

TeleGeography Workshop

Submarine Cable Growth: Fashions from Yesteryear

Tim Stronge

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Questions to answer

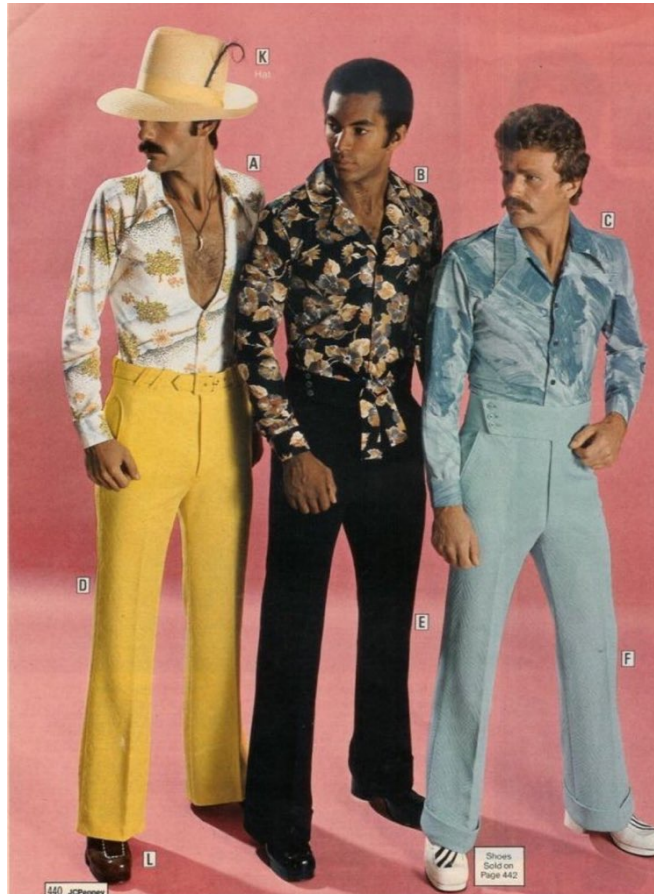
- What's driving bandwidth demand?
- Where are content & cloud providers contributing CAPEX?
- Will the cable buildout boom end?

My value proposition to you

1. I'm doing this live
 - If I mess up there's no going back
 - Point and laugh from the comfort of your own home
2. Some stuff might actually be interesting (?)
3. Awkwardly shoehorned theme
 - Fight your boredom by looking at these funny pictures

What you can expect

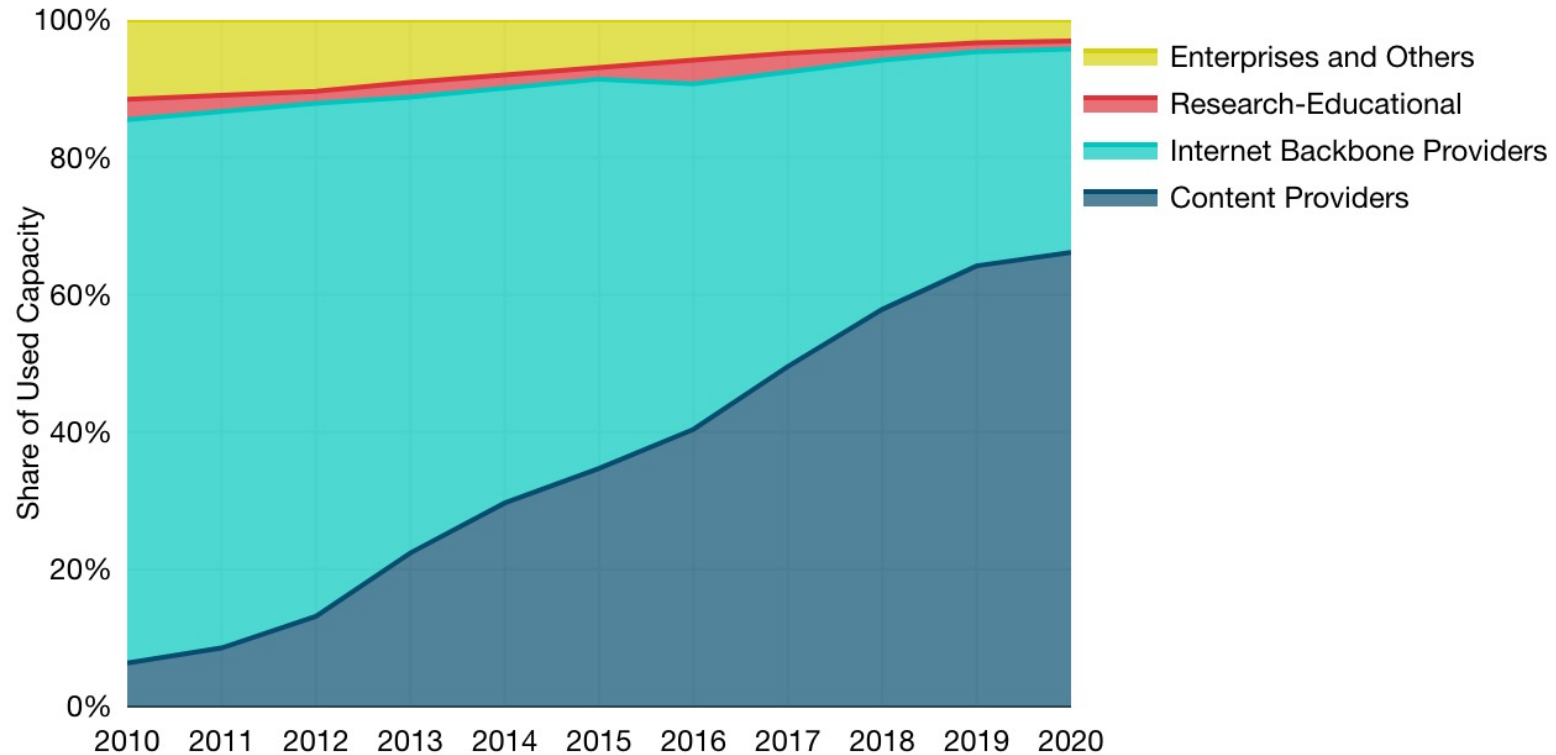
You still have time to leave.



Questions to answer

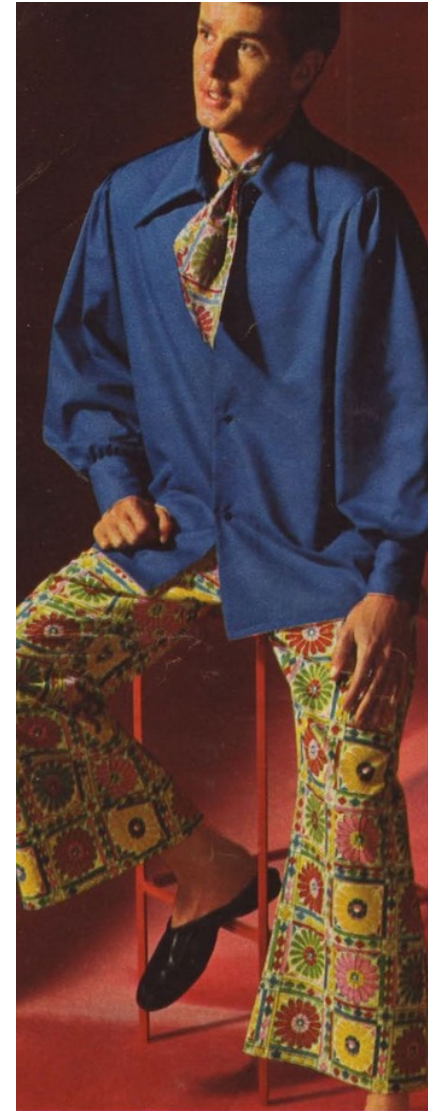
- What's driving bandwidth demand?
- Where are content & cloud providers contributing CAPEX?
- Will the cable buildout boom end?

International bandwidth usage



Celebrate with the fiesta look

Fiesta-look
For the siesta . . . Pajamas with
romantic styling, fiery
colors in no-iron broadcloth

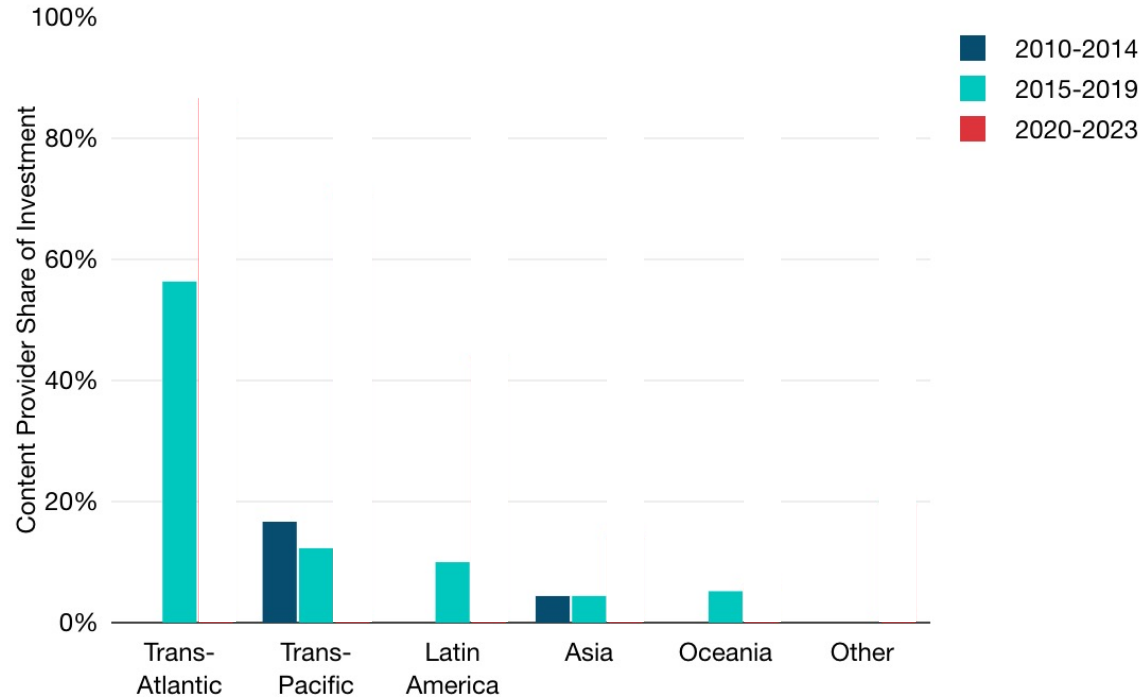


Questions to answer

- What's driving bandwidth demand?
- **Where are content & cloud providers contributing CAPEX?**
- Will the cable buildout boom end?

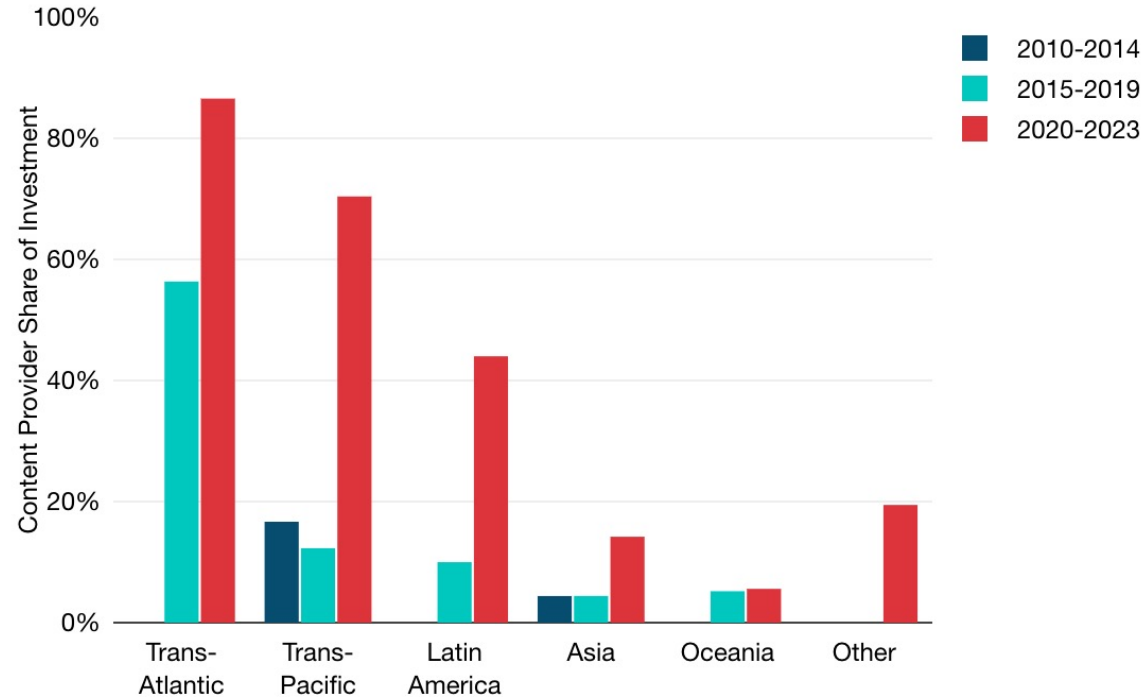
Content provider investments share

as % of CAPEX on New Submarine Cables



Content provider investments share

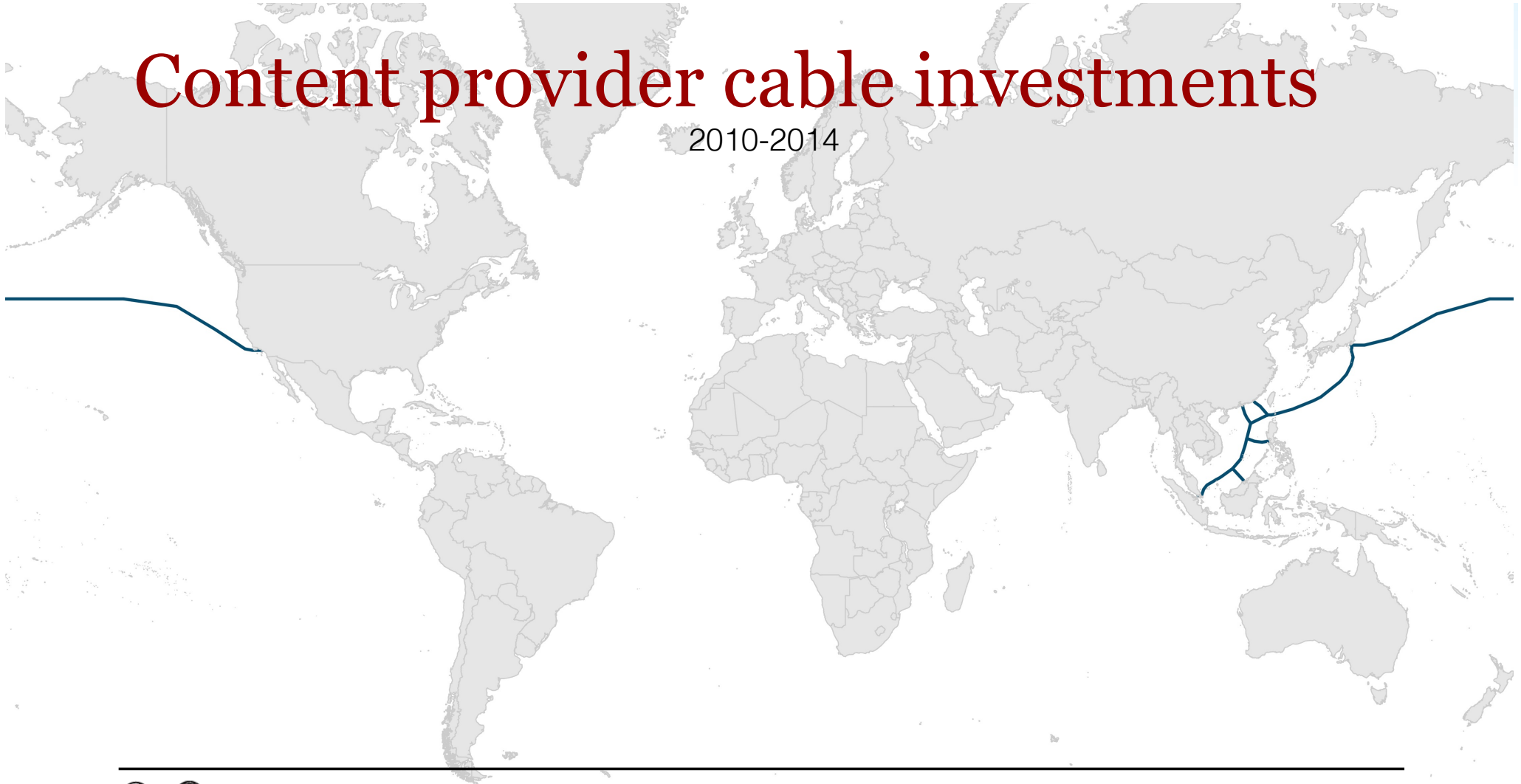
as % of CAPEX on New Submarine Cables



Note: publicly disclosed investments only.

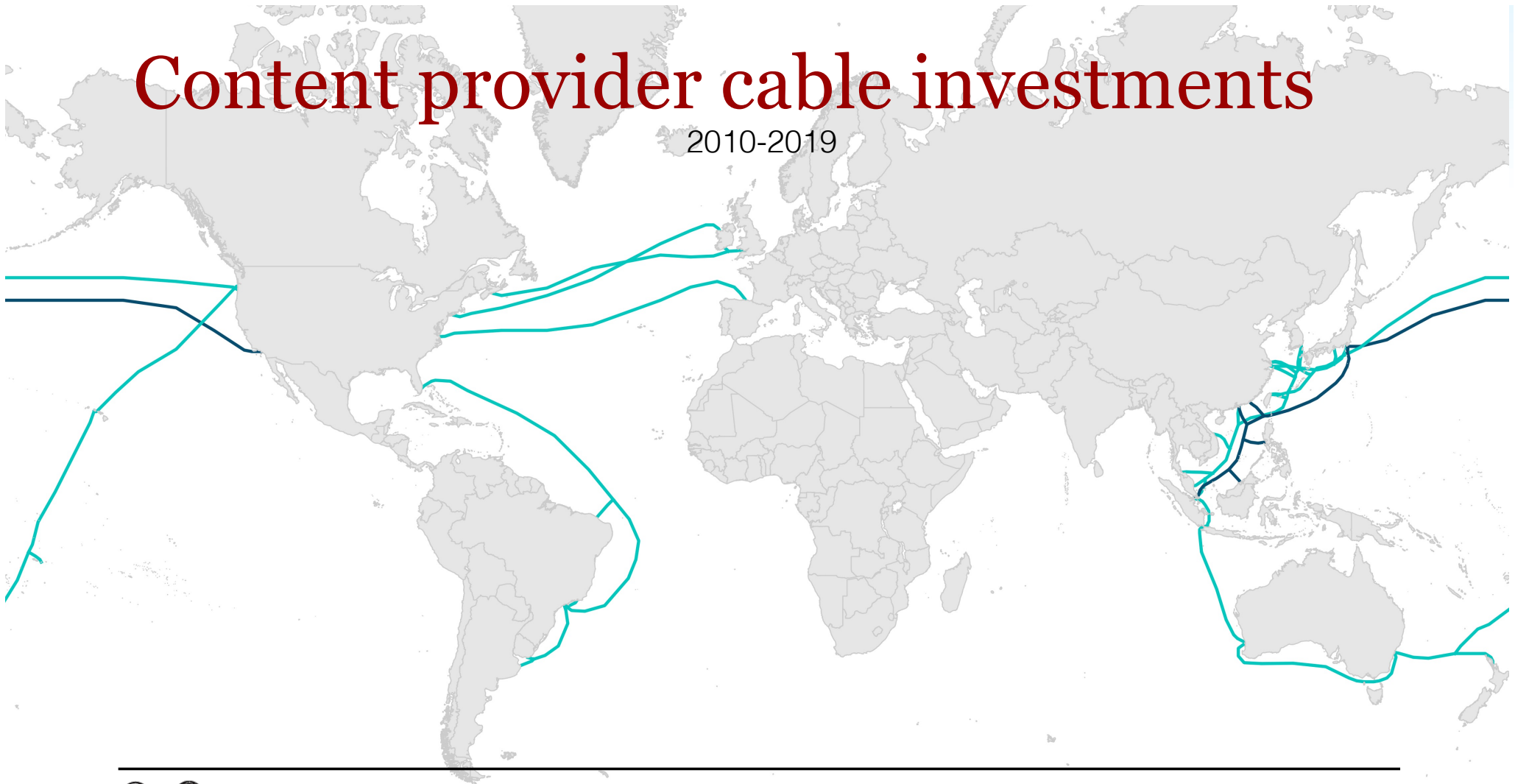
Content provider cable investments

2010-2014



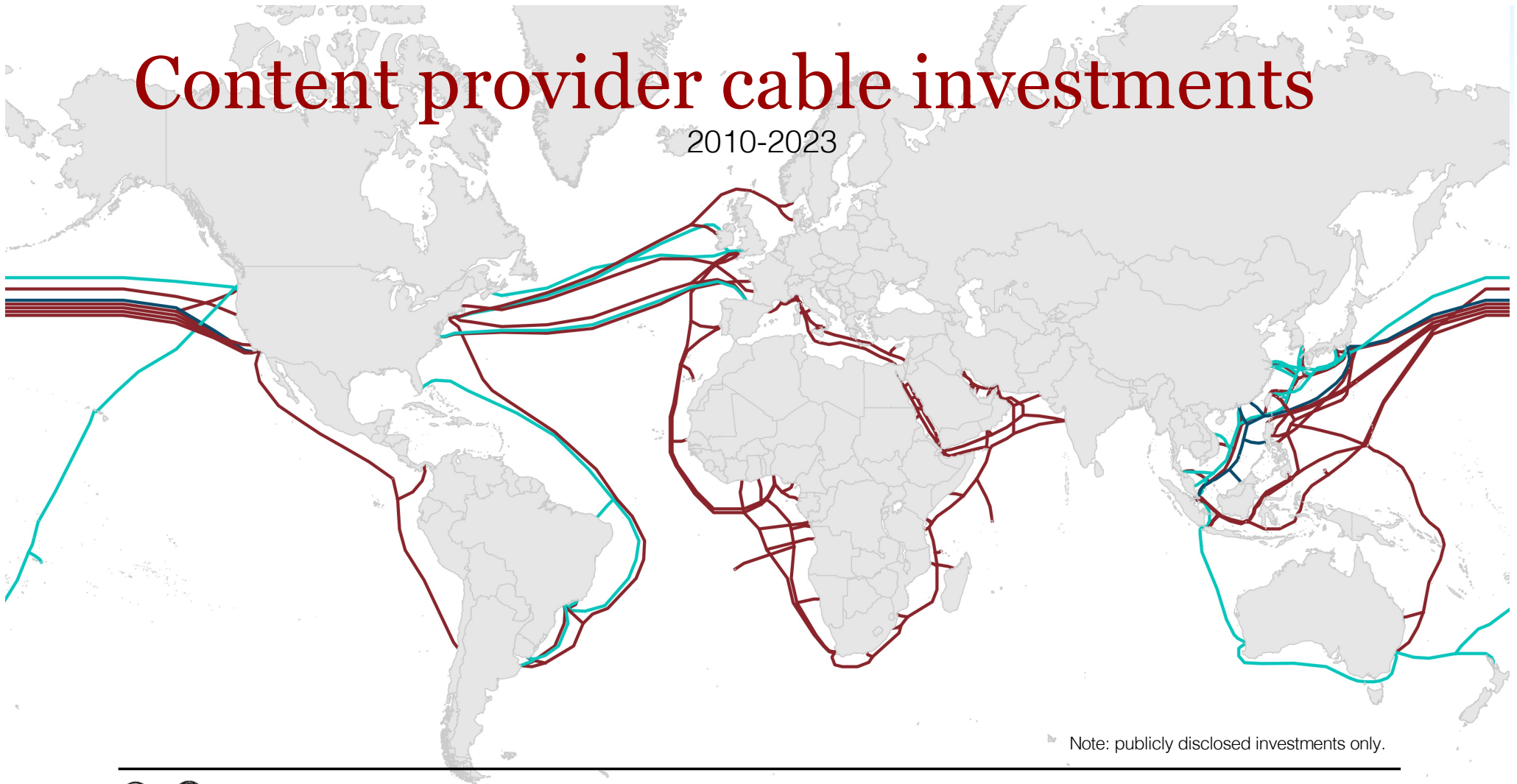
Content provider cable investments

2010-2019



Content provider cable investments

2010-2023



Note: publicly disclosed investments only.

Questions to answer

- What's driving bandwidth demand?
- Where are content & cloud providers contributing CAPEX?
- Will the cable buildout boom end?

The next part is exciting.

Penneys Exciting Slacks of Textured 100% Fortrel® Polyester

CELANESE FORTREL®
A CONTEMPORARY FASHION FIBER

1298 Each Any 2 for 2500*

A & B REGULAR-FIT SLACKS. Designed for the average figure. Penn-Prest. Plain front. 2 front, 2 back pockets. Hemmed bottoms. Machine wash, tumble dry—no ironing needed. Mailing weight 1.25 lbs.
Sizes: Waists: 32, 33, 34, 36, 38, 40, 42. Inseams: 29, 30, 31, 32. State waist size and inseam length.

[A] Beltless Tab-Top Continental Waist.
X 523-7649 E—Gold X 523-7664 E—Brown
X 523-7656 E—Olive green
X 523-7672 E—Lt. blue. Each 12.98; 2 for 25.00*

[B] Belt-Loop Waist.
X 523-7680 E—Gold X 523-7706 E—Brown
X 523-7698 E—Olive green
X 523-7714 E—Lt. blue. Each 12.98; 2 for 25.00*

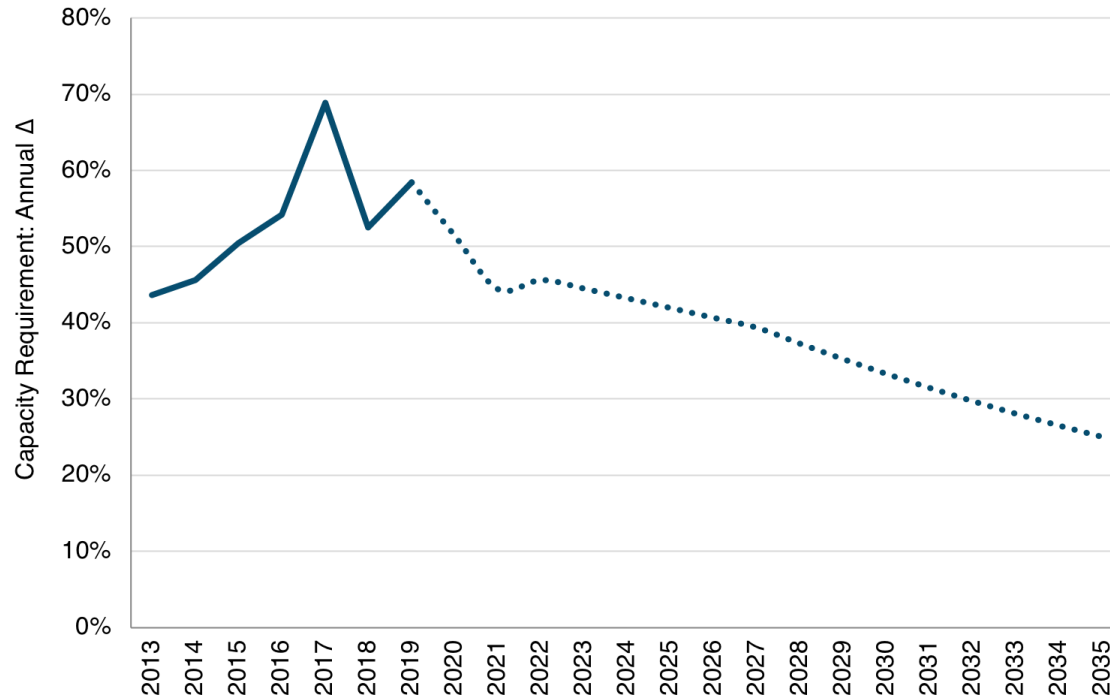
*Buy any 2 slacks for \$25.00... Choose any 2 slacks [A] or [B] in any size or color. State size and catalog number for each item desired.

FOR HOW-TO-MEASURE INFORMATION SEE PAGE 230.

penneys 85

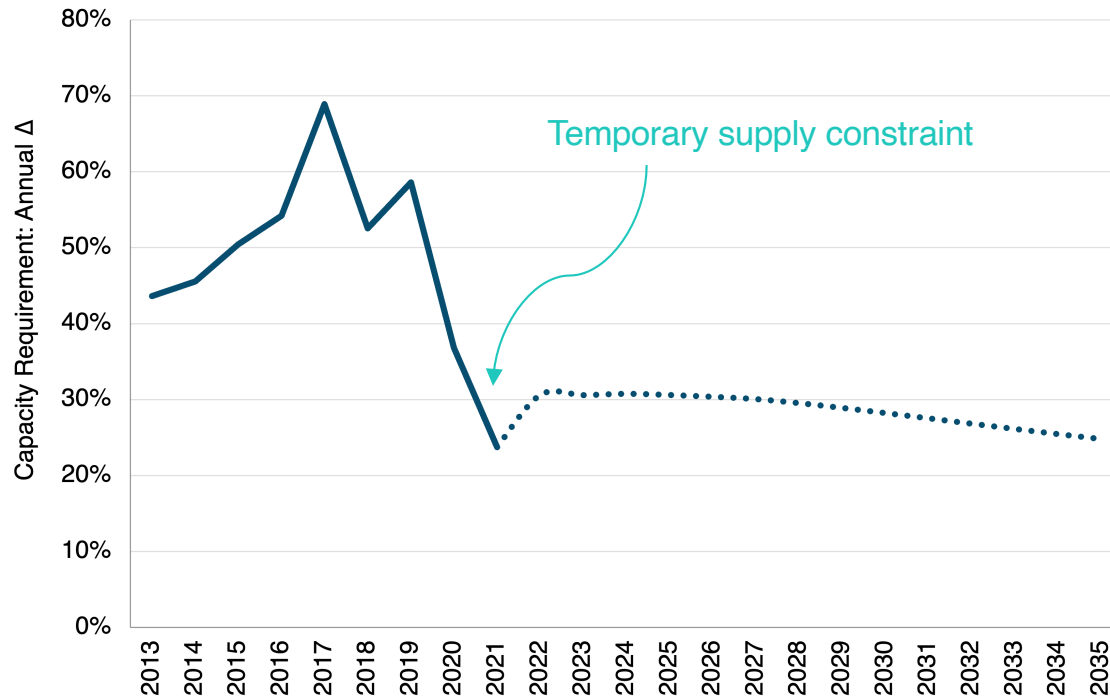
Huge change in growth rate

Trans-Atlantic Annual Growth Rate (View from 2020)



Huge change in growth rate

Trans-Atlantic Annual Growth Rate (Current View)



Inflation heating up?

Stay cool with business shorts

**Mens short &
long sleeve
business
shirts**

\$2⁹⁹
EA.

Polyester/cotton in white
and pastels. 37-44.

Fashion ties

\$3⁹⁹
EA.

Prints and woven
designs. Look smart in a
Target tie.

Fashion shorts

\$7⁹⁹
EA.

Fashion shorts in a good
range of styles. 3-7, 4¼,
5¼, 6¼, 7¼.

Leather belts

\$2⁵⁹

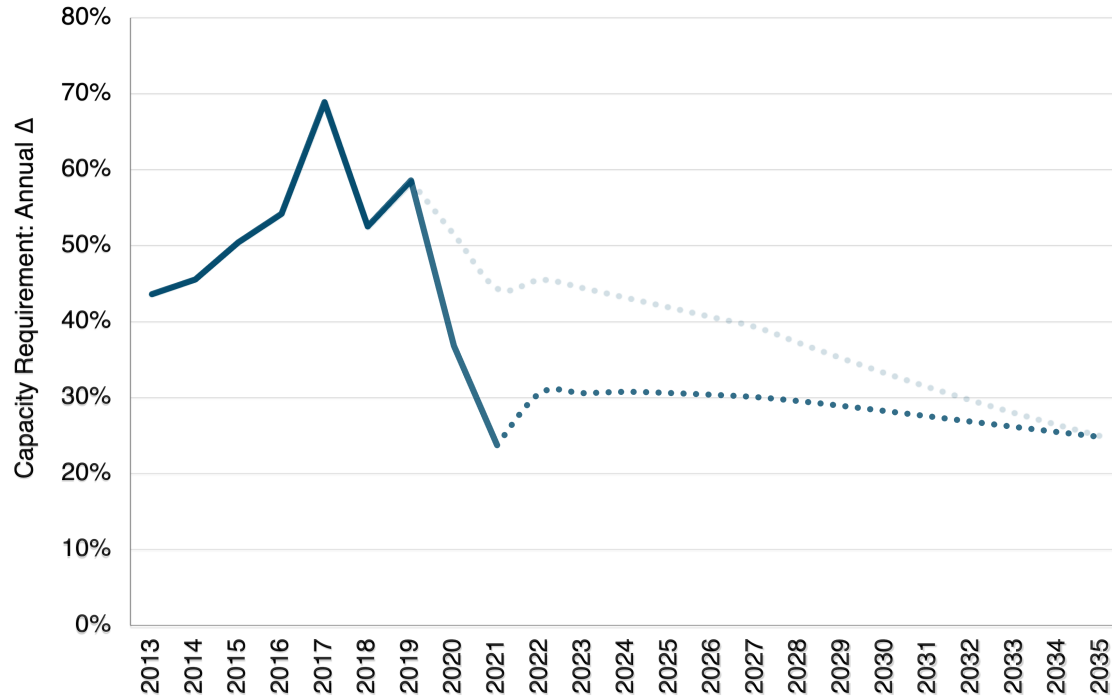
1½" size

Other sizes and prices
available too.



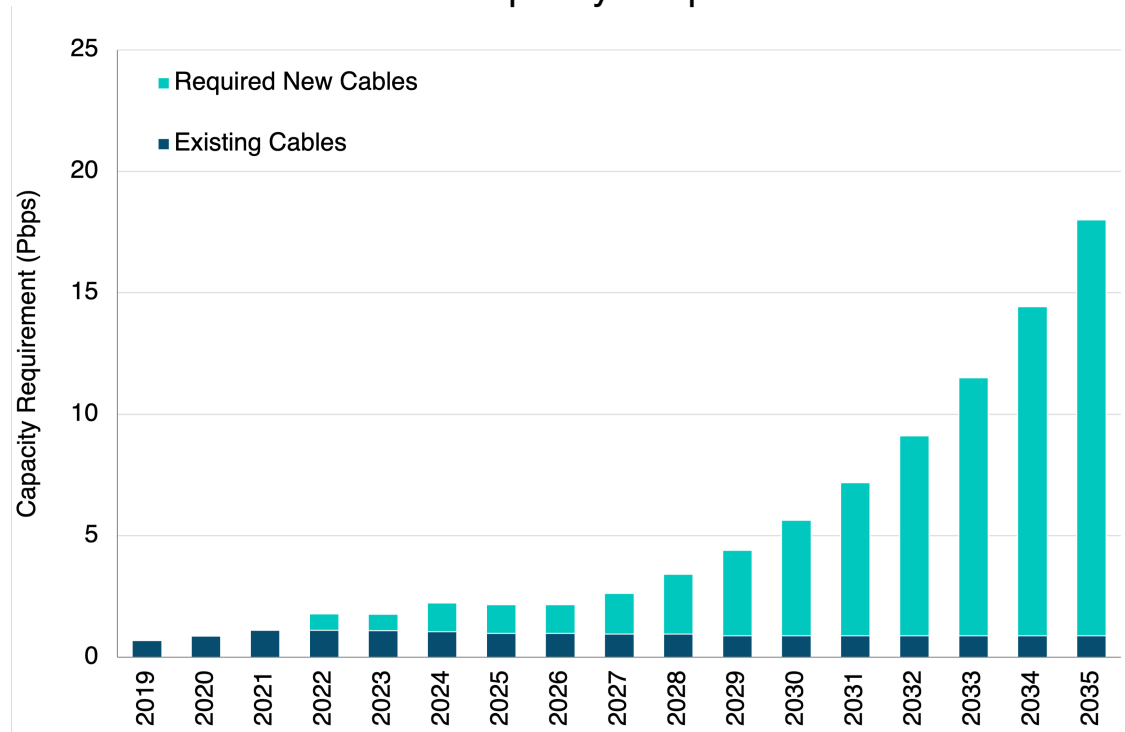
Huge change in growth rate

Trans-Atlantic Annual Growth Rate



Trans-Atlantic: capacity needed

Cumulative Capacity Requirements

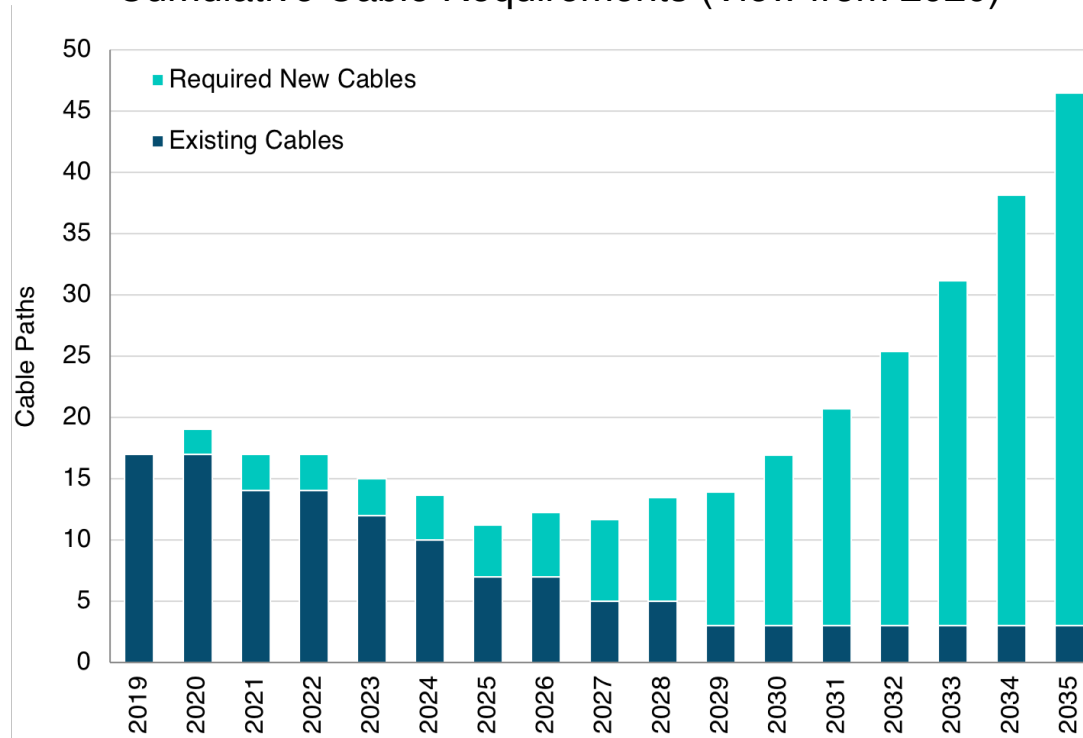


Translating demand to # of cables

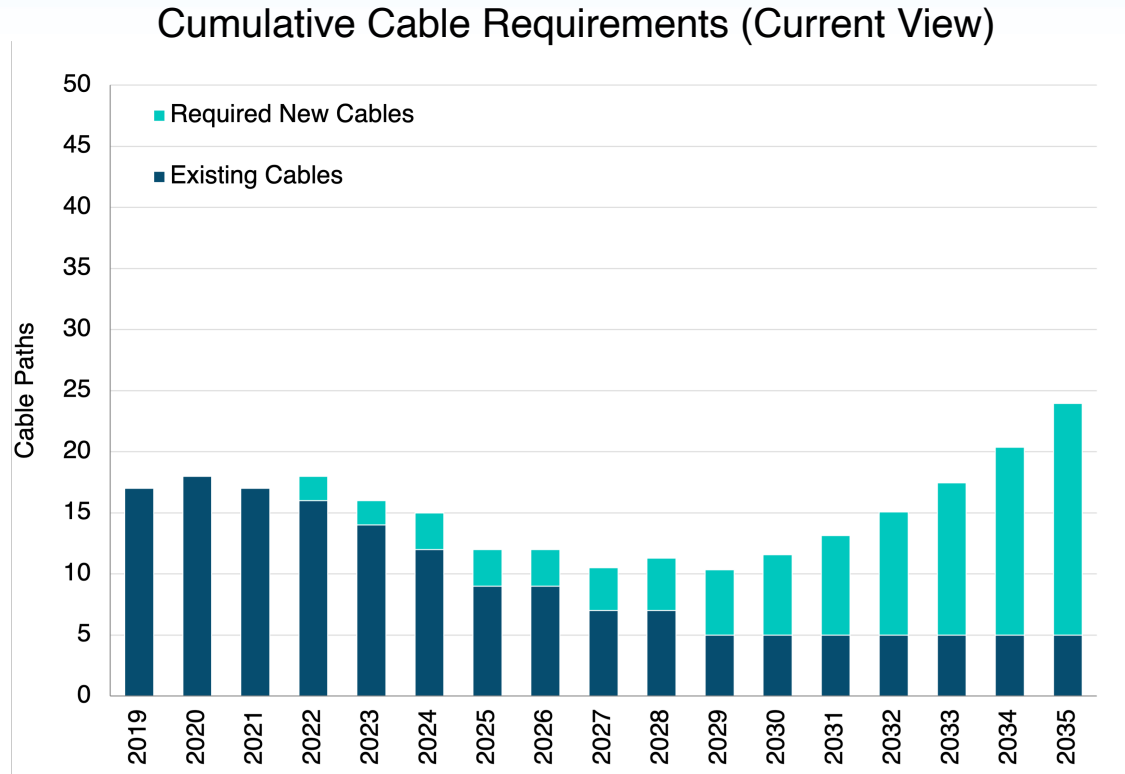
- Near-term (2022-2023)
 - Use planned cable RFS dates
- Long-term (2024-2035)
 - Big routes:
 - Translate capacity demand to cables by assuming Tbps per cable
 - Smaller routes:
 - Simplistic assumption of 1:1 replacement on 25th anniversary
 - Forecasts in outer years are very uncertain!

Trans-Atlantic: cables required

Cumulative Cable Requirements (View from 2020)

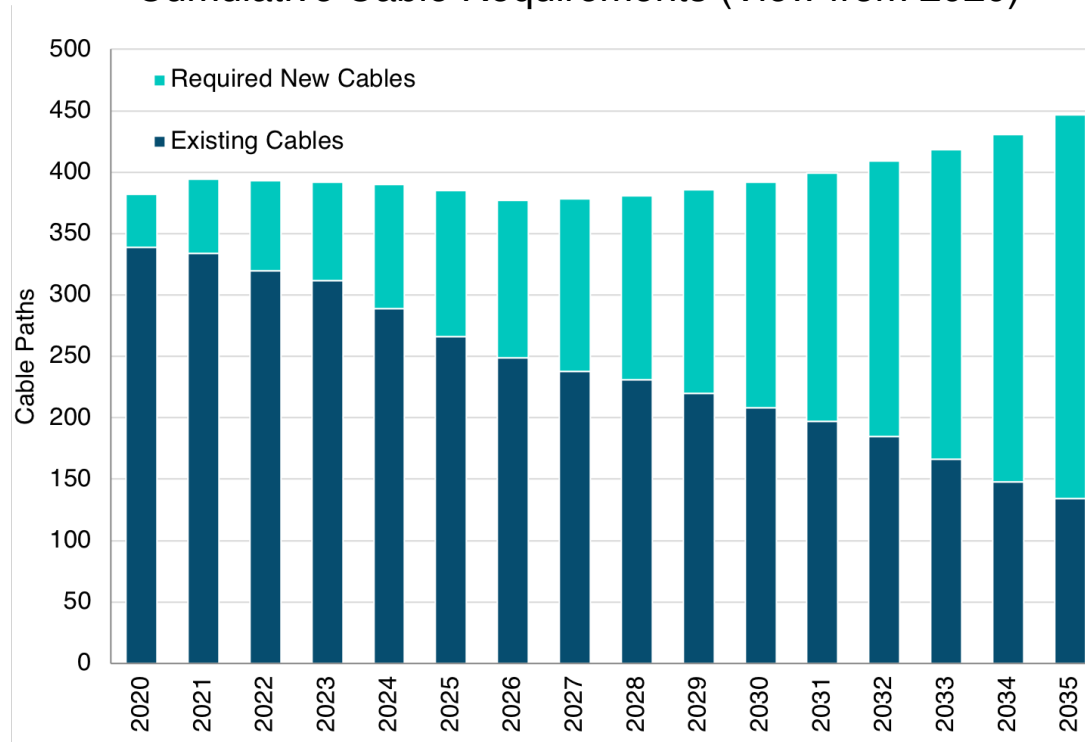


Trans-Atlantic: cables required



World: cables required

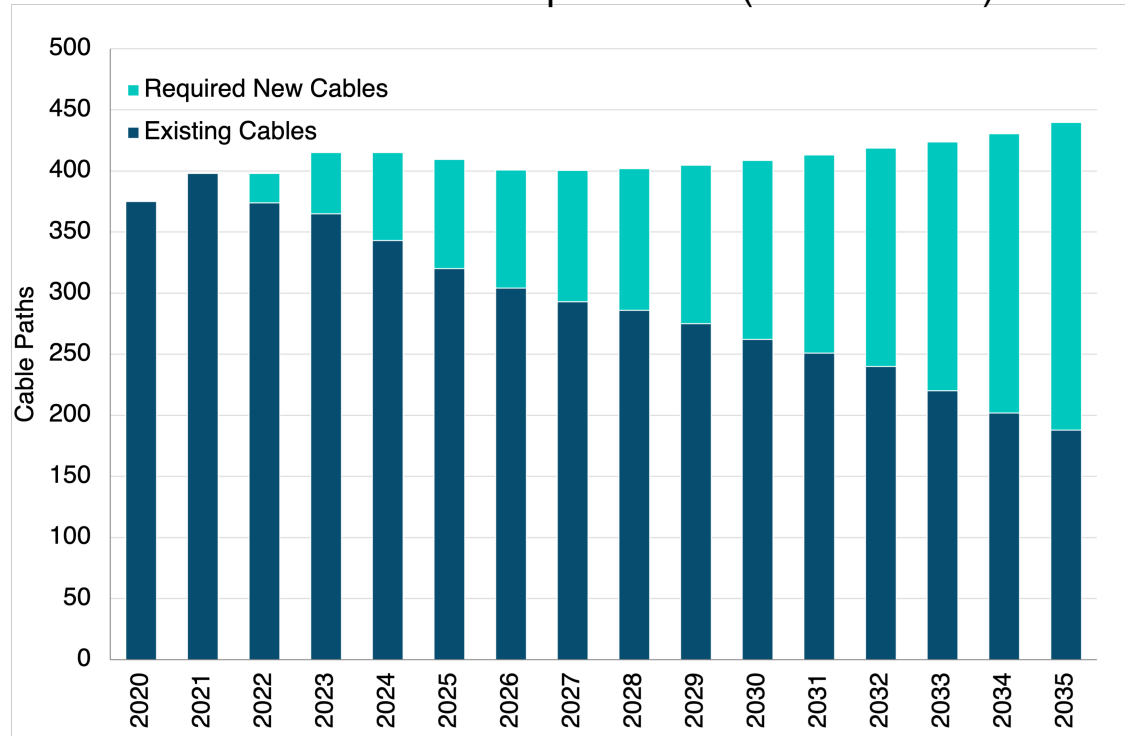
Cumulative Cable Requirements (View from 2020)



Note: Excludes cables that reached service in 1995 or earlier.

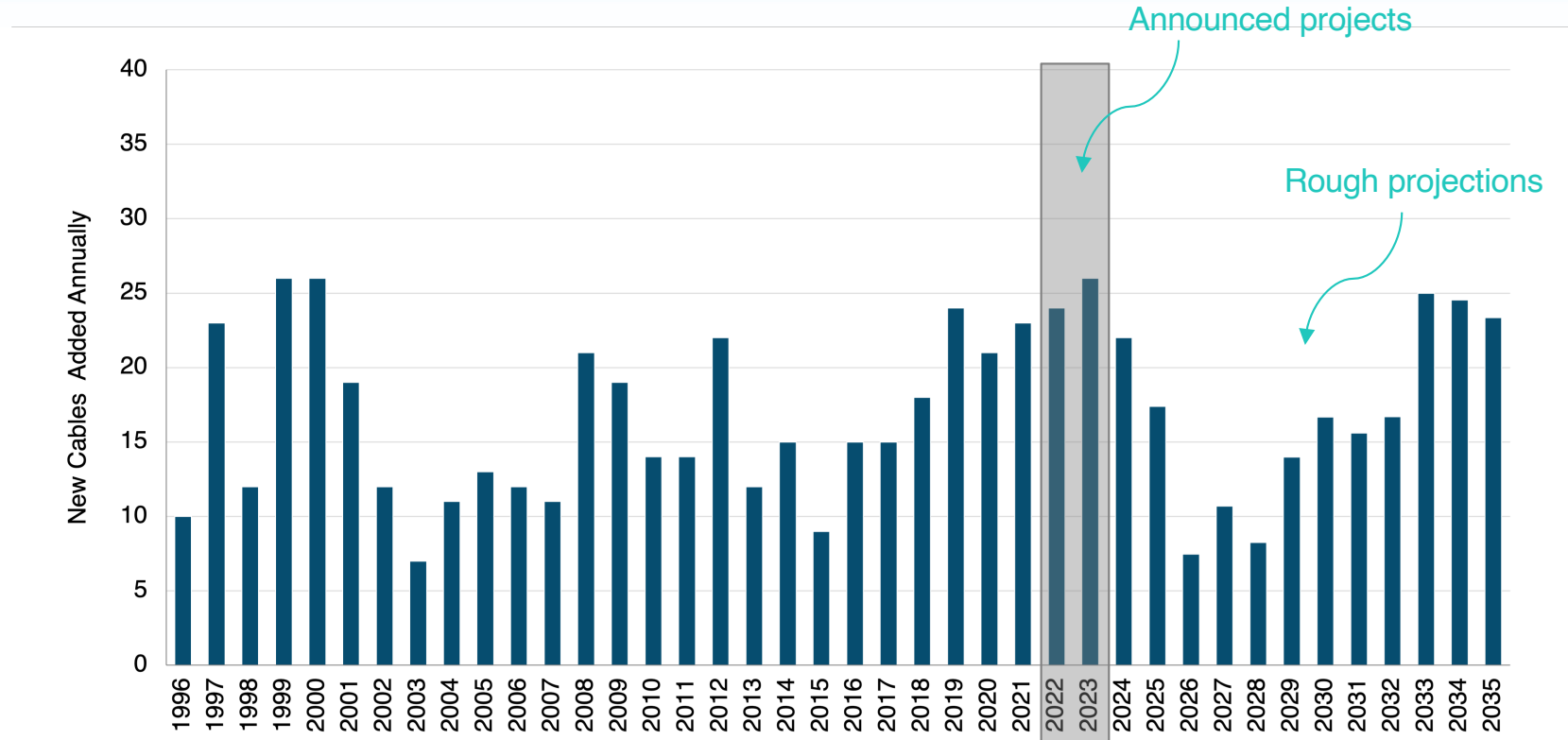
World: cables required

Cumulative Cable Requirements (Current View)

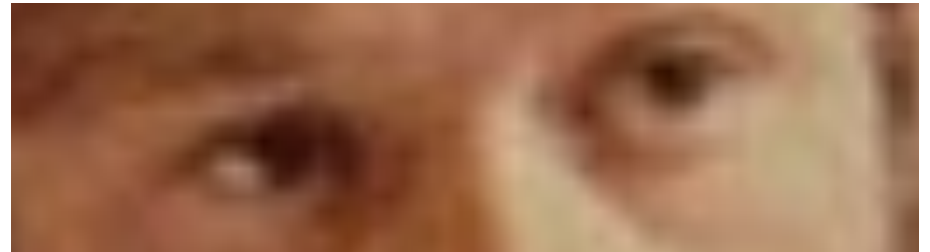


Note: Excludes cables that reached service in 1995 or earlier.

New cables added annually



This man knows pain.



Key supply assumptions

$$\text{Number of cables required} = \frac{\text{Total market demand (Pbps)}}{\text{Capacity per cable (Pbps)}}$$

This we've talked about

This we must estimate

Old supply assumptions

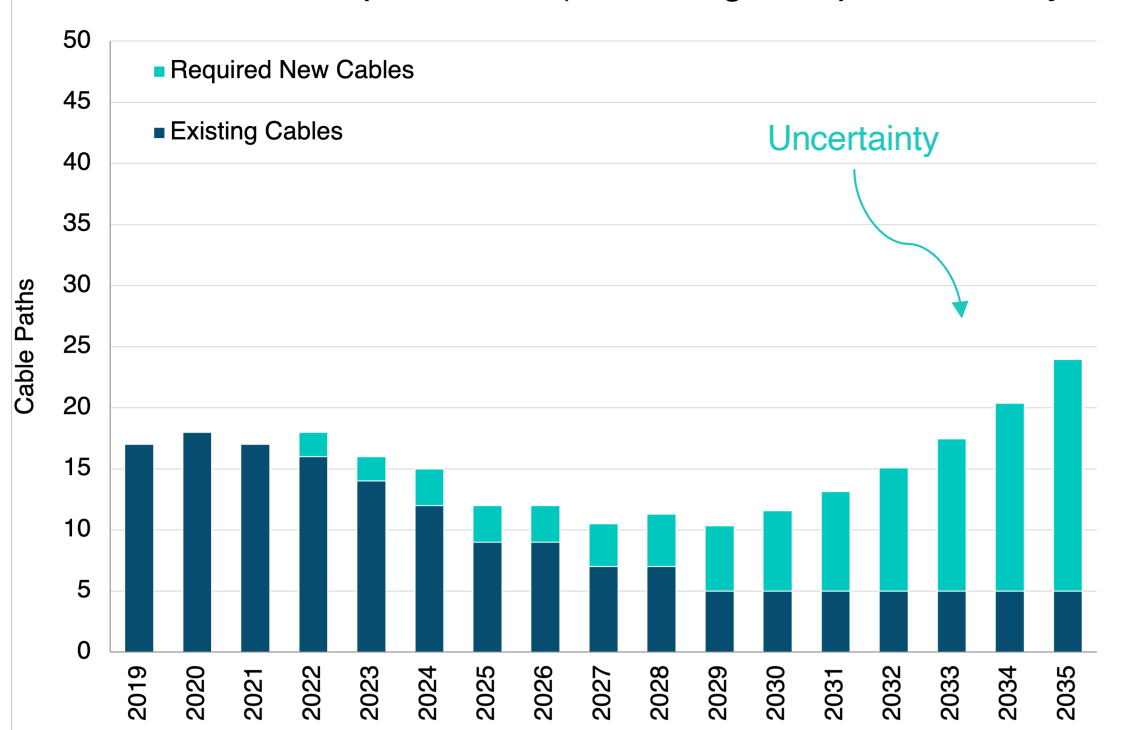
- 320 Tbps cables available in 2020
 - 16 FP x 20 Tbps per FP
- 640 Tbps cables by 2023
 - 32 FP x 20 Tbps, maybe?
- 1 Pbps systems by 2025
 - 50 FP x 20 Tbps, maybe?

Current supply situation

- 320 Tbps cables available in 2020
 - 16 FP x 20 Tbps per FP
- ~~640 Tbps cables by 2023~~
 - ~~32 FP x 20 Tbps, maybe?~~
- ~~1 Pbps systems by 2025~~
 - ~~50 FP x 20 Tbps, maybe?~~
- Current tech
 - 24 FP, 500 Tbps cables by 2024

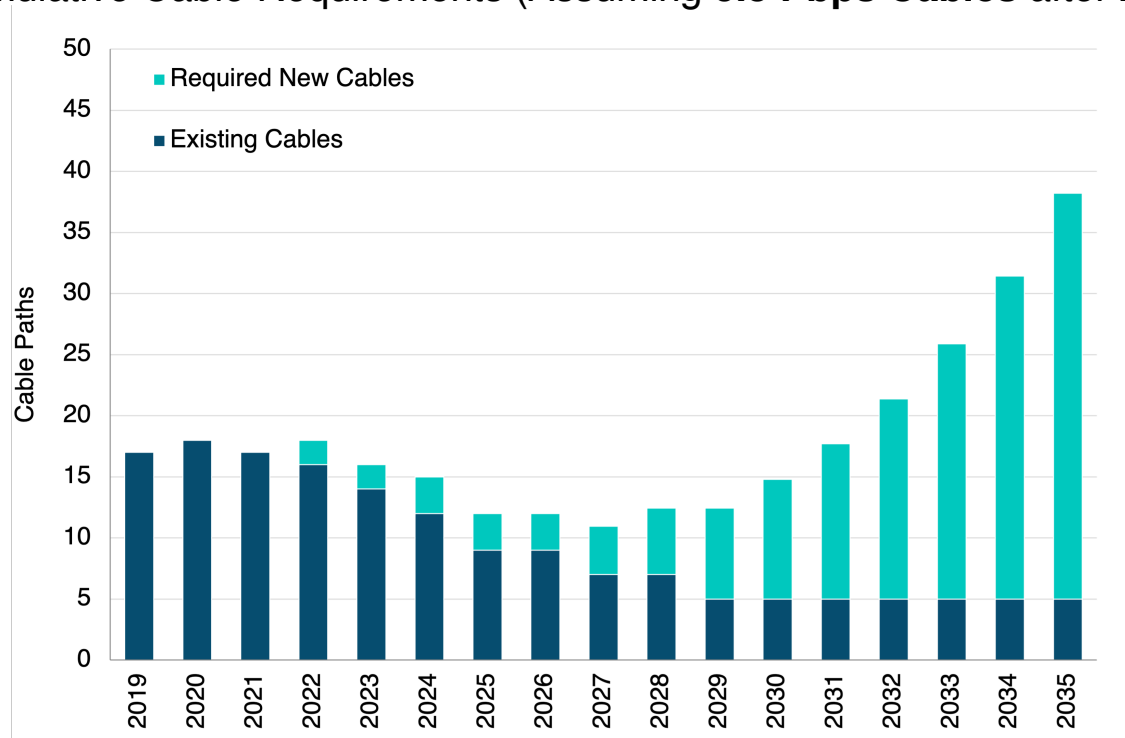
Trans-Atlantic: cables required

Cumulative Cable Requirements (Assuming 1 Pbps Cables by 2025)



Trans-Atlantic: cables required?

Cumulative Cable Requirements (Assuming **0.5 Pbps Cables** after 2023)



Questions to answer

- What's driving bandwidth demand?
 - ✓ Content and cloud especially
- Where are content & cloud providers contributing CAPEX?
 - ✓ Increasingly everywhere
- Will the cable buildout boom end?
 - ✓ More research required
 - ✓ Long-term boom still possible

Not entertained? You have options.

SAVE \$28
when you buy
3-Pc. Bar Group
(3), two of (1)
299⁰⁰
or \$12.00 monthly
installment price
see page 748
for credit terms

**BARRELS
for Fun
and
Entertaining**

SAVE \$27
when you buy
4-Pc. Seating Group
(1), (3), two of (2)
399⁰⁰
or \$15.00 monthly
installment price
see page 748
for credit terms

SAVE \$30
when you buy
5-Pc. Game Group
(3) and four of (1)
415⁰⁰ or \$15.99
monthly
see page 748 for credit terms

DOWN \$40
AT PENNEY'S

JCPenney 1123

**BARRELS
for Fun
and
Entertaining**

More resources

- Download these presentations
 - <https://www2.telegeography.com/telecom-events>
- Fashions of yesteryear
 - <http://www.wishbookweb.com>

Data Center Market Update

Development trends and pricing expectations

Jon Hjembo

jhjembo@telegeography.com

Outline

- Development: Deeper movement in subregional markets
- Pricing: Long-term stability. Short-term inflation?
- Key take-aways

Development: Deeper movement in subregional markets



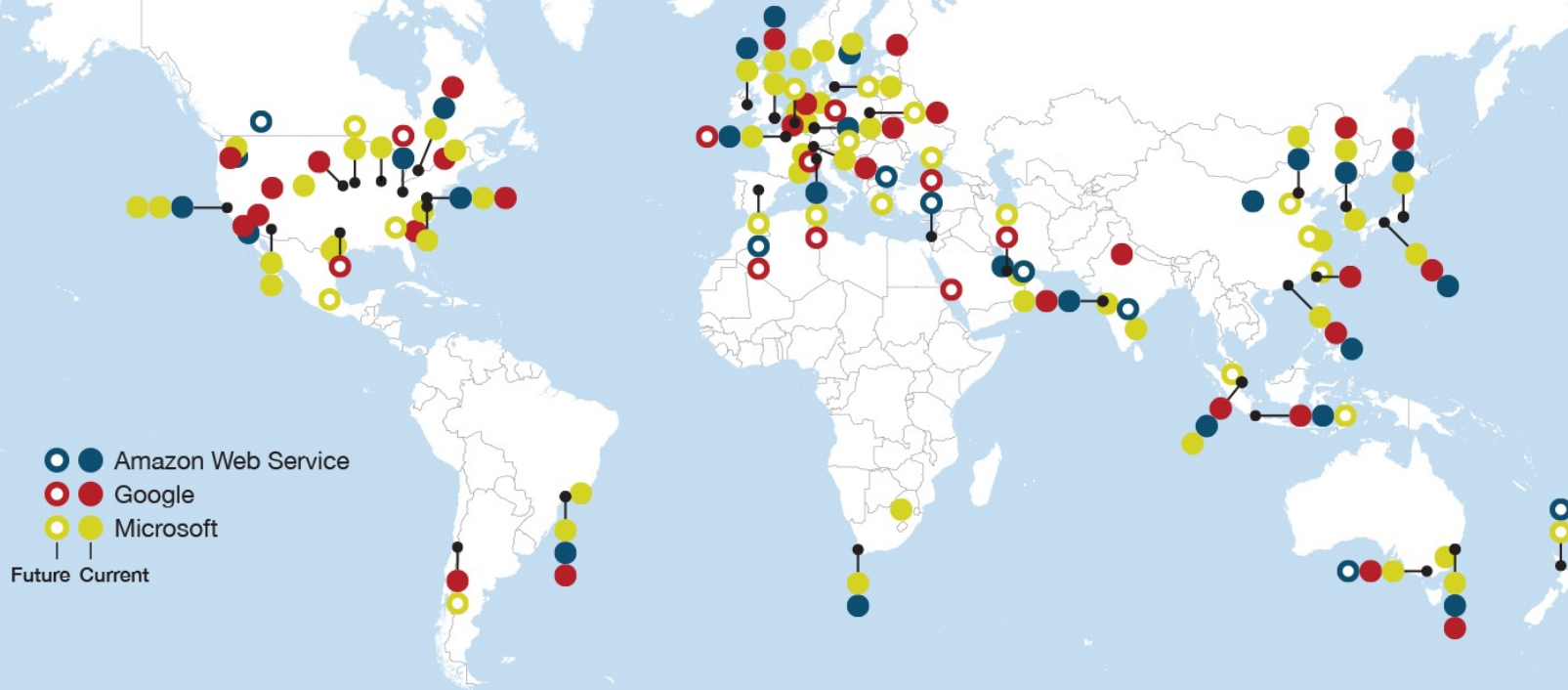
Atlas Obscura



Passport to Eden

Relentless Cloud Growth

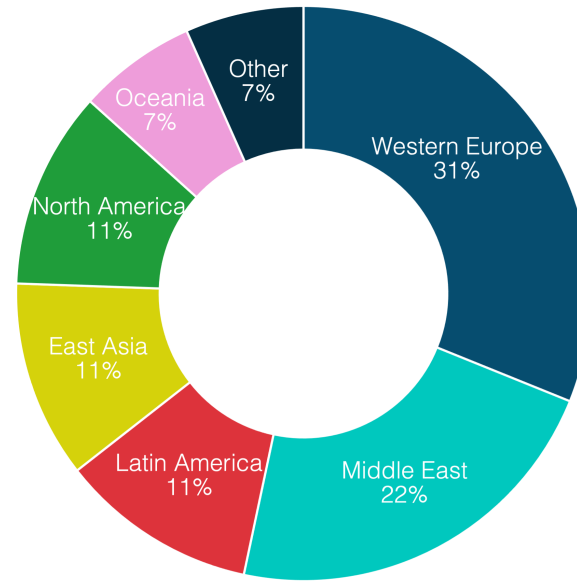
Cloud Region Data Center Deployments, Top Cloud Providers, January 2022



Where is the cloud moving in 2022 and beyond?

Future Cloud Region Deployments by Subregion

- Regional deployments in pipeline are heavily concentrated in Western Europe and Middle East
- At least 3 new cloud regions coming for: Israel, Italy, Spain, U.S.

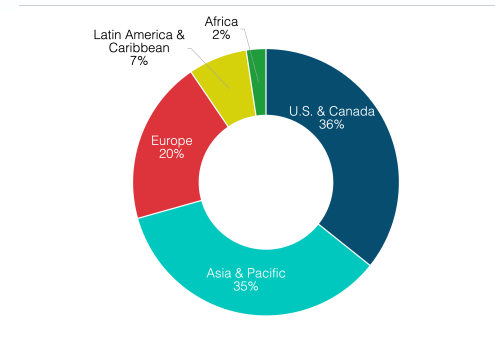


Note: Regions to be launched in 2022 and beyond

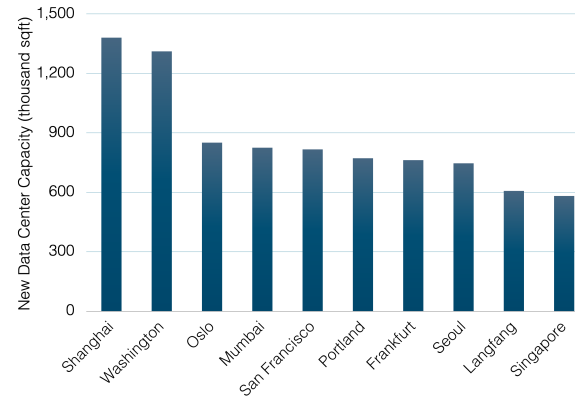
2021 Data center development spread across global nodes

- U.S. and APAC account for strong majority of recent deployments
- European buildouts focused on retail colocation
- Development across a wide diversity of core hubs and markets that are emerging as critical locations for peering, cloud, and content

Regional Share of Retail and Wholesale Sites Deployed, Sept 2020-Sept 2021



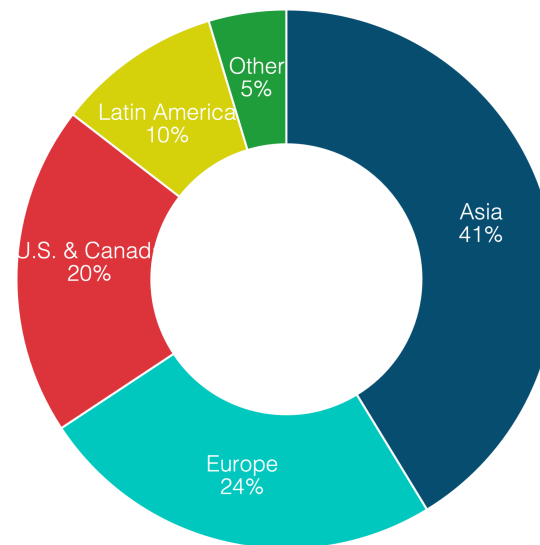
New Retail and Wholesale Site Capacity Deployed, Sept 2020-Sept 2021 (thousand sqft)



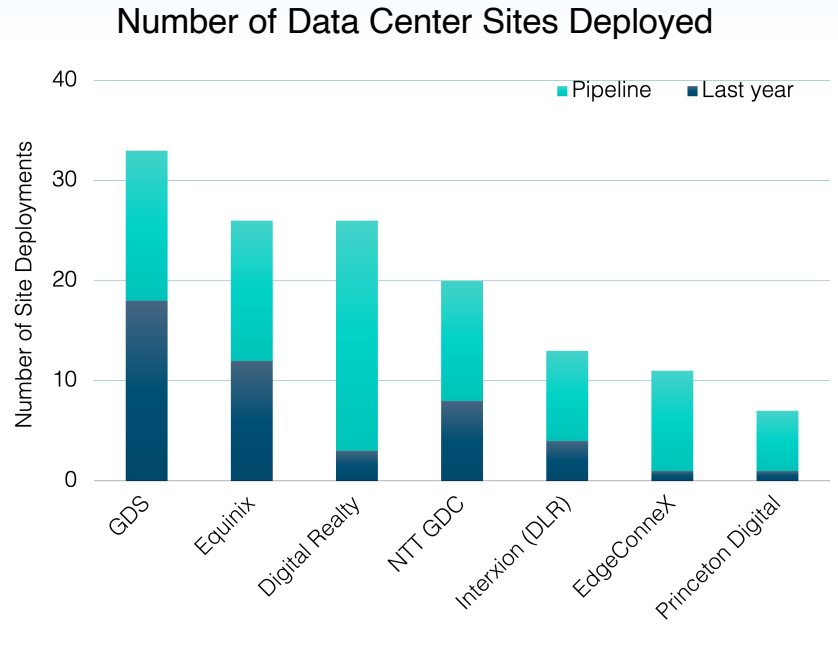
Pipeline investment heavy in Asia

- About 60% of deployments in pipeline are wholesale - geared toward hyperscale/large enterprise business
- As with 2021, pipeline retail carrier neutral development is concentrated in Western Europe.
- Wholesale concentrated heavily in Asia – especially China and India. To lesser degree in U.S. & Canada

Regional Share of Retail and Wholesale Sites in the Pipeline, Sept 2021



Who's generating the growth?



Notes: 'Last year' refers to sites launched from Sept 2020-Sept 2021.
Figure excludes recent acquisition capacity.

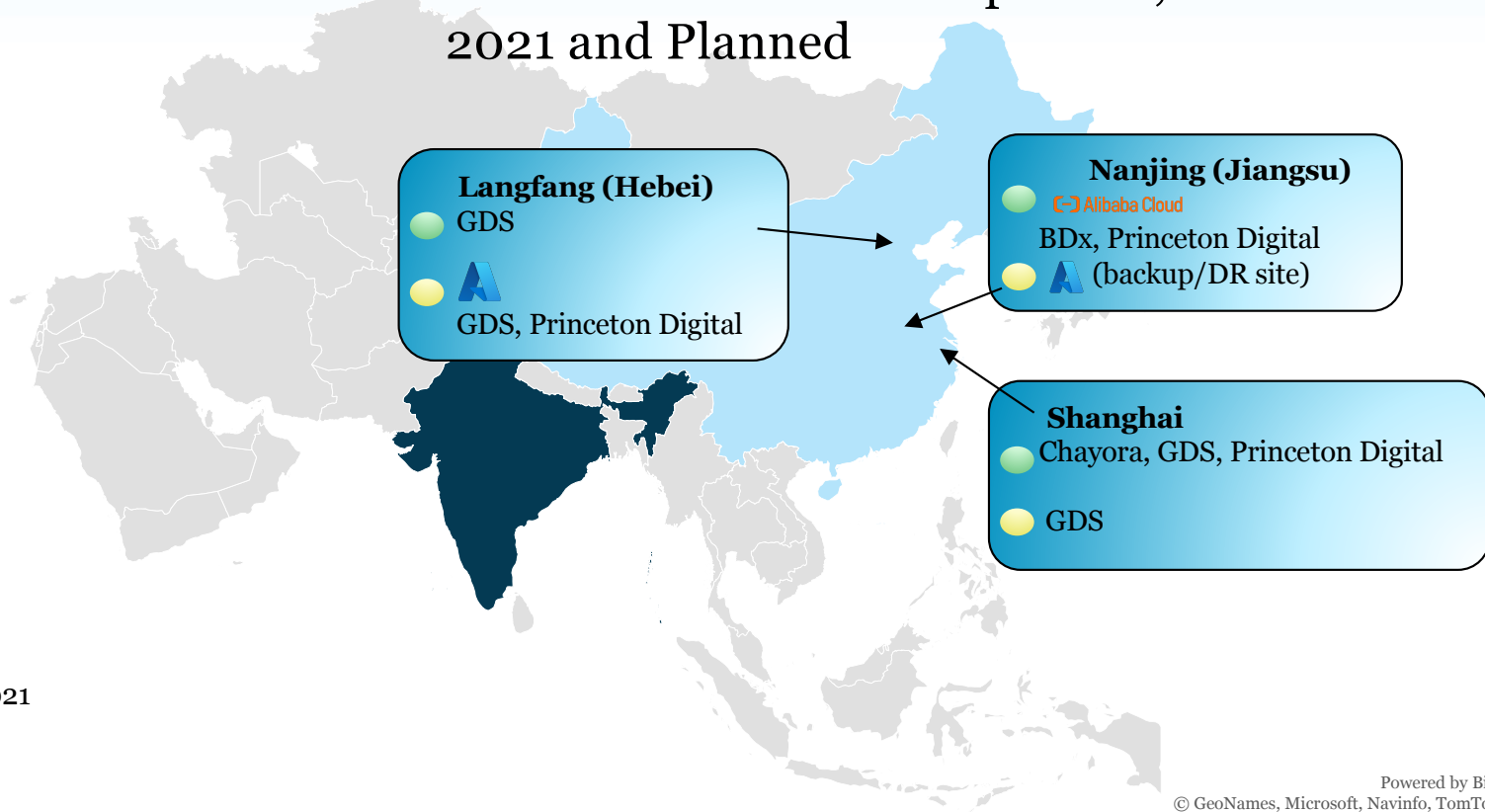
- GDS – 18 new sites in the past year and nearly the same number in the near-term pipeline
- NTT includes 6 NetMagic sites in 3 major Indian metro areas
- EdgeConneX includes 5 AdanaiConneX sites to be deployed in India
- Digital Realty pipeline include 12 new Ascenty sites in Latin America

Spotlight on China

Select Interconnection Market Developments, 2021 and Planned

 Microsoft Azure

 Alibaba Cloud





 Launched 2021

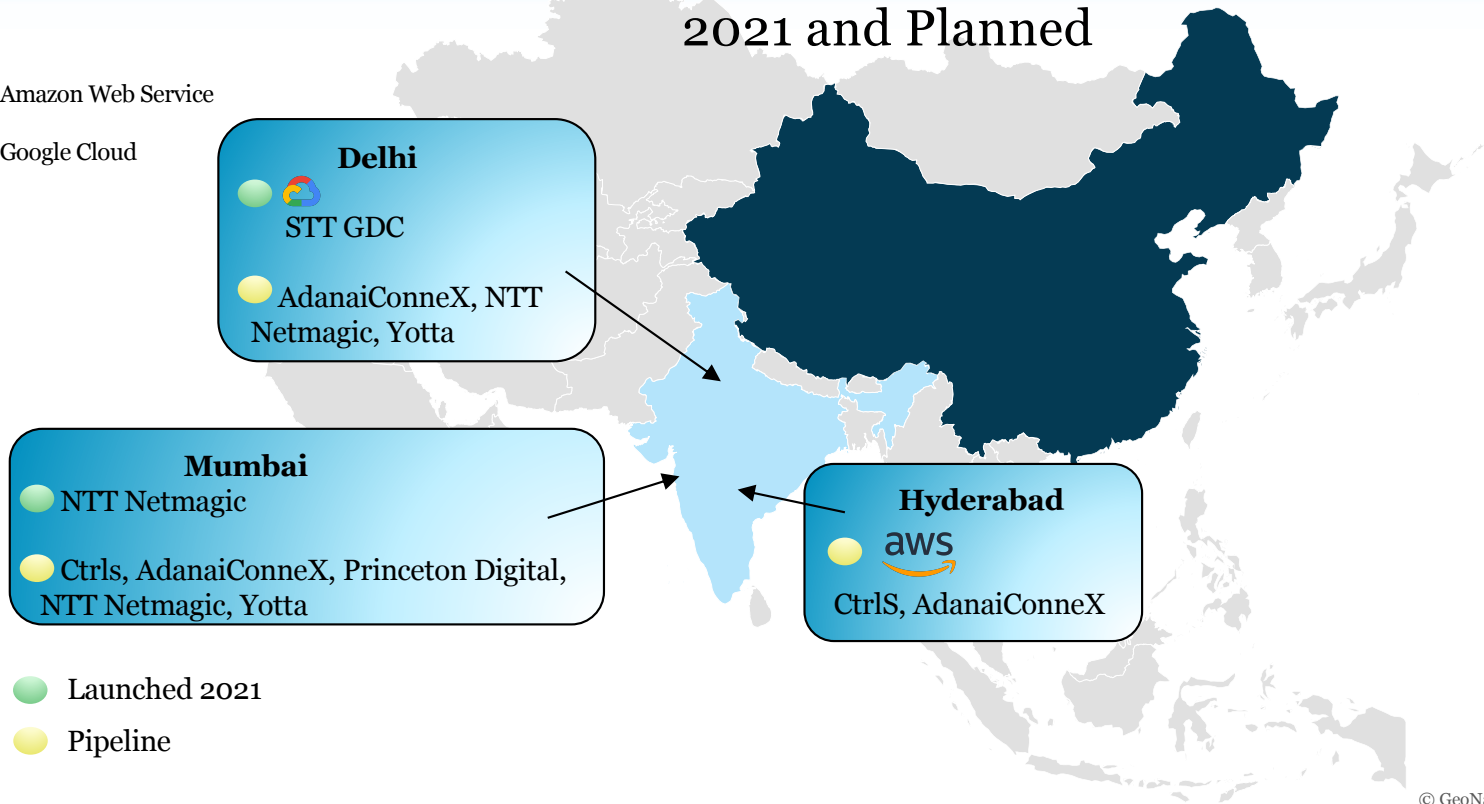
 Pipeline



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Spotlight on India

Select Interconnection Market Developments, 2021 and Planned

 Amazon Web Service
 Google Cloud



 Launched 2021
 Pipeline

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Cloud movement in the Middle East

Select Interconnection Market Developments, 2021 and Planned

-  Amazon Web Service
-  Google Cloud
-  Microsoft Azure
-  Oracle Cloud

Israel



Serverfarm Realty

Qatar





Saudi Arabia



UAE

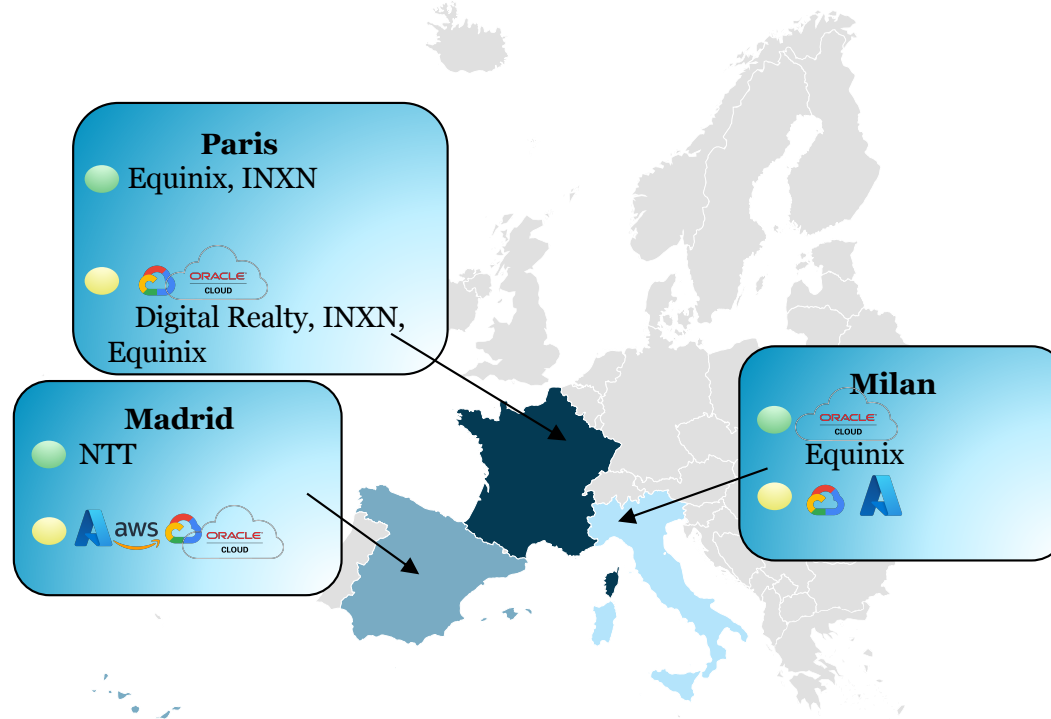


-  Launched 2021
-  Pipeline

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Europe – bolstering key markets

Select Interconnection Market Developments, 2021 and Planned



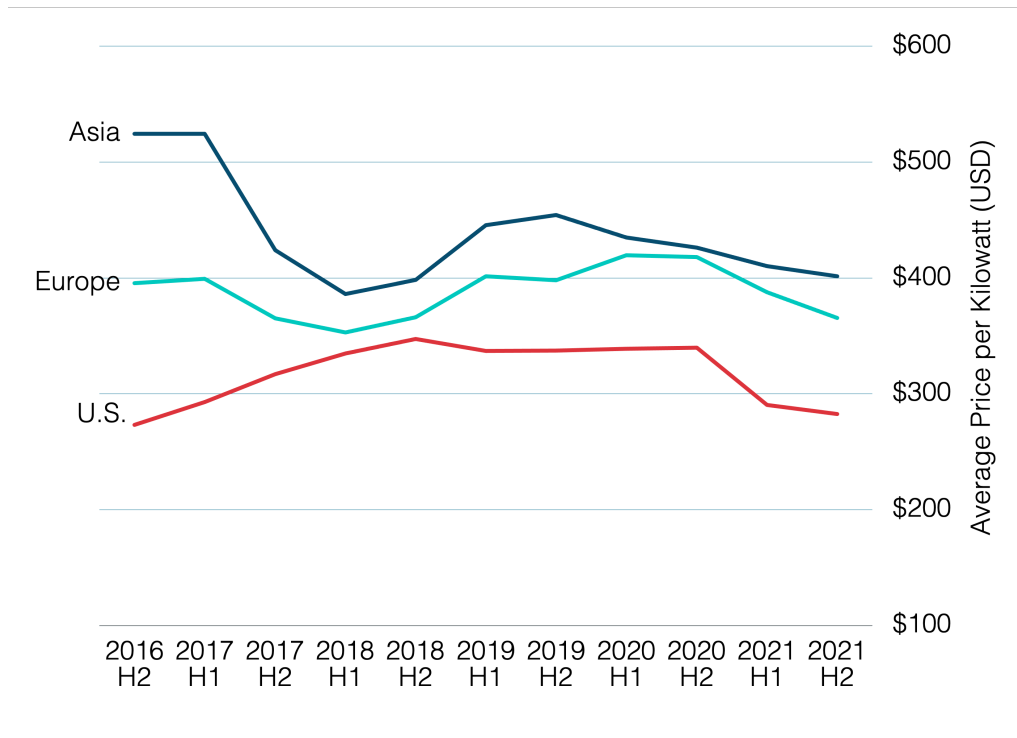
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Pricing: Long-term stability. Short-term inflation?



The long-term picture changes slowly

Average Monthly Price per Kilowatt at 4-Kilowatt Density, H2 2016-H2 2021

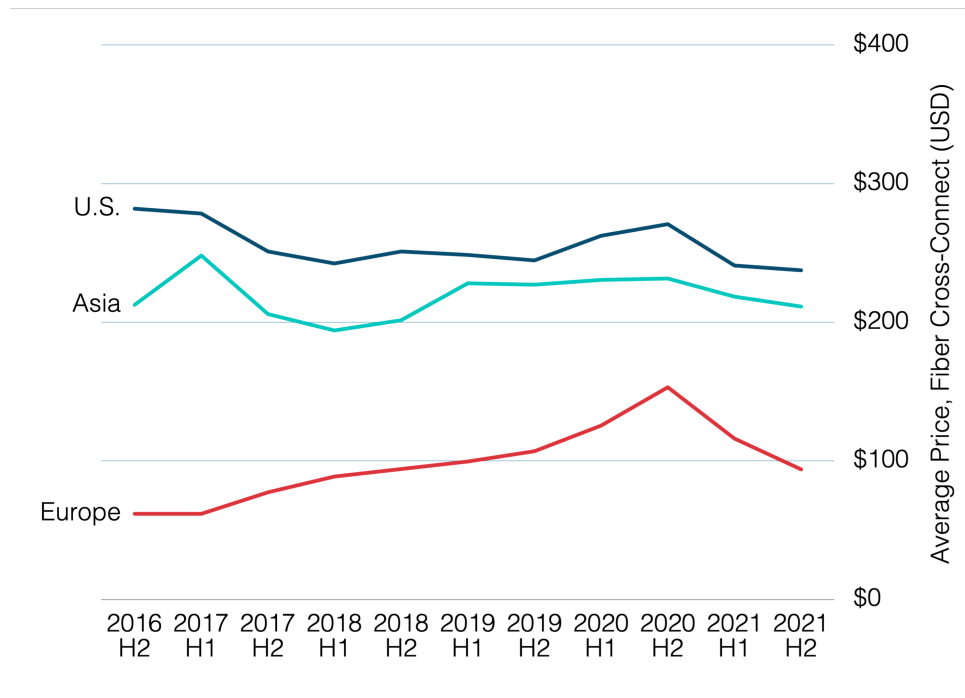


- Not much shift over the long-term
- Asian hubs have priciest rents per kw, and U.S. markets are most competitive

Cross-connect rate flux modest

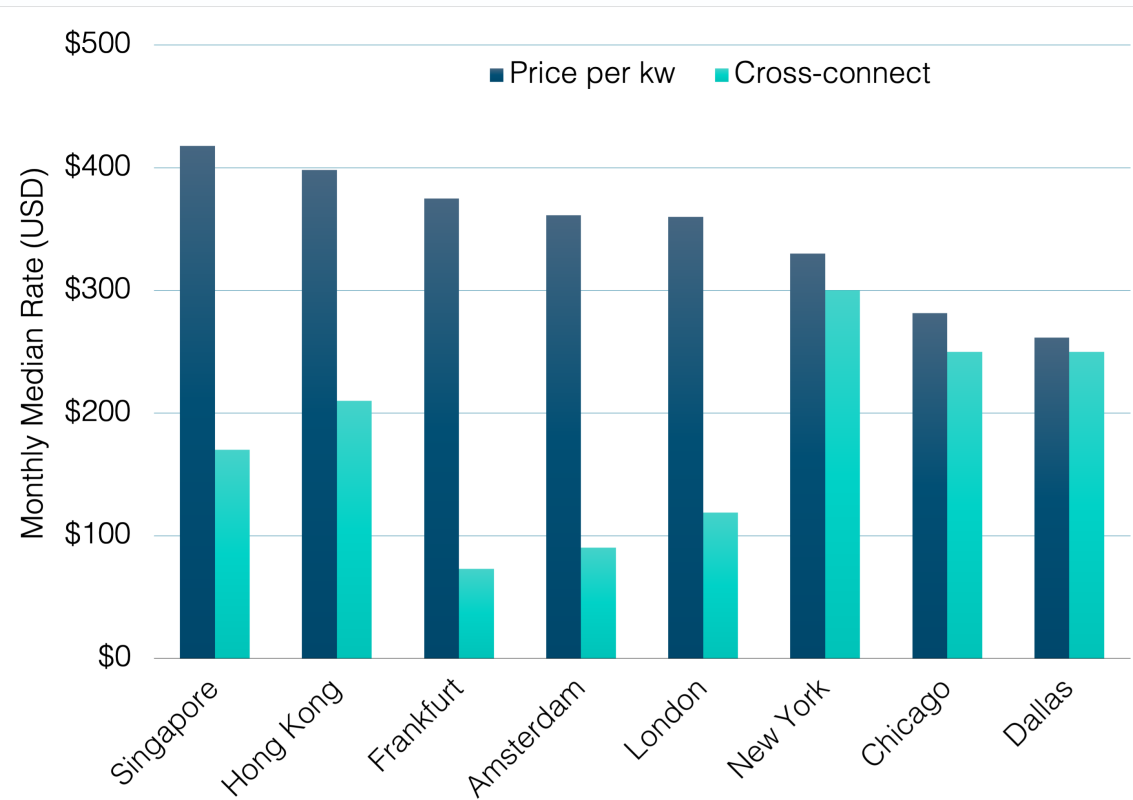
- U.S. cross-connect rates decline slightly but remain costliest
- Long-term price inflation for European cross-connects
- Short-term expectations mixed but show slight inflation

Average Monthly Fiber Cross-Connect Prices, H2 2016-H2 2021



Individual hubs reflect regional comparison

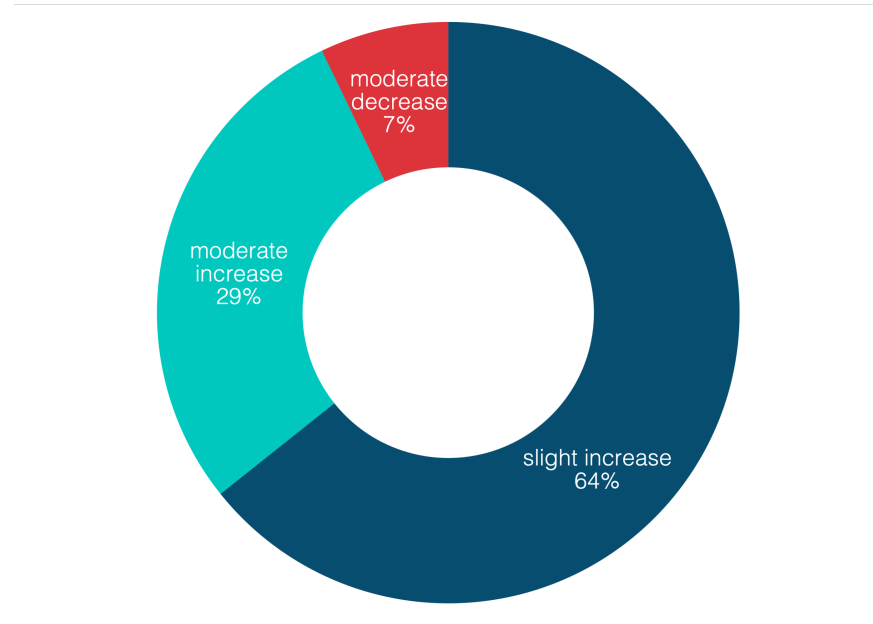
Median Monthly Prices, H2 2021



In near term, most are bracing for price hikes

- As of H2 2021, operators consistently expect price inflation over near term
- Indications of price hikes up to 5% in most markets
- Singapore particularly constrained. Short-term rates will soar

Changing Colocation Price Expectations, H2 2021



What will drive price increases?

- Pandemic – supply chain constraints
- Geopolitical concerns – rerouting from Hong Kong to other congested markets
- Regulatory constraints – Singapore, Frankfurt, Amsterdam



Key take-aways

- Regional growth to watch by segment
 - Carrier neutral: Europe
 - Wholesale/hyperscale: Asia – especially China and India
 - Cloud: Europe and Middle East
- Subregional markets continue to be a priority. JVs and acquisitions contribute to growing investment.
- Expect short-term price inflation as pandemic logistics and regulatory pressure continue to influence the market

Pricing Update: What to Watch in 2022

Brianna Boudreau
TeleGeography

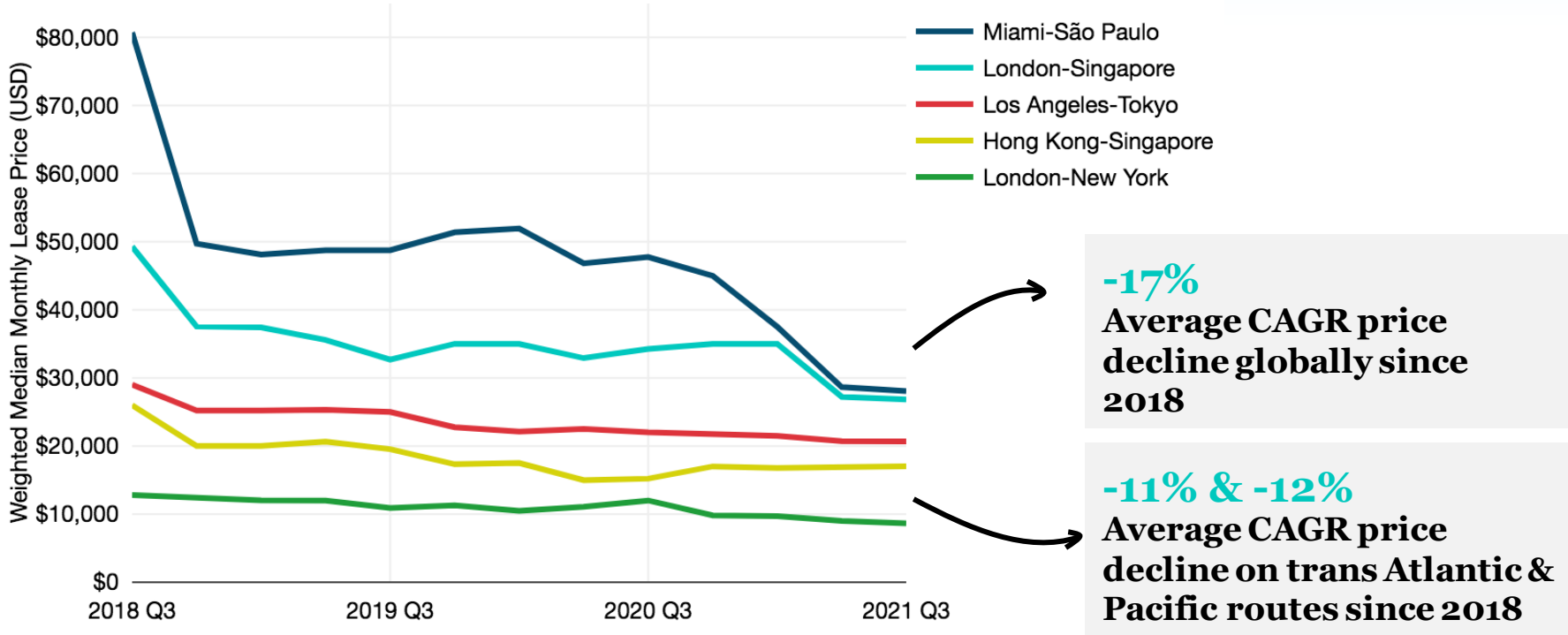
Overview

- Are prices increasing?
 - Where are we now and how did we get here?
 - How do trends compare across regions?
 - Impact of transport on transit pricing
- What does it take to be a new hub?
 - Impact of new supply & network investments on existing hubs & secondary markets in terms of pricing
- How might 400 Gbps pricing evolve?
 - Lessons learned from the roll out of 100 Gbps

Are prices increasing?

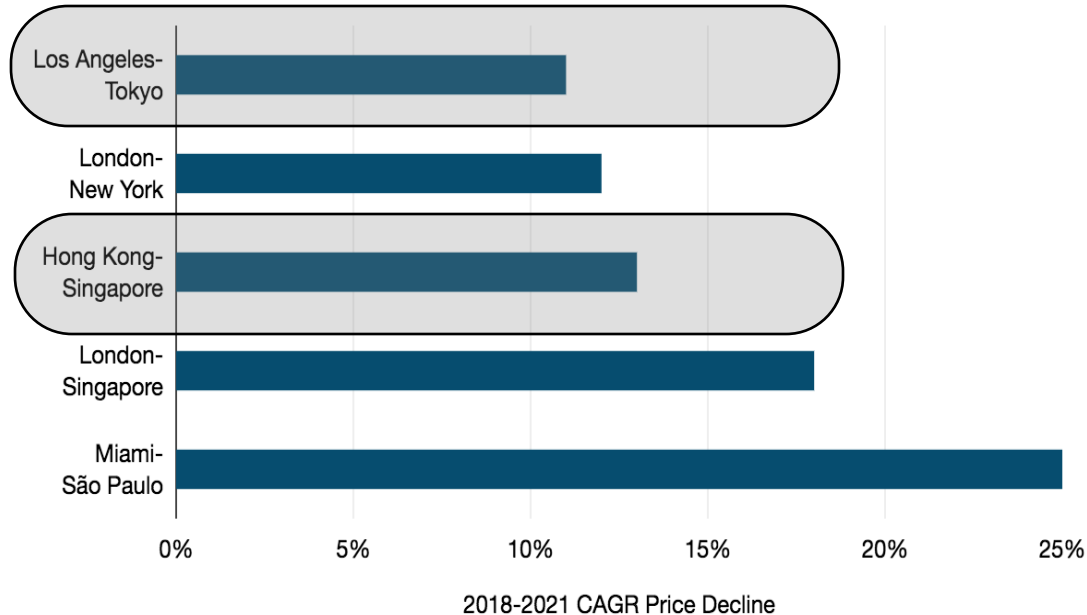
100 Gbps wavelength prices continue to decline globally

Weighted Median 100 Gbps Monthly Lease Prices, 2018-2021



But not all routes exhibit the same pace of price erosion

Weighted Median 100 Gbps Price Erosion, 2018-2021



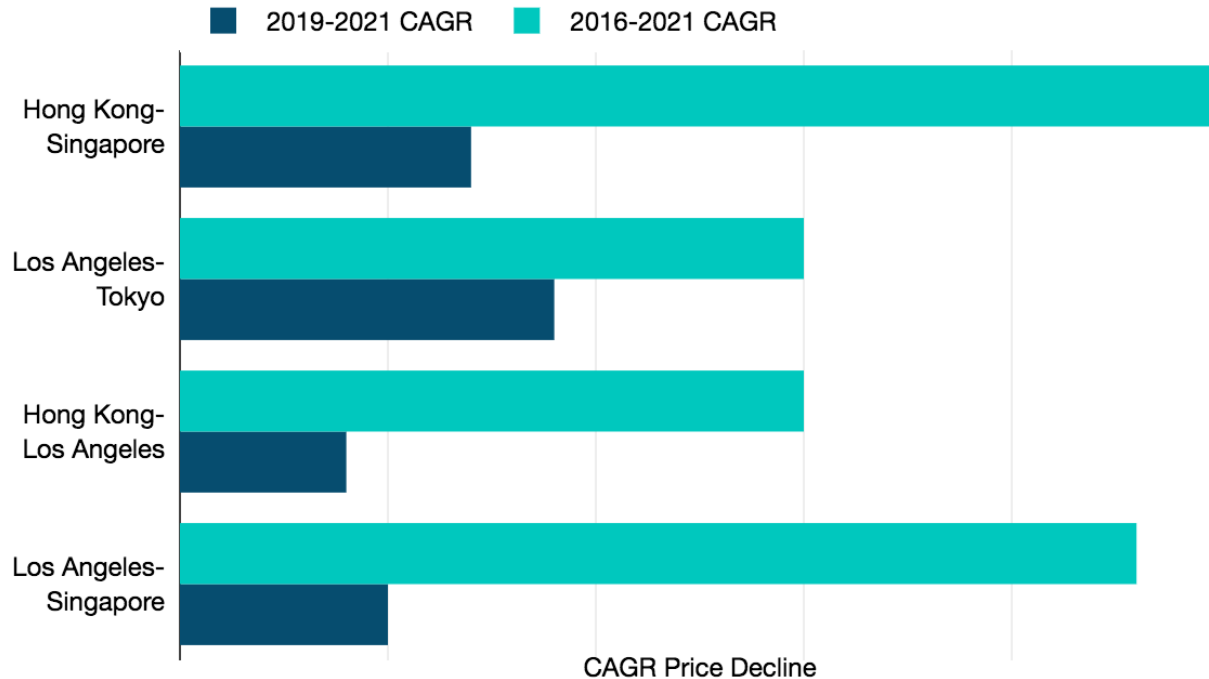
Declining Prices Across Routes ↓

On routes with ample supply (i.e. Miami-Sao Paulo) price erosion consistent with historical trends

On routes with limited supply, delays in new cables and upgrades, erosion is slower

Price erosion moderating in Asia and the trans-Pacific

CAGR Price Decline for Weighted Median 100 Gbps Wavelengths, 2019-2021 vs 2016-2021



**100 GBPS PRICE EROSION
MAJOR ROUTES (2019-21
CAGR)**

**Hong Kong-Singapore
-7%**

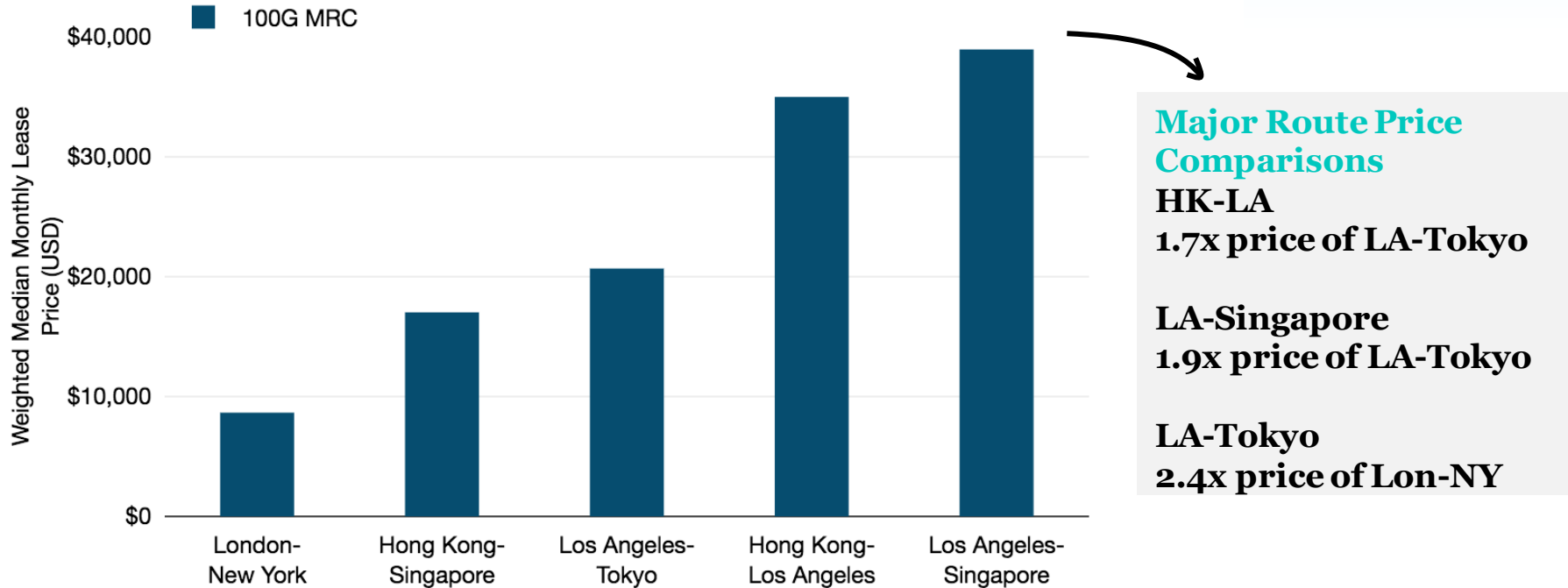
**Japan-U.S.
-5%**

**Hong Kong-U.S.
-4%**

**Singapore-U.S.
-9%**

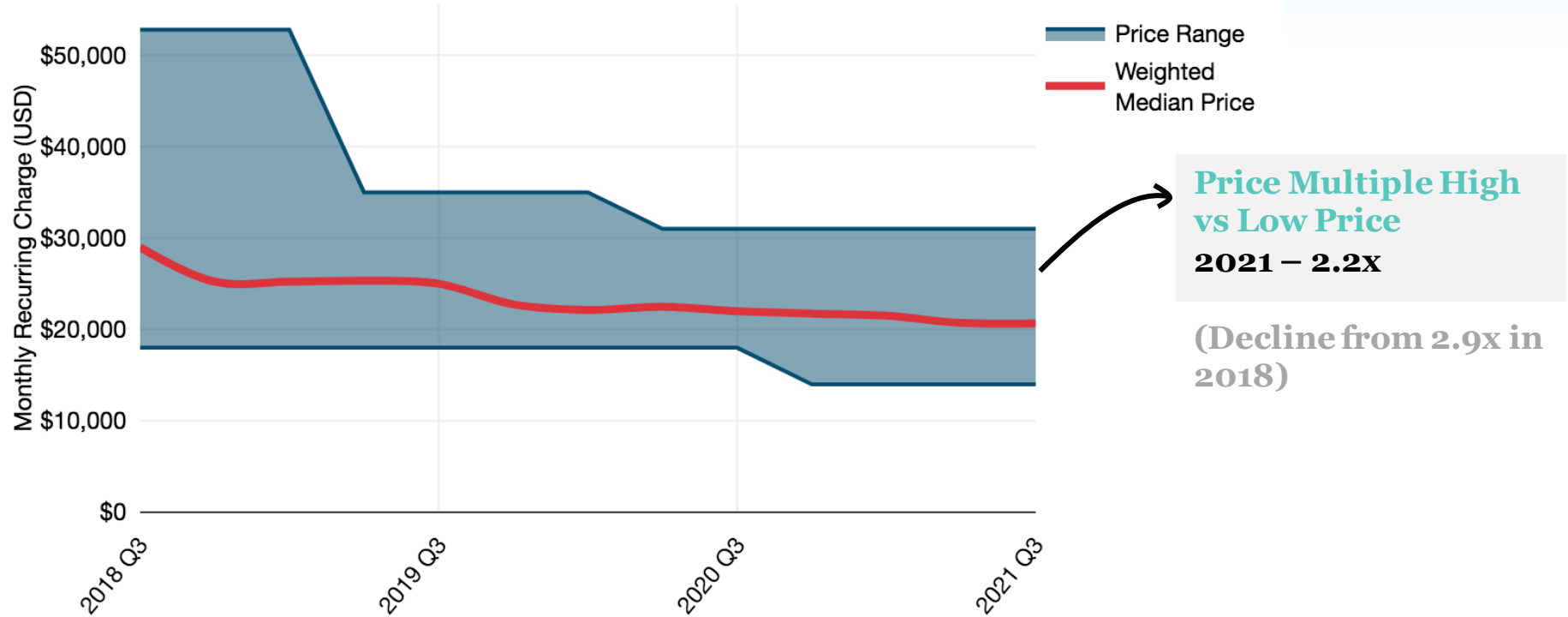
Maintaining price differences between routes

Weighted Median 100 Gbps Wavelength Prices on Key Global Routes, 2021



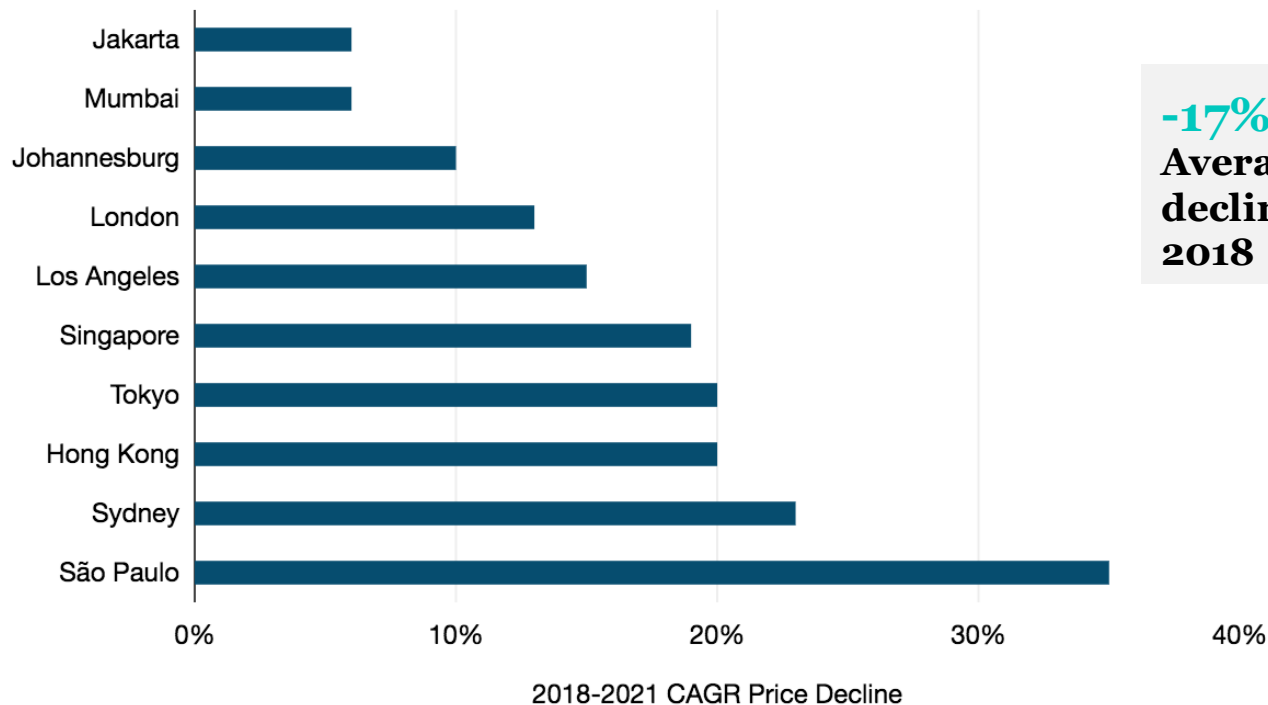
And the reported range on individual routes

Weighted Median & Price Range for 100 Gbps Wavelengths on Los Angeles-Tokyo



As transport goes, transit follows

Weighted Median 10 GigE IP Transit CAGR Price Decline, 2018-2021







-17%
Average CAGR price decline globally since 2018

Are prices increasing?

- The recent pace of price erosion has slowed compared to previous years. But we have not seen any increases in price.
 - On routes with ample supply, price erosion has been consistent with historical trends.
 - On routes with limited supply, delays in new submarine cable systems, and upgrades, price erosion has moderated.
 - This has helped to maintain price differences between routes and providers on individual routes.
- Our 2022 prediction
 - Delays in planned network projects and supply chain constraints for upgrades will likely keep price points fairly stable in the short term.
 - Once new systems are launched and supply chain issues resolve, an increase in the pace of price erosion is likely.

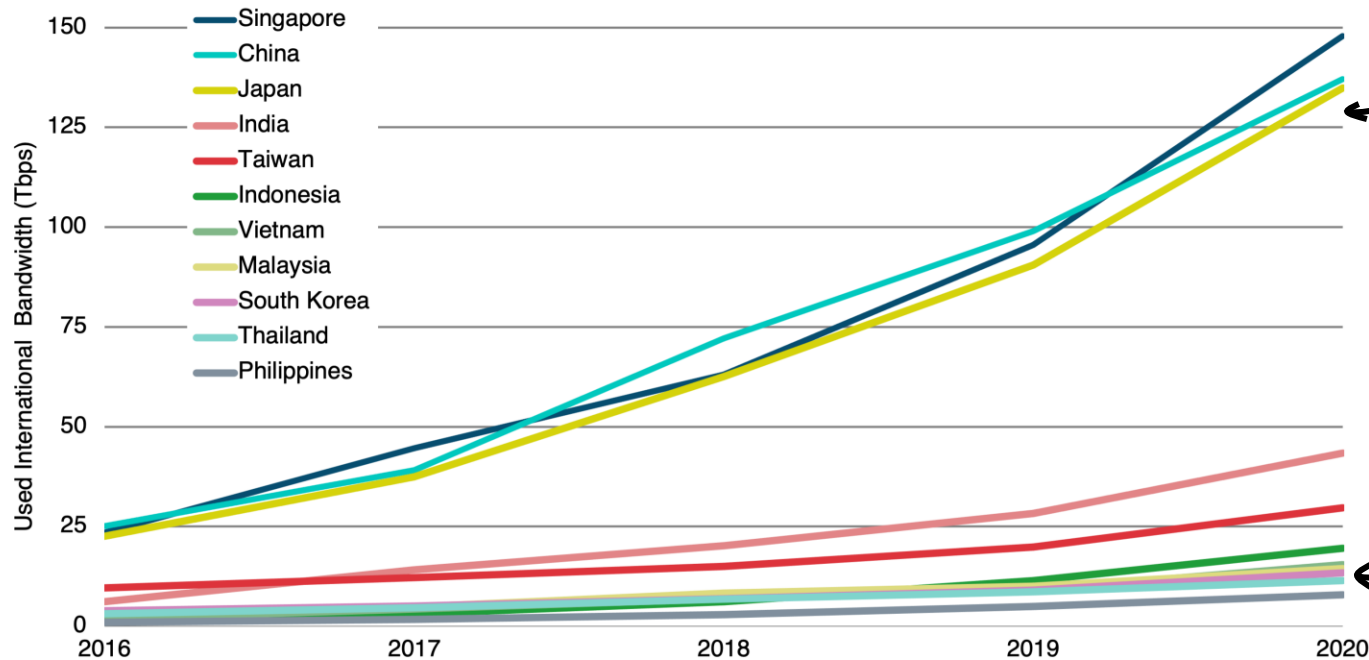
What does it take to become a new hub?

Characteristics of regional hubs

- Robust network connectivity 
 - Submarine cables
 - Data centers
 - Internet exchanges
- Numerous service providers 
- Cloud regions 
- Affordable bandwidth 

Big difference in hubs vs. non-hubs int'l bandwidth

Used International Bandwidth by Country, 2016-2020

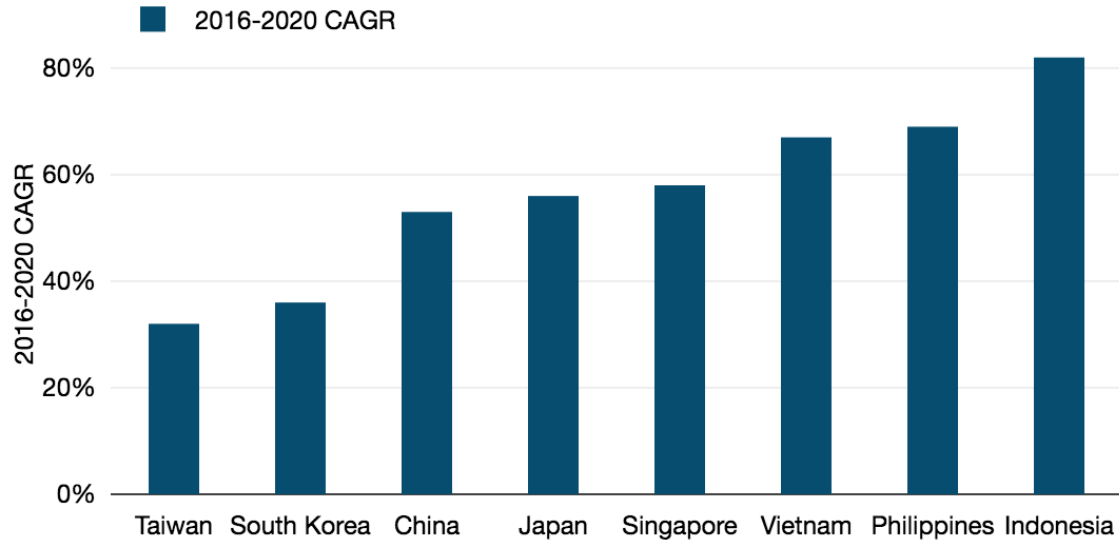


Major hubs
Singapore,
China,
Japan

Non-hubs
Taiwan,
Indonesia,
Philippines

Demand rising rapidly in most Asian countries, not just hubs

Used International Bandwidth by Country, 2016-2020 CAGR

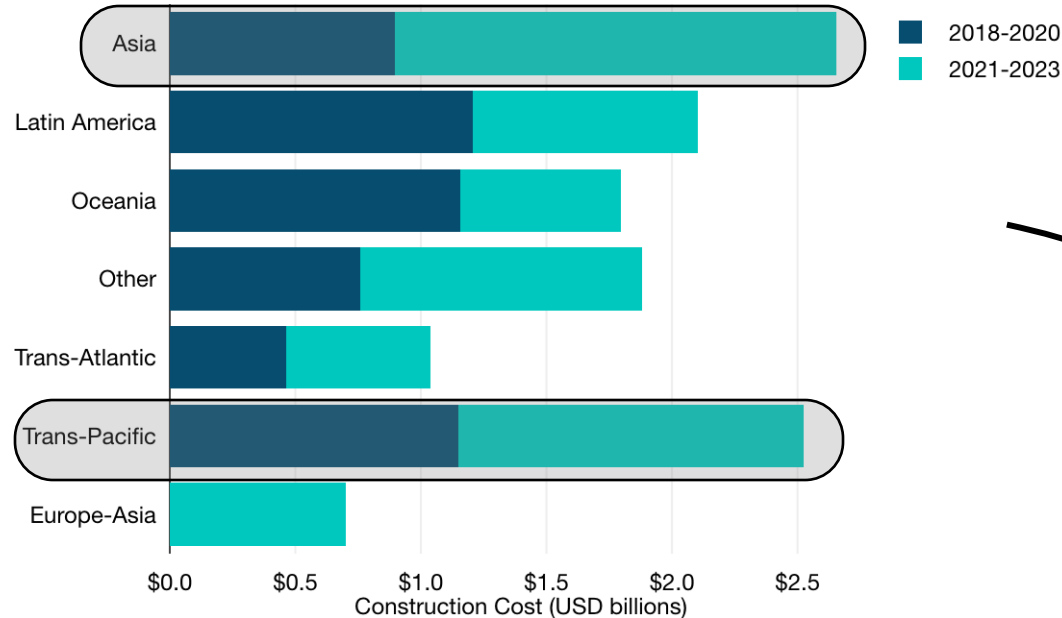


**Average CAGR
used bandwidth
growth rate
55%**

**Fastest
Growing
Countries
Indonesia
Philippines
Vietnam**

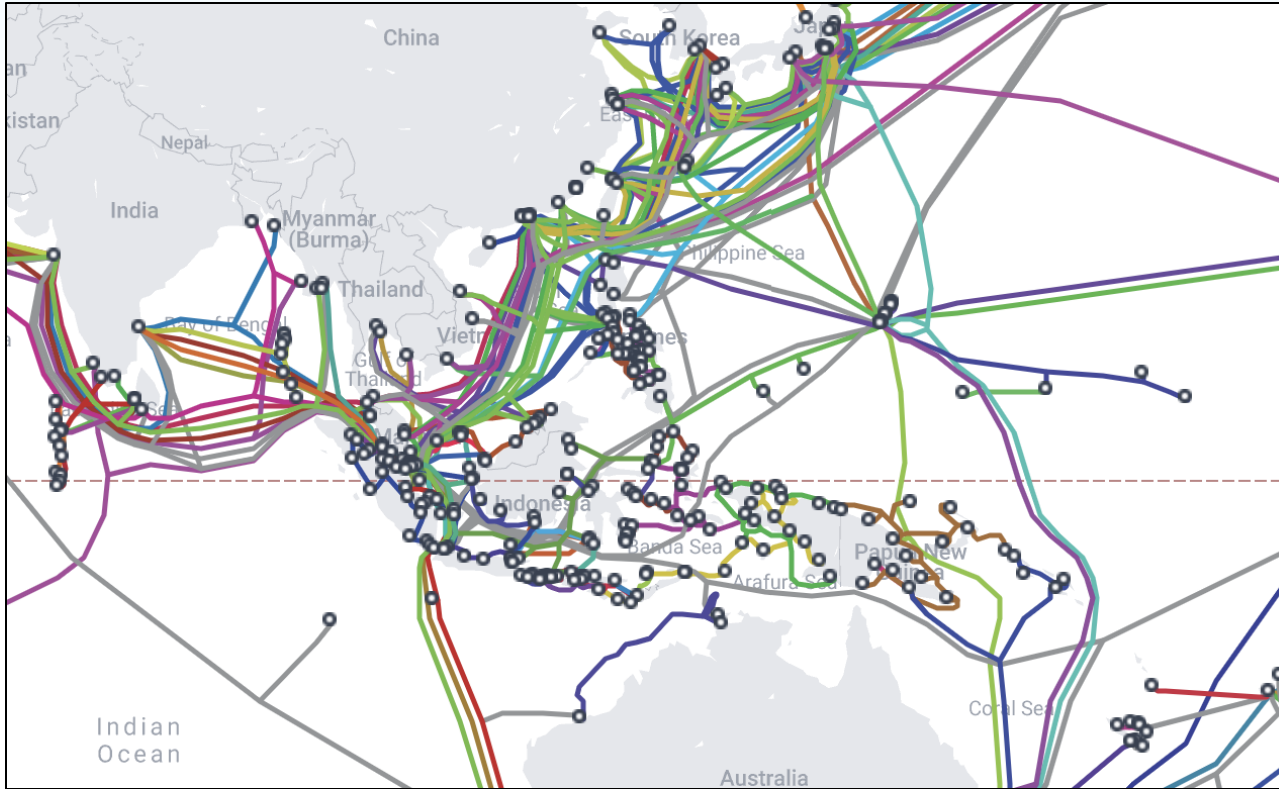
New cable investment especially strong to Asia

Subsea Cable Construction Costs by Route, 2018-2023



**Construction costs on
trans-Pacific & intra-
Asia routes
\$3.2 billion 2021-23**

The Future of Asian Subsea Geography



**Announced planned
cables connecting to:**

Hong Kong: 2

Japan: 3

Singapore: 8

Taiwan: 2

Indonesia: 4

Philippines: 4

Rapid cloud network expansion in Asia

Cloud Regions in Asia, 2017 & Planned Today

2017

Planned today



- AWS
- Alibaba
- Azure
- Google

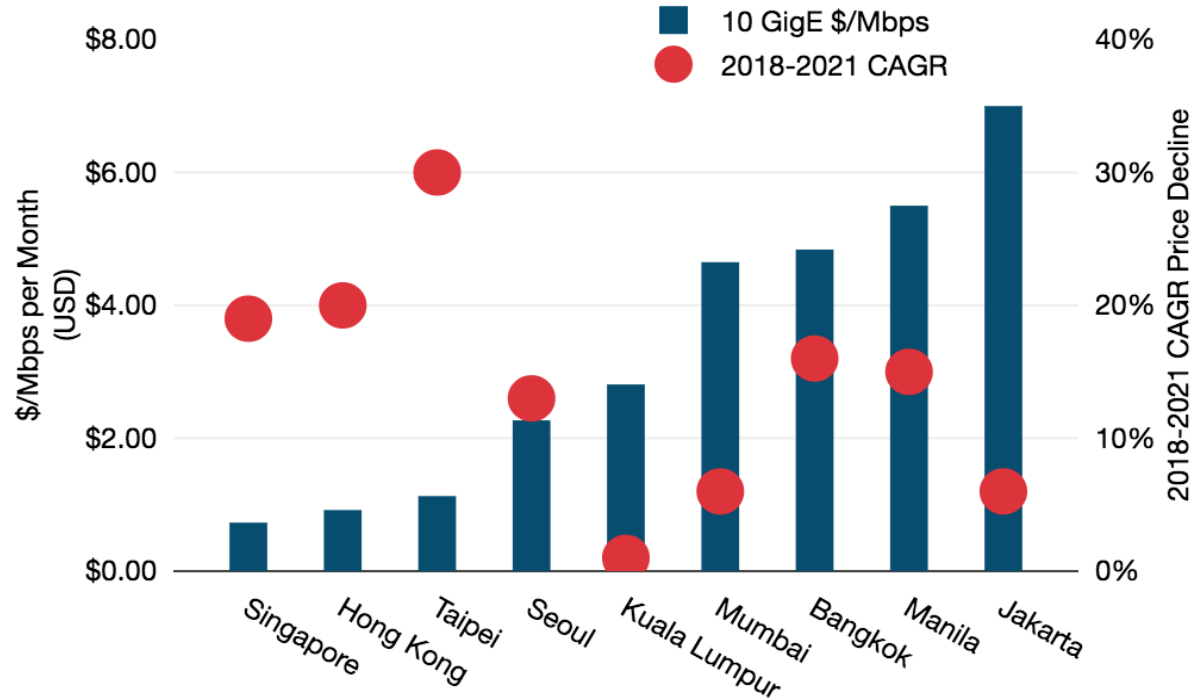


- AWS
- Alibaba
- Azure
- Google
- Oracle

New regions planned in:
India, Malaysia,
Philippines, Singapore,
Taiwan

Connectivity remains expensive in secondary markets

Weighted Median 10 GigE IP Transit Prices & CAGR Price Decline



Major City Price Comparisons

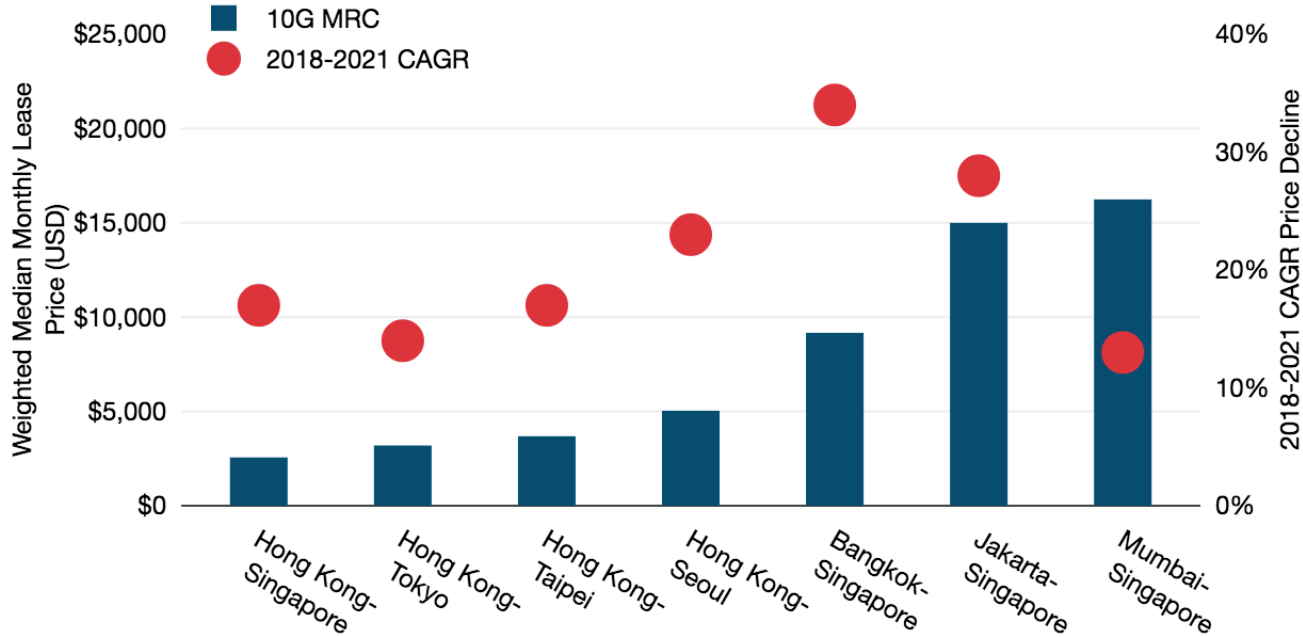
Jakarta
9.6x price of Singapore

Manila
7.5x price of Singapore

Taipei
1.5x price of Singapore

Underlying costs in these markets rapidly declining

Weighted Median 10 Gbps Wavelength Prices & CAGR Price Decline



-23%
Average CAGR price decline on routes to non-hubs since 2018

-16%
Average CAGR price decline on routes between hubs since 2018

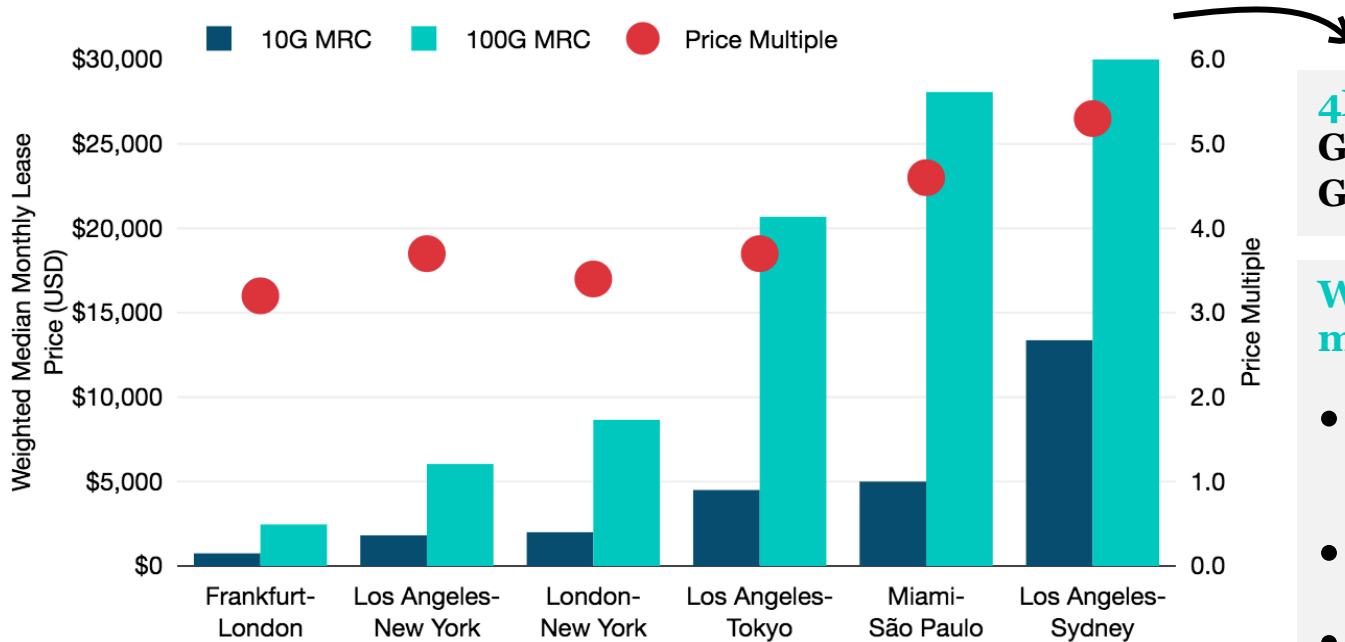
What does it take to be a new hub?

- Having lots of cable landings alone does not make a country an interconnection hub.
- Hubs have a rich ecosystem with open markets, large data centers, internet exchanges, interconnection platforms, cloud regions, and robust network connectivity.
- Affordable bandwidth & connectivity is also key!
- Connectivity prices to secondary markets remains expensive.
 - But bandwidth prices to these markets have exhibited the biggest declines over the past few years. Will trickle down to IP transit as well.
- A number of markets starting to show the characteristics of new hubs, but have a ways to go to be on par with existing hubs.

How might 400 Gbps prices evolve?

Price points & multiples differ globally

Weighted Median 10 & 100 Gbps Wavelength Prices & Price Multiples, 2021



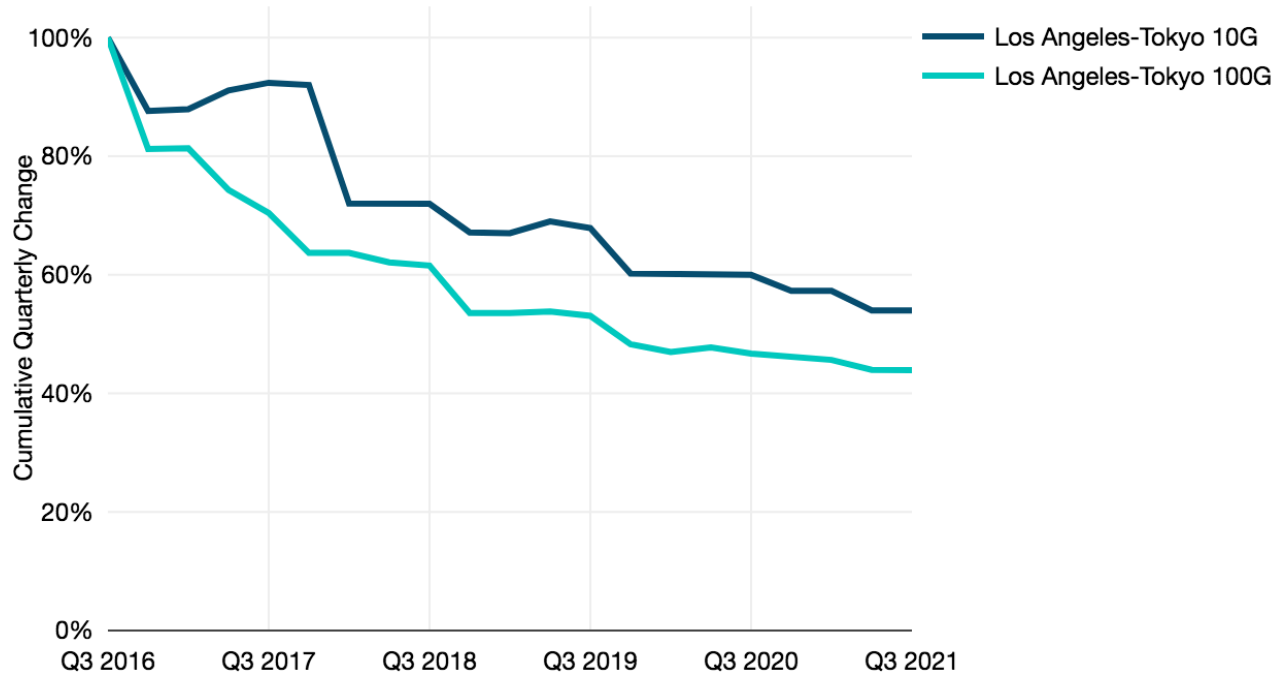
4X
Global average 10:100
Gbps multiple

What influences price multiples?

- **Adoption of 100 Gbps**
- **Prices of 10 Gbps**
- **Regional differences**

100 Gbps price erosion has outpaced 10 Gbps

Cumulative Quarterly Weighted Median Price Change 10 Gbps and 100 Gbps Wavelengths, 2016-2021



-12%
CAGR price decline
on LA-Tokyo for 10
Gbps since 2016

-15%
CAGR price decline
on LA-Tokyo for 100
Gbps since 2016

Compressing price multiples over time

10 & 100 Gbps Price Multiples, 2016-2021

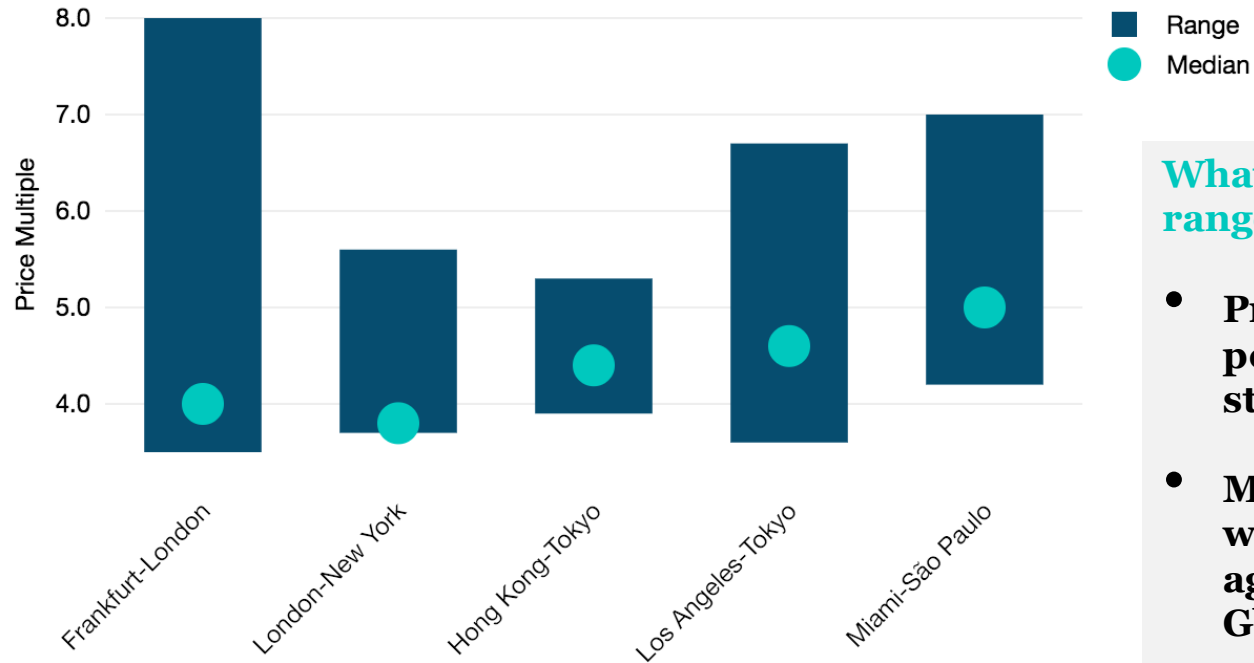


Implication

As 100 Gbps erosion outpaces 10 Gbps it compresses price multiples, making upgrades more economical.

Ranges persist based on carrier emphasis

Range & Median of Carrier 10:100 Gbps Price Multiples, 2021



What influences the range of price multiples?

- **Providers price positioning & market strategy**
- **Multiples skew low when sellers compete aggressively for 100 Gbps but not 10 Gbps**

How might 400 Gbps prices evolve?

- What could be similar to the rollout of 100 Gbps:
 - As with previous step changes in capacity, 400 Gbps upgrades are initially focused on shorter terrestrial links in Europe and the U.S. and will move on to transoceanic links starting with the Atlantic.
 - These shorter, competitive routes already boast the lowest prices on offer and lowest price multiples.
 - While initial prices may roll out at 4x100 Gbps, savings can be achieved based on savings on install & cross connects
 - And if history is any guide, price multiples between 100 & 400 Gbps will eventually compress.
 - High capacity routes first to experience reduced price multiples
 - Pricing strategy will depend on the carrier type/emphasis

Looking ahead

- While price erosion has slowed, it certainly has not stopped. Particularly on routes with ample supply.
- Focus going forward may not just be on new hubs (lots of investment in HK, Sing, Japan still) but new landings and direct connectivity. A real emphasis on emerging markets and bringing content closer to end-users.
- New direct routes, integrated backhaul, & technological improvements such as high fiber count cables will offer cost improvements over existing options. Lower costs passed along to customers in form of lower prices.
- 100 Gbps has become the common transaction on key routes. Lower unit costs have driven lower wavelength prices. With 400G rolling out, a similar price evolution can be expected.