Telefónica
since 1924

Telefónica's data networks

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Telefónica has been tremendously influential in the society of the countries in which it has operated, and particularly in Spain. Many of Telefónica's actions are installed in the collective imagination: Las Matildes, los Heraldos, Imagenio, Movistar+ ... But there is another chapter of Telefónica's history that is not so well known. I ask you to join me now for a different story: A story of pioneers, of developing our own technology, of customer orientation and of synergies with the business fabric.

Today, all networks are data: Any information of any kind (text, code, audio, video, etc.) is converted into a set of bits to be stored and transmitted by networks that use efficient technologies to transport these "packets" of bits. But it wasn't always this way. In fact, this has been the case for only a few decades: From the invention of the telephone until the 1970s, absolutely all networks were analog and served only to transport voice. It was not until the 1970s that "Special Networks" (as they were called) began to appear, gradually supplanting and absorbing the traditional ones, both in transport and access. In the 1990s, in telecommunications schools, data networks were still a specialty, a curiosity that served as a bridge with computer science...

1. How did it all start?

Data networks arise from the need to communicate computers at a distance. In a world where computers were few and expensive, they need to be accessed a lot and efficiently, from all corners of the world.

One of the sectors that was of most interest and that will be key to the development of the sector, both in Spain and in the rest of the world, was banking: The only way to operate on a large scale was to have a centralized, real-time record of all the transactions that were made in branches and shops. That is why it is the needs of teleprocessing and payment methods that fundamentally pull demand and shape the pace of network development. And to do this, we must use the only decent telecommunications infrastructures that are monopolies and are also designed to transmit voice.

In Spain, the sector had an additional incentive to ensure that transactions were processed in real time: cheques were less legally secure means of payment than in other countries (it was not until 1985 that the current legislation was approved) so technological progress that facilitated the use of other means of payment (cards, etc.). transfers) was a great fraud and cost reducer.

To meet this demand, there were three strategic alternatives:

- Attempting to adapt existing voice networks to carry data traffic. This was the route followed by most operators, who wanted to make the most of existing networks. Within a few years, this alternative was already a dead life because the packet technology was superior.
- Marketing point-to-point digital lines: A simpler business that left all the problems of building the networks (when there are many points and they are very far apart,

the costs of the point-to-point lines become unaffordable) to the customers themselves or to integrators. The fact that there are developed countries in which operators do not have a relevant position in data networks is explained by the many operators that opted for this alternative.

- Developing a specific network for data, based on the use of computers (UNIVAC initially) as switching centers and on the incipient standards and protocols developed in the military and academic world (ARPA, the germ of what has later become the Internet).

The bet on data networks was risky: incipient technologies, lack of experience, business to be developed... but Telefónica decisively opted for the disruption of building a public data network, based on the experiences of some North American private networks. Thus, in 1972, the first public packet network in the world, called RSAN ("*Red Secundaria de Alto Nivel*"), was established in Spain, three years before its equivalent in the USA (TELENET) or six years before the second European reference (France, with TRANSPAC).

Looking back this achievement is incredible, in a relatively small country, semi-isolated internationally, with a weak industry and that only invested 0.5% of GDP in R+D. There were three keys: A clear understanding of the needs of the clients, a business vision, and the great technical competence of the professionals.

Thus, the first and fundamental use of data networks was to allow the modernization of the banking system by connecting branches and ATMs to the data processing center, and later to the terminals of the merchants for credit card payment. Among other things, it is the early and extensive deployment of these networks that has allowed Spain to be at the forefront of credit card penetration and electronic payment even in the European Union. The first card reader, which allows card payment to be validated through a data connection accessed by telephone network, was installed in Spain in 1979.

I am not exaggerating when I say that data networks laid the foundations of what has historically been Telefónica's privileged business relationship with large customers and its position in the world of IT services: Telefónica I+D, Telefónica Sistemas, Telefónica Data, Telefónica Soluciones, TIWS, Tech, ... they have been the Group's vehicles that have provided support and continuity to the evolution of this strategy.

2. When we were making technology

The second achievement of this chapter is even more unimaginable: Not content with being the first in the world with public data networks, in 1978 the TESYS Project (Telefónica, Secoinsa, and Sytre) was launched to develop their own nodes for data networks.

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There are several reasons why we decided to develop our own technology:

- Strategic independence: There weren't too many technological alternatives, which left the business exposed to support, continuity, and price issues.
- Technological know-how: With RSAN's experience, Telefónica is at the forefront of ITU (then CCITT) in the specification of the new packet standards and fundamentally the X.25 protocol.
- Commercial opportunities for export: opportunities that materialized as TESYS was exported to Argentina, Canada or Greece.

In 1982, the first TESYS node went into service and in 1985 X.25 service was being provided. The public data transmission network, powered by TESYS, is now commercially renamed IBERPAC...

The explosion in the number of connections and the increase in their speed immediately made the TESYS technology small and the development of the next generation was launched: TESYS-B. TESYS-B ended up being one of the star projects of the newly created Telefónica I+D and was a second-generation node that multiplied the capacity and included multiprotocol, physical multi-interface, distributed process, and router capabilities. The first TESYS-B node was operational in 1991. [Videotex and telematics services].

3. UNO Network: From Technology to Services

Despite the technological solvency of TESYS and TESYS-B, in the early 90s it became clear that, in terms of withstanding constant technological evolution, only manufacturers that were able to work in global markets would be economically viable, which in turn would require international marketing and support models.

In addition, and simultaneously, and coinciding with regulation in many countries, global operators began to discontinue or segregate their technology units (probably the most successful being AT&T's that gave rise to Lucent in 1996, now integrated into Nokia) and focused on operating networks and providing services with third-party technology: More specialization and more efficiency, at the price of no longer having our own technology.

With this breeding ground and with the reality that there were other similar and even more advanced technologies in management tools (provision, pricing, SLAs), the decision was made to build the successor of IBERPAC with technology from Nortel Networks: The UNO network (early nineties) first with DPN-100 and then with Passport Nodes.

Throughout the 90's, Red UNO was a data network practically specific to large customers, constantly and rapidly growing and evolving:

- More than a 100-fold increase in the number of connected sites
- With urban, regional and national grids that guaranteed maximum availability

- With access speeds that evolved from 1200 bps to 622 Mbps
- Incorporating the successive protocols relevant in the business world: X.25, Frame-Relay, SNA, ATM... even a protocol that would end up sweeping away all the others and that was called IP.
- The convergence of voice with data has begun, with the first experiences of voice transport over data networks

At the same time, the potential of data networks for the consumer market was beginning to be sensed. In 1990, for example, the Videotex (Ibertex) service began to be marketed, a prehistoric precursor of the world wide web, which allowed information to be consulted on-line. It was slow, very limited in graphics and required a specific terminal, but it allowed you to consult weather, stock market, current affairs, etc. Although adoption in Spain was not strong, compared to other countries in our environment (France had several million Minitel terminals), it was clear that there would be great growth here in the future.

In the mid-1990s, it seemed that the future was defined by a multi-service, enterprise-specific, multi-protocol network with expensive, high-speed access. It seemed that residential customers would never have the same needs or be able to afford those prices. And that the needs of these residential customers would be followed and met with services that we would design in the operators.

But the future had other plans.

4. The Internet and Infovía changed everything

To understand how data networks evolved after the 1990s, we need to look at how the Internet evolved in Spain during the 1990s. An ISP has an Internet connection and a bank of modems connected to lines on Telefónica's network. A user with a computer and a modem could make a phone call to the ISP and once the modems were connected to each other over the voice network, the user was connected to the Internet to receive emails, search for information, participate in forums, etc.

In 1995, Telefónica launched Infovía. Infovía allowed users to connect via modem to different telematics service providers, including Internet service providers. Infovía sets up an infrastructure that achieves two things:

- The cost for the user of the connection to Infovía is the same throughout the territory
- That of a call to 055 that is charged as an urban call
- The ISP has access to customers throughout the national territory with nothing more to connect
- In one place as an Infovía provider

On the one hand, the Infovía architecture ensures that internet access is quickly democratized, as it has the same cost throughout the territory, and on the other hand, that the costs of setting up an ISP are minimal, so that Spain becomes the country with the most ISPs in the world.

But Infovía's architecture was not replicable by a third party that did not have the network, so the prevailing winds of liberalization and regulation forced us to close Infovía and use solutions that can be set up by a third party through a data network and not just the incumbent. By connecting modem calls to a data network with a presence in all cities, they can be urban and transported over the data network without relying on special routing in the voice network only available to the "monopoly"; In just three years, Infovía was born, grew exponentially, triumphed and was dismantled to make way for Infovía Plus (1998).

This data network for Infovía plus, which was called NURIA (New Advanced IP Network) or UnoIP and has several important features:

- Convergence of voice and data: Taking into account the type of traffic that it was going to carry (IP traffic, since the origin/destination of this was the Internet), the entire network is IP in such a way that the waste of having to encapsulate with other protocols is avoided and it takes advantage of the fact that technological evolution was already clearly opting for much lower unit costs for IP and Ethernet than for other technologies.
- Convergence of the Internet and corporate networks: Not only ISPs but in general, companies, in addition to having their corporate networks, begin to want to connect them to the Internet, which begins to connect to the IP network. The next logical step for efficiency is to ask whether they can't do everything for a single network, and so begins the slow but inexorable convergence of enterprise networks towards IP networks and the Internet. An evolution of data networks begins, which will be consolidated into multi-service, multi-access and multi-protocol and serving different types of customers. The path to the Single Network started here.
- Convergence of residential and business accesses. Infovía Plus allows for the first time to access the Internet at speeds of 56 Kbps. This speed, which today is ridiculous, was double the maximum that existed to date. For the first time, the access available to a residential user is beginning to approximate what is available to businesses. This trend, which would later intensify especially with ADSL, is what has made it possible to multiply the demand for data connections with the consequent drop in price (a data connection of 64 Kbps was worth per month in 1998 the equivalent of what today would be €670, that is, 22 times more than what fibre access costs today, which is no less than 4800 times faster)

5. Those Wonderful Years

We are witnessing a period of constant change and exponential growth: of users, connections, speeds, applications. These were the years of the explosion of the Internet and las.com. The number of users doubled in... months.

There was a constant demand for higher speeds, which when they arrived enabled a better user experience and more applications, which in turn produced more demand and it seemed like it never ended. For those of us who planned the networks, it was both a dream and a nightmare: We always had to grow, add more capacity, more redundancy, more access... But at the same time, nothing you did was ever enough to meet the demand it deserved. I remember putting into service a new high-capacity line with the USA to improve the speed of the Internet and filling up to the brim as you put it into service. It's fair to say that it was difficult not to have occasional saturation and quality problems. It's time to think on a different scale...

It was necessary to create data networks not only thinking about companies but also about all customers: Much greater capacity and many more nodes and with an architecture capable of absorbing the explosion of speeds that was still to come with ADSL and fiber optics, which would make the speeds managed until then a joke: RIMA (Advanced Multiservice IP Network) is born. RIMA (2001) would be able to:

- Resolve Capacity Issues
- Absorb ADSL traffic
- Provide transportation for both Internet and Business services.
- For the first time in Spain we have a data infrastructure capable of supporting the growth of the Internet and at the same time supporting services for companies. The two main effects were:
    - Enabling the explosion of multimedia. For the first time, it is becoming practical and accessible to transport music, photos, video... The germ of the majority use of the Internet today.
    - Laying the groundwork for enterprise networks to abandon specific solutions (X.25, FR, ATM, etc.) and use the same technologies as the Internet: The democratization and unification of data networks continues.

6. Another twist: fibre and convergence with mobile networks

The escalation of speeds continued unstoppable. ADSL technology was maturing and 128, 256, 512 Kbps, 1, 2 Mbps... More and more apps, more video, etc. and bandwidth never seemed enough. Everyone was aware that ADSL had given the copper pair a second youth, but the technology had its limitations: It could never exceed more than a few tens of Megabits per second. There was only one technology that promised virtually unlimited capacity compared to ADSL: fiber optics.

The residential world would move to fibre more slowly, to meet the needs fundamentally driven by television, games and later *streaming*. But companies didn't want to wait: They needed future-proof data networks that would also allow them to carry voice, separated from the Internet for availability and security, and that could benefit from the cost reductions of using the same technology (Ethernet) as local networks. Thus, in 2006, Macrolan was born, which is still active and interconnects company headquarters at speeds that reach 10 Gbps (an order of magnitude faster than domestic fibre and more than 100 times faster than ADSL).

As for mobile networks, they spent many years being a barely testimonial part of data networks: the limitations of coverage and availability, the high cost and the speeds (always much lower than those that could be achieved with fixed means) relieved them to the category of anecdote, despite the fact that we fantasized that a day would come when their ubiquity and convenience would allow us to build networks dynamically and instantaneously.

The two niches initially solved by mobile networks were:

- Limited access to networks in areas with no other alternatives (e.g. rural).
- Backup solution for when fixed networks failed

Mobile networks were comparatively late to data. The first data in mobile networks are SMS in 1993, when data networks had already been around for more than 20 years, but they were quickly recovering the delay so that before 2000 the first experiences of internet connection were made and at the turn of the century, we can already see people dispatching mail in their Blackberries. This was followed by cellular POS terminals, whose connection to data networks has made it possible to now pay cashless practically anywhere, and routers with a cellular connection made it possible to integrate mobile access into data networks without any protocol difference.

The convergence of fixed and mobile services, dictated by the needs of customers, and which had its maximum exponent in the Movistar Fusión range, is also being applied to networks, and data networks in particular, made possible by two factors:

- The network architecture, which differentiated the access from the transport, made it possible to integrate mobile data accesses as one more access, without difference from the existing ones.
- By now, the IP protocol has become the only de facto standard in the various networks.

Thanks to these two factors, the mobile data network is easily integrated into RIMA and the data networks already integrate all types of access: copper, fiber, cell phones...

7. There was life after the IP

The next major evolution of data networks is the concern of large companies to keep their traffic independent of the Internet, both in terms of saturation and security, as well

as the need to provide different quality to different types of traffic (for example, video needed different delay requirements than the display of a web page). The technology that is rapidly gaining ground to meet these requirements is called MPLS (Multiprotocol Label Switching) and it displaces pure IP solutions and becomes the reference solution – expensive, but of the highest quality and security – for large corporations.

"Expensive"... Here was the problem. Those in charge of the companies' data networks saw that at home they enjoyed great internet access speeds for a few tens of euros per month, while data network connections had much higher prices. Couldn't those connections be lowered? And if it couldn't, was there a way to use Internet access to make data networks, and make them cheaper and universal?

The cost problem wasn't just limited to access. The equipment that had to be placed in the customer's home had to be as sophisticated (and expensive) as the networks, and setting it up often required the deployment of specialized (also expensive) technical personnel.

In addition, no headquarters, no matter how small or remote, can function without being connected to the corporation, even if it is in the most backward or distant country or even if it is a mine in the middle of the desert. There is a need to integrate different accesses of different qualities and speeds and with different technologies into data networks.

To solve all these problems comes the next wave of technology: software-defined networking (SD-WAN). In essence, it is that the functionalities of the network are provided through a single centralized program that controls, configures and monitors the accesses that can therefore be more "dumb", diverse and cheaper. Security is achieved with encryption, the different routes with "tunnels" between the headquarters and also different traffic can be treated with different quality, and decisions can be made in real time in case of congestion. Finally, being able to change configurations centrally also makes installation and changes cheaper.

In 2015 Telefónica began to implement SD WAN projects for large customers and in 2017 launched FlexWAN, its standard service for this type of network.

8. SMEs

As we have seen, the history of data networks has been evolving, driven by the needs of large enterprises. Price and technological sophistication have been the two factors that have historically limited the penetration of these technologies. Telefónica was always aware that it needed to design cheap and simple services if it wanted to meet the needs of these customers. But that was easier to be said than done. It was not until ADSL burst onto the market, with what it meant in terms of cheaper access, that it was possible to design and market a specific data network service for these customers. This is Netlan (2002), almost 30 years later than the first networks for banks.

Since then, the adoption of this type of solution in SMEs has been increasing, led by the hospitality, retail and industrial sectors, as well as the speeds available, as fibre optic technologies have been introduced.

Data networks in SMEs have been part of the effort to integrate and simplify the offer with the different Movistar Fusion ranges, in which these solutions were combined with fixed and mobile voice, applications and cloud services to meet all the technological needs of these customers. In 2021, Fusión Digital Pymes was launched and just one year later the service already has more than 16,000 connected offices in Spain.

Finally, the needs of SMEs in terms of protection against cyberattacks are even more pressing than for large companies, due to the impossibility of having security specialists working for them. The offer of data networks for SMEs in a hurry (2021) is completed with "Your Secure Company", a service that protects the access and devices of SMEs.

9. International expansion

At the beginning of the 1990s, Spain was in the midst of an accelerated process of economic modernization, with integration into the European Union. The economy is abandoning decades of economic isolation, in a global context in which what we know today as "globalization" is beginning. Companies embark on international expansion and despite the growing importance of Europe in the Spanish economy, culture, history and language produce a strong attraction of Latin America for these companies, and a very important part of the initial internationalization effort takes place there.

Telefónica is no stranger to these transformations and is also beginning its internationalization process. The vision of "international network" or "world network" was articulated for the first time during the presidency of Cándido Velázquez (1990-1996) and from here began the incessant internationalization that led it to be the global company we know today. Telefónica is acquiring stakes in other operators (Chile, Peru, Puerto Rico, Brazil, etc.) that, although less technologically developed than the Spanish company, will provide it with the basis to continue being instrumental in the modernization of companies, from two points of view:

- Rapid export of data services that already existed in Spain, with a major modernization effort by Latin American operators. As an example, Infovía was launched in Argentina in 1997, just over a year after its launch in Spain.
- Development of an international infrastructure with its own assets and participation in Submarine Cable Consortia on which the same national services that had been developed in Spain and other countries will be deployed, but with a multi-country scope.

This international network will provide companies that are globalizing with the same services that they had on a national scale, accompanying them in their expansion and in some way enabling it. This international network will be managed by TIWS (Telefonica International Wholesale Services), now Telefonica Global Solutions.

The international network started timidly with 2Mbps satellite links, with nodes in Madrid, London, New York, Miami, Chile, Argentina, Brazil and Peru, in the 90s, and later on our own submarine cable infrastructure, SAM-1, and in 2002 it was already an IP network that interconnects 17 countries with 10 Gbps links. In 2005 the network already had points in 40 countries.

The first and main clients of this international network are once again the large Spanish banks, which are soon joined by hotel chains, oil companies, etc. And little by little, companies from all sectors of activity are joining.

The evolution of international services is rapidly introducing all the technological developments of national networks: MPLS, SDN, ADSL and fibre accesses, and the international virtual private networks of large customers are including connections to large data processing centres, distribution of video content, etc.

Although initially most of the clients of these services were Spanish companies in their internationalization process, soon the clients began to be companies from all over the world. For example, in 2013 the contract to provide international services to the multinational Nokia is won, which is served in more than 100 countries.

To give an idea of the rapid evolution of the International Network, it is worth mentioning that the total traffic managed by Telefónica in its international network has multiplied by 2500 in just 20 years, reaching today 25 Terabits per second. The growth in the number of connections has been equally impressive, from a few dozen locations in the early 2000s to 40,000 international company locations worldwide, with connections with more than 160 operators.

10. What's Next?: SASE and 5G

Despite their almost fifty years of history and technological disruptions such as the Internet or fibre optics, data networks have been and continue to be constantly evolving. A perspective such as the one we have wanted to give here would be incomplete without pointing out the new changes that we are experiencing and will experience in the coming years.

1. Cybersecurity Embedded in Data Networks

The ubiquity of the internet, the use of cloud services, and the explosion of mobility and offshoring fueled by the pandemic... All of these trends have made data networks increasingly difficult to secure because they have a heterogeneous, changing, and inherently insecure perimeter or "attack surface." All this in a world where cyber threats – from information leaks or hijackings to denial of service or disabling of applications or servers – are becoming more real, frequent, sophisticated and costly. For this reason, since 2019 Telefónica has continued to be at the forefront of this evolution, offering networks in the SASE (Secure Access Service Perimeter) model, providing, as an indissoluble integral part of the network solution, security services in access to it.

2. Wireless Data Networks Finally

Freedom from the "tyranny of cable," i.e., being limited by the availability of adequate fixed access, has always been a dream for those who designed or operated data networks. This freedom came before voice communications or internet access, but data networks have much more demanding requirements in terms of bandwidth guarantee, availability, protection against saturation, security, etc. It is not in vain that they sustain the businesses and critical operations of the vast majority of the productive fabric.

Until now, cellular networks have not been up to the task of what data networks required. Fixed solutions have always been far ahead, especially in terms of access capacity ("bandwidth"). For the first time, 5G has enough capacity to provide the required capabilities, as well as to accommodate the myriad sensors required in industrial applications. In addition, 5G will have embedded the ability to reserve capacity in the network ("network slicing") for specific customer networks.

There are still years to go before the promise of 5G becomes a reality for data networks, mainly because of the huge investments that are needed to deploy 5G networks with sufficient coverage and capacity across the board.

But the technology is already available and its first applications are in the industrial environment. Manufacturing plants are now dimension-controlled environments (making deployment cheaper and simpler). On the other hand, they are environments of tremendous automation and real-time management. The algorithms that make decisions in factories depend on the ingestion of huge amounts of data that come from all kinds of sensors (from thermostats to computer vision from robots) that have to be captured, transmitted, stored and processed at high speeds.

11. The Nervous System of the Digital Revolution

In this journey we have traced the history of data networks and Telefónica's active involvement in their conception, deployment and evolution.

These networks have been fundamental for Telefónica: They have been the driving force behind the mastery, development and deployment of all the technologies (analog-to-digital conversion, internet, fibre optics, cybersecurity, to name just a few) that are now at the heart of all the services we provide to customers.

We have come a dizzying path in these 100 years and even more so if we think that in the case of data networks, this history only goes back to the last 50. In this time, we have gone from transporting voice to providing the highways for the digitalization of all company processes: their commercial, marketing, customer service, financial, tax and operational processes.

These highways now have a capacity, speed, reliability, reach, and sophistication unimaginable just a few decades ago. Neither the present nor the future can be conceived without these highways, just as no company can be conceived without

digitalization as a key to its sustainable competitiveness. If it is often said that computing is the brain of the modern company, data networks are its nervous system and just as essential for its operation. It is with a certain pride that I conclude by saying that in Telefónica, over these hundred years, with data networks, we have developed a future-proof nervous system for companies.

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