Open and disaggregated networks

Leaders in digital infrastructures: the future that increasingly offers us to be a sustainable digital company

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After reviewing the exciting evolution of Telefónica's networks, we describe the current networks focusing on the characteristics that will shape their future.

To sum up, Telefónica's networks can be described in a very simple way as two very powerful accesses, fiber in the case of fixed access and 5G in the case of mobile access, complemented by network intelligence (hosted at the core of the network) that enables the services that can be provided through access and automation capabilities so that the network operation provides the levels of access and the of quality necessary. This description is too simple, let's go to a somewhat more detailed description.

To describe current networks, let's first review the needs that these networks have to cover in order to find the rationale for the main characteristics of networks.

- Efficiency. The efficiency of any implementation by a private company is an obvious requirement, so it should not be surprising that telecommunications networks, and especially those of Telefónica, have the same. However, the efficiency requirements imposed on telecommunications networks are much more demanding than usual in other industries. The reason is that revenue per user has fallen significantly (in the best case some markets have kept them stable) and traffic per user has increased significantly. To give an idea of the order of magnitude of this differential, these figures are worth as an example for mobile networks:
  - The ARPU (average revenue per user) of mobile telephony in Spain evolved in 10 years from approximately 300 euros to 60 euros.
  - Average traffic per mobile user will increase 10-fold in the period from 2018 to 2028 in European markets.

  The evolution of traffic on fixed networks is similar, although the ARPU has been reduced to a lesser extent, but the evolution of traffic is surprising, this table reflects this phenomenon well:

Year	Worldwide Fixed Data Traffic
1992	100 GB per day
1997	100 GB per hour
2002	100 GB per second
2007	2000 GB per second
2017	46,600 GB per second
2022	150,700 GB per second

  That is, networks must be several orders of magnitude more efficient measured in the cost of transporting each bit. Fortunately, technology has so far collaborated in this task, but it is clear that the progression has not ended, so networks must continue to increase their efficiency.

- Monetization. As we have just seen, the average revenue per customer is reduced or remains stable at best. The network has to develop new capabilities to be able to better monetize all the infrastructure deployed. That is, to enable new services that satisfy customers and, therefore, enable the arrival of new revenues.

- Sustainability. Despite the fact that telecommunications networks avoid a large number of tons of carbon thrown into the atmosphere by avoiding displacement of service users, being the industry with the greatest positive effect on the environment, it is still true that telecommunications networks are one of the largest consumers of energy in each country. In addition, the components of telecommunications equipment are major potential polluters. This, together with the significant increase in telecommunications network traffic, makes the requirement of sustainability particularly important. Not only is it necessary for consumption per bit to be reduced, but also for the total consumption of networks to be reduced, i.e. for networks to increase their energy efficiency above the rate of traffic growth. It is also necessary that the components of telecommunications networks do not generate polluting waste or, where appropriate, the complete reuse or recycling of them.
- Automation. Networks are becoming more powerful, extensive, and complex. The operation of the networks and the immediacy required for many of the activities that are required in the operation, forces a complete automation of the networks.
- Time to market. The obvious uncertainty of the telecommunications market, where services have to respond to demand quickly and with a large number of agents in the market that condition the supply of services in directions that are sometimes difficult to foresee, demand great agility to bring new products to the market. In other words, networks must be very agile to bring new products to market. Technologically, it is a relevant challenge when combined with the complexity of networks and the existence of numerous previously existing services and infrastructures.
- Exposure capabilities. An element that is necessary both to gain agility over time to the market of services and to promote the innovation of new services, is the ability to expose the functions of networks to developers outside the telecommunications industry, that is, to give the possibility to a developer who does not know telecommunications networks to include in their code the possibility of changing the behavior of telecommunications networks. telecommunications on which their services are offered.
- Differential traffic management capacity. The evolution of traffic mentioned above, together with the very demanding performance demanded by the new services, means that the paradigm of "best effort" networks in which all traffic is managed equally is not valid for at least part of the services. In other words, traffic will be managed so that services that consume a lot of resources without having a clear need for them do not compete for resources with services that really do need differential features. For example, high-definition video distribution does not require a very low network response time or a very high-speed spike, but it does require medium-high traffic. However, an automatic vehicle control will require a very short response time. In this example, networks will need to manage traffic in a way that always ensures low response time for vehicle control.
- Dependence on suppliers. Whether due to the supply problems that the industry has been suffering in recent years or due to the geopolitical constraints on certain suppliers of network equipment or due to the instability of the supplier industry and the innovation capacity of individual suppliers, networks must be reduced dependent on a single supplier, increasing their multi-supplier nature and making it possible to introduce a new supplier quickly and efficiently. efficient.

These needs can be summarized in three main ones: enabling the monetization of network assets through new services, increasing efficiency, and managing increasing network complexity.

Today's networks have evolved, and are evolving, to respond to these needs. This evolution is clear in a number of key features in today's networks.

1. Disaggregation

Disaggregation is known as decoupling the evolution of hardware and software, i.e. being able to have interchangeable HW and SW elements so that the supplier, the innovation cycle and the HW and SW life cycle are different.

Unbundling has a series of strategic advantages that have made operators, imitating the unbundling movement that was carried out in data centers, push, so far with limited success, unbundling. Among these advantages we find:

- Scale benefits derived from the use of HW not only used by the telco industry but by all industries.
- The innovation cycle of the SW is faster than that of the HW. Decoupling HW and SW accelerates innovation.
- A richer supplier ecosystem is fostered as HW is often a significant barrier to entry for new suppliers.
- Both for the above reason and for the possibility of interchanging the HW and SW, robustness is increased against incidents in the supply chain.
- The possibilities of automation are increased because the interfaces of the disaggregated equipment are open and allow incorporation into automation processes.
- Vendor lock in is reduced, i.e. the supplier can be changed more easily.

However, disaggregation has relevant challenges:

- Most network technology vendors see unbundling as a threat and are reluctant to adopt it easily.
- New suppliers are usually much less powerful financially and developmentally powerful than current suppliers, so competitive unbundled products take time.
- It is more complex for the operator to operate systems in which the HW and SW are decoupled.

Despite these challenges, unbundling is a clear trend, so the level of unbundling of networks will continue to progress. Currently it can be said that the core of the network is completely disaggregated since these equipment have been using general purpose HW (computer servers) for more than 10 years. In transport networks, there is already unbundled equipment handling a significant part of the traffic in large networks, so this unbundling is already a reality. In access, both the unbundling of fixed access (called "open broadband") and mobile access ("Open RAN") is in its early stages with a relatively low state of maturity.

Disaggregation is also understood as "softwarization" in the sense of increasing the importance of SW with respect to HW, with networks inheriting the characteristics of SW development in terms of agility and time to market.

The industry, the operators, count on disaggregation as a key tool in the evolution of networks and Telefónica is one of the operators not only most committed to this trend, but also the leader, in its implementation.

2. Open Networks

By open networks we mean those networks whose interfaces are clearly standardised and therefore elements from different suppliers can be used when composing the network of each operator. Telecommunications operators have always worked with standardized networks due to the need to interoperate between different networks and with different user terminals. This standardization, which has always existed, is intended to be extended to all interfaces so that the use of various elements from different sources is more granular than it is today.

For Telefónica, this is a fundamental requirement in the evolution of networks, if possible, more relevant today and that will be key in future evolution, especially for three reasons:

- Disaggregation. If the HW and SW elements of the network functions correspond to different suppliers, the interface between the HW and the SW must necessarily be open. This standardization is new (so far HW and SW are provided by the same vendor).
- Automation. As we will see later, a high level of automation and the use of artificial intelligence for operation is one of the fundamental characteristics of today's networks. To achieve this level of automation, the interfaces between the network function and the management elements must be completely standardized in order to be able to use the same automation processes in all network elements and also to stimulate innovation in the tools that enable such automation.
- Multivendor. Given the difficulties suffered both by supply difficulties and by the prohibition of the use of suppliers for geopolitical reasons, networks have increased, and will further increase their multi-supplier nature. To do this, the standardization of interfaces, open networks, is necessary.

3. Cloudification

Cloudification is the use of technology used in the cloud by network functions. The reason for this use is given by taking advantage of the economies of scale of the elements used by large hyperscaler data centers such as servers and switches and by the use of the advances in automation and flexibility achieved by hyperscalers. Thus, it is intended to replicate its agility when developing new services and the efficiency of operations.

This migration to cloud technologies is even due to the standardization of network functions. For example, 5G network core standards prescribe the use of microservices, which is how cloud services are organized. As a result, network functions are deployed on containers (virtualization technology created by Google for greater efficiency and SW agility).

But the use of microservices or containers does not determine whether a network function is truly cloud (or as it is called in the industry today "cloud native"). It is necessary to have another series of additional features that will provide the appropriate performance in terms of automation and agility, including:

- Ability for SW to be tested and deployed automatically (use of a CI/CD/CT tool).
- Ability for the network function to be orchestrated in a way that automatically automates the on-demand provision of user-required functions.
- Exposing Network Capabilities Using APIs
- Open interfaces to standardized operating tools.
- Ability to perform platform upgrades with no impact on service. In fact, extrapolating this feature we could say that there is no need for maintenance windows to modify this network function.
- Multicloud, i.e. the possibility for the network function to run on several different cloud infrastructures.

The fact that a network function is cloud native does not mean that it uses the public cloud (the cloud of the large hyperscalers) as an infrastructure, although it does mean that this use is another alternative for the network functions infrastructure.

Telefónica is currently analyzing the use of public cloud as an infrastructure for core network functions. This analysis is based on 4 criteria:

- Technological. Public clouds do not yet have all the technological functionalities required to host network functions with competitive performance, but progress is being made rapidly at this point and it is likely that the technology will be available in the coming months (probably in 2024).
- Regulatory. The use of public cloud imposes a series of regulatory requirements, especially regarding the visibility of data and customer traffic by hyperscalers, which must obviously be met. This requires specific developments that are not available in all cases.
- Economic. The use of the public cloud has to deliver on the promise that the scale of the public cloud will bring the benefits of the economies of scale of the cloud in a way that is more efficient than the current configuration of network functions. This is not yet the case, although this is expected to evolve.
- Strategic. The fact of using for the infrastructure of critical elements for the business of the operators infrastructure of companies that compete with the operators and that make up an oligopoly of very relevant strength must be properly evaluated.

In the future, a likely scenario is that operators will use a multicloud scheme, i.e. the use of both private clouds (operators) and public clouds (always more than one) in order to take advantage of the advantages of the different clouds and minimise risks.

4. Automation

The number of new services that the networks will be able to provide is very interesting in terms of providing greater satisfaction to Telefónica's customers and therefore greater possibilities for monetizing the network's assets, but it forces the networks to be more complex and powerful, with relevant service continuity needs. This, together with the demands of efficiency, forces networks to increase their level of automation significantly.

Automation is perceived as a necessity, since it will not be possible to operate the networks as they have been operated until now, but also as an opportunity to evolve the operating model in search of efficiencies and greater service possibilities.

Automation has paradigms such as "zero touch networks" or "autonomous network" that seek to make networks independent of human intervention in many of their operational aspects. This is graded from the basic level where automation assists manual operation to the highest level of fully autonomous networks.

Telefónica is immersed in all its operations in a process of renewal of the operating model of the networks that we have called "Autonomous Network Journey" through which it intends to scale up the automation degree. It is an ambitious process in which not only the technology is modified, but also processes, tools, capabilities of our teams and culture.

One of the relevant aspects of automation is the use of artificial intelligence for network operation. Telecommunications networks are a very suitable case for artificial intelligence because they have a huge amount of data that, through the appropriate AI algorithms, can provide very interesting capabilities, for example, for preventive maintenance, the search for causes of problems (troubleshooting) or increases in network capacity.

5. Slicing

One of the possibilities of providing new services is slicing. Slicing is the ability to dedicate a logical portion of the network to a client or group of clients or to a service in a way that provides (and even guarantees) a series of service characteristics in the end-to-end network, that is, the logical portion will be enabled in all network layers.

With slicing, the degree of service can be differentiated either by bandwidth, response time or any other parameter between clients and services. In this way, the services that need a specific service will not be competing with the resources with the rest of the customers but will have those resources dedicated to the service.

With Slicing, you can break the paradigm of "best effort" and be able to differentiate in such a way that the services that require a certain feature pay for it. This is always in compliance with the limitations imposed by the net neutrality regulation.

The main features of slicing are:

- Slices will be enabled end-to-end.
- The creation or modification of the slices will be dynamic.
- A client can access multiple slices simultaneously.

- The network will provide numerous (hundreds, thousands) slices with different characteristics. Slices can have very different attributes from each other.
- The different slices will be completely isolated.

As you can easily see, the implementation of slicing services will significantly increase the complexity of network operation because it is not only necessary to verify that the appropriate services are being provided to customers in the network, but also to verify that each of the numerous slices that we will have in the network behave according to the attributes that were defined for them.

Telefónica is starting to deploy slicing during 2023. At the moment a static version of slicing. The most advanced slicing service, the one that fulfills the promise of slicing's dynamism, will be implemented at the end of 2024 or the beginning of 2025.

6. Naas

Another possibility to increase the monetization of network assets is network APIs or NaaS (Network as a Service). NaaS is about exposing APIs with which you can manage the network, either by changing the behavior of the network for applications that use those APIs or by getting information from the network. For example, you can prioritize traffic from the application that uses an API defined for this purpose, or the application can get the client's location or any other information.

The business rationale behind the exposure of network APIs is to obtain revenue not only from customers of telecommunications operators, but also from developers and OTTs. That is, to achieve a "two-side market" that generates revenue opportunities from two ends of the value chain.

The operators, with the leadership and drive of Telefónica, have identified this opportunity and are providing the means for it to crystallize. In this sense, an agreement, Open Gateway MoU, has been signed, in which the operators commit to standardize the network APIs, that is, all operators will expose the same APIs, which will guarantee developers that they will develop applications not only for the network of an operator but for all operators as the APIs are the same. They also commit to having the same business model for network APIs (charging APIs in a similar model) and finally they commit to implementing network APIs in the networks of the signatory operators following an agreed roadmap.

Operators have tried on several occasions to expose network capabilities through APIs and receive income for it, but we have failed in previous attempts; however, there are reasons to be optimistic on this occasion, mainly due to technological development, there are more interesting network capabilities to exhibit, due to the widespread use of APIs by developers with established market places (those of hyperscalers) and due to the standardization of capabilities to be exhibited that 5G brings.

If the Open Gateway initiative is finally a success and Telefónica receives income from the exposure of network capacities, the possibilities of new services for customers will increase and a different behavior of networks can be thought of where network requirements are negotiated between the application and the network, which is able to provide adequate performance to each application.

7. Edge Computing

Edge computing refers to the location of applications used by customers near them, within the operators' networks. That is, when a Telefónica user uses a certain application, instead of having to connect to a server that is outside the network and far away (probably in the cloud of a hyperscaler far from even the country where the user is located) the application can be run on infrastructure within the Telefónica network so that the response time will be much shorter (interconnection or peering and the distances will be smaller).

Telefónica is already providing Edge computing services, although in a limited way. It is expected that with the advent of new services that require a very low response time, networks will have distributed computing capacity. The appropriate level of distribution must be that corresponding to the analysis of the customer's needs and the cost of distribution. That is, applying the maxim of the operators: "centralize everything you can and distribute everything you owe".

8. What will Telefónica's networks of the future be like?

It is difficult to answer this question. If there is one thing that characterizes the world of telecommunications, it is constant progress with accelerated changes that provide services and technologies that are often unexpected. The world of telecommunications lives in constant change and immersed in uncertainty (blessed uncertainty that makes us learn constantly).

Despite the difficulties, we can speculate on the present of the networks and what is already planned for the coming years (which is part of what has been described so far).

The first idea of the networks of the future, possibly the feature with the least uncertainty, is that access will be based on fiber for fixed access and 5G and its evolutions for mobile access. In the fixed sector, access performance will increase significantly (10Gbps accesses first and then 50); in mobile, the evolution of 5G, the sixth generation, is expected around 2030 (its standardization is scheduled for release 21 of the 3GPP and we are now standardizing the eighteenth). This evolution of access will be reflected in transport with an increase in capacity, flexibility and relevant programmability.

Beyond these capacity increases, I believe that the most disruptive feature, in terms of capacity to provide new services, will be the incorporation of computing, storage and artificial intelligence capabilities to networks to be able to provide services not only based on connectivity but also by combining computing, storage and AI in a single service offered by the networks. This is glimpsed in the long term of the networks. For example, one of the requirements for the standardization of 6G is the inclusion of artificial intelligence within the networks not only for a better operation of the networks but also to be able to offer AI services.

In this way, networks can be thought of as a gigantic computer with the capacity to connect with customers at different accesses. With this idea in mind, the concept of "earth computing" can be contrasted with the current concept of "cloud computing", that is, a network attached to the user (due to connectivity) that provides capabilities similar to those of current clouds, but with greater performance as they are coordinated with connectivity.

Networks will very likely be able to offer data from the environment that is not currently offered. For example, base stations and mobile devices will be able to provide information on the composition of materials by analyzing the reflection of electromagnetic waves (especially at very high frequency) or fiber equipment will be able to detect the vibrations of optical fibers in order to provide information on road traffic in the vicinity, measure seismic movements or ground displacements. In other words, the networks will be sensorized providing information about the environment.

Something that is very foreseeable is that network traffic will continue to grow inexorably, so they will be networks that will transport traffic of several orders of magnitude to the current one in a much more efficient way, both from an environmental and economic point of view than currently.

Another characteristic that is very likely to have the networks of the future is that of differentiating between services and providing performance adjusted to the needs of each service. The concept of slicing that we saw above is very likely to be extended to the entire network, making the network a flexible entity that negotiates with services and applications and provides the required capabilities.

This flexibility means great complexity in operating networks, for example in order to guarantee the right level of service for each service when the possibilities are countless. Therefore, fully automated networks, autonomous networks, will be a reality.

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