

TeleGeography Workshop Brianna, Tim, and Jon

PTC January 21, 2024

Here's what you get for the price of admission

- 1. Global Pricing Trends in a New Era
 - Brianna Boudreau
- 2. Towards an Interconnection Index: Ranking the World's Greatest Hubs
 - Tim Stronge
- 3. The Data Center Market Blazes a New Trail
 - Jon Hjembo



https://www2.telegeography.com/ptc-2024



Global Pricing Trends in a New Era

Brianna Boudreau

PTC January 21, 2024





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The Set List

Transport Pricing

- Are we out of the woods yet? Has price erosion returned to "normal?"
- How do trends compare across regions?
- 400 Gbps
 - How have 400 Gbps pricing models rolled out?
 - Lessons learned from 100 Gbps
- IP Transit Pricing
 - Impact of transport on transit pricing
 - Impact of network investments on existing hubs & secondary markets

Our Next Era

- Where are we headed in 2024?
- Potential changes in customer purchasing patterns

Transport Pricing Are we out of the woods yet?



Wavelength prices declining is Nothing New



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Long Story Short, declines slower than earlier eras

Weighted Median 100 Gbps Wavelength CAGR Price Decline, 2017-2020 vs. 2020-2023



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On routes to Asia, erosion has yet to Begin Again

Weighted Median 100 Gbps Wavelength Prices & CAGR Price Decline



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That's When modest price erosion maintains global price differences

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



X TeleGeography

But it's been a Cruel Summer on other routes



Weighted Median 100 Gbps Wavelength Prices, 2020-2023

X TeleGeography

But it's been a Cruel Summer on other routes



≫ TeleGeography

New cable construction isn't going out of Style

Total Cable Construction Costs by Region



X TeleGeography

New cable construction isn't going out of Style



https://www.submarinecablemap.com/status/planned

≫ TeleGeography

So, are we Out of the Woods yet?

- Delays in capacity upgrades and new cable activation
 - Global supply chain disruptions and card shortages have largely resolved themselves, but geopolitical issues (such as those in the South China Sea & the Red Sea) continue to delay new network projects.
 - Fewer cables with inventory at one time = less competitive price pressure.
 - On routes with recent upgrades, new supply, and pre-sales on new systems, price erosion returning to higher levels.

• Look what you made me do

- Uncertainty on the timeline of future supply on some routes has changed customer purchasing patterns.
- Supply is snatched up before it becomes available or bought in bulk. Customers taking capacity at the price that is offered helps maintain price points.

400 Gbps Pricing ...Ready for it?



I Can See You: 400 Gbps pricing models taking shape Global 400 Gbps Prices & Price Multiples



X TeleGeography

The Last Time: Evolution of 10:100 Gbps price multiples Global 10:100 Gbps Price Multiples



X TeleGeography

400 Gbps Pricing ... Ready for it?

- 400 Gbps uptake reportedly slower than initially anticipated.
 - Sales limited to shorter terrestrial routes within Europe and the U.S, & trans-Atlantic.
 - Asia and Oceania reporting limited demand so far.
- As a result, only a slight discount between 100 & 400 Gbps.
 - Low multiples of 2.5-3x on terrestrial routes have been reported.
 - As demand picks up, multiples will erode.
- Additional savings on install, cross-connect charges, and power consumption compelling for higher capacity buyers.

IP Transit Pricing

A trend we know all too well



Transit prices starting to Shake It Off

Weighted Median 10 GigE IP Transit Prices in Major Global Cities \$4.00 Sydney Johannesburg Tokyo Hong Kong \$3.00 \$/Mbps per Month (USD) Singapore São Paulo Los Angeles \$2.00 \$1.00 -17% Average CAGR price decline globally since 2020 \$0.00 2020 Q3 2021 Q3 2022 Q3 2023 Q4

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Returning to that trend we know All Too Well

Weighted Median 10 GigE CAGR Price Decline, 2017-2020 vs. 2020-2023



X TeleGeography

Timeless: Prices falling in APAC

Weighted Median 10 GigE IP Transit Prices & CAGR Price Decline



-20% Average CAGR price decline since 2020

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So It Goes: Reducing premium in secondary markets



Change to 100 GigE in global hubs



It's Time to Go: Assessing the case for 100 GigE



X TeleGeography

IP Transit Prices

- Return to a trend we know all too well
 - Global IP transit prices continue to fall at a steady pace.
 - In established hubs declines enabled by escalating volumes & lower unit costs.
 - In secondary markets declines drive by reductions in the underlying cost of transport and increasing local traffic exchange.
- 100 GigE ports now represent majority of sales in key hubs
 - Price multiples remain high, but savings on install, cross connects & ease of management are compelling factors.

Our Next Era

- Will price erosion return to normal? Or is there a "new normal?"
 - While supply chain constraints are largely resolved, geopolitical issues still delaying new submarine cable systems on some routes.
- Change in the competitive landscape
 - Approaching an era of cable retirements, which could change the number of bandwidth suppliers on some routes.
- Change in customer purchasing patterns
 - When does it make sense to purchase a fiber pair/spectrums vs leasing wavelengths?
 - Fiber pair pricing is very cable specific and not subject to the same pricing trends we are used to.
- More local market growth for IP transit



Towards an Interconnection Index: Ranking the World's Greatest Hubs **Tim Stronge**

PTC January 21, 2024

The interconnection index: what we're doing

- Questions we're often asked
 - What is the next emerging hub in region x?
 - How do various hubs compare to each other?
 - Where should I expand in country X besides the largest city?
- We will solve with data and *maps*





Let's think about the data sets for each city

- Data Centers
 - Data center infrastructure
 - Internet exchange infrastructure
- Network Connectivity
 - Cloud infrastructure
 - Long-distance internet
 - Long-distance transport
 - Pricing

- Market Potential
 - Geography and demographics
 - Local access
 - Power
 - Regulations and governance

Example city: Osaka Smallest city = 500 pop. Largest city = 32,224,328 pop. Normalized Score Data Group Category Value 17.7 Geography and Demographics GDP per Capita \$39.734 Geography and Demographics 39.8 Population 12.815.240 Osaka is 39.8% between the Geography and Demographics Population in Nearby Cities 20.298,215 25.2 MIN and MAX cities Group Average Geography and Demographics 27.6

Example city: Osaka

Data Group	Category	Value	Normalized Score
Geography and Demographics	Group Average		27.6
Cloud Infrastructure	Group Average		28.3
Data Centers	Group Average		31.8
Internet Exchanges	Group Average		18.0
Local Access	Group Average		36.3
Long-Distance Transport	Group Average		13.7
Power	Group Average		30.8
Pricing	Group Average		85.3
Regulations and Governance	Group Average		84.4

Overall Score	39.6
overall ocore	39.



Screenshot of full list: 600k data points

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What are the highest-scoring hubs?

Top 5 Cities by Overall Score



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Overall quantity isn't all that matters

The "shape" of a city's interconnection assets matters too!



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Top 3 hubs in each region



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Biggest gainers in near term

Top 20 Cities with Fastest Expected Gains in Next Two Years





Governance Scores for Selected Asian Hubs

	City	Control of Corruption	Government Effectiveness	Regulatory Quality	Rule of Law	Voice and Accountability	Average
	Tokyo	80	88	83	91	80	84
	Singapore	93	100	100	96	52	88
:0	Seoul	61	82	77	81	76	76
	Beijing	44	64	43	53	11	43
	Jakarta	33	62	56	49	57	52
	Kuala Lumpur	49	75	66	67	53	62
	Bangkok	33	56	56	55	37	47
	Manila	31	54	53	42	52	46
1	Darwin	85	86	93	89	88	88

Underlying data source: Daniel Kaufmann and Aart Kraay (2023). Worldwide Governance Indicators, 2023 Update (www.govindicators.org),

Let's talk electricity

Planned Electricity Generation Sites – All Sources



Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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Planned Electricity Generation Sites – Coal

Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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Planned Electricity Generation Sites – Gas

Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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Planned Electricity Generation Sites – Hydro

Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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Planned Electricity Generation Sites – Solar



Underlying data source: Global Energy Monitor (https://globalenergymonitor.org/)

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The importance of weighting

Selected City Scores – Default Weights



The importance of weighting

Selected City Scores – Heavier Weight on Power/Electricity



Final thoughts

- All the stuff you've just seen is subject to change
- We need your help!
 - What data sets are important to you?
 - What weights should we assign?



- Telecom and demographic:
 - <u>https://www2.telegeography.com/data-center-research-service</u>
 - TeleGeography proprietary datasets
- Power:
 - <u>https://globalenergymonitor.org</u>
 - Global Energy Monitor
- Governance:
 - <u>https://www.govindicators.org</u>
 - Daniel Kaufmann and Aart Kraay (2023). Worldwide Governance Indicators.





The Data Center Market Blazes a New Trail

Jon Hjembo

PTC 21 January 2024



Themes we'll investigate

Exploring the APAC frontier

Is power the new gold?

Coping with high costs

Exploring the APAC frontier



Source: National Geographic. "Admiral Zheng He, surrounded by the "treasure ships"" by Hong Nian Zhang



The market has already ventured forth

Capacity and Growth, Select Data Center Markets, 2023



- Singapore: few sites have opened since moratorium began
- Mumbai: among the 20 largest global markets, Mumbai's growing the fastest
- Kuala Lumpur and Jakarta already experiencing rapid growth that will only gain momentum

And continues to develop new markets

Changes in Growth, Gross Data Center Capacity, Select Markets

Singapore: Pipeline limited to license winners + SingTel

India 3rd only to U.S. and China globally for number of new projects

Chinese and U.S.-based operators converging in **Malaysia**

International providers snapping up land in **Malaysia** and **Indonesia**

Lots of global operators building into **Japan** and **Korea**



Chinese development pushes inland

Capacity and Growth, Select Data Center Markets, 2023

- Very slow growth for Hong Kong
- Strong growth in Yangtze River Delta and capital region
- Focus has moved to the mainland and will continue to do so



Chinese development pushes inland

Chinese policy: "Eastern Data, Western Compute"

- Eastern Data: low-latency applications for large population centers
- Western Compute: data storage in areas with more abundant power

Significant pipeline development:

- North Beijing
- Yangtze Delta Shanghai
- Greater Bay Area Shenzhen, Guangzhou
 - Hong Kong? Not so much



Number of Planned Sites by Metro in China, 2023

Is data power the new gold?



X TeleGeography

How much power do data centers use?

Commercial operators in these ten data center markets consume about 12 gigawatts (GW) of power

 That's roughly the same amount of power used by 9 million homes...for about 1,000 data centers

Metro Capacity by Gross Power (MW), 2023



Scarcity is already an issue

- Singapore: limited pool of licenses
- Netherlands: zoning laws effectively ban hyperscale
- Germany: Federal Energy Efficiency Act adds restrictions
- Dublin: operators must provision own energy generation, but projects still may not be approved
- UK: Ofgem urgently cleaning up power connection queue
- Dominion in NoVA is out of transmission capacity



≫ TeleGeography

Al will only make this situation tougher

Amount of power needed is staggering

- Estimates that AI data centers will require 2-5x capacity of other cloud data centers
- Latest gen of individual Nvidia GPU chips can use as much or more power than entire cloud servers.
- H100 and H200 Tensor Core GPUs tout up to 700W max thermal design power



Most sites can't handle the density needed

- Nvidia GPUs use about 6.5-11 kW per 6U box.
 - So about 45-80 kW per 42U rack
- Vast majority of sites can't support even 20 kW/rack

Supportable Colocation Rack Density, Share of Sites Globally (kW/rack), 2023



How far can we go in searching for power?

- Will data centers be constrained by location in their hunt for power?
 - Training perhaps less constrained
 - Could open opportunities to deploy to less crowded, more cost-effective locations with more abundant power
 - Inference more constrained due to latency requirements
 - Compounds demand for capacity in already congested locations



Source: Bulk Infrastructure



Adapting to the situation

Strong utility partnerships and creative power solutions will be key

- Location: Proximity to utility providers for access to generation
 - AWS in Louisa County, VA with Rappahannock Cooperative near nuclear plant
 - Digital Realty procuring hydropower from Süwag near Hattersheim campus (FRA)
- Conversion: Site-based mini generator solutions to convert gas power to electricity
 - Expensive but plausible
- Making use of waste heat: Heat transfer for resourceful use of power
 - Germany: will be increasingly mandated to transfer waste heat.
 - Telehouse to share in FRA via the Mainova district heating network

Coping with High Costs



Some tech workers fleeing San Francisco for Austin







Energy prices have dropped, but still sit higher than before IEA Wholesale Electricity Rates, 2H19-2H23

- Prices have generally fallen since 2020-2022 surge but sit historically higher than before 2020
- European rates down more than 60% Y-o-Y but still more than double what they had been
- Singapore sits 2x higher than Eur rates
- Rise and fall relatively moderate in U.S.



Source: IEA Real-Time Electricity Tracker

Do colocation prices rise with utility rates? It's complicated

- Long-term contracts and lag effect
- Pass-through vs. rolling increases
- Hiding inflationary costs elsewhere cross connects, base colocation rate, etc
- Government subsidization

Colocation prices are higher too

Average Monthly Price per Kilowatt at 4-Kilowatt Density, H2 2021-H2 2023

- European rates rose about 40% between 2H21 and 1H23 and have leveled off
- Asian hub rates continue to climb north of \$500/kW (driven by Singapore)
- U.S. has lagged at more competitive level due to localized competitive pressure



Will rates continue to rise?

- Still inflationary expectation but outliers are much less extreme
- Average expectation for price inflation per kW slightly slower than H1
- Average expectation for higher cross-connect rates has risen. Think lag effect and hidden cost



The takeaways?

- As Singapore's growth is curtailed, there's a concerted push into other subregional markets:
 - South Asia India
 - Southeast Asia Malaysia
 - North Asia Japan
- And as new infrastructure investment in Hong Kong diminishes, China's focus moves further into the mainland

• Commercialized generative AI compounds difficulties in sourcing power

• Inflation is slowing, but rates in many markets are settling at higher levels

Slide download



https://www2.telegeography.com/ptc-2024

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Thank You

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