What Does the Future Hold for Electronic Communications?

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Abstract: While they dominated the digital industry 20 years ago, telecoms operators are now confronted with an all-powerful Internet industry. Faced with a market that seems to be slowing in growth, faced with a technological evolution fragmenting the value chain, this article examines the relationships and confrontations of the telecommunications industry and the Internet industry. It seeks to appreciate the power relations and strategies that these vertical relationships could manifest in the coming years.

Key words: Telecommunications industry, Internet industry, vertical integration, dominance, value chain, double helix.

The telephone, which celebrated its 140th birthday in 2016, gave birth to a flourishing industry that developed copper networks around the world carrying mainly telephonic communications. That industry eclipsed the telegraph industry, older and much more consistent in its infancy (Western Union), but which did not believe in the scope of Graham BELL'S invention: it is true that initially the telephone could not communicate over long distances as the telegraph could. At the turn of this century, most people did not believe that the IP world was about to revolutionise the provision of electronic communications services and give birth to a new industry.

Faced with the Internet industry, will the telecommunications industry live to celebrate its 150th or 160th birthday? That is the question explored by this paper, in a summary format that will necessarily evade some nuances and alternative ideas it would have been interesting to develop.

Its first century neatly characterises this industry: it provides a switched telephone service accessible by copper wireline networks, under a virtually universal status of national monopolies, with AT&T, Sprint, Bell Canada, NTT, BT, ITT, Cable & Wireless and all the national public or private PTT administrations therefore being the shining examples. It developed on the back of a technology that was virtually stable for a century, copper and electromechanical switching, which gave birth to an equally powerful equipment industry[1]. The radio technologies (microwaves, satellites, etc.) gradually supplemented the original technological base.

In the space of 40 years, technology revolutionised the world on which this industry had grown its strength. On one hand, electronics became an increasingly important part of the networks from the 1970s; on the other hand, the digitisation of all the informational categories (voice, text, image, etc.) became more widespread over a very short period. In the face of this data deluge, techniques for carrying the data emerged: a swing away from circuit switched services towards datagram routing, the emergence of fibre optics as an almost unlimited transmission medium, etc. Furthermore, the radio technologies established themselves as the force behind an almost total switch from wireline access to radio access (cellular telephony, WiFi, etc.). We consider here that this industry provides two main services: a connection service (access to a network) and a connectivity service (carrying data to another access).

The telecommunications industry managed to cope with these developments without suffering too much: the competition between networks from the early 1980s led to the appearance of new giants (Vodafone and Hutchison for example), while globalisation placed in the mix other giants from the developing countries (China Mobile, Bharti-Airtel, America Movil, MTN, etc.), although the electronic communications world, a new name replacing that of telecommunications, has not yet completely transformed the industrial deal internationally with regard to the carrying of digital signals. Nevertheless, the fast-track digitisation of our informational worlds of all kinds gave birth to another industry, known as the Internet, or OTT (Over The Top) in reference to its being supported by the electronic communications networks (Google, Apple, Facebook, Amazon, etc.), which in 15 years has become mightier than the traditional telecommunications industry that we refer to in the rest of this paper as telcos.

The forced coexistence of the two industries today raises the question of their structuring: is there room for two separate industries, what distribution

[1] Western Electric and its Bell Labs, becoming Lucent then Nokia, Ericsson, Siemens, Marconi, NEC, ITT, etc.

of value can we envisage, what division of functions can be planned, etc. or are we moving towards a form of merger, and if so, what form will it take?

Electronic communication cannot disappear: there will always be a need for networks carrying content that is increasingly diverse and massive, and for electronic communications providing the interoperability of increasingly shared treatments to which such content is subject. Not only can the networks not disappear, they have to spread out geographically, expanding their volumetric capacities and functional capabilities. The question posed concerns the industrial organisation of these networks: can the telcos-Internet dichotomy continue to exist, and if not, what type of industrial organisation can be established?

To examine this question, we will follow three steps.

- We will first explore the volumetric development of this industry's markets: what growth can we expect?
- Next, we will analyse the functional evolution of this industry: what to make of the industrial fragmentation and integration of the electronic communications sector?
- Finally, we will assess the changes in its economic balances.

Each of these analyses will enable us to highlight some strong tendencies or alternative scenarios.

■ What market growth can we expect?

Telecommunications is one sector where market expectations have frequently been exceeded. Although this perception is still widespread, it seems to us that this historical progression could soon reach its asymptote.

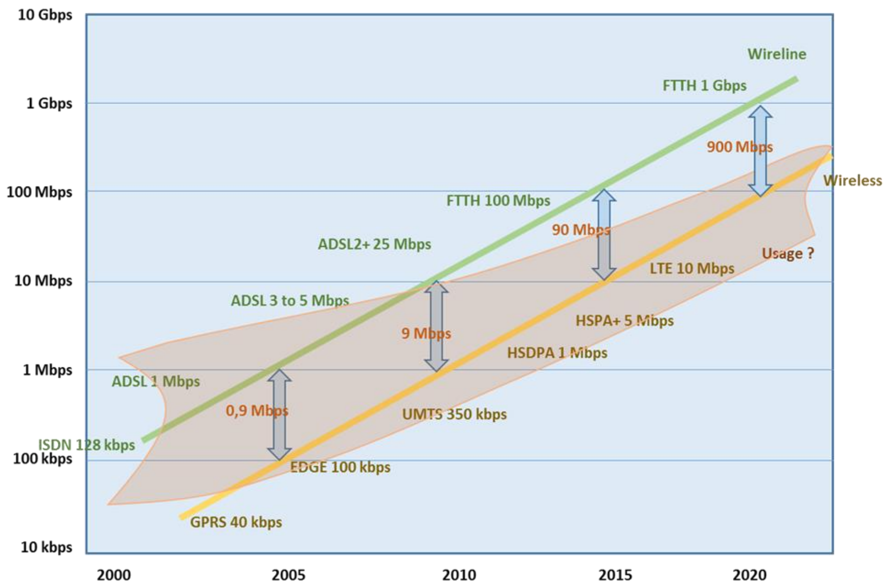
The annual growth rate of data traffic (IP) is falling year on year. It was over 100% in the 2000s, in the region of 50% in the early 2010s and, according to Cisco (2016), will undoubtedly be close to 20% in 2020. These projections take account of the growth in users (4.1 billion in 2020), connected objects (26.3 billion in 2020), the average access speed offered (30 Mbps in 2020 versus 18 Mbps in 2015) and are, according to Cisco, broadly comprised of video traffic (accounting for more than 80% of IP traffic in 2020).

To cope with this sustained traffic growth, the networks must be able to deliver constantly growing capacities: the replacement of copper with fibre glass for fixed networks and the succession of mobile generations (with 5G announced for 2020) ensures this progression. The graph below broadly illustrates changes to the average unit flow rates offered by the access networks, both fixed and mobile, on a logarithmic scale. From 1 Mbps in 2005, by 2020 the fixed networks should offer a unit flow rate in the region of 1 Gbps, i.e. 1,000 times greater, or an average annual growth rate of 58% over 15 years (x10 every 5 years). The mobile networks are following a similar pattern, albeit lower by a factor of 10, going from around 100 Kbps in 2005 to 100 Mbps in 2020. These rates are usage rates, given that the maximum rates which the 5G networks can deliver are expected to be in the region of 1 Gbps, i.e. on the usage pattern of the fixed networks, which themselves could deliver around 10 times the rate indicated.

Several points can be considered from this outline:

- The gap between fixed and mobile rates will continue to grow: from 0.9 Mbps in 2005, it will rise to 900 Mbps in 2020, and grow by a factor of 10 every 5 years.
- Are these patterns sustainable beyond 2020? To work at corresponding speeds means having increasingly efficient components that can cope with the mitigation of Moore's law; the performance for electronics is decreasing gradually, down to a progression of around 30% annually, lower than predicted by Moore's law: the rates provided by the networks should therefore rise slightly after 2020.
- The investments required to achieve these average rates are getting higher, both in terms of fibre optic cabling and, in particular, of densification of mobile networks as one rises in the frequency spectrum, due to the physical limitations of wave propagation.
- Finally, the central question that these changes raise is that of user needs. Will we need a flow rate of 1Gbps, or even 100 Mbps, in 2020? All the relevant market analyses produced by the regulators show that today we cannot tell the difference between the broadband market (<30 Mbps) and the high-speed market (>30 Mbps) (Arcep, 2014, p. 28 and following).

Figure 1 - Development of the rates offered for fixed and mobile access from 2000 to 2020



This latter line of reasoning raises the question of the asymptote of needs, and therefore of the rates offered by the networks. Can traffic per access continue to increase at a rapid pace? We are defending the idea that it is unrealistic to assume an exponential growth rate without accepting that it might one day be limited. On the one hand, future usages scarcely allow for major new needs, apart from a few very specific usages that only affect a small part of the residential market (massive games, virtual reality, etc.) while, on the other hand, compression technologies are continuing to make advances and, finally, the operators realise that consumers are hardly likely to want to pay more for the bandwidth provided, with the ARPU having undoubtedly reached its peak. Finally, all the current and foreseeable usages suppose a WiFi-type radio connection well below the wireline rates offered[2].

[2] Cisco expects 71% of traffic in 2020 to be coming from non-PC terminals. Fixed traffic will represent no more than 22% of the total, with mobile cellular traffic at 19%.

Table 1 - Average rate per type of access

In Mbps	*Average rate 2015*	*Share 2015*	*Average rate 2020*	*Share 2020*	*Average annual growth*
Wireline access	24.7	52%	47.7	34%	14.1%
WiFi access	12.5	42%	24.0	50%	13.9%
Cellular mobile access	2.0	6%	6.5	16%	26.6%
Total accesses	18.2	100%	29.3	100%	10.0%

Source: Cisco VNI[3]

The average rate per access expected for 2020 by Cisco is below 30 Mbps, with an average annual growth rate since 2015 of 10%. If these patterns are extended, that results in an asymptote below 100-150 Mbps, which will in all likelihood be the rate offered on the 5G networks. This may only be an average, but the standard deviation of this rate is probably not very high. Will we really need a connection at 1 Gbps? That is doubtful[4], although some limited categories of users may require it[5].

It therefore seems to us that we are not far (in 2030?) from reaching the asymptotes of the access and traffic rate per access to the IP world. In any case, we can reasonably assume that the marginal usefulness of the bandwidth provided is decreasing significantly and that there is little willingness to pay for an increase in this bandwidth: the ARPU relating to access and/or traffic has probably reached its asymptote (PWC, 2017).

On the other hand, the number of accesses will rise substantially, due especially to the devices connected. The figures will rise from 16.3 billion devices/terminals connected in 2015 to 26 billion in 2020, mainly due to the MtoM connections relative to the Internet of Things.

In conclusion to this first part, we find that the performance levels required of the accesses are falling, while the connections market continues to grow. It can also be expected that the more the connections market grows, the more the rate per connection will stabilise, or even fall, with each new access of a connected device requiring only a limited rate, certainly at

3 http://www.cisco.com/c/en/us/solutions/service-provider/vni-network-traffic-forecast/infographic.html?CAMPAIGN=VNI+2016&COUNTRY_SITE=us&POSITION=Press+Release&REFERRING_SITE=Cisco+page&CREATIVE=PR+to+static+Infographic&_ga=1.42632045.972356564.1491559591

4 CF. http://www.slate.fr/story/71065/internet-le-plus-rapide-du-monde-google-fiber

5 We are not referring here to professional users who might undoubtedly need such a bandwidth.

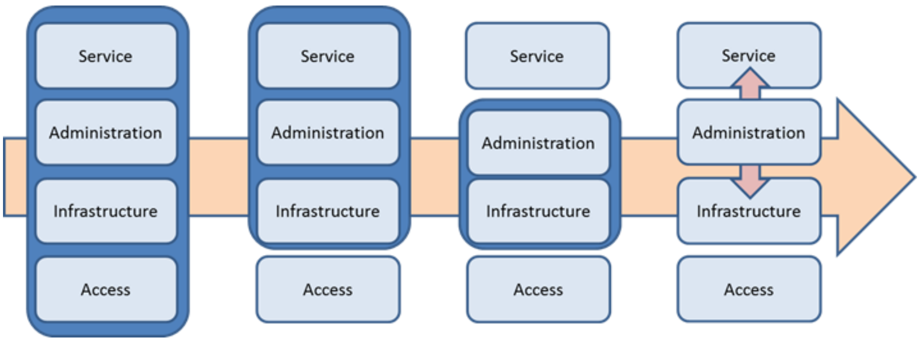
most equal to video traffic. The current technologies (FTTx-copper and 5G) should be sufficient to satisfy future needs[6]. We might even consider whether it is necessary to speed up their natural development by means of public spending (GILLE, 2016 and Pew, 2017).

■ Industrial fragmentation and integration of the networks

To consider the industrial structure of electronic communications, we need to consider its functional structure. Like most networks, an electronic communications network is made up of various functional layers.

A network is formed from an infrastructure composed of arteries and nodes on which services are offered from an access to this infrastructure. The services offered require the provision of an infrastructural capacity, whether it is a telephone link or a data channel, with certain characteristics depending on the type of service (that we will qualify here concisely as quality parameters). However, the allocation of the capacities to the services that need them is done via a special flow control or signalling layer, depending on the type of network. This "administrative" layer is key, especially to comply with the quality parameters and to manage any congestion phenomena. If the access function is added, an electronic communication of any kind will therefore cross 4 functional layers.

Figure 2 - Progressive dissociation of the functional layers of electronic communications



6 It should be noted that the increase in fixed-access rates is increasingly being achieved by an optics-copper coupling, with the optics approaching endpoints without necessarily serving them. The bar separating broadband from high speed (30Mbps) tends to be increased as the copper technologies (VDSL, G Fast) develop.

The traditional evolution of the industry occurred with a progressive dissociation of these layers. For a very long time, each infrastructure offered only a single type of service (telegraph network, telex network, telephone network, data network, television broadcasting network, etc.). As a result, the administration of flows was provided by functions that were fully integrated in the architecture, called signalling, as is the case with road or rail networks. The independence of this flow administration function (signalling/control) was then confirmed, with the signalling becoming more and more autonomous with its own network, boosted by the diversification of the services: the networks became multi-service or, to use the usual qualification, integrated services. This function then had to become more complex to cope with a finer pairing between the infrastructural capacities and the requesting services[7]. If this pairing takes place on a market, this function can be considered as a two-sided platform enabling services to be matched with infrastructural capacities.

The functional layers therefore became gradually separated with, at the bottom (access being emancipated very early[8]), an increasingly "passive" infrastructural layer and, at the top, a service layer extracting itself from the networks and heavily supported by the Internet industry. In the middle, the administration layer is torn between the two sides whose consistency it guarantees. In addition, the access function, which was completely passive, is becoming increasingly active in the selection of the networks by integrating an evolved intelligence closely linked to that of the services[9].

The bottom layer, the infrastructure, has become less intelligent and less expensive due to the explosion in the capacities offered thanks to fibre optic transmission and the capacity of the routers and multiplexing equipment free from any management of services. The top layer, the management of services, has become increasingly autonomous, initially in what is called the

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7 The allocation of capacities to the services can take different forms. A process (a protocol) "allocates" the available capacities, exclusively or not, to the requesting service, with or without a reservation system (connection oriented or connectionless).

8 The emergence of the telephone jack as the terminal point of the network, the hush-a-phone *vs.* US (1957) proceedings, and the gradually acquired freedom for users to purchase the terminal of their choice enable the gradual separation of the network's access function, to which the smartphone, from 2007, will impart a considerable intelligence.

9 Devices today referee access to the networks, in line with user preference and network availability. A smartphone can connect to the intended network, to an older generation network, or via WiFi depending on the speeds offered and the subscriptions taken. The user no longer knows much about it.

intelligent networks, then in the external network servers (soft switch, web servers, video servers, etc.) used by the telcos or the OTT.

This functional dissociation, and the development of the protocols and standards that enable the layers to inter-operate, led to the fragmentation of the telecoms value chain. Bit by bit, the telcos outsourced numerous aspects of their infrastructural activity: network maintenance increasingly assigned to the equipment manufacturers, transfer of the passive elements of the infrastructures (towers, dark fibres and their civil engineering, etc.), and a new industry was born from this outsourcing that ended up being quite powerful. The largest of the tower companies (American Tower Co) is presenting the 11th global market capitalisation of the telcos sector, outdistancing most of the European telcos[10].

However, the telcos also lost much of their range of services offered on top of their networks due to the applications present in the device equipment communicating with servers outside of the networks. Other actors have also got involved in the networks, where the telcos have not been quick enough or general enough: that is especially the case with content accelerators (CDN), those who install cache servers in networks, or with data centres that now store massive data or the processing of these "shared" data in the networks (the cloud)[11].

The telco networks are thus becoming "moth-eaten" by third parties, either voluntarily or involuntarily, and a large part of the intelligence required to manage the flows that they control now eludes them. In some ways, they have almost become pipes, whose remaining share of management varies greatly from one network to another (it is still larger on the mobile network than on the fixed), and is clearly declining. The virtualisation of the infrastructures, in all its forms (from mVNO to SDN/NFV – Software Defined Network/Network Function Virtualization), leads to this loss of control of the administrative layer in favour of the service providers, or even of the users, who can use them more and more dynamically, while the infrastructural layer

[10] It should also be noted that, apart from the network elements traditionally used (terrestrial optical or wireless transmission elements, satellites, base stations on towers, etc.), others could be added, which are being experimented with here and there today: balloons, drones, low-orbit satellite constellations, mesh architectures, etc.

[11] Operated by an unknown industry: Equinix, Akamai, etc. in addition to GAFA (Google, Amazon, etc.).

is becoming increasingly self-driving (self-driving network)[12]. No telco can ignore the productivity gains offered by these technological changes, and no low-cost strategy seems able to stand out: "Looking ahead to 2030, we can envisage completely automated systems for the creation and supply of services in a multi-supplier context" (GILLE & MARCHANDISE, 2016), once the requirements for inter-operability between the suppliers have been resolved.

Furthermore, the emergence of the triple or even quadruple play suggests a pattern of integrating services and an industrial structuring of networks along new lines: on one side, the core networks (or backbones) are developing, which are tending to become increasingly internationalised (the tier 1 of the IP networks) and on the other side are the multiple access networks, fixed and mobile, wired and radio, integrated or not. To the functional segmentation of the networks must be added their geographic fragmentation, especially in regard to the access networks, which are more stringently regulated and subject to territories.

An operator basically offers two products: a connection to a network and connectivity to other users. On the fixed networks, the connection is embodied by the telephone "jack", and today by the "box". On the mobile networks, by the SIM card, providing user identification and authentication on the network. The carrier selection offered on the fixed networks, the virtualisation of the box, and the mVNO (mobile Virtual Network Operator) provision on the mobile networks distend this user-network relationship, albeit still very strong up to now, which guarantees the quasi-capture of users by the operators and conversely gives rise to all of the migration problems (portability, etc.).

The connection offered is bindingly territorialised: the connection to an operator is only possible in areas in which there is an access network. It can be offered elsewhere, virtually via a third party network (roaming). The world of connected objects requires this connection model to be developed. The supplier of the object will create a connection agreement with one or more operators to free the user from this task and provide the item with the best mobility or universality around the world.

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12 See the ambitions of the equipment manufacturers on the matter, e.g. Juniper (http://www.juniper.net/assets/us/en/local/pdf/whitepapers/2000657-en.pdf)

The first to use this option was Amazon with its Kindle tablet[13]. The eSIM should make this possibility more widespread for connected devices in any case: acting as an intermediary in the relationship between the networks and their users, new types of mVNO for international activity could "uberise" the telecommunications sector in the years to come[14]. A double response could emerge:

- Either the creation of international telco alliances, like the air transport alliances, seeking to retain control of their connection markets;
- Or the appearance of new intermediaries (in particular OTTs, Apple, Amazon, etc.) gradually taking control of the market and then accessing the understanding of the demand needed for better management of the "administration" layer.

These separations of the value chain inevitably raise the question of its "administration": can they be accompanied by the inter-operability mechanisms they need and therefore support the independence of the administration layer, or will they require the reconstitution of specialist networks for each type of service (and not with integration of services). The current deployment of such networks (for example, low-speed networks for the Internet of Things such as Sigfox) opens the way to this break in the disintegrative trend. If this development were to be confirmed, we would probably see a functional reintegration of networks, with each specialist network reintegrating its administration and service layers, and even perhaps its access layers.

Is the single IP-based network, necessarily improved, the best suited to satisfying all the connectivity needs? Two considerations must be taken into account: the flows to be transmitted are now composed of increasingly polarised extremes: very small volume flows coming in particular from the Internet of Things can be carried with less dense and more flexible networks in development today (Sigfox, networks based on the LoRa protocol, etc.), while the video or virtual reality rates remain more significant; on the other hand, security issues will become increasingly central in a digital universe where application processing is shared between multiple servers, not content with poor transmission quality and security[15]. It is not completely

[13] In 2013, Amazon contracted with Vodafone, one of the most internationalised telcos, to allow users of Kindle tablets to buy books online, even without a WiFi connection, via a cellular network connection.

[14] See PwC, http://www.strategyand.pwc.com/media/file/Cutting-the-last-cord.pdf

[15] Cisco estimates that in 2020, 10% of IP traffic offloaded will be denial-of-service traffic.

impossible that the coming years will see the service integration IP networks separate into specific networks gradually able to offer better economic and security conditions[16].

The fragmentation of value chains is not necessarily inevitable. A network can indeed be regarded as a composite system, a huge collection of elements (parts) providing specific functions. These elements cover a wide spectrum of technologies – optics, hertzian, electronics, IT, energy, etc. – that do not necessarily evolve at the same speed. These composite systems therefore experience successive integration-disintegration cycles:

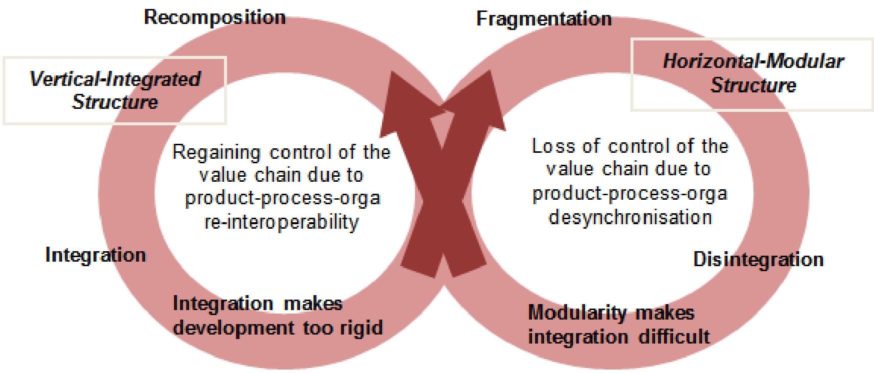
- A highly integrated composite system is faced with a disintegration movement when a present technology evolves more quickly: integration does not make it possible to benefit from the better performances of this technology and the players, to take advantage of the better performances, push the composite to disintegration, while developing the interfaces required for the inter-operability within the new system.
- However, progressively, the disintegration of the system raises an increasing number of problems related to the inter-operability of the elements between themselves. An integration movement then re-establishes itself so as not to penalise the composite system for diseconomies related to inter-operability issues.

This cycle, qualified as a double helix by FINE and WHITNEY (1999), brought to light in the automobile industry as in other sectors, seems to be used in the field of networks. The gradual breaking up of the networks, which we have called functional segmentation, sometimes appears to have reached its limits. Evidence of this seems to be, on the one hand, the emergence of dedicated networks, for example low-speed and, on the other hand, the very heavy integration of their management network operated by the OTT, in particular by Google[17].

[16] When telephony and television experienced strong post-war development, the question of their joint operation was raised in numerous countries, and many decided on separate operators.

[17] Cf. the network established by Google between its data centres: https://en.wikipedia.org/wiki/Google_Data_Centers

Figure 3 - Fragmentation – integration cycle of composite systems (from FINE)

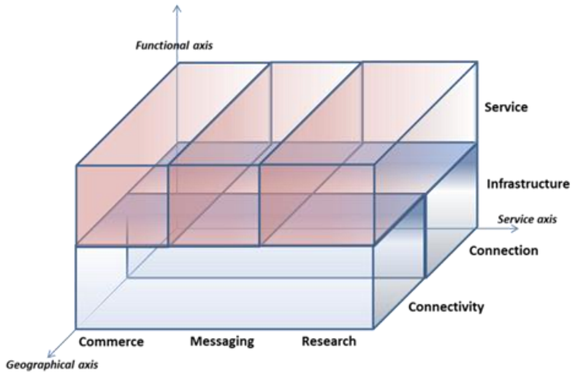


The fragmentation of networks continues to be advanced by their virtualisation, their integration and by the complexity of the interfaces to be defined. The functional segmentation of the networks therefore intensifies with the SDN architectures, and the battle for control of the administration layer (the layer that provides the allocation of infrastructural capacities to the services) develops between the telcos and OTT; an alternative comes to light between the networks that are reintegrating but specialising and networks that lose their intelligence and, in all likelihood, move towards an infrastructural, monopolistic layer.

The emergence of this monopoly is already evident through the sharing/pooling of infrastructures, especially passive ones. In numerous countries, where there are 2, 3 or 4 operators, there is only one towerco, in a genuine monopoly situation. Should these networks use a single supplier, there would be all the ingredients for a re-monopolisation of the infrastructural layer, with the operators becoming completely virtual.

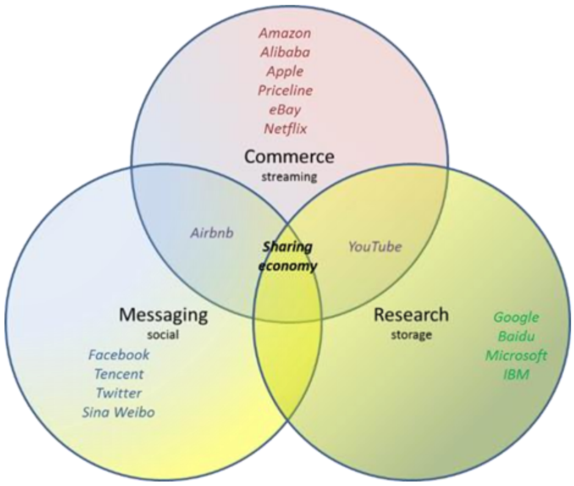
The industrial chain is therefore split over three dimensions: the four functional layers with a clear separation between infrastructure and services, the integration or not of services and the geographic fragmentation, which involves the connection/connectivity separation. This resembles a cube, as shown in figure 4, with an infrastructural plan increasingly divided between connection and connectivity, but with service integration, and a service plan, this time divided according to clusters of services, but integrated geographically (and frequently controlling access through applications, the famous "apps"). We appreciate that, in such a drawing with orthogonal sections on both infra and service functional levels, vertical integration might be a problem.

Figure 4 – The industrial cube



In fact, we consider that the service plan, on which the Internet industry is based, is fundamentally structured around clusters of services. The major players in this industry, whether in the USA or in China, are effectively structured around three constellations of services, represented in the following diagram. Even if each constellation tries to "eat" into its neighbours, they remain very solid. To realign the two plans, it is necessary to imagine either that the Internet industry is consolidated on the service axis, or that the telcos are realigned on the geographical axis, abandoning the integration of services. It is clear that this second option seems most likely.

Figure 5 - The service constellations



Economic balances

Networks were largely remunerated (infrastructure and service) in the 20th century by billing for the connection (connection and subscription to the networks) and billing for the connectivity (for use, on two complementary work units, call distance and duration, with the unique feature of billing only the caller). With the networks being mainly in a public monopoly situation (no regulation) or private monopoly (generally regulated according to a principle of "fair" return on investment[18]) with low elasticity of demand, this billing is "adapted" to the costs incurred by the operators, as is the case in any monopoly situation. The gradual bringing to light of the adverse effects of these monopolies (X-inefficiency, Averch-Johnson effect, etc.) led from the 1980s to the opening up of the sector to competition and to putting some competitive pressure on a sector undergoing profound technological change.

The upsurge of data occurred in a massive way on the fixed networks in the early years of the 21st century with the arrival of ADSL access, although telephony maintained its model on the mobile networks by significantly reducing the distance parameter. It is only with smartphones, so in the 2010s, that the networks are gradually changing to an economic data model.

This model is based on a pricing system initially charged per volume of data transmitted, although the "unlimited" flat-rate system is gradually becoming necessary owing to the fall in the capacity costs and of the perception of an individual asymptote of consumptions[19]. This trend is now affecting the mobile networks and it is fair to suppose that, in a few years' time, traditional telephone billing will have been completely eliminated. Any discrimination problems caused by the ceiling imposed on volumes should therefore soon fade[20].

These developments have required tariffs to be restructured so as to standardise pricing whose cost drivers change quickly. In the 1980s, it was the rise in local communications to address the rapid disappearance of the distance billing unit, the result of the competition from the mobile networks on which it had, by necessity, disappeared; in the 2010s, it is the rise, where

18 Rate of Return Regulation.

19 This billing eliminates the connection component (potentiality of access) that would certainly have to be re-identified.

20 For example, the constraints placed on the zero rating by the Berec 2016 regulation (art. 3.2).

data flat-rate pricing is not yet applied (as in the case of mobile networks in the emerging countries with prepaid pricing), of data-related billing to mitigate the progressive disappearance of telephone billing[21]. Unlike telephone billing, however, data broadband is paid by both parties on exchange, which alleviates the price restructuring at work against an ever-present backdrop of falling costs.

The services are no longer limited to interpersonal communication services alone (telephony, videophony, messages, etc.). These are even starting to become marginal in terms of the volume of traffic exchanged, certainly only 1 to 2% for traditional telephony. And yet, the economic balance of the other services (web consultations, audio and video streaming, etc. and all the emerging services linked to the cloud) rely on other, more complex, economic balances: advertising and personal data play a growing and layered role in this, and the contributions of Internet users, in-kind (content of all kinds posted for free on the web) or monetary (subscriptions to services, purchase of apps, etc.), increasingly play their part as well. The Internet of Things will generate flows associated with other tangible or intangible services.

The disappearance of a supply of differentiated services (telephone, fax, SMS-MMS, etc.) in favour of a broadband offer on which other actors offer their services (the OTTs) inevitably leads to the commoditization of the telcos offer, with competition on prices once the networks, in terms of coverage and quality of service, are more or less at the same level. This commoditization (PWC, 2016) leads, *de facto*, either to the emergence of cartels, or to a phenomenon of consolidation, to alleviate the competition in prices that sector regulation naturally tends to encourage[22].

These strategies therefore aim to unlock the shackles of commoditization, mainly by the association of services: with the connection/connectivity offer, via different networks (fixed, mobile, WiFi hotspot, etc.), the operators try to associate services that are supposed to make a difference, mainly the more or less exclusive "premium" content offer (films, tv series or sport). These offers, called triple play or quadruple play, may attract part of the market once the "bare connectivity", associated with competing contents, offers costs higher than bundled offers. This supposes

21 Under the competitive pressure of applications such as WhatsApp, Viber or Skype.

22 This consolidation should, however, happen, as mentioned, at the infrastructural level rather than at the level of the operators themselves, who, eased by virtualisation, no longer face the same cost constraints.

to a certain extent an agreement to drive up the price of this "bare connectivity", the availability of which is becoming quite rare.

This question of the vertical relationship between networks and services (OTT services from now on integrating the media) is now posed rather acutely, from two perspectives:

- Firstly, from the perspective of economic relationships: who pays whom? That is the debate on the net neutrality;
- Secondly, from the perspective of vertical integration: this is the question of convergence.

From the perspective of economic relationships, the debate becomes more heated: the telcos argue that the service providers should pay to carrying their services, while the service providers argue that the networks should be billed for the content they offer "free of charge" to their subscribers. Both cite the externalities they provide for the other party: the operators, the chance to reach new customers, the service providers, the appeal it can represent for network subscribers. In these externalities the notion of exclusivity obviously crops up: while the subscribers to networks are still often bound to them exclusively, their relationship with service providers is not exclusive. Each is thus seeking additional funding: the operators beyond what their subscribers pay, the service providers beyond the funding already acquired (subscribers or third parties such as advertising or commodification of the data collected).

In this power balance, the telcos, by capturing the subscribers (frequent exclusivity of the connection), can be favoured, hence the establishment of a principle curbs their dominance, that is the net neutrality (WU, 2003). Net neutrality is the result firstly of considerations regarding the interference that network carriers could have in data carriage. Once they control the notorious administration layer, they may be tempted to discriminate between the content requested by the users by facilitating the transport of some types of content and restricting that of others, at the whim of their strategic interests. A number of cases brought these discriminatory practices to light, mainly on the basis of the quality of the services distributed. While these discriminations, often associated with vertical integration phenomena (favouring one's own content to the detriment of third-party content) were logically and rapidly condemned as anticompetitive practices, the neutrality required of the network operators faced with the content[23], and in particular staunchly defended by the suppliers of such content, led to a second aspect of the net neutrality, i.e. the implicit obligation made to the content users to pay for the carrying of the requested content: net neutrality in a way involves a ‘postage due' obligation (shipping cost to be borne by users) in the delivery of the content as, otherwise, the postage paid content could be unduly favoured by comparison with those that are not. The *de facto* ban on postage paid in the access to the commonplace Internet, intended to support small innovators, which is, however, the norm (nevertheless contested) in the e-business sector and was present in the telephone services (green number or toll free), gradually established itself in the name of net neutrality.

This arrangement tends *de facto* to require the creation of data termination, just as there is a telephone call termination, in the relationships between operators. It is effectively circumvented, either by establishing traffic categories with different quality requirements, or by actually paying for a data termination[24] to ease the economic balance of the infrastructure operators. The question raised is that of sharing the costs of carrying the requested content between the supplier and the receiver. European regulation allows a number of solutions and leaves the matter to the discretion of the regulators (Berec, 2016). Another solution that would allow carriers to value the data collected on their users would probably be unfavourable for them in the long term.

The Internet of Things, which leads to the creation of multiple services built on an extensive collection of data and the deployment of an advanced artificial intelligence (a combination known as "big data"), will see the hatching of multiple forms of business models in which the service sold to users will be inclusive of network expenses (e.g. the preventive maintenance of vehicles or machines, driving aids, etc.). Carriage will often be paid by the supplier of the services and not by the user.

For some Internet firms whose growth is based on network externalities, it is essential to connect to their platform the broadest population, so as to generate significant revenue from the other catchment areas of the markets, especially advertising. And yet, substantial populations, those in developing countries, are barely solvent, especially as the costs of transport to the

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23 Offering users a "neutral" access to all content without discrimination.

24 Cf. the litigation between Comcast and Netflix, which resulted in Netflix contributing to network costs.

geographic areas in question are extremely high. This then leads to network costs being covered discriminatorily by the major Internet players, the most obvious examples being Facebook with its free basics offer or Google Free Zone. This strategy, called zero-rating, has come about through necessity and makes increasingly obsolete the idea that the OTT suppliers must be exempted from any contribution to transport costs, even when their income derives from subscriptions or fees paid by their users (as with Netflix). Clearly, however, this discrimination raises dominance issues[25].

In the vertical relationships, where there is a blend of the mobilisation of externalities, the quest for additional funding when a side of the market proves not to be very solvent, the presence or otherwise of exclusivities, the situations cannot be summed up in a simple diagram. We can see on numerous markets (cable television, video games, smartphone applications, etc.) that the financial flows develop in both directions, flows that the regulators must be able to audit to identify possible anticompetitive practices, especially on account of the presence of essential resources. The general interest therefore seems to be that there is the possibility of a cursor between the two parties, which effectively share the carriage of the contents, which would return to the telcos a negotiating power with the OTT-type service providers who have now become dominant (see below).

The question of the networks-services vertical integration (convergence) remains. The networks are by nature territorialised, but multi-service, while the services are quasi-universal, but often specialised. This vertical integration therefore appears to be slightly unnatural when it is accompanied by exclusivities, which is undoubtedly one of its *raisons d'être* – unless it is done by players in a dominant position who can hope to capitalise on the externalities created. It is hard to see how a network could buy Netflix, or how Netflix could buy a network: in our view, the convergence can only remain marginal, on small-scale service providers providing a small competitive advantage if also offering exclusivity. Hence the importance of regulating vertical relationships.

These developments could change if the networks prevent the commoditization of their connection and connectivity offers referred to above. To achieve this, the operators must be able to make their services stand out from those of their competitors. The main differentiation factors

[25] Zero-rating was therefore banned by some regulators (especially in India). Apart from these discriminatory and economic effects (possible cross-subsidies, etc.), potential solutions (e.g. free usage bonus) require sensitive handling. Cf. Wikipedia "zero-rating".

were until now associated with coverage and service quality: these factors will remain differentiation factors, especially with regard to the density of the stations of mobile networks, and therefore to the quality of connection, but these factors will become less important if infrastructural elements are outsourced (the pooling of infrastructures). The differentiation provided by the services offering terminals now seems irrelevant, except in the event of the re-specialisation of the networks.

The transience of these differentiation parameters strengthens the dynamic of commoditization of the offers. There remains perhaps one differentiation parameter that is not yet seen as essential, but which could quite quickly become so, which is the security provided in terms of both connection and connectivity. The encryption of the services might no longer be enough in view of the multiple weaknesses of the services, and it is likely that securing the services relies on an intelligence that remains part of the network. This could be a strategic possibility for the telcos before the OTTs snatch it up and offer it while becoming more involved in the networks. Especially as we cannot rule out that, in the new security/protection parameters, the question of access to advertising (seen as spam) and the protection of personal data will arise. In an environment of connected objects, this problem could become serious (Pew, 2014, 2017) and is already considered in the Berec regulation (2016).

Rather than attempt to compete directly with the OTTs with service offers with intrinsically lower savings (on account of the mobilisation of much lower network effects), surely the telcos have a trump card to play by defending the interests of users against the service providers with regard to security and protection, which would also curb the power of the OTTs by cutting back on the massive externalities that create their wealth. In other words, establishing a real power balance rather than seeking to copy an actor with exclusive advantages. Furthermore, it is probable that such a strategy will mobilise significant externalities that could give the telcos increasing power against the OTTs.

In this vertical interaction within the digital industries, the initial power balance (the absolute dominance of the telcos in the 1990s) has completely reversed in under 20 years. The OTTs, the largest of which are also known as GAFA, have become an extremely flourishing and powerful industry, with a major swing ensuing due to the expansion of smart devices (smartphones, connected items, etc.).

This success stems from the massive externalities generated by the services offered: these externalities provide the markets that form their core profession with dominant positions accompanied by very high returns. The best indicator of this dominance is still the stock market valuation of the firms, as it shows the expectation of future gains anticipated by the financial markets. The following table shows at the end of 2016 the market capitalisation of the top 12 firms that we consider to be the major Internet players and the top 12 firms that can be considered as telcos[26]:

Table 2 - Market valuations of the main Internet and telecommunications companies

Internet firm	*code*	*country*	*Value end 2016*	*Telecom firm*	*code*	*country*	*Value end 2016*
Apple Inc.	AAPL	USA	612.8	AT&T Inc.	T	USA	260.4
Alphabet - Google Inc	GOOGL	USA	532.1	China Mobile Ltd. (ADR)	CHL	China	216.6
Microsoft Corporation	MSFT	USA	477.3	Verizon Communica-tions	VZ	USA	216.2
Amazon.com Inc.	AMZN	USA	349.2	NTT Docomo Inc (ADR)	DCM	Japan	89.7
Facebook Inc.	FB	USA	327.9	NTT	NTT	Japan	87.8
Tencent Holdings Ltd	700	China	232.1	Deutsche Telekom AG	DTE	Germany	80.5
Alibaba.com Limited	BABA	China	218.4	KDDI Corp	KDDIF	Japan	66.0
Intl. Business Machines	IBM	USA	157.3	Vodafone Group Plc (ADR)	VOD	UK	64.9
Softbank Corp	9984	Japan	73.1	Hutchison Whampoa Ltd	HUWHY	China	61.9
Priceline Group Inc	PCLN	USA	71.7	Telefonica S.A. (ADR)	TEF	Spain	47.0
Baidu Inc (ADR)	BIDU	China	56.3	American Tower Corp	AMT	USA	45.1
Netflix, Inc.	NFLX	USA	52.5	BT Group plc (ADR)	BT	UK	44.7
Total			3160.6				1280.8

Source: Compiled by the author

Although operating on the same markets, the financial power of the telcos appears far less: they represent only 40% of the value of the Internet

[26] We have only included listed companies (Uber could appear in the place of Netflix and after Priceline if we were to include non-listed companies); IBM has been included among the Internet firms, as its involvement in artificial intelligence (Watson) seems to us to place it in this segment.

firms. The clearer it becomes that a telco could no longer buy a major Internet firm, the more the reverse scenario is not entirely unthinkable, especially for the international backbone networks (tier 1).

■ Outlook

The electronic communications industry, the telcos, should expect to see its power balance with the Internet industry, the OTTs, continue to deteriorate: slower growth, although still provided by the connections, profitability affected by the commoditization of its two mainstays: connection and connectivity.

Three scenarios that could come together seem to us to match the earlier developments in the electronic communications sector:

- A black scenario of the gradual concentration of infrastructures, of poorer profitability closely monitored by regulation, in which the networks once again become a monopolistic utility based on the model of the road or rail networks; with potentially quite strong public intervention; virtualised, with many telcos finding it difficult to survive in the face of the Internet industry;
- A specialist network scenario that enables them to "defragment" and regain a level of control of their markets while seeking a much larger geographical footprint, by alliance or otherwise. A complicated scenario for the "incumbent" telcos that have been involved with the integration of services and geographic segmentation on a massive scale;
- A differentiation scenario based on issues relating to user security and protection that gives them both control and a potential mobilisation of externalities, in the face of the Internet industry. A scenario more within the scope of the "incumbent" telcos, based on questions of sovereignty and more compatible with geographic segmentation.

It is hard to envisage a vertical integration scenario in which the OTTs take control of the networks, even more so the other way around, although it is clear that the vertical relationships can only become harder and a crucial place of regulation to arbitrate between industries that have the knowledge and ability to use potentially anticompetitive practices, based on discrimination phenomena (exclusivity), economies of scale and the mobilisation of externalities.

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