Research into Data Subsea Cables: Enabling Caribbean Netherlands digitally

Dutch Ministry of Economic Affairs

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Content

1. Summary

Summary

Existing subsea cable infrastructure in the Caribbean region

- The Caribbean region is generally well served by a digital infrastructure ecosystem with among others, data caching locations and rich regional and international subsea connectivity. However, there are numerous, micro-geographical areas like Saba, Sint Eustatius and Bonaire throughout the region which suffer connectivity issues for a variety of different reasons.
- The Caribbean region is connected by 40+ subsea cable systems. Some of them are purely intra-region, others are connecting the region to the U.S.A. or Latin America.
  - About 45% of the regional submarine cable infrastructure is over 20 years old and is reaching the end of the average technical lifetime of 25 years.
  - Much of the infrastructure is owned by large, incumbent telecom companies who are no longer building new cables.
  - Several companies due to their large infrastructure footprint, enjoy monopolistic positions in some countries and similarly have significant control over both 'intra-region' and 'out-of-region' connectivity.
- There are several reasons for continuous investment in new subsea cable systems: 1) replace cable systems reaching their end of life, 2) build more direct routes avoiding too many intermediate landings, and 3) offer more physical diversity from both route and cable perspectives for enhanced network resiliency and availability.
- The demand for international bandwidth – mostly transported over subsea cable systems – globally grows 30% to 40% worldwide. With no regional/local caching infrastructure. This growth rate would be even higher over subsea routes.
- It is reasonable to describe the majority of the submarine infrastructure surrounding the BES islands as mature of age. It is approaching its original technical lifetime of 25-years. There are newer cables i.e. PCCS (2015) which serves nearby Curaçao, however it does not directly serve Bonaire connection.

Summary

The current internet status in BES municipalities

- Although the quality of service varies between the three islands, the internet services are relatively slow and expensive. When compared regionally the costs of internet on Saba and Sint Eustatius and to a lesser extent Bonaire, remain high compared to regional averages (see graphs on slides 30 and 31. Therefore, the Dutch government has lowered the cost of internet access through structural subsidies.
- Offering end-users access to internet and digital services depends on a complex delivery chain involving several players and technologies.
  - Identifying the single weak link of the digital infrastructure/delivery chain responsible for unsatisfactory end-user experience may be challenging.
  - Development of terrestrial fiber optic cables within each of the BES municipalities would greatly improve the internet quality.
  - Developing commercially competitive, physically diversified, more direct subsea cable connectivity would also improve cost and reliability for connecting to regional telecom hubs and mainland Europe.
  - It is notable that there is no data caching point in Saba or Sint Eustatius. The only Content Delivery Server in the BES islands is a Netflix server on Bonaire.
- Given the population size on the BES-islands assuring the required amounts of subsea cable capacity is available is not an issue, as any fiber pair of a recent modern cable system would offer much more than the combined requirements. Issues related to international connectivity (IP-transit) experienced by the BES islands are not related to availability of enough subsea cable capacity, but instead to more nuanced issues around monopolistic behaviors over supply.

Summary

Monopolies in the Caribbean region (1)

- There is certainly a lack of competitive tension in the market for international connectivity to, from and within the Caribbean. The effect of this can be seen in varying degrees in numerous Caribbean countries, with some obvious examples like the Cayman Islands. They are served by two international cables who's on-island access is controlled by the same entity: LLA.
- This repeating pattern can be seen with varying degrees across the Caribbean region. With some companies actively extending their influence purchasing majority stakes in existing regional operators. For example the Bahamas Telecommunications Company (BTC) is 51% owned by Liberty Latin America (LLA).
- In numerous other locations in the Caribbean, LLA's influence often extends across the whole content delivery chain. LLA not just controls subsea assets, but also owns on-island infrastructure. An example of this is the Amerigo Vespucci system connecting Bonaire to Curaçao: even though Telbo owns 50% of the cable, their ability to maximise usage is inhibited by the fact it relies on 3rd party (LLA) assets to connect further afield beyond Curacao.
- The entry barriers to the subsea cable market, specifically the large initial capital costs of infrastructure, appear to be too high to support meaningful competition, leading to overwhelming first mover advantage. Without government intervention or significant competitive pressure, the first subsea cable operator appears to benefit greatly from a monopoly.
- Several former incumbent telcos (like AT&T) are no longer active or have become far more selective in subsea cable construction. They now operate ageing assets and take smaller stakes in consortia builds.

Summary

Monopolies in the Caribbean region (2)

- Increasing government involvement is also notable in the Caribbean's submarine cable landscape. State-owned enterprises or public-private partnerships frequently step in to address non-commercially viable connectivity gaps. For example, the Dutch central government has invested in the SSCS subsea cable to improve connectivity for Saba and Sint Eustatius. This intervention helps to guarantee that even the most isolated communities can access high-speed internet and other essential telecommunication services. These are crucial for socioeconomic development and integration into the global digital economy.
- Regionally, the two largest hubs for international submarine cables are US territory (Puerto Rico & Miami). Presently any traffic to European Netherlands from the BES islands is required to transit one of these two hubs.
- Both of Bonaire's links are to Curaçao, where a further 6 links are available to connect out of the region. It is currently not possible for Bonaire to access international connectivity without encountering the LLA monopoly in some form, whether this with the initial connections to Bonaire from Curaçao, or the following links from Curaçao to the wider region.
- And while the regional hubs of US Virgin Islands, British Virgin Islands and Puerto Rico, are all relatively close and host numerous modern, international cables, the direct connections from those hubs to Sint Eustatius, and Saba are currently limited, with most cables bypassing both Sint Eustatius and Saba.

Summary

Regional connectivity solutions for Bonaire, Saba and Sint Eustatius

- Connectivity to regional connectivity hubs, minimization of the latency and number of intermediate landing sites have guided the identification of the potential new connectivity options. Also Pioneer's experience shows that in general, the larger or more complicated a proposed submarine project is, the lower the likelihood of it being realized.
- Generally, the more cables and operators involved in a connectivity path, the higher the price, the more points of failure and the higher the risks.
- More connectivity options are available for Bonaire than for Saba/Sint Eustatius. For Bonaire there are subsea cables in the west part of the Caribbean Sea that offer additional connectivity paths to the U.S.A. via Colombia or Mexico. These options are not available for Saba and Sint Eustatius.
- There are several new, large-scale cables planned for the region. While some of these will transit reasonably close to the BES islands, none are planned to land in any of the three BES locations, so any improvements in connectivity due to these developments will be secondary at best. However, the options for the BES islands to join existing, newly planned systems would be significantly more complicated due to the multiple parties involved.
- Several new short subsea cable options exist for all the BES islands to increase their connectivity options to a regional hub. These would be considered the lower-risk, lower cost options for the regional solutions.
- While addressing the needs for route diversity, connectivity and increased competition, all the alternate regional routes identified, rely on existing regional hubs and do not provide route diversity away from the U.S.A.

Summary

Connectivity solutions to regional hubs (criteria see slide 12)

Criteria	Improved Reliability	Improved Latency to NL EU	Improved Competitive Landscape	Improved 'Directness' to NL EU	Delivery Confidence of Solution	Costs (mln Euro)
Direct Route to Regional Hub: Sint Eustatius/ Saba						
Puerto Rico	3	2	5	4	4	33
British Virgin Islands	3	2	5	4	4	25
U.S. Virgin Islands	3	2	5	4	4	26
Direct Route to Regional Hub: Bonaire						
Aruba	3	3	3	2	4	22
Curaçao	3	1	4	1	4	19
Venezuela	3	1	1	1	2	23
Joining Planned Cable						
Firmina	3	2	4	3	2	Not calculated
TAM-1	3	2	4	3	2	Not calculated
CSN-1	2	1	4	1	1	Not calculated
GD-1 / LN-1	2	1	3	1	1	Not calculated

Summary

Alternative termination destinations: long haul, out of the region solutions

- Understanding the requirement for high-level detail on possible ways to connect the BES Islands directly to non-regional hubs to gain more direct access to mainland Europe, Pioneer has identified five potential long-haul routes to achieve this objective.
- A self build subsea cable from Sint Eustatius to Bonaire that allows the extension of the long-haul routes would costs approximately € 55 mln. This would allow any solution to be effective for both Bonaire and Saba/Sint Eustatius.
- The five, long-haul trunk routes identified, and the summary Qualitative Assessment scores are:

Criteria	Improved Reliability	Improved Latency to NL EU	Improves Competitive Landscape	Improved 'Directness' to NL EU	Delivery Confidence of Solution	Costs (mln euro)
Sint Eustatius to French Guiana (Ella link)	2	1	2	1	1	86
Sint Eustatius to Azores Islands	2	5	4	5	3	171
Sint Eustatius to Bermuda	2	4	4	5	3	82
Sint Eustatius to Portugal	4	5	5	4	4	220
Sint Eustatius to Beverwijk, Netherlands	4	5	5	5	4	237

Summary

Direct connection to European Netherlands

- The simplest and most direct way to significantly improve the connectivity of the BES islands to European Netherlands, would be to build a dedicated cable out of the Caribbean region to either the European Netherlands directly, or to an intermediate, well-connected point along that direct route.

- At first appearance, a direct cable from the BES Islands to European Netherlands seems highly unusual in the submarine cable industry, as it is almost entirely cables with a positive commercial business case which are built. However, when viewed as from a strategic or an '*enabling digital government services*' point of view, such state-backed cables are something Pioneer recently is seeing more interest in.

- State intervention in building submarine cables for isolated communities is crucial to ensure equitable affordable access to high-speed internet and advanced e-services. Market forces often neglect certain destinations due to high costs and low profitability, leading to digital divides that hinder these territories growth and integration into the global economy.

- By investing in submarine cable infrastructure, governments can ensure these isolated islands are connected to international data networks, fostering social inclusion, economic opportunities and resilience against external shocks. This strategic intervention can also attract private investments, stimulate local businesses and support essential services, thereby contributing to long-term sustainable development.

Summary

Recap of the Questions raised in the RFP

1. Monopolies on (subsea cable) routes from the Caribbean to global destinations:
   a) overview of existing monopolies and reduced competition;
   b) ownership of cables / right to access for local connectivity.
2. Overview of existing connectivity around the BES islands (Saba, Sint Eustatius, and Bonaire), towards international destinations including:
   a) examination of existing cables: Ownership, age, capacity, technical details, access;
   b) new cables planned in the region.
3. Potential alternative routes for future development to reach global connection
   a) options;
   b) rough cost estimate.
4. Generate a simple map of possible/potential international routes from islands towards international destinations outside the Caribbean.
5. Alternate termination destinations (other than Miami) and efficient in reaching mainland Europe (Amsterdam).

Summary

Criteria: A Qualitative assessment (scored out of 5)

- To help address items 3, 4 & 5 of the RFQ Scope, Pioneer has developed the following five criteria to provide a qualitative assessment of each potential solution. Improved Reliability
  - Assessment against: "*would the suggested new link improve the resilience of the island's connectivity?*".
  - Improved Latency to NL EU
    - Assessment of: "*will this proposed solution reduce latency to European Netherlands ?*".
  - Improves Competitive Landscape
    - Assessment against: "*would the suggested new link offer the potential to improve the competitive environment and hence potentially lower end-consumer pricing?*".
  - Improved 'Directness' to NL EU
    - Assessment of: "*would the proposed new solution reduce complexity of end-to-end connections to the European Netherlands?*" i.e. a reduction in the number of different cables systems or infrastructure owners (hops) required to establish an end-to-end connection.
  - Delivery Confidence of Solution
    - Assessment of Pioneer's view on the likelihood of a potential new build coming to fruition.

NOTE: The qualitative scoring (out of 5) is based on Pioneer's subjective view of the likelihood seeing '*positive change vs the existing situation*', over several criteria, that any example solution may have, i.e. a score of '1' would indicate a marginal improvement, whereas '5' would indicate a significant improvement.

This assessment does not include any assessment of criteria of public policies on for instance security.

2. Content Delivery Chain and Bandwidth Demand in the Caribbean Region

Introduction

Introduction

- Unencumbered access to all the benefits of being fully connected to a 'Global World' can be likened to a chain lifting a weight, in that each link must be designed and able to do its job, and the whole chain is only as strong as the weakest link. Therefore, from a connectivity point of view, should any part of the chain be subject to restrictions of any kind, the performance of the whole chain suffers.
- The delivery of digital content and telecom services to end-users requires a chain of digital infrastructure components, including subsea cable systems, data centers with caching points.
- Subsea cable connectivity is vital for the development of countries as it underpins their digital communication. In many geographical areas, the private market for international connectivity supports multiple submarine cables, which can lead to highly competitive situations. This kind of competition often leads to competitive pressure on pricing, high quality customer service, innovation and flexibility. This in turn supports dynamic and thriving digital economies, with ongoing inward investment stimulating the economy and citizens benefiting from the advantages that connectivity can bring across education, healthcare, government services, entertainment and other sectors.
- Subsea cables are especially important in the Caribbean region to avoid any digital divide and connect islands and their sometimes-small communities to the rest of World, including to The Netherlands for Bonaire, Sint Eustatius and Saba.
- No alternative technology capable to replace subsea cables as the workhorse for moving large amounts of digital content around the World is planned to be available within the foreseeable future. That being said: in certain circumstances (places with small and/or low-density populations) LEO satellites may be able to meet connectivity demands in the future. However, there are still significant technical challenges to be addressed if LEO satellites are to be the main connectivity solution. These are explained in further detail in many publicly available articles, such as:

  https://www.microwavejournal.com/articles/41449-addressing-low-earth-orbit-satellite-communications-system-design-challenges
  https://www.spirent.com/blogs/sorting-technical-and-commercial-challenges-as-satellite-use-cases-span-new-horizons
  https://www.networkcomputing.com/network-infrastructure/5-challenges-for-enterprises-considering-leo-satellite-services
  https://www.fujitsu.com/global/vision/insights/22-leo-satellite-broadband/

2. Content Delivery Chain and Bandwidth Demand

Section Summary

- The density of caching points is directly driven by the economic trade-off between moving the content/data over long distances and pre-positioning them locally close to the end-users.
- This is a decision made by each content provider, obviously driven by the size of the market (population size and economic wealth). As of now, no content providers have decided to install caching points on Saba or Sint Eustatius. On Bonaire, the only CDN server is understood to be installed by Netflix. There is a larger caching location on Curacao hosted by AMS-IX, that also serves Bonaire.
- Having caching locations in Saba and Sint Eustatius would undoubtedly contribute to improve end-user experience (assuming other links of the digital infrastructure/delivery chain are not a blocking/limiting point), but this would have a cost and might not be the right economic trade-off from a global network perspective for the content provider in question.
- Therefore, there could be a case for government intervention to improve the end-user experience.
- Regionally, the two largest hubs for international submarine cables are US territory: Puerto Rico & Miami. Presently any traffic to European Netherlands from the BES islands is required to transit one of these two hubs.

Parties Involved in Internet/Cloud/Content Delivery Chain

Many specialized, complementary providers are involved in this chain.

Several Stakeholders Interact and Contribute to the Internet Ecosystem and Delivery Chain

- **Content Providers (CPs)** – They are the content owners that produce or aggregate various digital content and (may) use several intermediaries to deliver their content to end users. This category encompasses large content providers like Google and Meta, and small ones like website owners.
- **Hosting Service Providers** – Hosting service providers run servers that host the content managed by third parties (content providers, enterprises, or individuals). A common kind of hosting is web hosting service. Cloud hosting constitutes a large portion of this segment and includes Microsoft (Azure) and Amazon (Amazon Web Services – AWS).
- **Transit Providers** – Operators of international transport networks that act as intermediaries between hosting service providers and Internet Service Providers (ISPs) for relaying traffic. Tier 1 transit providers form what could be called the backbone of the Internet.
- **Interconnection Facility Providers** – Interconnection facility infrastructure enables the different parties to interconnect directly, through an exchange point, rather than going through one or several transit providers.

Examples for Internet Stakeholders for End-to-End Data Interconnection in Caribbean

Content Providers (CPs)	Hosting Service Providers	Transit Providers	Interconnection Facility Providers	Content Delivery Network Providers	Internet Service Providers (ISPs)	Internet End-Users (Residentials, Businesses, or Governments)
amazon prime video Meta NETFLIX YouTube	A2 HOSTING CARIBBEAN NETWORKS HOSTING pr technology	AT&T cirion LIBERTY SETAR	amsix Caribbean IX PUERTO RICO INTERNET EXCHANGE	Akamai CLOUDFLARE Google	eutel SATEL TELBO ta Di'Bo	

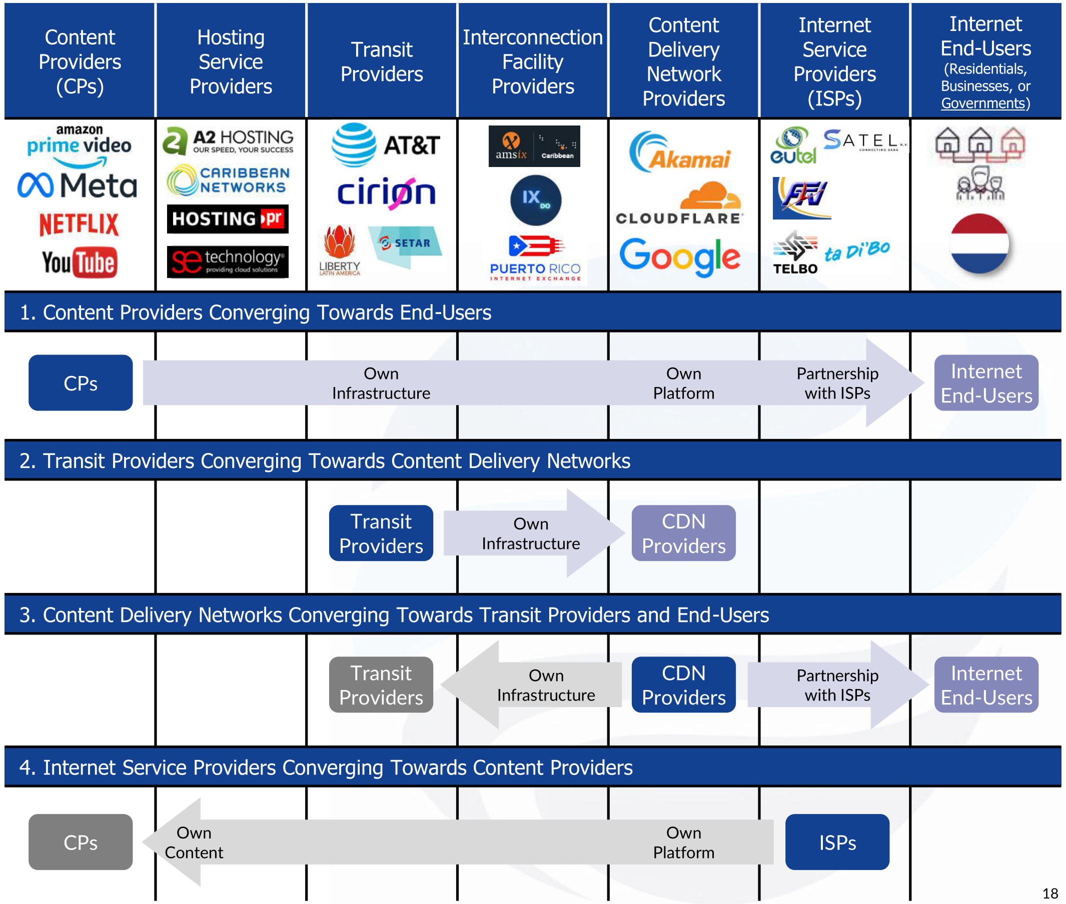
- **Content Delivery Network (CDN) Providers** – Network operators that specialize in relaying large volumes of traffic to several ISPs, in various geographical locations, using cache servers installed near Internet end-users. The purposes of these networks are to improve efficiency (i.e., so that the same static content does not need to be distributed from a unique centralized source to the destination) and for reducing latency to improve the user's experience.
- **Internet Service Providers (ISPs)** – Network operators that provide access to the Internet to both personal and business customers via fixed or mobile access technologies. They also provide additional services like email services, domain registration, and web hosting.

Evolution of the Party Roles in End-to-End Delivery Chain

One of the Current Market Trends is Convergence Between the Different Players

1. In order to get closer to end customers and to improve the resilience and quality of their services, some large Content Providers (CPs) are deploying their own network infrastructure and their own Content Delivery Network (CDN) platforms, and partner with Internet Service Providers (ISPs) to reach end-users.
   This approach is followed by Google and Meta (this does not prevent them from buying dark fiber pairs or capacity on other transport infrastructure to increase global connectivity/reach/diversity of their networks).
2. In addition to their transit services, some transit providers use their existing infrastructure to develop CDN products and host/deliver third-party content.
3. On one hand, CDN operators are behaving more and more like network operators by deploying their own infrastructure around the globe. On the other hand, they are establishing partnerships with ISPs to deploy their cache servers on the latter's network and be as close to end-users as possible.
4. Some ISPs are diversifying their businesses by creating their own content and distributing it themselves through their own platforms.

Notes
- The evolutions described above are not systematic for all regions and all players.
- "Own infrastructure" may correspond to building or buying the infrastructure pieces required for delivering services.
- Telcos try to shift to convergent plays and adjacencies to protect revenue base from price declines in core services.



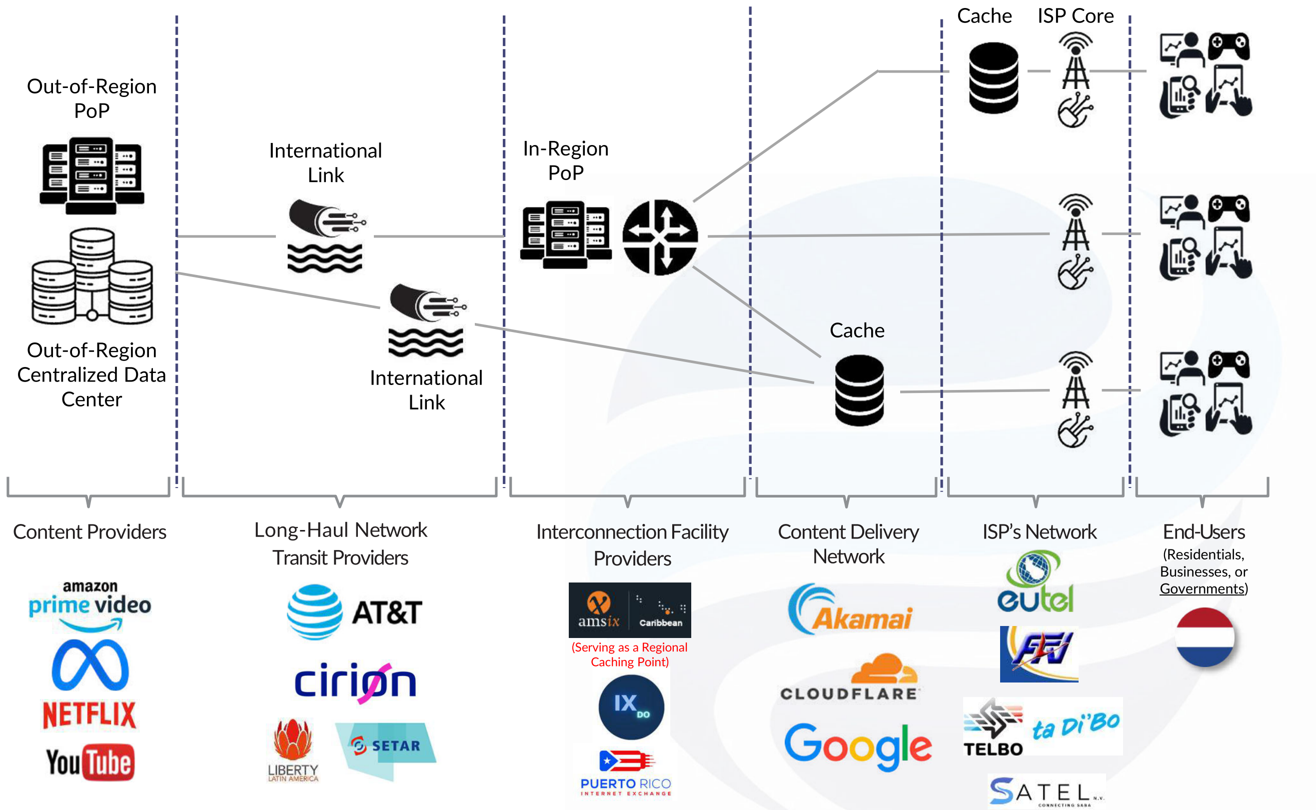
High-Level Content Delivery Chain in the Caribbean Region

The objective is to move data from remote storage locations to Internet end-users.

To allow their customers to access contents and websites outside their islands, BES telecom operators and Internet Service Providers (ISPs) have several options.

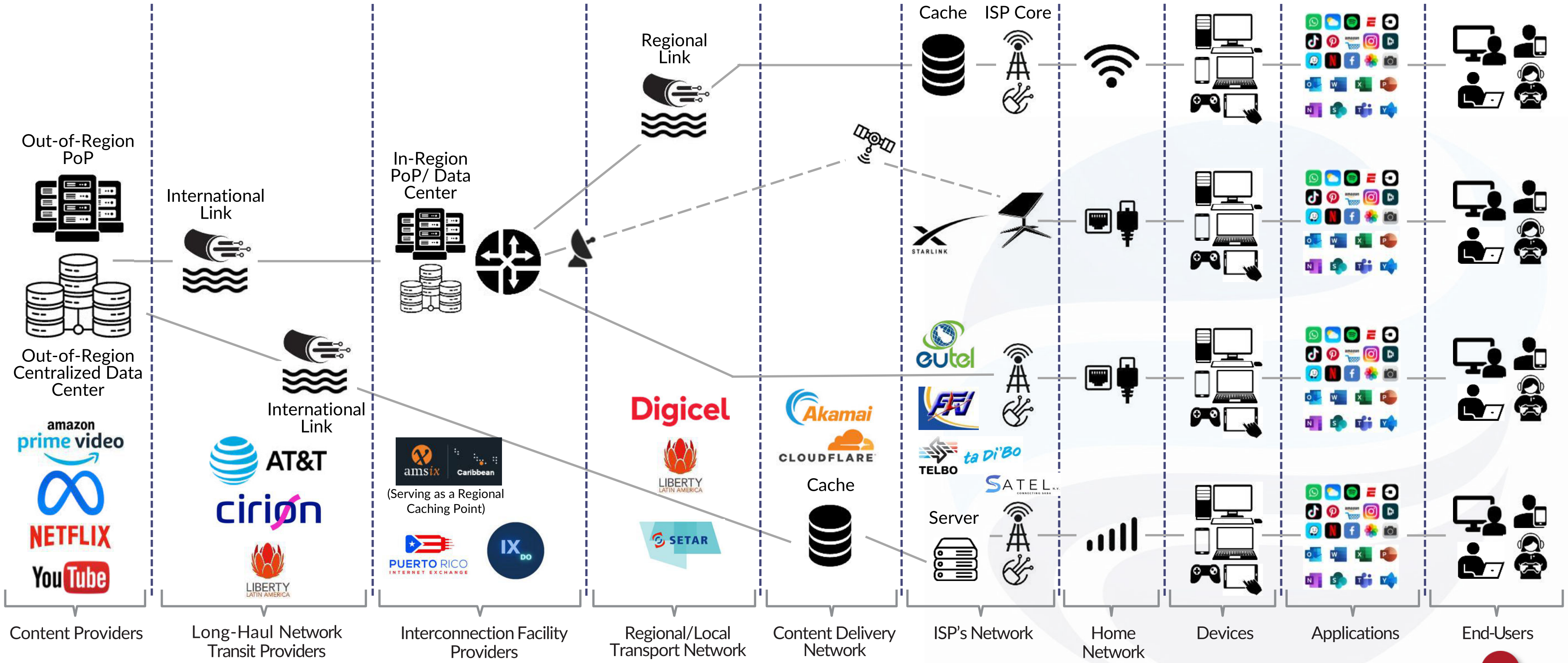
1. Buying services from an IP transit providers having a Point of Presence (PoP) in the region where IP router ports are made available.
2. Housing caching servers in their own data centers where content providers can pre-position their content.
3. Connecting to regional data centers (via subsea links) where content is stored.
4. Buying capacity on international subsea cables to access contents or IP transit services outside the region.

Main criteria for choice are cost and end-users' experience.



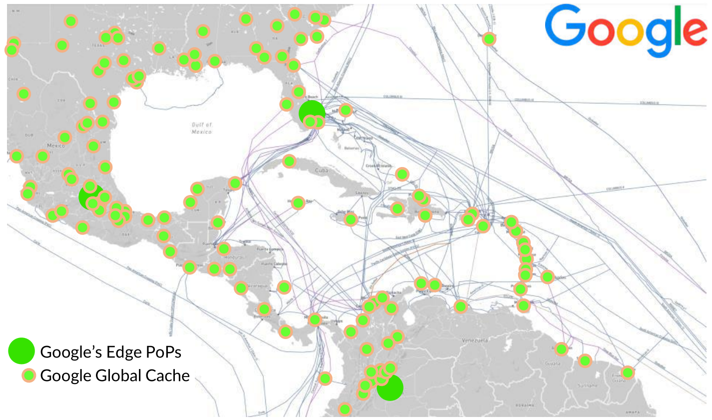
More Detailed Delivery Chain in the Caribbean Region

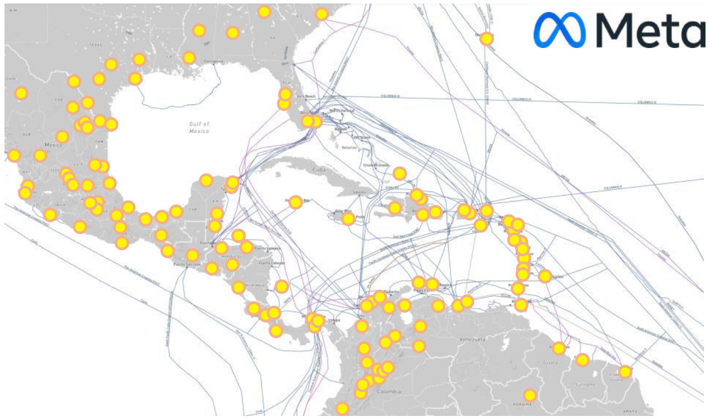
Several players/technologies interoperate to offer end-to-end connectivity. As such, several steps can contribute to the experience of a slow internet connection.

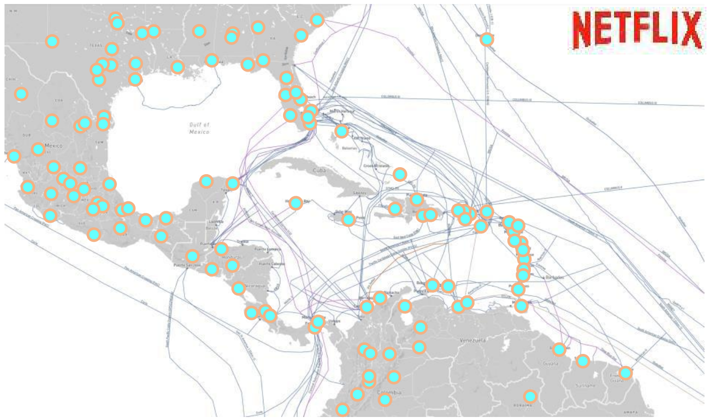


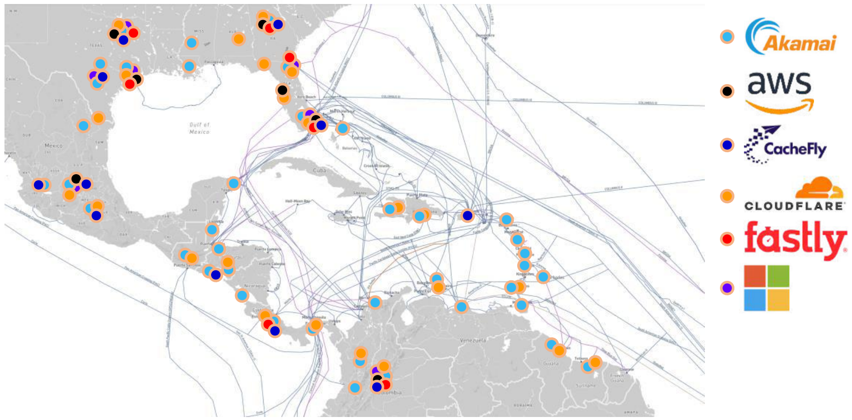
Content Caching Locations in the Global Region

The region is well and strategically served by the major CDN operators.



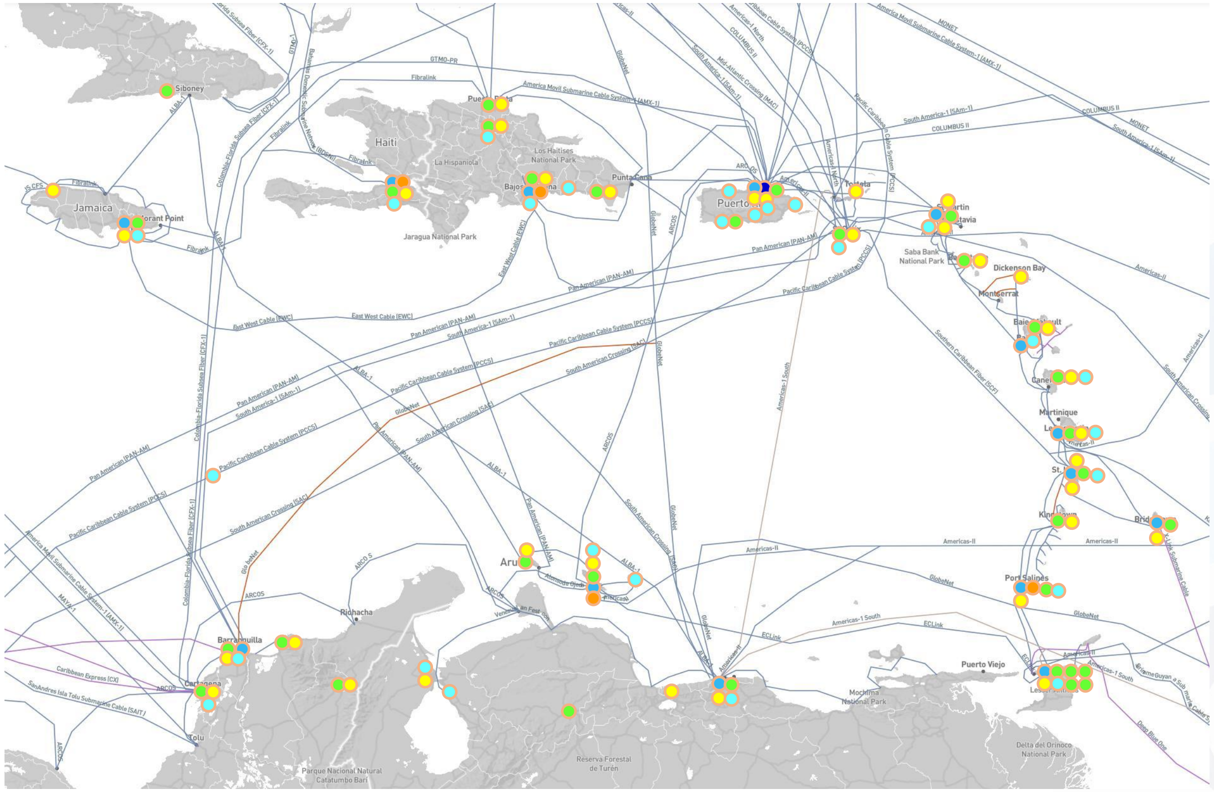






Content Caching Locations per Caribbean Country

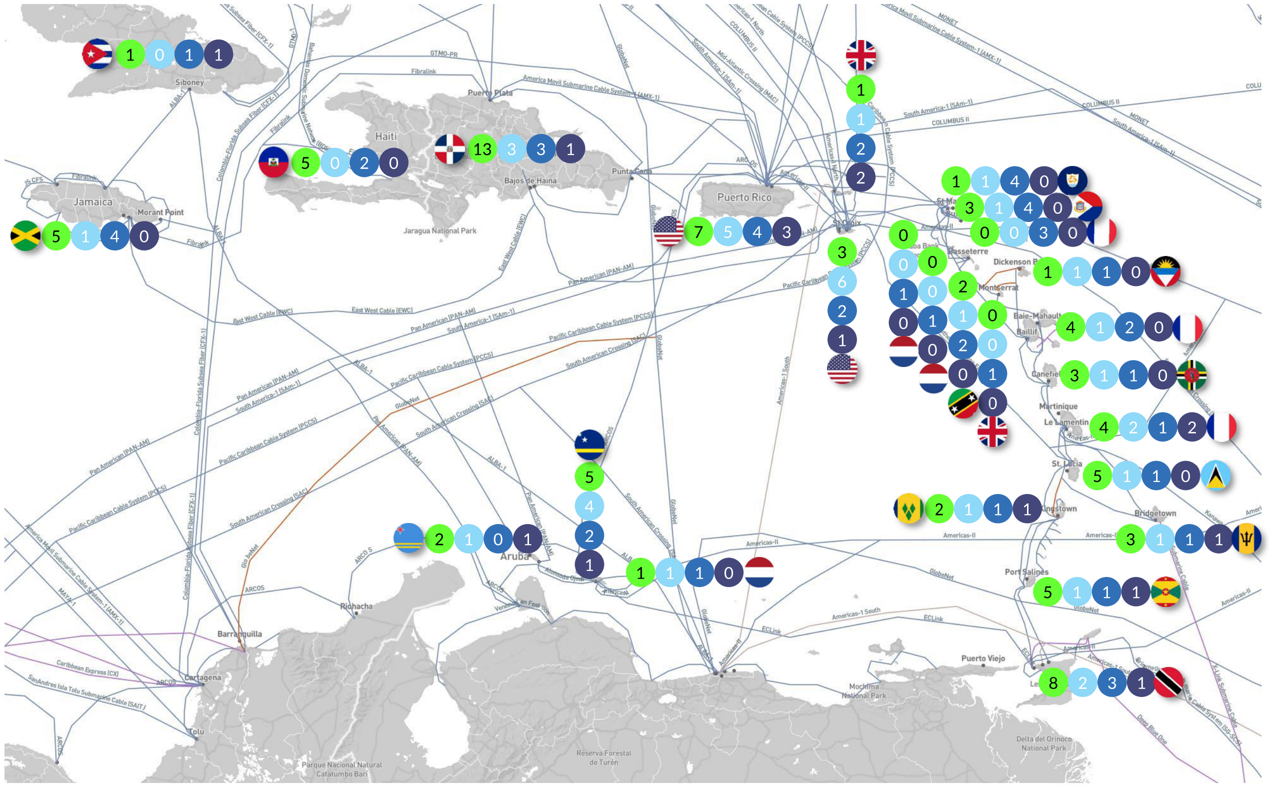
Only Saba, Sint Eustatius, Montserrat and Saint-Barthelemy have no CDN caches.



CDN Operators	Region	Bonaire	Saba	St Eustatius
Akamai	✓	×	×	×
aws	×	×	×	×
CacheFly	✓	×	×	×
CLOUDFLARE	✓	×	×	×
fastly	×	×	×	×
	✓	×	×	×
Meta	✓	×	×	×
	×	×	×	×
NETFLIX	✓	✓	×	×

Digital Infrastructure per Caribbean Country

Caches are installed in all the 5,000+ people islands.

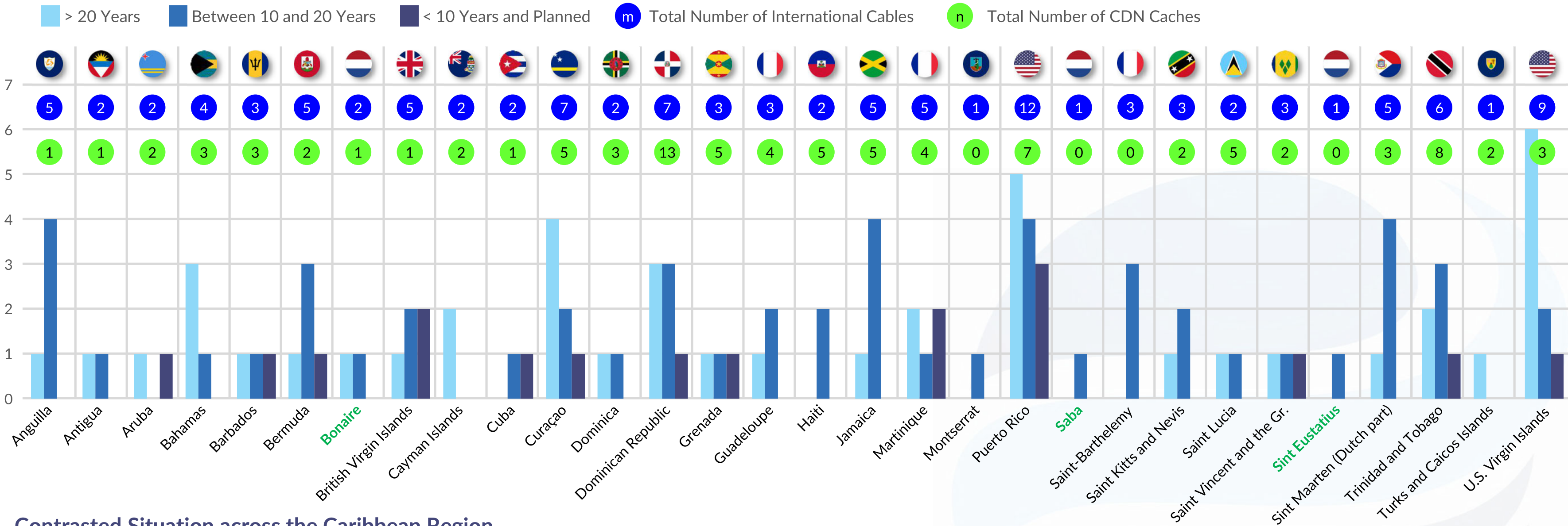


Number of CDN Caches	Subsea Cables: Age > 20 Years	10 Years < Age < 20 Years	Age < 10 Years	Country
1	1	4	0	Anguilla
1	1	1	0	Antigua
2	1	0	1	Aruba
3	3	1	0	Bahamas
3	1	1	1	Barbados
2	1	3	1	Bermuda
1	1	1	0	Bonaire
1	1	2	2	British Virgin Islands
2	2	0	0	Cayman Islands
1	0	1	1	Cuba
5	4	2	1	Curaçao
3	1	1	0	Dominica
13	3	3	1	Dominican Republic
5	1	1	1	Grenada
4	1	2	0	Guadeloupe
5	0	2	0	Haiti
5	1	4	0	Jamaica
4	2	1	2	Martinique
0	0	1	0	Montserrat
7	5	4	3	Puerto Rico
0	0	1	0	Saba
0	0	3	0	Saint-Barthelemy
2	1	2	0	Saint Kitts and Nevis
5	1	1	0	Saint Lucia
2	1	1	1	Saint Vincent and the Gr.
0	0	1	0	Sint Eustatius
3	1	4	0	Sint Maarten (Dutch part)
8	2	3	1	Trinidad and Tobago
2	1	0	0	Turks and Caicos Islands
3	6	2	1	U.S. Virgin Islands

Number of International Subsea Cables

Number of International Subsea Cable per Country and Age

Ageing infrastructure, with numbers of cables ranging from 1 to 12 (Puerto Rico)



Contrasted Situation across the Caribbean Region

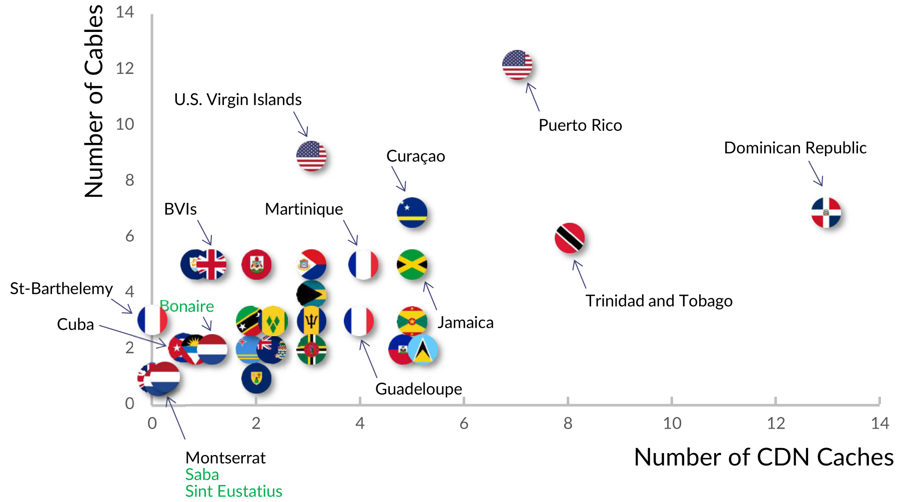
- Puerto Rico is THE interconnectivity regional hub (with a decent number of recent cables), followed by U.S. Virgin Islands and Dominican Republic (with a less favorable mix from cable age persecutive for the last two ones).
- No cables originating from mainland Europe land in the Caribbean region. U.S. remain the major international telecom and data hub facilitating the Caribbean region. All the cable systems touching Puerto Rico, U.S. Virgin Islands, and Dominican Republic connect to the Caribbean region, South America, or U.S. One cable system connects British Virgin Islands to Bermuda (CBUS put in commercial service in 2009, built with recovered and re-laid sections of the 1998 Gemini transatlantic cable) .
- British Virgin Islands and Martinique experience recent cable builds.
- Together with Saba and Sint Eustatius, Montserrat and Turks and Caicos Islands are the only territories with a single international subsea cable system. Although, it should be noted that for both Saba and Sint Eustatius there are two diverse cables, albeit on the same cable system.

Correlation of CDN Count with Cable Count and Population

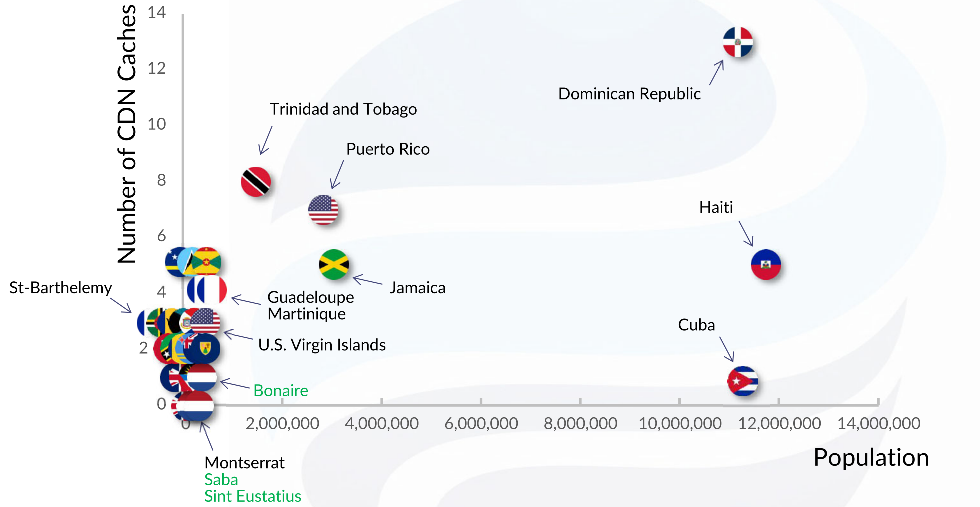
Dominican Republic, Puerto Rico, and Trinidad and Tobago are the main regional digital hubs from both CDN caches and subsea cable perspectives.

For different reasons, Cuba and Haiti are underserved by CDN operators with respect to their population size.

Number of Cables vs Number of CDN Caches



Number of CDN Caches vs Population

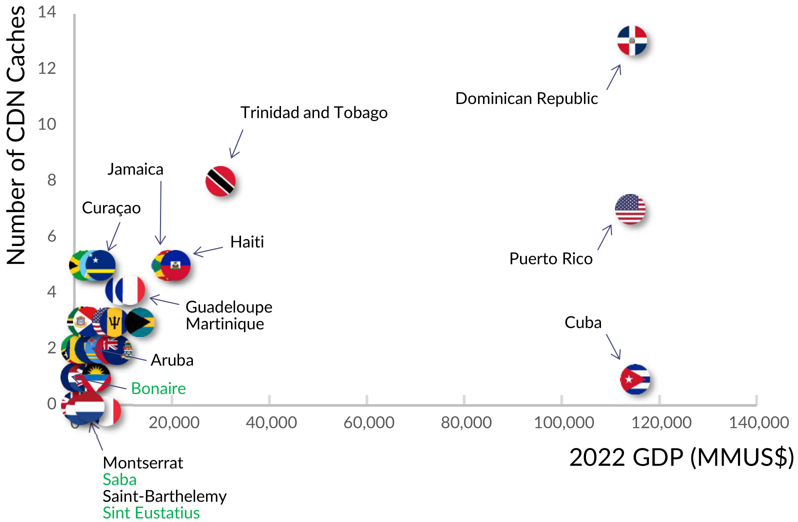


Correlation of Caches and Cables Count with Domestic GDP

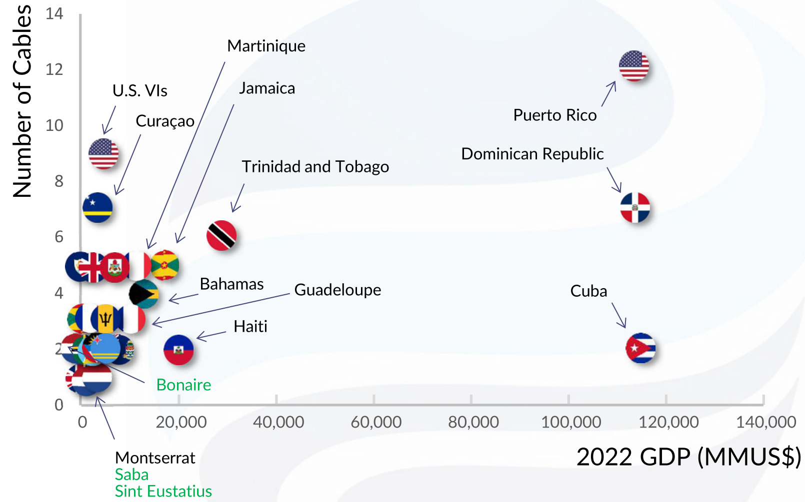
For similar domestic GDPs, Dominican Republic is a key data hub for CDN operators, surpassing Puerto Rico and Cuba. Trinidad and Tobago is over-equipped with CDN caches.

U.S. Virgin Islands have attracted more subsea cables than other islands with similar or larger domestic GDPs (with the exception of Puerto Rico), confirming the key cable interconnector role of U.S. territories in the region.

Number of CDN Caches vs 2022 GDP (Current US$)

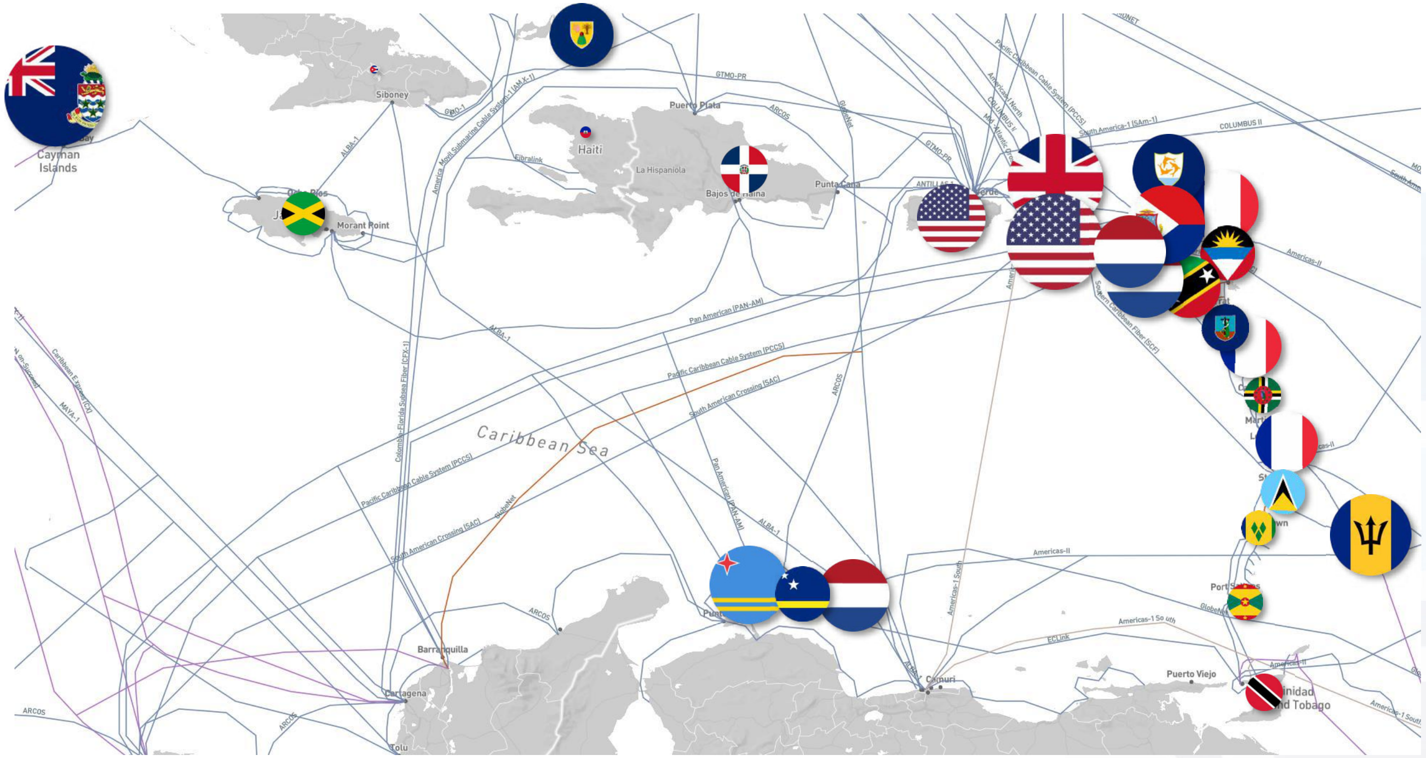


Number of Subsea Cables vs 2022 GDP (Current US$)



International Bandwidth Demand Per Capita (2023)

Mostly driven by GDP per capita and telecom infrastructure



Anguilla, Antigua, Aruba, Bahamas, Barbados, Bermuda, Bonaire, British VIs, Cayman Islands, Cuba, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, Saba, Saint-Barthelemy, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Gr., Sint Eustatius, Sint Maarten (Dutch part), Trinidad and Tobago, Turks and Caicos Islands, U.S. VIs

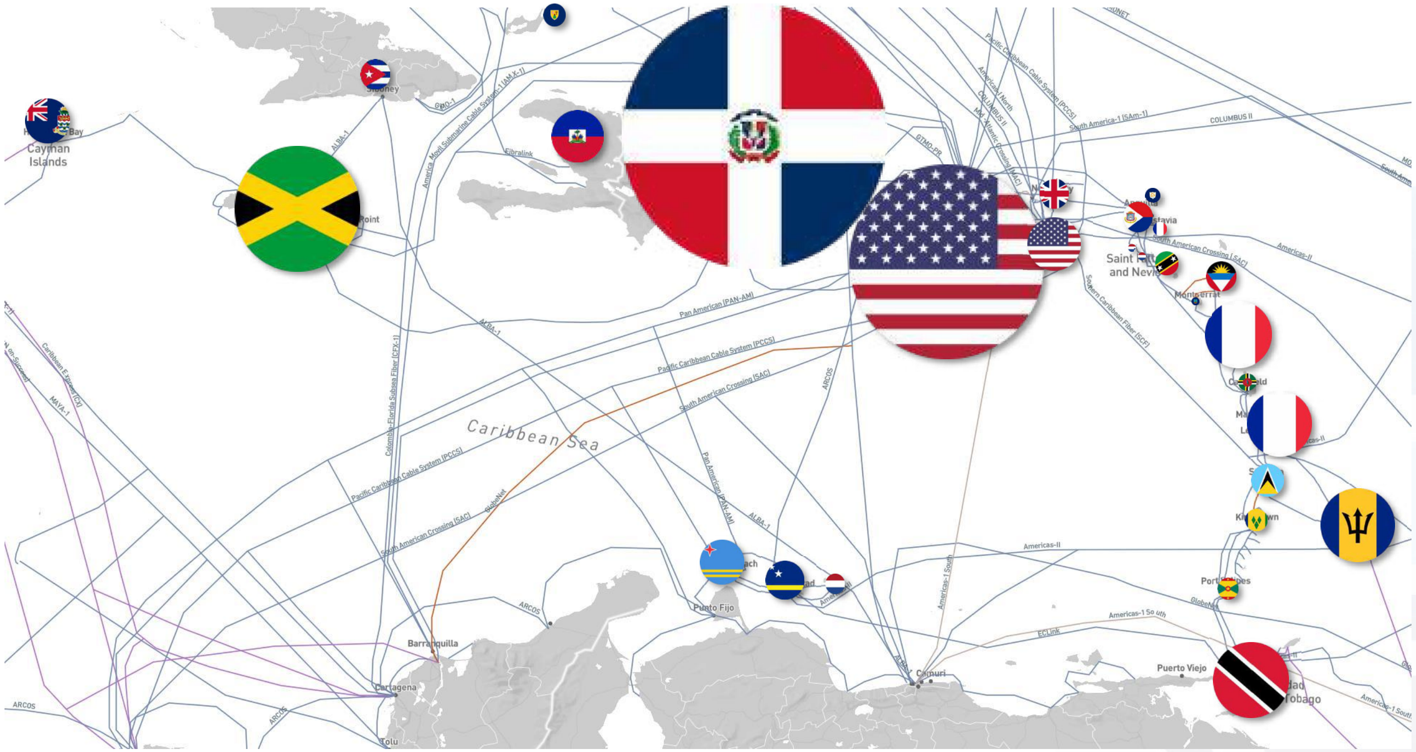
- The international bandwidth demand per capita is strongly correlated with the
  - GDP per capita
  - Telecom infrastructure (both domestic and international)
  - Human Development Index (HDI, statistical composite index of life expectancy, education, and per capita income indicators developed by the United Nations)
- The current International bandwidth demand per capita for BES municipalities is about 0.7 Mbit/s (to be compared with 1.4 Mbit/s in Cayman islands and less than 0.01 Mbit/s in Cuba)
- For reference, very developed countries have a typical international bandwidth per capita in the range of 1 to 10 Mbit/s per capita (with some countries housing dense data center industry offering even higher figures).

Used International Bandwidth by Country Per Capita (2023 - Proportional to disk areas)

0.1 | 0.5 | 1 | 1.5 Mbit/s Per Capita

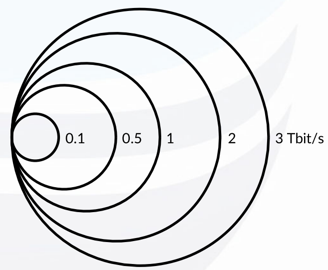
International Bandwidth Demand (2023)

Driven by demand per capita and population size



- Driven by a modest international bandwidth demand per capita (0.3 Mbit/s in 2023) and a large population (11.1m inhabitants), Dominican Republic is the major international bandwidth consumer in the region (3.1 Tbit/s in 2023).
- The current BES international bandwidth demand is modest (less than 20 Gbit/s in Bonaire, less than 5 Gbit/s for Saba and Sint Eustatius combined).

Used International Bandwidth by Country (2023 - Proportional to disk areas)

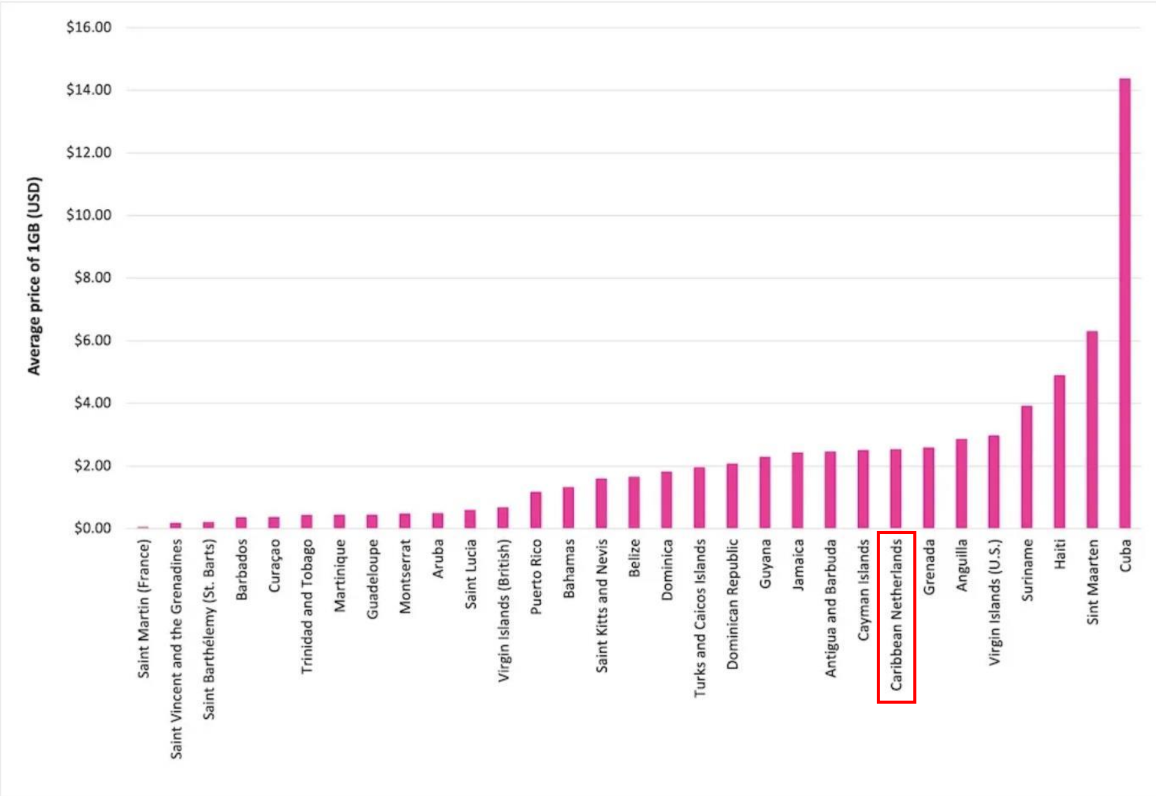


Regional Domestic Consumer Price Comparisons

The current internet status in BES municipalities

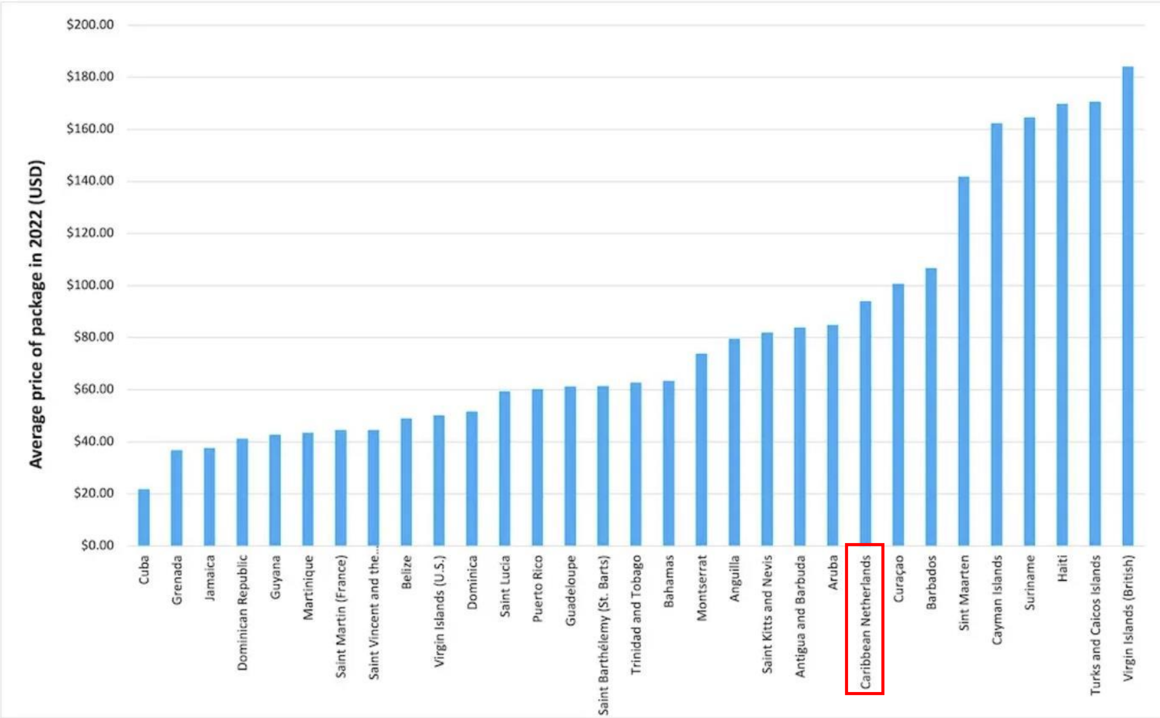
- The graphs on the following pages show two metrics for comparative pricing for fixed line broadband in the Caribbean region. In both cases, end-consumer pricing on the BES islands places towards the more expensive end of the scale.

Regional Comparison #1: Fixed-Line Broadband Pricing per 1Mbps



- The average price per Mbps allows for a reasonably precise comparison of fixed-line broadband rates across countries.
- The three BES islands have been grouped together and can be seen towards the higher end of the pricing range.
- Price per Mbps of fixed-line broadband Internet service in select Caribbean countries, as at March 2022 (Source: The Cable).

Regional Comparison #2: Fixed-Line Broadband Monthly Price



- Across the Caribbean there is a wide variance in the average price of monthly broadband internet plans.
- The three BES islands have been grouped together and can be seen towards the higher end of the pricing range.
- Average price of a fixed-line broadband plan per month in USD in select Caribbean countries, as at March 2022 (Source: The Cable)

3. Cable Ownership Structure in the Caribbean Region

3. Cable Ownership Structure in the Caribbean Region

Section summary

- The ownership structure of cables in the Caribbean is a complex mix of public and private entities, reflecting the diverse geographical and political landscapes. Major telecommunication companies, such as América Móvil, AT&T, LLA and Digicel, hold significant stakes in many of the region's key cables, leveraging their extensive resources to maintain their influence over regional pricing. These companies often form consortia to share the costs and risks associated with deploying and maintaining submarine cables, ensuring that multiple stakeholders have vested interests in the network's performance and reliability.

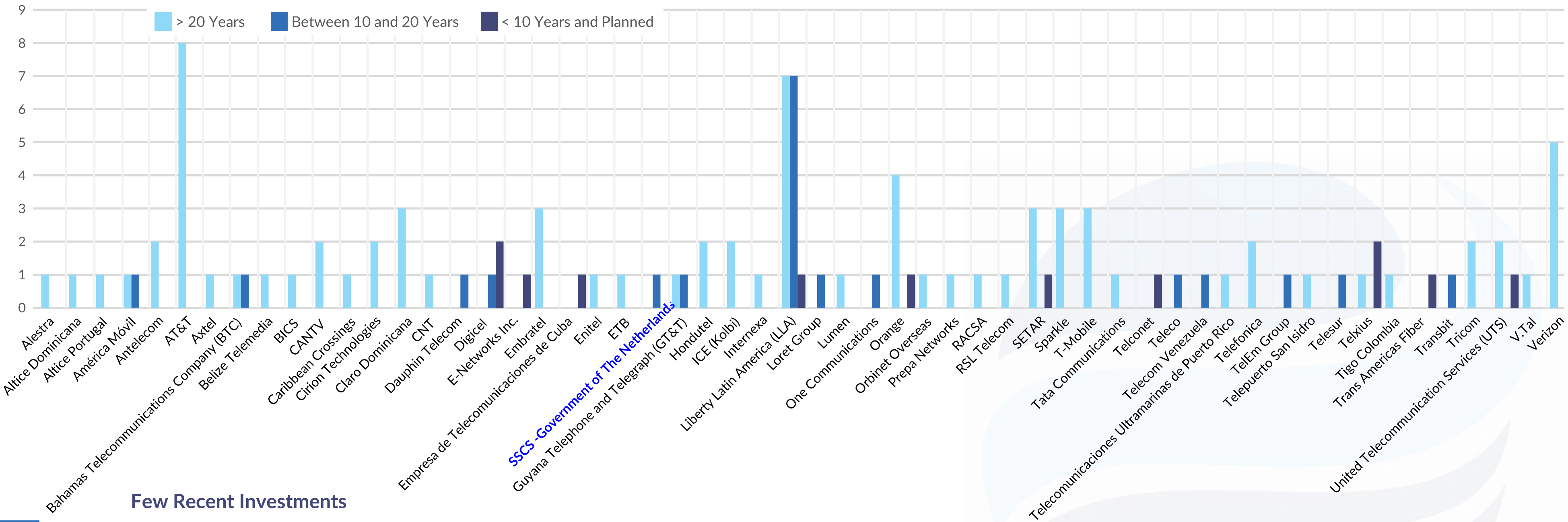
- Increasing Government involvement is also notable in the Caribbean's submarine cable landscape, particularly in smaller or less commercially attractive markets. State-owned enterprises or public-private partnerships frequently step in to address non-commercially viable connectivity gaps e.g. the Dutch central government has invested in the SSCS subsea cable to improve connectivity for the BES islands. This intervention helps to guarantee that even the most isolated communities can access high-speed internet and other essential telecommunication services, which are crucial for socioeconomic development and integration into the global digital economy.

- Several former incumbent telcos (like AT&T, Sparkle, Telefonica, or Verizon) are no longer active, or have become far more selective in subsea cable construction, and now operate ageing assets, and take smaller stakes in consortia builds.

- There is certainly a lack of competitive tension in the market for international connectivity to/from, and within the Caribbean. The effect of this can be seen in varying degrees in numerous Caribbean countries, with some obvious examples. For example, the Cayman Islands, which is served by two international cables (Maya-1 & CJFS) who's on-island access is controlled by the same entity – LLA. This repeating pattern can be seen with varying degrees across the Caribbean region. With some companies extending their influence by purchasing majority stakes in existing regional operators. For example, the Bahamas Telecommunications Company (BTC) is 51% owned by Liberty Latin America (LLA).

Cable Ownership Structure in the Caribbean Region

Number of International Subsea Cables per Operator and Age



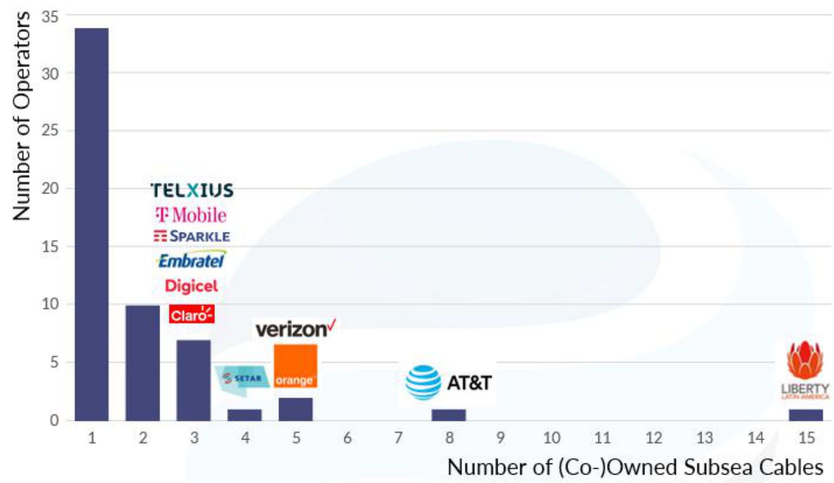
Few Recent Investments

- Several former incumbent telcos (like AT&T, Sparkle, Telefonica, or Verizon) are no longer active in subsea cable construction and now operate ageing assets.
- Many regional or local telcos built subsea cables 15-20 years ago to bring international high-speed connectivity to their territories as an alternative to communication satellites.
- Most of the recent builds come from new or regional players. In addition to TAM-1 (in construction), several cable projects have been developed (with unclear status as of today).
- Caribbean area is one of the very few regions where content providers do not (co-)build as of today.
- Note:
  - Bahamas Telecommunications Company (BTC) is 100% owned by Liberty Latin America (LLA).
  - Guyana Telephone and Telegraph (GT&T) and One Communications have the same parent company (: ATN International).
  - Except for single-owned cable systems, the ownership structure of a cable system is typically not publicly available.
  - Some of the operators listed above operate small inter island cable systems. They are purely local operators and are unlikely to launch a project for/in other countries.

Number of Operators and Number of (Co-)Owned Cables

Subsea bandwidth supply is a concentrated market due to LLA footprint.

- Liberty Latin America (LLA) is by far the operator (co-)owning the largest number of subsea cable system (15, not including BTC's BDSNi cable network).
  - Out of the 15 LLA cable, only Pacific Caribbean Cable System (PCCS, connecting USA, Puerto Rico, British Virgin Islands, Aruba, Curaçao, Colombia, Panama, and Ecuador) is under 10 years old.
- The operator second to LLA is AT&T with "only" 7 cable systems. All AT&T cables are over 23 years old.
- Next are Orange and Verizon with 5 subsea cable systems each in the region.
  - Orange is active in subsea cable builds to (i) connect French oversea territories (Kanawa cable between Martinique and French Guiana) and (ii) surprisingly to offer an international gateway to Cuba with the ARIMAO cable system that entered commercial service in 2023.
  - All Verizon cables are over 23 years old.
- SETAR (co-)owns 4 subsea cable systems.
  - SETAR is part of the PCCS consortium (cable in commercial service since 2015)
- 6 operators (co-)own 3 subsea cable systems each.
  - All Claro, Embratel, Sparkle, and T-Mobile cables are over 23 years old.
  - Digicel built two recent cables (CARCIP in 2019 and Deep Blue One in 2024).
  - Setar is part of the PCCS consortium (cable in commercial service since 2015)
  - Telxius is also part of the PCCS consortium (cable in commercial service since 2015) and the single owner of the BRUSA cable (2018, connecting USA, Puerto Rico, and Brazil).



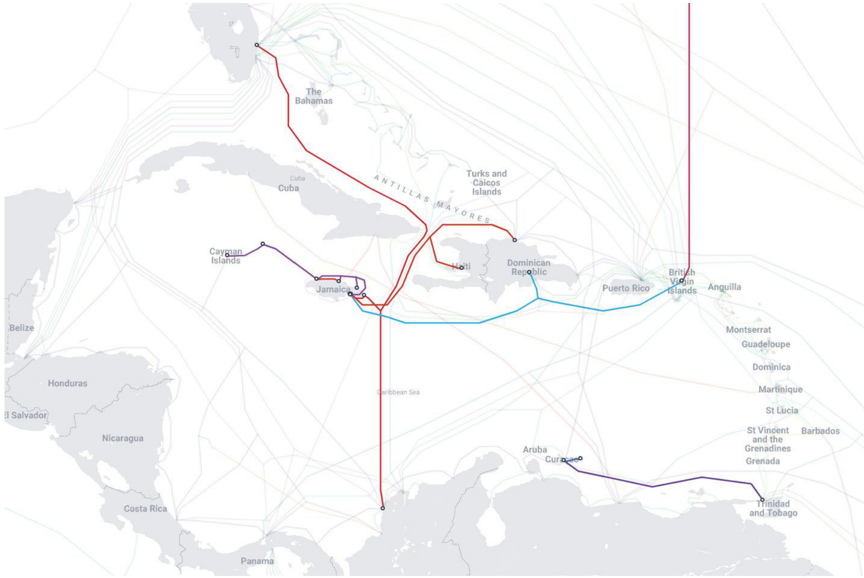
Simplistic Market Concentration Index

- The market share of each subsea cable system operator in the region is approximated by the number of (co-)owned cable systems divided by the total number of cable systems considered.
- The market concentration index estimated by Herfindahl-Hirschman Index (HHI), is 2,930 (up to 3,090 if LLA and BTC assets are combined under a single ownership).
- **Note:** The U.S. Department of Justice considers a market with an HHI of less than 1,500 to be a competitive marketplace, an HHI of 1,500 to 2,500 to be a moderately concentrated marketplace, and an HHI of 2,500 or greater to be a highly concentrated marketplace. A more refined market concentration study should not rely solely on the HHI.

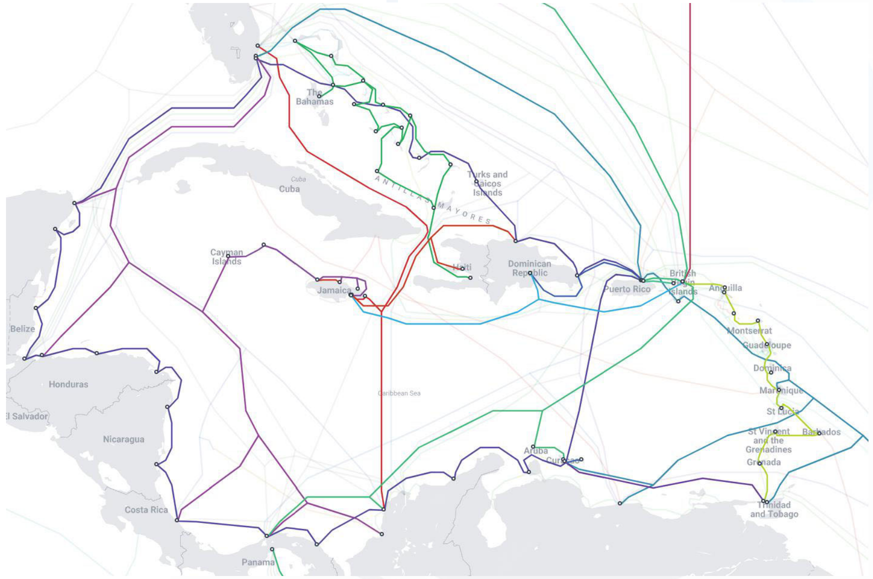
LLA (+ BTC) Subsea Cable Footprint in the Region

Maps below represent the cable asset that LLA (+ BTC) has (co-)built in the region.

100% Owned by LLA (+ BTC)
- Caribbean-Bermuda U.S. (CBUS)
- Cayman-Jamaica Fiber System (CJFS)
- Colombia-Florida Subsea Fiber (CFX-1)
- East-West
- ECLink
- Fibralink
- Gemini Bermuda
- Jerry Newton

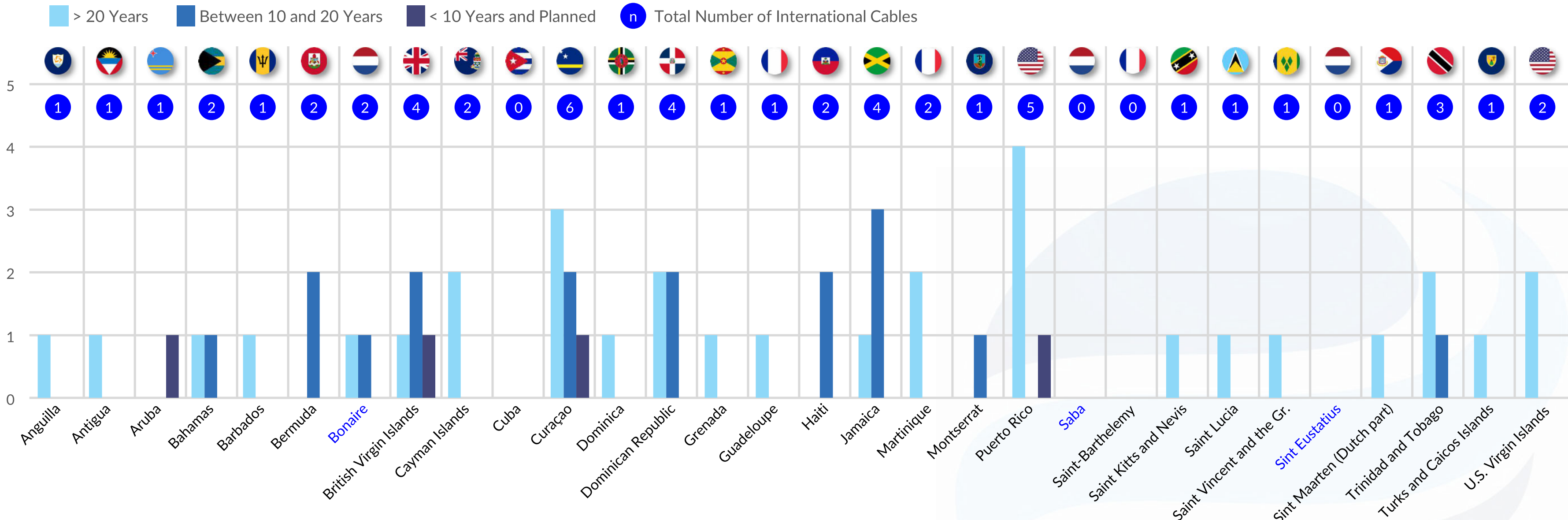


100% Owned or Co-owned by LLA (+ BTC)
- Americas-II
- Amerigo Vespucci
- Antillas 1
- ARCOS
- Bahamas Domestic Submarine Network (BDSNi)
- Caribbean-Bermuda U.S. (CBUS)
- Cayman-Jamaica Fiber System (CJFS)
- Colombia-Florida Subsea Fiber (CFX-1)
- East-West
- Eastern Caribbean Fiber System (ECFS)
- ECLink
- Fibralink
- Gemini Bermuda
- Jerry Newton
- Maya-1
- Pacific Caribbean Cable System (PCCS)
- Taino-Carib



Number of LLA (Co-)Owned Cables per Country and Age

LLA (+BTC) connects 26 out of the 30 island states considered in this report.



Very High Capillarity of LLA (+ BTC) Subsea Cable Network in the Region

- The chart above combines the subsea cable assets of both LLA and Bahamas Telecommunications Company (BTC, 100% owned by LLA). BTC assets include 2001 ARCOS cable system and 2006 Bahamas Domestic Submarine Network (BDSNi) cable systems.
- In the past 30 years, LLA and BTC have invested in 16 international subsea cables in the region that allows to connect 26 island states.
- Eastern Caribbean Fiber System (ECFS, co-owned with 5 other telcos) alone allows to connect 12 countries to British Virgin Islands, which offer connectivity to the USA, Colombia, and Central America. ECFS has been in commercial operation since close to 30 years but, based on unrepeatered segments, its lifetime might be extended by at least a further 5 years.
- The only four Caribbean countries that are not connected by LLA/BTC cable network among the 30 islands considered in this study are Cuba, Saba (2,050 inhabitants), Saint-Barthelemy (10,800 inhabitants), and Sint Eustatius (3,300 inhabitants).

Monopoly Situations

Caribbean Overview

- In many areas of the world, the market for international connectivity supports multiple submarine cables, which can lead to highly competitive situations. Where it exists, this kind of competition often leads to competitive pressure on pricing, high quality customer service, innovation and flexibility. This in turn supports dynamic and thriving digital economies, with ongoing inward investment stimulating the economy, and citizens benefiting from the advantages that connectivity can bring across education, healthcare, entertainment and other sectors.
- There appears, however, to be a lack of competitive tension in the market for international connectivity to/from, and within the Caribbean. The effect of this can be seen in varying degrees in numerous Caribbean countries, with some obvious example (e.g. Cayman Islands, which is served by two international cables (Maya-1 & CJFS) who's on-island access is controlled by the same entity – LLA). This pattern can be seen repeated numerous times, with varying degrees across the Caribbean region.
- The barriers to market entry, specifically the large initial capital costs of infrastructure, appear to be too high to support meaningful competition, leading to overwhelming first mover advantage. Without government intervention or significant competitive pressure, the incumbent operator appears to benefit greatly from a natural monopoly.
- It is worth noting that a monopoly as seen in Cayman Islands, can occur due to either one or a combination of two different mechanisms.
  1. Cable Ownership. The CJFS cable is entirely owned by LLA.
  2. Landing Party rights. While Maya-1 is a consortium cable, LLA is the Cayman Landing Party, and controls access to the cable.
- In the instance of Cayman Islands, the effect is the same, i.e. total control of international connectivity rests with one entity.
- Additionally in the Cayman Islands, and as is seen in numerous other locations regionally, LLA's influence often extends across the whole content delivery chain i.e. terrestrial on-island infrastructure, and not just control of the subsea assets. An example of this is the Amerigo Vespucci system connecting Bonaire to Curaçao, as while Telbo own 50% of the cable, their ability to maximise usage is inhibited by the fact it relies on 3rd party (LLA) assets to connect further afield.

4. Overview of Existing Connectivity

4. Overview of Existing Connectivity

Section Summary

- The BES islands (Bonaire, Sint Eustatius, and Saba) can be considered reasonably well connected, in that each has two separate submarine paths off-island, which is regarded as the minimum for any developed island wishing to be part of global digital world. The fact that for Saba and Sint Eustatius both routes are different legs of the same cable system, is not especially detrimental from a route diversity and resilience perspective.

- Both Saba and Sint Eustatius are <200km from the regional hubs of US Virgin Islands & British Virgin Islands, and <100km from Anguilla which has +6 other international links. Therefore, to connect to any of these regional hubs, low-risk, relatively inexpensive, unrepeatered cables could be constructed.

- Both of Bonaire's links are to Curaçao, where a further 6 links are available to connect to the wider-world. Significant additional international connectivity is available in Venezuela (~200km), with international 6 cables, 4 of which are not present in Willemstad, Curaçao, where both Bonaire cables land. Bonaire and Curacao are currently not connected with Venezuela. It is currently not possible for Bonaire to access international connectivity serving Bonaire without encountering the LLA monopoly in some form, whether this with the initial connections to Bonaire from Curaçao, or the following links from Curaçao to the wider region.

- It is reasonable to describe the majority of the submarine infrastructure surrounding the BES islands as mature age, with much of it being built during the 2000 dot.com boom and is subsequently approaching its original technical design life of 25-years. There are newer cables i.e. PCCS (2015) which serves Curaçao, for Bonaire connection. And while the regional hubs of US VI & BVI, plus Puerto Rico, are all 'relatively close' and host numerous modern, international cables, the direct connections from those hubs, to Sint Eustatius, and Saba are currently limited, with most cables bypassing both Sint Eustatius, and Saba.

4. Overview of Existing Connectivity

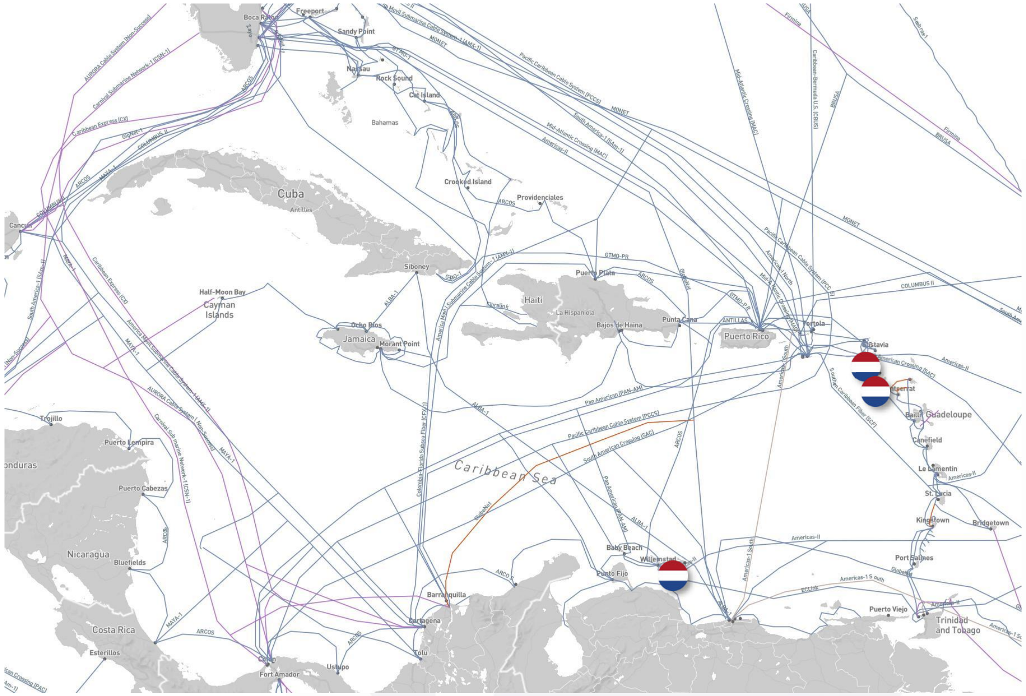
Section Summary

- There are several new, large-scale cables planned for the region (such as TAM-1, CELIA, TIKAL-AMX3, CSN-1 etc…). While some of these will transit reasonably close to the BES islands, none are planned to land in any of the three BES locations, so any improvements in connectivity will be secondary at best.
- As can be seen in later slides in this section, there are a small number of incumbent operators who have a disproportionally high level of influence in the Caribbean, and BES regions particularly. As highlighted, this situation can often lead to poorer end user outcomes, in terms or service, product choice, technology innovation or pricing.
- Saba, Sint Eustatius, and Turks Caicos are the only islands considered in this study connected to the rest of the world by a single subsea cable system.
- For the BES islands, subsea capacity is not an issue, as the combined bandwidth demand for the three municipalities only corresponds to a few 10G circuits in 2023 (to be compared to the typical capacity of 100,000 Gbit/s for recent cable systems deployed in the region).
- Per industry's norms, subsea cable systems are designed engineered, manufactured, and installed for a "*technical lifetime of 25 years*". Sometimes systems are retired for commercial reasons long before they reach 25 years. Likewise, some systems, particularly the smaller, unrepeatered cables can operate long beyond 25 years.
- Generally, the more cables (and operators) involved in an end-to-end connectivity path, the higher the price, the more points of failure, and the higher the risks (simple analogy: air trip with multiple legs, connections, and airlines involved).

Overview of Existing Connectivity In the Caribbean Region

Dense intra-region connectivity, with the U.S. playing the role of regional hub.

- 40+ subsea fiber optic cables have been deployed and are operated the Caribbean region. More cables are planned.
- In addition to the long backbone cable systems built in the 90s by AT&T to the U.S. (and to Brazil), local telcos built some old point-to-point cable systems.
- More recently, local/regional cable systems have been built by regional operators and/or private developers.
- As a result, most of the Caribbean islands have at least two international subsea cables landing on their shores. Montserrat, Saba, Sint Eustatius, and Turks and Caicos are the only islands considered in this study connected to the rest of the world with a single subsea cable.
- For the BES islands, subsea capacity is not an issue as the combined bandwidth demand for the three municipalities only corresponds to a few 10G circuits in 2023 (to be compared to the typical capacity of 100,000 Gbit/s for recent cable systems deployed in the region).
  - In the next slides, the potential capacity for the regional cable systems are estimated assuming 2024 transmission technology.
  - For unrepeatered cable system, estimating potential capacity can be challenging as the number of fiber pairs is rarely publicized and the potential capacity per fiber pair will be strongly dependent on the fiber attenuation (equally rarely publicized).



Overview of Existing Connectivity In the Caribbean Region

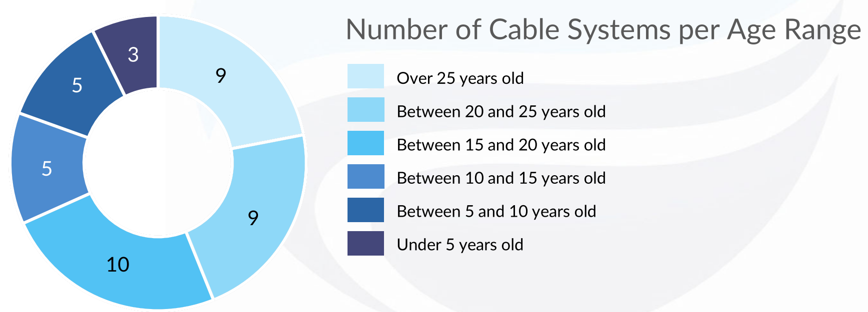
Technical and economic lifetimes of subsea cables are distinct (and may vary).

Technical Lifetime

- Per industry's norms, subsea cable systems are designed engineered, manufactured, and installed for a "technical lifetime of 25 years".
- This 25-year lifetime corresponds to the period of time over which the number of intrinsic failures of the wet plant (excluding external aggression due to, e.g., anchoring, fishing activities, or undersea seismic events) shall be smaller than a given value (typically 1 or 2).
- In other words, the intrinsic reliability of the cable sections, repeaters and branching units must be high enough to guarantee a total number of wet plant failures lower than 1 or 2 over 25 years.
- This 25-year technical lifetime does not represent a hard limit (cable systems do not systematically start to abruptly degrade past the first 25 years of operation). Some systems with submerged repeaters have been in continuous operation for more than 30 years (see, e.g., Americas-I North and Columbus-II b cable systems in the Caribbean region).
- Unrepeatered subsea cable systems (with no active repeaters deployed undersea) intrinsically offer a longer lifetime. The 130 km Taino-Carib cable has been in service since 1993. Some unrepeatered systems in Europe have been in service since 1992.
- Causes that may ultimately limit the technical lifetime include
  - Number of cable cuts higher than expected with additional cable attenuation due to subsequent cable repairs.
  - For repeatered systems: increasing rate of failure for optical and electrical components in the wet pant and availability of spare equipment.

Economic Lifetime

- Economic life is defined as the time when fixed operational costs make higher the cost per unit of bandwidth compared to more recent systems competing on the same route. Cable operational costs are virtually independent of the transported capacity: cable systems with the latest technology systematically offer higher capacity than the previous generation, then lower unit operational costs.
- On a very competitive market like across the transatlantic, this can happen very quickly.
  The Gemini cable was operated for only 8 years before being decommissioned in 2006 after new subsea cable systems based on more advanced transmission technologies offering higher capacity entered commercial service.
- Practically, most repeatered subsea cable systems are decommissioned about 20 years after Ready for Service (RFS) date. Some may be operated a further five years for connectivity uniqueness or strategic reasons (never for economic reasons).



Overview of Existing Connectivity In the Caribbean Region

Subsea cable systems put in service between 1993 and 2000

Cable System	RFS Date	Age	Relevancy for Onward Connectivity to Europe: Saba/Sint Eustatius	Relevancy for Onward Connectivity to Europe: Bonaire	Ownership	Total Length (km)	Type of System	# of Trunk Fiber Pairs	Potential Trunk Capacity (Tbit/s - 2024)*	Connectivity: Route / Number of Countries Connected / Number of Landing Sites
Taino-Carib	1993	31			AT&T, Embratel, LLA, Orange, T-Mobile	130	Unrepeatered			U.S. VIs – Puerto Rico / 2 / 3
Americas-I North	1994	30	✓ (Leg 3)	✓ (Leg 4)	AT&T	2,012	Repeatered	2	3	U.S. VIs – U.S. / 2 / 2
Columbus-II b	1994	30	✓ (Leg 3)	✓ (Leg 4)	AT&T, SETAR	2,068	Repeatered	2	3	U.S. VIs – U.S. 2 / 2
Eastern Caribbean Fiber System (ECFS)	1995	29	✓ (Leg 2)	✓ (Leg 3)	AT&T, Claro Dominicana (Codetel), Guyana Telephone and Telegraph (GT&T), LLA, Orange, Verizon	1,730	Unrepeatered			BVIs – Trinidad and Tobago / 12 / 13
Antillas 1	1997	27			Altice Dominicana, Antelecom, Claro Dominicana (Codetel), LLA, SETAR	650	Unrepeatered			Puerto Rico – Dominican Republic / 2 / 3
Bahamas 2	1997	27			AT&T, Telefonica, Verizon	470	Unrepeatered	5	69	Bahamas – U.S. / 2 / 3
Cayman-Jamaica Fiber System (CJFS)	1997	27			LLA	870	Unrepeatered			Cayman Islands – Jamaica / 2 / 6
Alonso de Ojeda	1999	25		✓ (Leg 2) (As a backup to PCCS)	SETAR, United Telecommunication Services (UTS)	128	Unrepeatered			Curaçao – Aruba / 2 / 2
Amerigo Vespucci	1999	25		✓ (Leg 1)	Antelecom/LLA and Telbo**	85	Unrepeatered			Bonaire – Curaçao / 2 / 2
Americas-II	2000	24	✓ (Leg 3)	✓ (Leg 2)	AT&T, Altice Portugal, CANTV, Corporacion Nacional de Telecomunicaciones (CNT), Embratel, LLA, Lumen, Orange, Sparkle, T-Mobile, Tata Communications, Verizon	8,373	Repeatered	4	9	U.S. – Puerto Rico – Brazil / 8 / 9
GlobeNet	2000	24	✓ (Leg 4)	✓ (Leg 5)	V.tal	23,500	Repeatered	4	32	U.S. – Colombia – Venezuela – Brazil / 5 / 7
Maya-1	2000	24		✓ (Leg 3)	AT&T, América Móvil (Claro), Axtel, BICS, ETB, Embratel, Hondutel, ICE (Kolbi), LLA, Orange, Prepa Networks, RSL Telecom, Sparkle, T-Mobile, Telefonica, Tricom, Verizon	4,400	Repeatered	2	5	Colombia – Panama – Mexico – U.S. / 7 / 7

* Estimates
Note: "Leg X"" indicates which leg in the end-to-end connectivity to Europe the cable is involved in (See Slides #37 to 42).

Overview of Existing Connectivity In the Caribbean Region

Subsea cable systems put in service between 2000 and 2006

Cable System	RFS Date	Age	Relevancy for Onward Connectivity to Europe		Ownership	Total Length (km)	Type of System	# of Trunk Fiber Pairs	Potential Trunk Capacity (Tbit/s - 2024)*	Connectivity: Route / Number of Countries Connected / Number of Landing Sites
			Saba/Sint Eustatius	Bonaire						
Mid-Atlantic Crossing (MAC)	2000	24	✓ (Leg 3)	✓ (Leg 4)	Cirion Technologies	7,500	Repeatered	2	16	U.S. VIs – U.S. / 2 / 3
South American Crossing (SAC)	2000	24			Cirion Technologies, Sparkle	20,000	Repeatered	4	32	Puerto Rico – South America / 8 / 11
ARCOS	2001	23		✓ (Leg 2)	AT&T, Alestra, Bahamas Telecommunications Company, Belize Telemedia, CANTV, Claro Dominicana (Codetel), Enitel, Hondutel, ICE (Kolbi), Internexa, LLA, Orbinet Overseas, RACSA, Telecomunicaciones Ultramarinas de Puerto Rico, Telepuerto San Isidro, Tigo Colombia, Tricom USA, United Telecommunication Services (UTS), Verizon	8,600	Unrepeatered and Repeatered	6 / 3	24**	Caribbean Ring / 15 / 24
Bahamas Internet Cable System (BICS)	2001	23			Caribbean Crossings	1,100	Unrepeatered	12	166	Bahamas – U.S. / 2 / 8
South America-1 (SAm-1)	2001	23	✓ (Leg 3)	✓ (Leg 4)	Telxius	25,000	Repeatered	4	28	U.S. – South America / 10 / 16
Sint Maarten Puerto Rico Network One (SMPR-1)	2004	20			Dauphin Telecom, TelEm Group	375	Unrepeatered			Sint Marteen – Puerto Rico / 2 / 2
Bahamas Domestic Submarine Network (BDSNi)	2006	18			Bahamas Telecommunications Company, Teleco	2,817	Unrepeatered			Bahamas – Haiti / 2 / 15
Fibralink	2006	18			LLA	1,000	Repeatered	3	24	Jamaica – Haiti – Dominican Republic / 3 / 5
Global Caribbean Network (GCN)	2006	18	✓ (Leg 2)		Loret Group	890	Repeatered			Puerto Rico – U.S. Vis – Saint Martin – Guadeloupe / 5 / 6
Southern Caribbean Fiber (SCF)	2006	18	✓ (Leg 2)	✓ (Leg 3)	Digicel	3,000	Unrepeatered and Repeatered			Trinidad and Tobago – Antilles – U.S. Vis – Puerto Rico / 14 / 16

* Estimates
** From EBA's "Digitale Infrastructuur Caribisch Nederland" report (October 2023)

Overview of Existing Connectivity In the Caribbean Region

Subsea cable systems put in service between 2007 and 2018

Cable System	RFS Date	Age	Relevancy for Onward Connectivity to Europe		Ownership	Total Length (km)	Type of System	# of Trunk Fiber Pairs	Potential Trunk Capacity (Tbit/s - 2024)*	Connectivity: Route / Number of Countries Connected / Number of Landing Sites
			Saba/Sint Eustatius	Bonaire						
ECLink	2007	17		✓ (Leg 2)	LLA	987	Repeatered			Curaçao – Trinidad and Tobago / 2 / 2
Gemini Bermuda	2007	26**	✓ (Leg 4)	✓ (Leg 4)	LLA	1,287	Repeatered	2	5	U.S. – Bermuda / 2 / 2
Jerry Newton	2007	17		✓ (Leg 1)	LLA	90	Unrepeatered			Bonaire – Curaçao /2 /2
Challenger Bermuda-1 (CB-1)	2008	16			One Communications	1,448	Repeatered	2	16	U.S. – Bermuda / 2 / 2
Colombia-Florida Subsea Fiber (CFX-1)	2008	16		✓ (Leg 3)	LLA	2,400	Repeatered	2	28	Colombia – Jamaica – U.S. / 3 / 4
Caribbean-Bermuda U.S. (CBUS)	2009	26**	✓ (Leg 3)	✓ (Leg 3)	LLA	1,600	Repeatered	2	5	BVIs – Bermuda / 2 / 2
Suriname-Guyana Submarine Cable System (SG-SCS)	2010	14			Guyana Telephone and Telegraph (GT&T), Telesur	1,249	Repeatered	2	16	Trinidad and Tobago – Guyana – Suriname / 3 / 3
East-West	2011	26**			LLA	1,750	Repeatered	2	5	Jamaica – Dominican Republic – BVIs / 3 / 3
ALBA-1	2012	12			Telecom Venezuela, Transbit (Cuba)	1,860	Repeatered	Unkn.	Unkn.	Jamaica – Cuba – Venezuela / 3 / 4
Saba, Statia Cable System (SSCS)	2013	11	✓ (Leg 1)		Government of The Netherlands	198	Unrepeatered	12		Saint Kitts and Nevis – Sint Eustatius – Saba – Sint Marteen – Saint Barthélémy / 4 / 5
America Movil Submarine Cable System-1 (AMX-1)	2014	10	✓ (Leg 3)	✓ (Leg 3)	América Móvil (Claro)	17,800	Repeatered	5	92	U.S. – Puerto Rico – Brazil + Colombia – Mexico – U.S. / 8 / 15
Pacific Caribbean Cable System (PCCS)	2015	9	✓ (Leg 3)	✓ (Leg 2)	LLA, SETAR, Telconet, Telxius, United Telecommunication Services (UTS)	6,000	Repeatered	8	202	U.S. – Puerto Rico – U.S. Vis – Aruba – Curaçao – Panama / 8 / 9
BRUSA	2018	6	✓ (Leg 3)	✓ (Leg 3)	Telxius	11,000	Repeatered	8	221	U.S. – Puerto Rico – Brazil / 3 / 4

* Estimates
** From EBA's "Digitale Infrastructuur Caribisch Nederland" report (October 2023)

Overview of Existing Connectivity In the Caribbean Region

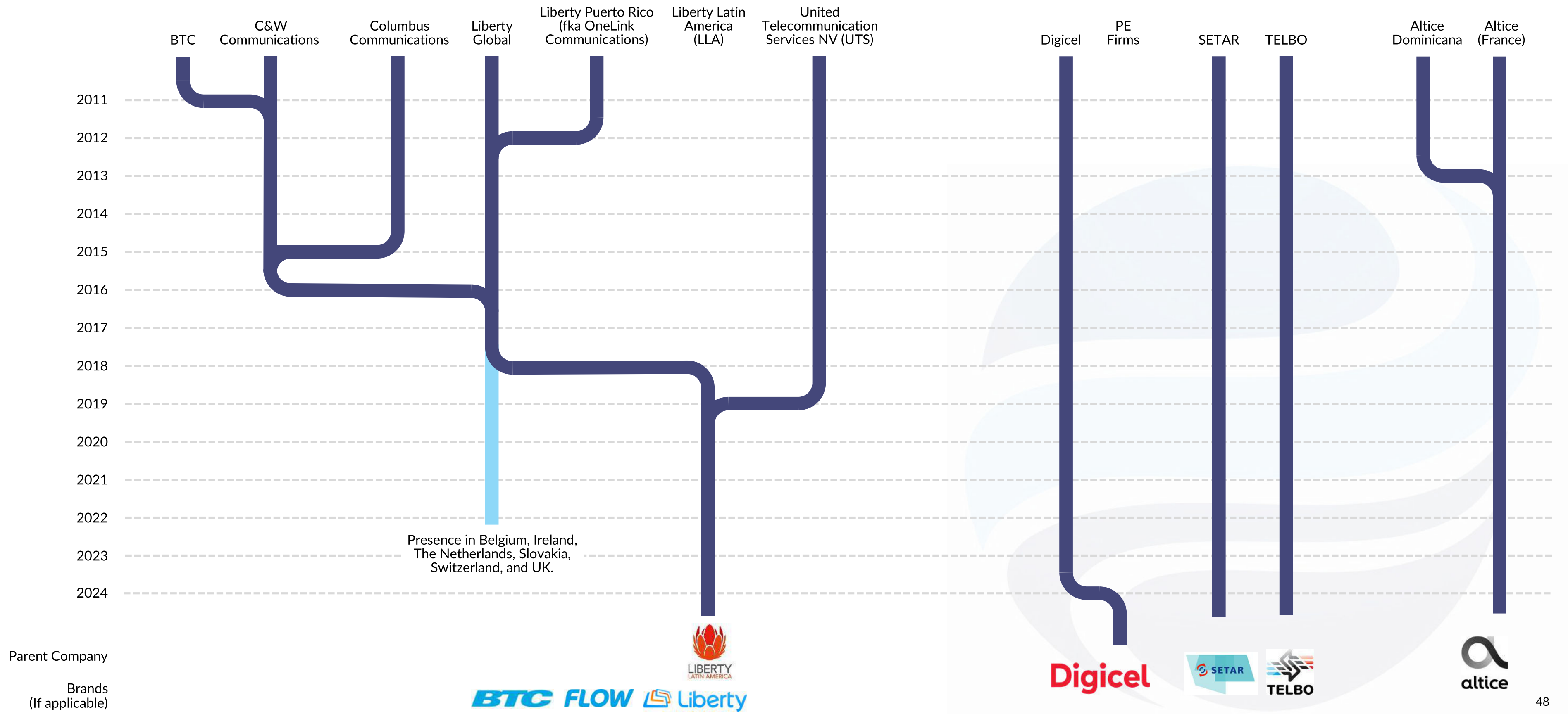
Subsea cable systems put in service after 2019

Cable System	RFS Date	Age	Relevancy for Onward Connectivity to Europe: Saba/Sint Eustatius	Relevancy for Onward Connectivity to Europe: Bonaire	Ownership	Total Length (km)	Type of System	# of Trunk Fiber Pairs	Potential Trunk Capacity (Tbit/s - 2024)*	Connectivity: Route / Number of Countries Connected / Number of Landing Sites
Caribbean Regional Communications Infrastructure Program (CARCIP)	2019	5			Digicel	225	Unrepeatered	Unkn.	Unkn.	Grenada – Saint Vincent and the Grenadines / 2 / 9
Kanawa	2019	5	✓ (Leg 3)		Orange	1,746	Repeatered	2	10	Martinique – French Guiana / 1 / 2
X-Link Submarine Cable	2019	5			E-Networks Inc.	775	Repeatered	Unkn.	Unkn.	Barbados – Guyana / 2 / 2
ARIMAO	2023	1			Empresa de Telecomunicaciones de Cuba and Orange	2,470	Repeatered	Unkn.	Unkn.	Cuba – Martinique / 2 / 2
Deep Blue One	2024	0	✓ (Leg 3)	✓ (Leg 3)	Digicel	2,250	Repeatered	8	110	Trinidad and Tobago – Guyana – Suriname – French Guiana / 4 / 5
TAM-1	2025	n.a.	✓ (Leg 3)	✓ (Leg 3)	Trans Americas Fiber	7,000	Repeatered			U.S. – Puerto Rico BVIs – U.S. VIs – Colombia – Panama – Mexico / 12 / 13
Projects in Planning Phase not Considered in "Cable Ownership Structure" Section										
Carnival Submarine Network-1 (CSN-1)	2025	n.a.		✓ (Leg 3)	Telconet	4,500	Repeatered			Colombia – Panama – U.S. / 5 / 5
TIKAL-AMX3	2026	n.a.		✓ (Leg 3)	América Móvil (Claro, AMX3), Telxius (Tikal)	1,935	Repeatered	Unkn.	380	Guatemala – Mexico – U.S. /3 / 3
Gold Data-1 (GD-1)/Liberty Networks-1 (LN-1)	2026	n.a.		✓ (Leg 3)	Gold Data, LLA	2,333	Repeatered	10	250	Colombia – Panama – Mexico – U.S. / 4 / 6
CELIA	2027	n.a.		✓ (Leg 2)	APUA, Orange, SETAR, Telxius	2,333	Repeatered	4	Unkn.	Aruba/Martinique/Antigua to U.S. / 4 / 4
Projects in Planning Phase with Unclear Status										
Aurora	?			✓	ACN Subsea / FP Telecommunications	2,750	Repeatered	16	320	Colombia – Panama – Mexico – U.S. / 6 / 6
Caribbean Express (CX)	?			✓	Ocean Networks	4,500	Repeatered	18	324	Colombia – Panama – Mexico – U.S. / 4 / 4
GigNet-1	?			✓	FB Submarine Partners and GigNet	1,200	Repeatered	Unkn.	Unkn.	U.S. – Mexico / 2 / 2

* Estimates

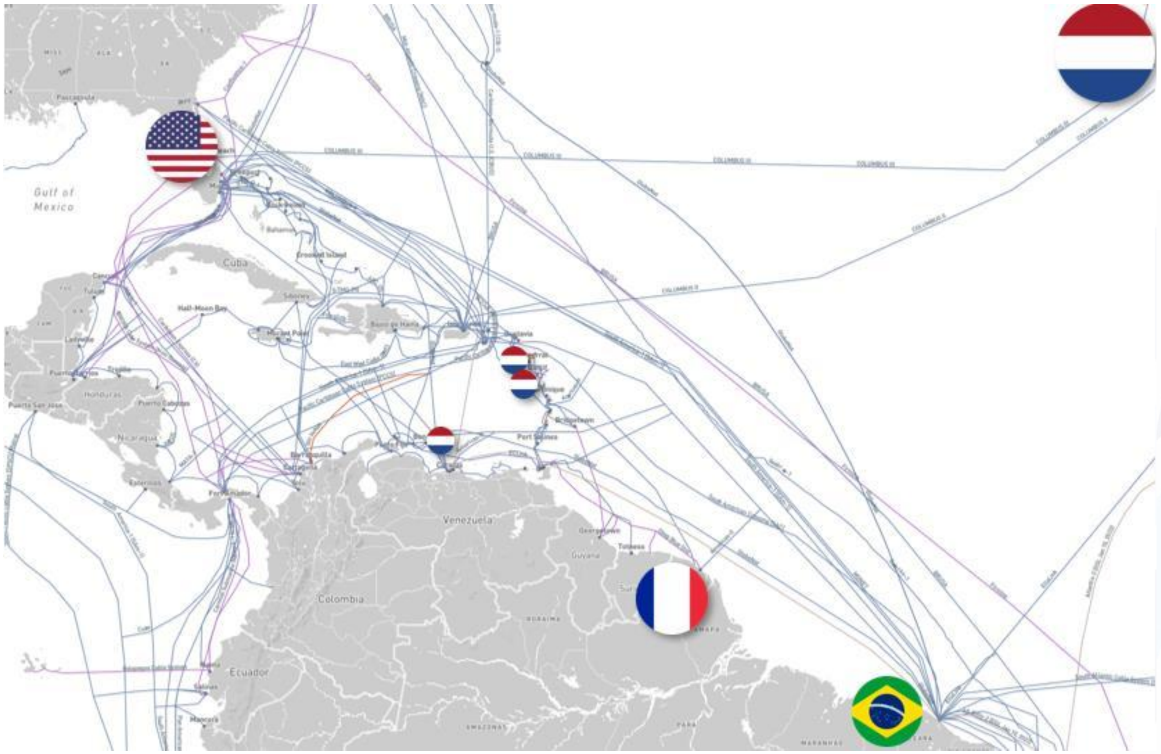
Review of Acquisitions which Have Affected Regional Connectivity

LLA acquired many regional providers to build a global network in the region.



Existing Connectivity for BES Municipalities

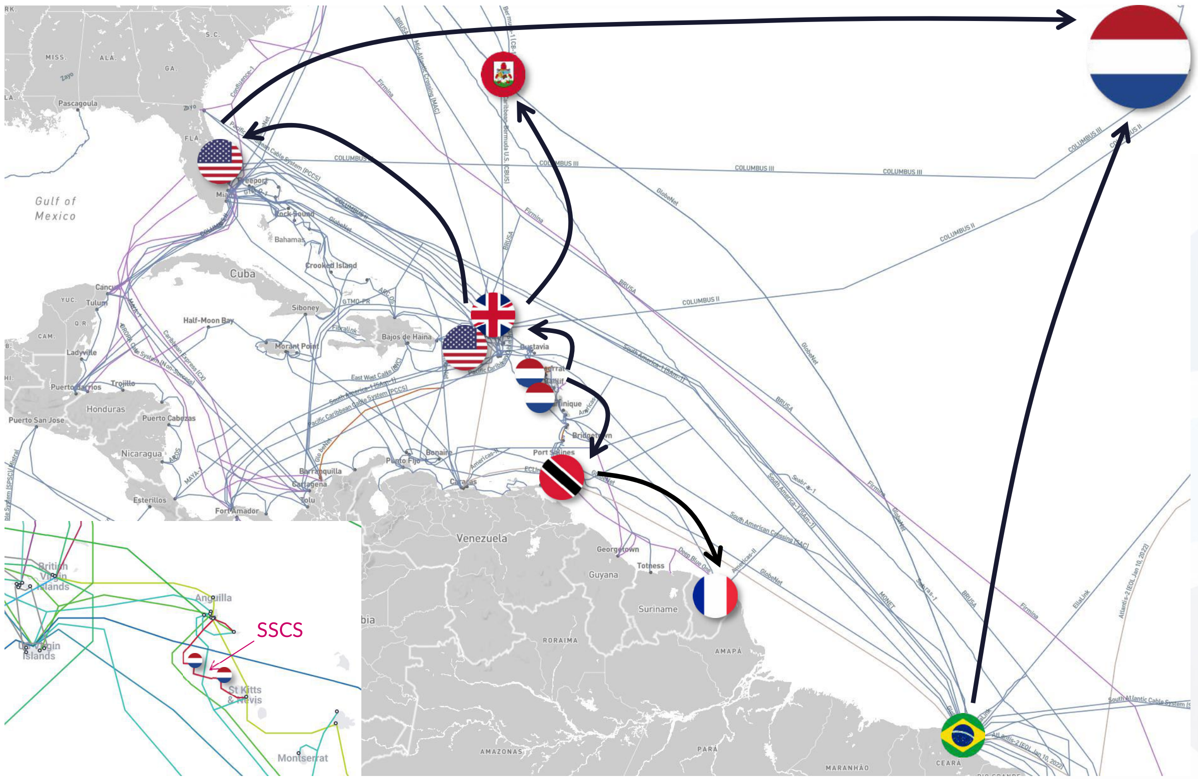
Rules and principles followed for reviewing existing BES connectivity



- The number, connectivity, and capillarity of the subsea cable systems deployed in the Caribbean region allow to build many paths for connecting BES municipalities to mainland Europe and The Netherlands.
- Generally, the more cables (and operators) involved in an end-to-end connectivity path, the higher the price, the more points of failure, and the higher the risks (simple analogy: air trip with multiple legs, connections, and airlines involved).
- The review of the existing connectivity between BES municipalities to mainland Europe and The Netherlands was focused on paths involving a maximum of 4 subsea cable systems between BES municipalities and mainland U.S., Fortaleza (Brazil), or Cayenne (French Guiana). This metric (4) reflects 'normal' industry practice when implementing real-world connectivity, to minimise complexity and price.
  - From mainland U.S., many trans-Atlantic cable systems are available in a competitive market to connect to mainland Europe.
  - From Fortaleza, Brazil, the carrier-neutral EllaLink cable system (in commercial service since 2021) offers direct connectivity to Portugal.
  - From Cayenne, French Guiana, a future branch to EllaLink could allow in the midterm, direct connectivity to Portugal. It is understood that the construction of this branch is now confirmed, part financed by CEF-2 support.

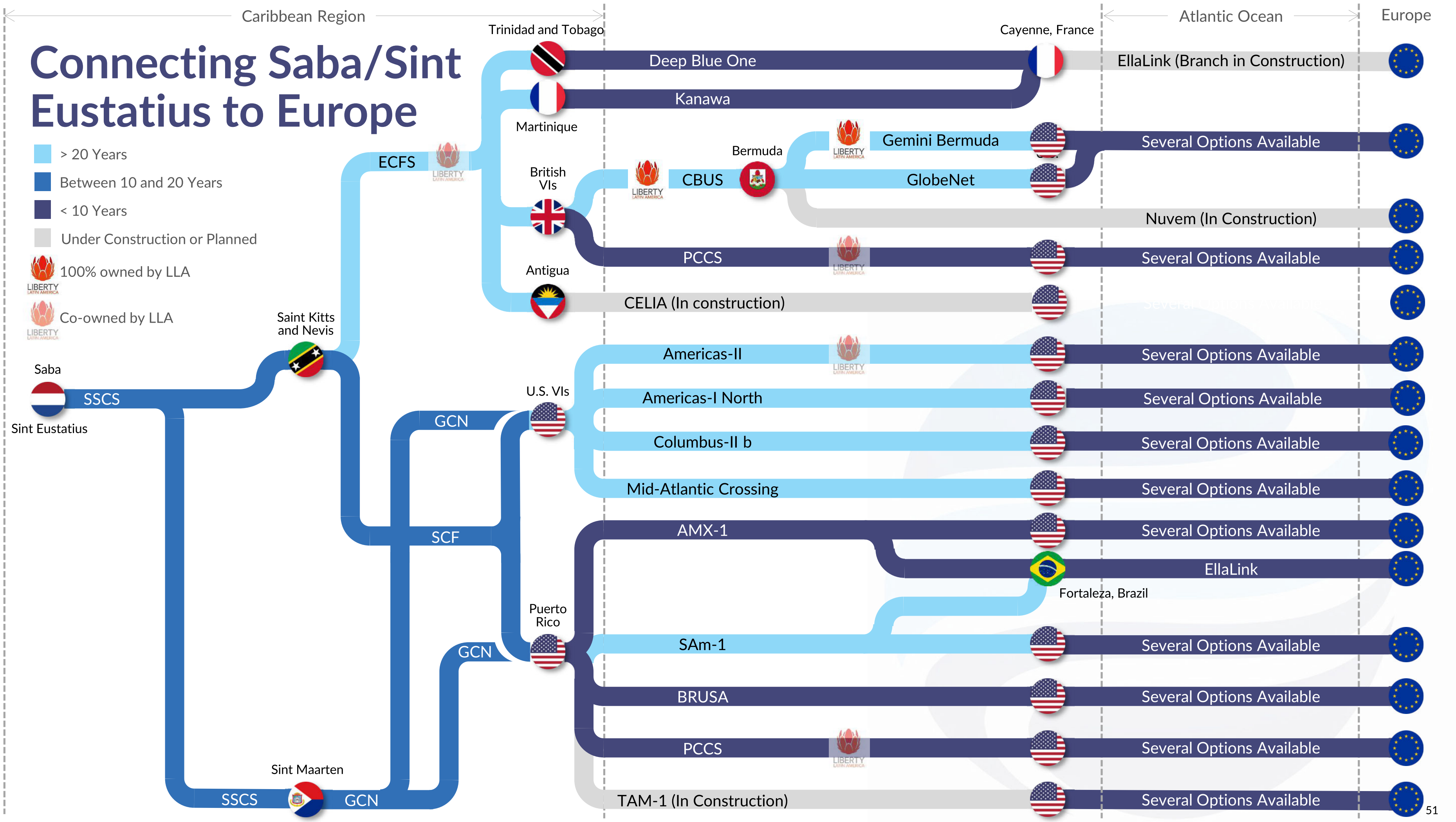
Overview of Existing Connectivity for Saba and Sint Eustatius

From Saba/Sint Eustatius to regional hubs and mainland Europe



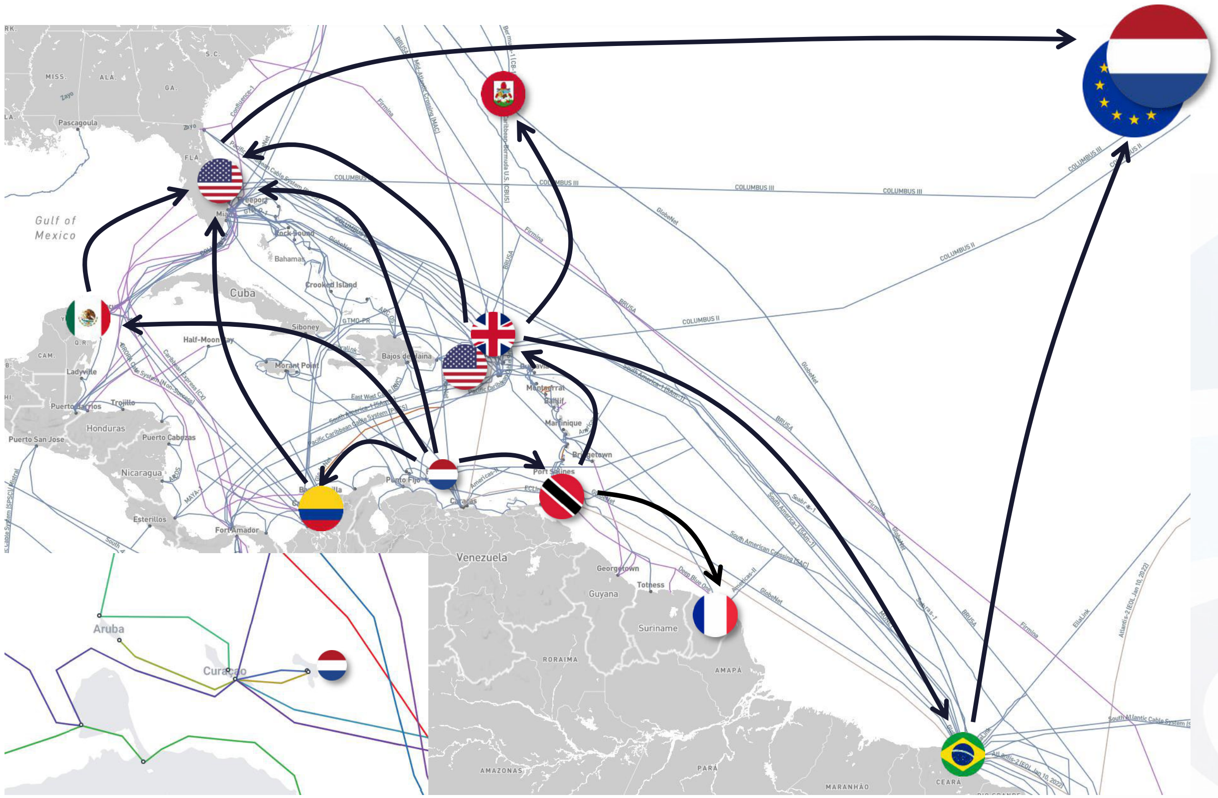
- The first step is to connect to either Sint Maarten or Saint Kitts and Nevis using the Saba, Statia Cable System (SSCS).
- From there, Eastern Caribbean Fiber System (ECFS), Southern Caribbean Fiber (SCF, Digicel), and Global Caribbean Network (GCN – Group Loret) are the key local subsea cable systems enabling Saba and Sint Eustatius to connect to the regional interconnection hubs in British VIs, Puerto Rico, and U.S. VIs, with onward connectivity mostly to the U.S. (and also to Bermuda and Brazil).
  - The Eastern Caribbean Fiber System (ECFS) was built in 1995 by a consortium of 6 local and global telcos to connect 11 islands to the regional hubs in British VIs and Trinidad and Tobago.
  - ECFS was “duplicated” in 2006 by Southern Caribbean Fiber (SCF, Digicel) and to a lesser extent by Global Caribbean Network (GCN – Group Loret).
- Minimal number of subsea cables required to reach mainland Europe: 4
- Most of the options need to go through mainland U.S.

Connecting Saba/Sint Eustatius to Europe



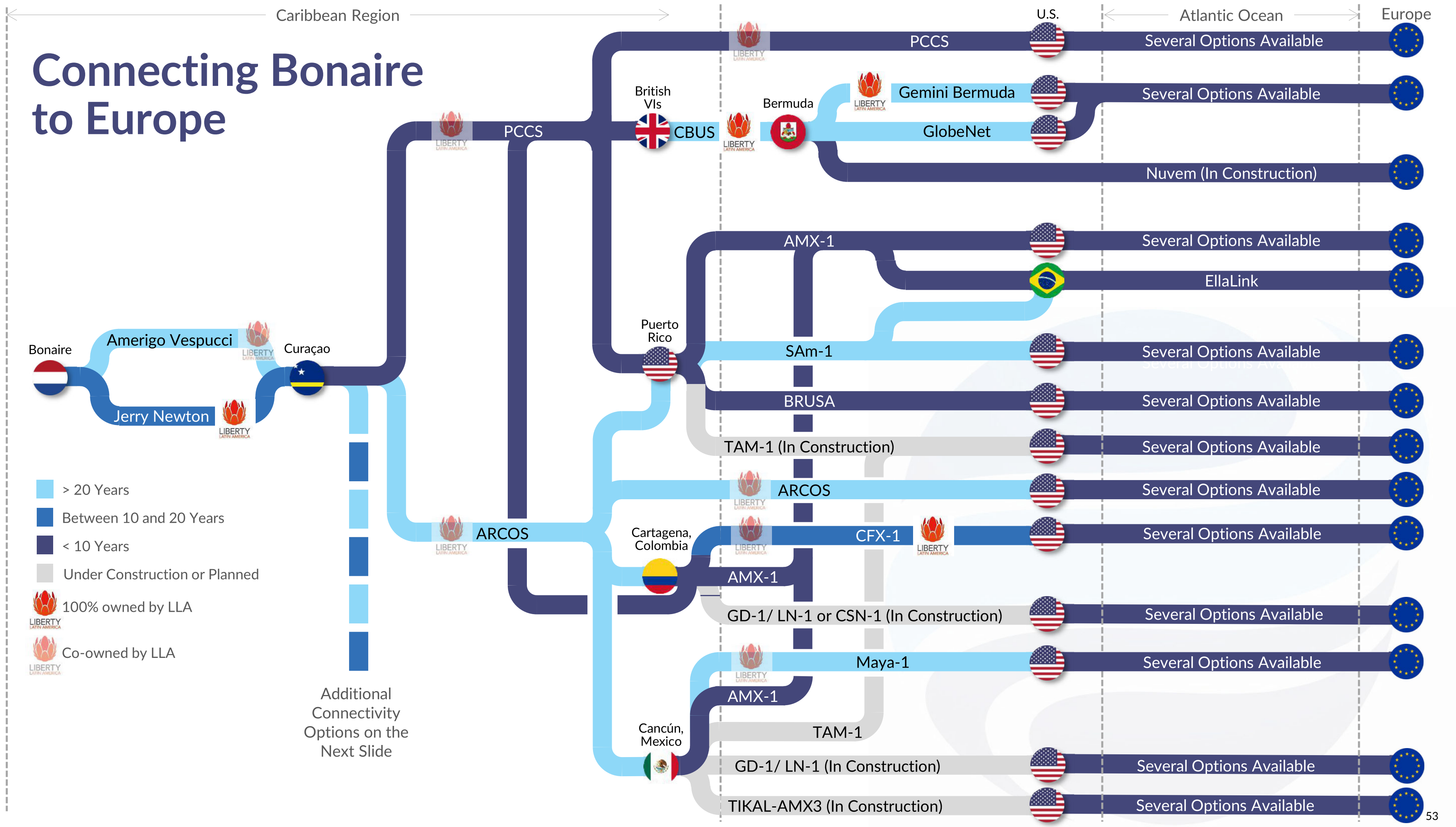
Overview of Existing Connectivity

From Bonaire to regional hubs and mainland Europe

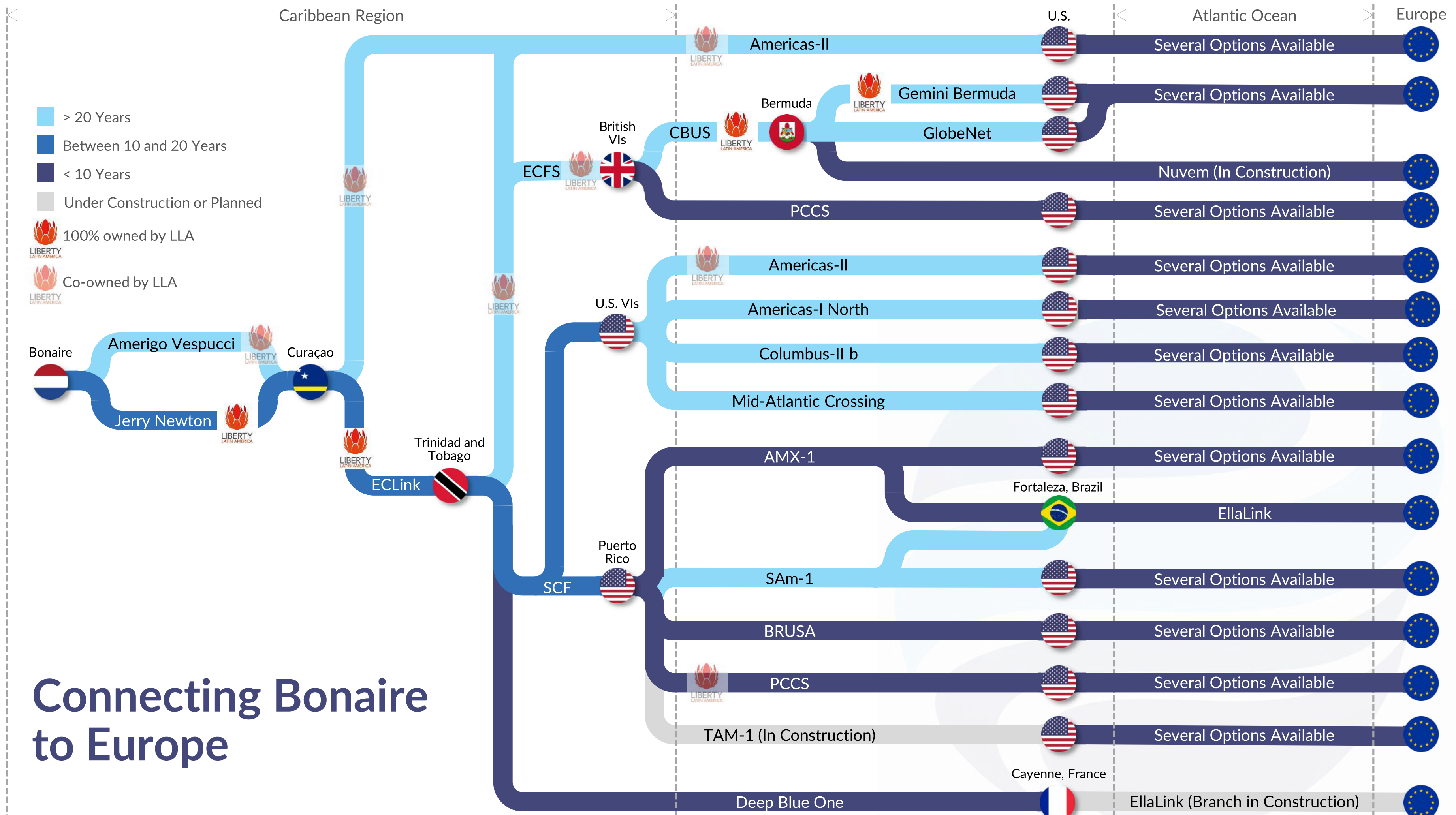


- Bonaire is connected by subsea cables only to Curaçao (2 distinct unrepeatered cables offering 1+1 protection/redundancy). Today, the first step to connect Bonaire to regional or international hubs is to go through Curaçao.
- More connectivity options are available for Bonaire than for Saba/Sint Eustatius as subsea cables in the west part of the Caribbean Sea offer additional connectivity paths to the U.S. (via Colombia or Mexico)
- Minimal number of subsea cables required to reach mainland Europe: 3
    - Amerigo Vespucci or Jerry Newton to connect first to Curaçao, then PCCS or ARCOS cable to the U.S., then trans-Atlantic cable to Europe.

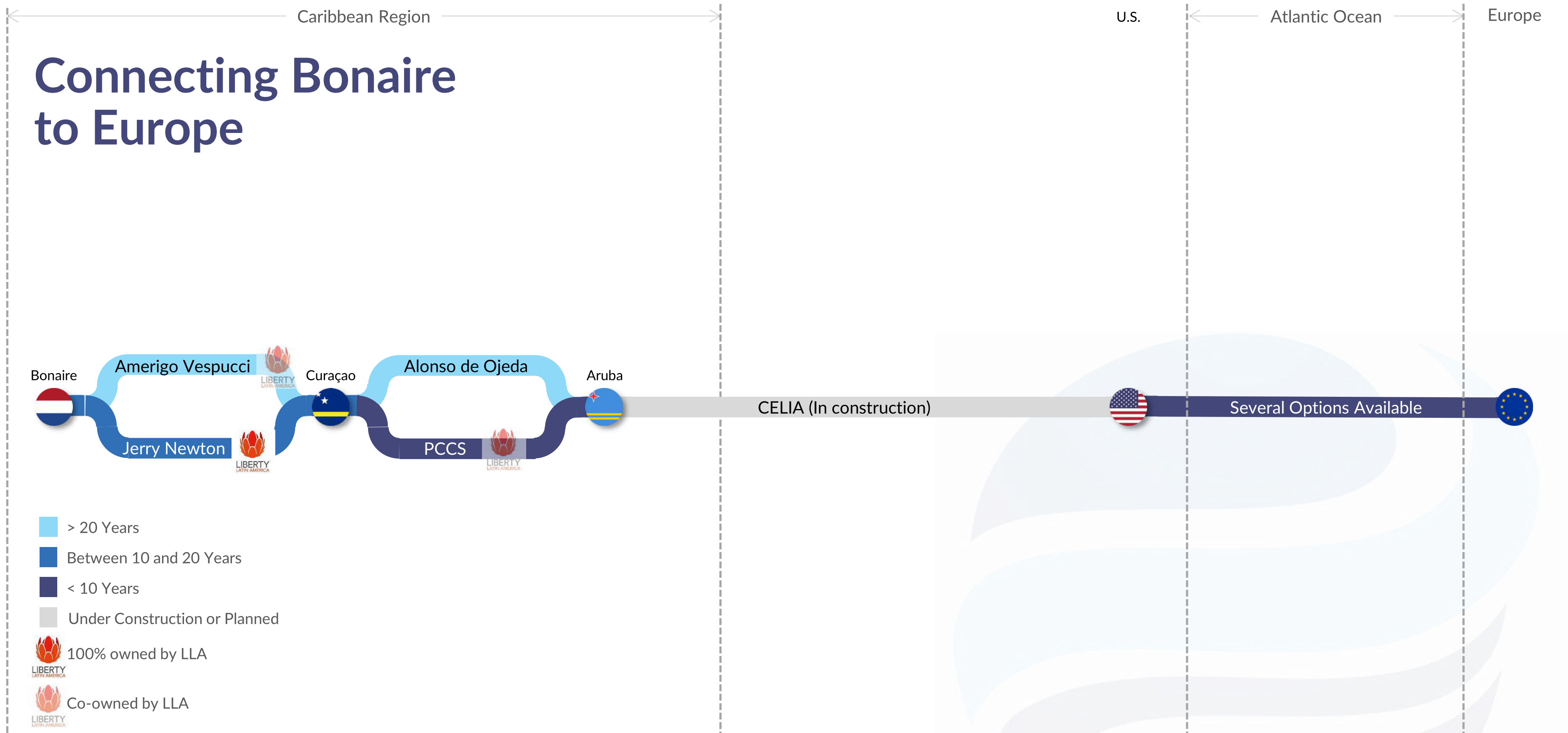
Connecting Bonaire to Europe



Connecting Bonaire to Europe



Connecting Bonaire to Europe



Review of Ownership for Connectivity to Regional Hubs

Depending on the actual role of TELBO, there may be a risk of monopoly situation for Bonaire connectivity.

	Bonaire				Saba		Sint Eustatius
Local Telcos and ISPs	Antelecom (Mobile and long distance) Antilliano Por/Digicel (Mobile, long distance, and Fixed Wireless Access – FWA) Flamingo TV (Internet and TV) TELBO (Internet, TV and telephony)				Antelecom (Long distance) Chippie/Flow (Mobile) Satel (Internet and telephony) TelCell/TelEm (Mobile)		Antelecom (Long distance) Eutel ((internet, TV and telephony) Flow (FWA)
First-Leg Subsea cable System(s)	Amerigo Vespucci		Jerry Newton		Saba, Statia Cable System (SSCS)		
RFS Date	1999		2007		2013		
Age	25		17		11		
Technology	Unrepeatered		Unrepeatered		Unrepeatered		
Landing Parties	Unknown at present.		Unknown at present.		SSCS BV		
Cable (Co-)Owners	Antelecom (Flow/LLA) and TELBO		Antelecom (Flow/LLA)		Government of The Netherlands		
First Intermediate Landing(s)	Curaçao				Saint Kitts and Nevis		Sint Marteen
2nd-Leg Subsea cable Systems	Americas-II	ARCOS	ECLink	PCCS	ECFS	SCF	GCN
Age	24	23	17	14	29	18	18
Technology	Repeatered	Unrepeatered/ Repeatered	Repeatered	Repeatered	Unrepeatered	Unrepeatered	Repeatered
LLA (Co-)Ownership?	Yes	Yes (via BTC)	Yes	Yes	Yes	No	No
# of (Co-)Owners different of LLA	11	18	0	4	5	1	1
2nd Intermediate Landings	U.S. VIs Puerto Rico Miami, FL, U.S. Fortaleza (French Guiana)	Puerto Rico Dom. Republic Miami, FL, U.S.	Trinidad and Tobago	British VIs Puerto Rico Jacksonville, FL, U.S.	British VIs (+ Martinique and Trinidad and Tobago, depending on future EllaLink branch to French Guiana)	U.S. VIs Puerto Rico	U.S. VIs Puerto Rico

5. Potential Alternative Routes, Costing & Mapping

Potential Alternative Routes, Costing & Mapping

Section Summary, General objectives and guidance

- Pioneer's experience shows that in general, the larger or more complicated (e.g. multiple landings, multiple 3rd parties etc..) a proposed submarine project is, the lower the likelihood of it being realized. Within Pioneer we see many proposed systems that never see the light of day, in general it is reasonable to say that the simpler the idea, the higher the chance of success. Therefore, we have used this philosophy to underpin the proposed designs in this section.
- Two types of connectivity options between the BES municipalities and connectivity hubs have been assessed.
  - Construction of new short point-to-point cable systems to connect the BES municipalities to regional connectivity hubs.
  - Construction of subsea branch cables to connect the BES municipalities to the trunk of new cable systems planned in the region.
- Connectivity to regional connectivity hubs and minimization of the latency and number of intermediate landing sites have guided the identification of the potential new connectivity options described in this section.
  - The 'main' regional connectivity hubs include British Virgin Islands, Puerto Rico, Trinidad and Tobago, and U.S. Virgin Islands.
  - As a general rule (and as already expressed on this slide): the more cables (and operators) between the end points, the higher the price, the more points of failure, the higher the complexity, and the higher the risks.
- Several short, unrepeatered options exist for all of the BES islands to increase their connectivity options. These would be considered lower-risk, lower cost options.
- The options for the BES islands to join existing, newly planned systems would be significantly more complicated owing to the multiple parties involved.
- Of note is that all the alternate potential routes identified while addressing the immediate needs for route diversity, connectivity & increased competition, rely on existing regional hubs and do not provide route diversity away from the USA.

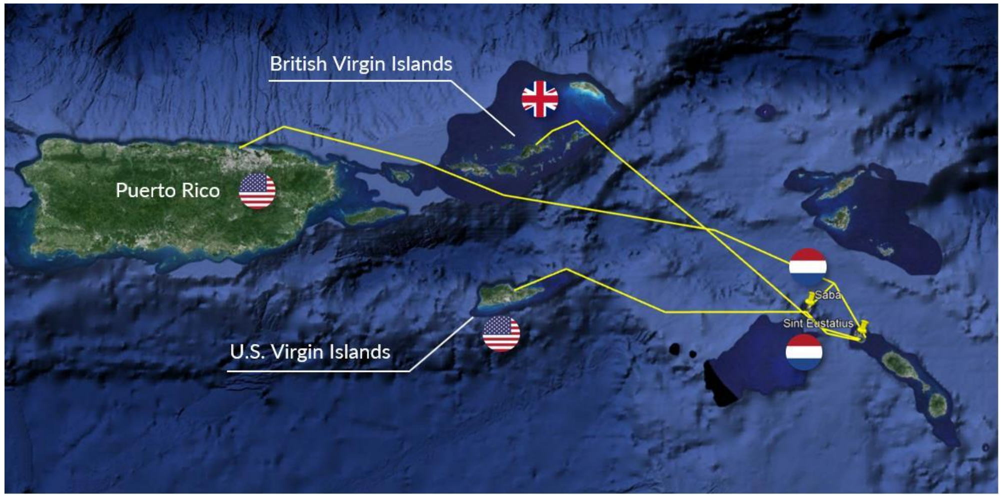
Potential Alternative Routes, Costing & Mapping

Qualitative Assessment Scoring Summary

Criteria	Improved Reliability	Improved Latency to NL EU	Improves Competitive Landscape	Improved 'Directness' to NL EU	Delivery Confidence of Solution
Puerto Rico- Sint Eustatius/ Saba	3	2	5	4	4
British Virgin Islands – Sint Eustatius/ Saba	3	2	5	4	4
U.S. Virgin Islands – Sint Eustatius/ Saba	3	2	5	4	4
Aruba – Bonaire	3	3	3	2	4
Curaçao – Bonaire	3	1	4	1	4
Venezuela – Bonaire	3	1	1	1	2
Firmina	3	2	4	3	2
TAM-1	3	2	4	3	2
CSN-1	2	1	4	1	1
GD-1 / LN-1	2	1	3	1	1

Potential Alternative Routes, Costing & Mapping

New routes for connecting Saba and Sint Eustatius to the nearest regional hubs



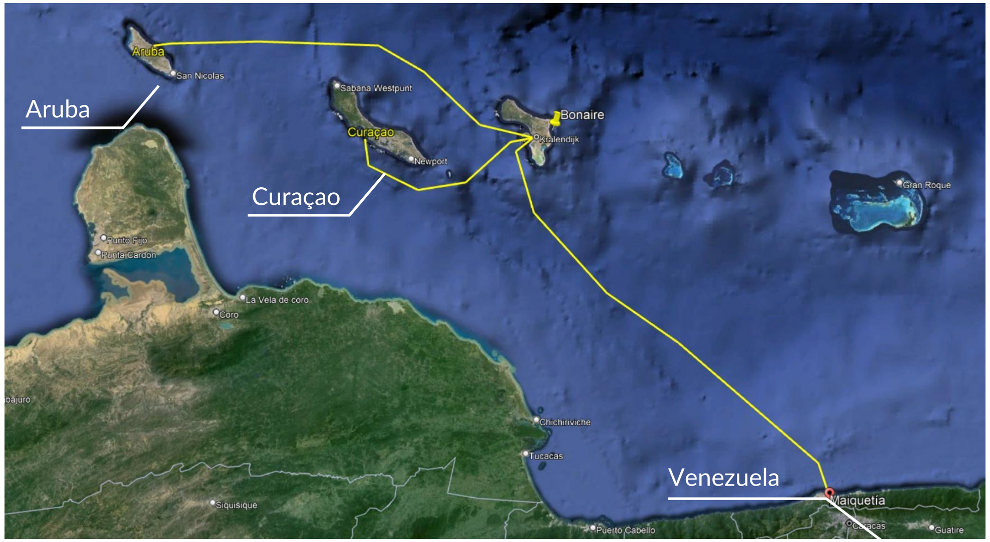
Regional Hub	Span Length	Estimated Cost
Puerto Rico (PR)	400 km	$33M
British Virgin Islands (BVI)	220 km	$25M
U.S. Virgin Islands (USVI)	200 km	$26M

Criteria	PR	BVI	USVI
Improved Reliability	3	3	3
Improved Latency to NL EU	3	2	2
Improves Competitive Landscape	4/5	4	4
Improved 'Directness' to NL EU	4	3	3
Delivery Confidence of Solution	3	3	3

- Connectivity to these regional hubs can be done either via festoon configuration or using a branching unit down to Saba.
- All three of these potential options can be achieved via unrepeatered systems, which are typically cheaper, simpler and quicker to deploy and operate than longer repeatered systems.

Potential Alternative Routes, Costing & Mapping

New routes for connecting Bonaire to its nearest regional hubs



Regional Hub	Span Length	Estimated Cost
Aruba	200 km	$22M
Curaçao	100 km	$19M
Venezuela	240 km	$23M

Criteria	Aruba	Curaçao	Venezuela
Improved Reliability	3	3	3
Improved Latency to NL EU	3	1	1
Improves Competitive Landscape	3	4	1
Improved 'Directness' to NL EU	2	1	1
Delivery Confidence of Solution	4	4	2

- Only point-to-point connections have been considered
- Curaçao is the most ideal location in terms of proximity and availability of other international cables, although all three locations have inherent challenges for out-of-region connectivity.
- All three of these potential options can be achieved via unrepeatered systems, which are typically cheaper, simpler and quicker to deploy and operate than longer repeatered systems.

Potential Alternative Routes, Costing & Mapping

Connecting Saba and Sint Eustatius to closest planned cable via new branch

Criteria	Score
Improved Reliability	3
Improved Latency to NL EU	2
Improves Competitive Landscape	4
Improved 'Directness' to NL EU	3
Delivery Confidence of Solution	2

- Firmina Cable System
  - Planned RFS date: 2024
  - Owner: Google
- Approximate branch length: 1,100 km
- Termination point is U.S., Connection to EU may be via Anjana or Nuvem (or any other trans-Atlantic cables if Confluence-1 cable or U.S. terrestrial connectivity is involved.
- Google has previously sold fiber pairs on international cables (e.g., Equiano), situation on Firmina is unknown.

Potential Alternative Routes, Costing & Mapping

Connecting BES municipalities to closest planned cable

Criteria	Score
Improved Reliability	3
Improved Latency to NL EU	2
Improves Competitive Landscape	4
Improved 'Directness' to NL EU	3
Delivery Confidence of Solution	2

- TAM-1 Cable
  - Planned RFS date: mid/late 2025
  - Marine Survey complete, manufacture underway
  - Owner: Trans Americas Fiber
- U.S. VIs is the closest landing of TAM-1 to Saba so repeaterless design can be considered.
- TAM-1 has landing in Florida, U.S. that provides several options to connect to the EU.

Potential Alternative Routes, Costing & Mapping

Connecting Bonaire to closest planned cable

Criteria	Score
Improved Reliability	2
Improved Latency to NL EU	1
Improves Competitive Landscape	4
Improved ‘Directness’ to NL EU	1
Delivery Confidence of Solution	2

- Carnival Submarine Network (CSN-1) Cable
  - Planned RFS: 2025
  - Owner: Telconet
- Approximate cable length from Bonaire to Barranquilla is 840 km
- CSN-1 has landing in Florida, U.S. that has several options to connect to the EU.
- Not a latency-optimized solution to connect to Europe compared to options involving cables east of Antilles.

Potential Alternative Routes, Costing & Mapping

Connecting Bonaire to closest planned cable via new branch

Criteria	Score
Improved Reliability	2
Improved Latency to NL EU	1
Improves Competitive Landscape	3
Improved 'Directness' to NL EU	1
Delivery Confidence of Solution	2

- Gold Data-1 (GD-1)/Liberty Networks-1 (LN-1) Cable
  - Planned RFS: 2026
  - Owners: Gold Data and Liberty Latin America (LLA)
- Approx. cable length from Bonaire to Barranquilla is 840 km
- GD-1/LN-1 has landing in Florida, U.S. that has several options to connect to the EU.
- Unclear if this project is progressing, limited information.
- Not a latency-optimized solution to connect to Europe compared to options involving cables east of Antilles.

6. Alternative Termination Destinations

6. Alternative Termination Destinations

Section Summary

- The simplest, and most direct way to significantly improve the connectivity of the BES islands to mainland Netherlands, would be to build a dedicated cable out of the Caribbean region to either The Netherlands directly, or to an intermediate, well-connected point along that direct route.

- While at first appearance, a direct cable of this type (from the BES Islands to mainland Europe) would seem highly unusual when viewed through the lens of what is '*usual*' in the submarine cable industry, it is almost entirely cables with a positive commercial business case which are built. However, when viewed as a strategic, or an '*enabling government e-services services to citizens*' point of view, such state-backed cables which while not common, are something we are seeing more interest in, in recent years.

- State intervention in building submarine cables for isolated communities is crucial to ensure equitable access to high-speed internet and advanced e-services, which are essential for economic development, education, healthcare, and overall quality of life. Market forces often neglect certain destinations due to high costs and low profitability, leading to digital divides that hinder their growth and integration into the global economy.

- By investing in submarine cable infrastructure, governments can ensure these isolated islands are connected to international data networks, fostering social inclusion, economic opportunities, and resilience against external shocks. This strategic intervention can also attract private investments, stimulate local businesses, and support essential services, thereby contributing to long-term sustainable development.

Alternative Termination Destinations

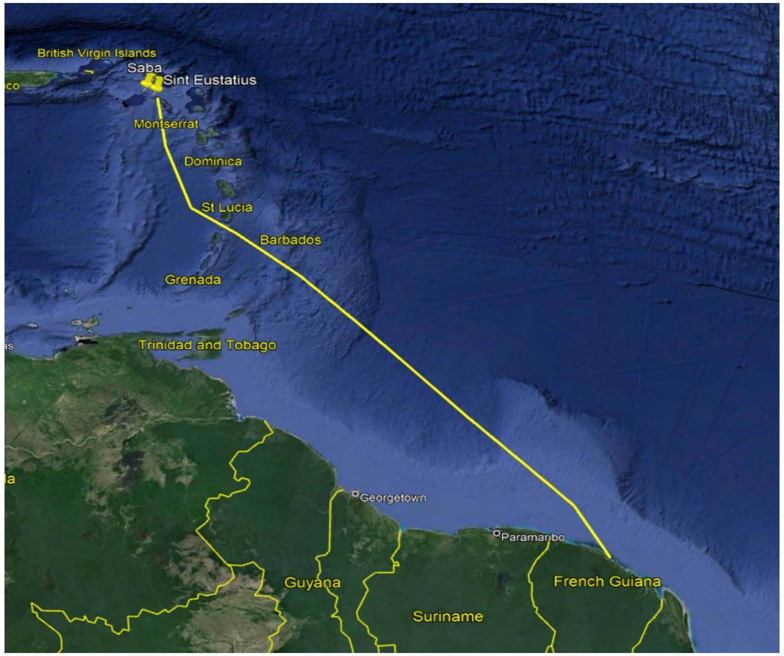
Alternative destinations for a long-haul Trunk, out of Region

- Understanding the requirement for high-level detail on possible ways to connect the BES Islands directly to non-regional hubs to gain more direct access to the EU, Pioneer has identified five potential long-haul routes to achieve this objective.
- To provide a comparative level of detail (mainly costs), we have based all five potential routes from a start point of Sint Eustatius.
- We have also included an overview of a self-build from Sint Eustatius to Bonaire, to allow the extension of the long-haul route.
- The five, long-haul trunk routes identified, and the summary Qualitative Assessment scores are:

Criteria	Improved Reliability	Improved Latency to NL EU	Improves Competitive Landscape	Improved 'Directness' to NL EU	Delivery Confidence of Solution
Sint Eustatius to French Guiana	2	1	2	1	1
Sint Eustatius to Azores Islands	2	5	4	5	3
Sint Eustatius to Bermuda	2	4	4	5	3
Sint Eustatius to Portugal	4	5	5	4	4
Sint Eustatius to Beverwijk, Netherlands	4	5	5	5	4

Alternative Termination Destinations

#1: French Guiana



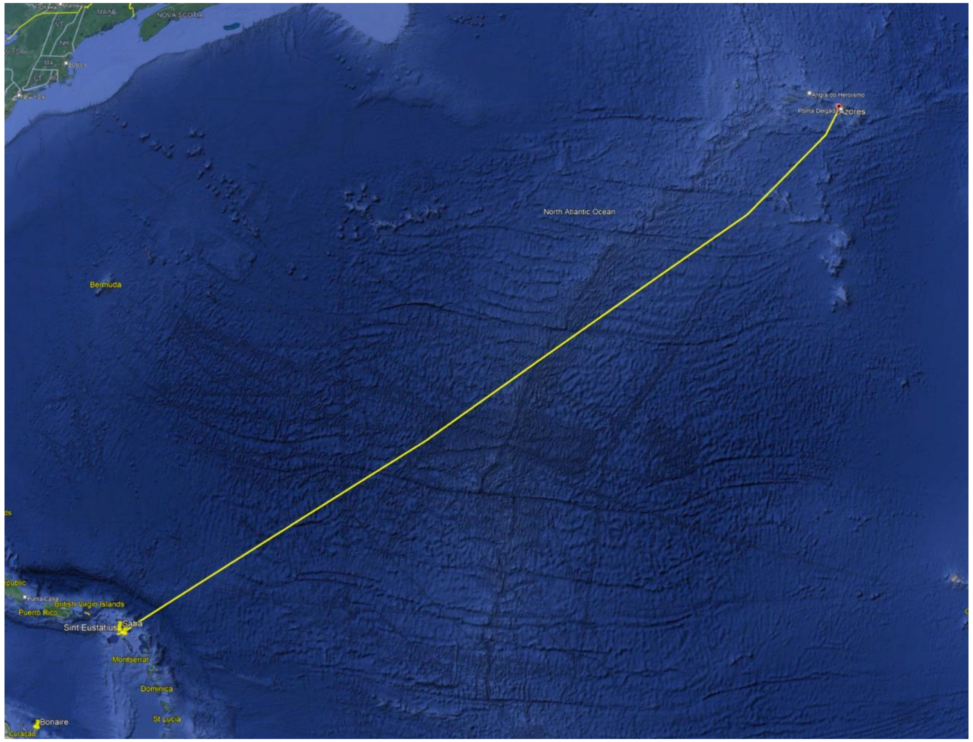
Criteria	Score
Improved Reliability	2
Improved Latency to NL EU	1
Improves Competitive Landscape	2
Improved 'Directness' to NL EU	1
Delivery Confidence of Solution	2

- There is an announced branch planned to connect EllaLink to French Guiana, although confirmed details are not yet publicly available.

Dutch Municipality	Termination Point	Span Length	Estimated Cost
St. Eustatius	French Guiana	1,800 km	$86M

Alternative Termination Destinations

#2: Azores Islands



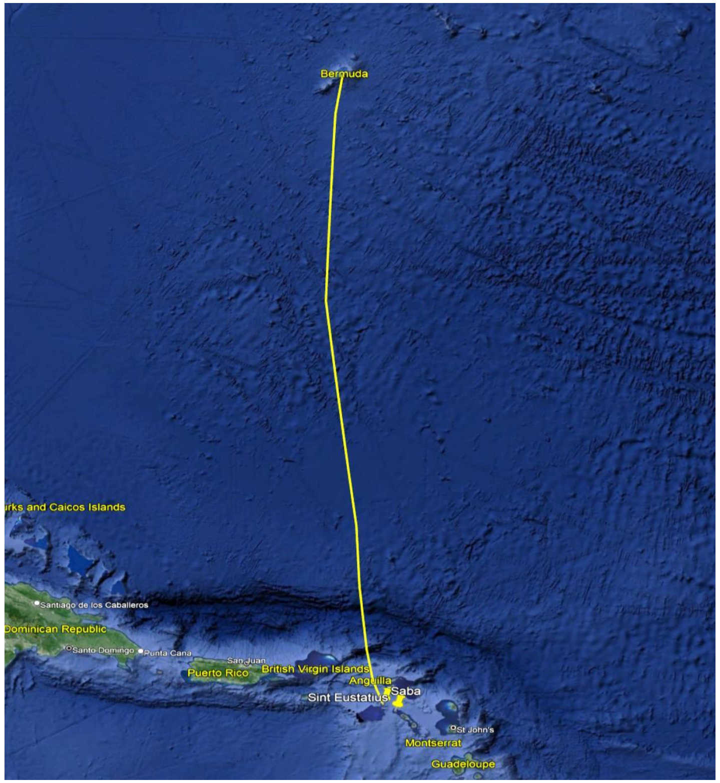
Criteria	Score
Improved Reliability	2
Improved Latency to NL EU	5
Improves Competitive Landscape	4
Improved 'Directness' to NL EU	4
Delivery Confidence of Solution	3

- The proximity of Azores to EU makes it also a candidate alternative termination before going to EU via Portugal.
- There's a planned New CAM Ring with double landing in Portugal, with expected completion in 2026.

Dutch Municipality	Termination Point	Span Length	Estimated Cost
Sint Eustatius	Azores Islands	4,300 km	$171M

Alternative Termination Destinations

#3: Bermuda



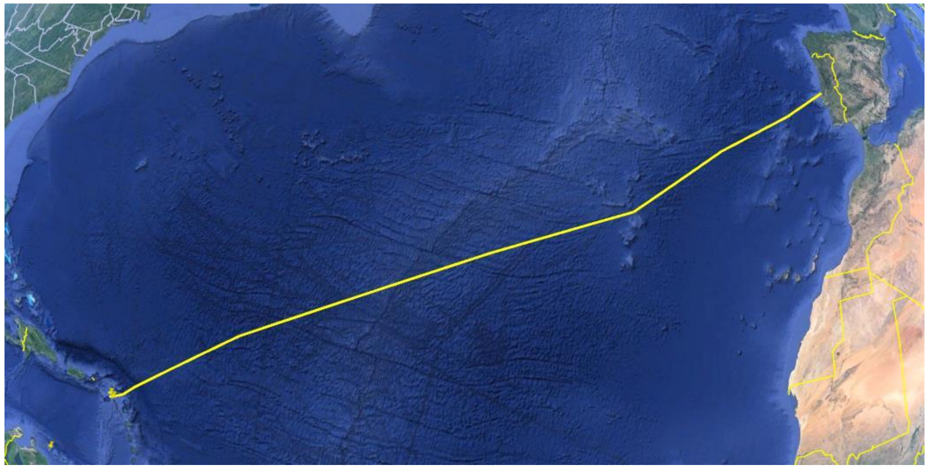
Criteria	Score
Improved Reliability	2
Improved Latency to NL EU	4
Improves Competitive Landscape	4
Improved 'Directness' to NL EU	5
Delivery Confidence of Solution	3

- There are three potential cables that connects Bermuda to EU: Gemini Bermuda (2007/1998), GlobeNet (2000), and the planned cable by Google – Nuvem (2026).

Dutch Municipality	Termination Point	Span Length	Estimated Cost
Sint Eustatius	Bermuda	1,640 km	$82M

Alternative Termination Destinations

#4: Portugal



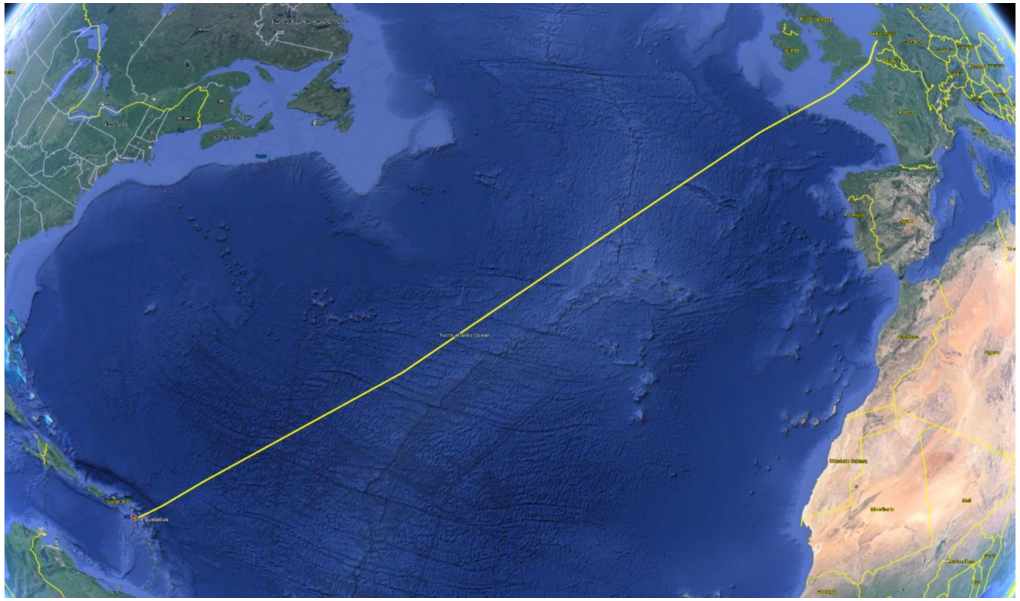
Criteria	Score
Improved Reliability	4
Improved Latency to NL EU	5
Improves Competitive Landscape	5
Improved 'Directness' to NL EU	4
Delivery Confidence of Solution	4

- Portugal is the closest mainland gateway to EU and has multiple terrestrial/express backbone connections to the rest of the EU countries.

Dutch Municipality	Termination Point	Span Length	Estimated Cost
Sint Eustatius	Portugal	5,750 km	$220M

Alternative Termination Destinations

#5: Beverwijk, Netherlands

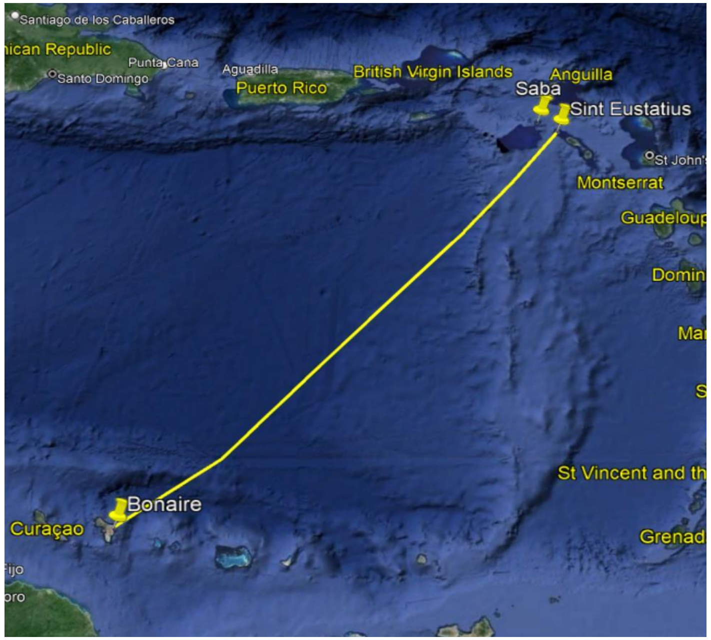


Criteria	Score
Improved Reliability	4
Improved Latency to NL EU	5
Improves Competitive Landscape	5
Improved 'Directness' to NL EU	5
Delivery Confidence of Solution	4

Dutch Municipality	Termination Point	Span Length	Estimated Cost
Sint Eustatius	Beverwijk, Netherlands	6,850 km	$237M

Alternative Termination Destinations

Bonaire-St. Eustatius Direct Connection



Criteria	Score
Improved Reliability	1
Improved Latency to NL EU	3
Improves Competitive Landscape	3
Improved 'Directness' to NL EU	4
Delivery Confidence of Solution	4

- From St. Eustatius to other potential alternative routes (Azores, Bermuda, French Guiana, and Portugal), a direct subsea connection to Saba and Bonaire is needed to completely serve all the three islands.

Dutch Island A	Dutch Island B	Span Length	Estimated Cost
Bonaire	St. Eustatius	820 km	$55M

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Owning the high-level design nature of the potential solutions outlined in Sections 5 and 6, and continued compounding global inflations pressures, all CAPEX costs should be considered with a tolerance of ±30/%.

Thank You

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