devices. To do so, it drew in particular on the sectoral regulation experience it gained in the telecoms sector. Arcep also took into account the positions expressed by stakeholders during the interviews and workshops it held, and relied on the contributions received to the public consultation it conducted from 11 December 2017 to 10 January 2018[90]. One of the purposes of this consultation was to obtain stakeholders' assessment of potential courses of action. These courses of action can be grouped into three categories, increasing in magnitude in terms of government intervention: the first is based chiefly on "soft power" measures while the other two involve more coercive mechanisms, which are more binding for the players they target. The first category of actions includes all of the measures taken as part of a data-driven regulation[91] – whose aim is to increase transparency and make devices' influence on internet openness more detectable. The second category corresponds to measures taken to enhance the market liquidity and foster competition in the device sector, which today is dominated by a duopoly over smartphones – as emulation helps to keep players in check on the internet openness front. The third category of actions includes tools of direct intervention, targeting practices that hamper the free rein of internet content and services on devices.

It should be noted that, here, Arcep is proposing courses of action that could be implemented at the national scale, but which could also help spur actions at the European level. Because of the international dimension of device suppliers and operating system providers, it does seem that the relevant scale for any course of action would be, at the very least, European. It should also be said that, if these measures were introduced solely at the national level, they would need to comply with Directive 2015/1535 of 9 September 2015 which lays down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services.

In this section, Arcep explores these perspectives, and delivers the tenor of its thinking, with the aim of opening up a debate.

4.1 Clarifying what constitutes internet openness, by establishing a principle of freedom of choice in content and services, regardless of the device

The Open Internet Regulation mentions devices since it recognises users' freedom to access the internet using the device of their choosing.

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[90] Arcep, *Public consultation - Smartphones, tablets, voice assistants… Are devices the weak link in achieving an open internet?*, https://www.arcep.fr/uploads/tx_gspublication/consult-devices-internet-ouvert-dec2017.pdf, December 2017

[91] Arcep, *Data-driven regulation*, https://www.arcep.fr/index.php?id=13329, 26 January 2018

However, the regulation fails to draw all of the necessary conclusions regarding internet openness. Device manufacturers and OS providers are thus excluded from the scope of obligations contained in the regulation that make up the core net neutrality rules, which are imposed *de facto* only on internet service providers (ISP).

As concerns the issues identified in this report, before setting out the courses of action below, it needs to be made clear that the principle of users' freedom to distribute, provide and access the internet content of their choice, which is established by the 2015 regulation, needs to be applied not only at the network level, but also at the device level.

4.2   Internet openness: a general interest objective that justifies demanding better information for public policymakers and individuals

By adopting a "data-driven" approach to regulation for telecom services, Arcep developed an approach that focused more heavily on creating better informed public policymakers and consumers. More agile than traditional regulation, this mode of action could be carried over to devices. Public authorities would thus have the data they need to better understand the changes at work, while users would benefit from a deeper knowledge of the characteristics of these devices, and the ways in which they affect their access to the internet. Ultimately, more and better information could help rectify the behaviour of equipment suppliers and operating system providers, by giving users the power to make informed choices.

As concerns their possible effects on internet openness, the proposals for improving information that are detailed below seem measured, and thus advisable.

4.2.1   Allowing an expert regulator to gather information from device manufacturers and OS providers, and to disseminate it

By examining the influence that terminal equipment has on the open nature of the internet, Arcep was able to ascertain the lack of quantitative and individualised information that is available. This lack is especially harmful as it limits public policymakers' ability to establish a detailed and objective diagnosis of the situation.

To improve the overall information available on how device manufacturers and OS providers operate, an expert regulator may be given the power to gather general information from all market players. This would be, above all, quantitative data on these markets' development (number of devices per user, time spent online on each type of device, time spent online using applications and their different app stores, growth of the number of available apps, etc.) and on the state of competition between them (average number of app stores installed on a device, number of versions of an OS a manufacturer distributes, number of users per OS and for each version of the OS, etc.). This data should also be the subject of a publication.

Taking things one step further, in a bid to empower users, a deeper examination of certain topics may be warranted. This could involve obtaining the means to understand the process that developers go through to market their apps, how app stores select the apps they will carry, how users choose their aps. Here, it would be useful to obtain information on particular aspects of device manufacturers' and OS providers' practices which are capable of undermining internet openness. An expert regulator could be given the power to collect detailed information from stakeholders that hold a special position when regard to internet access. This could, for instance, involve collecting detailed information on the indexing and ranking methods used by an app store that is linked to an operating system.

4.2.2 Enabling end-user reporting

Acquiring a detailed understanding of devices and OS could also be strengthened by drawing on users' experience and behaviours. To do so, it could be worthwhile to develop a dedicated reporting platform for device users. This type of tool would make it possible to centralise the information that would be useful to delivering a detailed snapshot of the risks engendered by device manufacturers' and OS providers' practices

The process that Arcep has already implemented for the electronic communications and postal sectors could help guide the development of such a tool. For instance, on 17 October 2017, Arcep launched an online reporting platform (https://jalerte.arcep.fr) to allow users to report any malfunctions in their relationship with postal or telecoms operators. Thanks to this tool, Arcep can provide a first level of filtering, better understand the issues users are encountering, and disseminate information on the issues that have been identified, without assuming the task of resolving them.

4.2.3 Promote comparison tools

The use of collaborative production tools would enable more effective monitoring of device manufacturers' and operating system providers' practices that have the ability to impede internet openness, as obtaining feedback from a wide array of contributors would increase the volume of available data, information and analysis.

As part of its data-driven regulation process, Arcep supports initiatives from third parties that seek to publish useful information that helps flesh out the data it publishes itself. Rather than create its own tool, Arcep cooperates with bodies that aggregate information and provide comparison tools (e.g. crowdsourcing specialists, consumer associations and trade associations). It also maintains an ongoing dialogue with crowdsourcing players to measure quality on the internet[92]. This approach makes it possible to tap into a wealth of information, under a "the State-as-a-platform" approach.

It would also be useful to call on third parties when conducting an examination into the device sector. These players could, for instance, help expose impediments that derive from devices, and to build qualitative comparison or rating solutions for the main terminal equipment[93]. In any event, the methods used to collect data will need to be of a high standard, to be able to guarantee the reliability of the information being shared[94].

To Arcep's knowledge, no such tools exist today. To help create them, public policymakers could – why not? – issue a call for proposals.

4.2.4 Demand transparency on the indexing and ranking tools used by app stores

Improving the information available on devices and their operating systems could also target content providers. If the Digital Republic Law includes an obligation for platforms to treat consumers fairly[95],

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[92] Arcep, *Arcep and the Qosbee app, partners in monitoring the quality of mobile operators' services*, https://www.arcep.fr/index.php?id=8571&no_cache=1&tx_gsactualite_pi1%5Buid%5D=2120&tx_gsactualite_pi1%5BbackI D%5D=26&cHash=031882c46b76fa757ecaa83597407be6, 17 January 2018

[93] One such solution was recommended by CNNum with regard to platforms, see https://cnnumerique.fr/nos-travaux/la-confiance-lere-des-platforms-numeriques.

[94] For comparisons between devices to be performed with ease, the environment (e.g. device model) on which the testing is done would need to be monitored.

[95] This fairness obligation is contained in Article L. 111-7 of the Consumer Code:

"*All online platform operators are required to provide consumers with fair, clear and transparent information on:*

there is no provision that protects professionals who rely on these platforms for their business. The information asymmetry between the main app stores, which are platforms, and certain developers has created an imbalance in their relationship.

When it comes to informing content providers about their editorial policies, some app stores – which enjoy unassailable positions in providing access to apps – willingly publish the technical specifications required to make applications available on their platforms, but remain more opaque about the rules they use to approve and index these same apps, whether in terms of how long it takes to review an app or rules of a more editorial nature. For developers to be able to access app stores under better conditions, one possible measure would be to require these stores to document the technical and editorial principles they apply to indexing and ranking online content and services, in an open and detailed fashion. This would encourage app stores to treat developers more fairly, in a way that would foster internet openness.

Likewise, an additional measure could involve extending this principle of transparency to the notice periods for app store updates, to ensure that these periods do not result in the deletion of online content and services at users' expense.

In a situation where it is not only app stores that index services and content, this demand for transparency should also be extended to voice assistants.

It should also be noted that the transparency of indexing tools in general appears to be a goal that is shared at the European level, since the Commission work programme for spring 2018 mentions the draft of regulation on the transparency of contractual relations between businesses and platforms.

4.3 Contestability of key players' positions as a way to protect internet openness

It is vital to emphasise the crucial role that competition law plays in correcting market shortcomings, *ex post*. As a complementary measure, by empowering users, the soft regulatory provisions suggested above could help rectify the behaviour of certain powerful players with respect to internet openness. Because of the device market's particularly concentrated structure, Arcep began examining the opportunity to introduce *ad hoc* provisions that aim to create a more liquid market, and stimulate competition. It should be emphasised that, in the present case, Arcep does not view competition as an end unto itself, but rather as a potential form of leverage for stimulating virtuous behaviour, and guaranteeing the conditions required for an open internet.

In the case of terminal equipment, increasing competitive pressure could help protect the open nature of the internet in two ways. First, making it easier to switch system or device would enable users to penalise device manufacturers whose behaviour towards internet openness is not to their liking. Second, the existence of alternatives would encourage device manufacturers and OS providers to offer their customers more attractive services, and so to provide a richer array of content and services to users and, ultimately, better uphold the internet's open nature.

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1) *The general terms and conditions of use of the intermediation service, and on the indexing, ranking and delisting methods applied to content, goods and services to which the service provides access;*

2) *The existence of contractual ties, capital links or financial benefit, when they influence the ranking or indexing of the content, goods or services made available online;*

3) *The status of the advertiser and the parties' civil and tax rights and obligations, when consumers are put into contact with professionals and non-professionals.*

In light of the analysis presented below, it appears that a number of public and private initiatives are emerging, and could help improve the device market's liquidity. It would therefore no doubt initially suffice to ensure these initiatives run smoothly, and to take the time to evaluate their outcome, before planning to take any additional measures. What would be most useful in the short term, then, would be to create a market liquidity scoreboard, rather than introduce any new provisions. As for working to enable the emergence of new players, the feasibility and effectiveness of any such actions remain to be proven, in the current technological landscape, given the device industry's particular structure (new players would be more likely to enter the market during future waves of innovation).

4.3.1   Making it easier to switch devices

To guarantee an open internet, a first step could be to ensure that users are not locked into a given system. In a way that is analogous to what was done in the mobile telephony market, actions aimed at providing end users with more freedom of choice could help improve market liquidity. More specifically, when certain devices impede internet openness, the goal would be to limit the impact that switching physical equipment and operating systems has on end users.

a)   Simplifying data and content portability when switching terminal equipment

Having to transfer one's data and content to a new device, and especially to a new operating system, can be a first barrier to switching for users. However, initiatives have already been taken to facilitate portability.

First, consumers already have the right to recover their data, since – in accordance with the Digital Republic Law – providers of public online communication services are obligated to provide a feature that allows consumers to recover "*all of their data*," which includes personal data (which fall under the purview of regulator CNIL[96]) and non-personal data (which fall under the purview of the General Directorate for Competition Policy, Consumer Affairs and Fraud prevention, DGCCRF). It should nonetheless be underscored that, for some data, there is no obligation to provide this feature for free[97].

Regarding the implementation of this right, particular attention needs to be paid to the effect of embedded AI. Certain data, whose availability could influence users' decision to switch devices, may not necessarily fall into the scope of application of the Digital Republic Law. First, data generated by artificial intelligence will not necessarily go through the providers of public online communication services that are targeted by the law. Second, this data could, in part, be the intellectual property of developers of apps that incorporate artificial intelligence. Despite this specific point, there is reason to welcome the existence of this framework.

Second, there are technical solutions that exist today for simplifying the process of migrating what could be qualified as "essential" data. This includes porting one's contacts, photos, SMS history, calendars, mail and messaging and certain other apps from one system to another. Several equipment manufacturers, operating system providers and third parties offers users apps that allow them to transfer their data and content easily from one operating system to another.

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[96] Article L. 224-42-2 of the Digital Republic Law echoes Article 20 of (EU) Regulation 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance).

[97] Providing a free service is not mandatory for the data listed in article L. 224-42-3 of the Consumer Code, which will come into effect on 25 May 2018, i.e. for certain files uploaded to the web and certain data resulting from the use of a user account and associated with that account.

Existing solutions for transferring data and content

Apple's Move to iOS solution is available to any Android user wanting to switch from their existing mobile operating system to iOS. This free application is available on the app stores for mobile devices that run on Android 4.0 or later. It allows a user to transfer their contacts, messaging history, photos and videos taken on their phone's camera, messaging and mail accounts, calendars and available free apps to their new device, over Wi-Fi. However, any app or multimedia content purchases, or app content will not be transferred.

Google, however, does not offer an equivalent app for transferring data from a device running on iOS to an Android device. But other tools are available to users. The Google Drive app is a cloud-based solution supplied by Google, which can allow users to move their content (contacts, photos, videos, calendars) from any old device to an Android device by saving and then transferring them. In practice, this solution can also be used to store and share content, be it photos, videos, documents or other files, using any device, fixed or mobile, and regardless of whether or not it runs on Android.

Other solutions have been developed by the makers of Android devices, and are available in the Play Store, to facilitate moving data and content to their brand of devices. One example is the *Samsung Smart Switch* apps that allows owners of old Android, iOS, Windows Phone or BlackBerry phones to transfer their contacts, calendars, messages, photos, music[98], videos[99], call logs, memos, alarms, Wi-Fi settings, screen savers and documents to a new Galaxy[100] device. In the same vein is the *LG Mobile Switch* for users wanting to transfer their data from an Android device to a new LG handset, and the *Xperia Mobile Transfer* for moving data from devices running certain versions of Android, iOS or Windows Phone to a new Sony Xperia device.

Other solutions may also be provided by telcos. One example is Orange which offers customers a choice of a for-pay data transfer service that is provided in its agencies, or the *Transfert de data* app available for iOS, Android and Windows Phone, and which has the particular feature of giving users the ability to choose the data they want to transfer.

Lastly, some content and service providers have developed their own transfer mechanisms that are not tied to devices and their operating systems. Their solutions use OS-agnostic cloud services to transfer data and content, and so circumventing any incompatibility between systems, both hardware and software. These techniques are by now widely adopted for paid and subscription-based apps, for which continuity of service, regardless of the device or operating system, is crucial.

An analysis of these solutions prompts three remarks

First, these solutions do not cover all data and content. Second, they do not take into account "invisible" data, i.e. those tied to the physical device, such as the history of the queries made using a smart keyboard that enabled it to learn to anticipate the words that the user might want to type, or the device's settings data. These data are not easy for a user to identify or locate, and are lost when switching devices[101]. These solutions also do not cover all of the data and content associated with the device's applications universe. A prime example here are the data tied to applications that are only

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[98] Online musical content with no DRM protection, and not those managed through iCloud.

[99] Online video content with no DRM protection, including those managed through iCloud.

[100] This application is available for recent models of Galaxy, Note and Tab mobile devices and tablets, starting with version S3.

[101] There can be several reasons for these difficulties. First, the absence of standardised formats and import/export methods for certain data and content in a mobile environment. Second, the lack of availability of APIs tied to operating systems or proprietary software overlays added by device manufacturers.

available for a given OS, data logs for certain free apps or data tied to a users' level of progress in mobile games[102].

Next, these solutions chiefly concern the two main mobile operating systems, namely Android and iOS, and could paradoxically help strengthen their *de facto* duopoly.

Lastly, in certain cases these solutions can force users' consent on the data to be transferred, and could prove an obstacle to switching for certain users.

Despite their pitfalls, this collection of solutions should help increase the device market's liquidity by facilitating the portability of data and content when switching devices or systems. To ensure that they cover both all devices and all data and content needed for a smooth switching process, the development of these tools can only be encouraged at this stage. Further down the road, an evaluation should be made of the mechanisms in place.

b)   Increasing devices' compatibility with the different online services and content

Users' fear of losing access to certain online content and services can also be detrimental to the device market's liquidity, and to the existence of an open internet.

The fact that certain content and services are absent on certain devices can be explained by the difficulties that developers encounter in making their content and services available on every device. This can be due to the editorial policies of OS and app stores, or the multiplicity of operating systems which make development costs too high for most app designers.

Creating the conditions that would enable maximum compatibility for content and services with all terminal equipment may be required. For instance, it would be possible to advertise support for browsers that have the features required to integrate Progressive Web Apps, currently being standardised by W3C, such as Push API. It could also be worthwhile to create a system for monitoring standardisation timelines, and particularly for measuring how long it takes the different systems to adopt new standards. Monitoring by a public authority could indeed help foster more virtuous behaviour from market players.

In any event, simply having all browsers support Progressive Web Apps would not be enough to ensure their adoption, if users are not aware of them. Here, one possible path could be to require app stores to index Progressive Web Apps, which would diminish the club and scale effects that are detrimental to this type of online content and service. It does seem premature to address this issue at this stage, however.

c)   Encourage hardware compatibility between different types of device

One final obstacle to having a liquid device market could lie in its organisation in silos, alongside other devices. Quite often, the device that allows users to access the internet is not their only connected device. Users may also have a connected car, a smart thermometer or a smart speaker, all of which talk to each other.

Some manufacturers have created walled gardens that could hem users in, due to the interactions that might exist between the different devices, e.g. between a smartphone, a voice assistant and a smart watch. This would make it hard for the user to switch the operating system on one of their devices, often their smartphone, without it becoming incompatible with the rest of their equipment.

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[102] It should nevertheless be pointed out that certain systems have introduced a feature that allows providers to reimburse paid content that cannot be transferred to other systems. This is what Android developed for certain purchases that could not be transferred to iOS.

However, there are already several solutions for limiting hardware incompatibilities between devices in the home. The USB type-C port, which offers the advantage of being compatible with smartphones and computers, tablets and cars, and allows users to transfer data between their devices, is being used more and more widely: the pro-active adoption of this new connector format, which can be attributed to its high-speed data and video transfer capabilities,[103] its ability to provide electric power, its support for a large number of standards and how easy it is to use, should result in greater hardware compatibility between users' different devices. By the same token, hardware incompatibility could become a less influential factor with the ubiquity of wireless solutions (provided everyone uses the same wireless communication protocol).

Once users can naturally find themselves less and less constrained to acquire their products from vendors that are all offering the same operating system, there seems no reason to intervene to improve hardware compatibility between connected devices.

4.3.2   Enable competing operating systems to emerge?

Seeing the positions of power that a few players today enjoy over devices that are essential for accessing the internet, some believe it would be worthwhile, alongside other actions aimed at increasing the fluidity between equipment, to create conditions that would enable the emergence of effective competition between operating system providers. They point out that alternative operating systems could stand out by providing more bountiful internet access, for the benefit of end users. They also believe that this would chasten existing players, by giving them an incentive to compete with regard to internet openness.

However, as underscored in section 3.3.1, having more operating systems will not necessarily have a positive impact on openness if it does not go hand in hand with the widespread adoption of standards: having too many non-interoperable systems would only increases the impact of technical restrictions imposed on developers and can, in the long term, be counterproductive[104].

If the arrival of new players could naturally be a welcome event, it does seem difficult for public authorities to proactively push for such a scenario without also taking action on the standards front, which brings us back to the issues discussed in sections in 4.3.1.b and 4.3.1.c.

Here, Arcep notes that in 2014, France's Competition Authority delivered a particularly nuanced analysis[105] of the ways in which systems' more or less pronounced openness affects competition. The Authority concluded its report thus:

"*Five ways in which ecosystem openness is good for competition have been discussed. Greater compatibility reduces switching costs. Openness achieves full benefits of network effects and economies of scale for component makers, increased intra-ecosystem competition and market entry through component innovation is more easily feasible. However, two ways have been discussed which show that closure can be good for competition: closed systems increase inter-system competition (which can lead to fierce competition 'for the market') and they can lead to an increased incentive to innovate and to entry due to future profit expectations.*

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[103] For instance, the USB 3.0 standard enables a speed of 5Gbits/s, and the USB 3.1 standard enables speeds of 10 Gbits/s.

[104] Likewise, it is interesting to note that in its Order of 7 September 2016, the Court of Justice of the European Union concluded that the sale of a computer equipped with pre-installed software does not constitute, in itself, an unfair commercial practice.

[105] French Competition and Markets Authority, *Economic analysis of open and closed systems*, http://www.autoritedelaconcurrence.fr/doc/analyse_eco_syst_ouvert_ferme.pdf , 16 December 2014, notably p. 31.

Open systems generate efficiencies in four ways: they maximise network effects, they maximise scale economies, they enable the system owner to commit not to renegotiate ex post the access fees with the component developers, once the specific investments in the system have been incurred and they enable the system owner to commit not to exploit the users who have joined the system, which increases incentives to join the system. However, there are also four ways in which closed systems generate efficiencies: they ensure compatibility between components, they avoid freeriding, they allow user coordination, and avoid the drawbacks of standardisation."

In addition, past failures reveal that, when it comes to operating systems, it is not necessarily realistic to want alternative services to emerge. Heavyweight players such as Microsoft and Mozilla, which attempted to stake out a claim in the mobile operating systems environment, eventually gave up under the weight of network externalities.

The arrival of a new operating system will no doubt occur more through a change in technological model. Innovation is likely to be the most efficient force for ushering in new players. As a result, Arcep is not proposing any measures to enable the emergence of new operating systems.

It nevertheless remains that length of innovation cycles cannot be known, and are potentially long, and that internet openness cannot wait. This is why it may be advisable to take direct actions to protect this "shared asset".

4.4 Direct actions with key stakeholders to protect the proliferation of internet content

Because the device market's evolution will not naturally lead to a satisfactory situation in terms of internet openness, more direct measures may need to be introduced to guarantee the wealth of the content available. These more restrictive measures could target key terminal equipment, and the problematic behaviours of those players with unassailable positions on the internet access chain. The aim would be to strive for a greater abundance of content and services available on terminal equipment. This would suppose, on the one hand, limiting the leading device manufacturers' and app store operators' practices that seek to promote certain content and services at the expense of others and, on the other, to work to ensure that they do not adopt practices that would deliberately lead to a reduced selection of online content and services.

4.4.1 Allow users to delete pre-installed apps

The pre-installation of apps on a device, whether configured by the device's manufacturer or the operating system provider, can lure users away from certain content and services, particularly when these applications are displayed on the device's home screen.

As a result, it would be advisable either not to preinstall any apps or to take a cue from the measures adopted by South Korean lawmakers, which allow users to delete any pre-installed app from their device, provided they are not vital to the device's operation or security.

4.4.2 Enable alternative rankings of the online content and services available on app stores

Through their necessarily subjective ranking policies, app stores favour certain content and services over others. The impact this has on the internet's openness is especially acute as users rarely have access to more than one app store.

Users should therefore be allowed to interact with available app stores using third-party recommendation engines. The emergence of such tools[106] would make it possible to separate app indexing and rankings. Users could thus circumvent app stores' ranking algorithms and play a more active role in configuring the selection criteria applied to the applications available on app stores.

4.4.3 Allow users easy access to the applications offered on alternative app stores, once they have been deemed reliable

It could be useful to complete the measures suggested above with actions that aim to stimulate the availability of a wider selection of available content and services.

This could involve challenging the dominant position enjoyed by the key app store providers, by creating conditions conducive to the emergence of effective competition between stores. If app stores undeniably play a crucial role in terms of security, it does not mean that other stores could not guarantee the same prerogatives, while also differentiating themselves by providing access to a more bountiful internet, for the benefit of end users. Over time, this could lead incumbent players to behave righteously in terms internet openness.

In today's mobile market, control over the app store segment is shared chiefly by Google's Play Store and Apple's App Store, and the providers of these operating systems either prevent or discourage the installation of alternative app stores. Through its walled garden model, Apple imposes a single app store, even though we can mention the Cydia initiative, which is an alternative downloading platform to the App Store that can be downloaded to jailbroken Apple devices[107]. Google, meanwhile, leaves open the possibility of installing alternative app stores, but warns users of the threat they might pose to the device's security. For instance, users can install the F-Droid Open Source app store only after having activated an advanced setting, and having been warned that apps downloaded off third-party stores can be harmful.

In practice, then, it would be possible to lower the barriers to entry for app stores with alternative editorial methods: this would involve preventing those actions that the main operating systems take to block or discourage the installation of third-party app stores, provided the latter do not undermine the device's integrity. It should be noted that the reach of such a measure could be limited by the fact that app stores' success also derives from having achieved a critical mass in terms of users and app providers. Samsung, for instance, put an end to developing its Galaxy Apps store for its own brand of devices after having failed to build a credible applications universe for its users.

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[106] To give an example, the Linux OS separates depot functions (app code storage) from user interface (ranking, editorialising) functions assumed by app stores. This means users can install alternative interfaces that differ from one another in their graphic interfaces, their editorial choices and their ranking methods, while still accessing the same depots. See: Ask Ubuntu, *Are there alternatives to software center?*, https://askubuntu.com/questions/339697/are-there-alternatives-to-software-center, 3 November 2013.

[107] Jailbreaking a device is a process that allows the owners of iOS mobile devices to eliminate all of the restrictions and security mechanisms imposed by Apple.

4.4.4   Allow all content and services developers to access the same device functions

Inescapable device manufacturers should not, merely for business reasons, deliberately degrade the selection of content and services available on their own devices, by preventing providers from accessing the functions they need to fully operate their services.

Discrimination, for commercial ends[108], between service providers over access to the APIs controlled by an operating system (which give access to the devices' functions) could be prohibited. It would no longer be possible to confine access to one or several APIs to only certain content and service providers, and particularly to apply different pricing terms depending on the content and service provider, for no reason other than commercial ones.

This means that Android could no longer be the only one able to use its APIs for accessing physical geolocation components; a company such as Open Street Map could also use them.

4.4.5   Monitor the evolution of devices' exclusive content and service offerings

An analysis of terminal equipment led to the observation of certain (legal or factual) exclusivity practices employed by device manufacturers. These practices could hamper the openness of internet access when they drain away the online content and services from rival equipment.

It would be preferable for a choice of device not to prevent end users from access content and services developed by a player other than the manufacturer that produced their device, the provider of the operating system that powers it or, when applicable, parties that have exclusivity deals with the manufacturer or the OS provider.

Competition law establishes the principle of a case-by-case analysis of exclusivity practices, as they can have pro- or anticompetitive effects. A general ban on such practices would therefore raise questions of principle, and thus seem premature given the developments observed in device markets.

On the other hand, given the threats they represent to the open nature of the internet, it could be useful to monitor the evolution of these exclusivity practices to ensure that they do not, ultimately, impair the wealth of content available to users as a whole.

4.5   Employ an agile procedure to support SMEs and start-ups

Today app stores are a gateway to the digital ecosystem for a great many businesses, notably SMEs and start-ups. But, for all of the reasons listed in Parts 2 and 3, these businesses have no guaranteed access to users. At cause are apps stores' refusals to list or indexing practices.

A procedure should be invented when internet openness is challenged by device manufacturers' and OS providers' unjustified practices that would enable prompt action tailored to small businesses. To give an example, Arcep currently has a certain number of regulatory methods at its disposal for taking swift action (four months), and which are adapted to the specific sectors that fall under its purview. These tools are distinct, in particular, from those of a generalist competition authority, which has the power to heavily penalise antitrust behaviour, but are also part of a lengthy process, with an investigation period that can last several years in complex cases, and so appears incompatible with the time scale of a particularly fast-moving digital universe whose future development is very hard to estimate.

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[108] Which excludes justified ends, such as the desire to protect the device's security.

The process of treating certain unjustified practices by device market stakeholders that restrict internet openness could take its cue from the dispute settlement procedure that Arcep employs as part of its telecoms regulation mandate. An expert regulator could be given the power to settle disputes related to internet openness and devices, including those regarding their operating systems, browsers and app stores. In particular, there can be an imbalance in the relationship between certain content and service providers and certain device manufacturers. It could thus be advisable for content and service providers to have a path for swift and efficient recourse when a dispute arises over the conditions governing their access to devices, whether through operating systems, browsers or app stores. A dispute settlement procedure could be introduced[109] to arbitrate, on a case by case basis, disagreements between professional actors regarding:

- The indexing and ranking criteria used by app stores (alongside the measure proposed in section 4.2.4),

- operating systems showcasing certain content and services (alongside the measure proposed in section 4.4.1),

- third-party search engines' access to app stores (alongside the measure proposed in section 4.4.2),

- third-party app stores' access to operating systems (alongside the measure proposed in section 4.4.3),

- applications' access to operating systems' APIs (alongside the measure proposed in section 4.4.4).

<p style="text-align:center">***</p>

To ensure and future-proof an open internet, Arcep believes it necessary, first, to clarify that the principle of internet openness must apply to devices. Within this framework, Arcep then considered three types of intervention.

Thanks to data-driven regulation, it believes that it is possible not only to allow a public authority to increase its powers but also to encourage virtuous behaviour by creating more informed users and providing business users with greater clarity.

If, in this particular case, it is not looking at competition in and of itself, Arcep nevertheless perceives it as a central market mechanism and as an important form of leverage for better empowering users, and making internet openness a criterion that differentiates devices. To this end, Arcep welcomes the different public and private initiatives that should make it easier to switch from one system to another. They must be monitored closely and assessed once they have been tried and tested. As for the more fundamental challenge to today's unassailable operating system players, Arcep predicts that this will come with the emergence of new technological models.

However, internet openness is a core principle that device manufacturers may already be eroding; Arcep thus considers it necessary to introduce tools immediately for remedying the situation directly. It is therefore proposing measures aimed, first, at limiting the bias that devices induce over the content consumed and, second, at sustaining the proliferation of content on the internet.

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[109] If these provisions were to be considered only at the national level, their compliance with Directive 2000/31/EC of 8 June 2000 on e-commerce, including notification obligations would need to be verified beforehand.

Lastly, to guarantee the effectiveness of the rights and obligations it proposes creating, Arcep is calling for the introduction of a rapid and pragmatic procedure for settling disputes regarding internet openness, notably for the benefit of SMEs and start-ups.

5 Conclusion

Through this process that could appear as widening the scope of its investigation to new topics, Arcep wanted to emphasise the degree to which the principle of internet openness – of which Arcep has been the full guardian since the adoption of European Regulation 2015/2120 and the Digital Republic Law of 7 October 2016 – is vital. The way in which this Regulation defines end-users' right to the freedom to choose their content, regardless of access conditions (hence regardless of the device they use) is an impetus to examine the entire chain of technical intermediaries in the internet access and, particularly, the restrictions they can impose.

The regulation situates the end-user as the one who is at the termination point of the network, be they customer or content provider, in keeping with the fundamental principle of the internet's architecture, whereby the network's intelligence is located at the extremities (and not in the intermediate steps). This has been Arcep's main angle of attack, taking utmost account of end-users, both consumers and content providers, when consulting with the sector's stakeholders. It is their perception of internet openness, in terms of the services which can be consumed and designed, that guides this report's analysis.

The process of drafting this report, and in particular the many interactions with stakeholders, enabled Arcep to map out a relatively large number of impediments to internet openness that stem from devices. They are multifarious in nature and do not necessarily testify to a deliberate move on the part of device manufacturers and operating system providers. This is especially true, for instance, of devices' inherent technical constraints. Regarding these impediments deriving from devices' inherent properties, there is reason to believe that users are aware of these limitations and that they naturally gravitate towards devices that meet their internet access needs.

Conclusions are more detailed when it comes to impediments resulting from wilful actions by device manufacturers or OS providers, such as those that derive from editorial policies or competition models between systems.

Some of these impediments have a positive counterpart for end users. For instance, Arcep ascertained that walled garden systems could be synonymous with increased guarantees in terms of security, privacy protection pledges or a more user-friendly experience for the less technically savvy users. By the same token, the pre-installation of apps, which creates the risk of skewing internet users' access to certain content, offers the advantage of allowing consumers to use a new device straight out of the box.

On the flipside, some restrictions that device manufacturers or OS providers have deliberately put into place harm the distribution of content or access to certain online services, with no proven positive counterpart and so, *a priori,* at end-users' expense. A case in point is when an app store refuses to index a service, without justification. This is also what happens when a user is made anxious about installing an app from an alternative app store when, by all evidence, it is no less reliable.

All of these impediments could be resolved over time, spurred by players offering innovative services that have power to drive the emergence of new behaviours and challenge existing established positions.

However, given the uncertainties surrounding innovation cycles, which can be lengthy and unpredictable, and which could allow a handful of players to consolidate their hold on the market (due to strong scale and club effects, which in return could also be essential characteristics of future innovations, notably those based on the use of big data), public policymakers may need to take action.

Several levels of immediate action therefore seem advisable, beginning with a clarification of the fact that the principle of internet openness needs to apply to devices.

Data-driven regulation is required beforehand, to analyse the topic and ensure fully informed users: employing a range of tools (collecting information from device manufacturers and OS providers, end-user reporting, promoting comparison tools, obligation of transparency towards professional users), the aim would be, on the one hand, to enable the public authority to deepen its expertise and, on the other hand, to encourage virtuous behaviour by informing consumers about their choices and providing professional users with greater clarity.

Moreover, while not setting it up as a goal in and of itself, Arcep views competition as a paramount form of leverage for guaranteeing internet openness: by better empowering users, it could make internet openness a leading criterion for users in their choice of device. This is why Arcep welcomes the different public and private initiatives that will make it easier to switch devices. Arcep is thus calling for the available tools to be closely monitored and assessed.

Having ascertained that internet openness may already have been eroded by device manufacturers, Arcep thus considers it necessary to seek to remedy the situation immediately through targeted actions. It recommends measures both for limiting the bias that devices induce over the content consumed, such as the ability to delete pre-installed apps, and to maintain the internet's bounty, such as opening up access obligations for APIs.

Lastly, dispute settlement mechanisms such as those that are currently in place in the electronic communications sector, could guarantee the effectiveness of most of the measures being suggested: Arcep thus proposes introducing a rapid and pragmatic procedure for settling disputes regarding internet openness, notably for the benefit of professional users, and particularly SMEs and start-ups.

Generally speaking, because the framework that currently protects internet openness is European, EU lawmakers should take up this mantle. Device manufacturers' and operating system providers' eminently international dimension also leads to the conclusion that any action that is eventually taken must be European in scale. In the meantime, Arcep plans on doing its part by proposing courses of action that it recommends to put into effect immediately at the national level, with the goal of stimulating actions at the European level. It is also participating in the work being done by BEREC (the Body of European Regulators for Electronic Communications) which will be publishing a report in the coming weeks on the impact that content and devices have on the functioning of the telecoms market.

6 Annexes

6.1 Recap of the main proposals to ensure internet openness and users' freedom of choice

Clarify the scope of the open internet by enshrining the principle of users' freedom to choose their content and applications regardless of the device

Data-driven regulation

- Gather information from device manufacturers and OS providers, and disseminate it

- Gather reporting from end users, both consumers and businesses

- Promote comparison tools

- Impose transparency on the indexing and ranking criteria that app stores use

Increase fluidity

- Closely monitor and, once tried and tested, assess initiatives designed to facilitate device switching

Lift certain restrictions imposed by key device market players, more directly

- Allow users to delete pre-installed apps

- Enable alternative rankings for the online content and services available in app stores

- Allow users to easily access applications offered by alternative app stores, once they have been deemed reliable

- Allow all content and service developers to access the same device functions

- Monitor the evolution of devices' content and service exclusivity practices

Act quickly

- Invent an agile procedure for supporting businesses, and particularly SMEs and start-ups, when they encounter questionable practices

6.2 List of people Arcep met with, who participated in workshops or responded to the public consultation

Below is a list of the people who Arcep interviewed as part of the work it did to produce the first report published in May 2017, as well as this report, and those who participated in the workshops that were held in the second half of 2017, and responded to the public consultation that ran from 11 December 2017 to 10 January 2018. The positions listed are those they held at the time.

N.B.: This report expresses the conclusions that Arcep has drawn from its investigation, and not those of the people who were interviewed or who participated in the workshop during the report's production stage.

AfNum	Maxence DEMERLÉ, Delegate general
	Stéphane ELKON, Delegate general
	Pascal CHEVALLIER, Deputy delegate general
	Armand CLAUDEL, Marketing manager for smart TV, Samsung
AFUTT	Bernard DUPRE, President
Air France KLM	Christian REGNIER, Manager of communication services
Apple	Marie-Laure DARIDAN, Director of institutional affairs, France
	Sylvain SCHNERB, Legal officer, France
AppleisaPro	Arthur BENCHETRIT, Founder
Archambault Avocat	Alexandre ARCHAMBAULT, barrister
Autorité de la concurrence	Nicolas DEFFIEUX, Deputy reporter general
Board Game Arena	Gregory ISABELLI, Founder
Bouygues Telecom	Laurent BONNET, Head of the regulation department
BEUC	Guillermo BELTRA, Head of the legal and economic department
	David MARTIN, Senior lawyer, digital and consumer rights
Canal Plus	François FOURRIER, Director of product marketing
	Philippe RIVAS, Technical director of distribution
	Christophe ROY, Director of European affairs, Deputy legal director
CNIL	Brice BASTIE, Economic affairs department, legal counsel
	Olivier DESBIEY, Head of foresight studies, study division, innovation and forward-planning
	Vincent TOUBIANA, Technologist, technological expertise department
CNNum	Romain DELASSUS, Reporter general

	Judith HERZOG, Rapporteur
	Marylou LE ROY, rapporteur
Cozy Cloud	Tristan NITOT, Product manager
CSA	Antoine VICTORIA, Deputy director of studies, economic affairs and competition
	Sacha DESMARIS, New services policy officer
	Arnaud ROLAND, Competition policy officer
CSF	Cécile TERRANCLE, policy officer
DGCCRF	Geneviève CAVAZZI, Industrial products bureau (bureau 5A)
	David HELM, bureau 6B
	Paul-Emmanuel PIEL, Media, telecommunications, cultural goods and services bureau chief (bureau 6B)
	Vincent PONET, bureau 5A
	Philippe SAUZE, bureau 6B
DGE	Olivier COROLLEUR, Deputy director, electronic communications and postal division
	Mélanie PRZYROWSKI, Policy officer, national and European regulation, Deputy head of the electronic communications and postal department
Diffraction Analysis	Guillaume SOULERES, Analyst
Facebook	Anton'Maria BATTESTI, Head of public affairs, France
La fédération FDN	Benjamin BAYART, President
	Oriane PIQUER-LOUIS, Vice-president
FPWA Avocats	Jean-Baptiste SOUFRON, Lawyer
France Télévisions	Stéphane VAN BOSTERHAUDT, CTO, digital
Free	Ombeline BARTIN, Head of institutional relations
	Thanh PHAM-DOAN, Director of regulatory affairs
Google	Olivier ESPER, Head of public policy, France
	Benoît TABAKA, Senior economic policy manager (EMEA)
	Elisabeth BARGES, Senior public policy manager, France
Huawei	Michael JOLLY, Senior marketing manager
	Denis MOREL, Vice-president of the consumer division

	François HINGANT, Product marketing director Eric MASERA, Director of business development and technology planning
Heetch	Teddy PELLERIN, Co-founder
Hogan Lovells	Winston MAXWELL, Partner
IdF mobilités	Jean-Luc PRAT, Owner of Vianavigo
InoCUBE	Benjamin JEAN, President
IGNES	Guillaume ADAM, Head of regulatory affairs
Netflix	Colin BORTNER, Director of global public policy
Lysios	Jean-Luc ARCHAMBAULT, President
Microsoft	Camille VAZIAGA, Head of public policy Quang-Minh LEPESCHEUX, Head of public affairs Xavier BESSEYRE DES HORTS, Head of the digital transformation, digital communication and public affairs
Mozilla	Sylvestre LEDRU, Head of Mozilla France Jérémie PATONNIER, Web expert
Nexedi	Jean-Paul SMETS, President, CEO
Nokia Networks	Yann BEGASSAT, Director of new technologies Mirela DOICU, Public relations director
Oracle	Franck JOURNOUD, Senior Director for the Cybersecurity and Technology Policy Peter LORD, Senior Director for strategic initiatives Charlotte THORNBY, EMEA Senior Director Public Policy and Corporate Affairs and Head of EU Affairs
Orange	Gilles FILARY, Head of forward-planning and device technology Jean MAHE, Director of audiovisual regulation and content Brice MIRANDA, Director of device and service expertise Stéphane RAULIN, Head of software, connected products and partnerships Julien SICART, Technology expert, connected products Christophe ABRIAC, Digital regional development – Local authority relations department

Quadrature du Net	Benjamin BAYART, Co-founder
Qualcomm	Guillaume LEBRUN, Director regulation, spectrum and technology
	Dahlia KOWNATOR, Director of competition policy
	Alberto DE FELICE, Senior regulation analyst
	Joseph SCHUMAN, Director of public affairs
Qwant	Geoffrey KAZMIERCZAK, Designer
Replicant	Denis CARIKLI, Developer
	Paul KOCIALKOWSKI, Developer
Samsung	Roberto MAURO, Vice-president, strategy, marketing public affairs
	Charlotte RADVANYI, Public affairs manager
SELL	Emmanuel MARTIN, Delegate general
SIRTI	Charlotte GABARROT, Head of legal affairs and public policy
Smartly	Hicham TAHIRI, Founder
SNCF	Marc KIEKEN, Programme manager
SFR	Marie-Georges BOULAY, Director of regulatory affairs, competition, operator contracts and frequencies
	Jean HYBRE, Head of procurement and devices
Spotify	Marine ELGRICHI, Head of public affairs, Europe
Thales communication France	Jean Francois QUESNE, Programme manager
T-Regs	Yves BLONDEEL, Founder
UFC-Que Choisir	Antoine AUTIER, Deputy director of the study department
	Nicolas GODFROY, Legal officer
Tech In France	Loïc RIVIERE, President, CEO
	Alice GARZA, Public policy manager
Voila Intralunaire	Anonymous, Developer
Webshell	Medhi MEDJAOUI, Founder