TeleGeography

Executive Summary

IP Networks Research Service

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Three years after the COVID-19 pandemic struck, the internet appears to have achieved a state of normalcy. After a tumultuous 2020, in which the COVID-19 pandemic caused internet traffic patterns to shift and volumes to surge, network operators have returned to the business of adding bandwidth and engineering their traffic in a more measured manner.

In our *IP Networks Research Service,* we analyze the meaning of our robust internet capacity and traffic data sets. We also discuss factors impacting IP transit pricing, and the role individual backbone operators play. Based on hard survey data gathered from dozens of regional and global network operators around the world, we conclude that COVID-related expansion of internet traffic and bandwidth was largely a one-off phenomenon, and that the trends we had been observing in recent years have reasserted themselves. International internet bandwidth and traffic growth had been gradually slowing in recent years, but they remain brisk. IP transit price declines continue globally, but significant regional differences in prices remain.

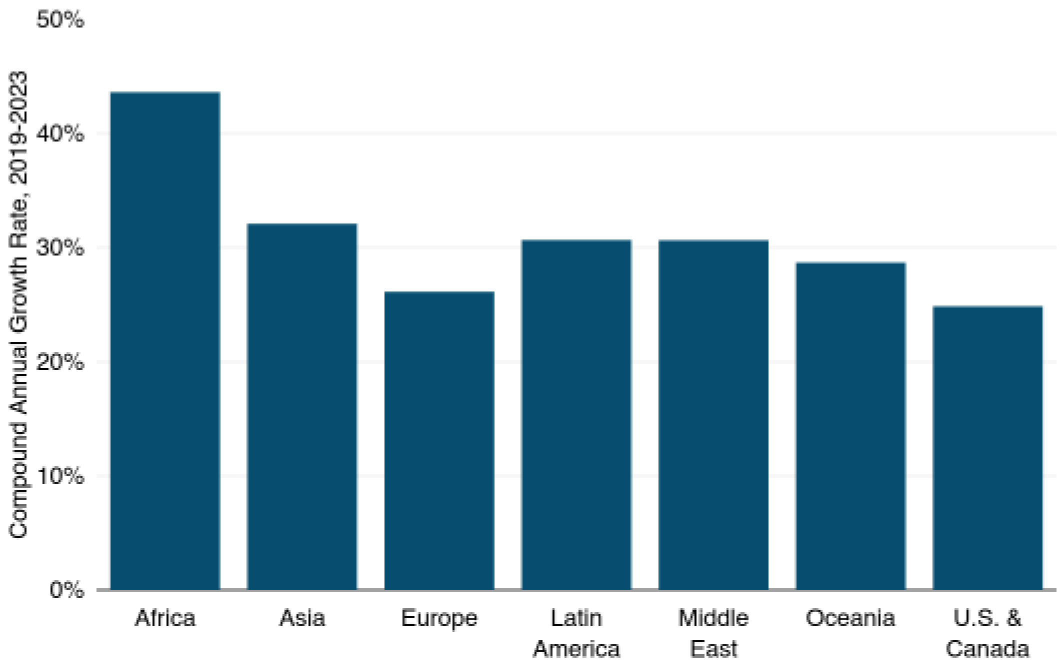
Internet Traffic and Capacity

Global internet bandwidth rose by 23% in 2023, continuing to fall from the pandemic-generated bump of 2020. Total international bandwidth now stands at 1,217 Tbps, representing a 4-year CAGR of 28%. COVID bump aside, the pace of growth has been slowing. Still, we do see a near tripling of bandwidth since 2019.

Strong capacity growth is visible across regions. Once again, Africa experienced the most rapid growth of international internet bandwidth, growing at a compound annual rate of 44% between 2019 and 2023. Asia is a distant second, rising at a 32% compound annual rate over the same period.

FIGURE 1

International Internet Bandwidth Growth by Region



Notes: Data as of mid-year.

Source: TeleGeography

International internet traffic growth largely mirrors that of internet bandwidth. Both average and peak international internet traffic increased at a compound annual rate of 30% between 2019 and 2023—slightly above the 28% compounded annual growth rate in bandwidth over the same period. All of the stay-at-home activity associated with COVID-19 resulted in a spike in traffic from 2019-2020. The return to more normal usage patterns over the last couple of years has resulted in a substantial drop in average and peak traffic. Average traffic growth dropped from 46% between 2019-2020 to 23% between 2022-2023, while peak traffic growth dropped from 45% to 21% over the same time period.

FIGURE 2

Global International Internet Traffic (Gbps)

	2019	2020	2021	2022	2023	Change 2019-20	Change 2020-21	Change 2021-22	Change 2022-23	CAGR 2019-23
Internet Bandwidth	452,606	605,584	776,311	990,831	1,216,708	34%	28%	28%	23%	28%
Average Traffic	113,574	165,870	202,844	259,834	320,661	46%	22%	28%	23%	30%
Peak Traffic	190,592	276,804	348,644	445,490	539,433	45%	26%	28%	21%	30%
Average Utilization	25%	27%	26%	26%	26%	9%	-5%	0%	0%	1%
Peak Utilization	42%	46%	45%	45%	44%	9%	-2%	0%	-1%	1%

Notes: Data reflects traffic over internet bandwidth connected across international borders. Data as of mid-year.

Source: TeleGeography

This return to normalcy can be seen across regions of the world. With the initial rapid traffic growth due to COVID-19 continuing to wane in 2023, many global networks appear to have started to return to more typical rates of utilization. Global average and peak utilization rates were essentially unchanged from the year before at about 26% and 44% percent, respectively, in 2022.

FIGURE 3

International Internet Traffic by Region (Gbps)

	2019	2020	2021	2022	2023	Change 2019-20	Change 2020-21	Change 2021-22	Change 2022-23	CAGR 2019-23
Africa										
Internet Bandwidth	12,227	18,320	26,062	36,885	52,020	50%	42%	42%	41%	44%
Average Traffic	4,610	6,890	9,128	13,553	17,262	49%	32%	48%	27%	39%
Peak Traffic	7,577	11,370	15,984	22,351	30,675	50%	41%	40%	37%	42%
Average Utilization	38%	38%	35%	37%	33%	-0%	-7%	5%	-10%	-3%
Peak Utilization	62%	62%	61%	61%	59%	0%	-1%	-1%	-3%	-1%
Asia										
Internet Bandwidth	103,687	144,021	191,181	253,173	315,535	39%	33%	32%	25%	32%
Average Traffic	32,881	49,247	65,361	86,846	107,023	50%	33%	33%	23%	34%
Peak Traffic	51,889	77,110	103,689	134,001	166,431	49%	34%	29%	24%	34%
Average Utilization	32%	34%	34%	34%	34%	8%	-0%	0%	-1%	2%
Peak Utilization	50%	54%	54%	53%	53%	7%	1%	-2%	-0%	1%
Europe										
Internet Bandwidth	295,052	390,230	495,569	622,080	746,325	32%	27%	26%	20%	26%
Average Traffic	72,021	102,727	121,434	152,003	187,415	43%	18%	25%	23%	27%
Peak Traffic	119,000	170,201	205,382	258,169	309,351	43%	21%	26%	20%	27%
Average Utilization	24%	26%	25%	24%	25%	8%	-7%	-0%	3%	1%
Peak Utilization	40%	44%	41%	42%	41%	8%	-5%	0%	-0%	1%
Latin America										
Internet Bandwidth	53,973	71,483	91,029	117,326	157,257	32%	27%	29%	34%	31%
Average Traffic	10,144	16,026	19,979	24,790	30,544	58%	25%	24%	23%	32%
Peak Traffic	22,156	33,155	43,857	57,267	67,276	50%	32%	31%	17%	32%
Average Utilization	19%	22%	22%	21%	19%	19%	-2%	-4%	-8%	1%
Peak Utilization	41%	46%	48%	49%	43%	13%	4%	1%	-12%	1%
Middle East										
Internet Bandwidth	31,693	43,544	56,246	74,355	92,283	37%	29%	32%	24%	31%
Average Traffic	11,088	15,520	19,754	25,004	31,071	40%	27%	27%	24%	29%
Peak Traffic	17,065	23,945	30,973	39,568	49,641	40%	29%	28%	25%	31%
Average Utilization	35%	36%	35%	34%	34%	2%	-1%	-4%	0%	-1%
Peak Utilization	54%	55%	55%	53%	54%	2%	0%	-3%	1%	-0%
Oceania										
Internet Bandwidth	5,572	7,390	9,327	12,317	15,273	33%	26%	32%	24%	29%
Average Traffic	1,655	2,126	2,704	3,560	4,451	28%	27%	32%	25%	28%
Peak Traffic	2,658	3,407	4,292	5,875	7,178	28%	26%	37%	22%	28%
Average Utilization	30%	29%	29%	29%	29%	-3%	1%	-0%	1%	-0%
Peak Utilization	48%	46%	46%	48%	47%	-3%	-0%	4%	-1%	-0%
U.S. & Canada										
Internet Bandwidth	101,414	128,165	158,260	198,312	246,284	26%	23%	25%	24%	25%
Average Traffic	25,277	36,062	42,180	53,152	65,459	43%	17%	26%	23%	27%
Peak Traffic	46,250	64,292	77,806	98,626	117,131	39%	21%	27%	19%	26%
Average Utilization	25%	28%	27%	27%	27%	13%	-5%	1%	-1%	2%
Peak Utilization	46%	50%	49%	50%	48%	10%	-2%	1%	-4%	1%

Notes: Data reflect traffic over Internet bandwidth connected across international borders including links within each region. Data as of mid-year.

Source: TeleGeography

Prices

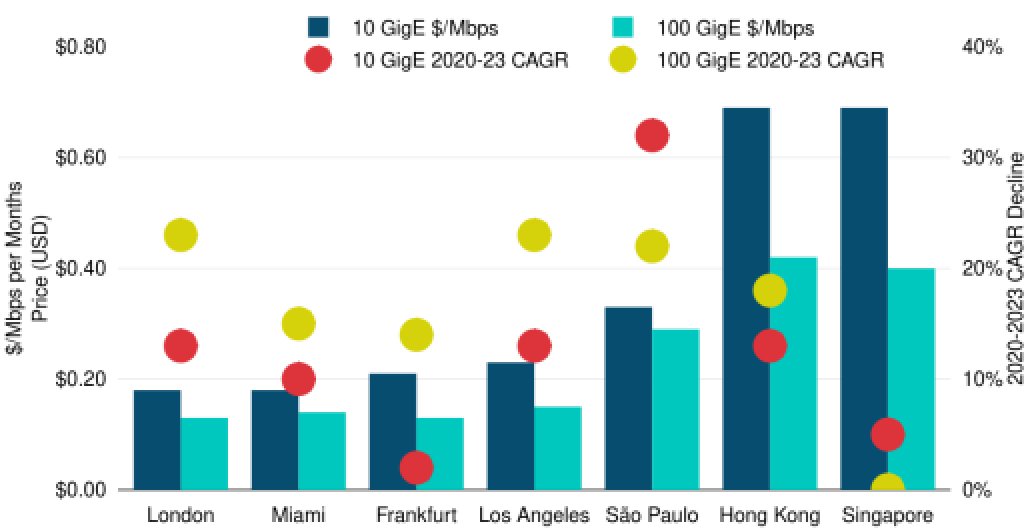
Providers' shift to predominantly 100 Gbps internet backbones continues to reduce the average cost of carrying traffic and enables profitability at lower prices. As a result, price erosion remains the universal norm. It reflects the introduction of competition into new markets and the response of more expensive carriers to lower prices. Trends in the IP transit market generally follow regional trends of the transport market. And while some have suggested that price erosion may slow as a result of recent inflation and supply chain constraints (as it has in the wavelength market), we have not seen this trend make its way into the IP transit market.

Across the cities included in the figure below, 10 GigE prices fell 13% compounded annually from Q2 2020 to Q2 2023. Over the same period 100 GigE port prices fell 16%. In Q2 2023, the lowest 10 GigE prices on offer were at the brink of $0.09 per Mbps per month. The lowest for 100 GigE were $0.06 per Mbps per month.

The sharper decline in 100 GigE reflects the advanced maturity of 10 GigE, as well as more carriers offering it and more competition. While 10 GigE remains a relevant increment of IP transit, particularly in more emerging markets, its share of the transaction mix continues to yield to 100 GigE. In 2023, providers indicated that a majority of their sales mix in key U.S., European, and Asian hubs were now 100 GigE. On average, across the cities noted, the Monthly Recurring Charge (MRC) for a 100 GigE port was 6.9 times the MRC for a 10 GigE port. Operators are poised to adopt 400 GigE IP transit ports as the next fundamental upgrade from multiple 100 GigE ports.

FIGURE 4

Weighted Median 10 GigE and 100 GigE IP Transit Prices & Three Year CAGR Decline in Major Global Hub Cities



Notes: Each column represents the weighted median monthly price per Mbps in the listed city. The circle represents the percentage decline of the weighted median price calculated as a three year compound annual growth rate. Prices are in USD and exclude local access and installation fees. 10 Gigabit Ethernet (10 GigE) = 10,000 Mbps and 100 Gigabit Ethernet (100 GigE) = 100,000 Mbps

Source: TeleGeography

Provider Connectivity

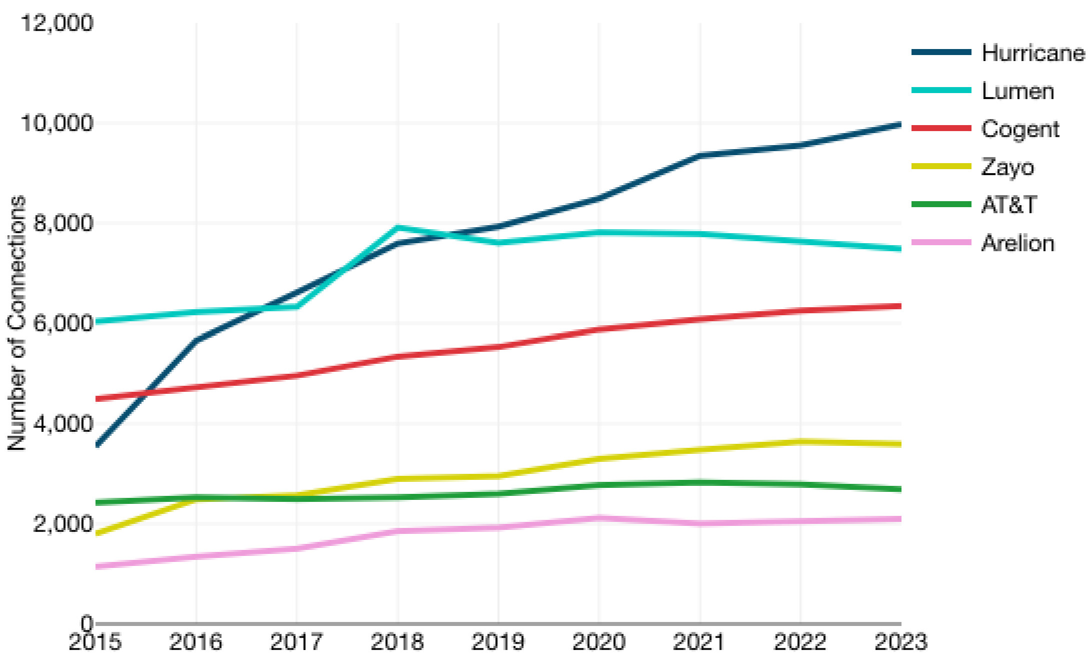
Our rankings of provider connectivity includes analysis based on BGP routing tables, which govern how packets are delivered to their destinations across myriad networks as defined by autonomous system numbers (ASNs). Every network must rely on other networks to reach parts of the internet that it does not itself serve; there is no such thing as a ubiquitous internet backbone provider.

If you want a single, simple number to identify the best-connected provider in the world, you may come away disappointed. There are several ways to measure connectivity, and each highlights different strengths and weaknesses of a provider's presence. One basic metric is to count the number of unique Autonomous Systems (AS) to which a backbone provider connects, while filtering out internal company connections. The results are presented in the table below.

Hurricane Electric has experienced consistent gains, and now ranks as the clear number one in terms of connections. Cogent has also experienced steady growth. Lumen and Hurricane Electric had swapped the top spot back and forth for several years. Lumen (the rebranded CenturyLink) experienced huge gains a few years ago when the company bought Level3. Since then, the number of ASNs connected to Lumen has stagnated.

FIGURE 5

Number of Connections for Selected Providers



Notes: Data shows the number of connections to other ASNs. The line indicating Lumen's number of connections reflect Level 3 (parent ASN 3356) rather than Lumen (formerly parent ASN 209) prior to 2018.

Source: TeleGeography

In addition to examining overall number of connections, we also used our analysis of BGP routing tables to look at the "reach" (a measure of the number of IP addresses an upstream ASN has been given access to from downstream ASNs) and "share" (which compares an upstream provider's reach to all other upstream providers of a downstream ASN.) The results of this analysis paint a different picture. In some cases, an ISP might end up high-ranked in terms of number of connections but low-ranked in terms of share or reach when the number of IP addresses passed from its customers is relatively small.

Finally, to focus on which backbone providers best serve the end-user ISP market and corporations, we compare upstream provider connections to downstream broadband ISPs, calculated the top providers to Fortune 500 companies, and examined connectivity to specific industry sectors such as hosting, medical, and finance.

Outlook

The combined effects of new internet-enabled devices, growing broadband penetration in developing markets, higher broadband access rates, and bandwidth-intensive applications will continue to fuel strong internet traffic growth. While end-user traffic requirements will continue to rise, not all of this demand will translate directly into the need for new long-haul capacity. A variety of factors shape how the global internet will develop in coming years:

- **Post-COVID-19 growth trajectory.** Initial evidence suggests that the spike in the rate of bandwidth and traffic growth in 2020 from the pandemic was a one-time event and we have returned to more traditional rates of growth.

- **IP Transit Price Erosion.** International transport unit costs underlay IP transit pricing. As new international networks are deployed, operational and construction costs are distributed over more fiber pairs and more active capacity, making each packet less expensive to carry. We already see a major shift from 10 GigE requirements to 100 GigE requirements, and expect that 400 GigE will emerge in two to three years as a significant part of the market. The introduction of new international infrastructure also creates opportunities for more regional localization of content and less dependence on distant hubs. As emerging markets grow in scale, they too will benefit from economies of scale, even if only through cheaper transport to internet hubs.

- **International versus domestic.** While there’s little doubt that enhanced end-user access bandwidth and new applications will create large traffic flows, the challenge for operators will be to understand how much of this growth will require the use of international links. In the near-term, the increased reliance on direct connections to content providers and the use of caching will continue to have a localizing effect on traffic patterns and dampen international internet traffic growth.

- **Bypassing the public internet.** The largest content providers have long operated massive networks. These companies continue to experience more rapid growth than internet backbones, and they are expanding into new locations. Many other companies, such as cloud service providers, CDNs, and even some data center operators, are also building their own private backbones that bypass the public internet. As a result, a rising share of international traffic may be carried by these networks.

- **Artificial Intelligence (AI).** This is the most hyped demand driver in recent years, but its impact on international internet capacity is not entirely clear. A large amount of AI-driven demand is likely to be carried over the private networks of Google, Microsoft, Amazon, and Meta. Microsoft's infrastructure is also supporting OpenAI, the company behind ChatGPT.

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