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WHITE PAPER

The Southern European interconnection landscape

TeleGeography
Authoritative Telecom Data

1. Introduction

The world of networking is undergoing a seismic shift in regard to how and where we interconnect. The emergence of new bandwidth-intensive applications and the mandates to deploy increasingly dense and distributed network infrastructure mandate that networks can no longer concentrate solely in traditional hubs. Rather, they must distribute resources to increasingly localized nodes.

Europe is no exception to this trend, and the need to shift and distribute network configurations has fostered significant demand for connectivity outside of traditional hubs and into increasingly localized sub-regions including Southern Europe.

When the Internet started, there was one major global converging point for networks across the globe – the U.S. As networks evolved and developed resilience, operators quickly realized that they could not converge on a single point of failure. Rather they needed multiple redundant paths to maintain consistent service and more localized hubs to reduce network latency and tailor localized demand for network access.

In response to these demands, traffic has shifted to more localized hubs. In Europe, these hubs include the so-called FLAP markets of Frankfurt, London, Amsterdam, and Paris. These places have the full mix of content, cloud, peering, and network services that mark the very largest of global hubs.

The current shift in global network configuration marks another major transition. As global hubs have matured, we now see increased demand for localization at a sub-regional level. Several factors influence this trend:

- **High cost:** While network and data center costs are competitively priced in some hub markets, others are incredibly expensive. Networks absorb the cost of interconnecting in these locations because their demand is relatively inelastic. They need to be in these places regardless of the expense. In Europe's FLAP markets, colocation prices are astronomically high, particularly in the densely interconnected market of Frankfurt, where retail colocation rates routinely rank among the world's highest by TeleGeography's estimates.

- **Network resilience:** Networks don't want to converge on a single point of failure. Many cloud and enterprise networks have a mandate to deploy in geographically separate zones to ensure service delivery. This causes many networks to look beyond the obvious regional hubs in determining where to interconnect.

- **Latency and proximity:** Perhaps one of the greatest reasons networks are increasingly interested in shifting away from complete dependence on major regional hubs is the fact that advanced networks and services will increasingly mandate deployments closer to the network edge. Bandwidth-intensive applications like gaming and video streaming already necessitate proximity to end users to optimize packet delivery. In the very near future, services like 5G, advanced cloud applications, sensor networks, AI, and self-driving vehicle platforms will require nodes to be deployed wherever there are population clusters. Even back-end computing services will need to be closer to edge locations as increasingly bandwidth-intensive applications are deployed to the network edge.

It's with this context that we turn to an evaluation of Southern Europe. Is this region ready to meet the challenges of the digital age? Is there sufficient investment in the region to address the growth of demand for increasingly localized interconnection infrastructure? Let's take a look at the dynamic growth taking place in this critical gateway between Europe and the rest of the world. We'll first assess the relative growth in demand for connectivity to Southern Europe and take a close look at where that demand is coming from geographically. We'll then evaluate the growth of infrastructure in key nodes throughout Southern Europe as the region rises to meet this demand.

First, let's define the scope of our geographic coverage for this study. For the purposes of this white paper, Southern Europe is defined to include the following countries and sub-regions:

- Bulgaria
- Greece
- Italy
- Portugal
- Spain
- Southern France

Specific metropolitan markets included in this assessment of Southern Europe include:

- Athens
- Barcelona
- Lisbon
- Madrid
- Marseille
- Milan
- Palermo
- Sofia

2. International Internet capacity

Southern Europe's international Internet connectivity gives us the clearest sense of the sub-region's influence on the global interconnection market. From the regional vantage-point, we can see both tremendous growth in international capacity and the diversity of the region's global reach. At the city-level, we will see that each market within Southern Europe plays a unique role in the wider region's influence.

Let's first look at the region-wide picture. As you can see in the figure on the right, Southern Europe's international Internet bandwidth has increased at a robust rate, compounding nearly 30% annually since 2016 to reach almost 150 Tbps. That's 2.75-times the capacity connected to the region five years ago.

Where does all the international bandwidth from this region connect? As with all other regional markets, it's no surprise that most of the capacity is intermeshed with other nearby countries. However, what's notable is the diversity of international Internet capacity shared by Southern Europe and regions beyond its proximity. The region's shared connectivity is reflective of its geographical position as a launching point to Africa, the Middle East, and beyond.

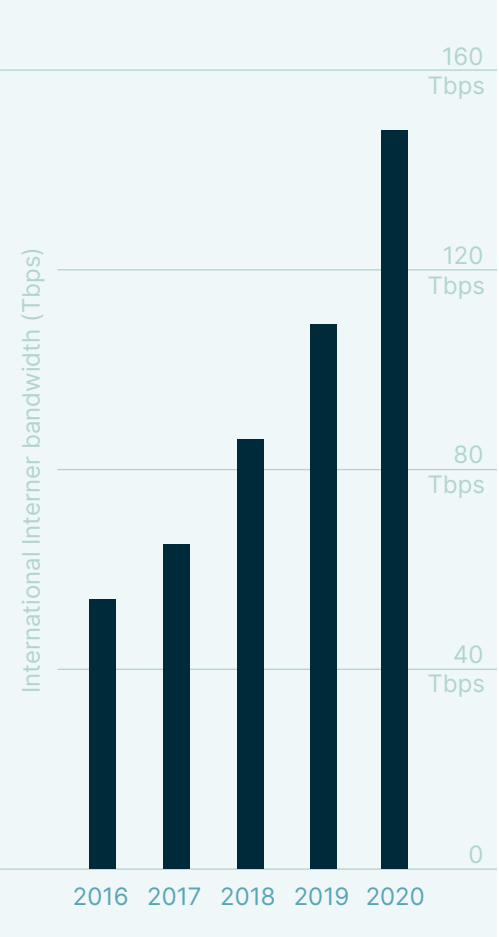
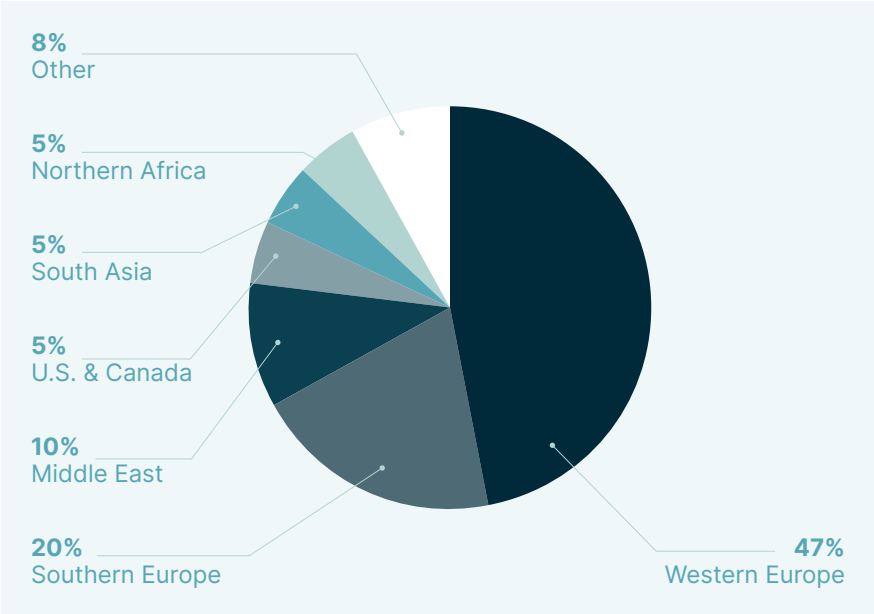


Fig 1. **International Internet bandwidth, Southern Europe,** 2016-2020 (Tbps)
Source: TeleGeography

Fig 2. Share of international Internet bandwidth connected to Southern Europe by sub-region
Source: TeleGeography



For several of these regions, Southern Europe serves as a major gateway for their own access to the global Internet. For instance:

- Nearly one-quarter of Sub-Saharan Africa's international Internet bandwidth is connected to Southern Europe.

- Fully one-third of the Middle East's international Internet capacity connects to Southern Europe.

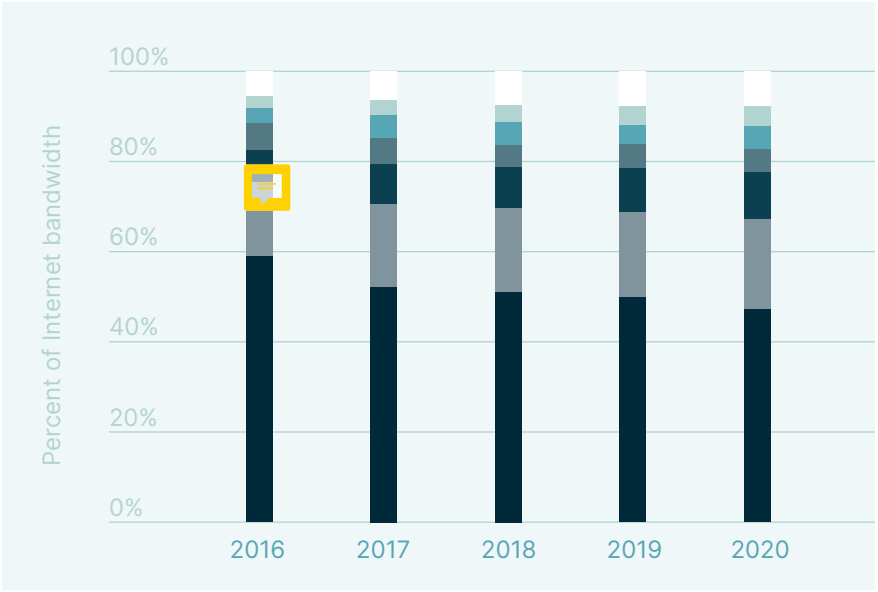
- North Africa is deeply interwoven with Southern Europe, with more than 80% of its international Internet bandwidth tethered to the region.

How has Southern Europe's international Internet connectivity shifted in the past five years? A couple of key observations stand out from the accompanying 100% stacked bar chart. For one, there's been a slight decrease in the share of international connectivity to other Western European countries and a slight increase in the share of intra-regional connectivity within Southern Europe. In 2016, 60% of Southern Europe's international Internet capacity linked to other Western European countries.

That proportion has fallen to less than 50%. At the same time, the proportion of cross-border Internet capacity connected between countries within Southern Europe has risen from 16% to 20%. This trend is consistent with TeleGeography's observations in other parts of the world. As interconnection ecosystems grow in increasingly localized markets, international Internet connectivity increasingly concentrates in more intra-regional areas of relatively close proximity.

Where have we seen the biggest growth in share of international Internet capacity for Southern Europe over the past five years? As it turns out, some of the fastest growth has been with the sub-regions that are most heavily dependent on Southern Europe. Southern Europe's share of capacity connected to North Africa has grown 14% compounded annually to reach about 6.7 Tbps. Its share of capacity connected to the Middle East has risen 10% compounded annually to reach 15 Tbps. As digital demand continues to accelerate in these regions, so too does their need to access gateways to the global Internet in Southern Europe.

Fig 3. Change in share of international Internet bandwidth connected to Southern Europe by sub-region
Source: TeleGeography

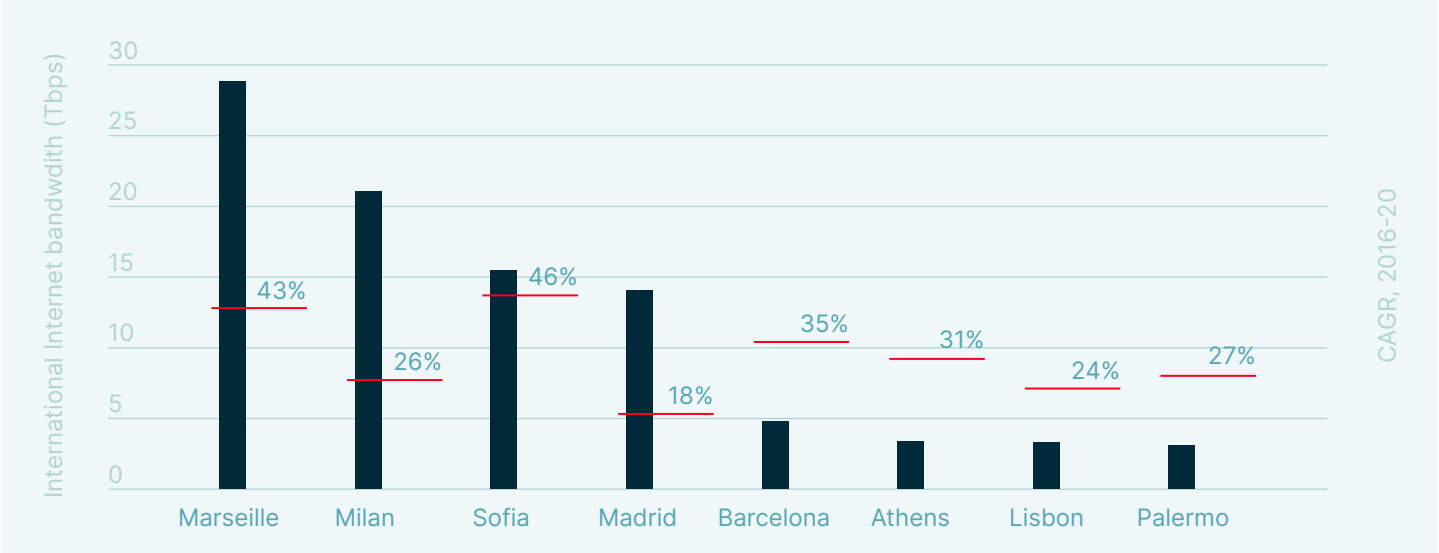


While only accounting for about 5% of Southern Europe's international Internet capacity, it's worth noting that the region's capacity with South Asia is growing at a faster clip than its capacity shared with any other region besides North Africa. Why South Asia? Because Southern Europe serves as a critical landing point for subsea cables spanning from Europe to the Indian subcontinent.

Let's shift our attention from the broader Southern European region to a closer examination of some of the emerging interconnection hubs within it. We'll start with a comparison of the international capacity connected to some of these markets, and then look at the distinctions of how each of those markets connect.

First, it's clear that Marseille is the single largest hub for international Internet connectivity in Southern Europe, with nearly 29 Tbps of bandwidth as of 2020. The city is also growing as a hub much faster than almost any other city in the region. That said, Sofia is the fastest-growing connectivity hub in Southern Europe, increasing at close to 50% compounded annually to reach 15.5 Tbps. Though much smaller, Barcelona's international Internet growth is also impressive at 35% compounded annually.

Fig 4. International Internet bandwidth by city (Tbps)
Source: TeleGeography

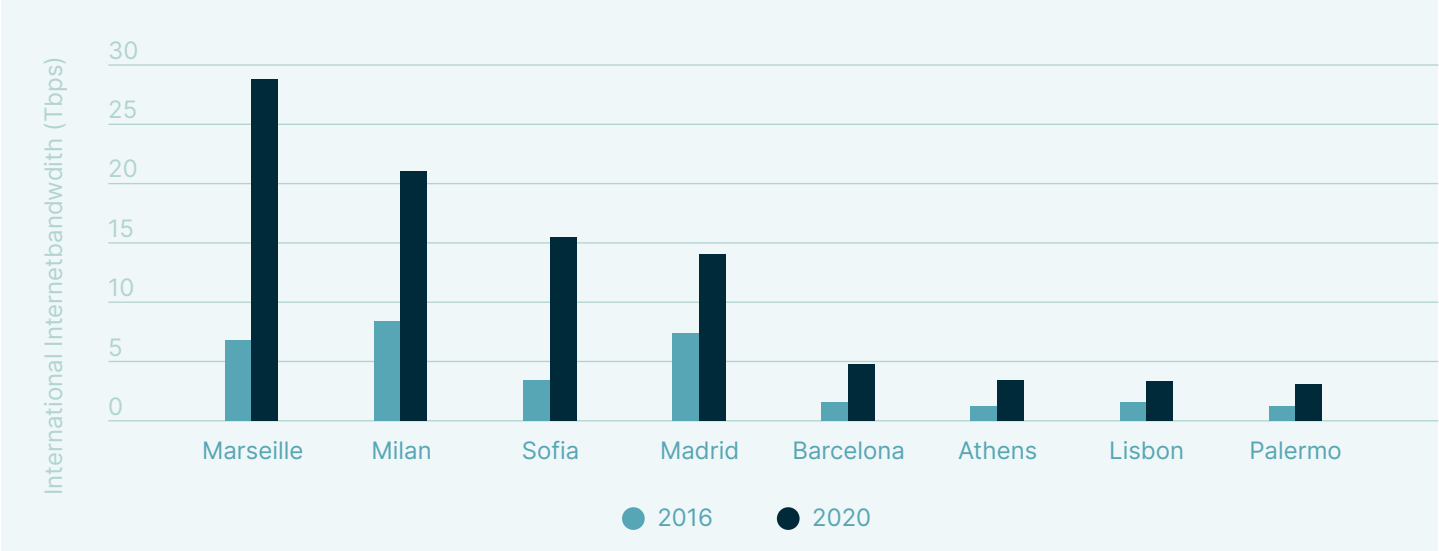


Marseille and Sofia are noteworthy for their positions in Southern Europe's broader communications markets. Following a rapid rise to hub status, Marseille is now firmly established as one of Europe's major Internet nodes, behind only the FLAP markets (Frankfurt, London, Amsterdam, Paris) and Stockholm in international Internet bandwidth.

On the eastern end of Southern Europe, Sofia has seen international carriers and content providers move in en masse. This has allowed the city to capture some bandwidth demand from the East that would otherwise move onward to Frankfurt. Sofia has become an important route destination for Central Asian and Middle Eastern countries like Turkey, Georgia, Azerbaijan, and Iraq. As a result, Sofia's international Internet bandwidth has experienced a remarkable 46% compound annual growth rate between 2016 and 2020.

The juxtaposition of the amount of international capacity connected in these markets five years ago versus 2020 creates a truly stark contrast. Again, this visual highlights the particularly stunning transformation of Marseille and Sofia since 2016. Both markets have more than quadrupled their international Internet capacity in that timeframe. In fact, every market depicted at least doubled its capacity between 2016 and 2020.

Fig 5. International Internet bandwidth by city, 2016 vs 2020 (Tbps)
Source: TeleGeography

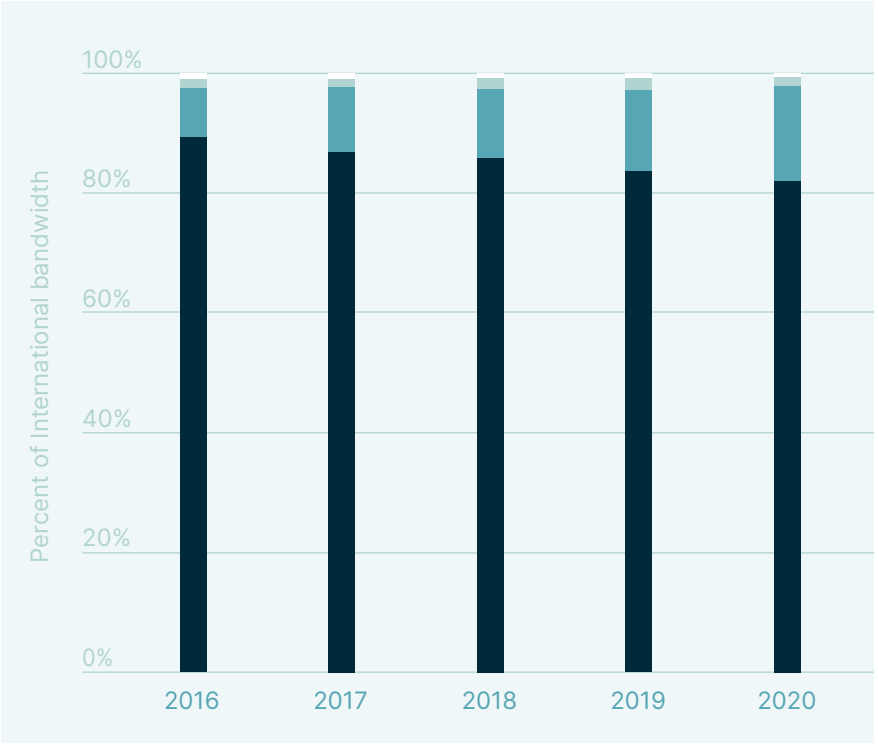


Next, we'll examine specific hub cities in Southern Europe and where they're connected to, giving us a much richer view of the full scope and diversity of the region's growing reach.

Lisbon's international connectivity

Let's start with Lisbon. Long a pivotal landing for subsea cables spanning Africa to Western Europe, its importance for Sub-Saharan African connectivity has grown over the past five years. In fact, the amount of Internet bandwidth connected between Lisbon and Sub-Saharan Africa has grown 46% compounded annually since 2016, nearly twice as fast as growth between Lisbon and any other region. As a result, Lisbon's share of capacity connected to Sub-Saharan Africa has doubled to 16% since 2016, as seen in the accompanying chart.

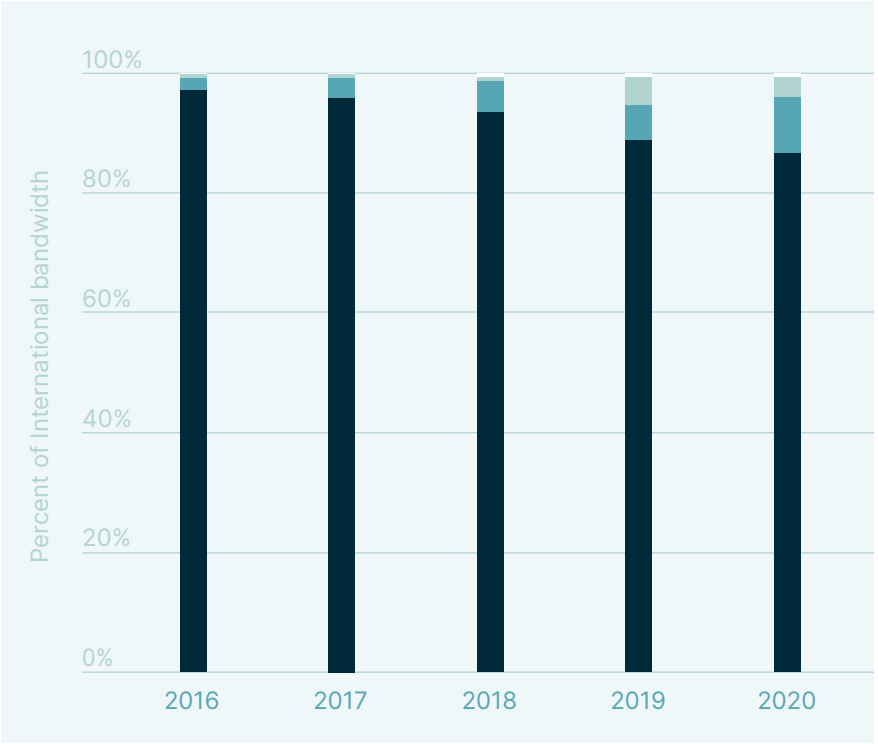
Fig 6. Share of international Internet bandwidth connected to Lisbon by sub-region, 2016-2020
Source: TeleGeography



Madrid's international connectivity

Turning our attention northeast of Lisbon, Madrid's international Internet landscape has seen a significant shift since 2016. While the city's international connections outside of western Europe were negligible just five years ago, its connections to North Africa have accelerated more than 70% compounded annually and now account for nearly a 10% share of Madrid's international connectivity. Increasing capacity between Madrid and the Americas is also emerging.

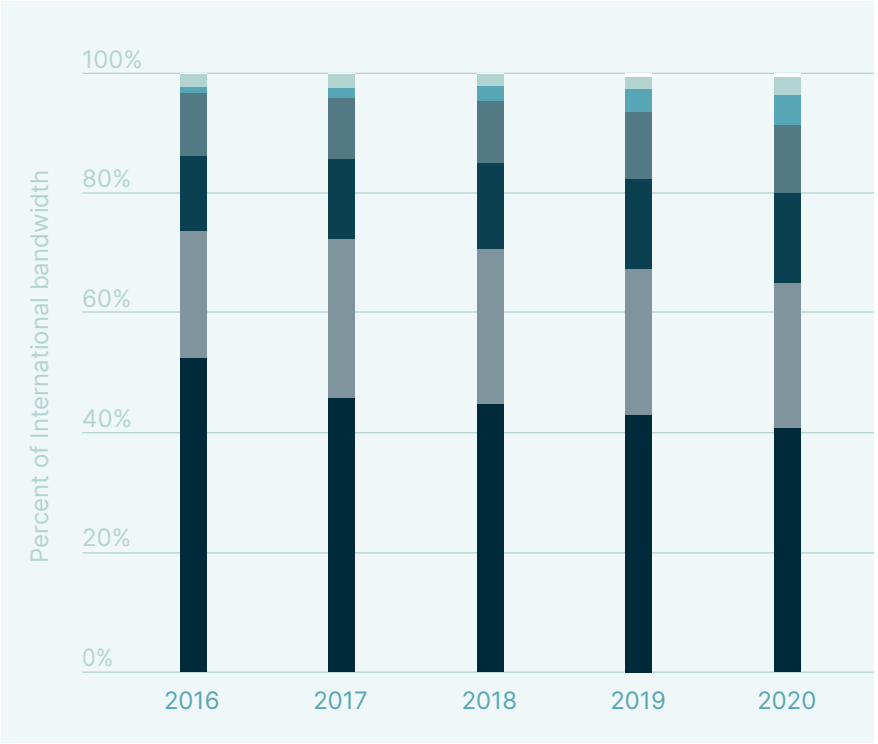
Fig 7. Share of international Internet bandwidth connected to Madrid by sub-region, 2016-2020
Source: TeleGeography



Marseille's international connectivity

Within the broader Southern European interconnection market, the rise of Marseille has been exceptional. With the confluence of inter-regional subsea connectivity, carrier neutral data centers, Internet Exchanges, and cloud ecosystems, the market has transformed into something of an edge European hub for networks from the Middle East and North Africa, while also serving as the key European interconnection node for cables spanning Europe to Asia. As seen earlier in this section, not only is Marseille's amount of international Internet capacity impressive, but its growth has been almost unrivaled in Europe as a whole. This growth in international capacity has been heavily focused outside the region. As a result, Marseille's share of international Internet bandwidth connected to other Western European countries has fallen from more than half just five years ago to about 40% as of 2020. The major drivers of the city's growth have been South Asia (the Indian subcontinent), the Middle East, and North Africa.

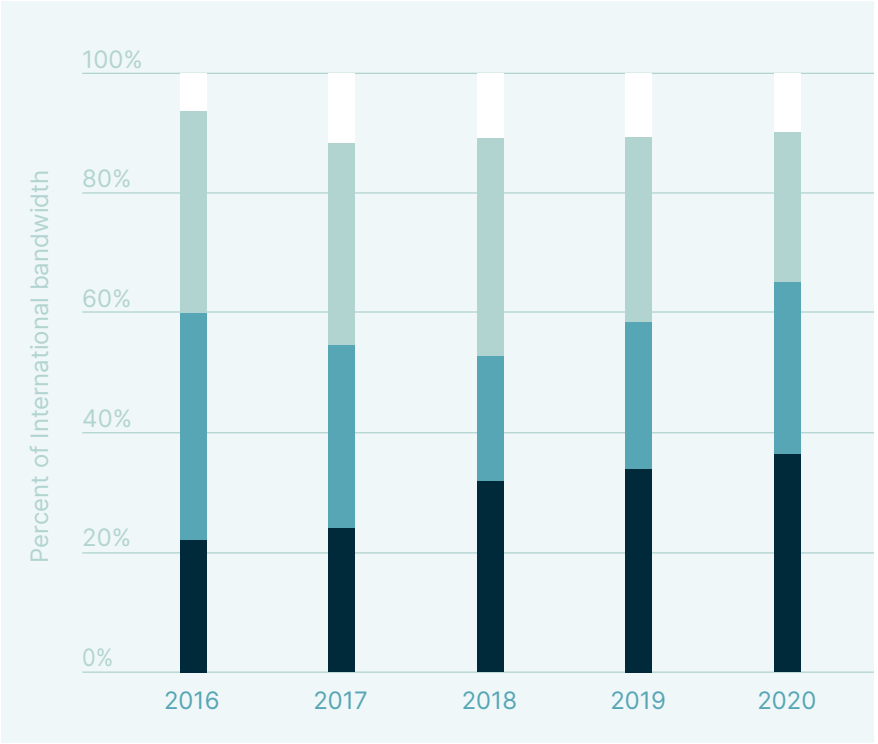
Fig 8. Share of international Internet bandwidth connected to Marseille by sub-region, 2016-2020
Source: TeleGeography



Sofia's international connectivity

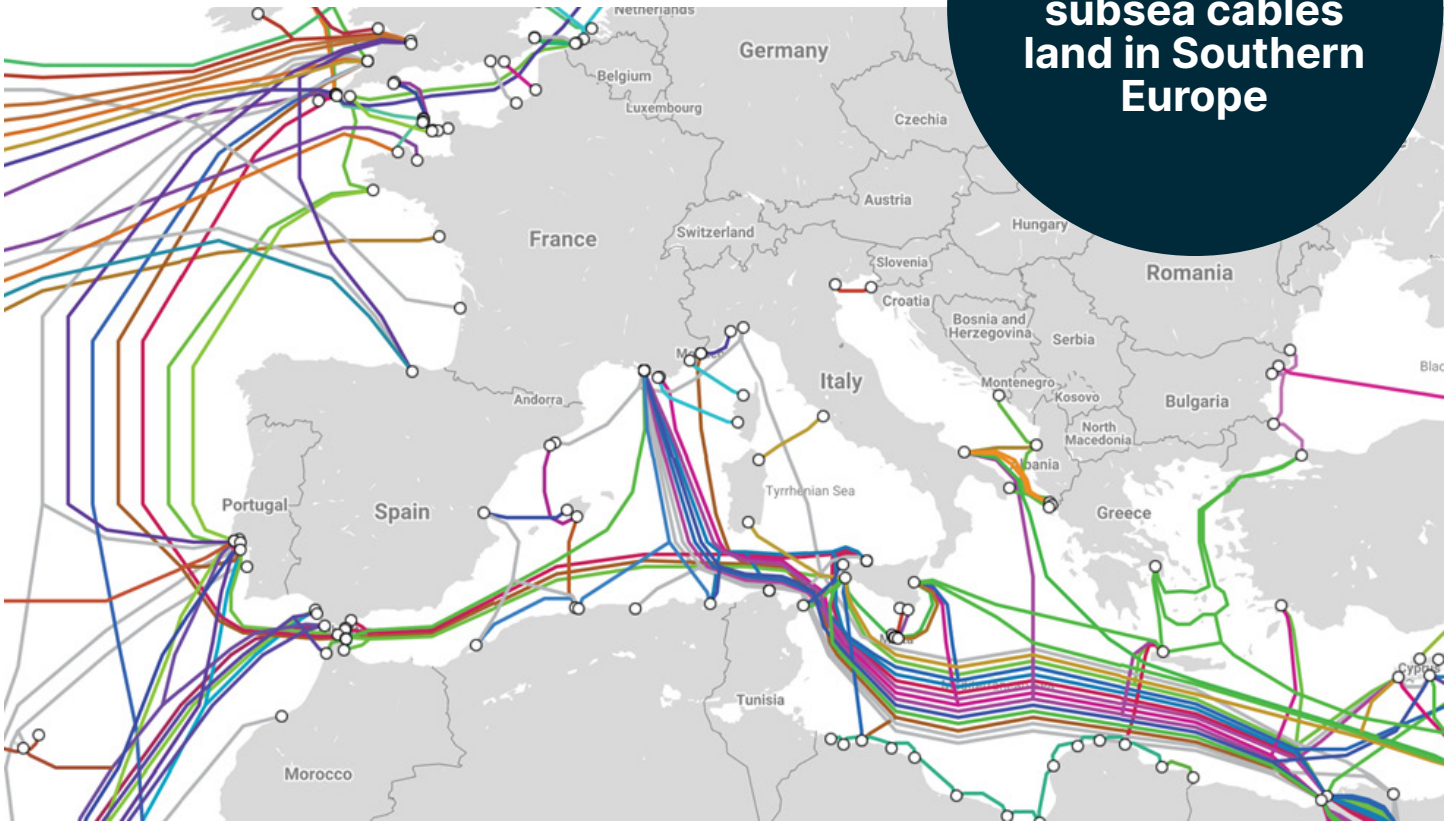
Sofia is unique among Southern European hubs in that its largest share of international Internet bandwidth isn't connected in Europe at all, but rather to the Middle East. Its capacity with the Middle East is also growing faster than to any other destination, at more than 65% compounded annually. As a result, Sofia's capacity to the Middle East grew from only about 20% of its total international capacity in 2016 to nearly 40% as of 2020. Sofia's next fastest-growing regional market? Its connections to Central Asia are growing far faster than its capacity connected to either Western or Eastern Europe.

Fig 9. Share of international Internet bandwidth connected to Sofia by sub-region, 2016-2020
Source: TeleGeography



3. Submarine cable connectivity

44
international subsea cables land in Southern Europe



Let's turn our attention to the underlying supply fueling growth in bandwidth demand in Southern Europe. The region is a focal point for many international submarine cables. At the end of 2020 there were 44 international submarine cables connected to Southern Europe, with another 7 cables planned. Beyond these planned cables, many others are in advanced stages of development.

Submarine cable connectivity to the region can be divided into a few primary routes.

Transatlantic

Prior to 2018, only 2 Transatlantic cables connected Southern Europe: Columbus-III and Atlantis-2. Columbus-III originally connected Florida with Portugal, Spain, and Italy. However, in December 2020, the cable was decommissioned except for the segment connecting Azores to mainland Portugal. Atlantis-2 was also activated in 2000 and remains in service linking Portugal and Brazil.

A new generation of cable has emerged to replace these aging systems and provide a huge capacity boost.

- **MAREA** – Facebook, Microsoft, and Telxius own this cable, which entered service in 2018. MAREA is the first Transatlantic cable to land in Bilbao, Spain. It is capable of 224 Tbps.

- **EllaLink** – the EllaLink cable will provide direct PoP to PoP connectivity between Brazil and Portugal by Q2 2021. The cable is capable of 100 Tbps. The privately-owned system has 2 spurs that run from the main route to Funchal, Portugal, and Praia, Cape Verde along with stubbed BUs for eventual connectivity to Morocco, Mauritania, the Canary Islands, French Guiana, and São Paulo. Ellalink's systems design includes terrestrial links to Madrid and Marseille. EllaLink will provide dramatically lower latency between Latin America and Europe than was previously possible.

- **Grace Hopper** – Google's privately-owned Grace Hopper cable will link the U.S. to the U.K. and Spain in 2022. The cable will feature 16 fiber pairs and be capable of 352 Tbps.

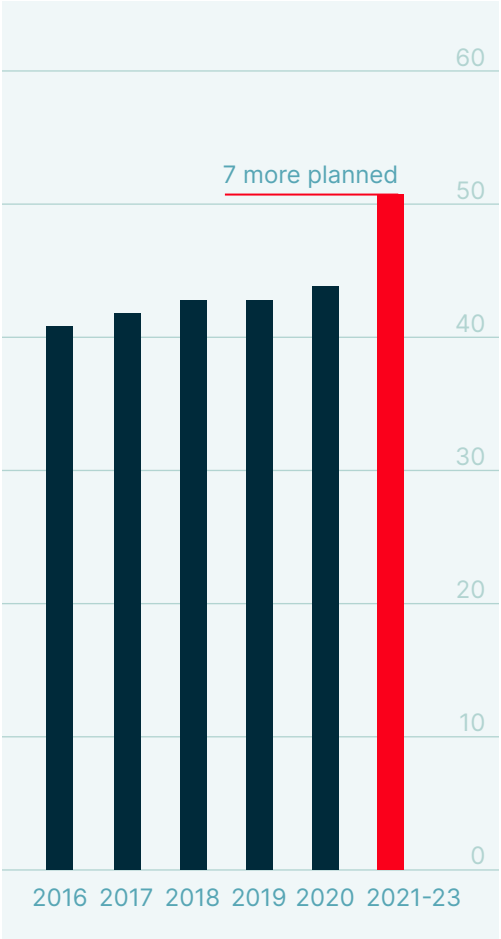


Fig 10. Number of international submarine cables connected to Southern Europe, 2016-2023
Source: TeleGeography

Southern Europe-Asia via the Middle East and East Africa

As noted above, Southern Europe is the primary gateway for international connectivity for the Middle East and East Africa. Most of the bandwidth connecting these regions is provisioned on systems that span between Southern Europe and Asia. Several new projects in the pipeline are expected to add capacity from Southern Europe to the Indian subcontinent, with major branches providing further direct connectivity to Africa and the Middle East.

- **PEACE Cable** – This privately owned cable is expected to launch in late 2021. The cable will stretch between Pakistan and Marseille, with extensive branch coverage down the east coast of Africa. In Pakistan, the cable will connect to the recently-activated Pak-China terrestrial fiber optic cable project along the China Pakistan Economic Corridor (CPEC), enabling full Europe-East Asia connectivity bypassing India.

- **Blue-Raman** – Another important project in the works is the Blue-Raman system, which plans to connect Italy and France to India. The system is backed by Google, Telecom Italia Sparkle and Omantel. When completed, this project will offer the first India-Europe route to bypass Egypt. The timeframe for completion of this system is uncertain.

- **Africa-1** – this cable, owned by a consortium of carriers, has a remarkably similar footprint to PEACE. The cable will also connect Marseille to Pakistan with landings in the Middle East and branches to the East Coast of Africa. Unlike PEACE, the cable will extend all the way down to South Africa.

- **2Africa** – Facebook is leading a new African submarine cable consortium project planned to extend 37,000 kilometers, linking 23 countries in Africa, the Middle East, and Europe (Italy, France, Spain and Portugal). Designed to encircle Africa on the east and west coasts, plus the Mediterranean, the cable also has planned landings in Saudi Arabia and Oman in the Middle East.

- **India Europe Xpress (IEX)** – Indian carrier Reliance Jio, along with several content provider partners, is planning the IEX cable to link India to Europe. RFS for the cable is uncertain. Jio is also developing the India Asia Xpress (IAX) between India and Singapore, thus bringing two systems online that would provide a full path between Europe and East Asia.

Beyond these cables, there are numerous other cables planned that will connect Southern Europe to the Middle East, India, and beyond.

Southern Europe-West Africa

Unsurprisingly, West African submarine cable connectivity is heavily focused on the Iberian peninsula due to its proximity. Portugal is a landing for most major West African cables, including WACS, ACE, MainOne, and SAT-3/WACS. New cable investments are coming which will continue to augment Portugal's role as a major hub for West African cables:

- **Equiano** – Google plans to build the Equiano cable linking Portugal to multiple landings along the west coast of Africa, including Nigeria, Namibia, Dem. Rep. of Congo, South Africa, as well as St. Helena. Additional branches for the cable are planned.

- **2Africa** – as mentioned above, this consortium cable's footprint is massive in scope. The segment along the west coast Africa will connect 8 countries to Portgual as well as the U.K.

Southern Europe-North Africa

North Africa is entirely dependent on subsea connections to Southern Europe. While some of the major Europe-Middle East and Asia systems have branches that connect to North African countries, such as EIG and SeaMeWe-4, the newer cables, such as SeaMeWe-5 and AAE-1, completely bypass landing in North African countries (other than Egypt). North Africa also relies on smaller, dedicated systems – such as Atlas Offshore for Morocco, ALPAL-2 for Algeria, Didon and Hannibal for Tunisia, and Silphium for Libya – that connect to Southern Europe. EllaLink's stubbed branching unit to Morocco will add further connectivity between these sub-regions on a diverse path.

Egypt is clearly at a different level here. Given the fact that all Europe-Middle East-Asia cables cross Egypt, the country has a diverse array of cable connections to France, Italy and Greece.

4. Data center development

Data centers are the housing that shelters and supports the world's interconnection fabric, and Southern Europe has seen significant investment in this critical infrastructure over the past five years. By TeleGeography's estimates, the number of colocation data centers in our grouping of key metropolitan markets across Southern Europe has increased 20% since 2016 to exceed 55 sites as of 2020. By way of comparison, the much larger FLAP markets, which have at least 270 colocation sites, have seen a slightly slower increase of about 16% in the same period.

Fig 11. Data center ecosystem deployments in select Southern European metro areas
Source: TeleGeography

	Data center ecosystem
	Major data center providers
Athens	Interxion/Digital Realty, (Lamda Hellix)
Barcelona	Adam, Colt DCS, Equinix
Lisbon	Equinix (frmr Itconic)
Madrid	DATA4, Colt DCS, Equinix, Interxion/Digital Realty, Global Switch, Nabiax (frmr Telefonica), NTT GDC
Marseille	Interxion/Digital Realty, Jaguar Networks
Milan	DATA4, Equinix, Keppel, IRIDEOS, SUPERNAP, Vantage
Palermo	TI Sparkle
Sofia	Equinix, Neterra, TelePoint

Note: As of May 2021, NTT and Vantage are not yet operational in these markets.

As can be seen in the table on the previous page, the network of Southern European colocation data center sites comprises a tremendous mix of local and international providers. In several cases, international operators have aquired critical local assets in order to establish presence in these locations. Let's take a closer look at some of the individual market developments.

Interxion enters Athens

In November 2020, Interxion, which had recently merged under Digital Realty, itself acquired Lamda Hellix, the primary interconnection data center provider in Athens. The company made an entrance into another Southern European market in the same timeframe with its purchase of Altus in Zagreb, Croatia.

Equinix enters multiple markets through Itconic

Equinix made its first foray into several Southern European markets in September 2017 with its acquisition of Spanish operator Itconic. The purchase gave Equinix initial sites in Barcelona, Madrid, Seville, and Lisbon. Several of these sites are focal points for carriers, cloud onramps, and Internet Exchanges.

Continual growth in Madrid

Madrid is one of the very largest interconnection markets in Southern Europe, and it has seen continuous activity in its data center sector. Aside from Equinix's entry in 2017, the investment group Asterion purchased 11 Telefonica data centers in 2020, including two sizable facilities in Madrid, and rebranded the portfolio as Nabiax. Regional

operator DATA4 deployed 5 MW in 2020 on a campus that will ultimately host four modular sites with 20 MW of IT power. Interxion has seen aggressive growth in Madrid, opening the first phase of its third site in the market in June 2019 and closing out its third and final phase within a year. The company is moving forward with a 4th site that will ultimately provision 15,000 square meters of colocation space and 30 MW of IT power.

NTT Global Data Centers (GDC) is poised to enter the Madrid market as well. The company is currently deploying its Madrid 1 facility, which is slated to go live at the Europolis Business and Technology Park in Q3 2021 with 3,600 square meters of colocation space and 6 MW of IT capacity. NTT has cited Madrid's status as a European global gateway and converging point for new subsea cables connecting with the US, North Africa, and Latin America as pivotal to its investment in the market.

Interxion relentless in Marseille

Interxion's expansion in Marseille has been no less relentless than its growth in Madrid. Having launched its third site in July 2020, the company expects to close out its third and final phase by the end of 2021 and will start the construction works for its fourth data center in Marseille, MRS4. The first phase of MRS4 is planned for Q2 2022.

International operators expand in Milan

Another of Southern Europe's largest interconnection markets, Milan is undergoing new investment from international data center operators. In early 2021, Equinix opened its fourth facility in the market (ML5). Vantage Data Centers intends to build out a massive campus,

ultimately comprising four sites, in support of cloud and hyperscale development in the Milan market. Its first phase is slated to be operational in 2022.

Local and international investment in Sofia

Both Telepoint and Equinix have recently added to a growing ecosystem of data centers in Sofia. Telepoint already operates one of the most critical interconnection ecosystems in the market and added a second site, Telepoint Sofia East, to its local portfolio in November 2018. Equinix added its own second site to the market in March 2019.

5. Cloud development

If cloud network investment is a bellwether for immediate market demand (and it is), then we are witnessing a surge in demand for access to Southern European markets. More than other types of investments, cloud infrastructure is deployed in response to tangible, current constraints in serving local populations. Cloud providers have to distribute network access across increasing numbers of edge nodes in order to provide acceptable levels of service to growing customer bases. To accomplish this, cloud providers first deploy one or more onramps to new locations – small edge locations in colocation facilities, where networks can interconnect with them for dedicated backhaul to larger cloud facilities elsewhere. Once demand reaches an inflection point, cloud providers will move into a new market with full-blown cloud regions, which consist of redundant zones each containing at least one data center deployment. When cloud providers invest in onramps and cloud regions, it's not speculative. It's based on tangible demand.

In Southern Europe, major global cloud providers have already established onramps in numerous markets, and now they're starting to deploy cloud regions across the same markets. Take a look at the accompanying table.

	Cloud ecosystem	
	Major cloud onramps	**Major cloud regions**
Athens	Microsoft	Microsoft
Barcelona	Google	-
Lisbon	Google	-
Madrid	Amazon, Google, Microsoft, OVH	Amazon, Google, Microsoft, OVH
Marseille	Amazon, Google, Microsoft	Microsoft
Milan	Amazon, Google, Microsoft, Oracle	Amazon, Google, MIcrosoft, Oracle
Sofia	Google	-

Notes: Table only depicts deployments by the largest global cloud providers. Companies in red indicate planned deployments.

Fig 12. Cloud ecosystem deployments in select Southern European metro areas
Source: TeleGeography

Until now, there have been few cloud region deployments in Southern Europe. Between 2018 and 2020, only one cloud service region had been deployed in the region – Microsoft's France South deployment in Marseille, which serves as a disaster recovery location for France Central in Paris. Amazon added its cloud region in Milan in April 2020. Milan and Marseille have arguably been the focal points for cloud services in the region up to this point, given these data center investments and the presence of multiple onramps in both locations. While it hasn't yet deployed cloud regions in Southern Europe, it's notable that Google has covered nearly all of the major metropolitan markets here with onramp nodes. We'll discuss the future deployments highlighted here in red in the conclusion of the paper.

6. Internet Exchange market development

Source: Internetexchangemap.com. Figure depicts individual building nodes for IXs throughout the region.

Internet Exchanges are the fabric that weave together interconnection ecosystems. They create network communities clustered around geographical focal points and expedite the process of building peering connections. Internet Exchanges serve as primary building blocks of the Internet itself. As the demand for network connectivity pushes to increasingly localized places, so too does the demand for distributed peering nodes. In fact, high-demand content and cloud networks examine a locality's peering opportunities as a primary consideration in determining whether or not to deploy to a new market. When entering a new location, these networks have a mandate to peer with a multiplicity of networks – preferably through multiple exchanges.

So what is the state of peering in Southern Europe? It's changed dramatically in the last five years. In the markets we're tracking for this study, the number of locally based exchanges has jumped 47% from 15 to 22 since 2016. Nearly all of these new exchanges have been deployed by DE-CIX or Equinix. For comparison's sake, the FLAP markets (which have far bigger exchanges) have seen a 58% increase in the number of locally based exchanges in the same time period, growing to just under 20 exchanges.

Fig 13. IX ecosystems in Southern Europe, April 2021
Source: TeleGeography

	IX ecosystem		
	Number of local IXs	**Peak traffic (top IX)**	**Number of members (top IX)**
Athens	2	285 Gbps (GR-IX, 2009)	53 (GR-IX, 2009)
Barcelona	2 (1 planned)	88 Gbps (CATNX, 1999)	42 (CATNX, 1999)
Lisbon	3	34 Gbps (DE-CIX, 2018)	49 (DE-CIX, 2018)
Madrid	3	1,130 Gbps (Espanix, 1997)	200 (DE-CIX, 2016)
Marseille	3	127 Gbps (DE-CIX, 2015)	98 (DE-CIX, 2015)
Milan	3	1,334 Gbps (MIX-IT, 1996)	345 (MIX-IT, 1996)
Palermo	1	55 Gbps (DE-CIX, 2015)	23 (DE-CIX, 2015)
Sofia	5	1,170 Gbps (NETIX, 2013)	102 (NETIX, 2013)

Note: Table depicts number of local exchanges based in each market, peak traffic of the top IX in each market, and number members for the top IX in each market. Year of IX launch is also shown.

DE-CIX made its first foray into Southern Europe in 2015, when it deployed to Telecom Italia Sparkle's Sicily Hub data center in Palermo and to Interxion's campus in Marseille. The mix of member network origins in both of these markets reflects the diverse array of network locations along the subsea routes connected to these port cities.

DE-CIX has rapidly expanded from Marseille and Palermo to cover other Southern European locations with local data center-neutral and carrier-neutral Internet Exchanges. DE-CIX's Madrid exchange, deployed just five years ago, has grown to be one of the largest ecosystems in the region with 200 ASNs connected. Lisbon was added to the DE-CIX portfolio in 2018, where it operates out of Equinix's former Itconic facility, and the company's partnership with SEECIX in Athens was established in 2020. While in a nascent stage of development, this ecosystem capitalizes on Athens' proximity to the Balkans, the Middle East, and Africa along the broader Europe-Asia subsea corridor. SEECIX is operated out of Athens' primary data center Lamda Hellix, which was recently purchased by Interxion/Digital Realty.

Equinix has more recently deployed its IX fabric to Southern Europe, adding peering infrastructure to its sites in Milan, Madrid, Lisbon, and Barcelona between 2018 and 2020. Aside from the international providers DE-CIX and Equinix, a host of local IX providers contribute to the local exchange fabric in Southern European markets. Notable both for their size and number of connected ASNs are MIX-IT in Milan and NETIX in Sofia.

7. Network pricing trends

Network pricing competitiveness is vital for robust interconnection ecosystems. High pricing can be an indicator of a monopolistic operating environment and can be a costly deterrent to networking scale. Conversely, competitive pricing generally indicates that a given location is “on-net”, with a strong mix of local and international carriers providing affordable network access. Few interconnection ecosystems can truly fulfill their potential until market competitiveness is established.

It’s abundantly clear from the accompanying bar chart that Southern European network pricing is “on-net”. A couple of key observations:

- Southern European IP transit prices are every bit as competitive as those of the FLAP (Frankfurt, London, Amsterdam, and Paris) markets, most ranging between $0.24 and $0.28 per Mbps for a 10 GigE port.
- The average IPT rate in the Southern European markets shown here is identical to that of the FLAP markets, at $0.25.
- Price erosion in the Southern European markets shown is outpacing that of the FLAP markets, at about 24% CAGR over the past three years compared to 19% for the FLAPs.

Fig 14. Weighted median 10 GigE IP transit prices, Southern Europe and FLAP, Q1 2018 – Q1 2021
Source: TeleGeography

8. Closing thoughts

Is Southern Europe rising to the challenge of the digital age? As the lowest-latency gateway to Europe for many parts of the world, demand for access to interconnection infrastructure in this region is clearly strong. North Africa, Sub-Saharan Africa, and the Middle East are already highly dependent on Southern Europe for access to the global Internet. This, in itself, is significant. Networks from these locations traditionally had to traverse further north to the FLAP markets and are now able to interconnect with vital partners closer to home. The connections to Southern Europe are extending further as well, as South Asia, Central Asia, and the Americas rapidly increase their capacity levels tethered to the region.

And the appetite of local networks in the region can't be underestimated either. This is clear in the robust peering markets of Milan, Madrid, and Sofia. According to DE-CIX, local Spanish networks account for more than 60% of the connections at their exchange in the booming market of Madrid. Demand from local networks is a tremendous driver of the growing maturity of distributed interconnection nodes throughout Southern Europe.

So what about the infrastructure to meet the growing appetite to reach this market? Is Southern Europe building the interconnection ecosystems needed to meet digital demand? Indeed, investment in interconnection infrastructure throughout the region is robust. Take a look at the accompanying figure on the next page. In the past five years, Southern Europe's colocation data center market has grown nearly 20%, and its IX market

has grown at a blistering 50%, increasing from 15 to 22 exchanges. Investment in cloud regions has changed even more dramatically. In 2016, none of the largest global cloud providers had deployed cloud regions to Southern Europe. As of 2020, there were two. Within the next year or two, there will be at least eight more spread across three of the region's major metropolitan markets. Subsea cable investment continues to pour into the region as well, giving us a sense of how inter-regional connectivity will continue to shift.

Let's briefly recap some of the major infrastructure investments that are coming to Southern Europe in the near term.

Data centers: Aside from aforementioned projects in Madrid (several current deployments including ones by Interxion and NTT), Milan (Equinix's new facility and Vantage's project in deployment) and Interxion's continued investment in Marseille, Portugal will soon see an unprecedented injection of investment in its data center sector with a massive project in Sines. Investment groups Davidson Kempner of the U.S. and Pioneer Point Partners of the U.K. plan to invest as much as $4.2 billion over the next four years in a five-site campus. The project specifically targets network demand from major content and cloud providers and hopes to capitalize on the new intercontinental landing point for the EllaLink subsea cable between Brazil and Portugal. Portugal's prime minister hailed the project as "the largest foreign direct investment in Portugal in recent decades."

Further data center investments are moving into the region as well. Global real estate investment firm Colliers recently spun up a data center division in Spain to focus on the development of digital infrastructure in that market. Likewise, MERLIN Properties and Edged Energy are partnering to build a network of data centers with zero-net water consumption in Madrid, Barcelona, Bilbao, and Lisbon.

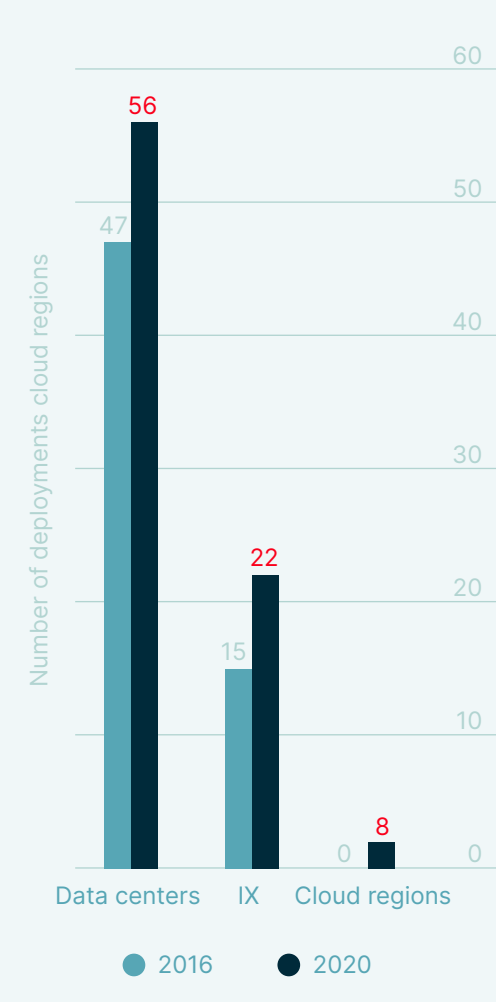


Fig 15. Number of interconnection ecosystem deployments in Southern Europe, 2016 and 2020
Source: TeleGeography

Cloud regions: It's becoming clear that Madrid must be included as one of the main anchor points for cloud interconnection in Southern Europe, as no fewer than four new cloud regions are planned for that market (or at least somewhere in the vicinity) in the next few years. When the dust settles, both Milan and Madrid will be home to massive data center deployments for all three of the world's largest cloud providers (Amazon, Google, and Microsoft).

IX: DE-CIX's newest exchange in Southern Europe is in Barcelona, where it is deploying to two data centers – that of local operator BitNAP, and Equinix's densely interconnected former Itconic facility. This brings DE-CIX's coverage in Southern Europe to six markets.

Subsea cables: A tremendous amount of new submarine cable infrastructure is in the pipeline for Southern Europe. The projects being planned both bolster pivotal existing routes to the region and open new routes and opportunities for increasingly diversified and low-latency interconnection to be established. Furthermore, these new projects solidify the growing influence of international content and cloud investment in the region.

- Following the launch of MAREA in 2018, Spain will continue to grow as a Transatlantic node, as Google lands its new Grace Hopper cable in Bilbao.

- Numerous projects will cement the growing interdependence of Southern Europe and South Asia (the Indian subcontinent), as Blue-Raman, PEACE, Africa-1, IEX, and other systems come online. Many of these will further serve to fuel continued growth in demand for access to Southern Europe from all across Africa and the Middle East, solidifying Southern Europe as the main (and lowest-latency) gateway to Europe for these regions. New systems will further solidify Marseille's status as a submarine cable hub within the region, as multiple new cables will land directly in that market.

- EllaLink will bring the first direct connection between Latin America and Europe since Atlantis-2 became operational more than twenty years ago. This could open opportunities for interconnection in Southern Europe with an entirely new region of the globe as the connection between Portugal and the dynamically growing market of Latin America is greatly bolstered.

It's clear that Southern Europe is ready to meet the network demand converging on it from a growing number of global regions. As we noted last year in the DE-CIX paper entitled "New interconnection markets in Southeast Asia", Europe has undergone a significant shift from heavy centralization in the FLAP markets to increasingly distributed nodes. Growing Southern European hubs, including Madrid, Marseille, Sofia, and others, are increasingly ready to provide the robust and diverse network, cloud, and data center infrastructure needed to support network demand from across the world.

9. Appendix of key terms

interconnection hub	A critical converging point of global network interconnection, characterized by growth in bandwidth, cable infrastructure, data centers, IX platforms, and cloud providers within a concentrated metropolitan market.
Internet Exchange (IX)	A physical interconnection fabric that facilitates the interconnection of member networks through a common portal for Internet peering.
international Internet bandwidth/capacity	Aggregated capacity of direct layer 3 router-to-router bandwidth connected across international borders. These links comprise the public Internet, which carries general Internet traffic, including email, web pages, streaming video, voice-over-IP (VoIP) calls, and corporate IP VPN traffic. The data do not include IP links used as part of a private network.
cloud onramp	A cloud provider edge deployment, typically in a colocation facility, where networks can port in to dedicated network paths to access the cloud provider's services in a geographically separate location.
cloud region	A territory (generally, a metro area) that comprises one or multiple zones of data center deployments for local provisioning of cloud services.
major cloud providers	The largest global cloud service providers by revenue. For the purposes of this study, the sampling includes Amazon, Google, Microsoft, Oracle, and OVH.
Southern Europe (countries)	For the purposes of this paper, the sub-region is defined to include Bulgaria, Greece, Italy, Portugal, Spain, and the southern portion of France.
Southern Europe (metros)	For the purposes of this paper, metros highlighted in Southern Europe include Athens, Barcelona, Lisbon, Madrid, Marseille, Milan, Palermo, and Sofia.

About DE-CIX
DE-CIX is the world's leading Internet Exchange provider and operates several carrier and data center-neutral Internet Exchanges in Europe, the Middle East, Asia, and North America. We provide thousands of carriers, ISPs, content networks, and enterprises with peering, cloud, and interconnection services. For further information please visit www.de-cix.net.

About EllaLink
EllaLink is a privately funded and independent company committed to providing low latency products and services over a unique route between Europe and Latin America on a Carrier Neutral and Open Access basis. For more information please visit ella.link or follow us on LinkedIn.

About Interxion
Interxion: A Digital Realty Company, is a leading provider of carrier- and cloud-neutral data centre services across EMEA. With more than 700 connectivity providers in over 100 data centres across 13 European countries, Interxion provides communities of connectivity, cloud and content hubs. As part of Digital Realty, customers now have access to 47 metros across six continents. For more information, please visit interxion.com or follow us on LinkedIn and Twitter.