TeleGeography

TeleGeography Workshop

Brianna Boudreau
Jon Hjembo
Alan Mauldin

PTC 2025

January 19, 2025

Overview

Brianna’s presentation

- From Clickbait to Reality: A Deep Dive into Global Pricing Trends

Jon’s presentation

- Evaluating Interconnection Market Health

Alan’s presentation

- Mother Earth, Motherboard

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From Clickbait to Reality: A Deep Dive into Global Pricing Trends

Brianna Boudreau

Overview

- Transport Pricing
  - New supply is finally coming, are prices falling?
  - Price implications of ensuring network diversity and resilience
- Keeping Pace with Capacity Requirements: 400G
  - How have 400G prices evolved?
  - Price multiples by route & provider
- IP Transit: Established Hubs vs. the Next-Generation
  - Impact of transport on IP transit prices
  - Impact of network investment on existing hubs & secondary markets
  - 400 GigE ports

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New Supply is Finally Coming, Are Prices Falling?

ACCESS EVOLUTION

Asia's seabed is a hotbed of cable-laying activity

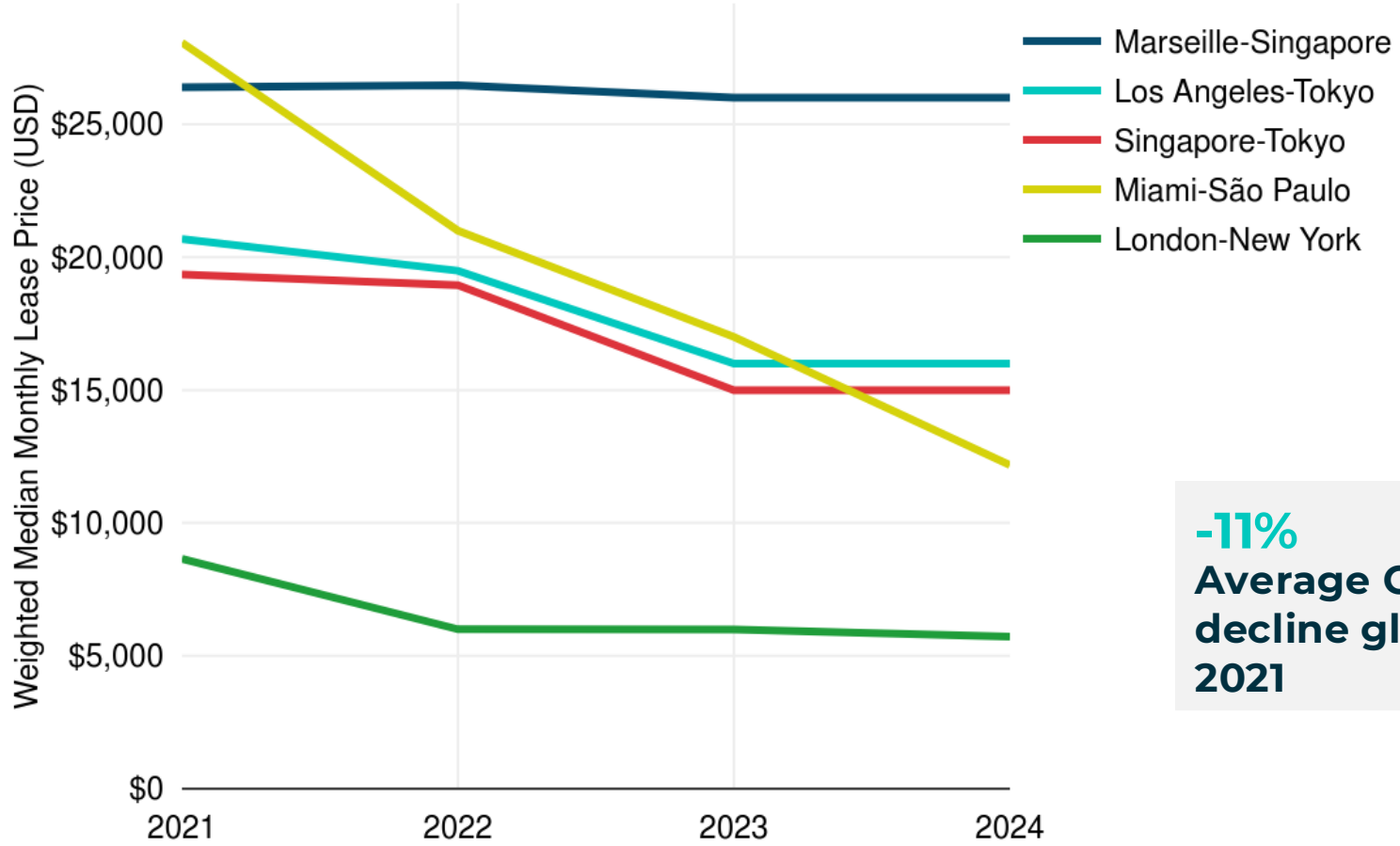
OPTICAL & FIXED NETWORKS

Two more APAC subsea cable projects announced

9 subsea cable projects redefining Latin America's digital future

100 Gbps wavelength prices continue to decline globally as new supply comes online

Weighted Median 100 Gbps Wavelength Prices, 2021-2024



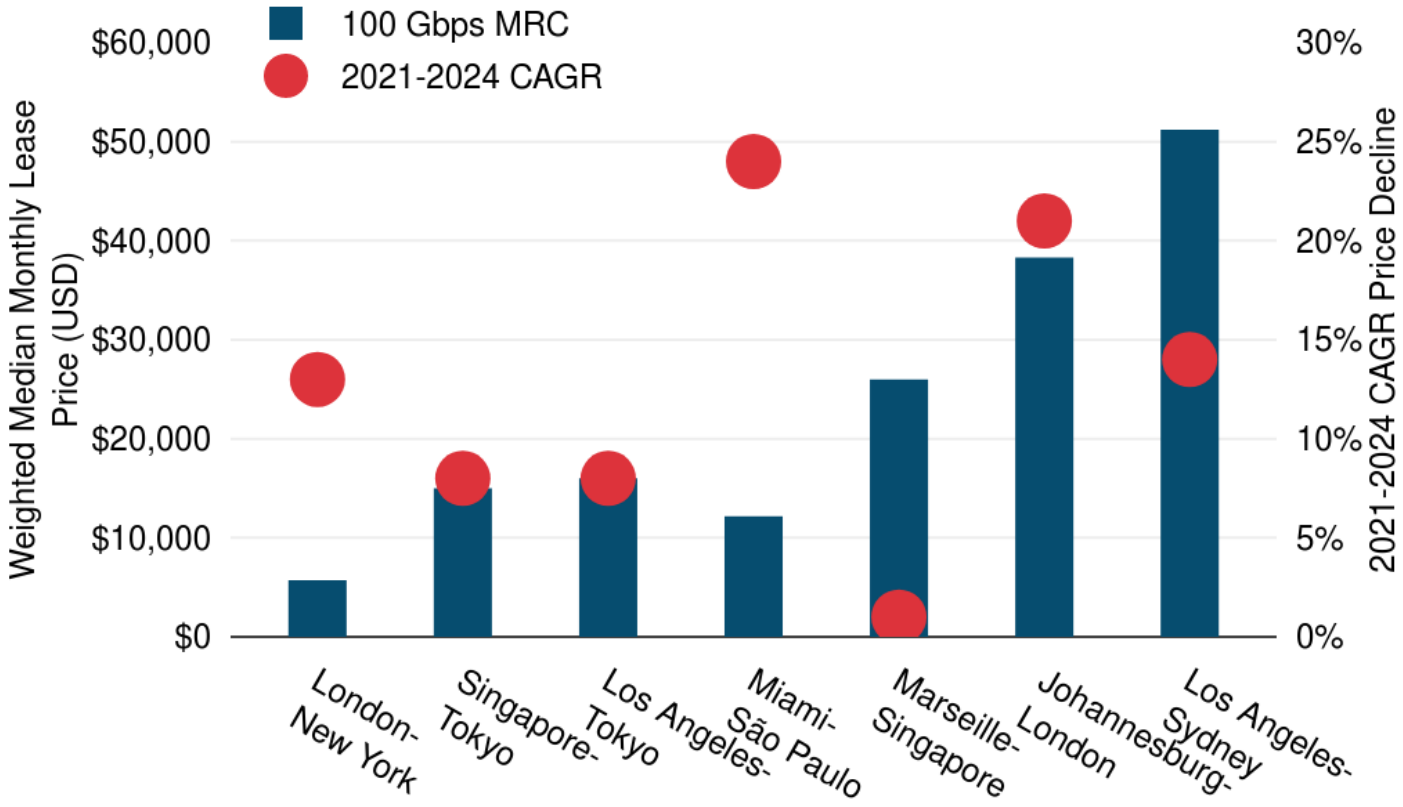
-11%
Average CAGR price decline globally since 2021

Source: TeleGeography's Network Pricing

How these investments are impacting each region varies significantly

- In regions where new high-capacity cables have recently entered service, price erosion is accelerating.
  - Africa & Latin America reporting the highest rate of price erosion.
- On routes with continued delays in new supply, the pace of price erosion is slower.

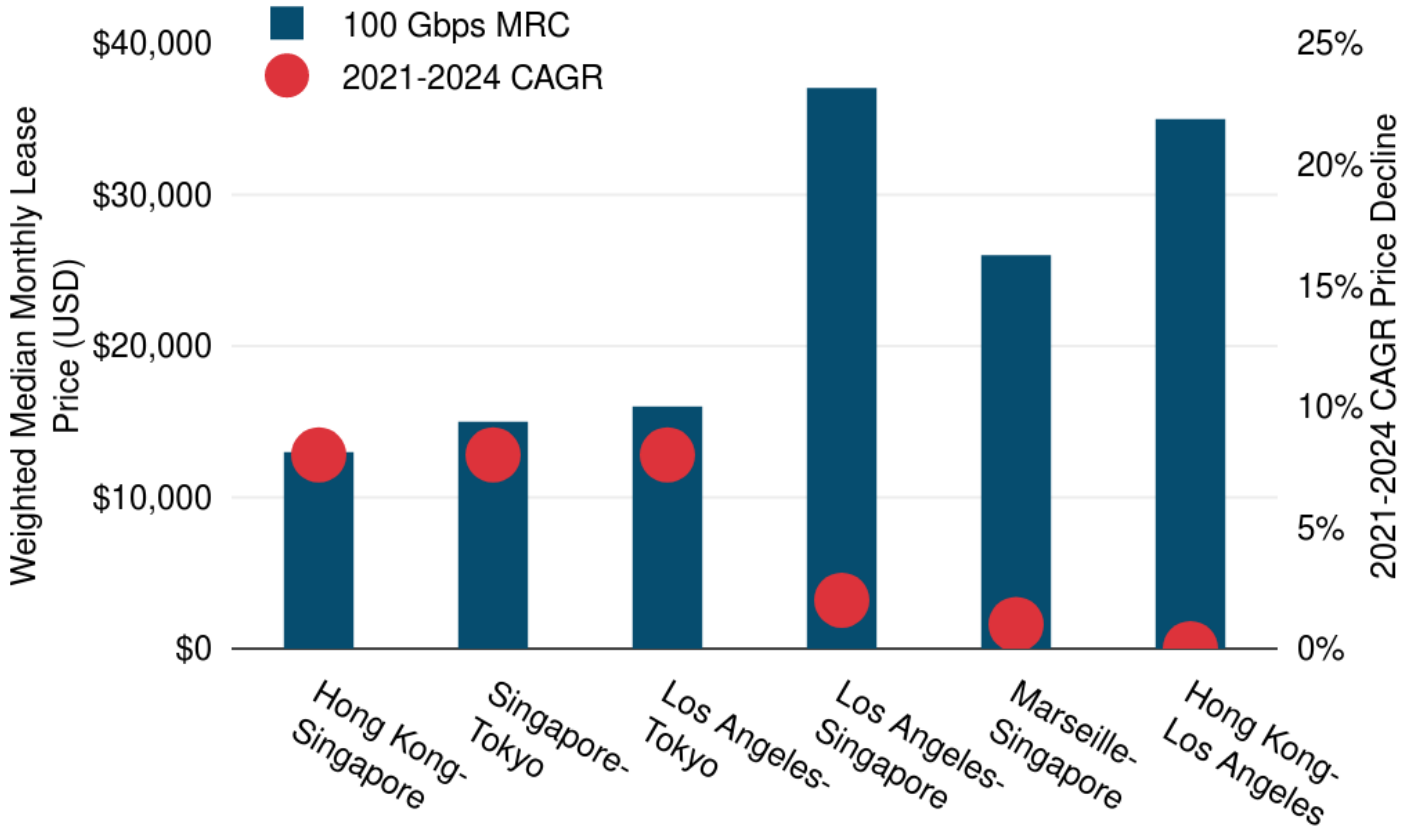
Weighted Median 100 Gbps Wavelength Prices & CAGR Price Decline



Source: TeleGeography's Network Pricing

Price erosion still slower on core APAC routes

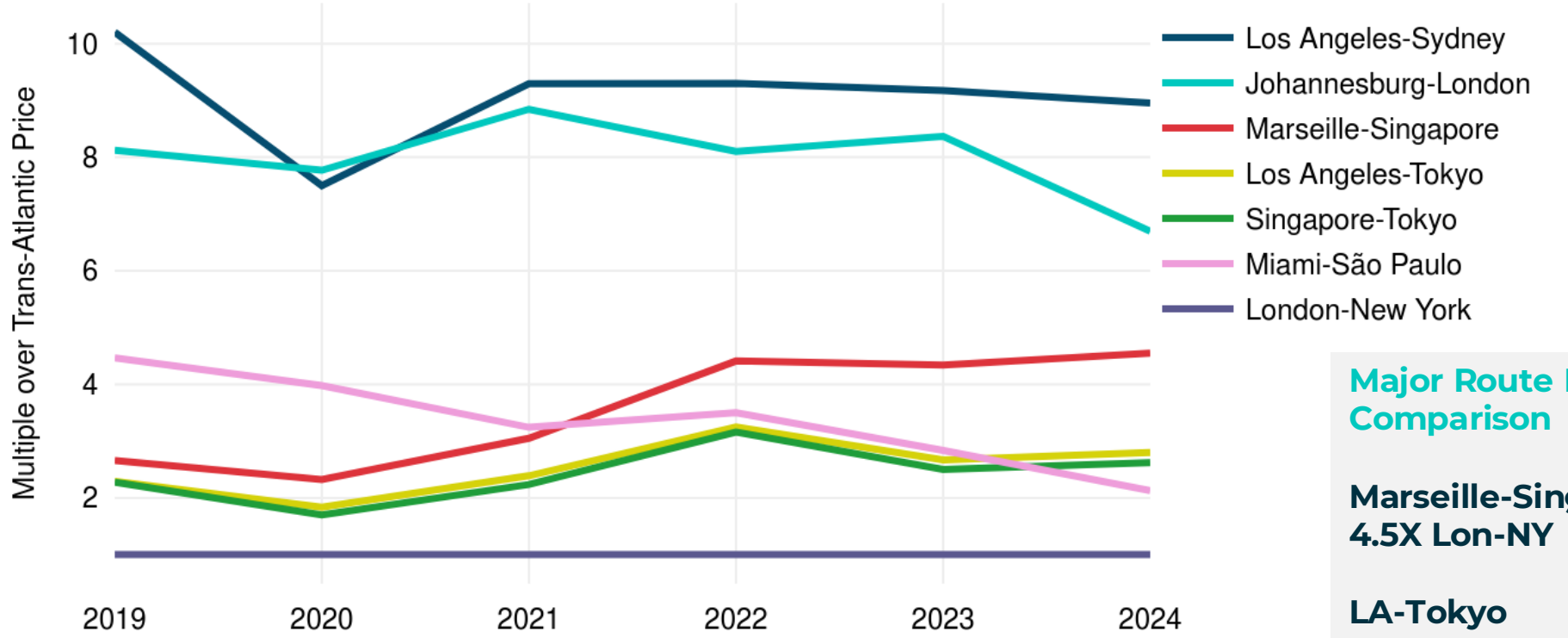
Weighted Median 100 Gbps Wavelength Prices & CAGR Price Decline



Source: TeleGeography's Network Pricing

Maintaining global price differences

Weighted Median 100 Gbps Monthly Lease Prices Relative to London-New York



Major Route Price Comparison

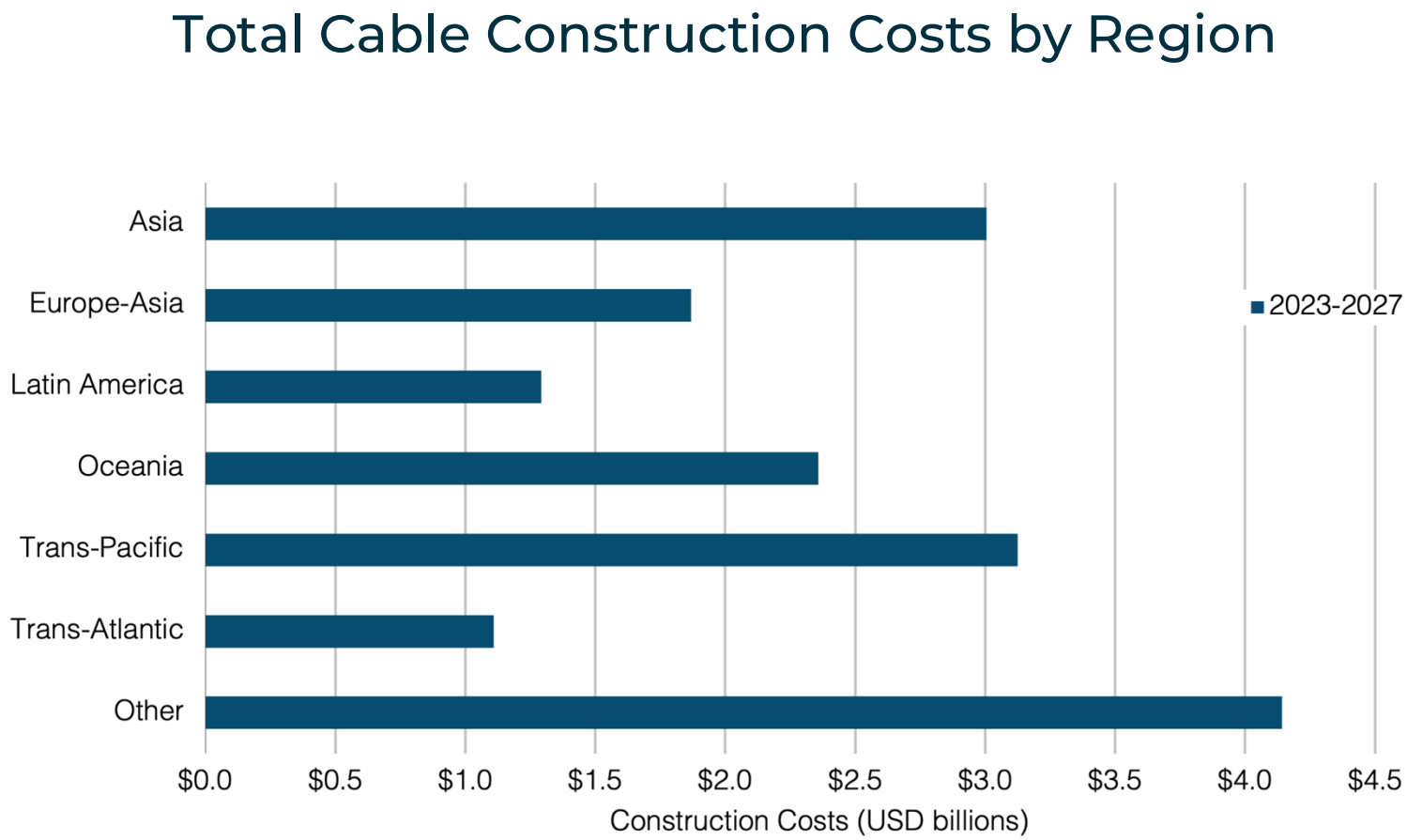
Marseille-Singapore
4.5X Lon-NY

LA-Tokyo
2.8x Lon-NY

Miami-São Paulo
2.1x Lon-NY

Source: TeleGeography's Network Pricing

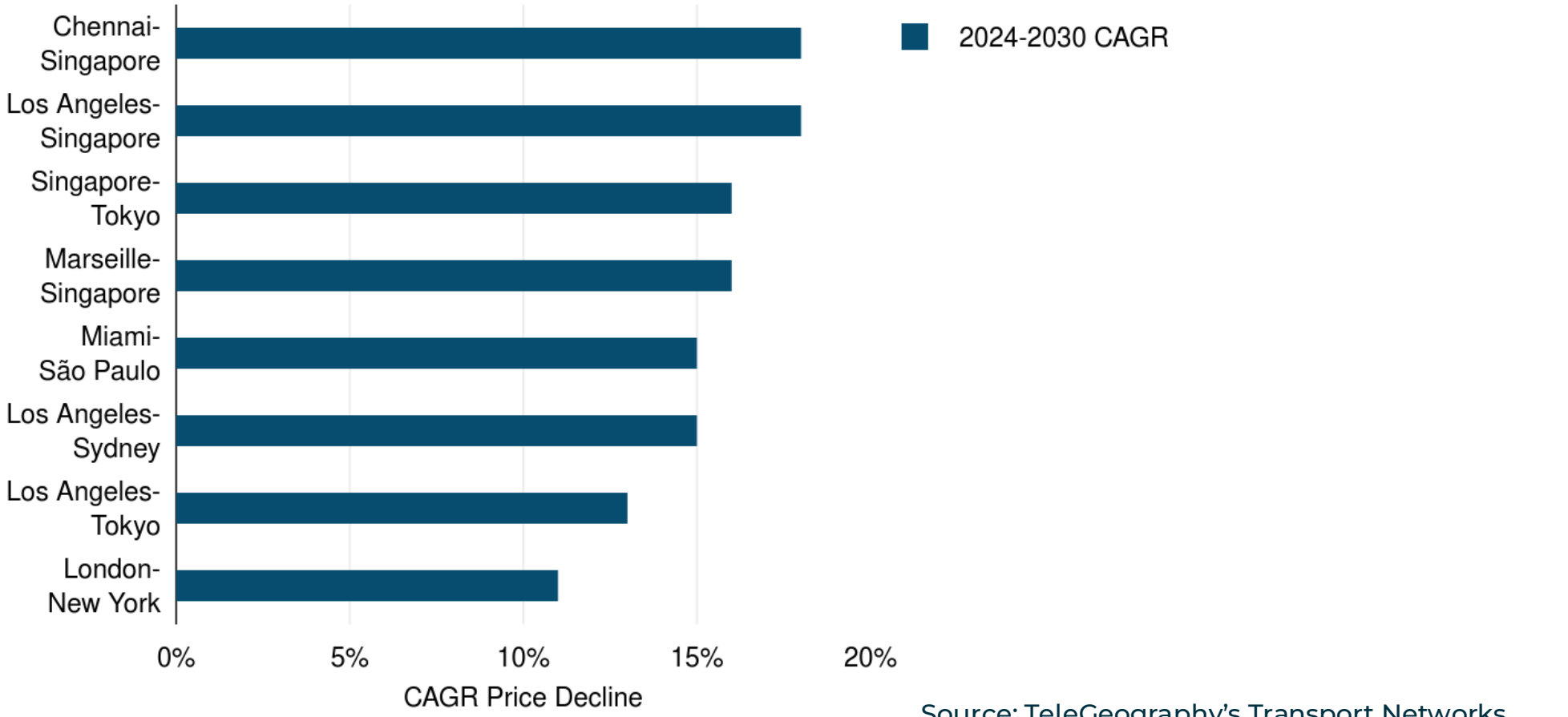
Surge in new cable construction, particularly to Asia



Source: TeleGeography's Transport Networks

Fueling forecasted price erosion

Forecasted 100 Gbps Wavelength CAGR Price Decline, YE 2024-YE 2030



Source: TeleGeography's Transport Networks Forecast Service

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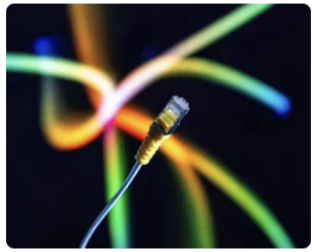
Price Implications of Ensuring Network Diversity and Resilience

Fragile lifelines: The rising threats and resilience of submarine cable networks

Submarine cable damage in the Red Sea ‘severely underestimated’

Yemen Subsea Cable Repairs Delayed



CABLE TECHNOLOGY

Multiple cable failures impact Africa's Internet

MAR 15, 2024 | 3 MIN READ

ars TECHNICA

FIBER FIASCO —

Cut submarine cables cause web outages across Africa; 6 countries still affected

Parts of Africa were already seeing web disruptions from damaged Red Sea cables.

SCHARON HARDING - 3/15/2024, 11:40 PM

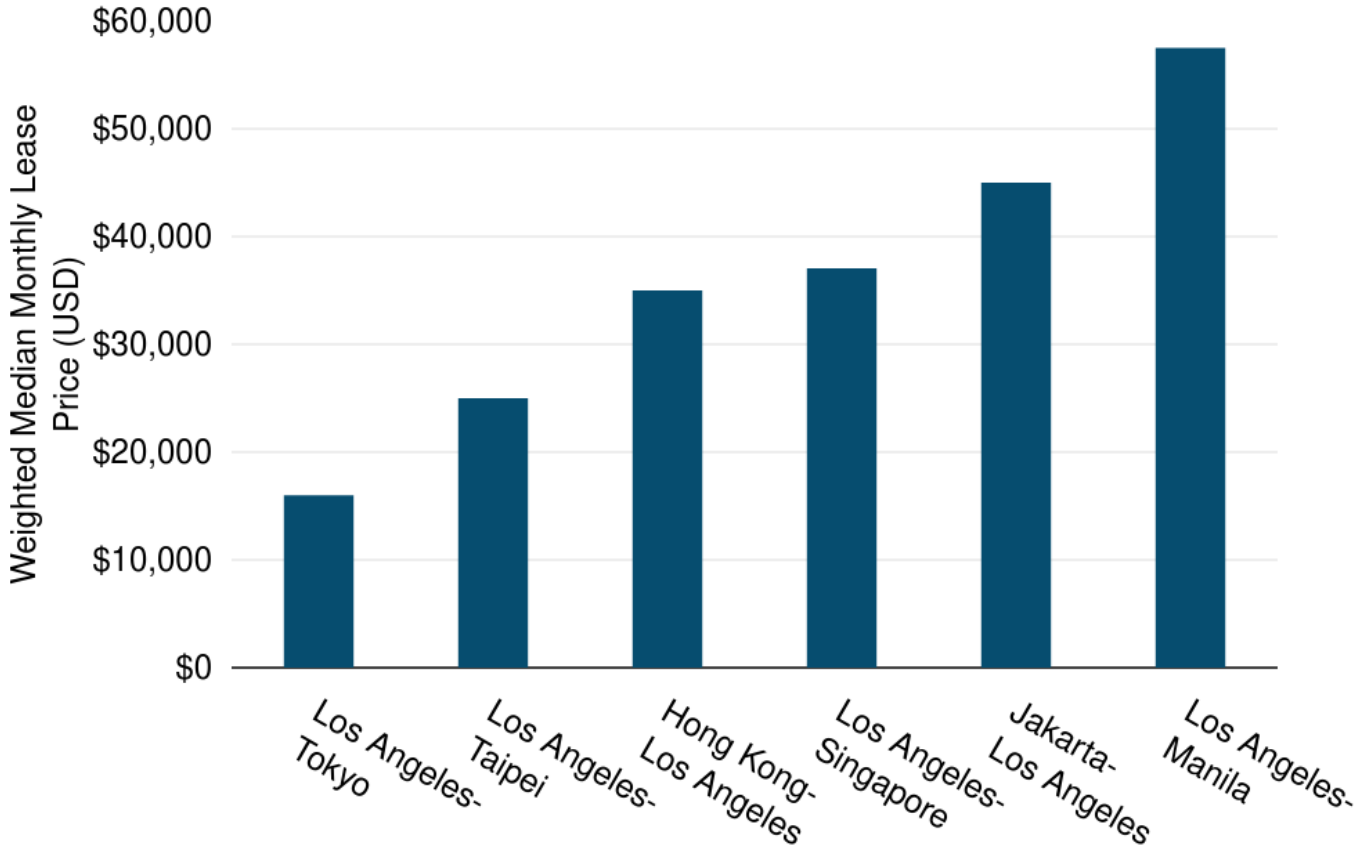
Network diversity & resilience can be achieved a few ways

- By route
- By supplier or path
- By geographic corridor

All have price implications

Pricing for diverse paths on the Trans-Pacific route

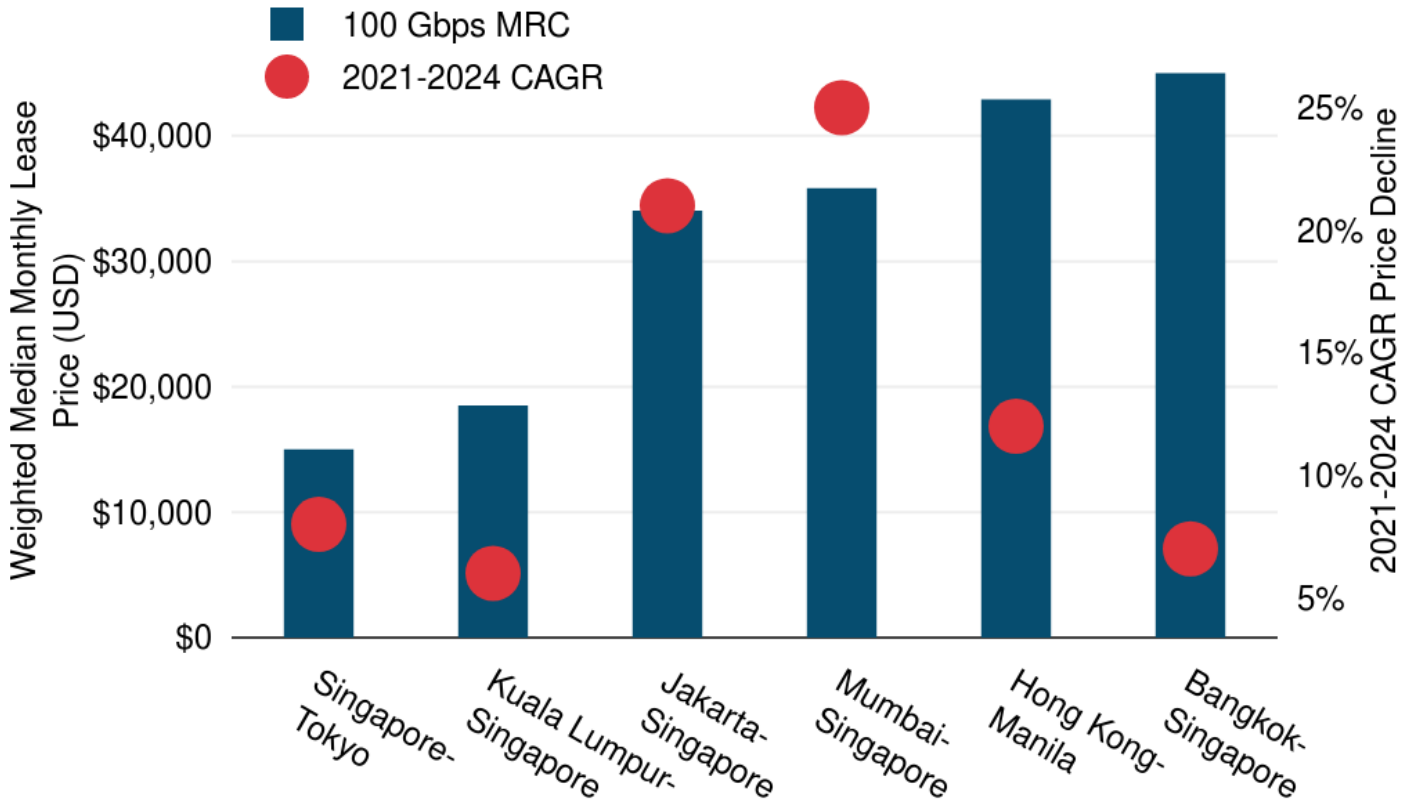
Weighted Median 100 Gbps Wavelength Prices on Trans-Pacific Routes, 2024



Source: TeleGeography's Network Pricing

Pricing for diversity across routes in Asia

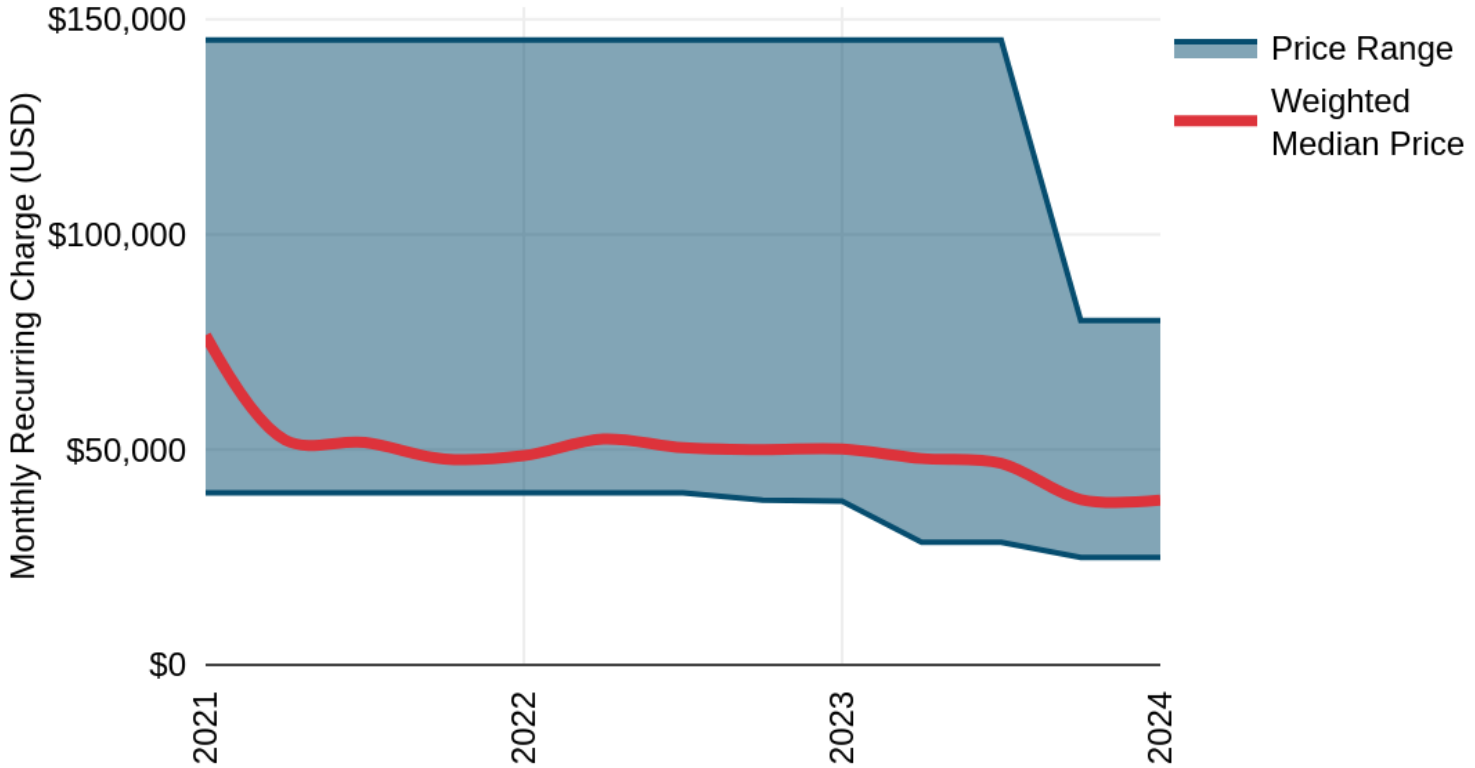
Weighted Median 100 Gbps Wavelength Prices & CAGR Price Decline



Source: TeleGeography's Network Pricing

Diversity by supplier and path

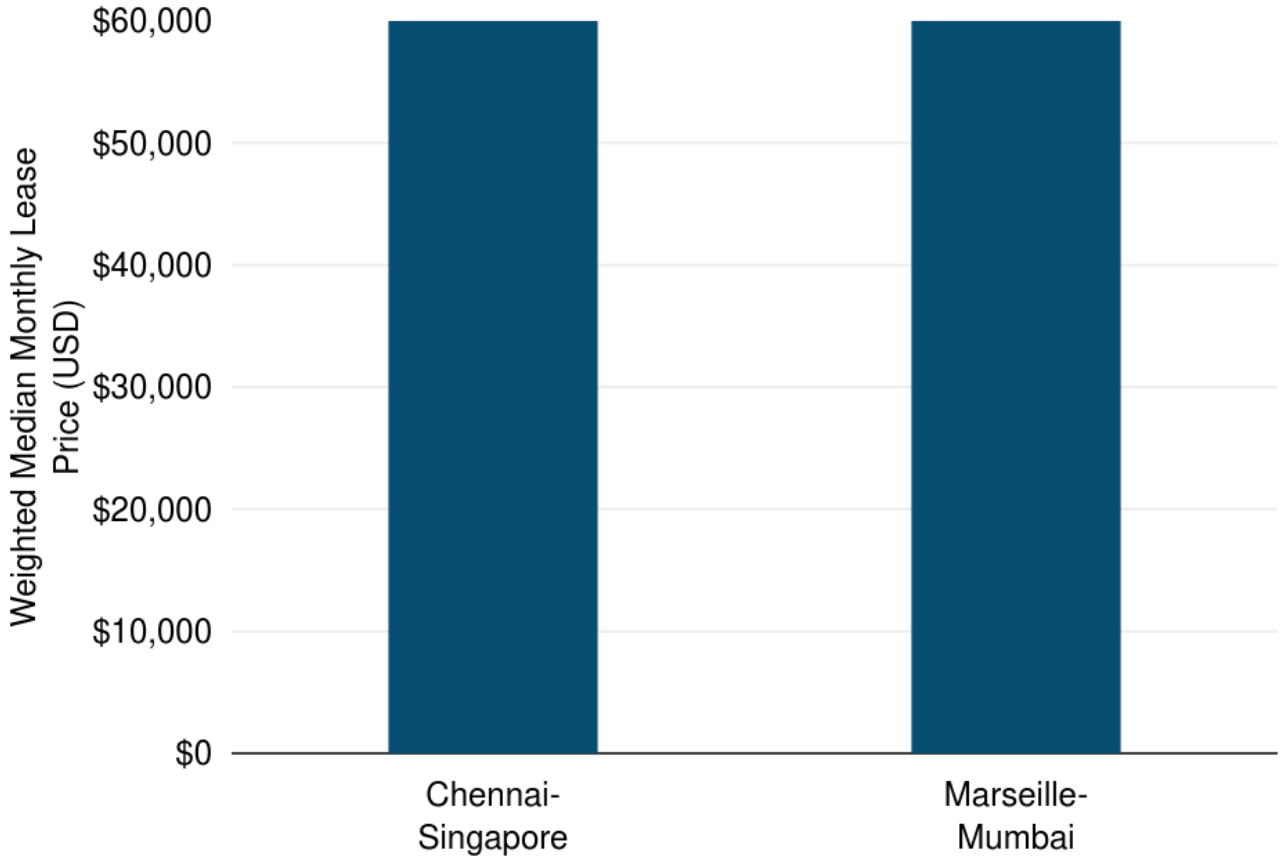
Weighted Median & Price Range for 100 Gbps Wavelengths on Johannesburg-London



Source: TeleGeography's Network Pricing

Diversity by geographic corridor

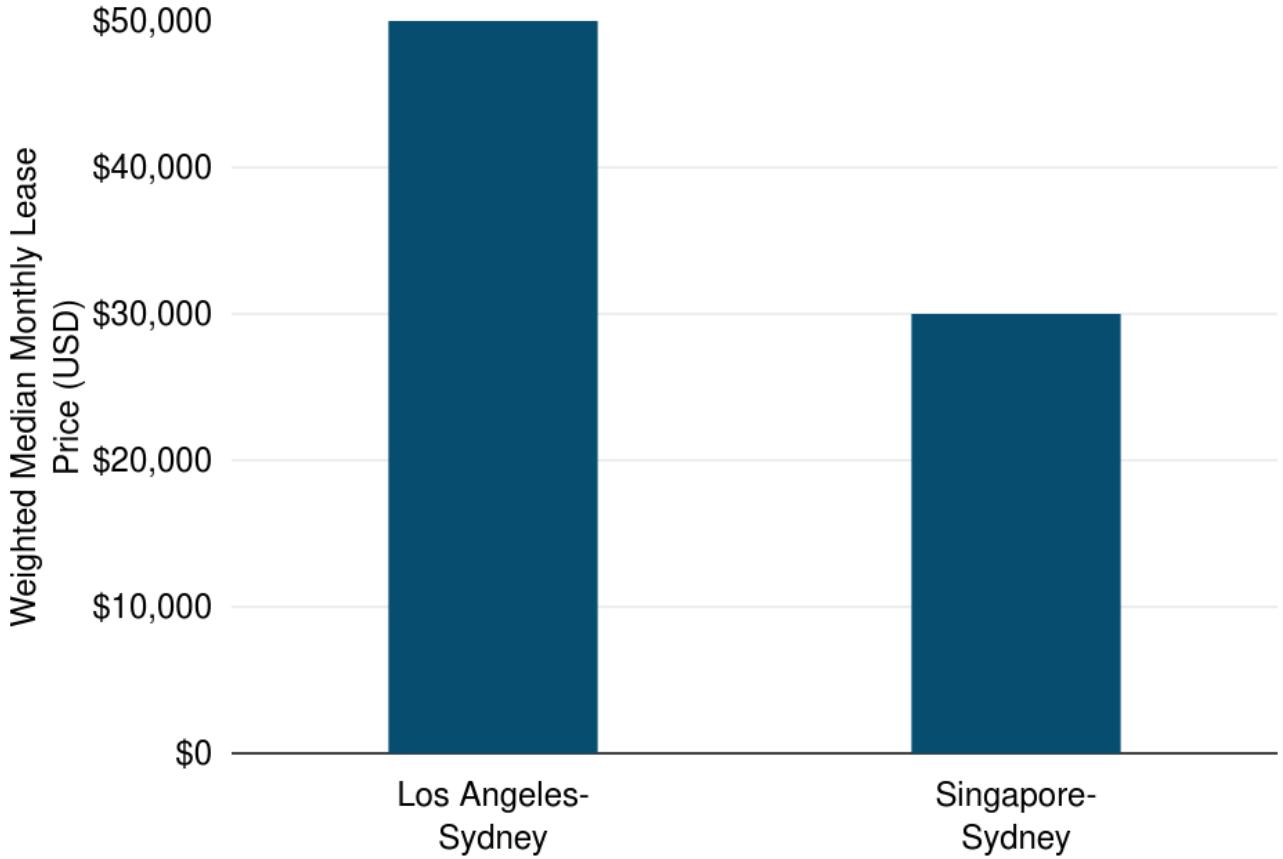
Weighted Median 100 Gbps Wavelength Prices on Key Routes to India, 2024



Source: TeleGeography's Network Pricing

Diversity by geographic corridor

Weighted Median 100 Gbps Wavelength Prices on Key Routes to Australia, 2024



Source: TeleGeography's Network Pricing

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Keeping Pace with Capacity Requirements: 400G

Businesses have high hopes for AI. Are their networks ready?

Prepare for the AI traffic wave

Bandwidth and Network Speeds Exploding with Hyperscale Deployments

Industry Voices

Meeting the growing demand for connectivity

400G more widely available & competitively priced

Global 100 & 400 Gbps Wavelength Prices & Price Multiples, 2024

100G:400G Average Global Price Multiple

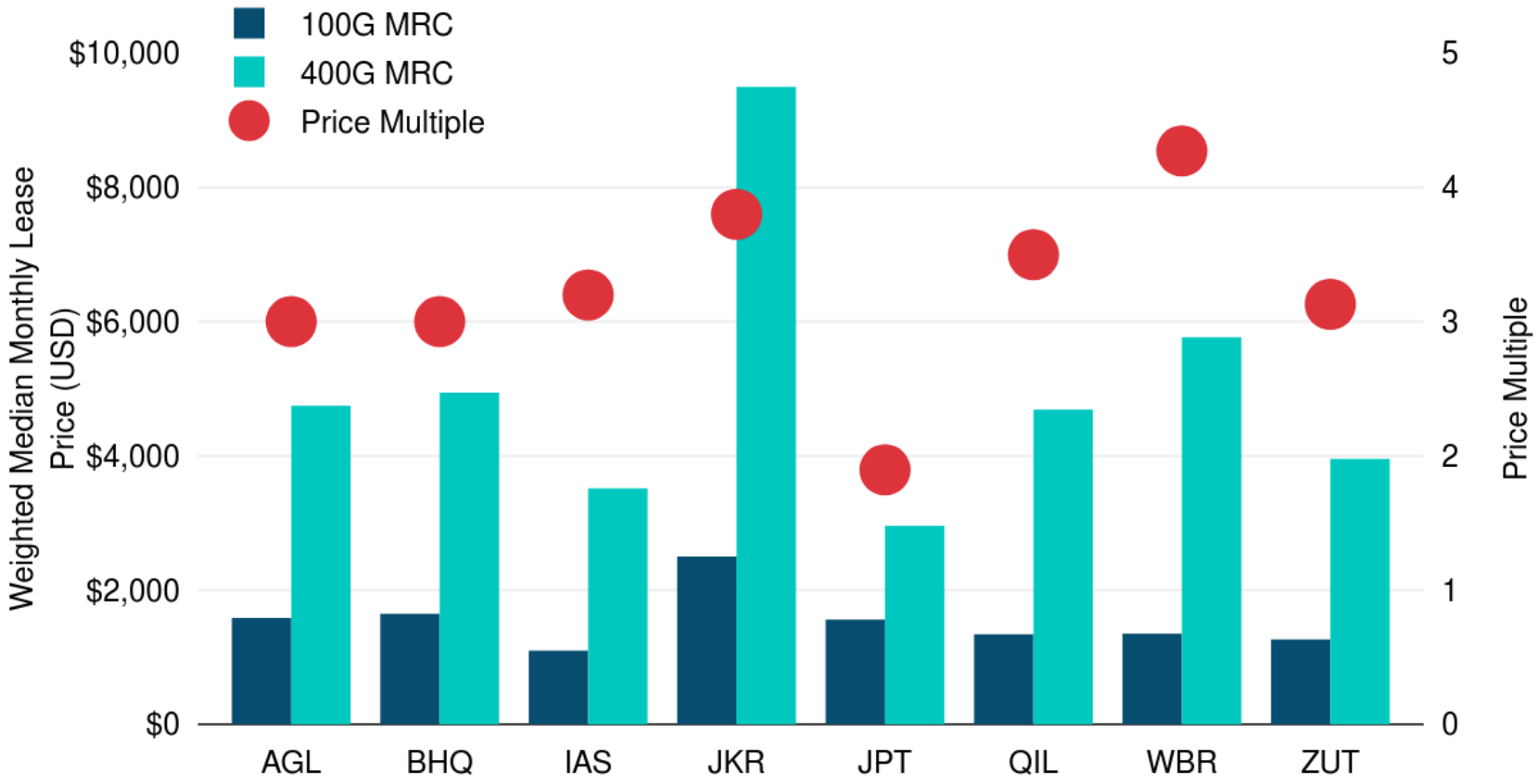
Terrestrial
3.2X

Subsea
3.9x

Source: TeleGeography's Network Pricing

Pricing strategy depends on carrier emphasis

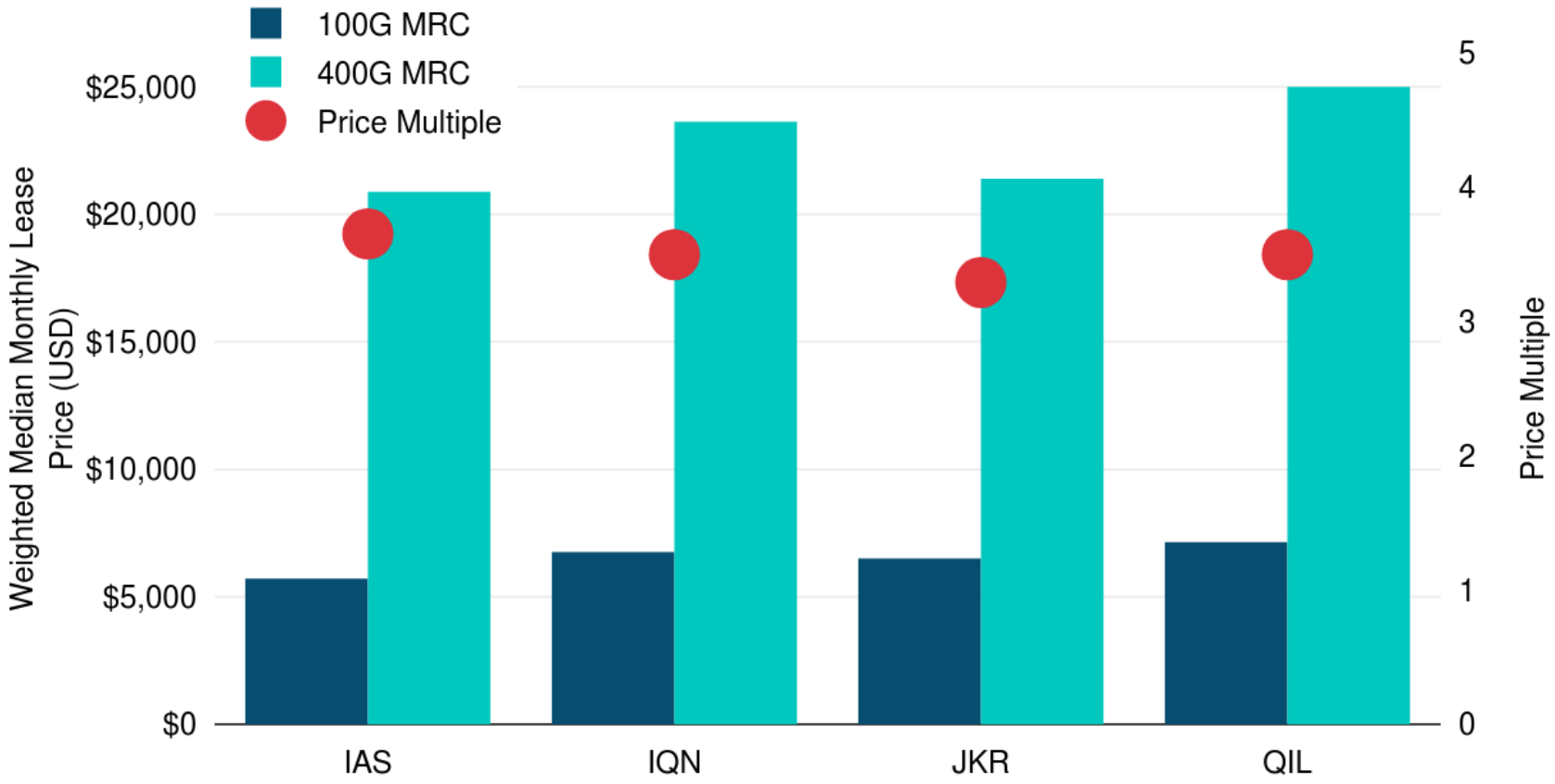
100 & 400 Gbps Wavelength Prices & Price Multiples by Carrier on Frankfurt-London, 2024



Source: TeleGeography's Network Pricing

Pricing strategy depends on carrier emphasis

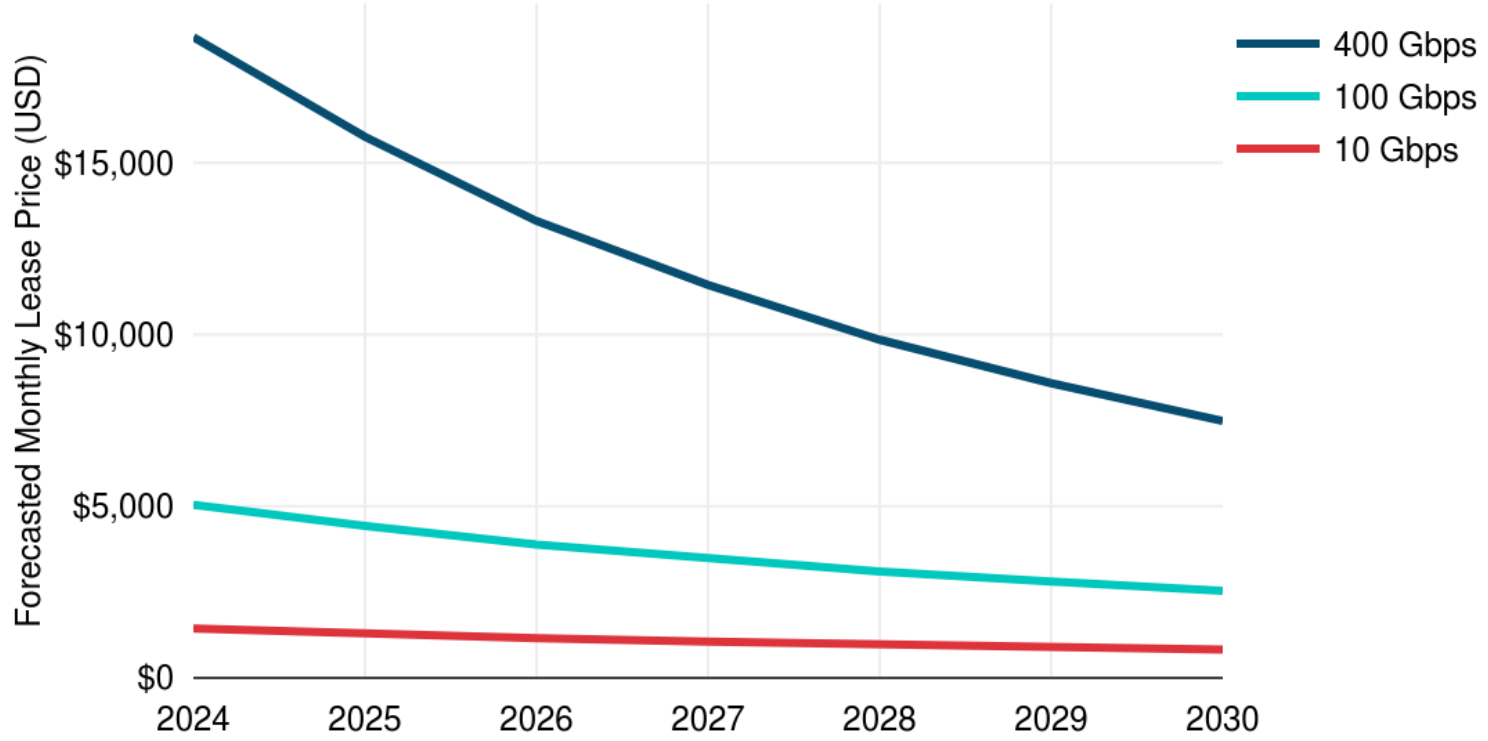
100 & 400 Gbps Wavelength Prices & Price Multiples by Carrier on London-New York, 2024



Source: TeleGeography's Network Pricing

Price multiples will continue to compress over time

London-New York Forecasted Wavelength Prices, 2024-2030



Source: TeleGeography's Transport Networks Forecast Service

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Evolution of IP transit in the World's Biggest Hubs vs. the Next-Generation

Up-and-coming digital hubs ready to sparkle in the Americas

Fresh PoPs expand potential of spreading internet hubs

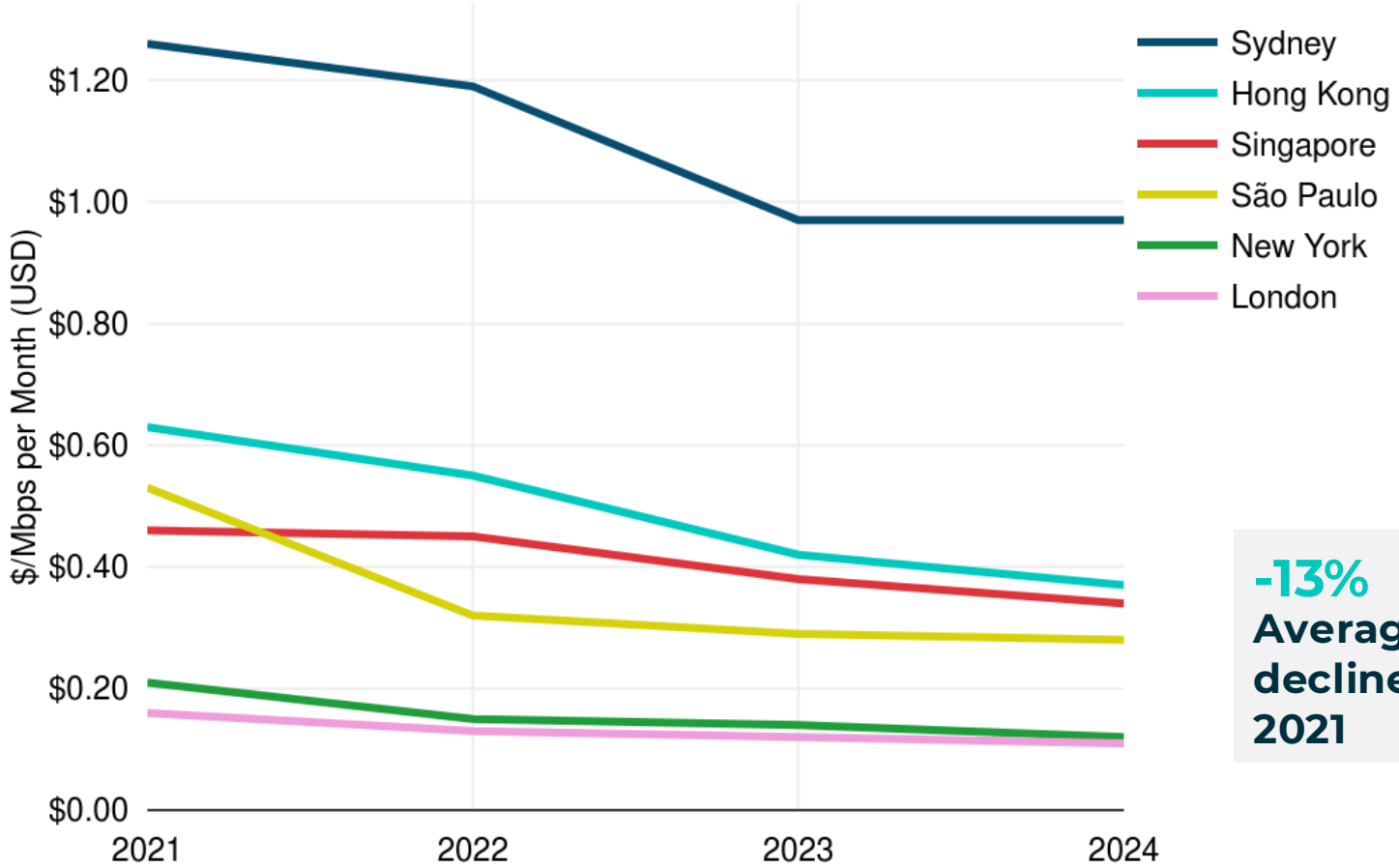
The World's Next Global Internet Hub Isn't a City But A Megaregion

MARKET STUDY

New interconnection markets in Southeast Asia

IP transit prices continue to decline globally

Weighted Median 100 GigE IP Transit Port Prices, 2021-2024

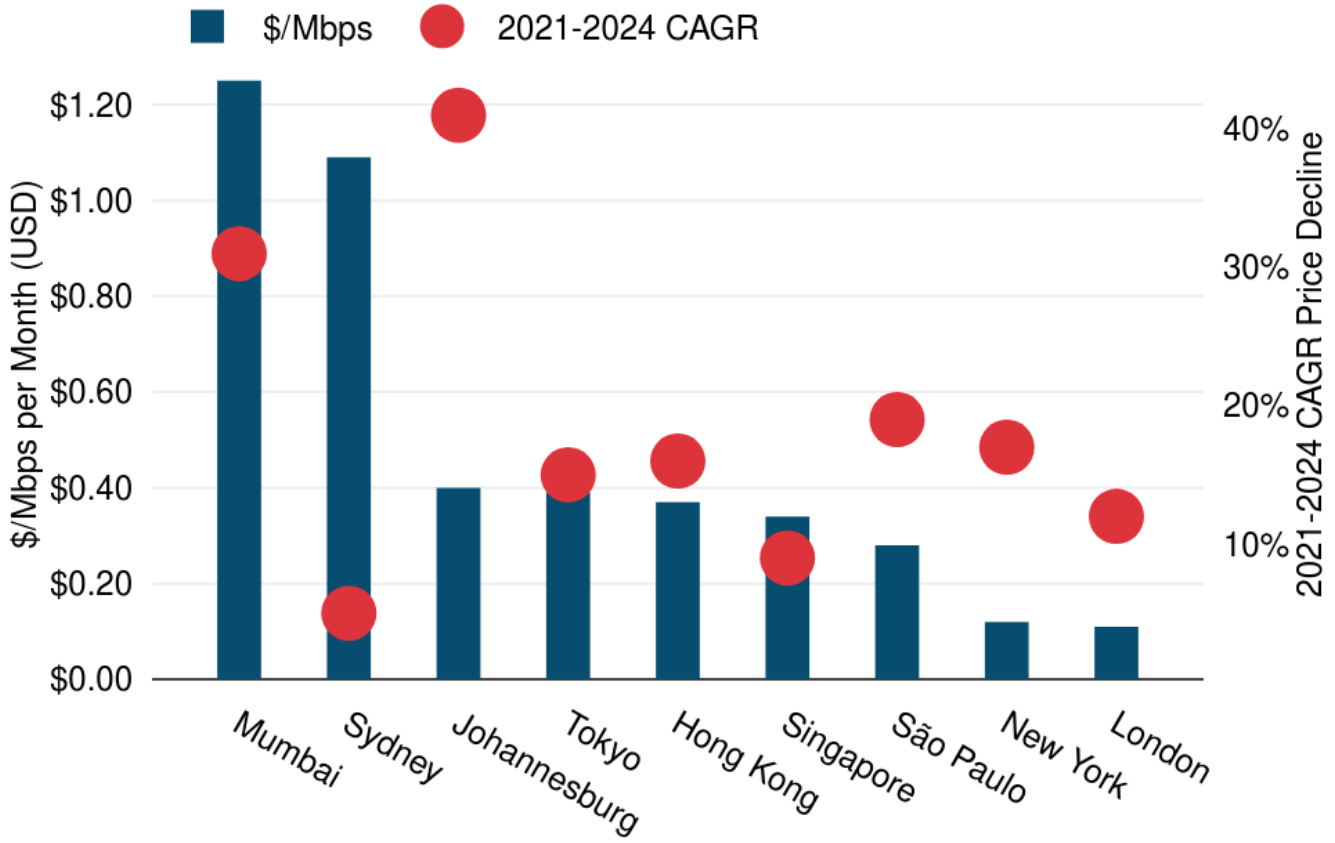


-13%
Average CAGR price decline globally since 2021

Source: TeleGeography's Network Pricing

Pace of price erosion varies widely by market

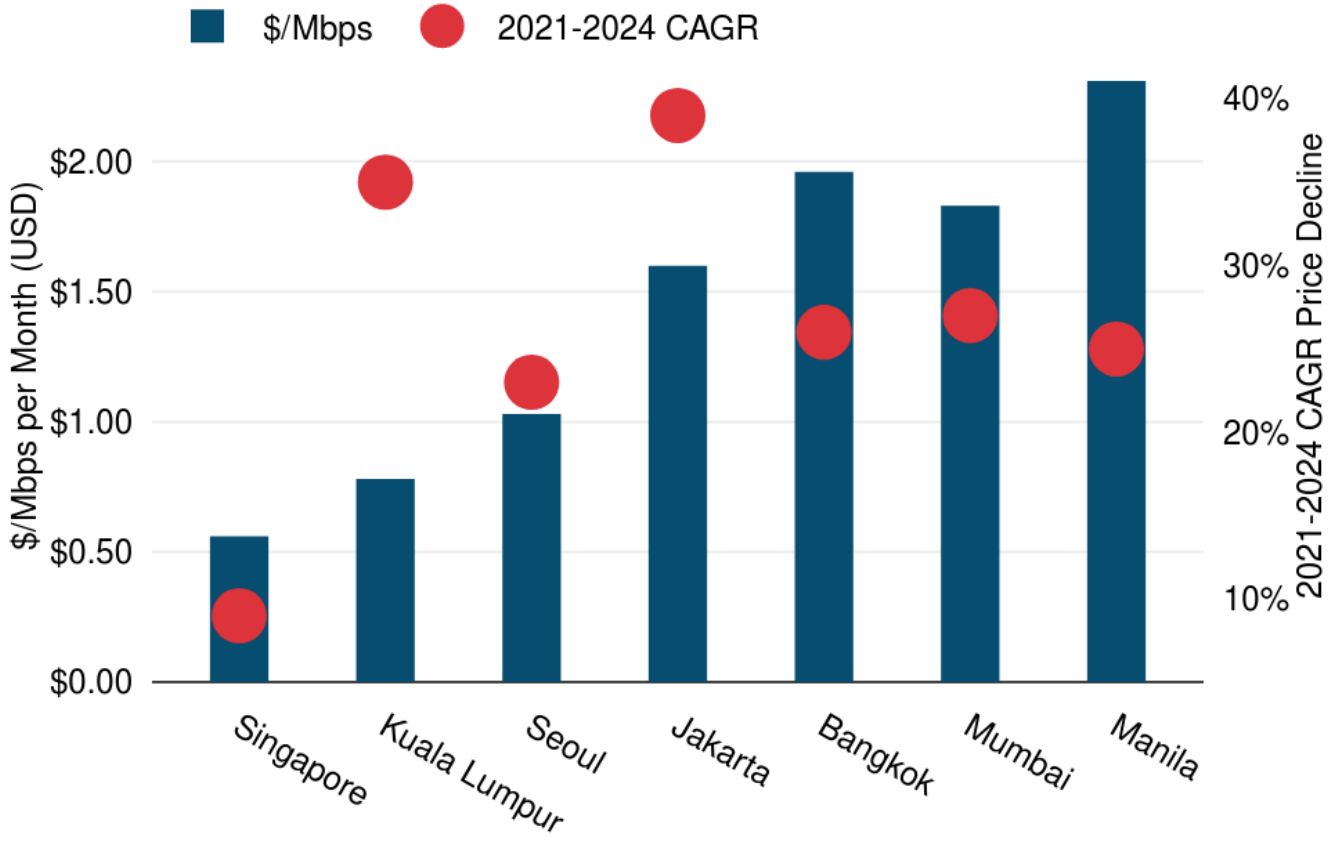
Weighted Median 100 GigE IP Transit Port Prices & CAGR Price Decline



Source: TeleGeography's Network Pricing

Lower costs and local traffic exchange lowering prices in secondary markets in Asia

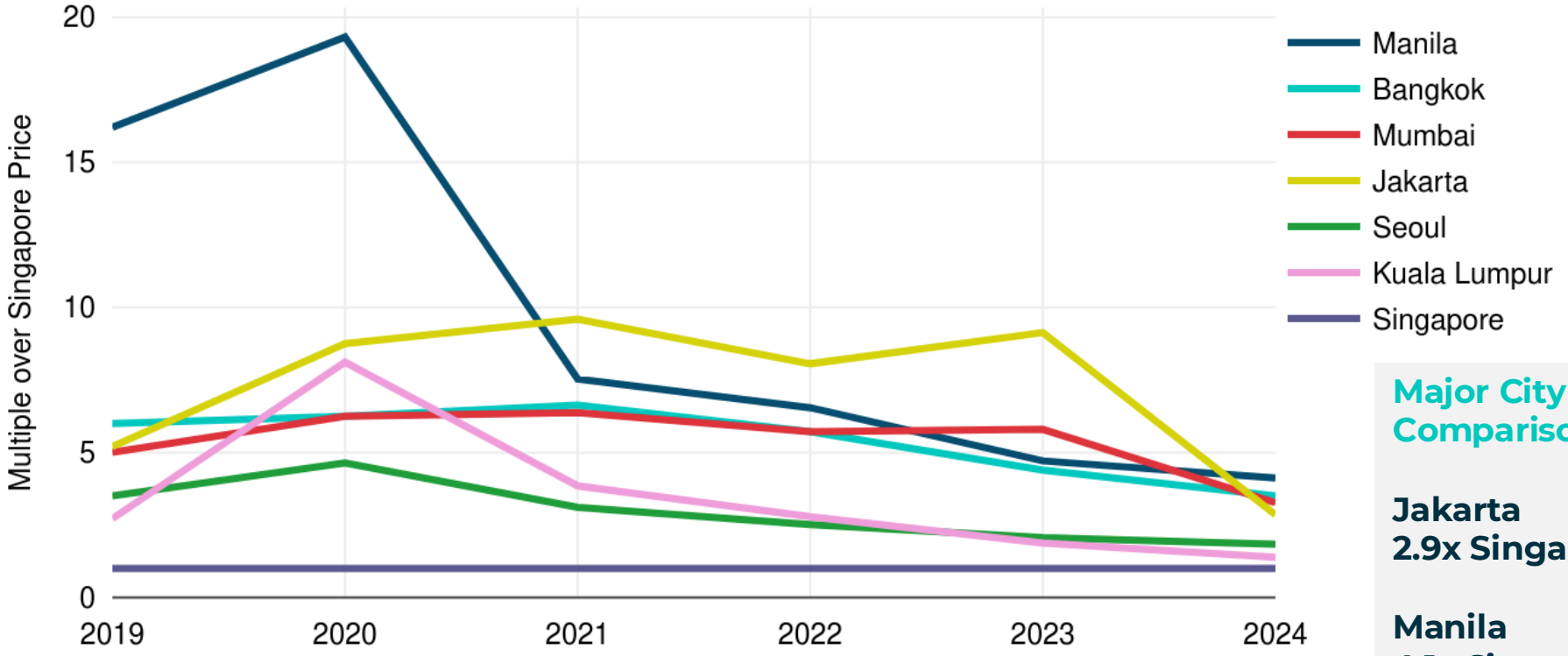
Weighted Median 10 GigE IP Transit Prices & CAGR Price Decline



Source: TeleGeography's Network Pricing

Narrowing the gap with established hubs

Weighted Median 10 GigE IP Transit Port Prices Relative to Singapore



Major City Price Comparison

Jakarta
2.9x Singapore

Manila
4.1x Singapore

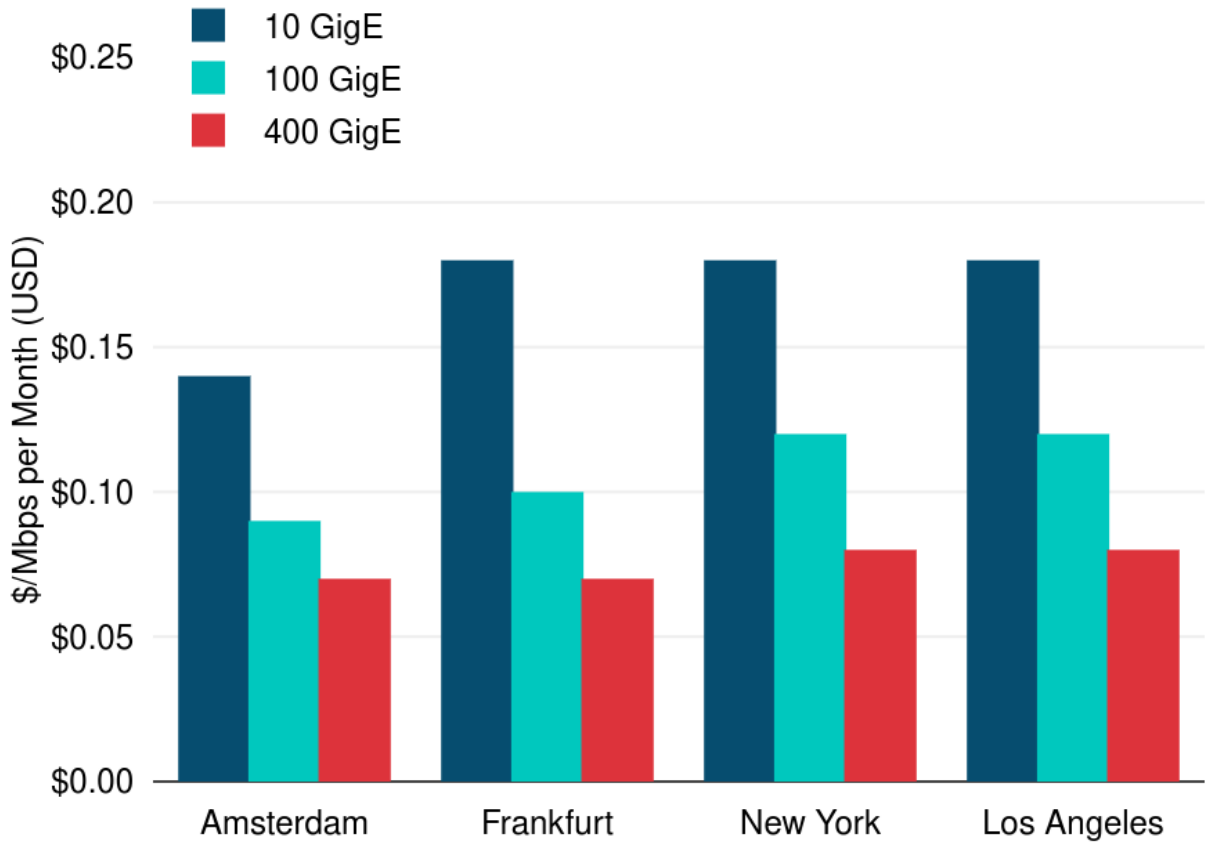
Mumbai
3.3x Singapore

Source: TeleGeography's Network Pricing

Emergence of 400 GigE ports in established hubs

- Price Multiples for 100 GigE : 400GigE average 2.8x
- 400 GigE represents a very small portion of providers' sales mix in the largest hubs in Europe & U.S.

Weighted Median IP Transit Port Prices in Key Global Cities, 2024



Source: TeleGeography's Network Pricing

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Thank you

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Evaluating Interconnection Market Health

Jon Hjembo

Outline

- Interdependent Parts
  - The key components of interconnection markets
- Comparing Relative Health
  - Side-by-side market analysis using the Market Connectivity Score
- Impaired Development
  - Markets with strong potential that lack key infrastructure
- Power: The Lifeblood of Connectivity Markets
  - Which markets have access to this critical commodity?

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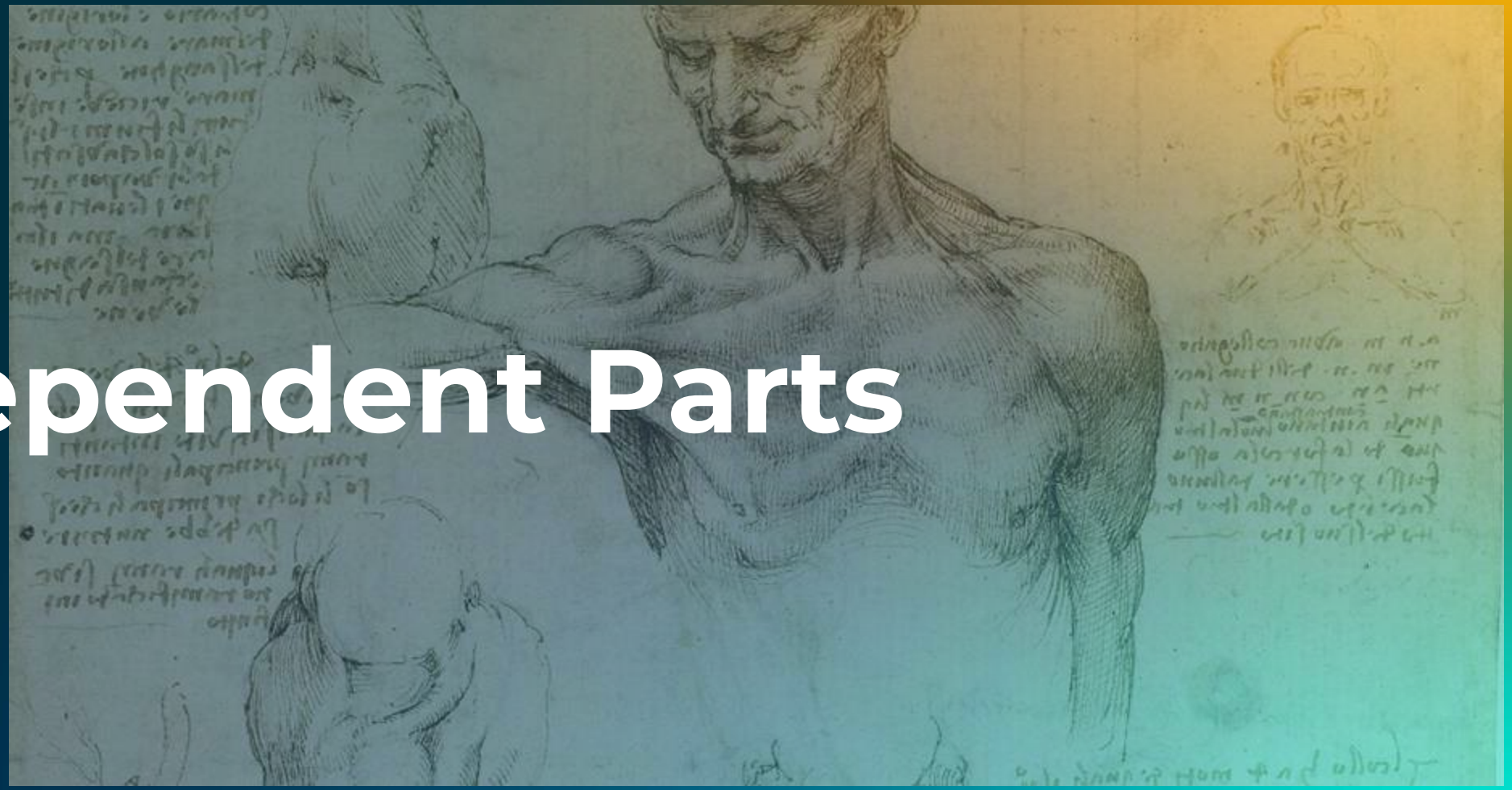
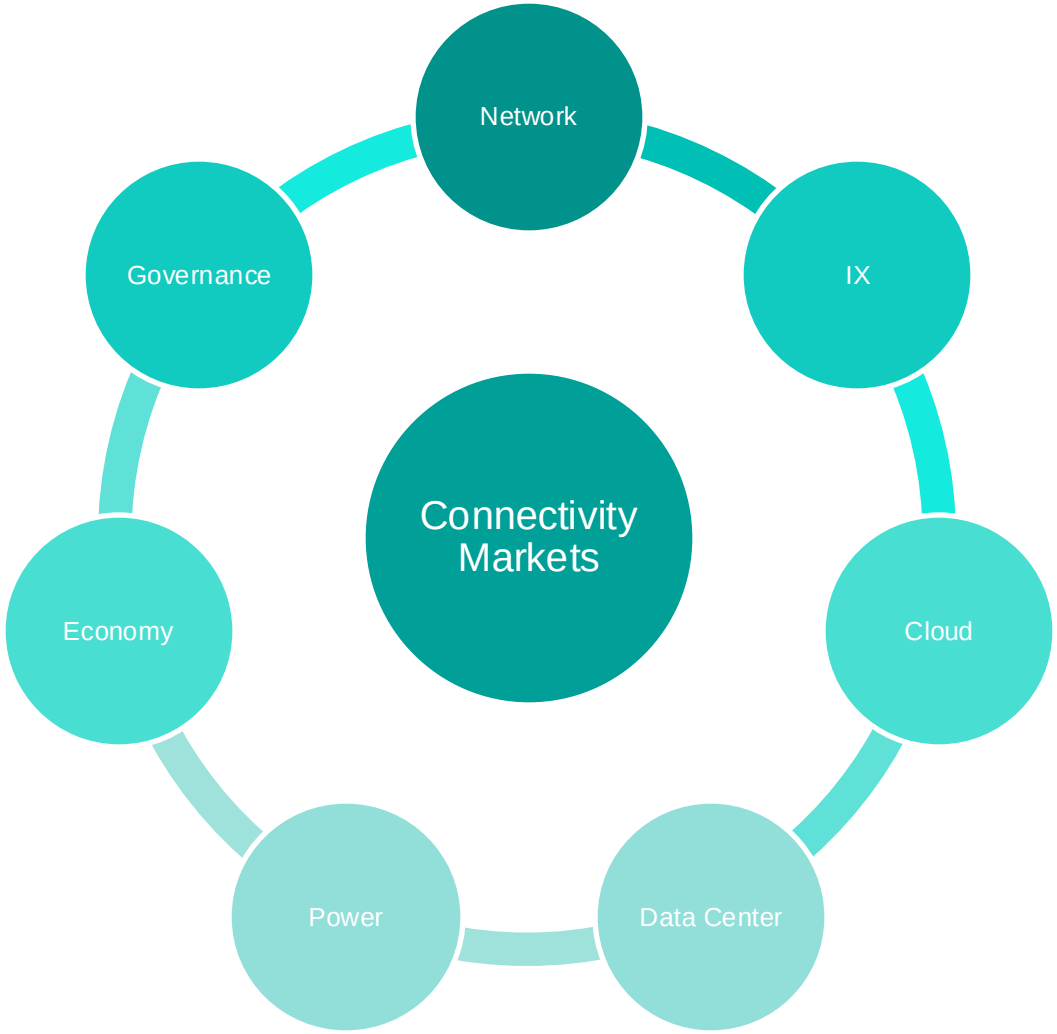
Interdependent Parts



Critical components working together

- Network: local and global connectedness
- IX – the traffic intersections
- Cloud – delivering content and compute
- Data centers – providing the housing
- Power – keeping it all running
- Economy – the commercial and personal activity that generates traffic
- Governance – the framework of stability and transparency that enables flourishing



Data center markets do not develop in isolation

- Similar to a bioactive enclosure, they are part of a “technoactive” ecosystem where mutual interdependence enables thriving

Source: Hendershot Habitats

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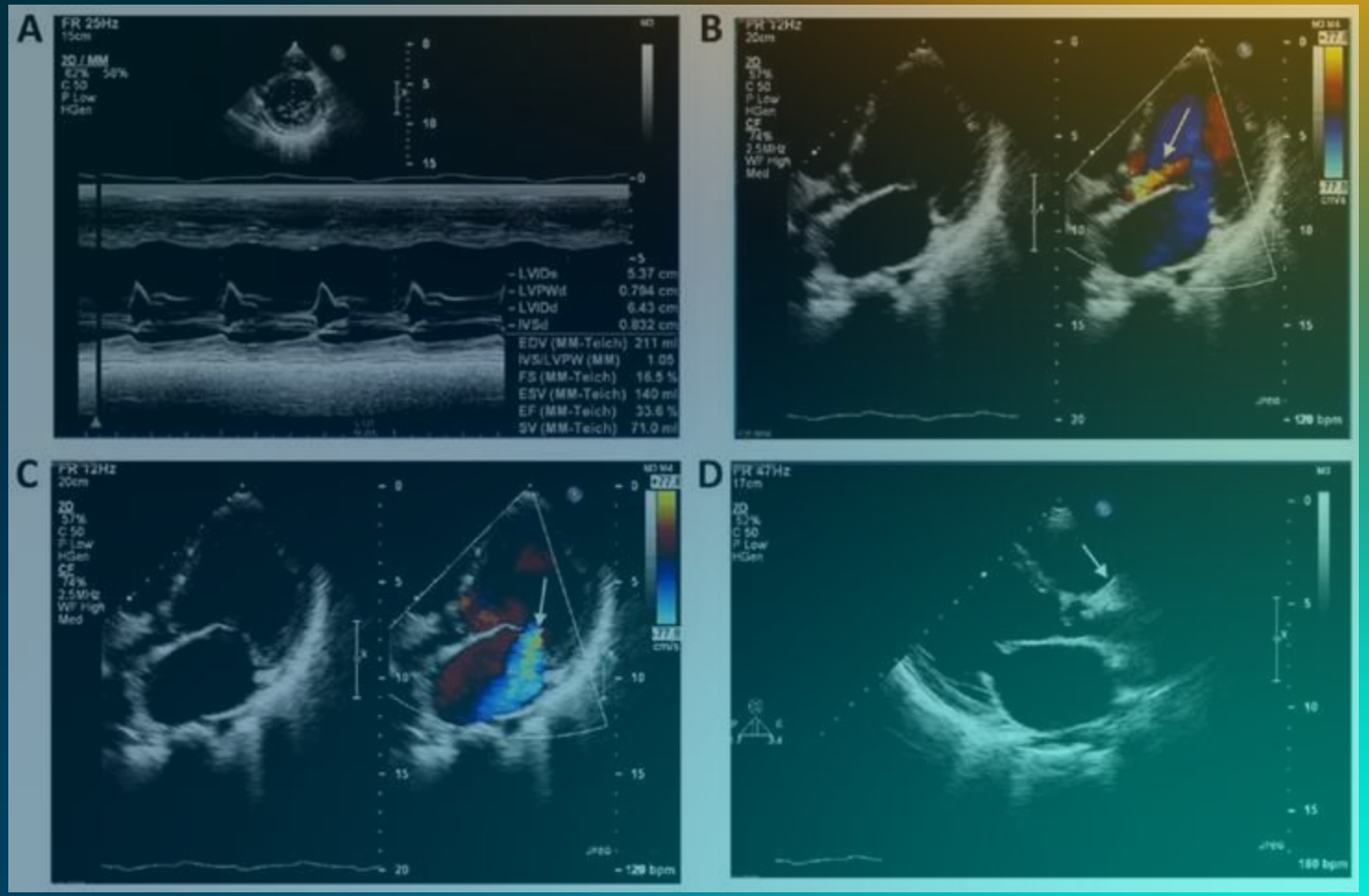
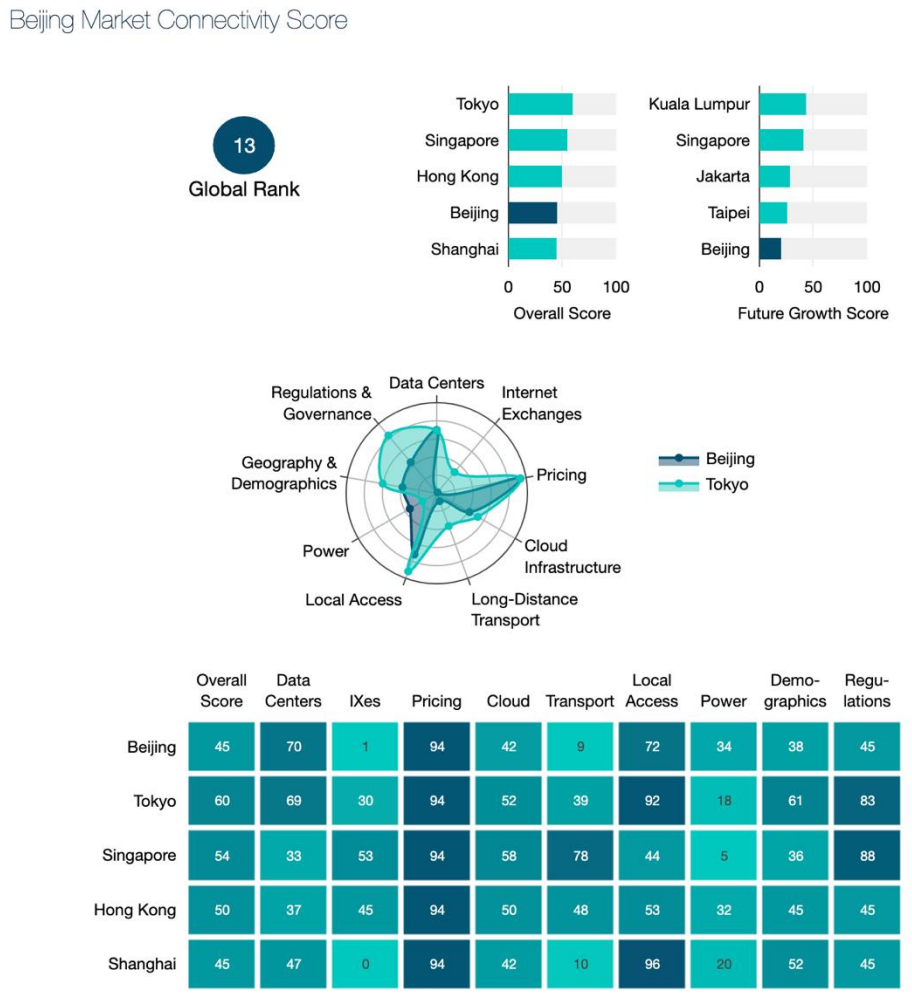
Comparing Relative Health



The Market Connectivity Score can help

- This tool captures 43 distinct market health metrics to help users diagnose the competitiveness of 3,000 global network and data center markets.

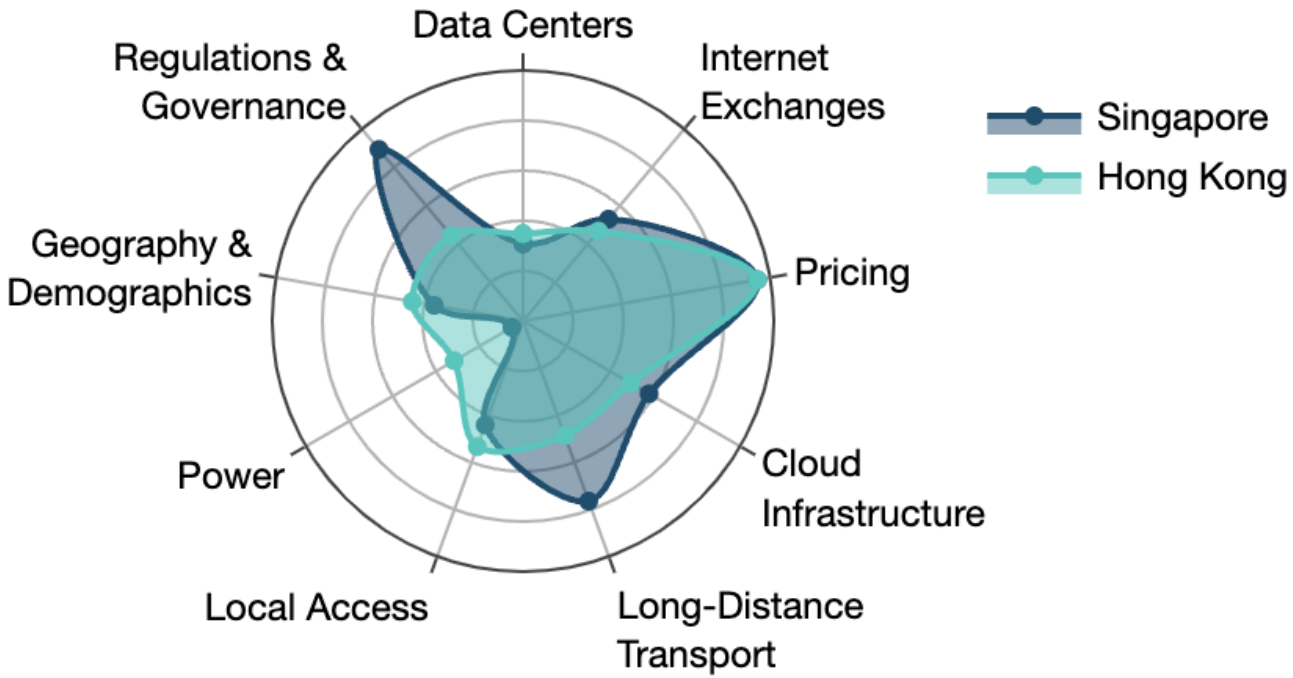


	Overall Score	Data Centers	IXes	Pricing	Cloud	Transport	Local Access	Power	Demo-graphics	Regu-lations
Beijing	45	70	1	94	42	9	72	34	38	45
Tokyo	60	69	30	94	52	39	92	18	61	83
Singapore	54	33	53	94	58	78	44	5	36	88
Hong Kong	50	37	45	94	50	48	53	32	45	45
Shanghai	45	47	0	94	42	10	96	20	52	45

Source: TeleGeography's Data Center Research Service

Polar charts are our X-rays

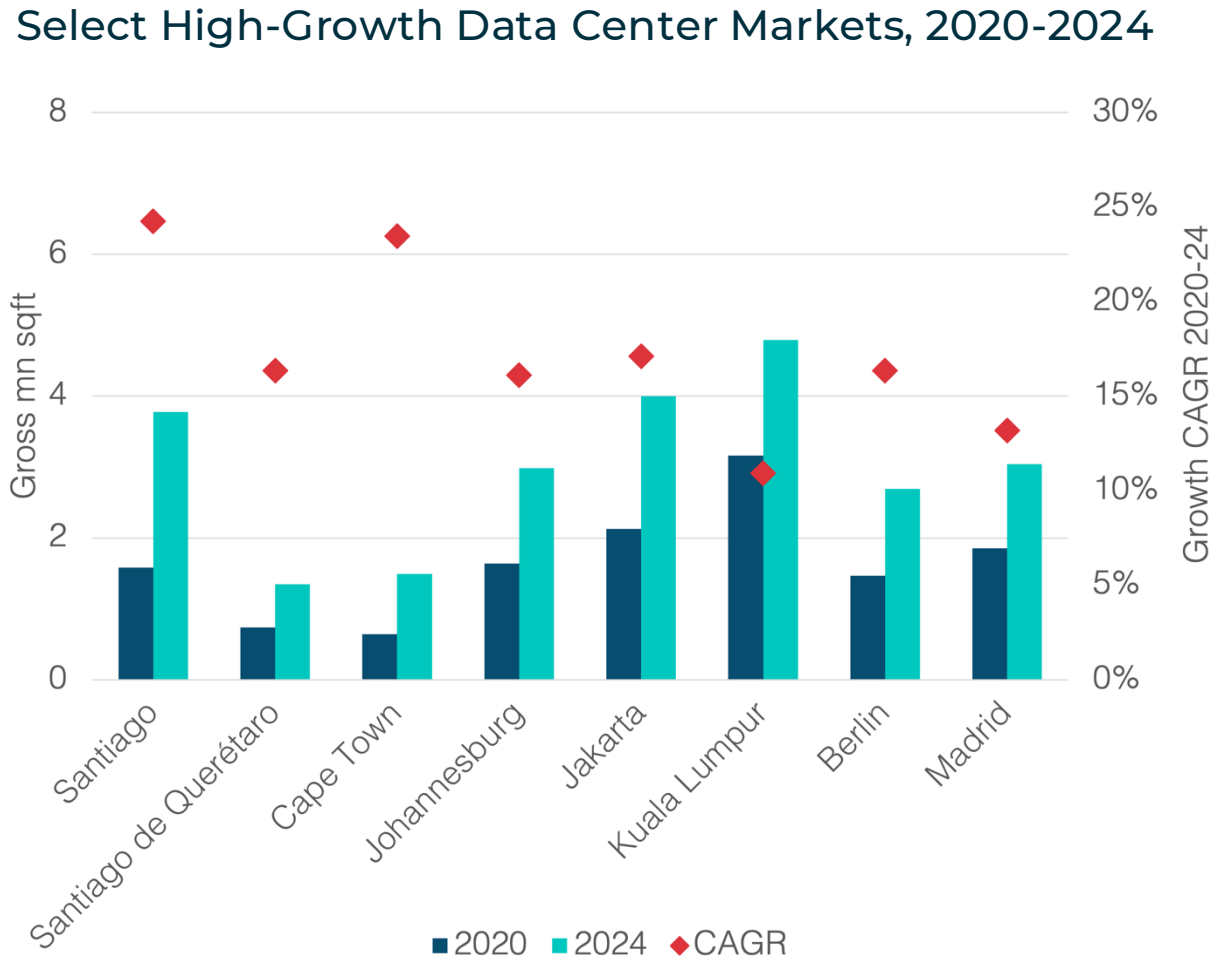
- Overlap two metros on the chart to observe relative strength across 9 metric groupings



Source: TeleGeography's Data Center Research Service

Some markets to compare

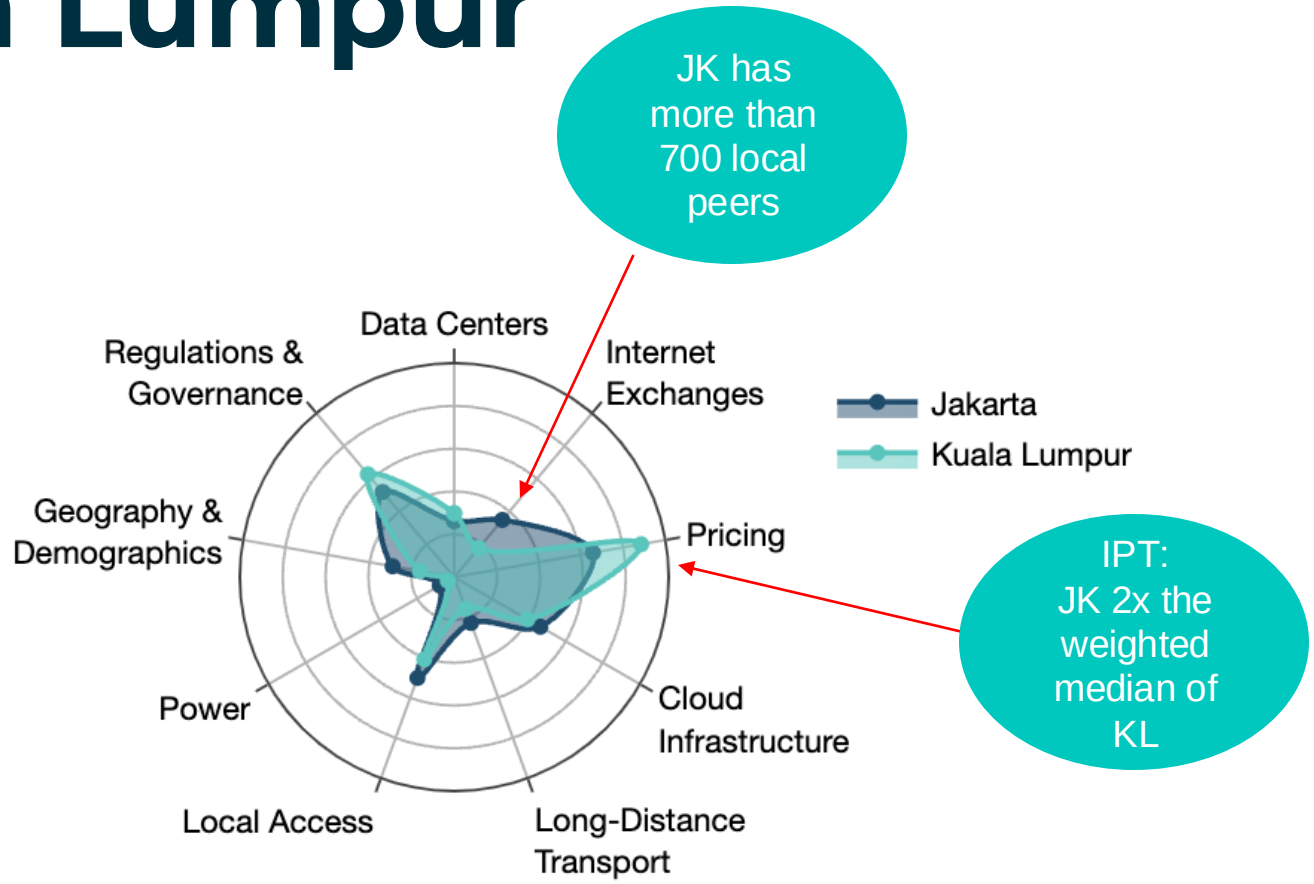
- Looking at a sampling of fast-growth data center markets
- Each has more than 1 million square feet of space in operation and more than 10% CAGR growth



Source: TeleGeography's Data Center Research Service

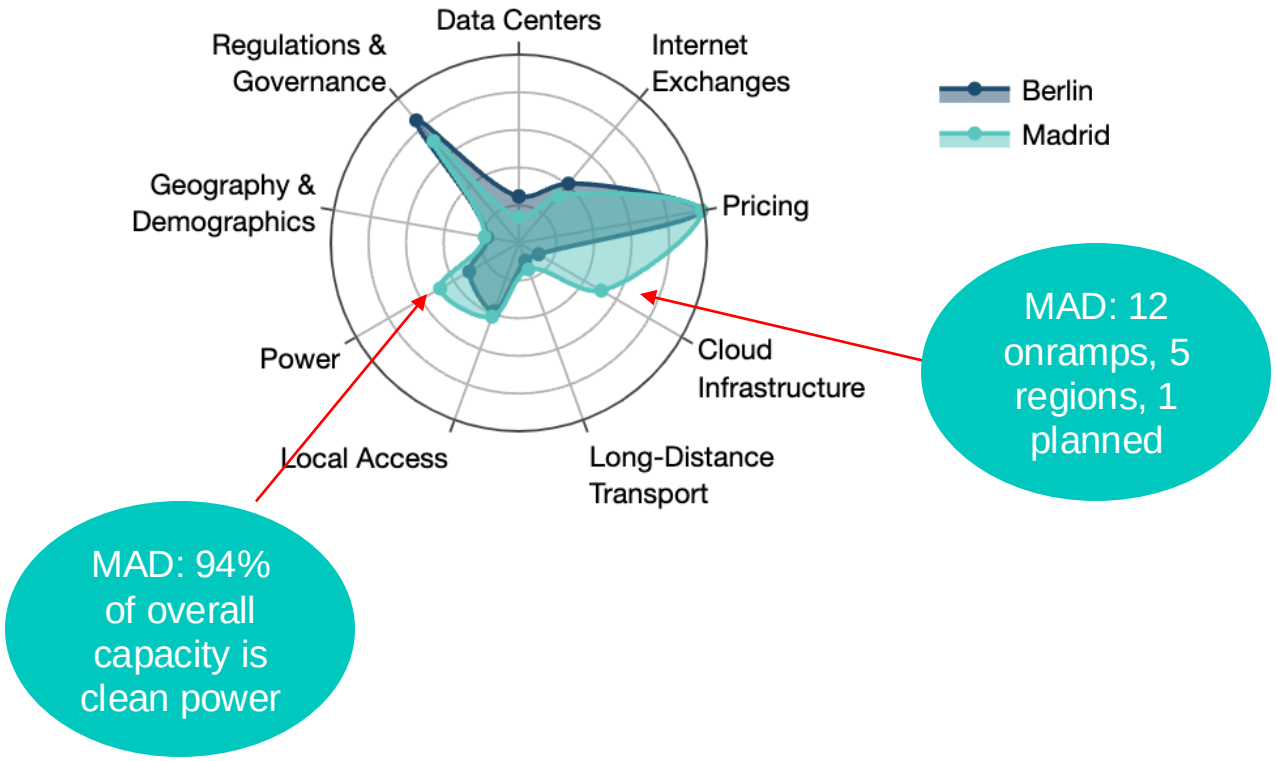
Jakarta and Kuala Lumpur

- Comparable rankings and similar strengths and weaknesses
- Jakarta has stronger IX market with 7x the local peering membership of KL
- KL has advantage of more competitive network pricing



Source: TeleGeography's Data Center Research Service

Berlin and Madrid

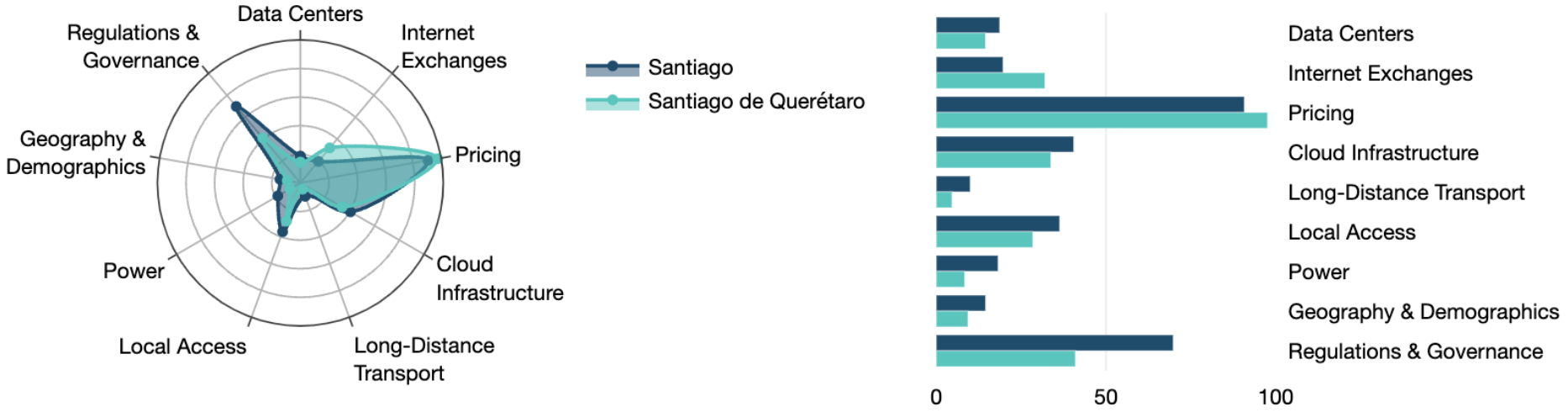


- Madrid has more cloud deployments and a higher share of clean power
- But Berlin is a fast-growing data center market with more than 10 sites in the near pipeline

Source: TeleGeography's Data Center Research Service

Santiago de Chile and Santiago de Querétaro

- Chile has more clean power planned and higher governance score
- Mexico has more competitive network pricing



Source: TeleGeography's Data Center Research Service

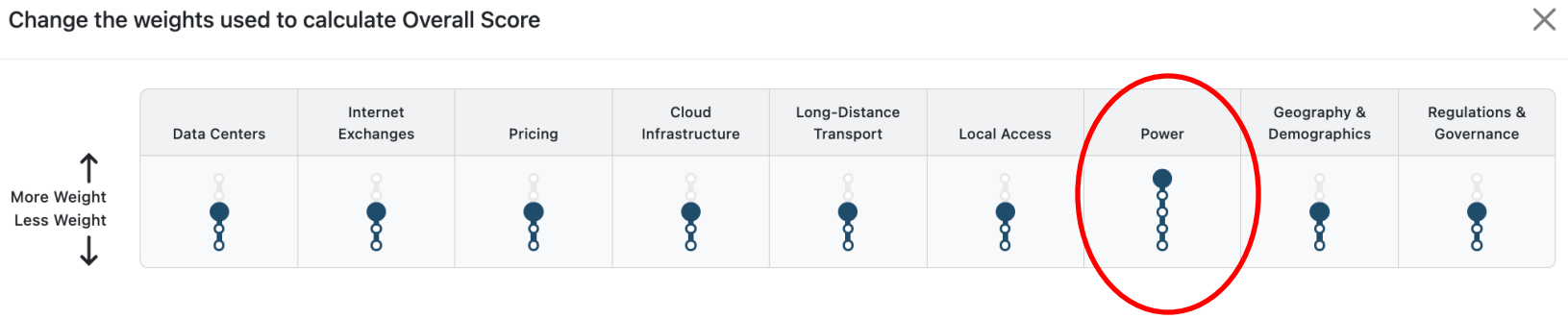
Johannesburg and Cape Town

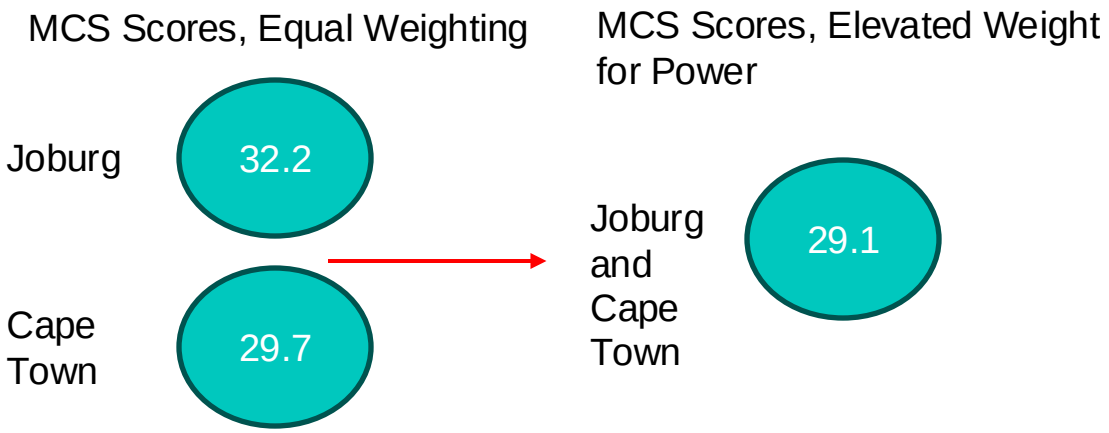
- Base chart shows Johannesburg's status as a primary data center/ cloud market…

Source: TeleGeography's Data Center Research Service

Johannesburg and Cape Town

- If we elevate importance of clean power in the evaluation, Cape Town's score becomes as high as Joburg's. Why?
- Cape Town's power supply is nearly 70% comprised of clean energy





Source: TeleGeography's Data Center Research Service

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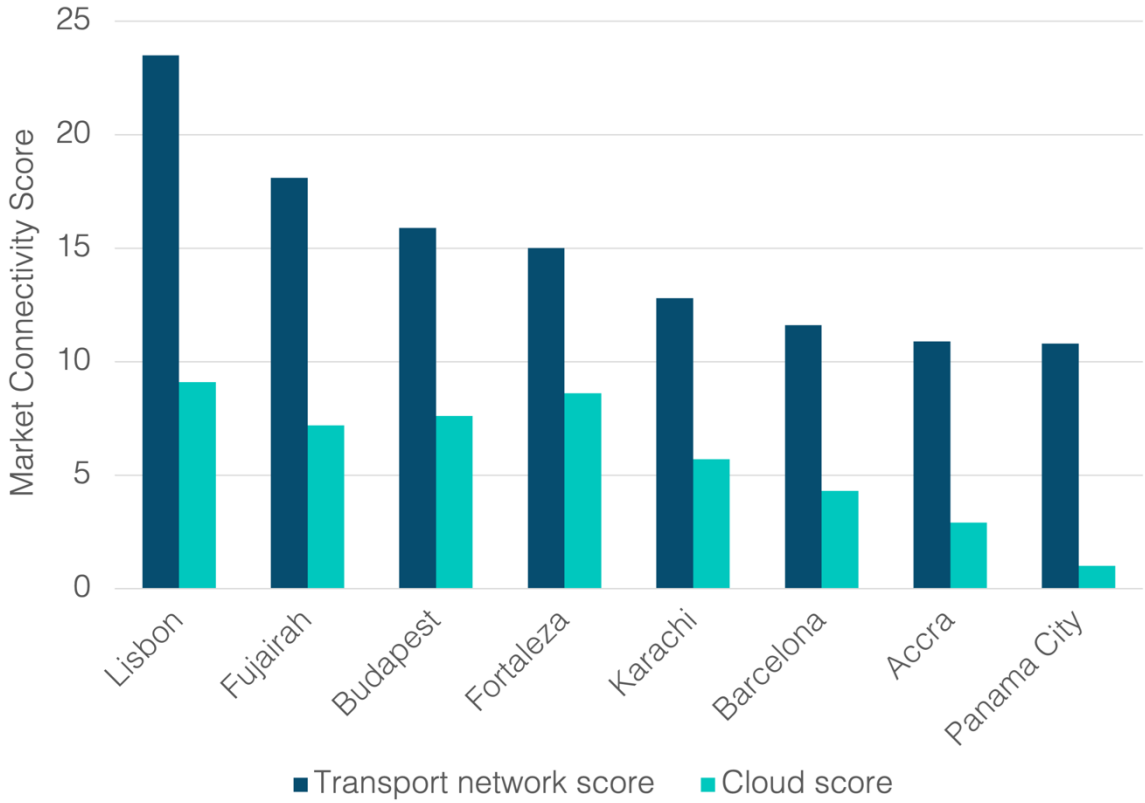
Impaired Development

Strong network but lack of cloud...

- Lisbon directly connects with more than 40 international cities and has 13 subsea cables...
- Budapest has more than 35 Tbps of international internet capacity...
- Fortaleza has over 10 Tbps of international internet capacity and 10 subsea cables in service...
- But local cloud provisioning in all of these locations is limited to a few onramps at most

Transport and Cloud Market Connectivity Scores, Select Markets

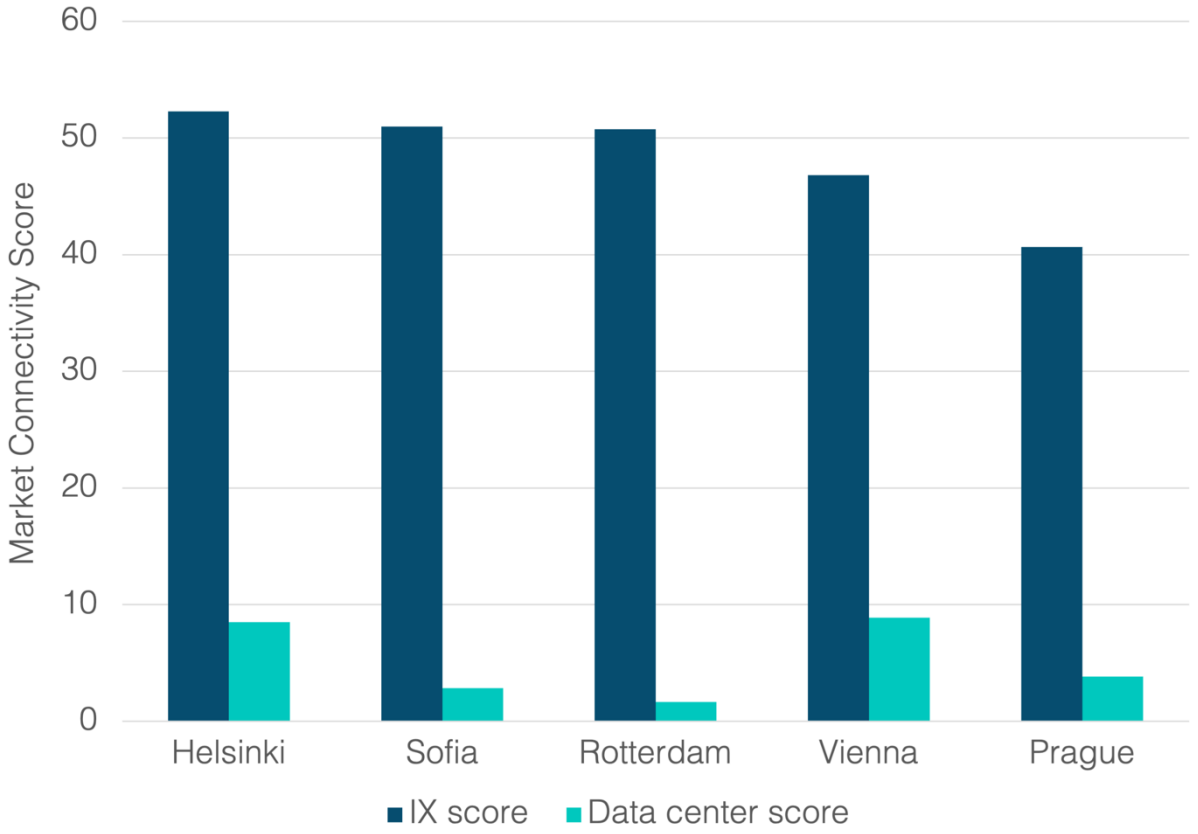


Source: TeleGeography's Data Center Research Service

Strong IX but lack of DC space…

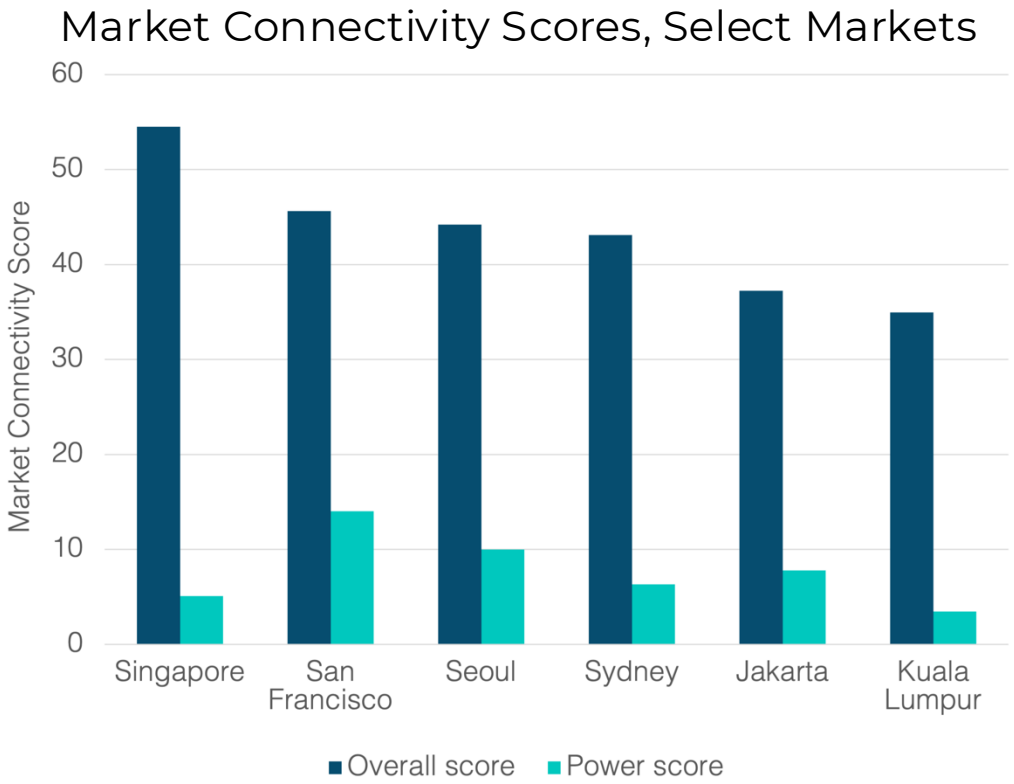
- Each market has:
  - multiple exchanges
  - hundreds of ASNs
  - high concentration of international ASNs…
- …but relatively little data center capacity

IX and Data Center Scores, Select Markets



Source: TeleGeography's Data Center Research Service

And some key markets with no major clean power plans in the pipeline…



Source: TeleGeography's Data Center Research Service

- APAC is home to several of the strongest connectivity markets with the *weakest* scores for clean power provisioning

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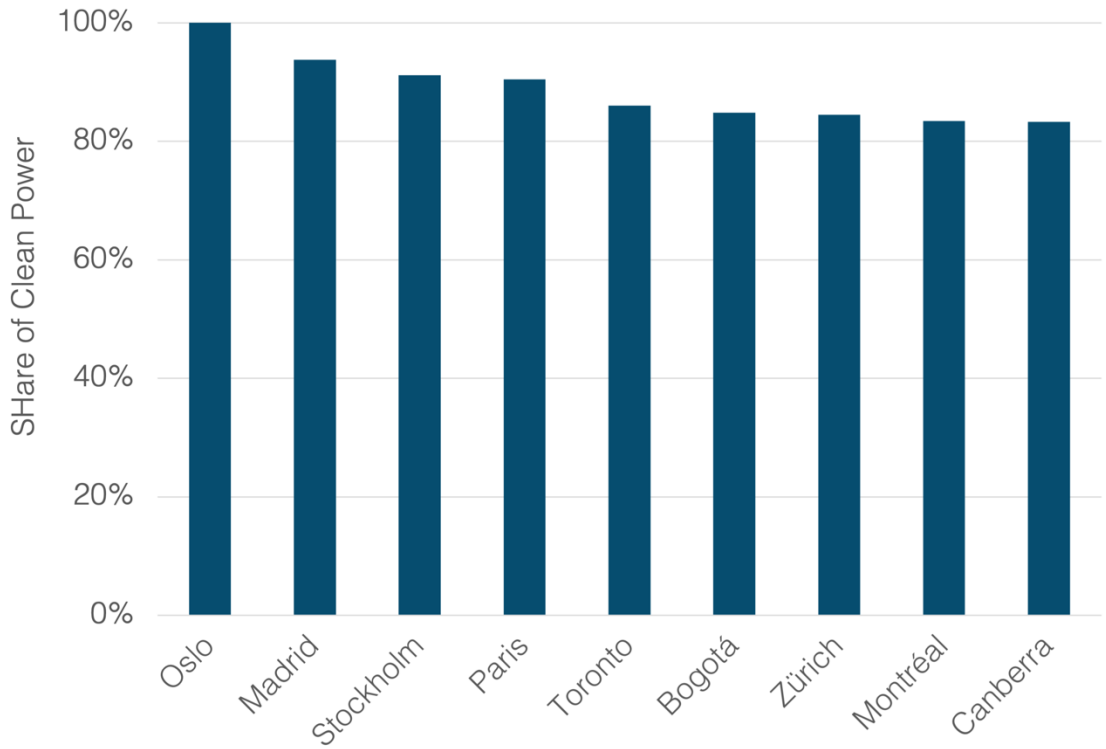
Power: The Lifeblood of Connectivity Markets

Markets with strong power scores

Clean Power Share of Total Power, Select Markets

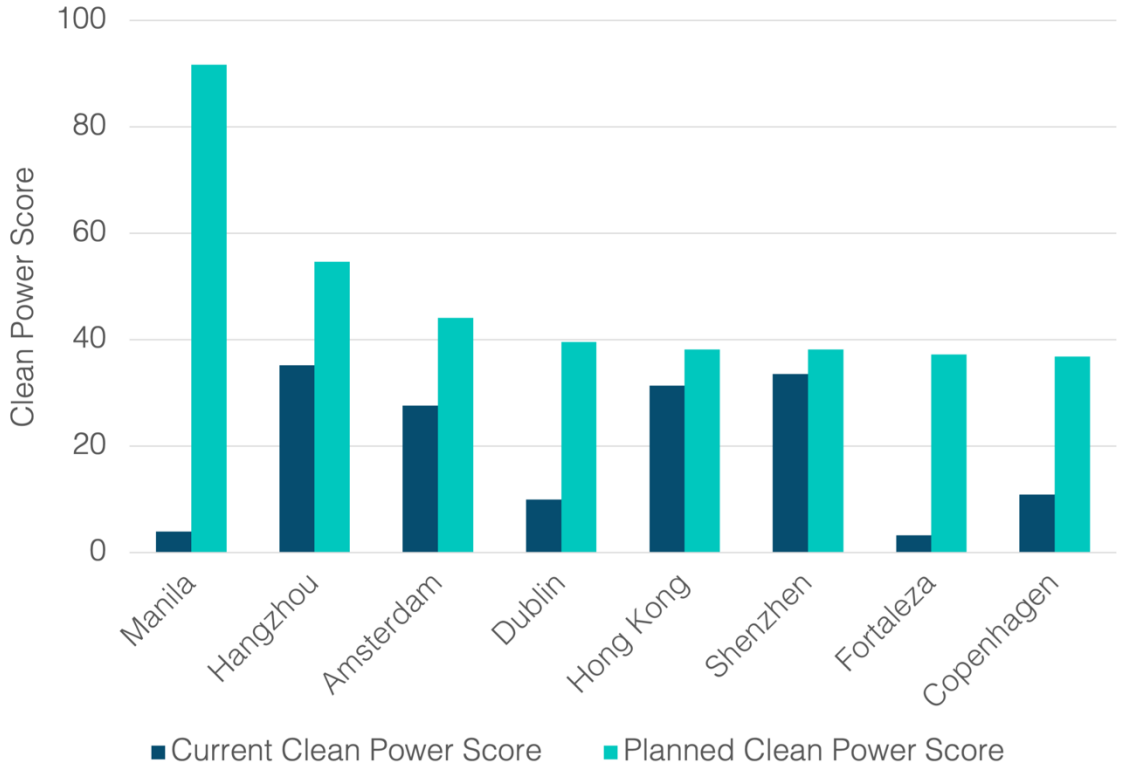


Source: Global Energy Monitor; TeleGeography's Data Center Research Service

Note: Market Connectivity Score filters – Data Center and Cloud Infrastructure scores >5; Clean Power Share of Overall Capacity > 83

Markets with strong power scores

Current and Planned Clean Power Scores, Select Markets

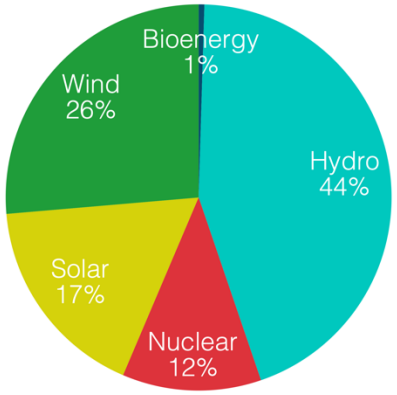


Source: Global Energy Monitor; TeleGeography's Data Center Research Service

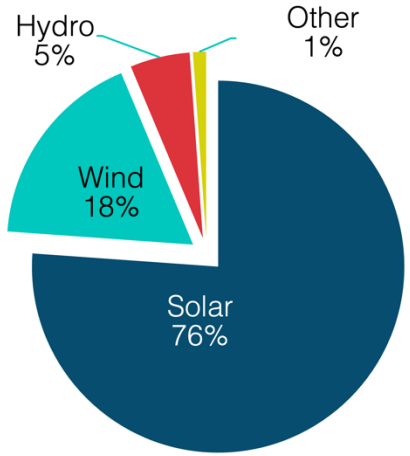
Note: Market Connectivity Score filters - Data Center and Cloud Infrastructure scores >5; Clean Power Share of Overall Capacity > 83; Clean Power Planned Capacity > 34

Sources of planned clean power in select countries

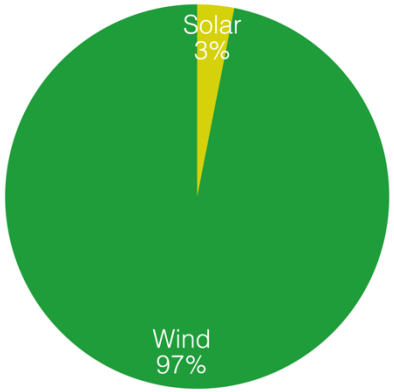
Share of Planned Clean Power by Source, China



Share of Planned Clean Power by Source, Philippines



Share of Planned Clean Power by Source, Netherlands



Source: Global Energy Monitor; TeleGeography's Data Center Research Service

Take-aways

- Interconnection market health depends on numerous network and macroeconomic components working together
- Individual markets have differing strengths and weaknesses…and the Market Connectivity Score can help you evaluate those!
- As power increasingly takes priority for interconnection market development, new clean energy options are popping up in some surprising places

TeleGeography

Thank you

Jon Hjembo

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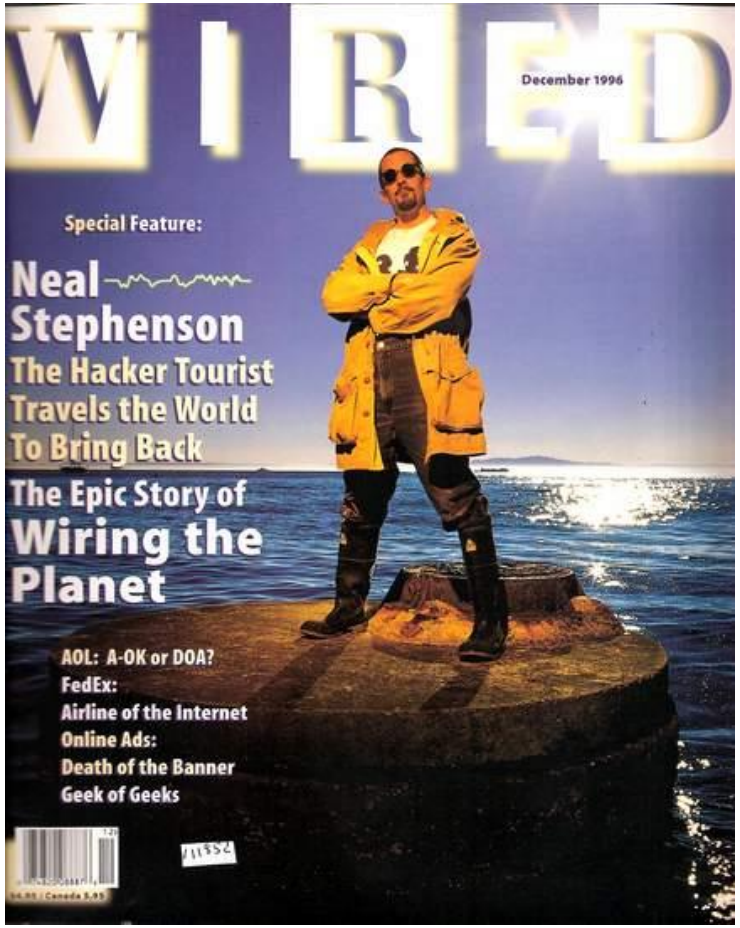
TeleGeography

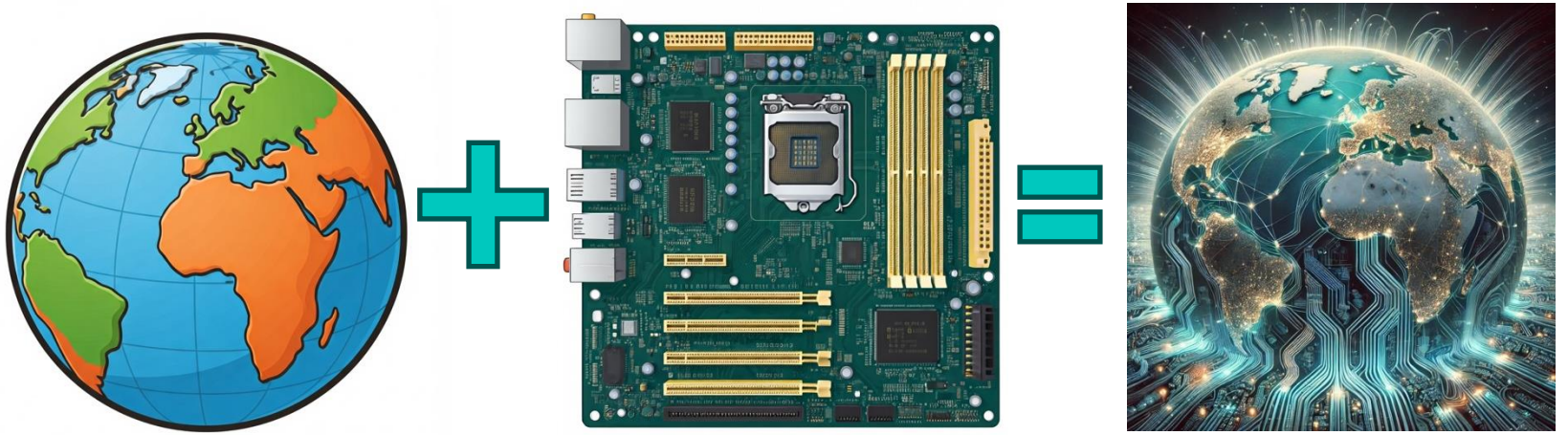
Mother Earth, Motherboard

Alan Mauldin

Inspiration for this presentation title



Neal Stephenson wrote an article in Wired in 1996 about the laying of FLAG Europe-Asia entitled “Mother Earth Mother Board”.



Source: Wired, https://www.wired.com/1996/12/ffglass/

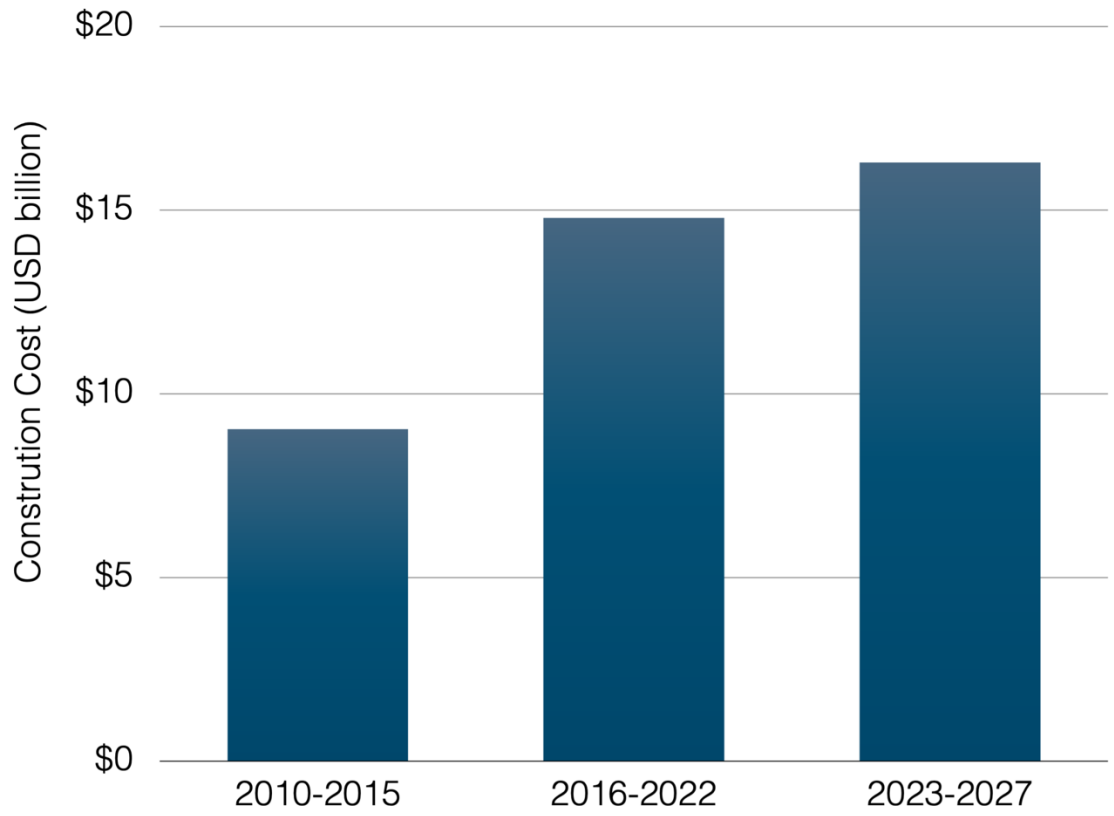
TeleGeography

Cycles of Renewal

AI prompt: create an image of the earth's seasons that ties into the lifecycle of submarine cables please

New cable investment

Construction Cost of New Submarine Cables by Ready-for-Service (RFS) Date



Why new cables?

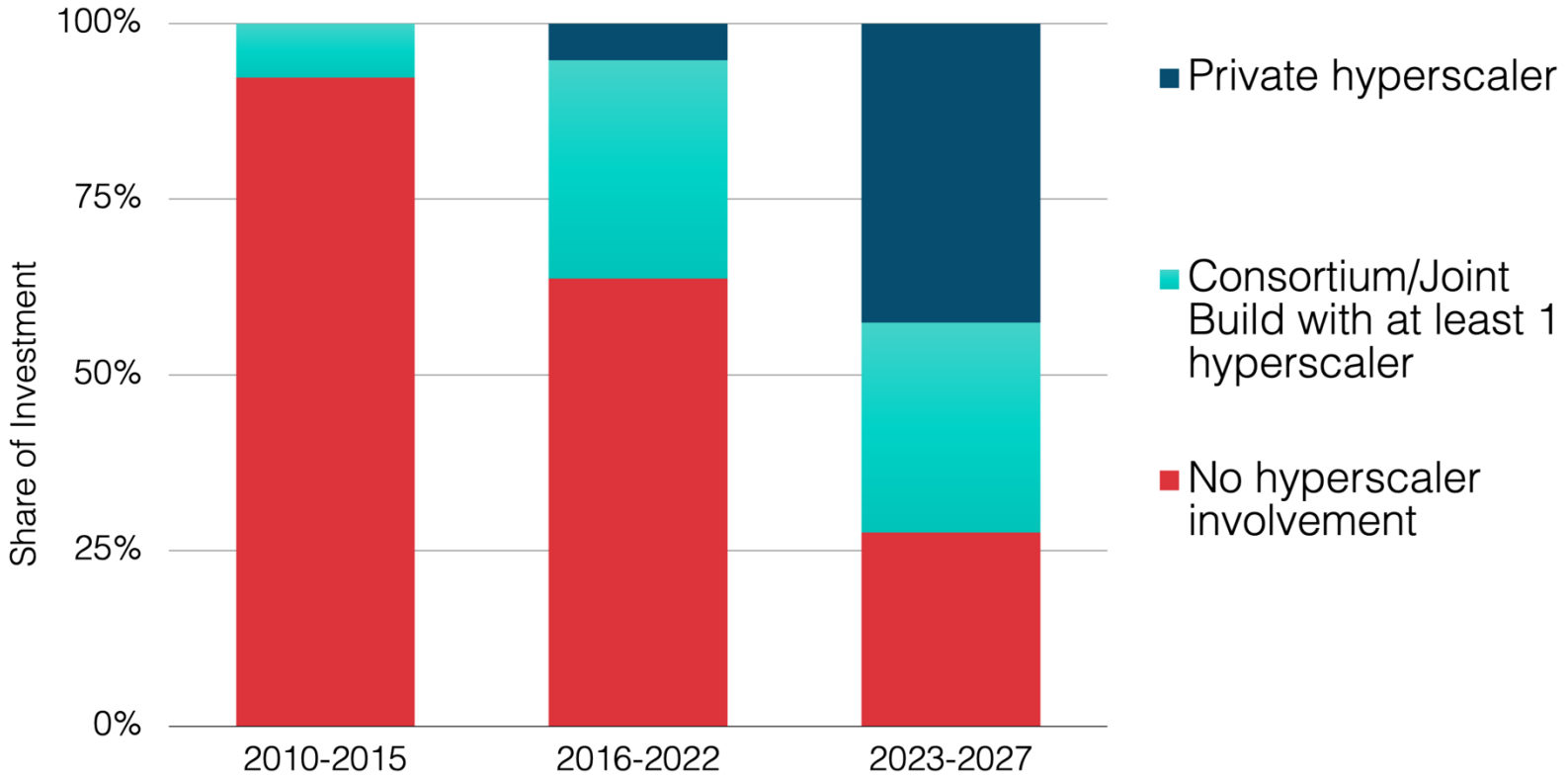
- Bandwidth demand is still growing
- Commercial factors
  - Reducing unit costs
  - Inability to source requirements on existing cables
- Enhance route diversity and improve resiliency
- Aging cables
  - Many cables nearing end of economic lives

Source: TeleGeography's Transport Networks

Shifting to private hyperscaler cables

Hyperscalers:

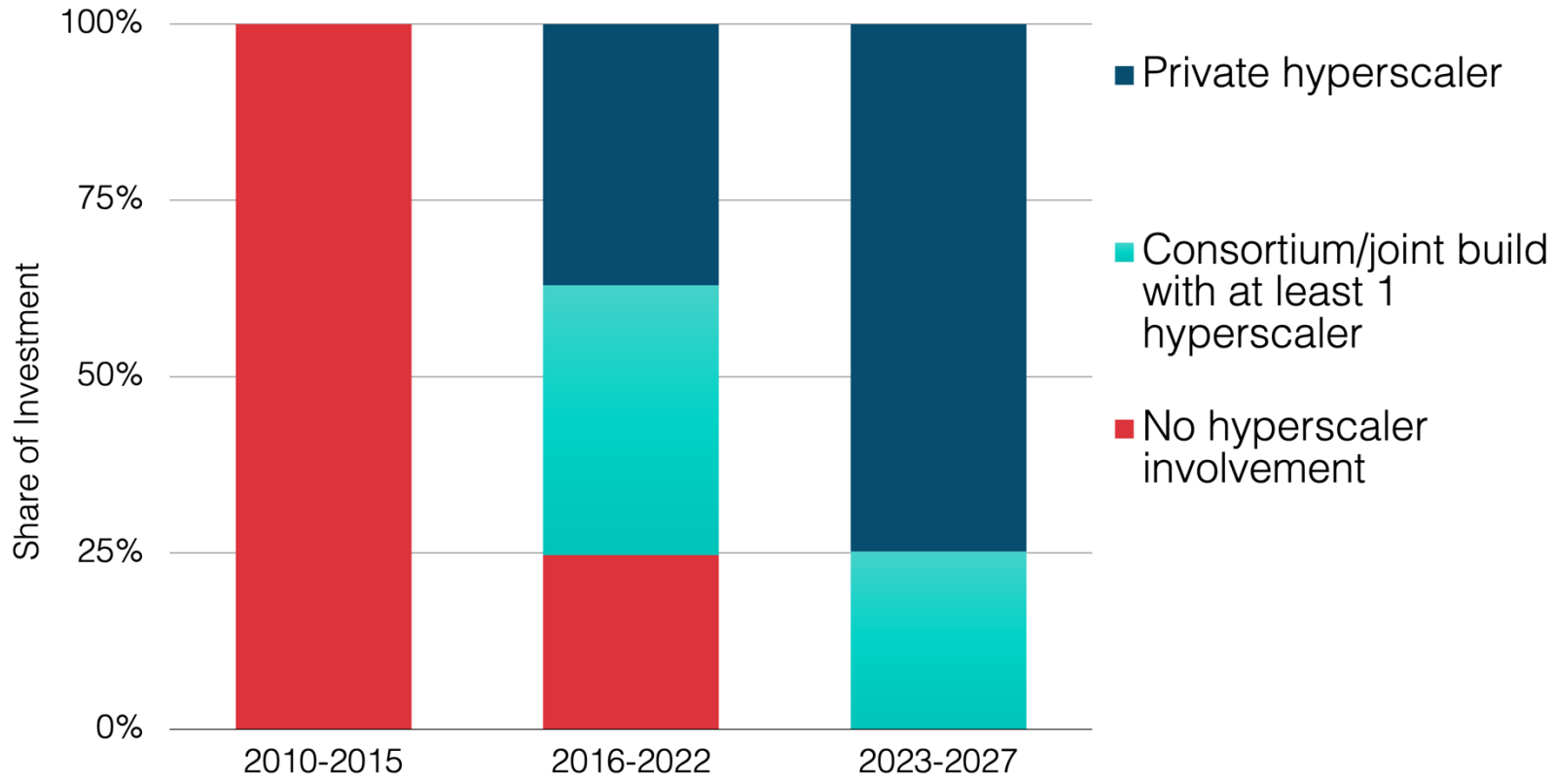
- Google
- Meta
- Microsoft
- Amazon



Source: TeleGeography's Transport Networks

Shifting to private hyperscaler cables

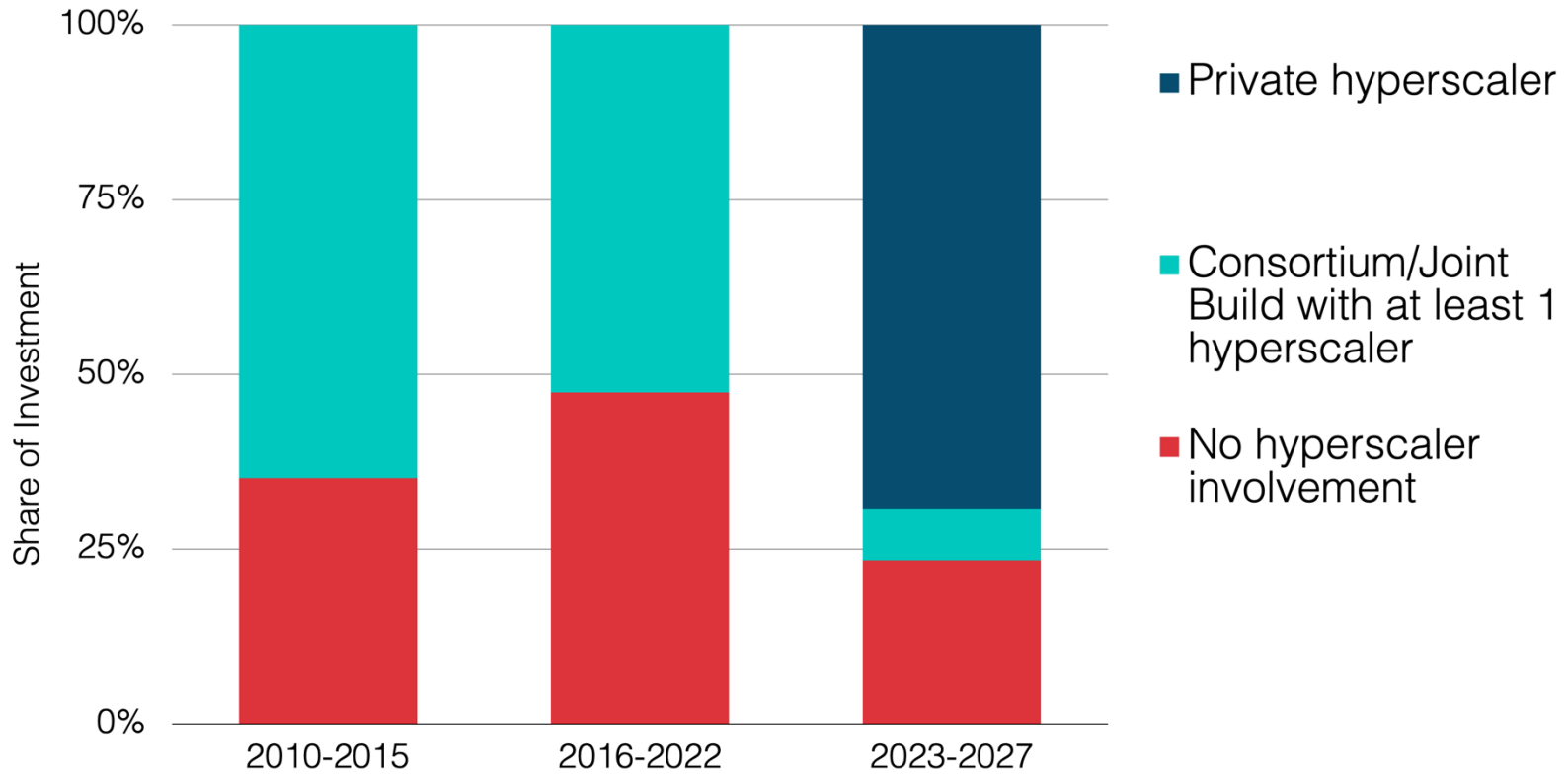
New Cable Investment by Ownership Type – Trans-Atlantic



Source: TeleGeography's Transport Networks

Shifting to private hyperscaler cables

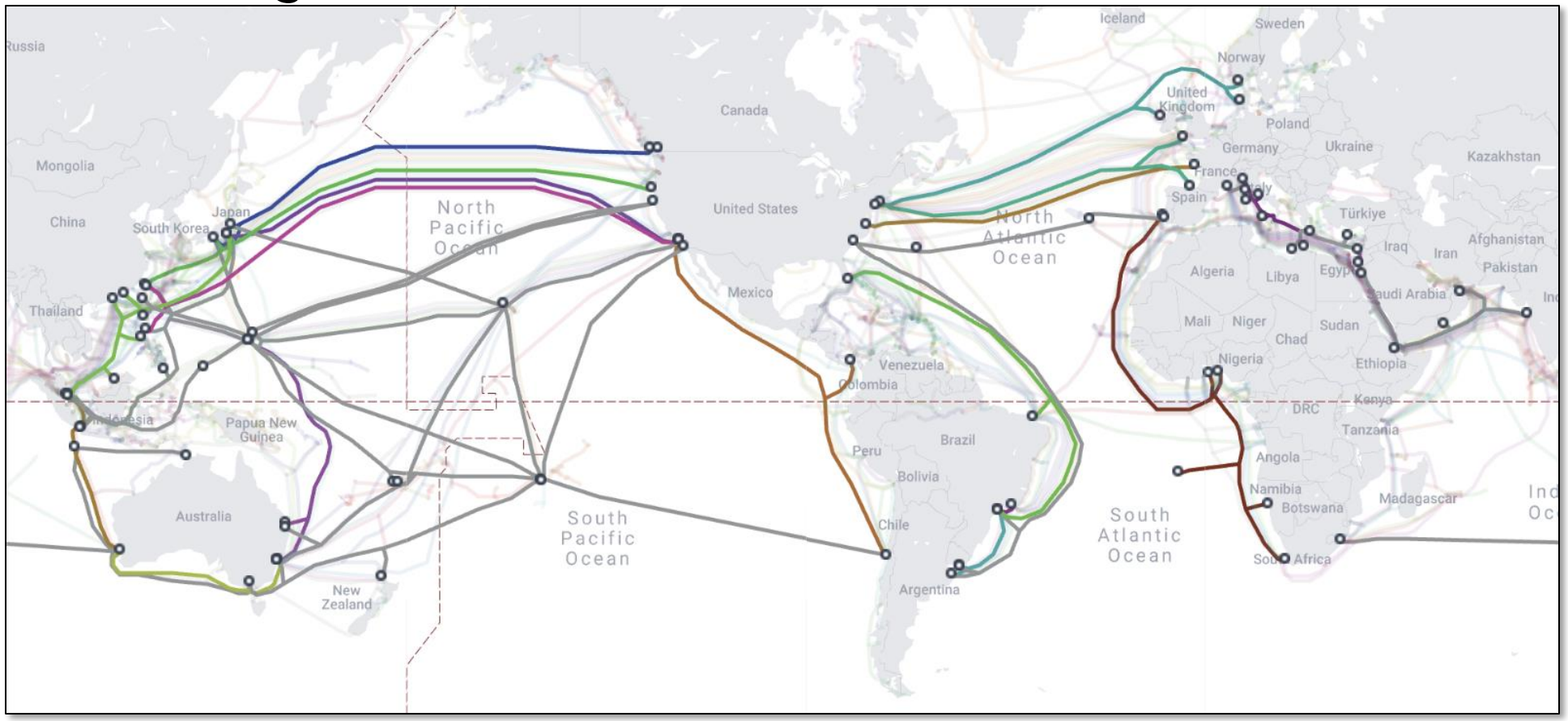
New Cable Investment by Ownership Type – Trans-Pacific & Oceania



Source: TeleGeography's Transport Networks

Google cables

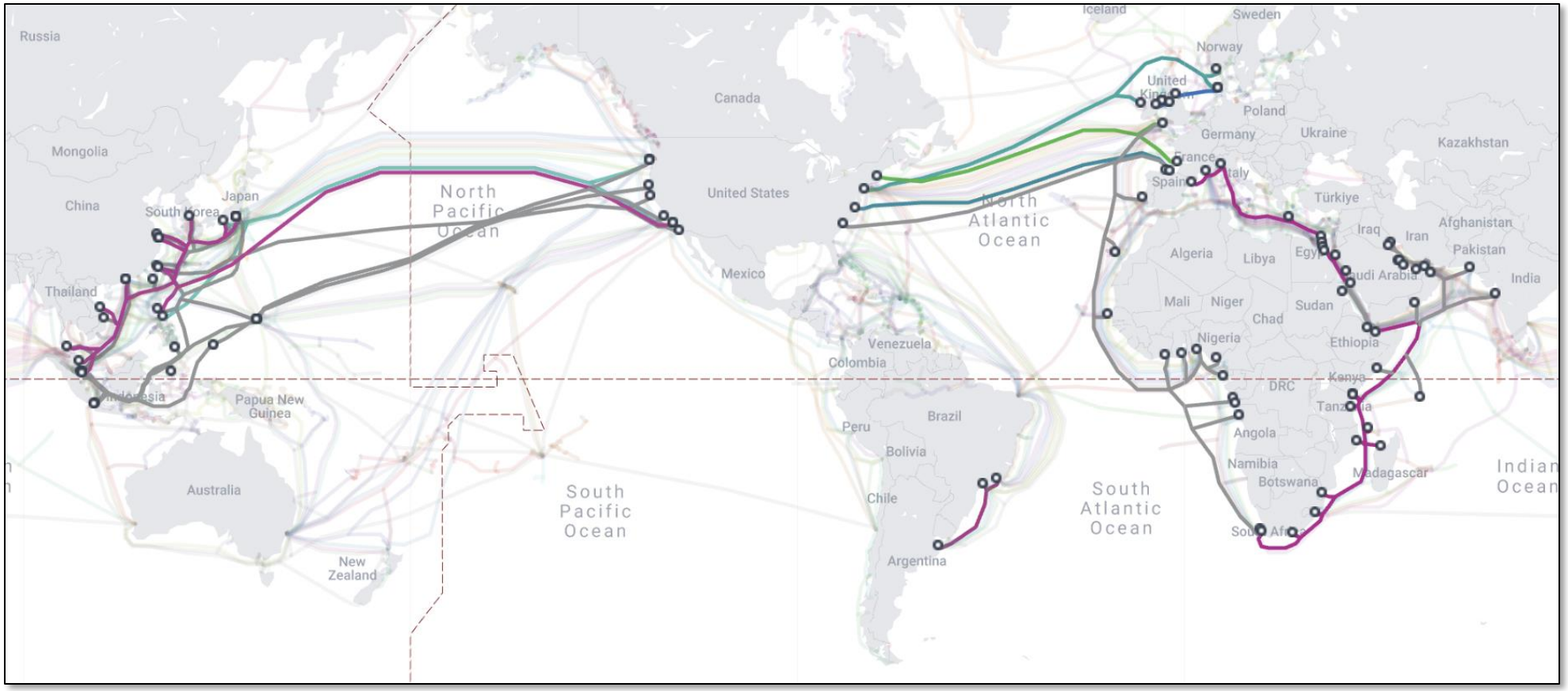
Google's Private Cable and Consortium Investments



Notes: Publicly disclosed investments only. Google has fiber pairs and capacity on additional cables.
Source: TeleGeography's Transport Networks

Meta cables

Meta's Private Cable and Consortium Investments



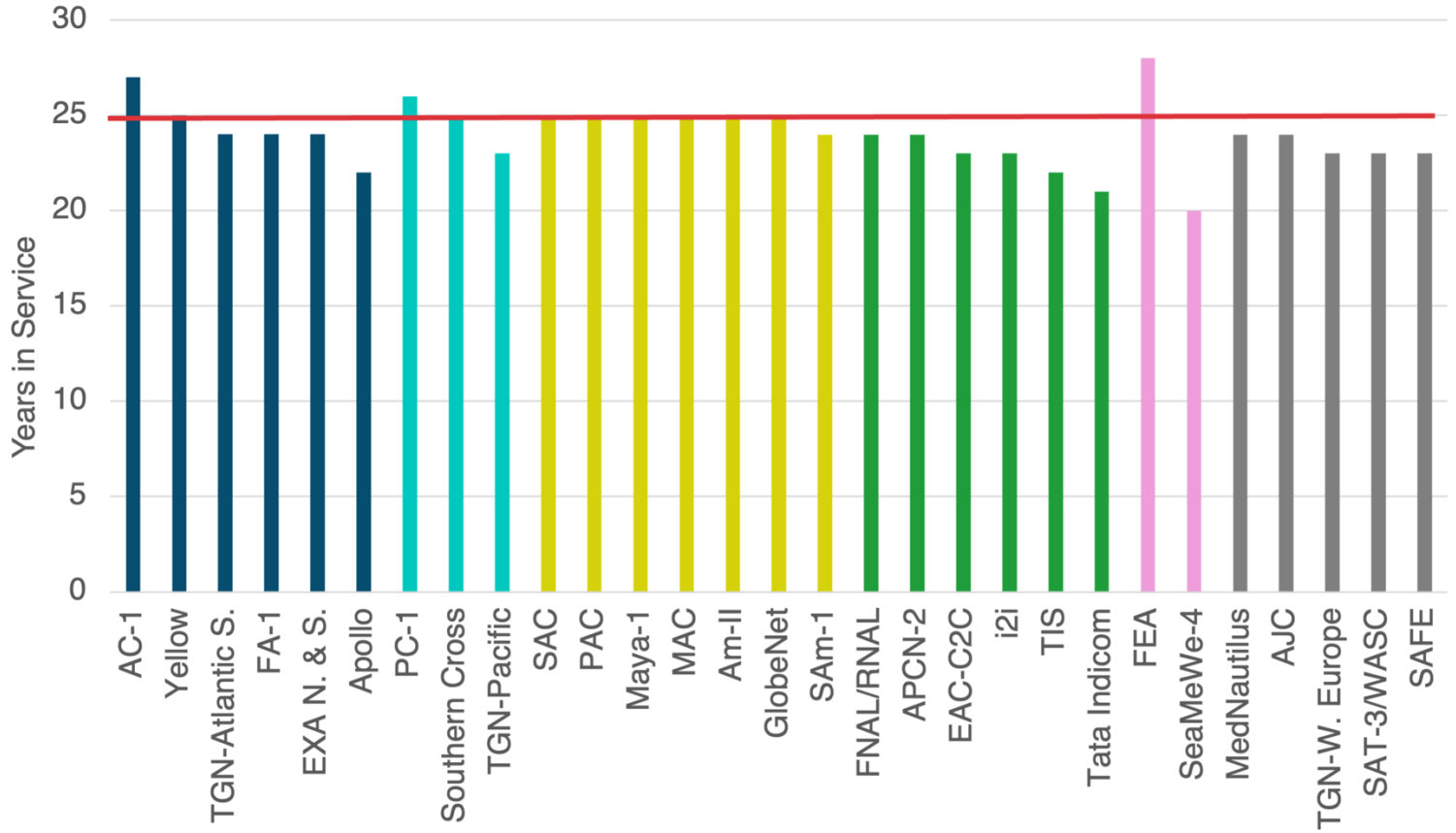
Notes: Publicly disclosed investments only. Meta has fiber pairs and capacity on additional cables.
Source: TeleGeography's Transport Networks

Market implications

- Private cables are not for the sole use of hyperscalers
  - They will engage in swaps and also sells IRUs for fiber pairs, as well as ¼ and ½ pairs
  - Carriers may collaborate with hyperscalers to fund entire branches that link into private cables
- Building new cables without hyperscaler involvement is increasingly challenging
- Carriers still needed as partners for hyperscaler cables in less open regulatory/investment environments (e.g. Middle East, Africa)

Heading to retirement?

Selected Active Cables +20 years of service



Source: TeleGeography's Transport Networks

TeleGeography

A Resilient System

AI prompt: create an image that combines Mother Earth with a resilient global submarine cable network please

TeleGeography

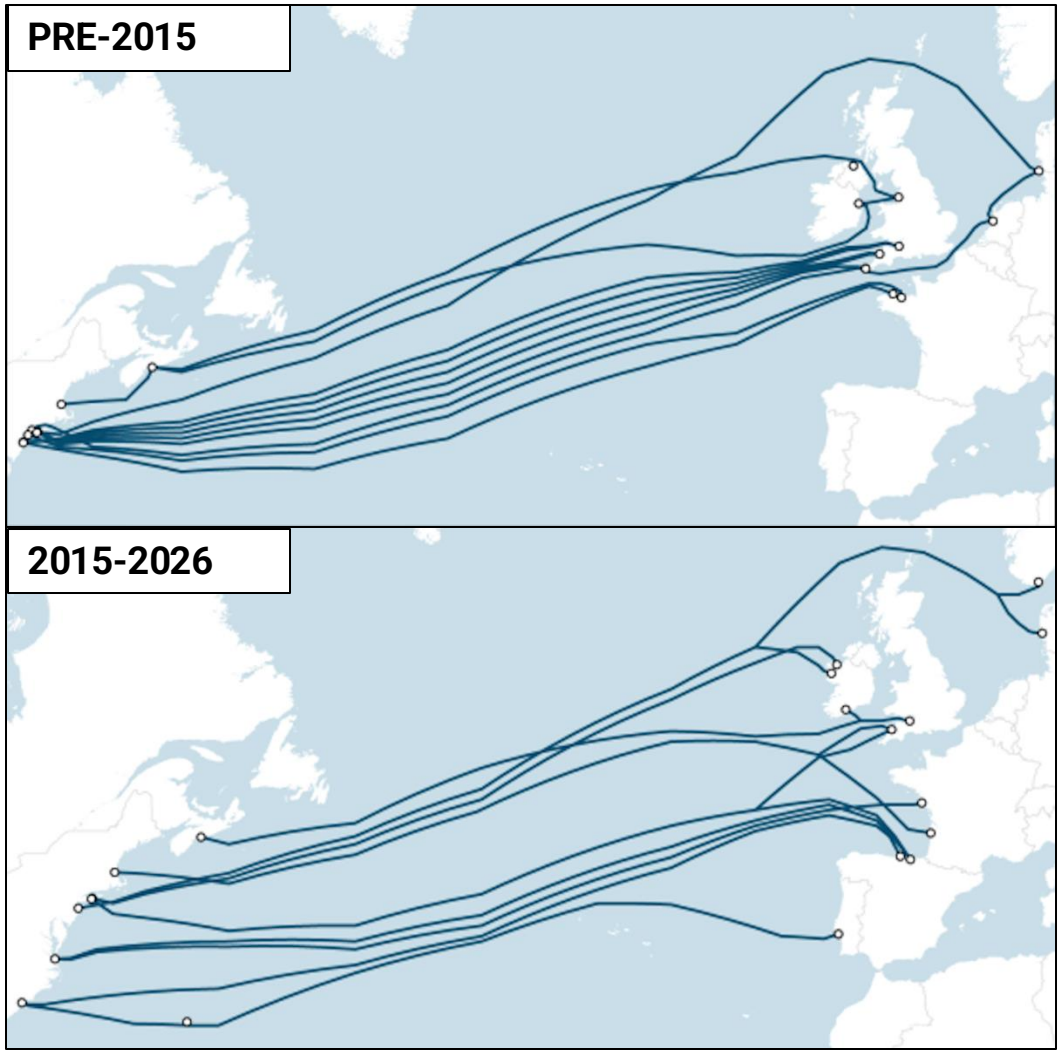
A Resilient System

AI prompt: create an image that combines Mother Earth with a resilient global submarine cable network please

AI prompt: uhh, let's use a globe, not a human body please

Diversity on the trans-Atlantic route

- Focused on New York/New Jersey



- Mainly focused on the U.K. and NW France

- Broad distribution from Canada to SE USA now
- New landings in Virginia Beach and Myrtle Beach

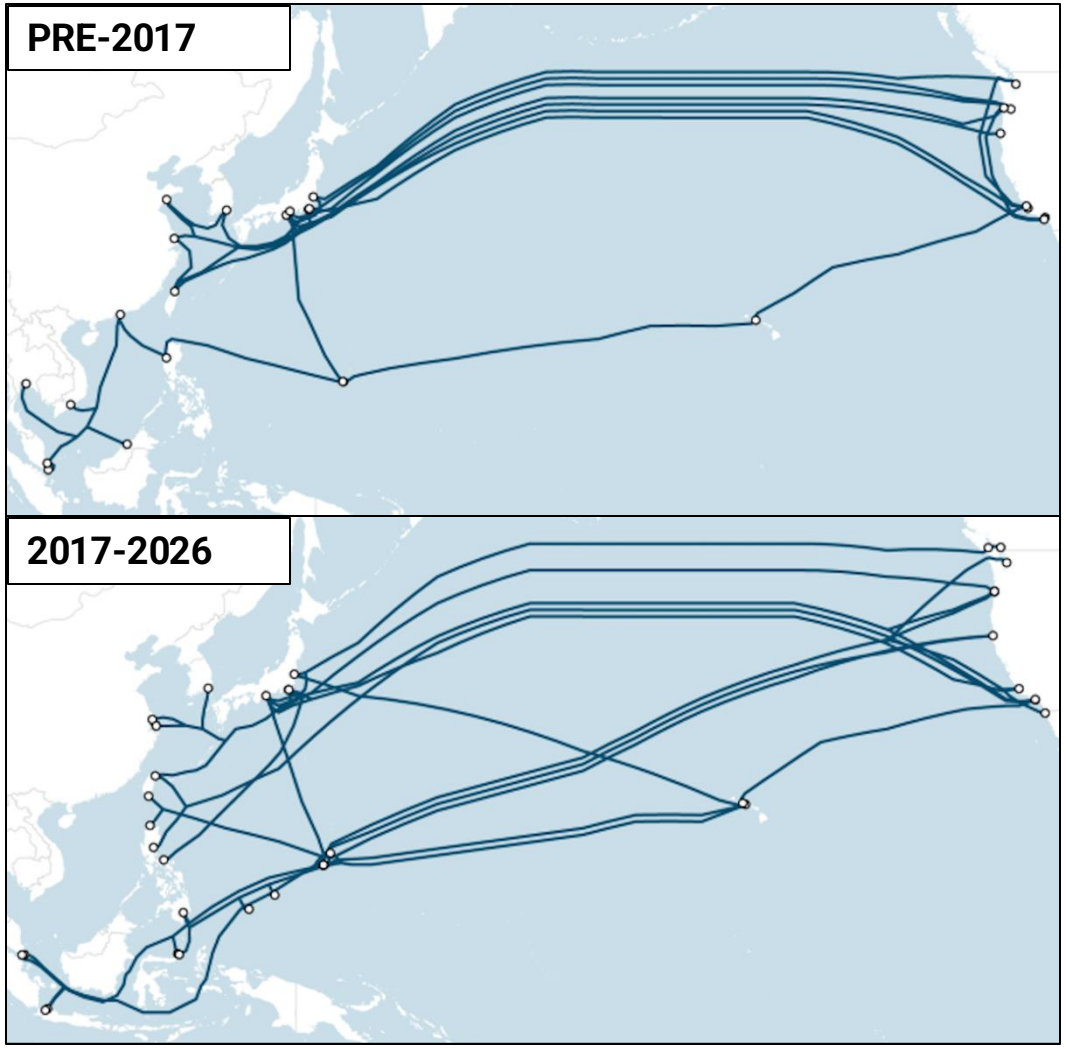
- Broad distribution from Scandinavia to the Iberian Peninsula
- New landings in SW France, N. Spain, W. Ireland, and Norway

Source: TeleGeography's Transport Networks

Diversity on the north trans-Pac route

- Heavily focused on Japan

- More cables to Japan, but increasingly Singapore, the Philippines, Taiwan, and Indonesia



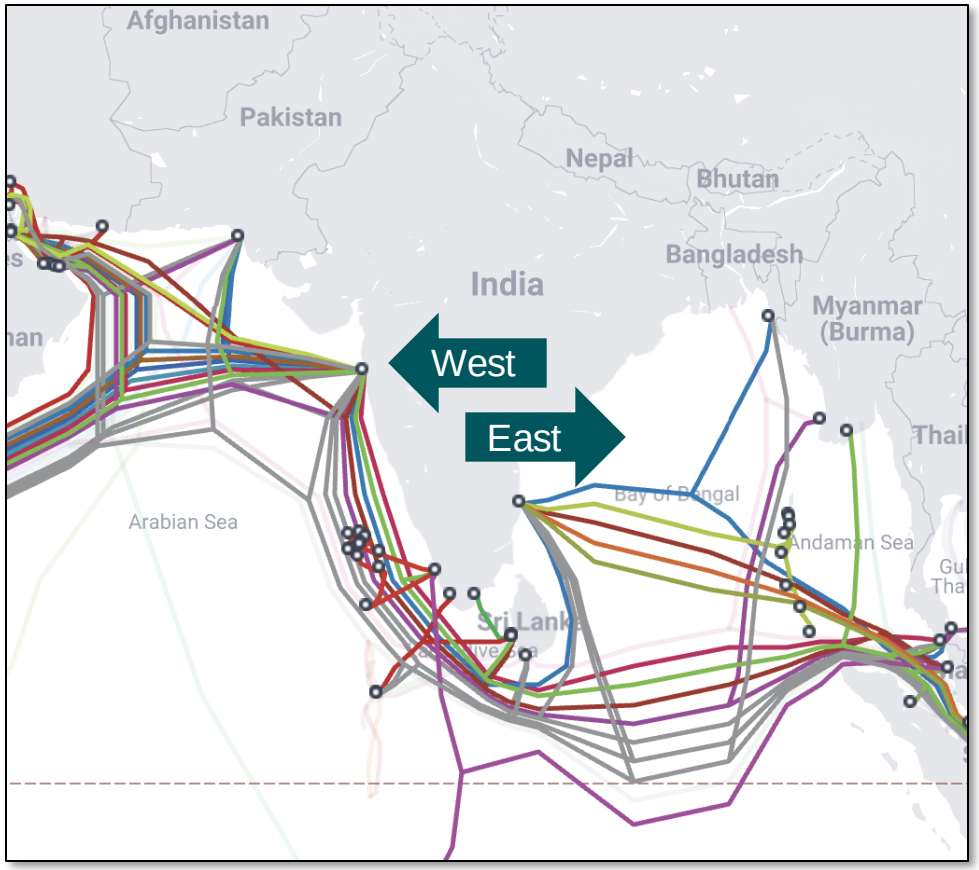
- U.S.-focused on Oregon and Southern California mainly

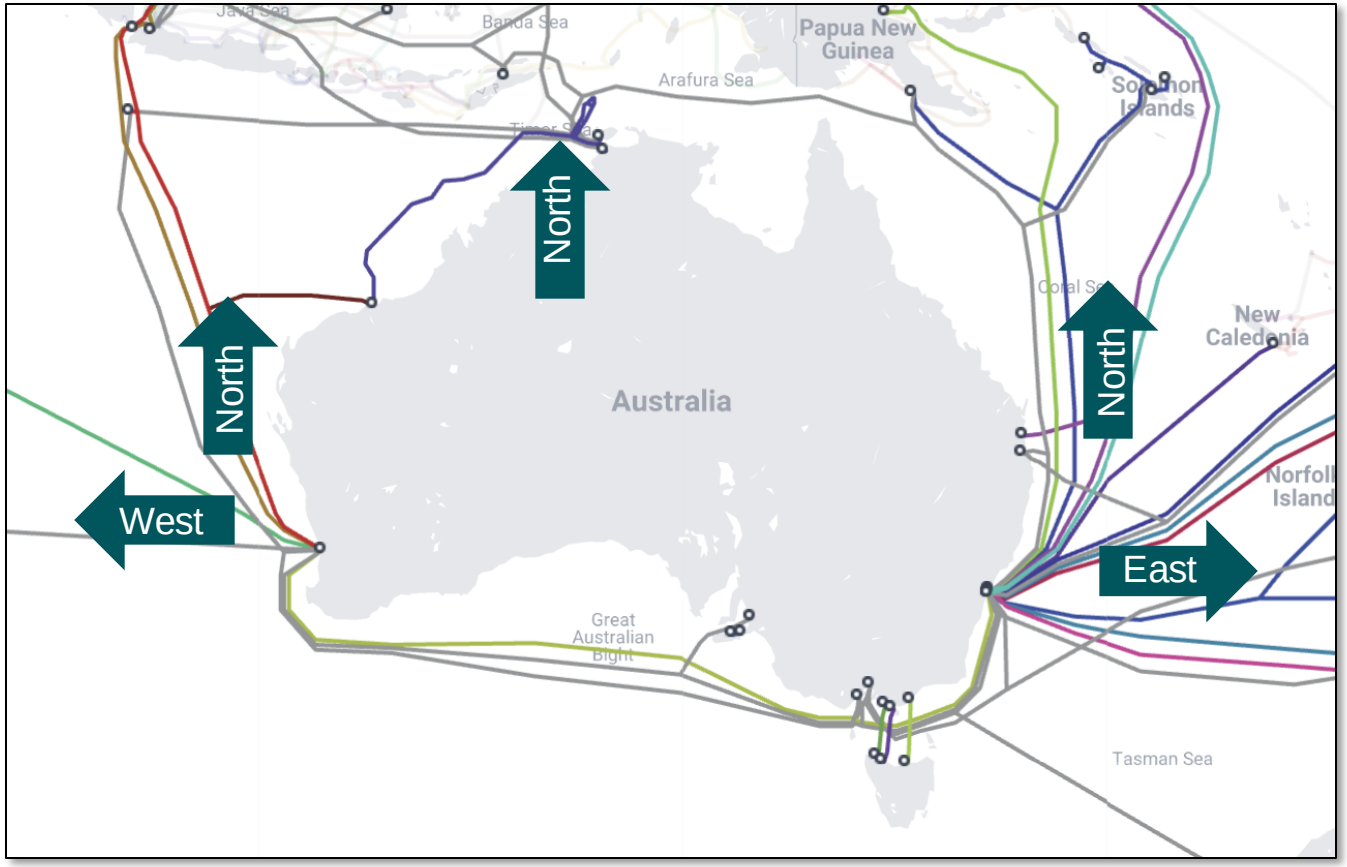
- New landings in California (San Diego, Manchester, Eureka)
- Cables connected to Canada and Mexico

Source: TeleGeography's Transport Networks

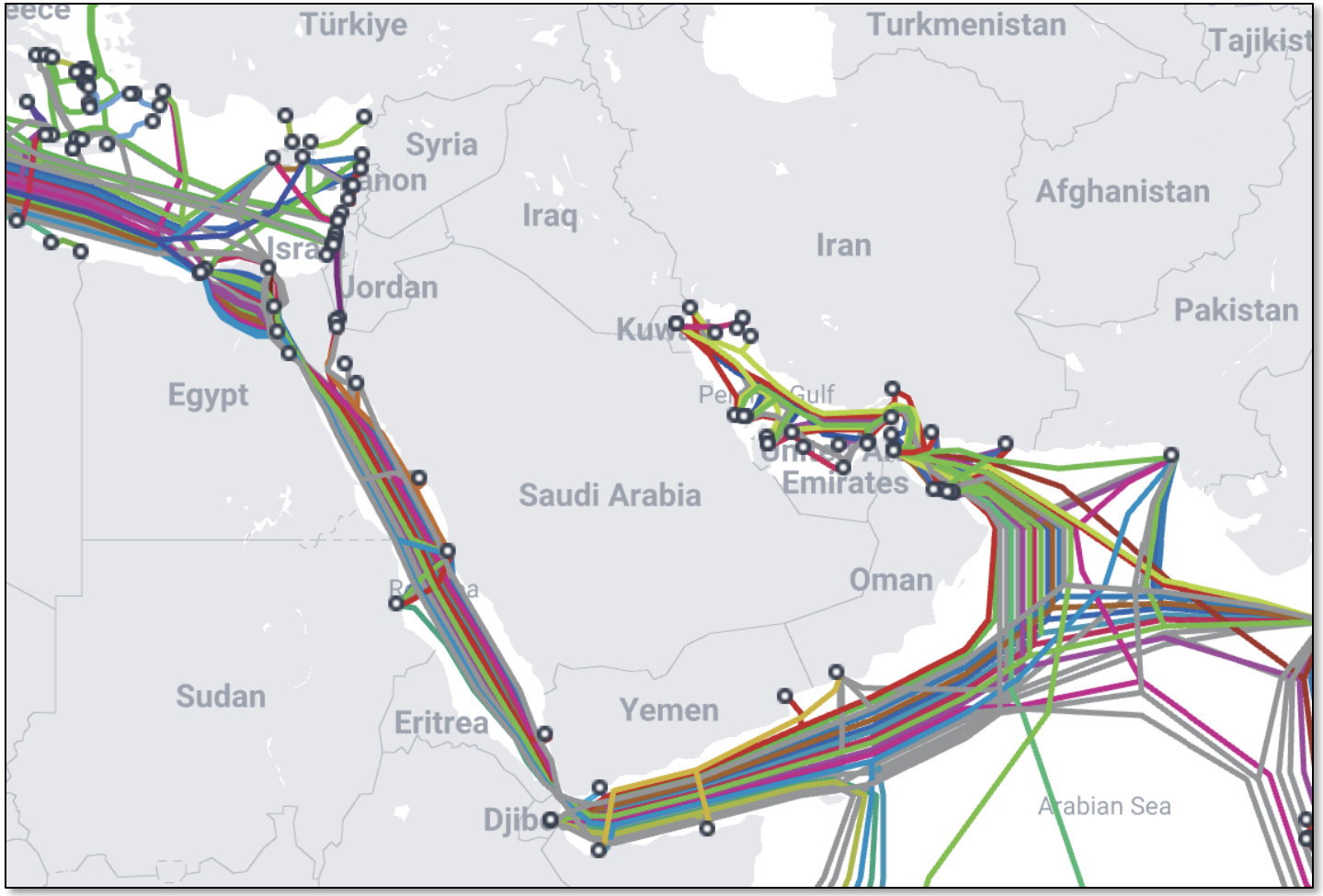
Diversity through corridors

- Diversity of corridors, not just multiple cables on a single corridor.





Connectivity ≠ capacity



- Don’t be fooled, cable maps show connectivity, **not** how capacity is deployed.
- The Middle East has substantial cable connectivity in many directions, but 82% of the region’s used international capacity is linked to Europe.

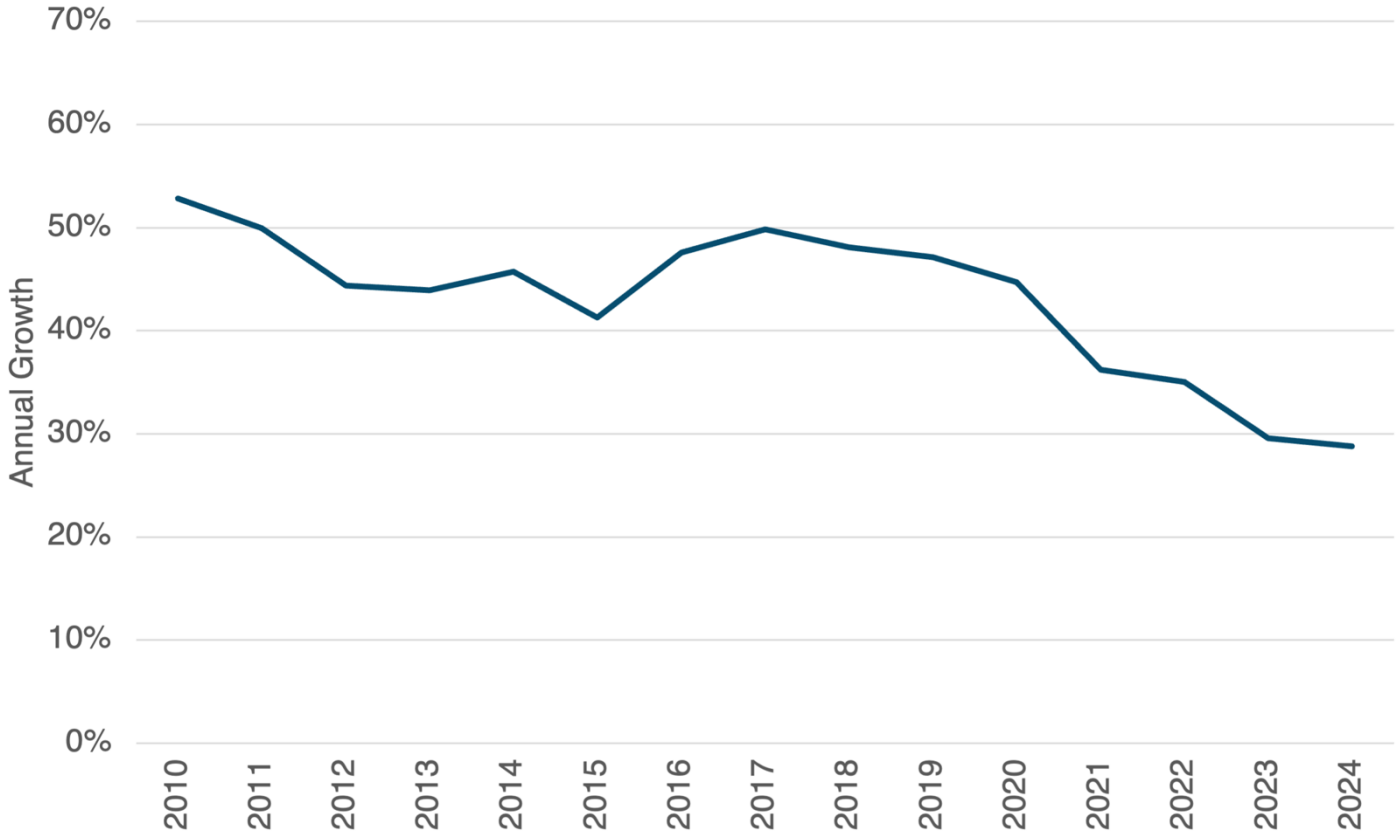
TeleGeography

Global Climate Change

AI prompt: create an image that ties in climate change to the pace of bandwidth demand growth please

Demand: Global cooling

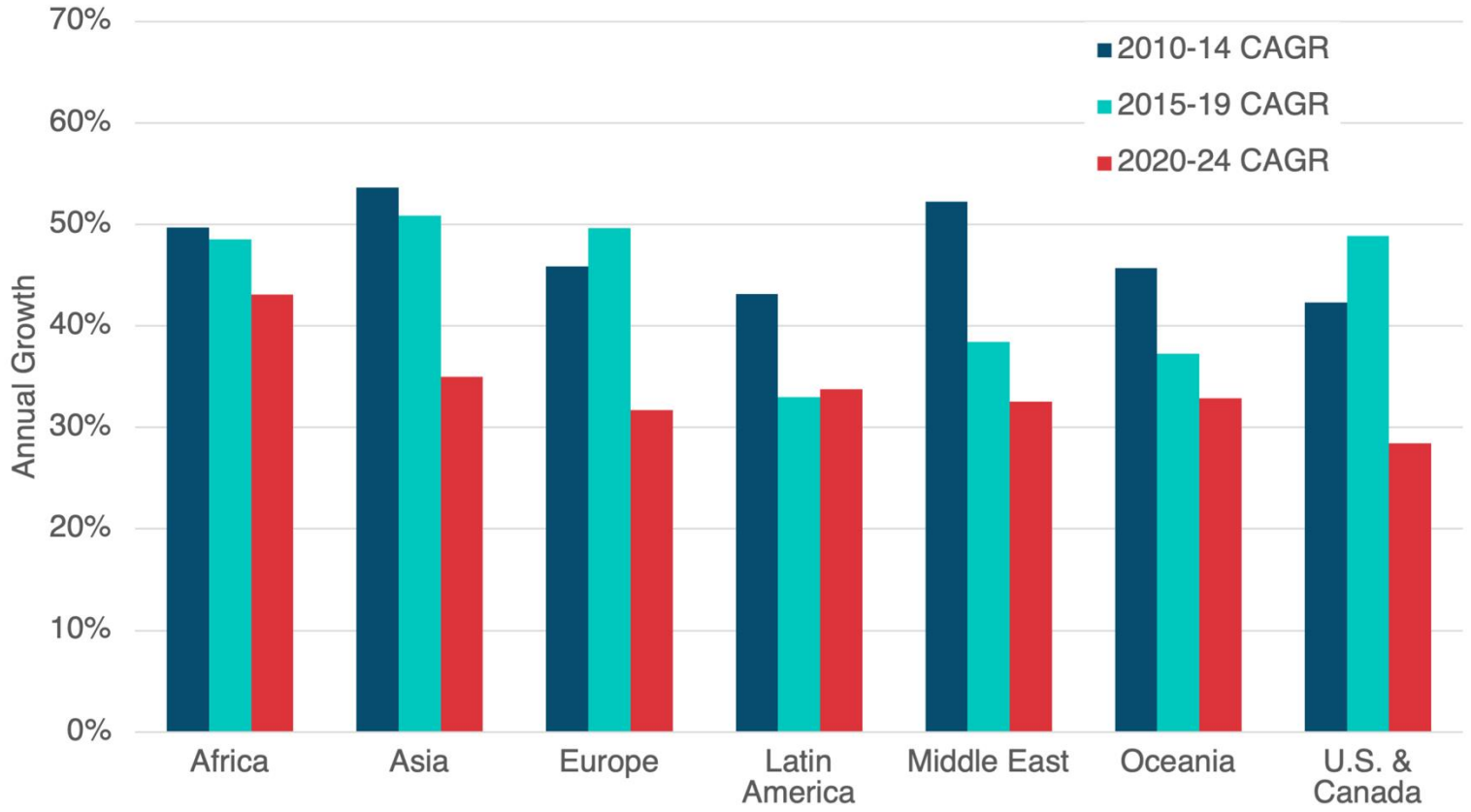
Used International Bandwidth Annual Growth, 2010-2024



Source: TeleGeography's Transport Networks

Widespread deceleration

Used International Bandwidth Growth by Region, 2010-2024



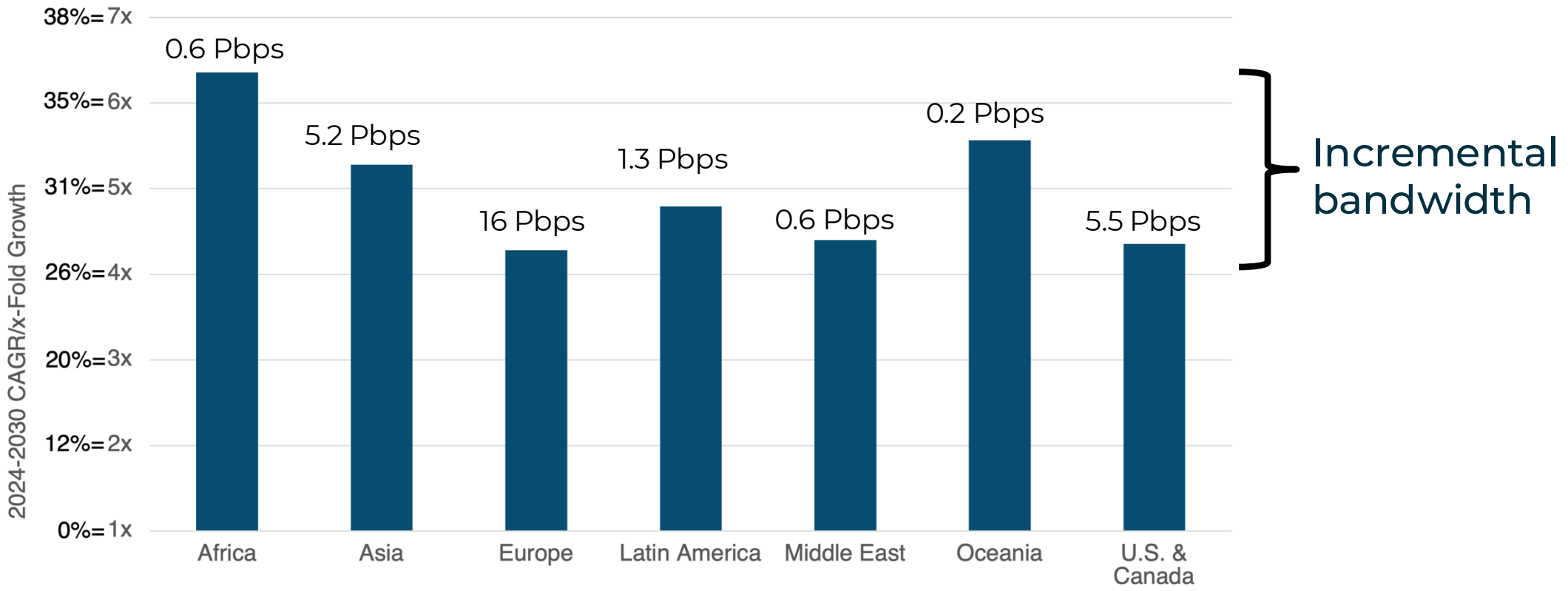
Source: TeleGeography's Transport Networks

What's going on?

- Continued localization of content, applications, and compute
- Submarine cable delays
- Phase of network buildout
  - New market entry drives rapid capacity growth as operators overbuild to accommodate uncertain demand
  - Once sufficient scale and diversity is achieved, the pace of growth tends to slow
- The law of large numbers = "a large entity which is growing rapidly cannot maintain that growth pace forever"

Slower growth still leads to massive volumes

Used International Bandwidth Increases, 2024-2030



Source: TeleGeography's Transport Network Forecast

TeleGeography

Evolution

AI prompt: create an image that ties in Mother Earth as a motherboard and the rise of AI

Factors shaping long-haul demand from AI

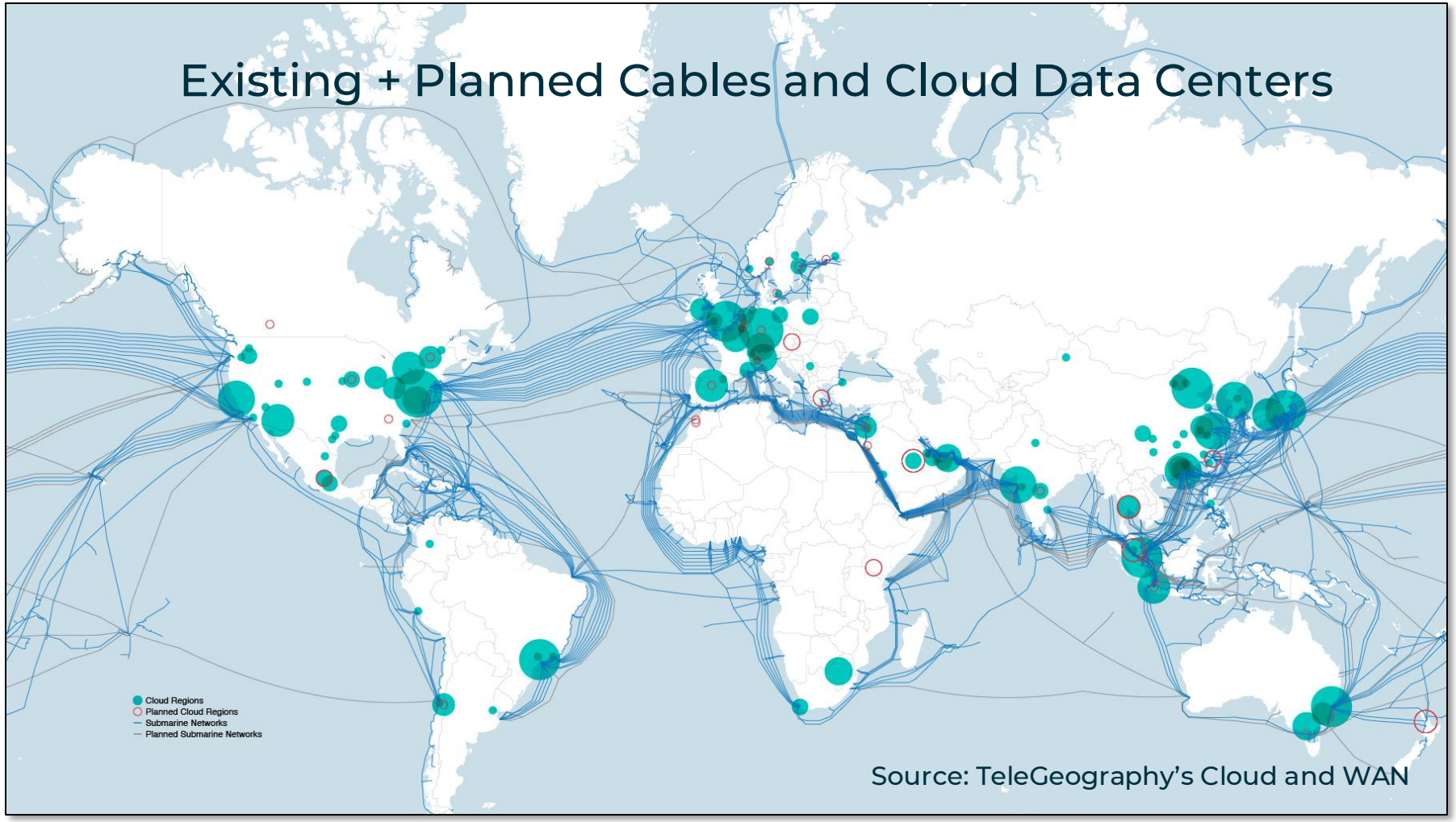
- Model training locations
  - Huge power and computing requirements but less latency sensitive.
  - May be done in locations outside of traditional cloud hubs due to power requirement availability

- Inference locations
  - May be in cloud-based inference clusters or on-device.
  - Limiting distance between users and inference clusters is key for performance

Factors shaping long-haul demand from AI

- Distributed training and federated learning
  - Use of multiple locations to train models which could be in different countries
- AI-based data compression and traffic routing improvements
- Spatial temporal load shifting
  - Moving workloads among data centers to optimize for power and processing availability
- Legal issues
  - Export controls - Which countries can get advanced AI chips?
  - Data sovereignty - Over 100 countries have laws governing where data can be stored and processed

Mother Earth as a motherboard



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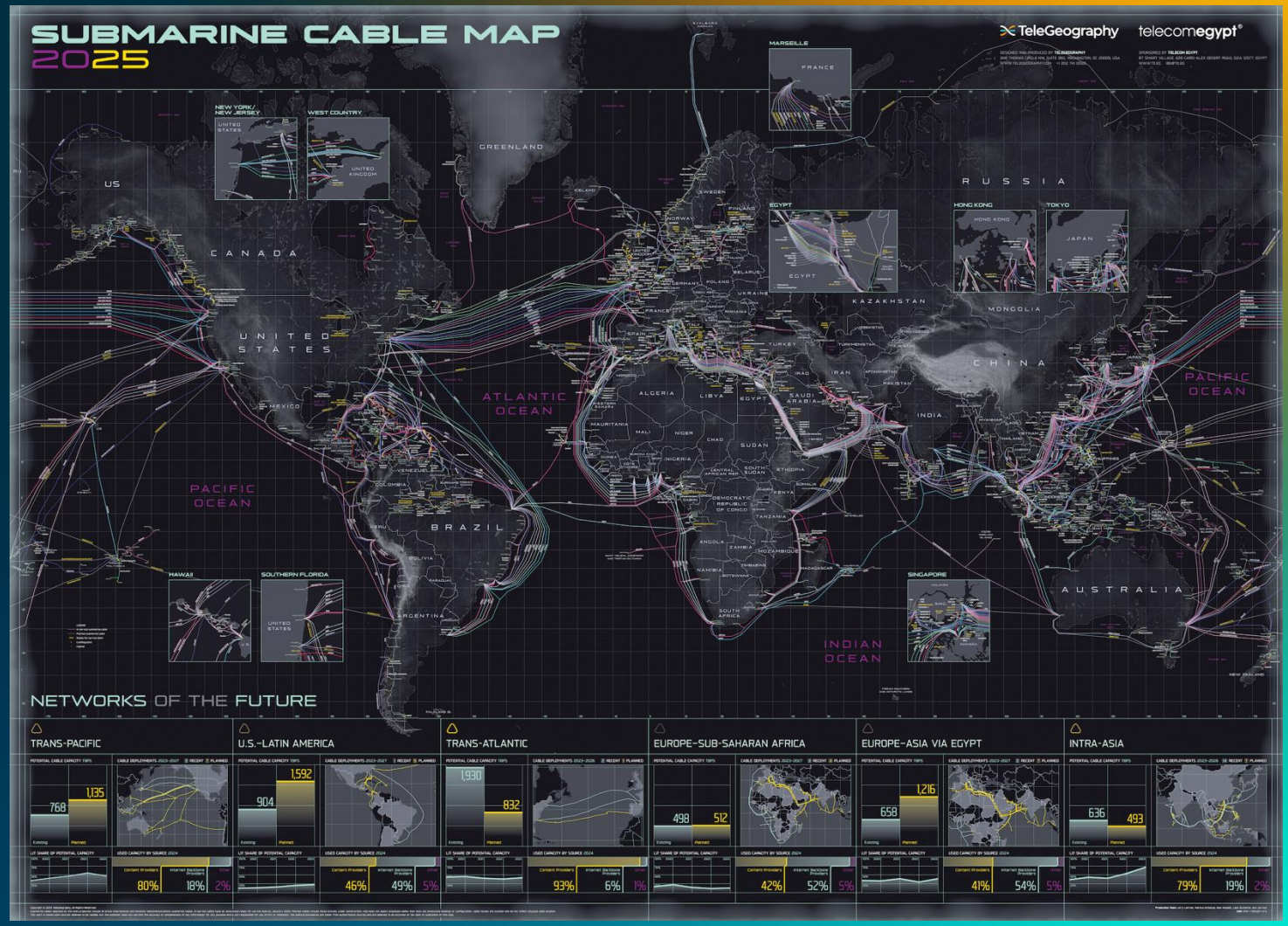
The Future

HI prompt: please create a final image for my “Mother Earth, Mother Board” presentation in the style of the movie “Blade Runner”



Note: generated by human intelligence at TeleGeography

TeleGeography

Thank you

Alan Mauldin

Research Director

amauldin@telegeography.com

TeleGeography

Would you like these slides?