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Myths Surrounding Network Usage Fees: South Korea

by Trevor Wagener

Myths About Network Usage Fees: South Korea

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About the Author

Trevor Wagener is the Director of the Research Center & Chief Economist for the Computer & Communications Industry Association, where he leads CCIA's research agenda, conducts and oversees economic and policy research, and educates policy makers and the public about relevant empirical findings. Before joining CCIA in February 2021, Mr. Wagener served since 2019 as Deputy Chief Economist at the U.S. Department of State, where he directed economic research and analysis and advised senior U.S. policy makers on global economic and regulatory issues.

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Executive Summary

South Korean telecommunications companies (telcos) and internet service providers (ISPs) have claimed that content providers like Netflix and "big tech" need to pay their "fair share" to help offset purported costs of increased traffic from content generated by video streamers and other digital services. This claim has sparked an age-old debate that has existed since the postal service and telegram days over who should pay for fees: recipients of messages, senders, or both? In 2016, the Korean government adopted a "Sending Party Network Pays" (SPNP) model for traffic exchanged by ISPs within Korea. ISPs have since sought to require foreign content providers to pay for traffic consumed by Korean customers interacting with content providers' services, with mixed success. Perhaps emboldened by the court victory that Korean ISP SKB secured over Netflix in a domestic court,[1] members of the Korean National Assembly are now proposing legislation to require value added service providers such as content providers and digital platforms to enter into contracts with ISPs to pay "network fees."

The Korean government should reject demands from Korean telecom firms for a new network usage fee, which would be detrimental to Korea's economy, its consumers, and potentially its security for the following reasons:

1. Contrary to myths perpetuated by Korean ISPs, data traffic is increasing linearly and operating costs for ISPs are essentially flat, both globally and in South Korea. There has been no traffic or operating cost explosion for Korean telcos. Per capita data consumption was expected to increase from 90 GB/month in 2017 to 218 GB/month in 2022, about a 19% annual growth rate.[2] This is very close to what was observed: actual traffic growth was slightly below the forecast. Operating costs for Korea's leading three ISPs were lower in 2022 than in the years preceding, and are almost identical to operating costs in 2017.

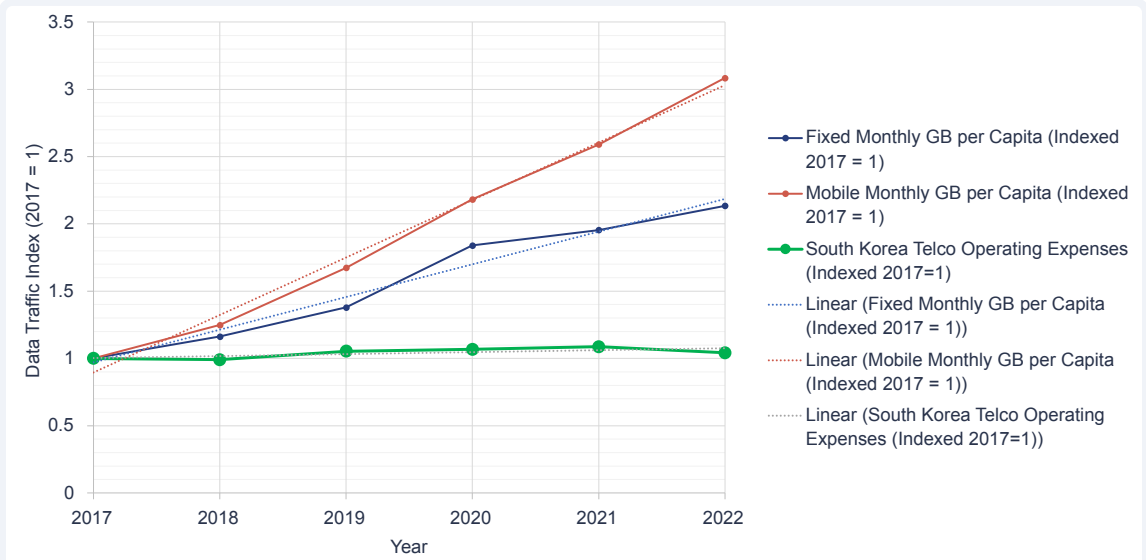
1 https://www.shinkim.com/eng/media/newsletter/1537;shinkimfront=6660C0163E85EDF205DA3BEA9A49B4BA

2 https://www.cisco.com/c/dam/m/en_us/solutions/service-provider/vni-forecast-highlights/pdf/Korea_Network_Connections.pdf

Figure 1: South Korean Data Traffic Growth Since 2017 Has Been Linear, Not Exponential

Notes and Sources: Author's calculations, data from Telegeography. 2017 values indexed to 1.

Figure 2: South Korean Telco Operating Costs Have Been Flat While Data Traffic Has Grown



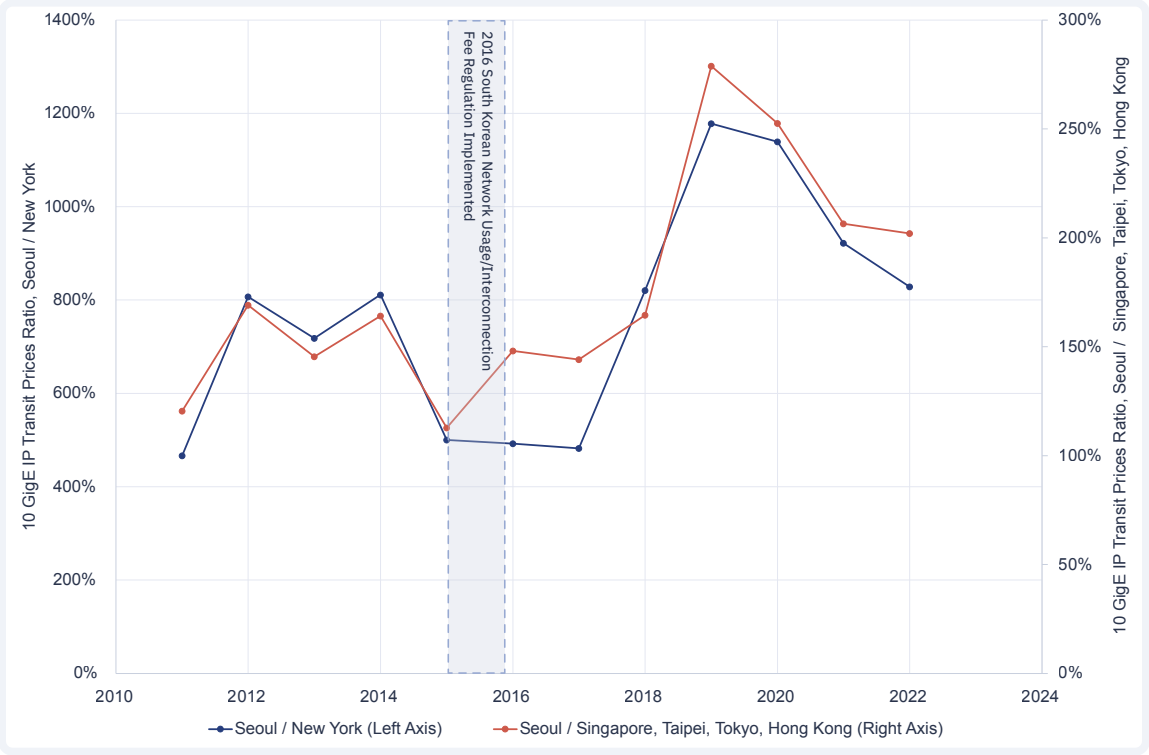
Notes and Sources: Author's calculations, data from Telegeography. 2017 values indexed to 1.

2. The costs of interconnection in Korea are already significantly higher than elsewhere in the world. For example, the cost of transit in Seoul is typically eight to ten times that of major European network hubs like London and Frankfurt.3 In fact, relative transit costs in Seoul have risen significantly since Korea implemented the sending party network pays (SPNP) policy in 2016, making these costs even more out of step with peer cities in Asia,

3 https://carnegieendowment.org/files/202108-KoreanWayWithData_final4.pdf

and nearly an order of magnitude more expensive than hubs in Europe and North America. SPNP appears to have reduced incentives for ISPs to lower costs, because with SPNP many of those costs can be pushed onto others. Network usage fees would be just another, unjustified attempt by Korean telcos to use policy levers to extract economic rents.

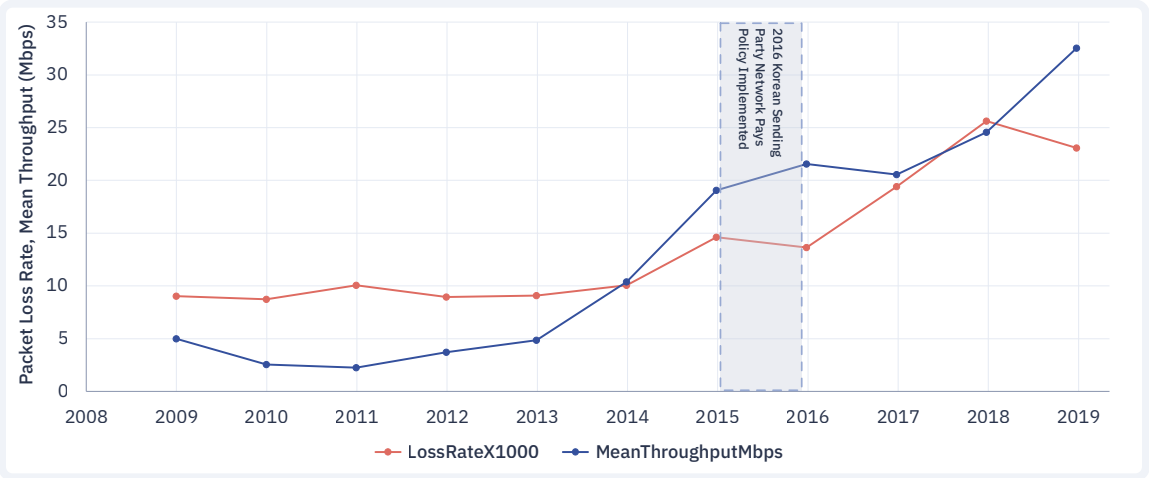
Figure 3: Seoul's Q4 Transit Prices Rose Relative to Peer Cities Following 2016 SPNP Regulation



Notes and Sources: Author's calculations, data from Telegeography.

3. Proposals to require network fees of all content providers, including foreign content providers, will make access to the particular internet services available in Korea less useful to consumers, as they will have to pay more for content online. In addition, the performance of Korea's internet since implementation of SPNP is already suffering relative to baseline trends, as reflected in increased latency, as well as increased packet loss and degraded mean throughput trends. Korea developed the worst latency in the OECD after SPNP despite its top-quality infrastructure buildout. It is likely that the Korean internet will increasingly suffer relative to trends prior to SPNP. Korean ISPs have a termination monopoly which, when combined with the sending party network pays model, significantly reduces ISP incentives to save costs because they can push many costs to others. The adoption of a network usage fee policy by the Korean government would exacerbate this problem by creating clear incentives for ISPs to create, or at the least allow, traffic bottlenecks for which they then can charge content providers additional provisioning fees to reduce latency.

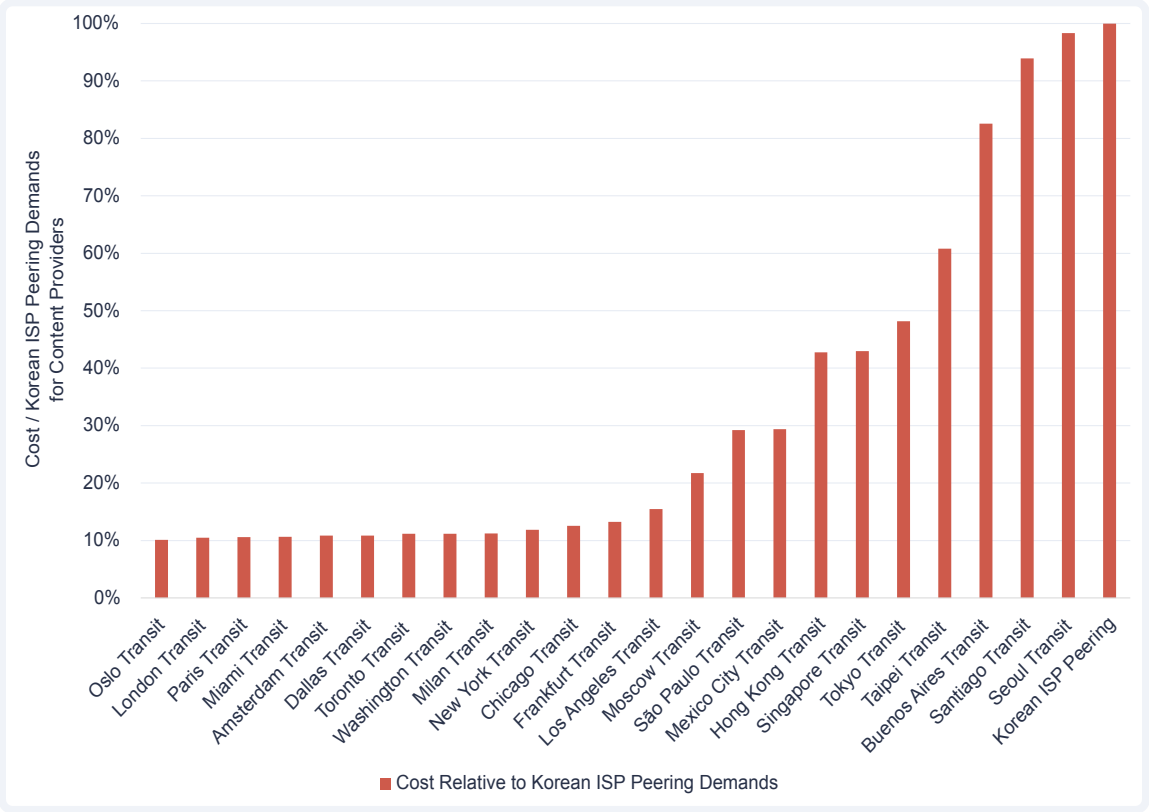
Figure 4: M-Lab Data Suggests Korean Network Quality Degraded After the 2016 SPNP Policy



Notes and Sources: Author's calculations, data from M-Lab.

4. Korean internet firms and content providers that have been pressured into paying ISPs network usage fees for domestic traffic should be relieved of this unnecessary cost as well, per net neutrality norms. There is no economic rationale for Korean or foreign content providers to pay ISPs for domestic traffic consumed by Korean customers when those customers have already paid the ISPs for internet service. For traffic that requires international transit, it is normal to pay a transit fee, but Korean transit prices are much higher than developed country peers. If Korea followed international pricing for transit – well below $1 per Mbps per month – transit fees to reach the whole globe would be significantly lower than what Korean content providers are now paying domestically in network usage fees: about $1.60 per Mbps per month. The current rates will make it increasingly unlikely that Korean content makers will be able to score domestic hits and expand them globally. Indeed, for a burgeoning market of streaming gaming, it is increasingly likely that content makers will opt not to sell into the Korean market, as network usage fees will exceed international pricing for leading gaming services.

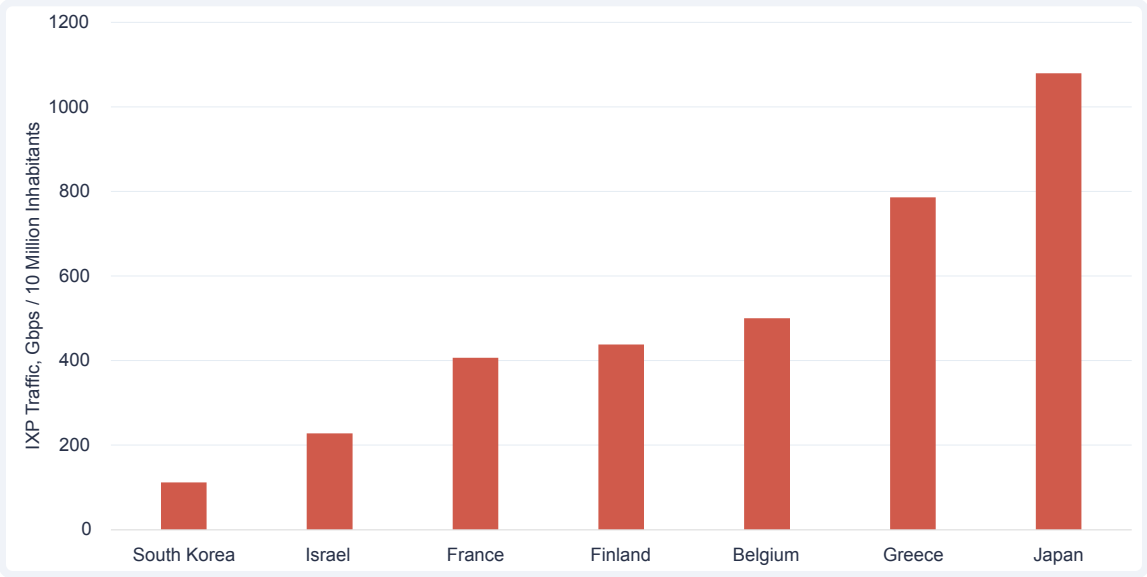
Figure 5: Korean ISP Demands For Peering Are Up To An Order of Magnitude More Expensive Than Transit



Notes and Sources: Author's calculations, data from public sources and Telegeography. SKB's demand of $1.60 per Mbps per month from Netflix is used as the benchmark for Korean ISP Peering.

5. A fundamental problem of the Korean internet market since the SPNP is an underdeveloped domestic market for interconnection, with only one main carrier-neutral Internet Exchange Point (IXP): the Korean Internet Neutral eXchange (KINX). Only about 1.3% of Korean traffic is exchanged locally, with IXP traffic peaking at about 112 Gbps per 10 million inhabitants, which is a small fraction compared to the domestic traffic exchange in other developed countries. As such, a large portion of Korea's domestic traffic, at least 17%, is exchanged abroad. This creates both increased latency for Korean end-users as well as an incredibly fragile network architecture. Korea has no land borders with friendly countries, and thus relies almost entirely on nine submarine cable systems to access the outside world. With very little domestic traffic exchanged locally and limited use of local cache servers due to SPNP incentives, cable cuts could bring Korean domestic networks to a standstill. Given that Korea has up to three potentially hostile neighbors who could target Korean cables for sabotage, as well as the relative frequency with which fishing vessels and ships dragging anchors accidentally cut submarine cables, Korean internet policies should incentivize resilience, not fragility.

Figure 6: Korean Internet Exchange Point Traffic per 10 Million Inhabitants Lags Peers By a Wide Margin



Notes and Sources: Author's calculations, data from IXPs.

6. The top three Korean ISPs are major players in the Korean content space: they collectively controlled an 86% market share in the Korean pay TV market as of 2022. Revenues from pay TV are not far off of revenues from fixed broadband service for leading Korean ISPs, and are thus likely to be taken into account for strategic decisions. In particular, the content providers the ISPs are attempting to charge for latency improvements are competitors in the content space with the ISPs' pay TV offerings. Korean authorities should be careful about using government power to help large Korean telcos use the power of law to force competitors in content markets to either pay ISPs for latency improvements, or suffer a degradation of service relative to the ISPs' own content offerings. Notably, the Korean ISPs directly identify leading foreign content providers as competitors in filings with the U.S. Securities and Exchange Commission.

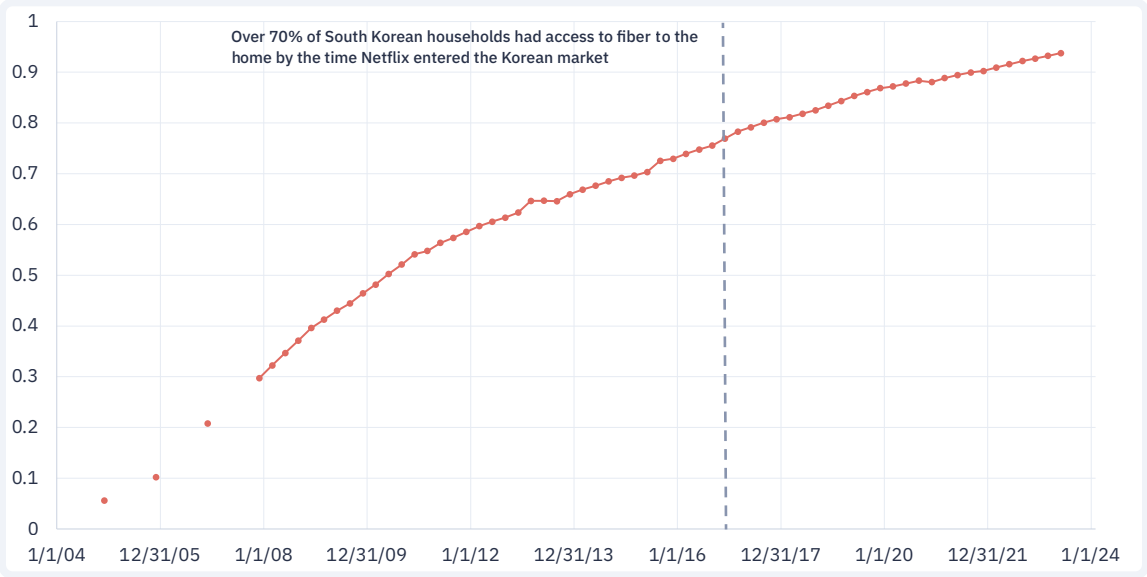
7. Moreover, many of the dubious narratives offered by Korean telcosaround network usage fees are little more than myths used to justify rent-seeking:

8. Contrary to Korean ISPs' insistent framing, content providers operating their own backbones and autonomous systems are not "customers" of Korean ISP networks for domestic traffic and do not "use" Korean IPS networks. Rather, Korean household end-users are the customers of Korean ISPs, and they are already paying the ISPs for access to the content on the internet, including that of content providers. Content providers with backbones and autonomous system numbers (ASNs) are more akin to purpose-built ISPs in the interconnection market. Korean Tier 1 ISPs might have a dominant enough position in Korea to charge Korean content providers for transit and refuse free peering, but such payments for latency reductions are not consistent with network neutrality.

9. Even Korean Tier 1 ISPs are just net customers outside of Korea, and would be expected to pay for transit, IXPs, and remote peering. Given that Korean end-users are specifically paying the Tier 1 ISPs to bring the content of the world to them, and are often paying ISPs for premium-tier data packages specifically to consume leading foreign content, Korean ISPs are in no position to claim that any major foreign content provider with its own backbone "uses" their network as a customer and should pay the ISP a fee — in fact, the Korean ISPs are using the foreign content from content providers' networks to drive revenues from price discrimination. The Korean ISPs should be pleased to be able to peer freely with leading content providers, especially when content providers offer to provide cache servers to improve service quality and network performance for ISPs and their end-users.

10. Korean ISP claims that foreign content providers are driving costly surges of traffic are unambiguously untrue. As has already been established, total operating costs have been essentially flat at the top 3 Korean ISPs for years. Moreover, while Korean ISPs did invest in significant capital expenditures on broadband internet infrastructure, most of those decisions were made years before leading foreign content providers became popular in Korea. Korea made plans to connect everyone to fiber by early 2005, before YouTube or Netflix were even available as streaming services. By 2008, when YouTube and Netflix streaming were tiny new services with limited content and no targeted rollout in Korea, 43% of Korean homes were connected to fiber, with plans to connect every home. In 2012, Korea made plans to connect every Korean household to a "giga" fiber connection. By 2016, when Netflix was finally rolled out in Korea, well over 70% of Korean homes were already connected to fiber. In short, barring the invention of time travel, it is not possible for foreign content providers to have driven Korean decisions to connect every home to fiber that date to before the advent of widespread streaming.

Figure 7: Korea Fiber To The Home Subscriptions (% of Households) Were Widespread Even Before Streaming Was Popular



Notes and Sources: Author's calculations, data from Telegeography.

11. Korean ISPs claim that leading U.S. content providers pay U.S. and EU ISPs, and therefore it is only "fair" that they pay Korean ISPs as well. This ignores the fact that, as of November 2023, there are no laws or court rulings forcing leading U.S. content providers to pay U.S. and EU ISPs, so to the extent that there are any such payments, they are voluntary and the market has worked without the government picking winners and losers. It is unusual to claim that the absence of government requirements for content providers to pay network usage fees in other countries supports Korean ISPs' claim that such a law is required in Korea.

12. Korean ISPs also sometimes point to how they have pressured many Korean content providers to pay network usage fees, and therefore claim that certain leading foreign content providers' unwillingness to pay is "unfair" to Korean content providers who have given in to the pressure. However, provided that such agreements are negotiated in an open market without the government picking winners and losers, this comparison ignores the relative investments of Korean content providers and leading foreign content providers. Different content providers can make different investments in their network backbones and content. It is not inherently unfair that a small content provider local to Korea with limited network backbone would need to pay a Korean ISP for connection to the outside world, whereas a Korean ISP should be pleased to peer settlement-free with a leading content provider who can "bring the outside world to Korea" with a global network backbone and a broad portfolio of content highly sought by Korean end-users.

13. In Korean ISPs' current treatment of both Korean content providers and foreign content providers as of November 2023, there can be no question that network neutrality is being violated. Korean ISPs attempt to make semantic distinctions without a difference, but the core features are demands for payments from content providers for latency improvements. For example, SKB peers[4] freely with many public IXPs outside of Korea, but is attempting to charge within Korea. This is functionally equivalent to charging for latency improvements.

14. South Korea should not want to set a global network usage fee precedent. If a network usage fee becomes the norm around the world, South Korean companies like Samsung whose networked devices are sold all over the world would end up paying far more to foreign ISPs than Korean ISPs could hope to collect from foreign content providers. Samsung alone could end up paying foreign ISPs $5.1 billion per year in network usage fees.

Introduction

Seven proposals have been made by the Korean National Assembly to mandate **"network use fee"** payments by certain content providers over the past two years. Proponents often rely on the argument that network fees will help fund the costs of extending and adding capacity to local broadband markets, but would likely distort investment incentives and lead to discriminatory treatment of content and application providers. This follows years of conflict[5] between U.S. content providers operating in the region and local telecommunication providers following Korea's adoption of a Sending Party Network Pays (SPNP) policy in 2016.

These proposals have been consolidated into the seventh piece of legislation[6] on this matter, introduced by Rep. Young-chan Yoon, called the **"Netflix Free Ride Prevention Act"** on September 8, 2022. The legislation would effectively mandate foreign content access providers—namely U.S. firms such as Google, Meta, and Netflix—to enter into paid contracts with internet service providers for the content demanded by ISPs' customers. The bill would directly undermine[7] long-standing global norms and procedures that serve as the foundation of the internet ecosystem and would likely violate[8] Korea's trade obligations to the U.S. by targeting U.S. content providers for rent-seeking that would require contracts and extractive fees for any company meeting arbitrary data transfer thresholds.

4 https://www.peeringdb.com/net/184

5 https://techcrunch.com/2021/06/28/korean-court-sides-against-netflix-opening-door-for-streaming-bandwidth-fees-from-isps/

6 https://blog.naver.com/yyc8361/222870020115

7 https://www.internetsociety.org/blog/2022/05/old-rules-in-new-regulations-why-sender-pays-is-a-direct-threat-to-the-internet/

8 https://www.project-disco.org/21st-century-trade/091922-new-korean-legislation-undermines-internet-norms-and-raises-broad-trade-concerns/

In addition, the bill would have a detrimental impact on the domestic content industry by increasing the cost for users to access content and inhibit the overseas expansion of K-content. Korea's existing Sending Party Network Pays (SPNP) model, adopted in 2016 and applicable to ISPs operating in Korea, demonstrates that these concerns are not merely speculative. Multiple studies have found that Korea's SPNP model has led to higher transit prices, high regulatory costs, and reduced network quality relative to baseline trends in the form of higher latency, increased packet loss, and reduced mean throughput growth.

The legislation would put South Korea in danger of violating[9] several provisions of their Free Trade Agreement with the United States, including KORUS Article 14.2 (Access and Use); KORUS Article 14.5 (Competitive Safeguards); and KORUS Article 15.7.

Sending Party Network Pays Increased Korean Transit Costs

In 2016, South Korea revised its first interconnection policy, adopting a sending party network pays (SPNP) policy requiring mutual settlements, charging based on traffic (bits) rather than bandwidth (bps).[10] As a result of SPNP, ISPs would be charged by other ISPs for having content hosted on their network that had to be sent to end-users of other ISPs' networks when those end-users accessed a content provider. Consequently, ISPs tried not to host content providers as customers, but rather to persuade them to "peer" in an extremely costly paid-peering scheme, charging content providers $1.60 per Mbps per month—significantly more than transit in most developed economy major cities, and higher even than Seoul's elevated transit rates. Needless to say, when virtually all peering is paid, and the cost of peering significantly exceeds the typical cost of transit, the incentives created for all parties are not consistent with operating an efficient, resilient network across a country.

Notably, SPNP is a rarity for internet interconnection, where "bill and keep" is the norm. As the Body of European Regulators for Electronic Communications (BEREC) noted in 2012, "interconnection on the internet has operated on the basis of [...] a 'bill & keep' approach where the terminating access network operator does not receive payments at the wholesale level for terminating the traffic, but recovers its costs at the retail level from the end-user. If 'bill & keep' were to be replaced by SPNP then the ISP providing access could exploit the physical bottleneck for traffic exchange and derive monopoly profits, requiring regulatory intervention."[11] BEREC came to a similar conclusion in 2022, stating

9 https://ccianet.org/wp-content/uploads/2022/09/CCIA-Trade-Analysis-of-Korean-Network-Usage-Fee-Proposals.pdf

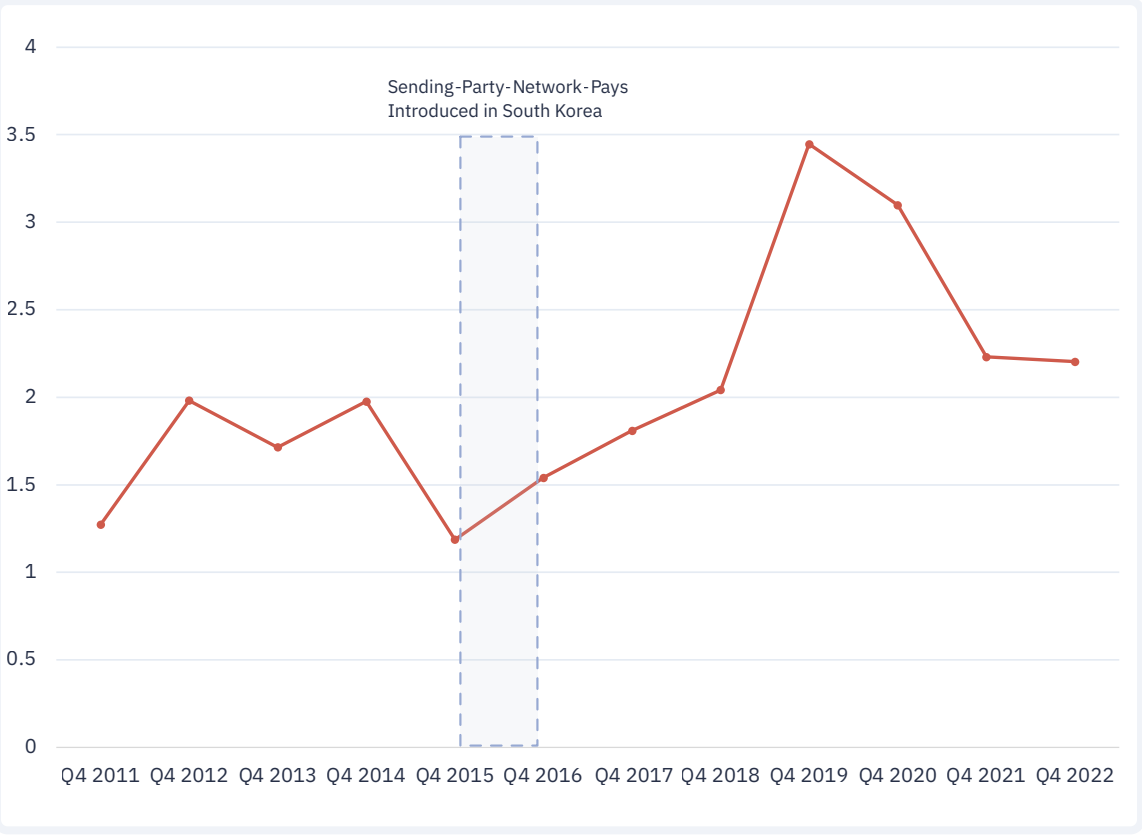
10 https://35v.peeringasia.com/files/Internet.Regulation.in.Korea.pdf

11 https://www.berec.europa.eu/sites/default/files/files/document_register_store/2012/11/BoR%2812%29120rev.1_BEREC_Statement_on_ITR_2012.11.14.pdf

that "The "sending party network pays" (SPNP) model would provide ISPs the ability to exploit the termination monopoly and it is conceivable that such a significant change could be of significant harm to the internet ecosystem."[12]

The results were predictable: IP transit prices that had been dropping in Korea alongside peer cities suddenly stopped dropping as quickly as peers. In Seoul, the weighted median price per Mbps for all 10 GigE ports fell at an average annual rate of 29% between 2013 and 2016, and only 11% between 2016 and 2019.[13] Analysts noted that after 2016, prices in "Seoul have experienced less price pressure and continue to retain a premium in comparison" to peer cities in Asia.[14] Peer cities increasingly have significantly lower IP transit costs than Seoul.

Figure 8: Transit Prices In Seoul Rose Relative To Developed Asia Cities After SPNP Policy



Notes and Sources: Author's calculations; data from Telegeography.

12 BEREC, "BEREC preliminary assessment of the underlying assumptions of payments from large CAPs to ISPs", 7 October 2022, available at https://www.berec.europa.eu/system/files/2022-10/BEREC%20BoR%20%2822%29%20137%20BEREC_preliminary-assessment-payments-CAPs-to-ISPs_0.pdf

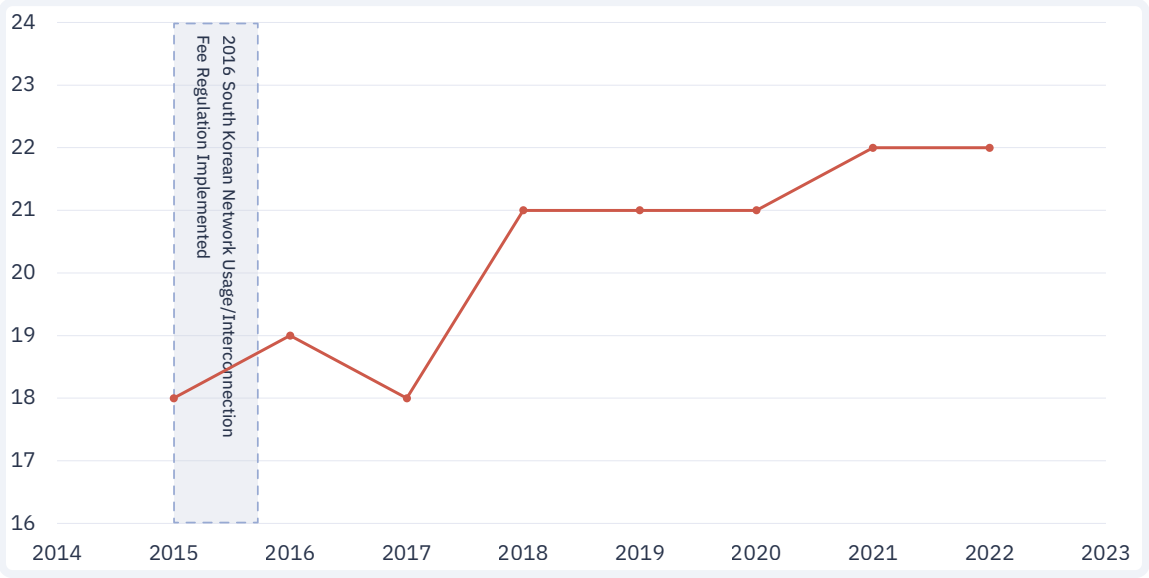
13 https://web-archive-org.translate.goog/web/20220808044736/http://kinternet.org/policy/data/view/63?_x_tr_sl=ko&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=wapp

14 https://web-archive-org.translate.goog/web/20220808044736/http://kinternet.org/cfile1/00fa2721-4ef4-4bac-a740-3b3aab796387.pdf?_x_tr_sl=ko&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=wapp

Figure 9: Seoul's Q4 Transit Prices Rose Relative to Peer Cities Following 2016 Network Usage Fee Regulation

Notes and Sources: Author's calculations, data from Telegeography.

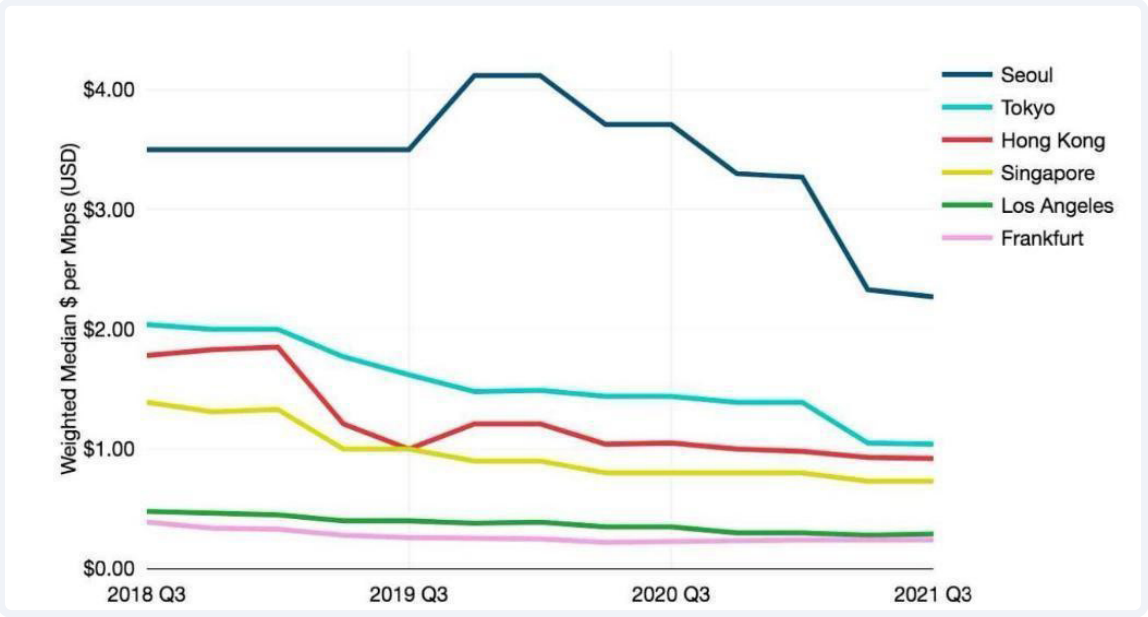
Figure 10: Increasing Numbers of Major Hub Cities Have Significantly Lower Transit Costs Than Seoul Following 2016 SPNP Policy



Notes and Sources: Author's calculations, data from Telegeography.

Korea doubled-down on SPNP in 2020, with the approval of the Content Providers' Traffic Stabilization Law, which required large content providers to ensure reliable access to their content, effectively placing a traditional ISP responsibility on content providers' shoulders while expecting content providers to pay ISPs for the "privilege" of allowing Korean ISPs' end-user customers to access CP content.[15] This law coincided with a further jump in Seoul IP transit prices relative to peer cities.[16]

Exhibit 1: Exhibit X: Seoul IP Transit Pricing Trends Are A High Outlier



Notes and Sources: Kinternet.[17]

Notably, in 2023, BEREC once again concluded that network usage fees along the lines of SPNP were neither necessary nor desirable in Europe:

"There is no evidence of a competition problem or a market failure to the detriment of end-users regarding IP-interconnection[.]"

"It is questionable that mandatory payments from CAPs (content and application providers) to ISPs (internet service providers) would lead to member states meeting the connectivity targets ...] On the contrary, it is rather likely that ISPs in already well supplied areas would benefit the most." BEREC also indicated that a mandatory fee may disadvantage smaller telco operators with less economies of scale and bargaining power, while other telco companies with their own streaming or cloud services may discriminate and unfairly promote these

15 https://carnegieendowment.org/files/202108-KoreanWayWithData_final5.pdf

16 Translated by Google Translate from https://web-archive-org.translate.goog/web/20220808044736/http://kinternet.org/cfile1/00fa2721-4ef4-4bac-a740-3b3aab796387.pdf?_x_tr_sl=ko&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=wapp

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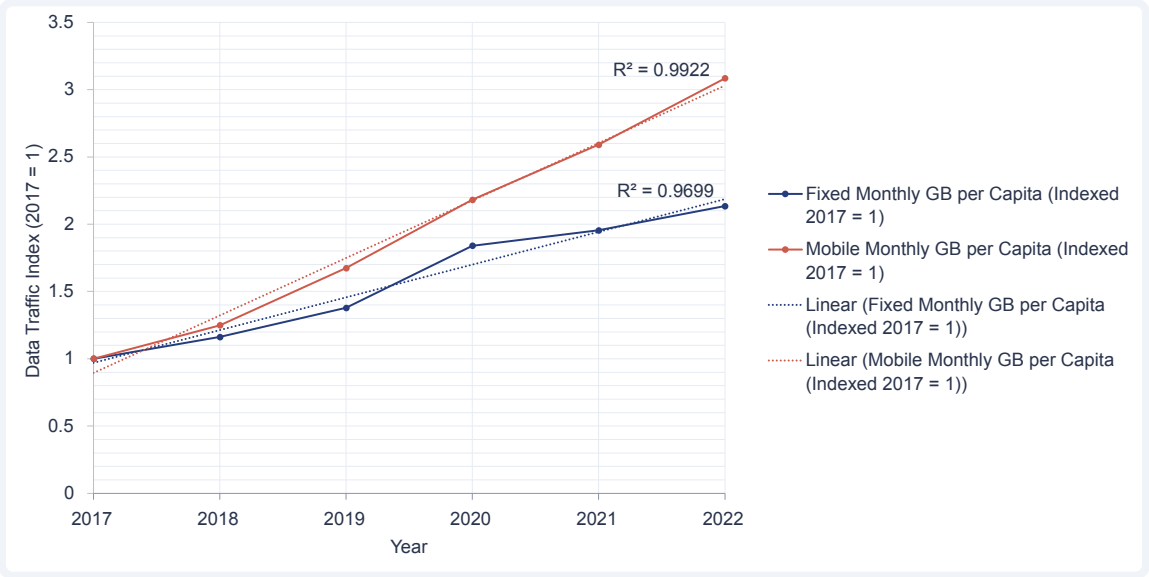
services. This concern echoes the situation in Korea, where the three leading ISPs are also the three largest players in pay TV content. BEREC also expressed concern that such a fee may also lead to price hikes for consumers, disincentivize content providers and digital services from making network investments, and breach net neutrality rules.[18]

Traffic Growth Has Been Linear and Unexceptional

In the Netflix lawsuit, Korean ISPs like SKB have argued that, "Netflix transmits its data through SKB's network to reach Korean subscribers. Since launching its business in Korea in 2016, Netflix has seen a steady rise in the number of Korean subscribers. As a result, Korean ISPs, including SKB, have experienced a significant rise in costs for expanding and operating their network to meet the increased demand for delivering Netflix contents through their network. Given such a rise in costs, SKB had repeatedly requested Netflix to pay network usage fees, on the ground that SKB had to expand its network to meet Netflix's demands."[19]

ISPs have tended to portray internet traffic growth as explosive. However, simply looking at the data puts this notion to rest. Even when separating out Korean mobile and Korean fixed broadband data traffic, the trends are both linear. Moreover, fixed broadband traffic, which accounts for almost 90% of data in Korea, is growing much more slowly than mobile traffic.

Figure 11: South Korean Data Traffic Growth Since 2017 Has Been Linear, Not Exponential



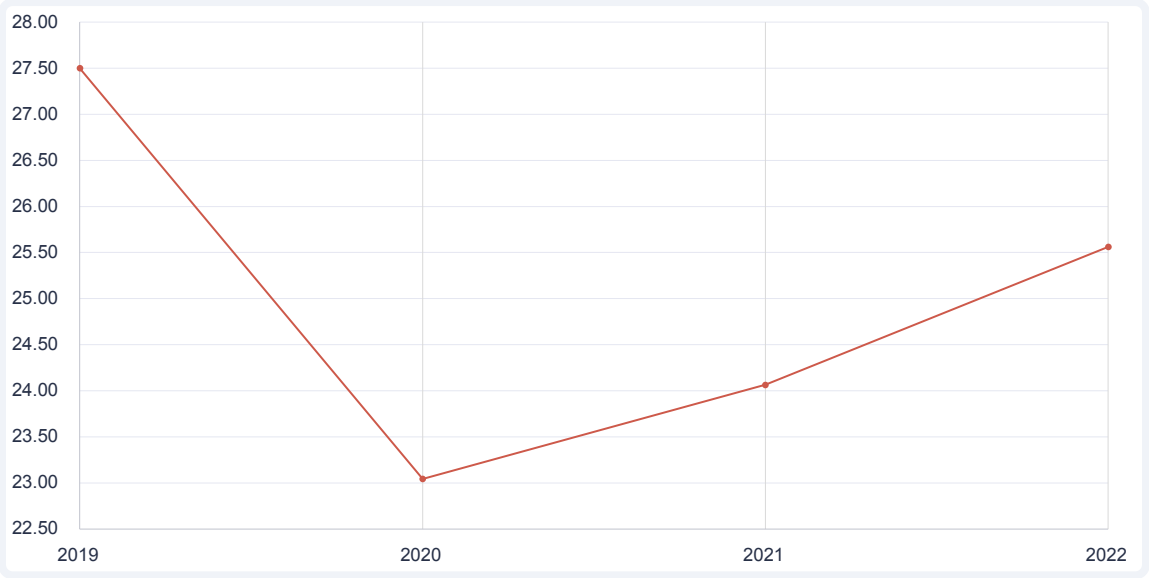
Notes and Sources: Author's calculations, data from Telegeography. 2017 values indexed to 100%.

18 https://www.reuters.com/business/media-telecom/eu-telecoms-regulators-group-criticises-forcing-big-tech-pay-5g-rollout-2023-05-19/

19 https://www.shinkim.com/eng/media/newsletter/1537;shinkimfront=6660C0163E85EDF205DA3BEA9A49B4BA

In the mobile space, Korean internet traffic growth is primarily attributable to the increasing share of 5G subscriptions, rather than growth in data use by 5G subscribers.

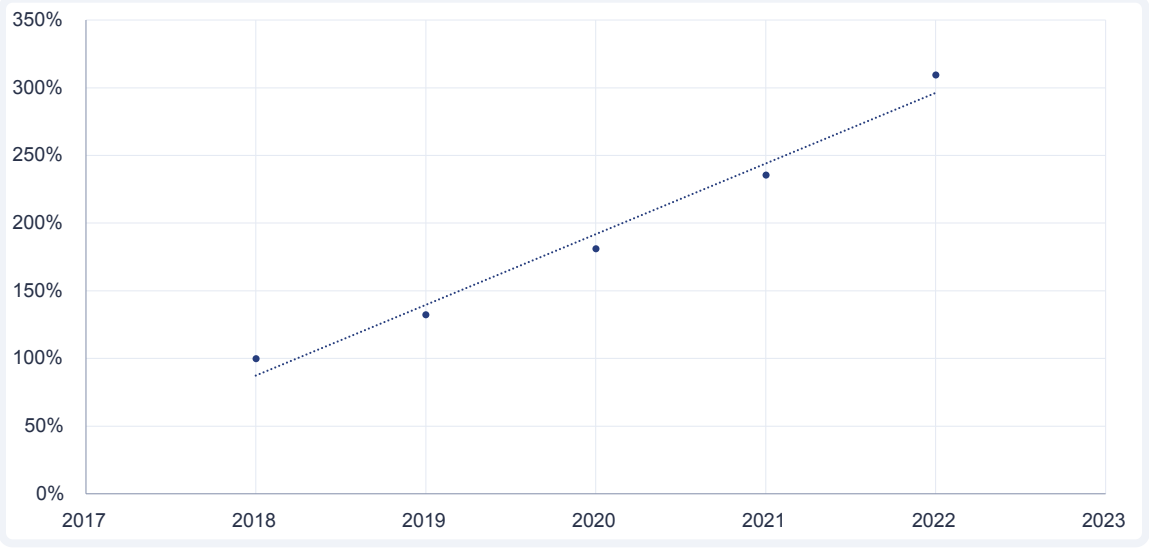
Figure 12: Korean Traffic in GB per 5G Subscription Has Been Relatively Flat



Notes and Sources: Author's calculations, data from Telegeography.

Korea is not an outlier in this regard: global data traffic has likewise been growing linearly in the aggregate.

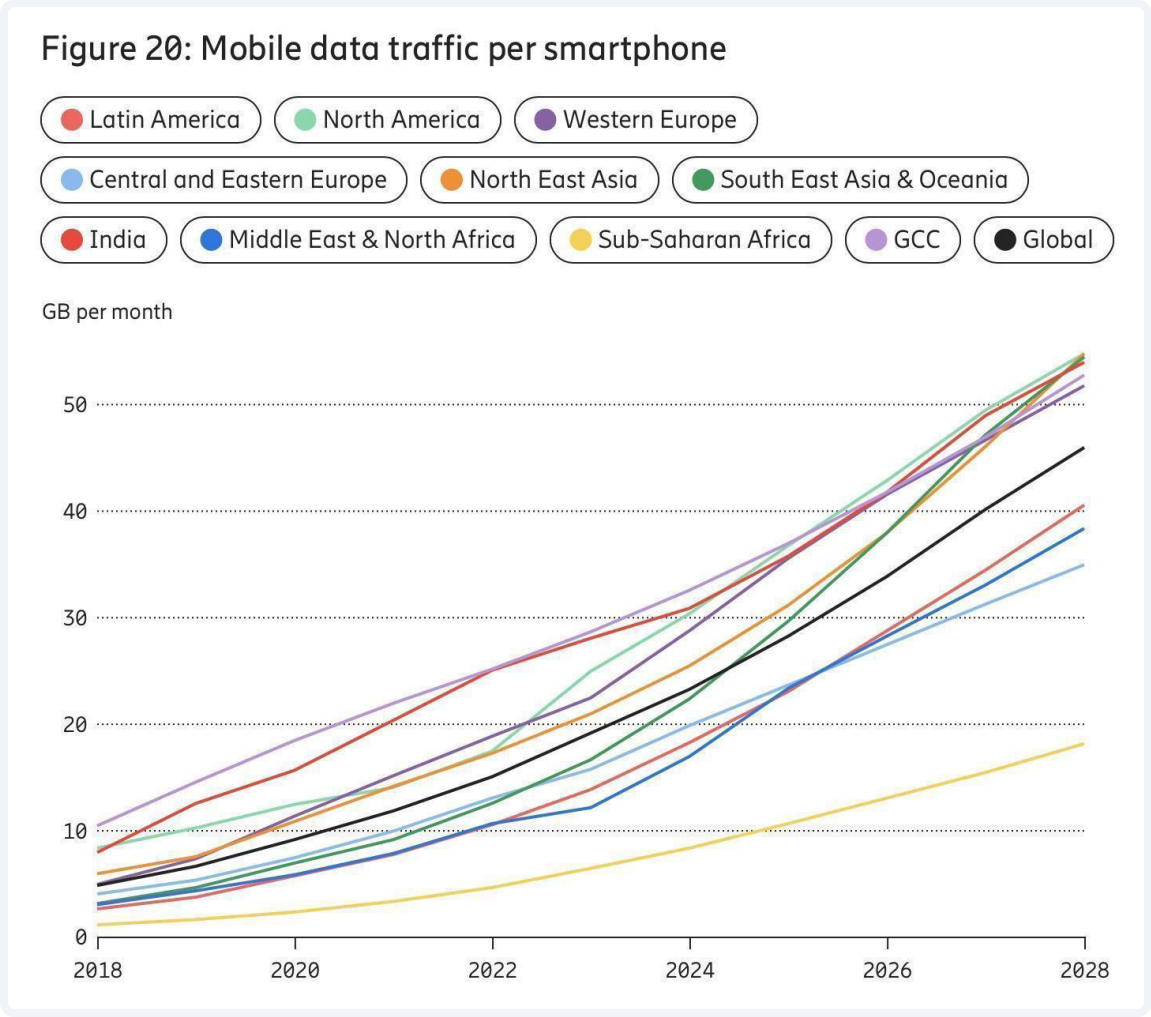
Figure 13: Global Mobile Traffic Growth Has Been Linear



Notes and Sources: Author's calculations, data from Telegeography. 2018 value indexed to 100%.

Global data traffic has likewise been growing linearly across the globe when broken out by regions.[20]

Exhibit 2: Mobile Data Traffic Per Smartphone Grows Linearly Around the World



Notes and Sources: From Ericsson.[21]

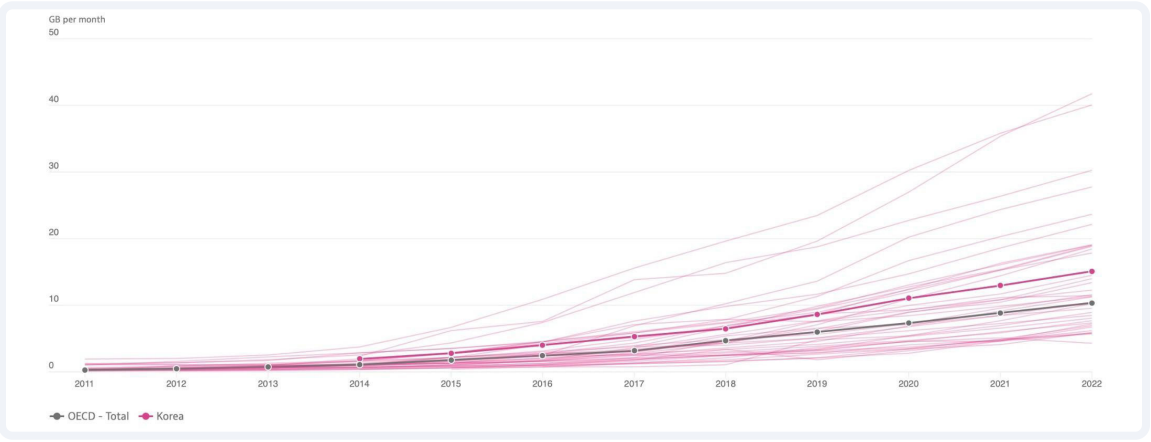
Korean Traffic Levels Are in Line With Peers

The levels of traffic volume and traffic growth in Korea are not exceptionally high, especially relative to South Korea's role as an early adopter of both fiber and 5G. Numerous OECD countries exceed Korea's mobile traffic per capita, and many of them are seeing faster traffic growth.

20 https://www.ericsson.com/en/reports-and-papers/mobility-report/dataforecasts/mobile-traffic-forecast

21 https://www.ericsson.com/en/reports-and-papers/mobility-report/dataforecasts/mobile-traffic-forecast

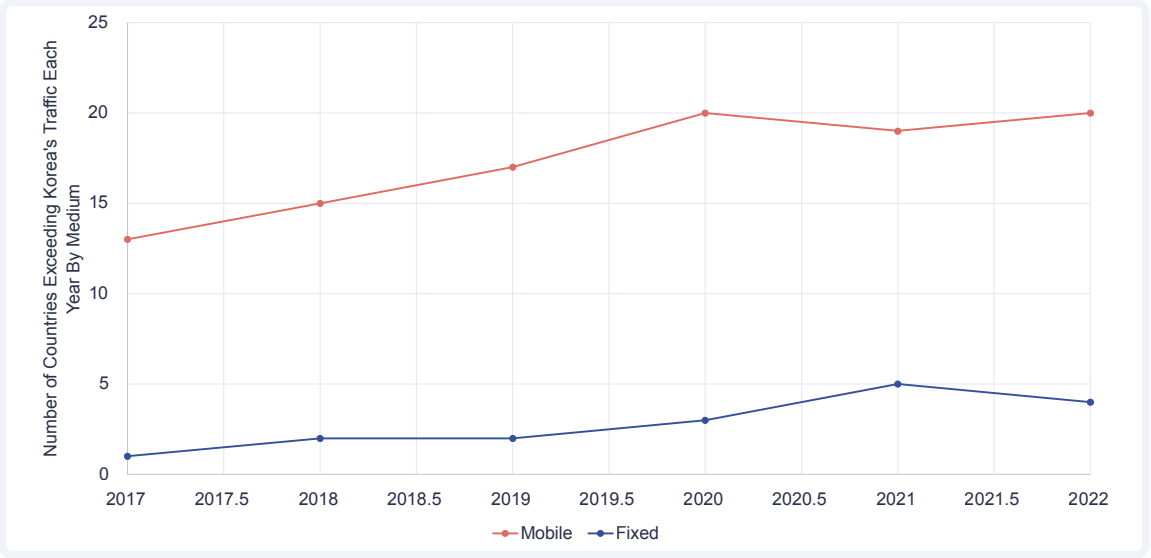
Exhibit 4: Korean monthly mobile traffic per capita is exceeded by numerous OECD countries, many of which are seeing faster traffic growth



Notes and Sources: From The OECD Going Digital Toolkit.[22]

In fact, Korean traffic growth is falling behind other countries, leading an increasing number of countries across time to have higher internet traffic. This should be surprising, as Korea began building out a world-leading physical infrastructure to future-proof its economy in the early years of the 2000s, well before streaming became a major traffic driver. If any country should be leading global traffic rankings, it is Korea, and yet Korea's rank continues to drop after 2016 as more countries overtake it. As will be explored later, this slow growth in traffic is actually harmful to ISP financials, as ISPs have developed a price discrimination strategy to drive profits that relies upon many Koreans wanting to pay significant upcharges for premium-tier subscriptions offering more and faster data along identical infrastructure.

Figure 14: Korean Traffic Growth Is Slower Than Many Countries', And Korea's Ranking on Data Traffic Per Capita Has Dropped Over Time for Both Mobile and Fixed Broadband

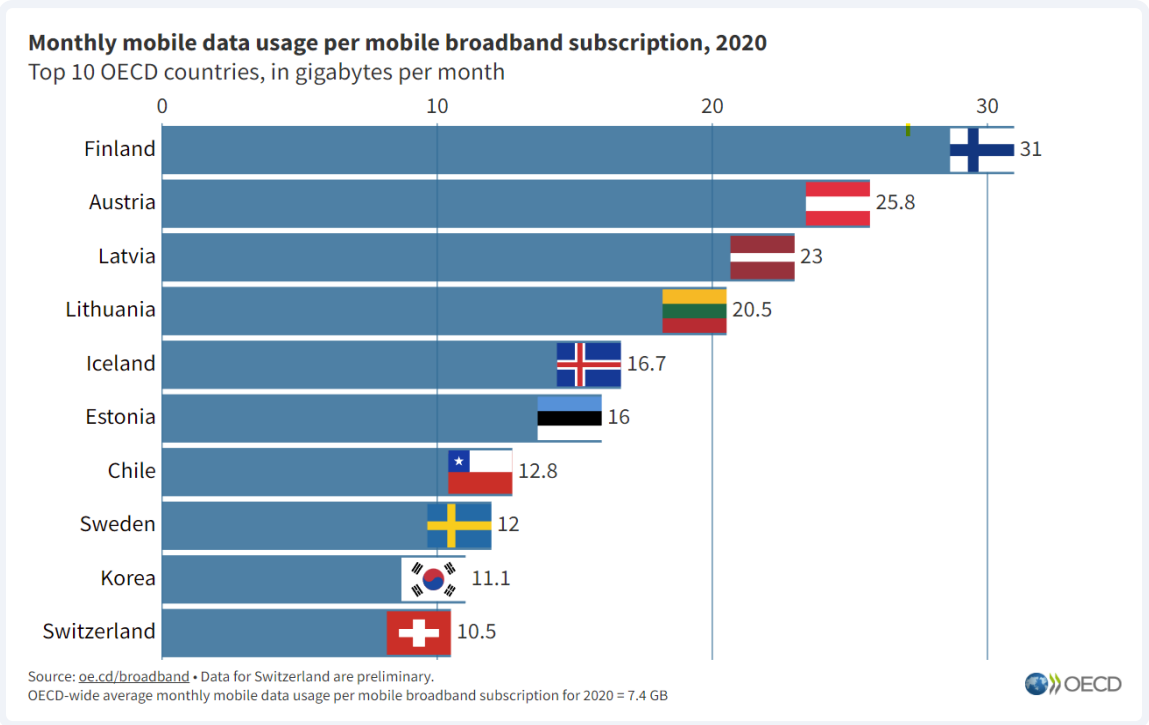


Notes and Sources: Author's calculations, data from Telegeography.

22 https://goingdigital.oecd.org/en/indicator/15

After the SPNP was implemented, Korean mobile data usage fell behind countries on multiple continents.

Exhibit 5: Many Other Countries Exceed Korea's Data Usage Per Subscriber



Notes and Sources: From OECD.[23]

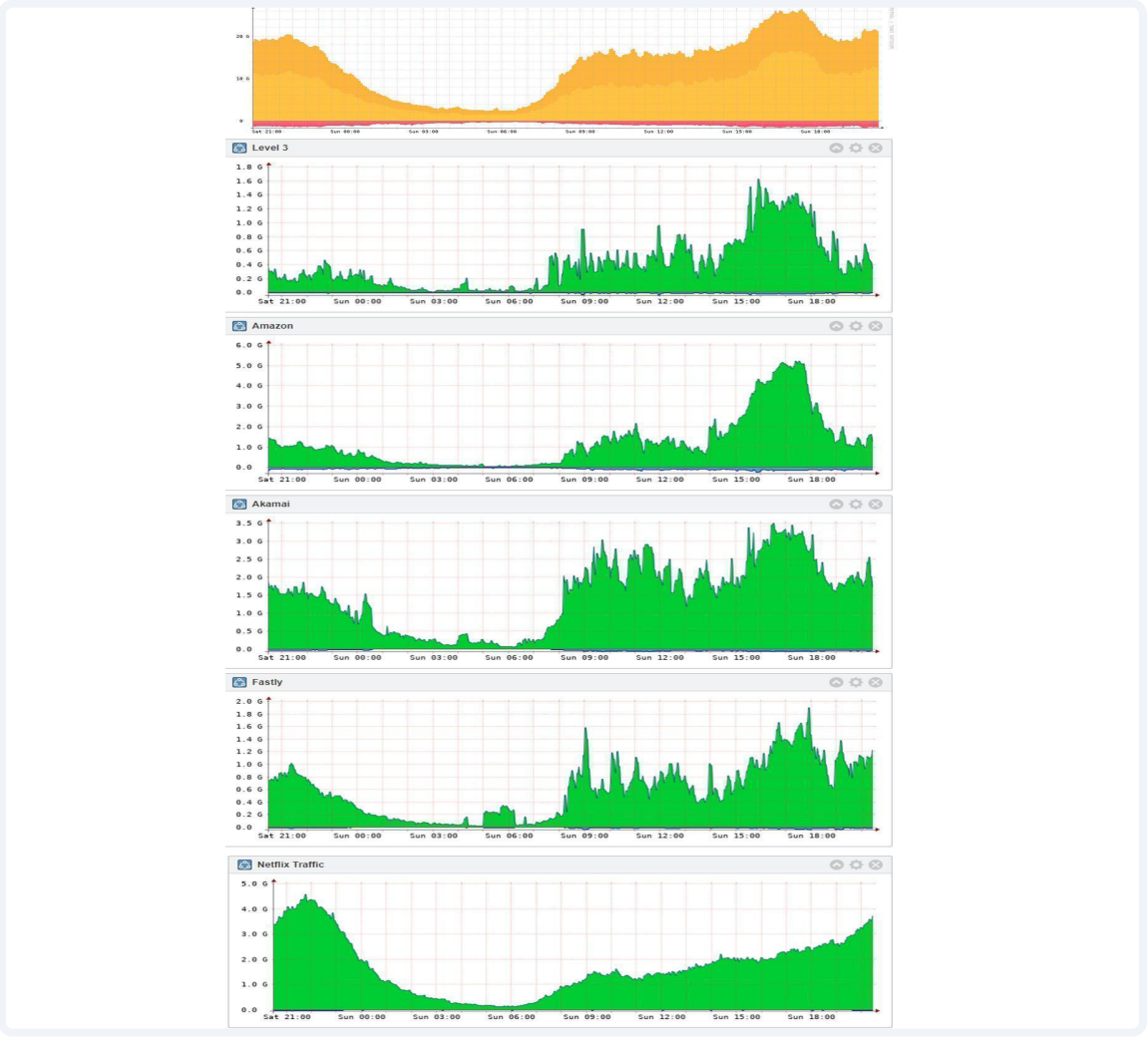
Despite ISP claims to the contrary, ISPs in developed countries around the world have not had significant issues dealing with traffic growth or surges in peak traffic, because they generally prepare their networks ahead of time, and the trends are generally clear in advance. As mentioned previously, Cisco forecast 19% annual Korean data traffic growth from 2017 to 2022, which was very close to actual data trends realized by 2022.[24] In the Netherlands, KPN made an offer to allow competitors to offer service over its FTTH network. It calculated that the average consumer would use an average of 3.86Mbps[25] at peak hour, with a 20% year on year growth, slightly more than in Korea. This estimate includes the IPTV service, which is not always counted in traffic levels. SKV Veendam, a smaller Dutch ISP, saw its traffic levels were highest in the Netherlands during the start of the Formula 1 season. Normal traffic peak is approximately 21Gbps at 9pm, whereas the Formula 1 traffic peak is 26Gbps in the afternoon. The increase in traffic for both KPN and SKV are visualized in the graphs to demonstrate how well their networks were able to handle spikes of traffic of 2.5Tbps, or 25% over normal traffic levels.

23 https://www.oecd.org/digital/broadband/broadband-statistics/

24 https://www.cisco.com/c/dam/m/en_us/solutions/service-provider/vni-forecast-highlights/pdf/Korea_Network_Connections.pdf

25 https://www.acm.nl/sites/default/files/documents/annex-a-vula-pon-prijslijst.pdf

Exhibit 6: Traffic on KPN and SKV Shows Both Could Handle Spikes of 25%, Above Korean Traffic Growth



Notes and Sources: From SKV.[26]

In the UK, other networks had similar traffic levels. For example, BT UK reported peak traffic levels due to the streaming of football matches. The ISP saw an increase in traffic to 25.5Tbps for its broadband network with 9.2 million[27] broadband subscribers[28] or 2.7Mbps/broadband subscriber. The same night, its competitor TalkTalk[29] reported 8.1Tbps for its broadband network with 2.8 million subscribers, and averaged 2.9Mbps per subscriber.

Based on the mentioned examples, Korea's internet traffic levels are not exceptional, and its well-designed ISP networks are demonstrably built to handle their current traffic levels.

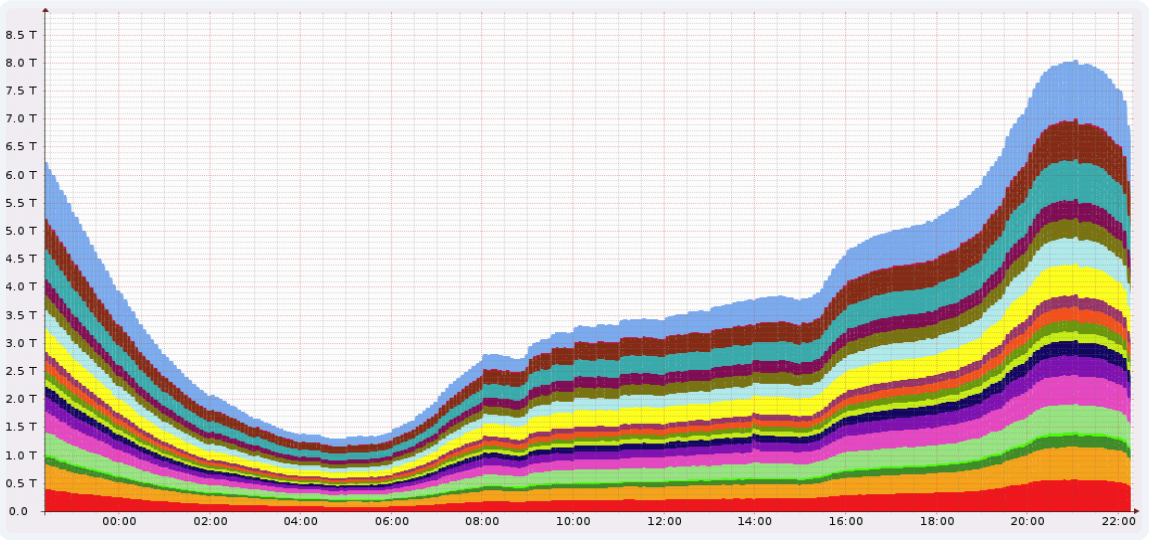
26 https://www.skv.nl/dataverkeer/

27 https://www.choose.co.uk/broadband/guide/market-share/

28 https://www.ispreview.co.uk/index.php/2021/12/broadband-isp-bt-sees-peak-uk-network-traffic-hit-25-5tbps.html

29 https://www.ispreview.co.uk/index.php/2021/12/football-pushes-talktalks-uk-internet-traffic-to-8-1tbps-record.html

Exhibit 7: Traffic Variation on TalkTalk's Broadband Network

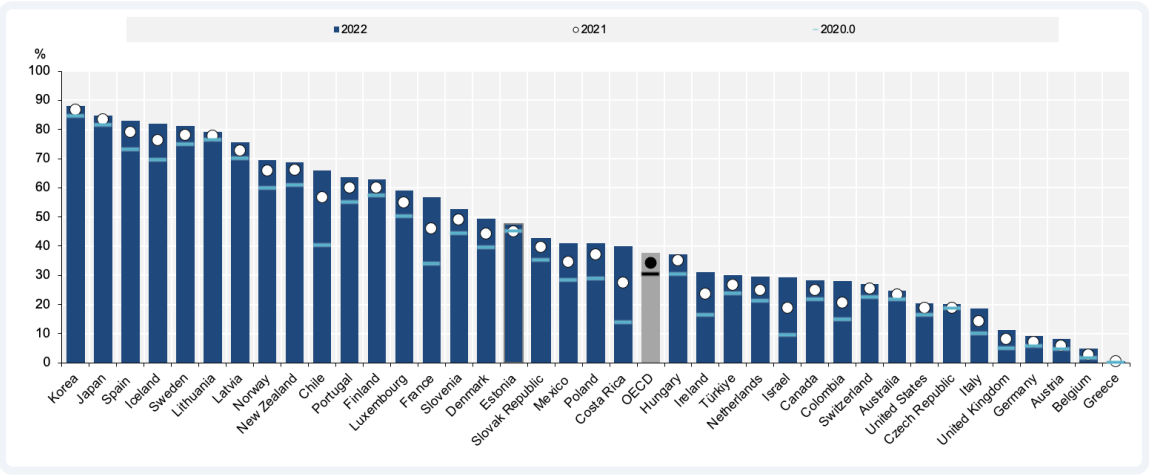


Notes and Sources: ISP Review.[30]

Korean Network Infrastructure Can Handle High Traffic

Data show that Korea has the best and fastest telecommunications network infrastructure in the OECD, both for fixed and mobile networks. Among OECD countries, Korea has the highest share of fiber subscriptions, as fiber to the home buildout was already completed for nearly every resident years ago. The last mile of fixed broadband connectivity has already been fully built in Korea, and it will meet future data traffic growth for decades.

Exhibit 8: Koreans Have a Higher Share of Fiber Subscriptions Than Any Other OECD Country



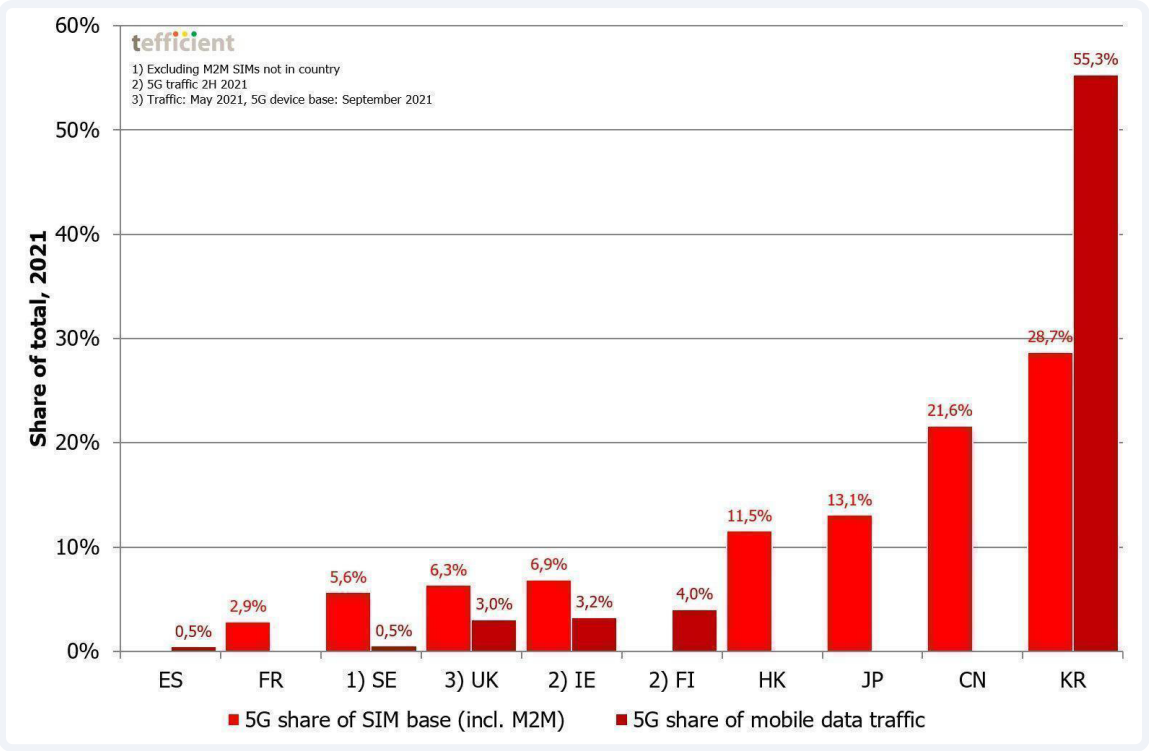
Notes and Sources: From OECD.[31]

30 https://www.ispreview.co.uk/index.php/2021/12/football-pushes-talktalks-uk-internet-traffic-to-8-1tbps-record.html

31 OECD, Percentage of fibre connections in total broadband, https://www.oecd.org/sti/broadband/1.10-PctFibreToTotalBroadband-2022-12.xls

In addition, Korea has historically ranked at or near the top for both 5G uptake among consumers and the performance of 5G mobile networks. Not only was Korea among the first to adopt 5G, but it also has some of the highest densities of 5G base stations of any country.

Exhibit 9: Koreans Have a Higher Share of 5G Subscriptions and Traffic Than Most Peers



Notes and Sources: From Tefficient, Figure 12.[32]

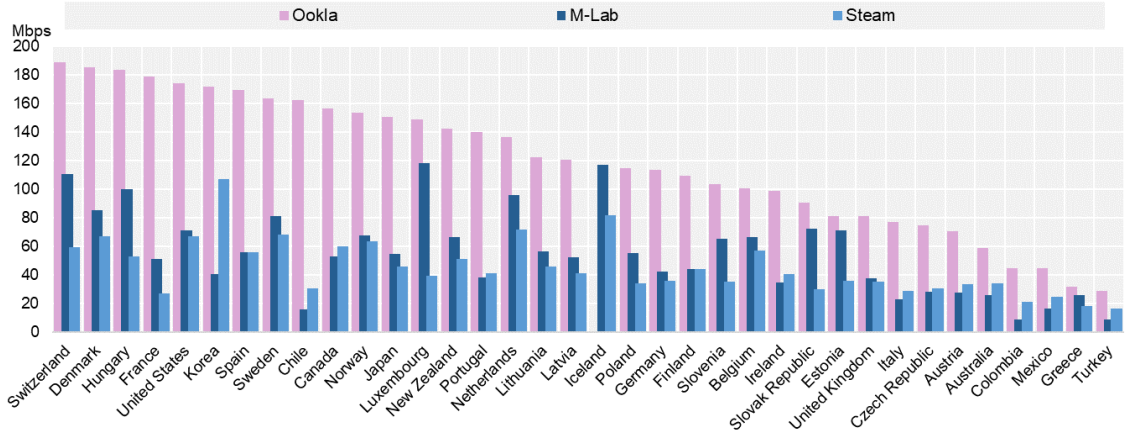
Rankings also show that Korean broadband infrastructure is state of the art. The reach of Korean broadband facilities is amongst the largest in the world: every Korean has access to a broadband connection and nearly every Korean uses it daily. Moreover, Korea's telecommunications networks handle this high traffic at high speeds consistently, which is unsurprising as the fiber to the home is a future-proofed, last-mile connection that should handle data traffic for decades.[33]

32 https://tefficient.com/wp-content/uploads/2022/01/tefficient-industry-analysis-3-2021-mobile-data-usage-and-revenue-1H-2021-per-country-16-Dec-update-2-Jan.pdf

33 OECD Broadband statistics [http://www.oecd.org/sti/broadband/broadband-statistics/]

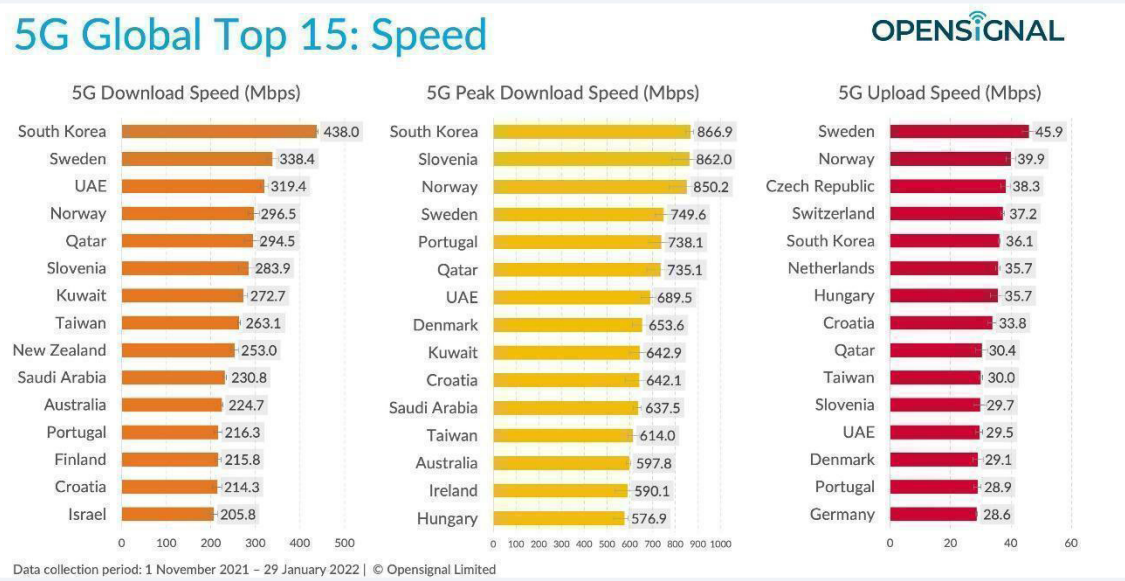
Korea Has Among the Highest Internet Speeds Due to Infrastructure

Exhibit 10: Exhibit X: Average Experienced Download Speed of Fixed Broadband Connections



Notes and Sources: From OECD.[34]

Exhibit 11: Korea's 5G Infrastructure Puts It At the Top of Global Download Speeds



Notes and Sources: From Opensignal.[35]

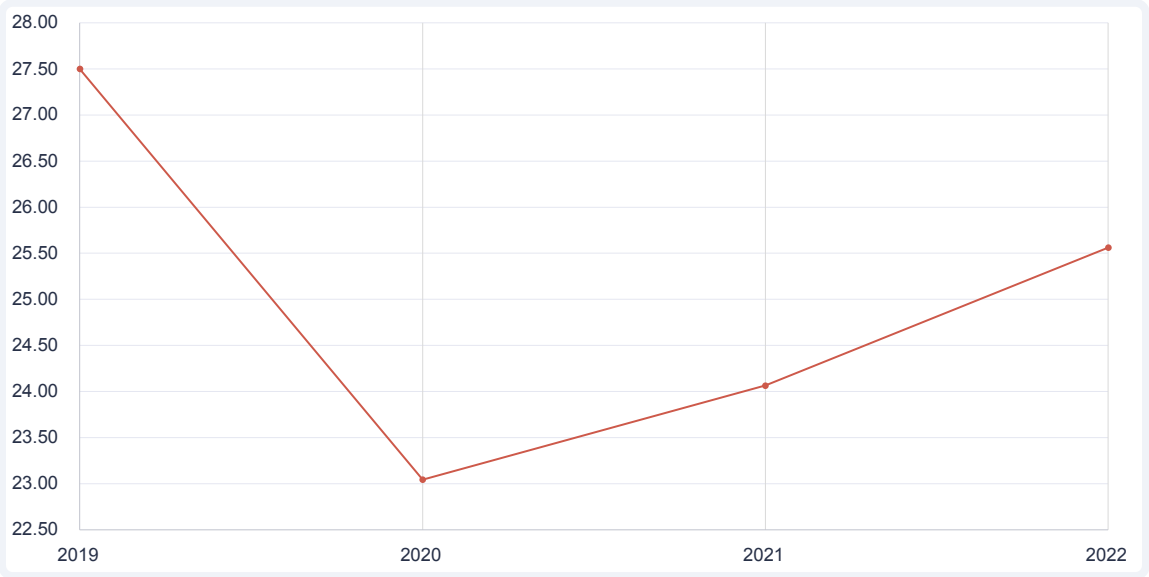
Assuming that any high-volume broadband use is possible over Korea's fixed and mobile networks, if Korea's networks can't handle it, then no network in the world can. Conversely, if internet services work in countries in other OECD countries with lesser developed broadband networks, then it should also work in Korea, and any failure is due to poor incentives for market participants.

34 OECD, Fixed broadband experienced download speed, https://www.oecd.org/sti/broadband/2.2-Download-Speeds-2020-12.xls

35 https://www.opensignal.com/2022/06/22/benchmarking-the-global-5g-experience-june-2022

Korea ranks 9th in the OECD for mobile data usage: 5G users account for a third of subscriptions, while 4G subscribers account for two-thirds of subscriptions. But, despite having fewer users, 5G carries more mobile data than does 4G, with 68% of mobile data traffic over 5G. These 5G subscribers use an average of 27GB per month, which has remained stable because new 5G subscribers use more data than when using 4G, but it does not raise the overall average use. This means that the traffic growth on Korean mobile networks has become stable – while 27GB per month per subscriber is high, it is not exorbitant. Korean mobile networks also can handle this traffic currently, because it has more 5G and 4G base stations than other countries.

Figure 15: 5G Mobile Traffic Is Relatively Stable Per User as 5G Market Share Grows



Notes and Sources: Author's calculations, data from Telegeography.

Deployment data show that Korean ISPs can handle the traffic their customers generate in the network. The public internet traffic in Korea is estimated to reach 125Tbps or less than 6 Mbps per household. Because almost every Korean household has a fixed network connection capable of handling more than 1000 Mbps downstream, and with multiple ISPs who use redundant networks and switches, there is no major ISP in Korea who cannot handle the current and future traffic levels.

Additionally, if Korean ISPs were to use best practices such as local interconnection, CDNs, and caches, ISPs could prevent at least 50% of traffic from leaving Korea and staying local. For example, a video watched in Busan does not need to come from Seoul or from Tokyo. Instead, a cache server from a video provider or a CDN could keep a copy in Busan and allow hundreds of thousands of views without the traffic traveling across the country. If Korean ISPs offered free peering for content providers, many content providers would provide cache servers that would reduce non-local traffic on Korean ISP networks.

Korea's investment in fiber and base stations has made their telecommunications network potentially one of the best in the world; they will remain so if Korean policies facilitate best practices. Policies aside, the existing Korean telecommunications infrastructure ensures that ISP networks can handle significant increases in traffic with minimal effort and no significant extra costs.

Traffic Growth Will Not Require ISP Capital Expenditures for Many Years

ISPs argue that content providers must pay a usage fee to ISPs due to increased traffic growth. This argument is based on the premise that when network traffic increases, the ISP is forced to increase its network capacity to handle said traffic. This argument is invalid – the current Korean internet infrastructure can handle increases in internet traffic.

Despite having the highest internet traffic in the world, Korean internet traffic to the end user is easily handled by Korean current broadband network infrastructure. Most Korean consumers have fiber to the home at a minimum of 1000Mbps. An average speed of 6Mbps per user for fixed broadband should not be an issue for ISPs. However, ISPs would argue that increased traffic levels are increasing its costs. But this is not true, operation costs are largely independent of the level of traffic, and specifically on fixed networks, the total usage-based cost per user is likely declining, despite the increase in traffic.[36]

ISPs likely will continue to argue that Korea's current infrastructure cannot handle the peak traffic levels that consumers reach for very short periods of time. First, individual devices cannot peak above 1Gbps because both Wifi and fixed ethernet in consumer electronics cannot handle higher speeds. But more importantly, it can also be explained by the examples in the previous section, KPN and SKV Veendam handled a 25% surge in traffic due to Formula 1, SKV had 80 Gbps available over 2 links of 40Gbps. Prepared networks do not have to worry about handling peak traffic levels. Nor are the costs to networks very high: indicatively, at least five Dutch telecom operators can add 1 Gbps network capacity for 5,500 residents to their network for just €11 per month per person if the fiber is already connected to the homes, as it is throughout Korea. That's just €60,500 per month total for four 100 Gbps lines to the rest of the internet, including switches and other network equipment, as well as support services.[37]

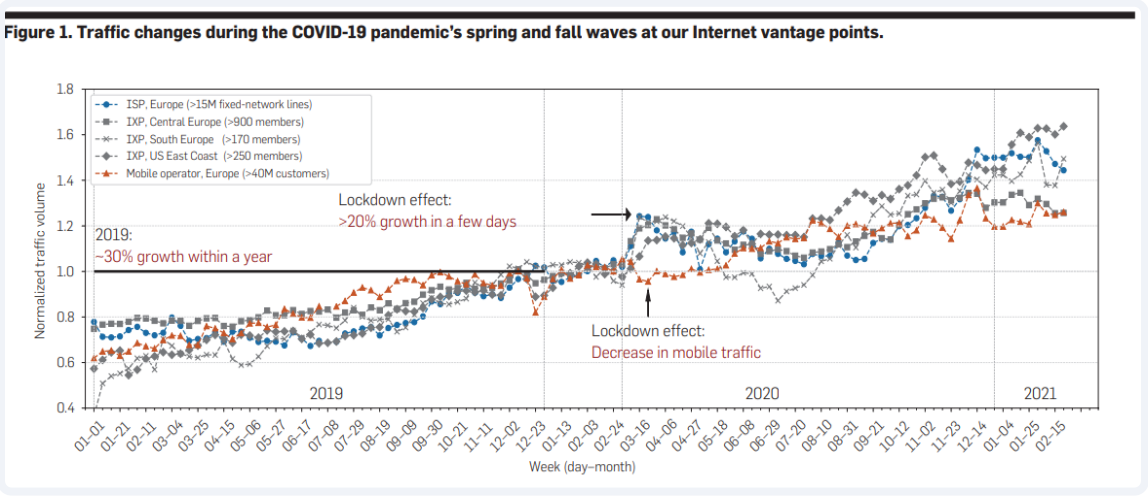
36 Marcus, J. Scott, The Economic Impact of Internet Traffic Growth on Network Operators (October 24, 2014). Available at SSRN: https://ssrn.com/abstract=2531782 or http://dx.doi.org/10.2139/ssrn.2531782

37 https://www.project-disco.org/european-union/020123-fast-internet-doesnt-cost-eu-telecom-operators-much-at-all/

Although high-quality 4K video, the metaverse, and virtual reality will increase traffic, it will not require incremental capital expenditure. These services might require speeds of 35Mbps, but that throughput is not close to the technical limit of the connection. The only consumers who will approach using the maximum bandwidth for slightly longer periods are people such as professional videographers who need to upload or download large quantities of video. However, even in this scenario, it is not possible for one consumer to use all the bandwidth to the detriment of others. And, Korea's ISPs are already working on faster connection to homes of 10Gbps and higher speeds, so such networks will be able to handle growth for years to come.

Feldmann, et al.[38] provided insight into how traffic changes happened during the pandemic.

Exhibit 12: Well-Provisioned Networks Were Able to Cope with the Traffic Surge from the Pandemic Related to Online Video Services



Notes & Sources: From Feldmann et al.[39]

Traffic growth in developed nations before Covid-19 was stable amongst networks, with only a slight variation. During the initial phase of the lockdown, mobile traffic decreased and other traffic saw a dramatic increase. However, the authors say: *"Well-provisioned networks, such as the ones we measured for our study, could cope with this surge. However, networks that 'ran hot' may have faced problems as this increase is significant and takes place in a relatively short period of time."* This phenomenon is similar to the example of KPN and SKV handling a traffic surge during Formula 1.

38 Feldmann, A., Gasser, O., Lichtblau, F., Pujol, E., Poese, I., Dietzel, C., Wagner, D., Wichtlhuber, M., Smaragdakis, G., & More Authors (2021). A Year in Lockdown: How the Waves of COVID-19 Impact Internet Traffic. Communications of the ACM, 64(7), 101-108. https://doi.org/10.1145/3465212

39 https://dl.acm.org/doi/pdf/10.1145/3465212

"*Traffic related to remote working applications, such as VPN connectivity applications and video-conferencing applications, surges [sic] by more than 200%. VPN traffic seems to remain at elevated levels even during the fall 2020 wave.*" This data shows that videoconferencing during the day did require an upgrade of some links to video conferencing sites, and experienced increased traffic, but did not impact overall network capacity.

The authors also note that this increase in traffic was often to networks and services that weren't part of the hypergiants, or what many pejoratively refer to as 'big tech.' They conclude "*Our study reveals the importance of covering different lenses to gain a complete picture of these phenomena. Additionally, our observations highlight the importance of approaching traffic engineering with a focus that looks beyond Hypergiant traffic and popular traffic classes to consider 'essential' applications for remote working. In fact, our study demonstrates that over-provisioning, proactive network management and automation are key to provide resilient networks that can sustain drastic and unexpected shifts in demand such as those experienced during the COVID-19 pandemic.*" This shows that the capacity to large online video services were adequately dimensioned for growth, but the increased traffic by video conferencing sites did require quick upgrades due to unforeseen growth.

ISP Operating Costs Vary Little with Internet Traffic

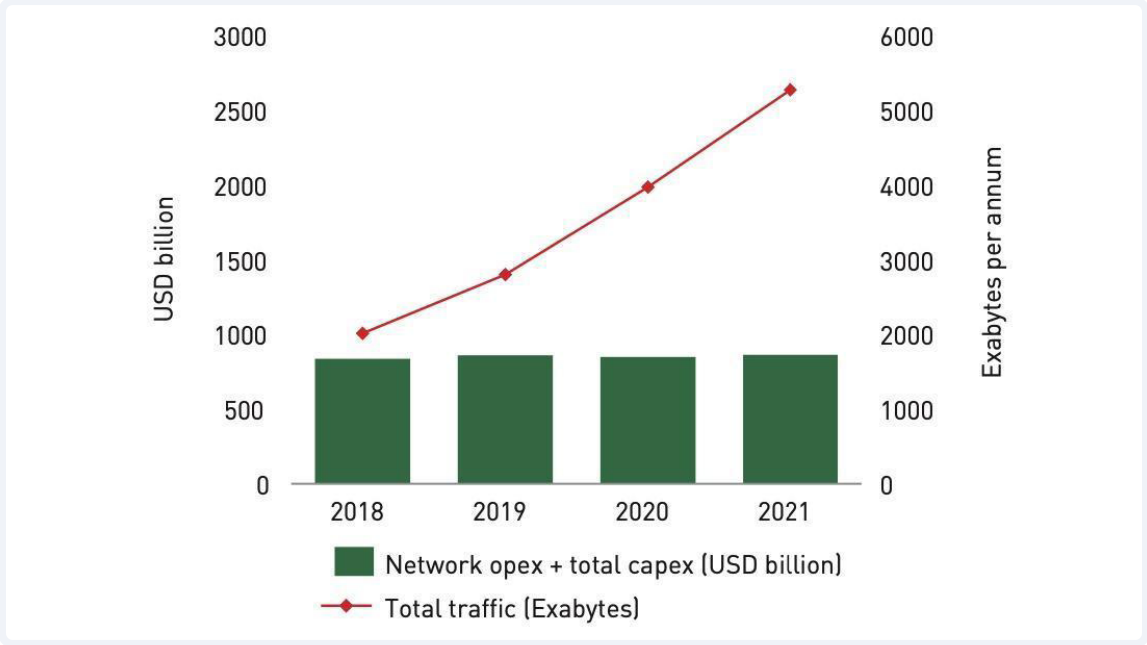
ISPs claim that increases in traffic are simultaneously increasing network operating costs. As shown in the previous section, this argument is based on the flawed premise that increased traffic increases ISP operating costs linearly and throughout the network. However, a large fraction of fixed network costs is associated with the last mile, which is only ordered once and/or upgraded at rare intervals – whether it is copper twisted pair, cable, or fiber – and then maintained for long periods of time. These facilities do not need to be upgraded for every increase in traffic, meaning that the largest cost input faced by ISPs is not increased by more traffic. Additionally, many operating costs ISPs face are a function of the number of customers, and are largely independent of the level of traffic. These include costs associated with customer acquisition, customer care, billing, and bad debt, which have nothing to do with internet traffic over broadband connections. For these reasons, economists have reached the conclusion that increased levels of traffic will not increase ISP operating costs.[40]

Analysys Mason found in 2022 that global growth in data traffic has not been accompanied by corresponding increases in network costs, as significant portions of ISPs' networks are not sensitive to traffic. Traffic-sensitive core and backhaul costs tend to only account for a small share of costs: Analysys Mason

40 Marcus, J. Scott, The Economic Impact of Internet Traffic Growth on Network Operators (October 24, 2014). Available at SSRN: https://ssrn.com/abstract=2531782 or http://dx.doi.org/10.2139/ssrn.2531782

estimates that traffic-sensitive costs in the core and backhaul of fixed networks typically account for 20–30% of network costs, and 10–15% of revenue. Notably, even these "traffic-sensitive" costs do not increase remotely close to one-for-one with traffic. The trend of network costs remaining relatively stable while traffic volumes grow is expected to continue in the future, particularly as fixed networks move toward fiber-based architectures, and as mobile technologies evolve to enable operators to add network capacity more efficiently. In particular, equipment costs tend to fall over time while the capacity of equipment tends to grow, driving a reduction in the unit cost of traffic.[41]

Exhibit 13: Exhibit X: Growth in Global Traffic Delivered Over Fixed and Mobile Networks Has Been Linear But Non-Trivial, While Global ISP Opex+Capex Have Remained Flat



Notes & Sources: From Analysys Mason.[42]

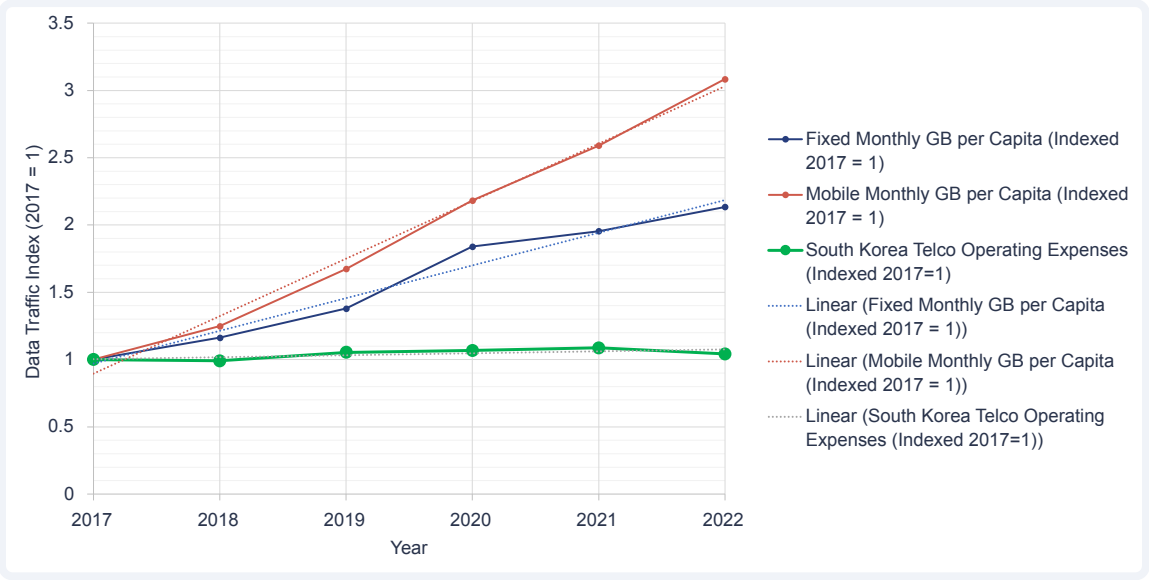
Despite this evidence and analysis, ISPs likely will continue to argue that increases in traffic are increasing their operating costs. A recent example of this persistence is in the dispute between SK Telecom and Netflix, SK Telecom demanded a network fee of $23M for Squid Game traffic levels peaking at 1.2Tbps of traffic, equal to $19.17 per Mbps per year, or $1.60 per Mbps per month.[43] But increased traffic levels are not driving higher network operating costs for Korean ISPs, as Korean telecom operating costs have stayed flat while internet traffic has grown steadily.

41 https://www.analysysmason.com/consulting/reports/internet-content-application-providers-infrastructure-investment-2022/

42 https://www.analysysmason.com/consulting/reports/internet-content-application-providers-infrastructure-investment-2022/

43 https://www.reuters.com/business/media-telecom/skorea-broadband-firm-sues-netflix-after-traffic-surge-squid-game-2021-10-01/

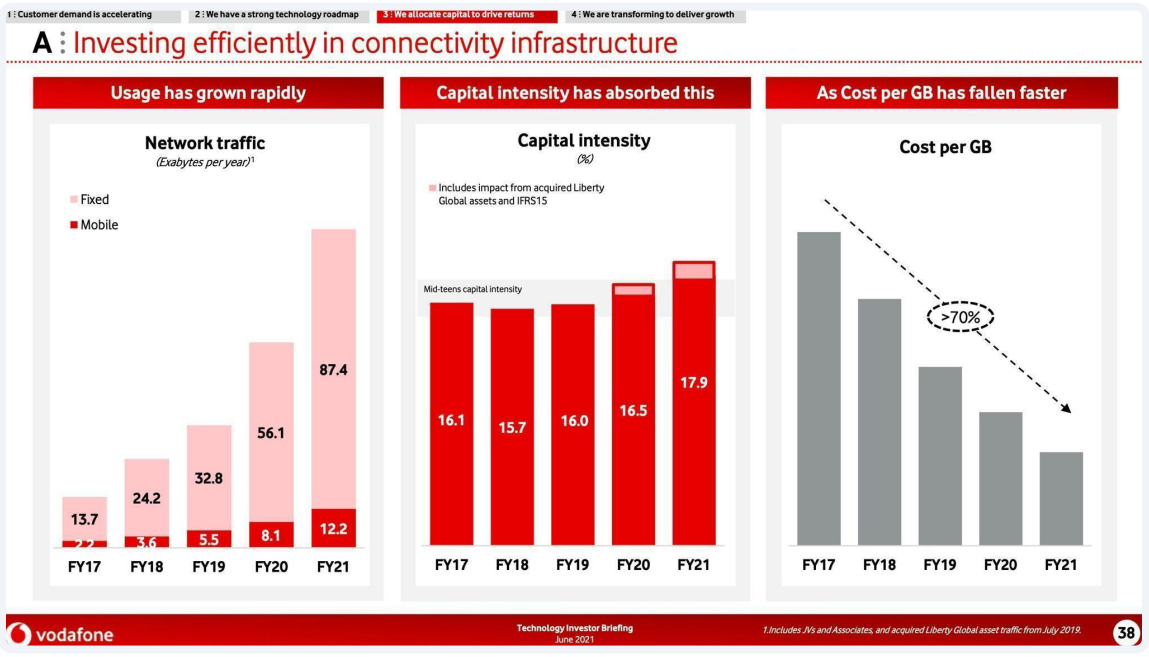
Figure 16: South Korean Telco Operating Costs Have Been Flat While Data Traffic Has Grown



Notes and Sources: Author's calculations, data from Telegeography.

This finding is consistent with aforementioned global trends as well as what leading global ISPs tell their investors. For example, Vodafone told investors in 2021 that while network traffic has grown, cost per GB has fallen faster.[44]

Exhibit 14: Vodafone Told Investors in 2021 That Cost Per GB Has Fallen Faster As Network Traffic Has Grown



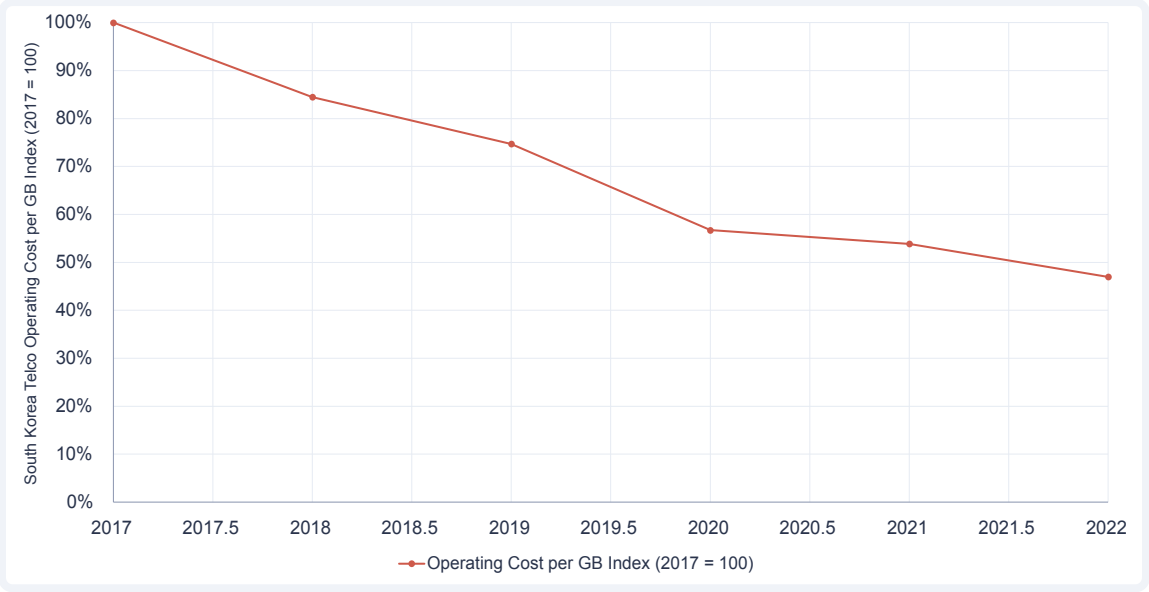
Notes and Sources: From Vodafone.[45]

44 https://investors.vodafone.com/sites/vodafone-ir/files/2021-06/vodafone-technology-investor-briefing-presentation.pdf

45 https://investors.vodafone.com/sites/vodafone-ir/files/2021-06/vodafone-technology-investor-briefing-presentation.pdf

South Korean ISPs' financials show similar trends to Vodafone, with average cost per GB falling by more than 50% since 2017, explaining how operating costs have remained flat as data traffic has continued to grow linearly.

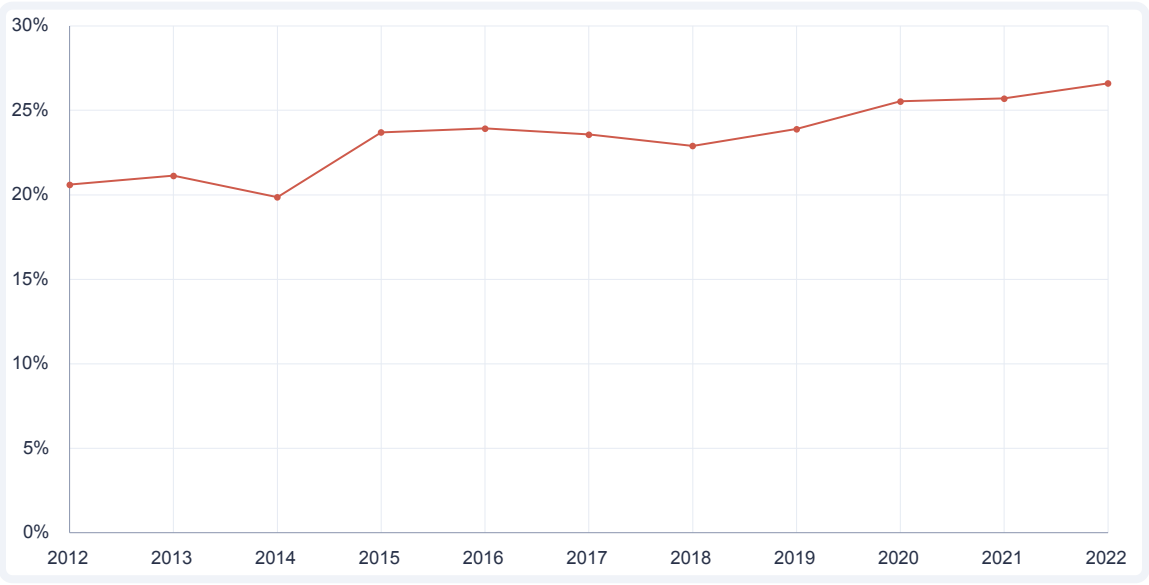
Figure 17: South Korea Telco Operating Costs per GB Are Dropping Quickly



Notes and Sources: Author's calculations, data from Telegeography and telco financial reports.

Moreover, Korean telecom earnings before interest, depreciation, and amortization (EBITDA) have been *rising* over time, dispelling any myths about Korean ISPs' facing operating cost challenges.

Figure 18: South Korean Telco EBITDA Margins Are Consistently Positive and Rising Over Time



Notes and Sources: Author's calculations, data from Telegeography and SEC Filings.

The demands for network usage fees are not limited to Korea. European telcos are making the same requests based on this same, flawed rising-costs argument – that a growth in total traffic raises costs throughout a network, when in fact the per-user or per-household cost increase is actually trivial. For example, Deutsche Telekom complained that 7MB of YouTube traffic per subscriber per day was financially and ecologically unsustainable. Specifically, Deutsche Telekom complained that their costs increased, but costs are determined by peak traffic, and average peak traffic per subscriber is 2 to 3Mbps. However, Telcos sell 2000Mbps for 30 to 70 euro per month to their subscribers – not being able to handle 1/1000th of that looks suspicious at best. It does not cost ISPs significantly more money or energy if traffic doubles.

As another example, the pricing of the Dutch incumbent KPN[46] has a wholesale offer for ISPs that use its FTTH network to pay for traffic. KPN proposed to the regulator to reduce the fee it charges to €1.34 for 3.81Mbps of traffic with 21% of traffic growth allowed, making the price of an Mbps at €0.347/Mbps/month.[47] Dutch ISPs argue that this fee is too expensive because the cost of network equipment is a fixed cost for ISPs. However, it is still significantly lower than the network fee Korean ISPs want to charge, $1.60/Mbps/month, which equals about €1.50/Mbps/month, or more than four times KPN's pricing.

In Ireland, the Commission for Communications Regulation, or ComReg,[48] determined that for access to Eircom's (the privatized successor to Telecom Éirann) network, other ISPs must pay €0.11/Mbps/month for regional traffic handoff, and €0.29/Mbps/month for national traffic handoff. ComReg set this rate based on economic, long-run incremental cost modeling. The rate is included in the monthly price for the consumer who can use the bandwidth how they see fit.

The Irish split between regional and national handover also shows it is beneficial for Irish ISPs to have content providers put caches deep into the network. If traffic is handled regionally, it is cheaper when users increase their traffic use, while it is more expensive if the traffic went back to the capital. As a result, regional caching saves costs for Eircom, such as the costs for backhauling the traffic and the costs of upgrading inter-regional capacity. Additionally, regional network connections are over-dimensioned for future traffic growth, thus ensuring that increases in traffic levels do not increase costs As such, the broadband network owner need not upgrade transmission facilities for a few years.

46 https://www.acm.nl/nl/publicaties/ontwerpbesluit-toezeggingen-glasvezelnetwerken-kpn-en-glaspoort

47 https://www.acm.nl/sites/default/files/documents/annex-a-vula-pon-prijslijst.pdf

48 https://www.comreg.ie/media/2021/12/ComReg21130.pdf, p. 20, Table 3.

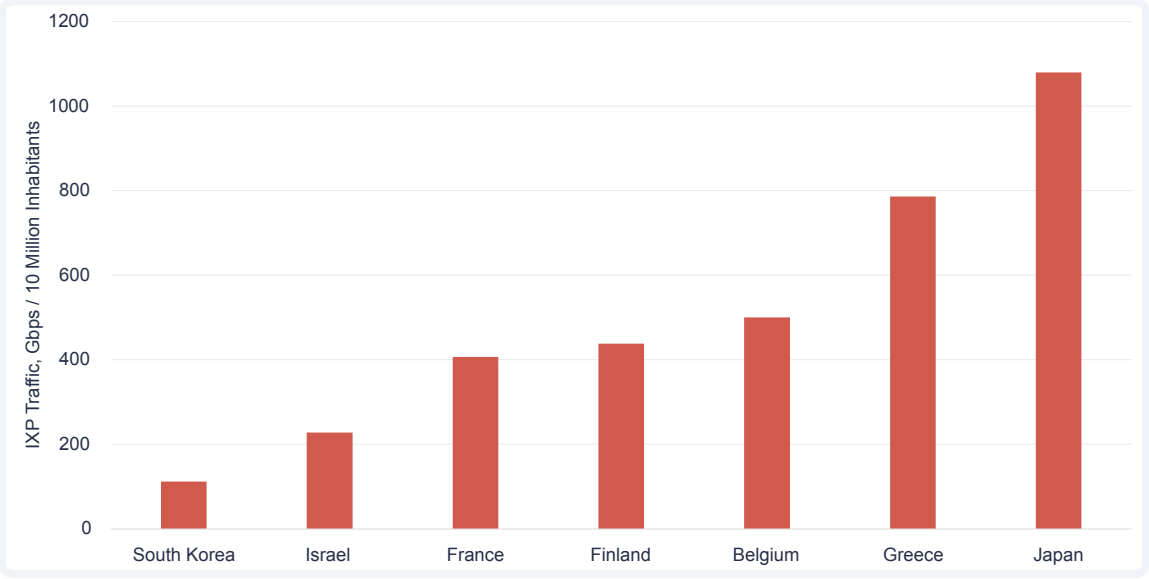
Overall, the prices that ComReg calculated are only 7%-19% of the costs that Korean ISPs say they incur to handle increased levels of traffic. However, this number seems unrealistic given the high quality of the Korean network and that it uses the same equipment as other broadband networks around the world.

Korea Exchanges Far Less Traffic Domestically than Peers

An unusual feature of Korean broadband networks is that Korean ISPs exchange very little traffic domestically. This configuration represents a break with network management best practices; Korean networks could handle vastly more data usage by end users if they exchanged more traffic domestically.

This conclusion can be derived from data regarding Korea's sole neutral internet exchange point (IXP), the Korean Internet Neutral eXchange (KINX). Comparing KINX traffic to IXP traffic in other developed countries, it is clear that KINX handles too little traffic for the size and situation of the country. This is particularly surprising considering the Korean network infrastructure is among the best in the world in technical terms. With the quality of Korean networks, there should be more traffic exchanged within Korea than anywhere else in the world.

Figure 19: Korea Exchanges Far Less Traffic Per Capita Domestically Than Peer Countries

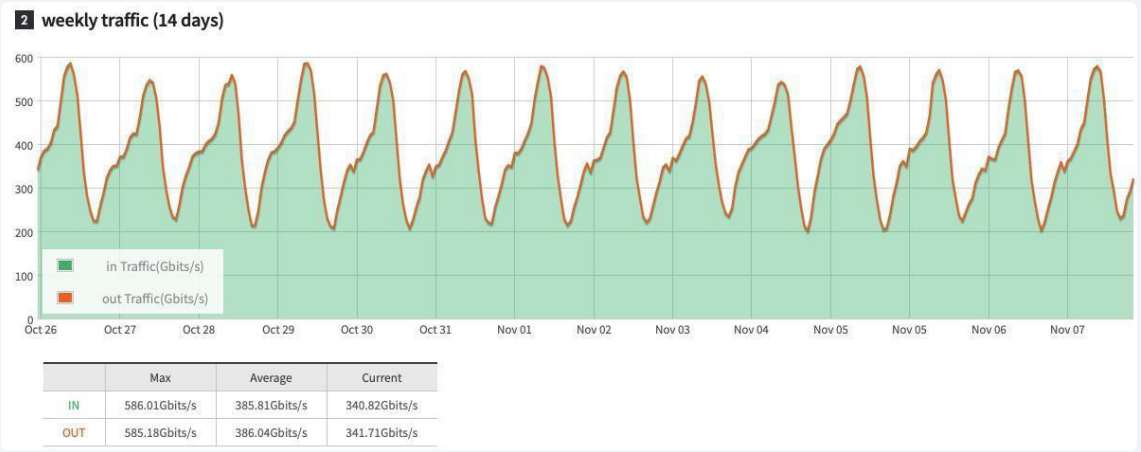


Notes and Sources: Author's calculations, data from Internet Exchange Point websites.

Keeping traffic local is one of the most effective ways to reduce costs, and given the geographic and geopolitical situation of Korea this arrangement would seem prudent. The question, then, is whether Korean ISPs exchange their traffic with the other 70 thousand autonomous systems on the internet in a way that is in line with global best practices? It seems the answer is no.

The amount of traffic handled by Korea's one IXP gives an insight into the size of the long tail and the quality of local interconnection. When comparing the Korea IXP to IXPs in other countries, even to countries at the bottom of the OECD-rankings, the results are surprising. In 2023, the Korean Internet Neutral Exchange has 64 connected AS-numbers and 586 Gbps of traffic for 52 million inhabitants, which is 112 Gbps/10M inhabitants.[49] That's 0.0112 Mbps/inhabitant. This is not a lot of traffic, even when measured per household or compared to total traffic. So how does this compare to other countries?

Exhibit 15: Korea Internet Neutral eXchange (KINX) 2023 Traffic Data

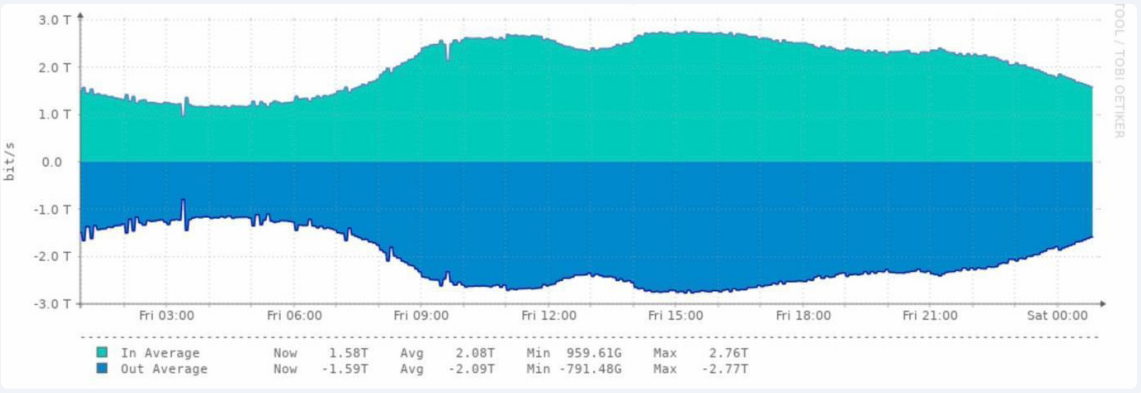


	Max	Average	Current
IN	586.01Gbits/s	385.81Gbits/s	340.82Gbits/s
OUT	585.18Gbits/s	386.04Gbits/s	341.71Gbits/s

Notes and Sources: From KINX.[50]

In Europe, Euro-IX publishes statistics on its internet exchange points. France-IX[51] operates 2.76Tbps for about 67 million inhabitants, or about 407 Gbps per 10M inhabitants, which is significantly more than Korea. This is despite some French operators refusing public peering in France.[52]

Exhibit 16: France-IX November 2023 Traffic Data



Notes and Sources: From France IX.[53]

49 https://www.kinx.net/infrastructure/traffic/?lang=en

50 https://www.kinx.net/infrastructure/traffic/?lang=en

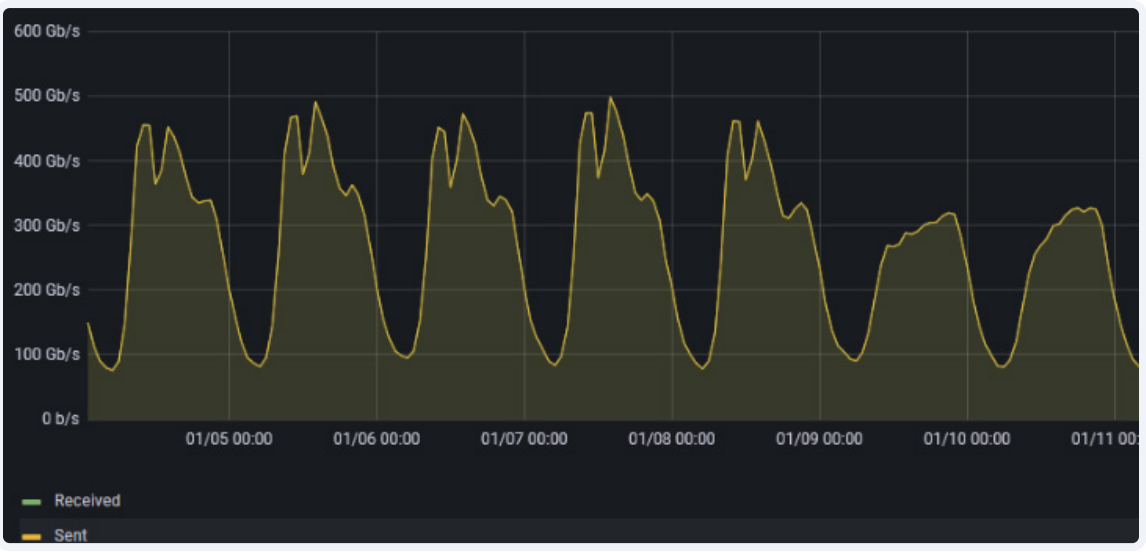
51 https://www.franceix.net/en/

52 https://en.arcep.fr/uploads/tx_gspublication/report-state-internet-2021-edition-july2021.pdf

53 https://www.franceix.net/en/

The Belgian Neutral Internet Exchange BNIX[54] has 60 participants with up to 500-600Gbps of traffic on a given day. With only 11.5M inhabitants in Belgium, that is 500Gbps/10M inhabitants.

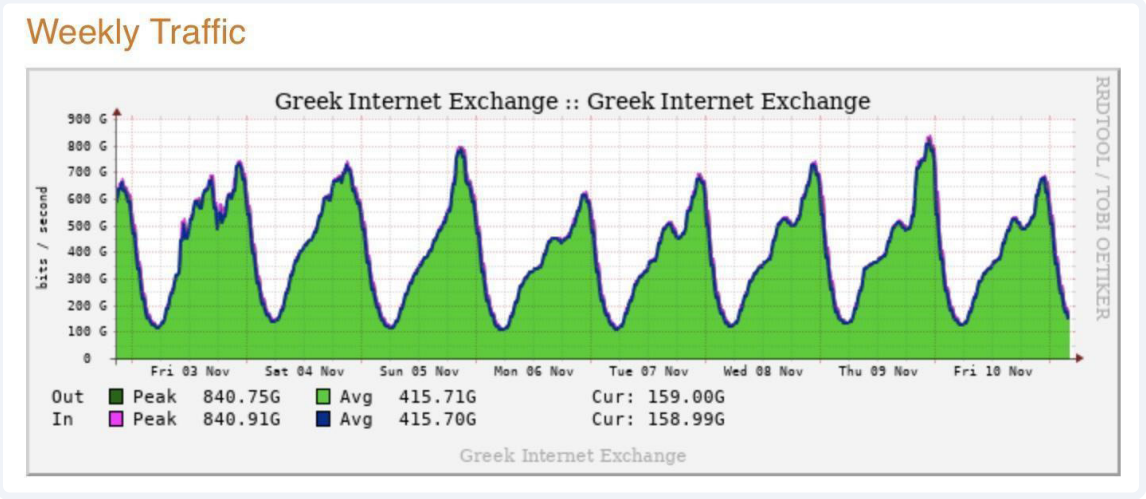
Exhibit 17: Belgian Neutral Internet Exchange (BNIX) Traffic



Notes and Sources: From BNIX.[55]

The Greek IX (GRIX) handles up to 841 Gbps each day with 60 participants[56] and 10.7M inhabitants, which is 786 Gbps/10M inhabitants. It is evident that Korea is exchanging far less traffic domestically than other countries in the world.

Exhibit 18: Greek Internet Exchange (GRIX) Traffic



Notes and Sources: From GRIX.[57]

54 https://www.bnix.net/en/news/internet-traffic-continued-increase-2021-exchange-point-bnix-recorded-new-record-peaks

55 https://www.bnix.net/en/news/internet-traffic-continued-increase-2021-exchange-point-bnix-recorded-new-record-peaks

56 https://www.gr-ix.gr/traffic/

57 https://www.gr-ix.gr/traffic/

Looking now to Finland, which is much like Korea in that it has a lot of mobile data and 5G use, and despite having only 5.5M inhabitants, we see that it has the highest use of mobile networks in the world. It reports a peak of 241 Gbps, which would put it at 438 Gbps/10M inhabitants.[58] This is significantly more than Korea.

Exhibit 19: Finnish Communication and Internet Exchange (FICIX) Traffic

Notes and Sources: From FICIX.[59]

Israel is another country whose inhabitants – population 9.5M – use a lot of mobile data. The Israel Internet Exchange reports a peak traffic exchange of 217Gbps, which is 228Gbps/10M inhabitants.[60] Despite having little interconnection with ISPs in neighboring countries due to politics, it still has traffic on the IXP significantly more than that of the Korean IXP.

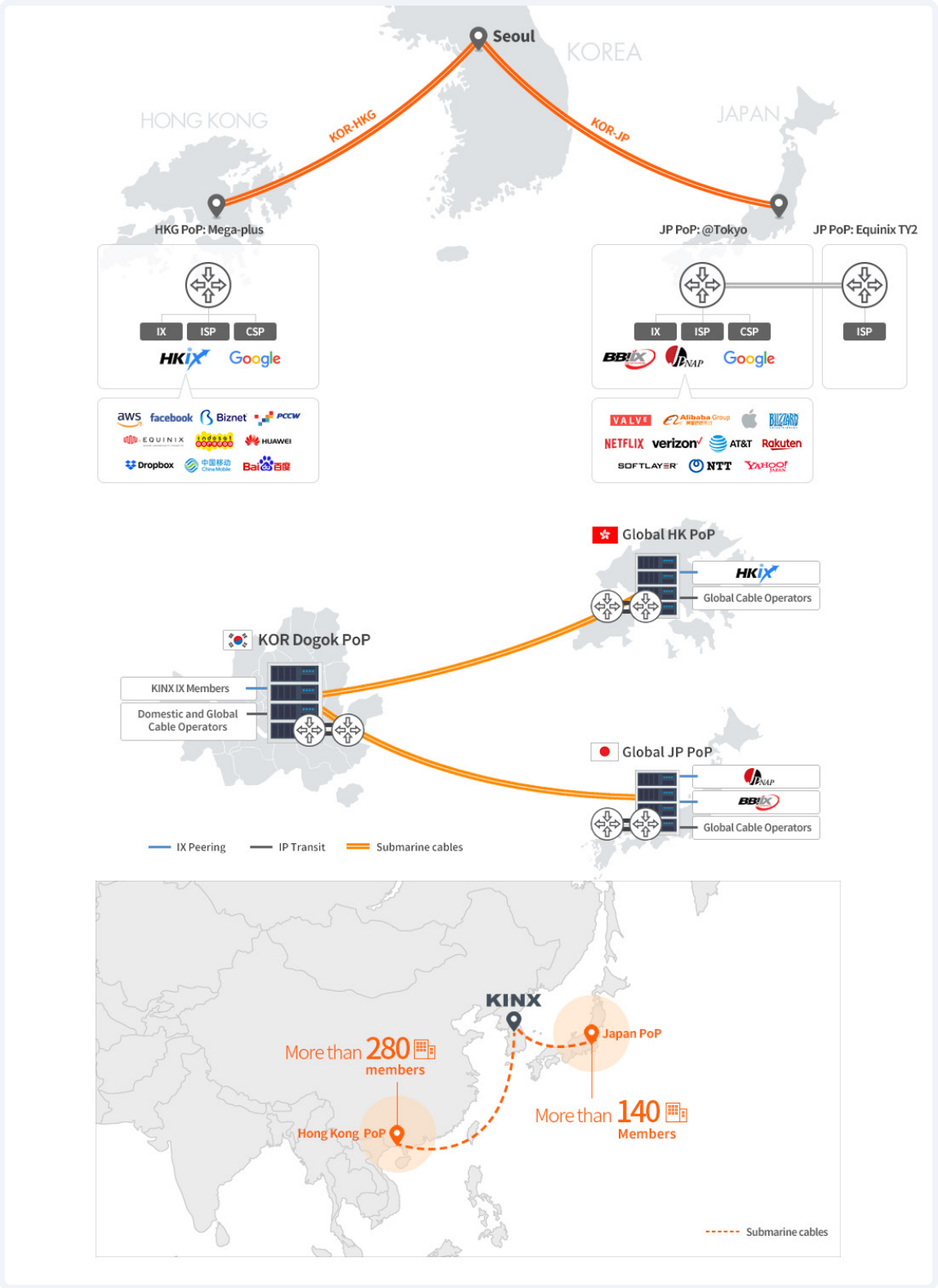
The reason for this anomaly becomes clear on the KINX website: Korean ISPs don't interconnect in Korea, but instead, Korean ISPs exchange traffic with each other 1200-2000km away in Japan and Hong Kong. Not only is this illogical and needs explaining, but it is a questionable networking practice and can be harmful to Korean national security.

58 https://ficix.fi/news/traffic-growth-was-strong-in-2021, https://stats-ficix.basen.com/#/page?name=StatsWelcome&source=wiki

59 https://stats-ficix.basen.com/#/page?name=StatsWelcome&source=wiki

60 https://en.isoc.org.il/iix/mrtg/total.html

Exhibit 20: Korean ISPs interconnect 1200-2100km from Korea



Notes and Sources: From KINX, Remote Peering.[61]

61 https://www.kinx.net/service/ix/remotepeering/?lang=en

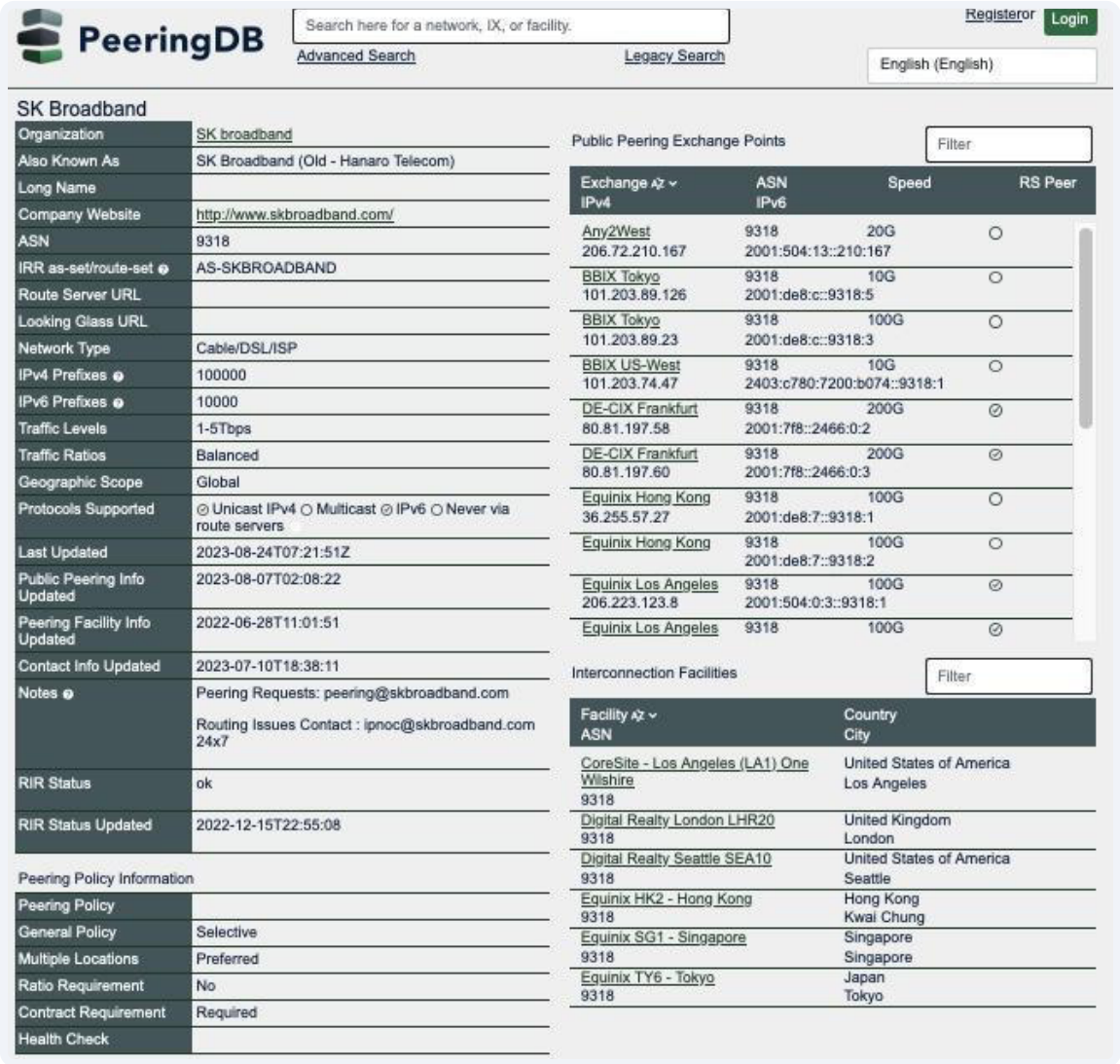
Notes and Sources: From KINX, Remote Peering.[62]

According to the KINX website, Korean ISPs do not interconnect in Korea, but instead, Korean ISPs exchange traffic with each other in Japan and Hong Kong. KINX reported an early November 2023 two-week average of about 386 gigabits per second, which is only about 1.3% of Korea's 3.6 terabytes per second in total traffic. By contrast, KINX states that about 17% of Korean internet traffic is remotely peered abroad, and the significant presence of Korea's three major ISPs at peering points and exchanges abroad, especially in Tokyo and Hong Kong, likely pushes the share of Korean domestic traffic exchanged abroad even higher. This suggests that very little traffic is being exchanged between Korean ISPs within Korea when compared to the traffic exchanged outside Korea. It is inefficient, and also uncommon, for Korean ISPs to interconnect outside of Korea for so much of their traffic.

As to Korean ISP peering practices, they do not peer within Korea, but do peer in foreign countries. For example, SK Broadband frequently peers abroad, but does not appear to do so within Korea. This is contrary to best practices actually employed by many ISPs in the United States and Europe, where domestic settlement-free peering is quite common. It also means that content providers are left with a straightforward choice: peer for free with Korean ISPs abroad and accept latency degradation, or pay Korean ISPs for domestic peering to decrease latency.

62 https://www.kinx.net/service/ix/remotepeering/?lang=en

Exhibit 21: SK Broadband Peers Freely Abroad, But Charges Domestically



PeeringDB

Search here for a network, IX, or facility.

Advanced Search | Legacy Search

Registeror | Login

English (English)

SK Broadband

Organization	SK broadband
Also Known As	SK Broadband (Old - Hanaro Telecom)
Long Name	
Company Website	http://www.skbroadband.com/
ASN	9318
IRR as-set/route-set	AS-SKBROADBAND
Route Server URL	
Looking Glass URL	
Network Type	Cable/DSL/ISP
IPv4 Prefixes	100000
IPv6 Prefixes	10000
Traffic Levels	1-5Tbps
Traffic Ratios	Balanced
Geographic Scope	Global
Protocols Supported	⊘ Unicast IPv4 ○ Multicast ⊘ IPv6 ○ Never via route servers
Last Updated	2023-08-24T07:21:51Z
Public Peering Info Updated	2023-08-07T02:08:22
Peering Facility Info Updated	2022-06-28T11:01:51
Contact Info Updated	2023-07-10T18:38:11
Notes	Peering Requests: peering@skbroadband.com Routing Issues Contact : ipnoc@skbroadband.com 24x7
RIR Status	ok
RIR Status Updated	2022-12-15T22:55:08

Peering Policy Information

Peering Policy	
General Policy	Selective
Multiple Locations	Preferred
Ratio Requirement	No
Contract Requirement	Required
Health Check	

Public Peering Exchange Points — Filter

Exchange AZ / IPv4	ASN / IPv6	Speed	RS Peer
Any2West 206.72.210.167	9318 2001:504:13::210:167	20G	○
BBIX Tokyo 101.203.89.126	9318 2001:de8:c::9318:5	10G	○
BBIX Tokyo 101.203.89.23	9318 2001:de8:c::9318:3	100G	○
BBIX US-West 101.203.74.47	9318 2403:c780:7200:b074::9318:1	10G	○
DE-CIX Frankfurt 80.81.197.58	9318 2001:7f8::2466:0:2	200G	⊘
DE-CIX Frankfurt 80.81.197.60	9318 2001:7f8::2466:0:3	200G	⊘
Equinix Hong Kong 36.255.57.27	9318 2001:de8:7::9318:1	100G	○
Equinix Hong Kong	9318 2001:de8:7::9318:2	100G	○
Equinix Los Angeles 206.223.123.8	9318 2001:504:0:3::9318:1	100G	⊘
Equinix Los Angeles	9318	100G	⊘

Interconnection Facilities — Filter

Facility AZ / ASN	Country / City
CoreSite - Los Angeles (LA1) One Wilshire 9318	United States of America Los Angeles
Digital Realty London LHR20 9318	United Kingdom London
Digital Realty Seattle SEA10 9318	United States of America Seattle
Equinix HK2 - Hong Kong 9318	Hong Kong Kwai Chung
Equinix SG1 - Singapore 9318	Singapore Singapore
Equinix TY6 - Tokyo 9318	Japan Tokyo

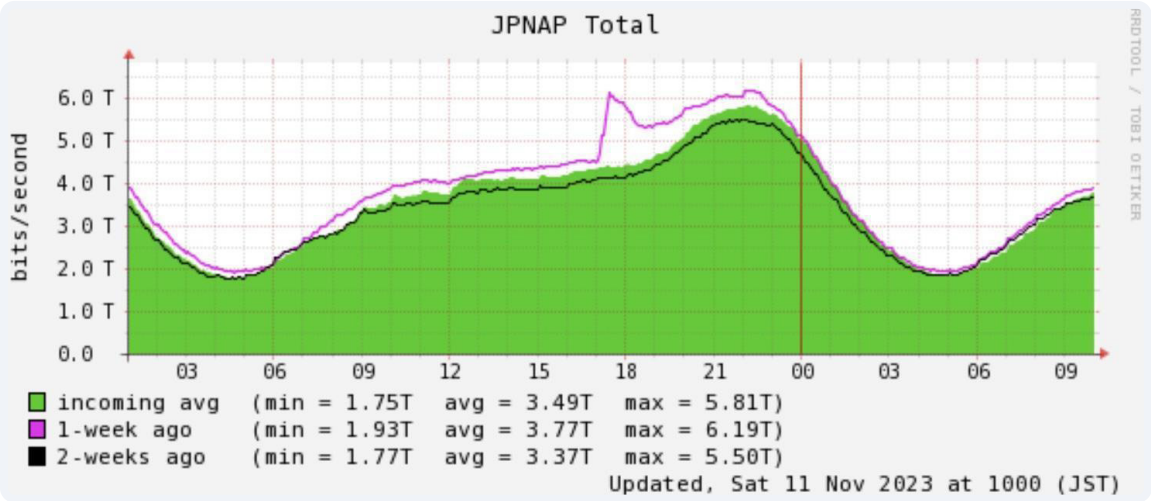
Notes and Sources: From PeeringDB.[63]

Japan's leading Internet Exchange Point, JPNAP, handles 6.2Tbps to Japan's 125M inhabitants. From JPNAP alone this is 496 Gbps/10M inhabitants, which is significantly above what Korea's internet exchange handles. This figure actually understates Japan's domestic traffic exchange, as Japan has multiple neutral IXPs, unlike Korea with just one, and when all of Japan's neutral IXP traffic is summed, Japanese domestic traffic exchange is at least 13.5Tbps, or about 1,080 Gbps/10M inhabitants.[64]

63 https://www.peeringdb.com/net/184

64 https://blog.apnic.net/2023/09/04/the-internet-landscape-of-japan/ ; https://www.jpnap.net/en/ix/traffic.html#jpnap-total-traffic

Exhibit 22: Japan Network Access Point (JPNAP) Traffic



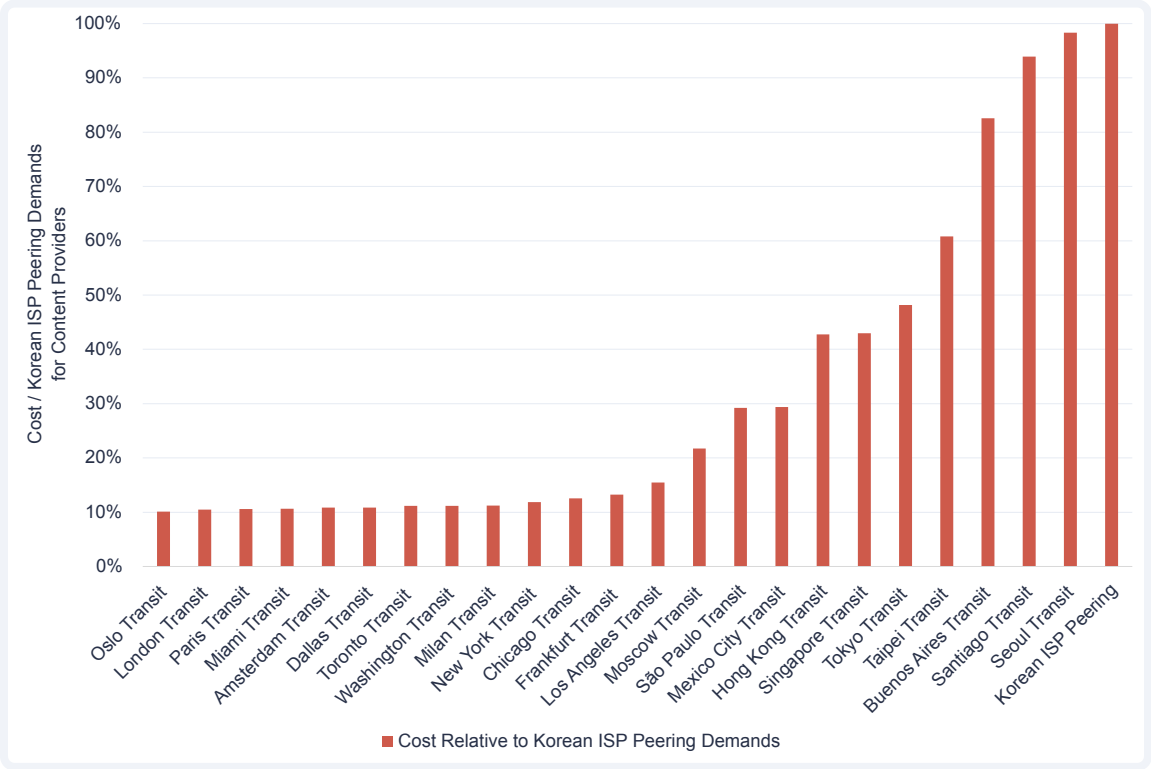
Notes and Sources: From JPNAP.[65]

All of this analysis demonstrates that the Korea IXP does not have the same traffic levels as other countries with lower-ranked broadband capabilities. This is in large part because the three largest South Korean ISPs, responsible for well over 90% of subscribers, do not peer at the domestic IXP.66 This state of affairs is incentivized by the 2016 sending party network pays regime, as an ISP hosting content domestically would be charged for any user accessing that content from another ISP's network. The ISPs do not want to send traffic to another ISP domestically and incur related interconnection fees, so they exchange very little traffic domestically. The leading ISPs were eager to have content providers pay them enormous sums for the "privilege" of peering with content provider cache servers: at the Korean ISPs' requested rate of $23 million for 1.2Tbps, equal to $23 million for 1.2 million Mbps, or $19.17 per Mbps per year, or $1.60 per Mbps per month, peering with Korean ISPs would have been more expensive than paying for Korean transit, more than twice as expensive as paying for Tokyo or Hong Kong transit, and more than six times as expensive as paying for Los Angeles transit. Content providers were not keen on paying several times the going rate for transit in connected cities just to peer, when peering is typically free or very inexpensive, and the ISPs are major beneficiaries of peering with local cache servers from content providers, which increase Korean ISPs' network resilience. The much lower cost of peering and exchanging traffic in Tokyo or Hong Kong, as little as thirty milliseconds away, presented an obvious alternative.

65 https://www.jpnap.net/en/ix/traffic.html#jpnap-total-traffic ; See also https://blog.apnic.net/2023/09/04/the-internet-landscape-of-japan/

66 https://www.internetsociety.org/wp-content/uploads/2021/06/Internet-Peering-in-Asia-Pacific-EN.pdf

Figure 20: Korean ISP Demands For Peering Are Up To An Order of Magnitude More Expensive Than Transit



Notes and Sources: Author's calculations, data from Telegeography and public reports.

As a result, both Korean ISPs and foreign content providers have tended to exchange traffic abroad when feasible, increasing traffic statistics in Tokyo and Hong Kong. Korea has increased its international bandwidth capacity with Tokyo by about 60% per year from 2019 to 2023, and Korea has increased its bandwidth capacity with Hong Kong by about 30% per year over the same time period. This shows there is no technical reason for any network to peer with Korean networks outside of Korea, which is contrary to best practices for designing and building networks.

Exhibit 23: Exhibit X: Korea Relies On Nine Major Submarine Cable Systems to Connect to the Outside World

Notes and Sources: From 2023 Submarine Cable Map, Telegeography.[67]

From Korea's perspective, Japan and Hong Kong are its closest neighbors and, due to geopolitical situations, other nearby nations may not be used for IP-traffic exchange. The crucial question remains, however, why don't the telcos and content providers exchange traffic domestically, at KINX in Korea? Many firms are willing to carry the traffic to Korea and exchange it in Korea. Also, for most of the content, a cache server in Korea would allow a file to be sent once to Korea and then can be viewed a million times in Korea. It is unnecessary to carry the same video a million times from Hong Kong or Tokyo, which uses up valuable and limited submarine cable capacity.

67 https://submarine-cable-map-2023.telegeography.com/

Notably, the four submarine cable systems that carry traffic between Hong Kong and Tokyo are old and do not have a lot of capacity. Assuming SK Telecom's statements are correct in that Netflix was 1.2Tbps and the traffic came from Tokyo, then it is evident the submarine cables between Japan and Korea are creating a massive bottleneck. 40Tbps over a new fiber pair is possible, but most cables to Korea are old and not easily upgraded.

To analogize, what we have is like a Korean online shop shipping all of its goods from Tokyo or Hong Kong, and then back to Korean customers, which does not make sense. Sometimes, when goods are popular and sold in large quantities, it is logical to ship them to a warehouse in Korea and distribute them from there. The reverse is also true. Samsung and LG would not ship each product individually from Korea to Japan or Hong Kong via Federal Express. Instead, it would ship to retailers via a container ship and then sell them locally.

The design is also unsafe. If Korean ISPs are exchanging traffic with each other outside of Korea, and Korea is dependent upon foreign countries for internet traffic exchange, then an accidental cable cut could remove Korea from the connected global economy. This further confirms that Korea's current interconnection practices coupled with the proposed introduction of 'network fees', make it difficult and costly to connect within the country at a peering point, which ultimately puts Korea's national security at risk.

Korea's Interconnection Market Is Inefficient and Undercuts Network Neutrality

The 2016 SPNP/interconnection fee regulation from the Korean government and network usage fee pricing by Korean ISPs disincentivizes traffic exchanges within Korea and domestic hosting of content, driving content abroad and increasing traffic costs. Until 2016, several content providers had significant presence in Korea and exchanged traffic with Korean ISPs in Korea. This arrangement gave their Korean end users fast access to the content and reduced the distance ISPs had to carry content to end-users.

But when the Korean ISPs started demanding payment for the traffic, far above the rates that are charged in competitive markets, content providers found themselves coerced into exchanging traffic outside of Korea instead.

The Korea Herald highlighted this 2016 shift, stating: *The network-sharing regulation, enacted in 2016, ended the principle of ignoring costs that occur when internet service providers (ISP) send data to and from each other, which was based on the proposition that they are on equal footing and the networks are "public good."*

This description is further supported by the Carnegie Endowment for International Peace,[68] which stated that "*according to TeleGeography, the cost of transit in Seoul is typically eight to ten times that of major European network hubs like London and Frankfurt. Elsewhere in Asia, technological improvements in optical fiber network technology and vigorous competition are leading the cost of transit to fall about 20 percent per year. That is simply not happening in Korea, in part due to the added costs imposed by these interconnection fees.*

Therefore, many Korean content providers cannot handle the higher cost for hosting their content in Korea and have either moved overseas or were outcompeted by foreign content providers because Korean firms cannot provide speed-intensive content, such as 4K video. As a result, Korean consumers are shifting to foreign content providers."

These observations are completely in line with the results of the 2011 and 2012 BEREC-OECD research and meetings on IP-interconnection. The European telecom firms organized in ETNO tried to convince the ITU that their "Sending Party Network Pays" proposal - akin to today's Korean proposal of "network usage fees" - would have to be introduced to force content providers to pay for traffic.

The European group of regulators BEREC concluded that,[69] "ETNO's proposed end-to-end SPNP approach to data transmission is totally antagonistic to the decentralised efficient routing approach to data transmission of the internet. The connection-oriented nature of end-to-end SPNP, with its focus on charging based on the actual volumes or value of the traffic, would represent a dramatic change from the existing charging framework operating on the internet." Additionally, BEREC stated that "If 'bill & keep' were to be replaced by SPNP then the ISP providing access could exploit the physical bottleneck for traffic exchange and derive monopoly profits, requiring regulatory intervention."

Such "exploitation" is made possible by the termination monopoly possessed by ISPs over their customers. If a service provider wants to reach an ISP's customers, it must go through the ISP's network, at least at the last mile. This results in a monopoly, and if ISPs are allowed to charge for that last mile of data connection to terminate a content provider or service provider's data with their customers, they will charge the monopoly price. Even if an ISP faces retail competition, meaning that its customers could in principle sign up for another ISP with comparable size and market power without needing to move, the dynamic should not change significantly, as each ISP will charge the monopoly price.

68 https://carnegieendowment.org/2021/08/17/afterword-korea-s-challenge-to-standard-internet-interconnection-model-pub-85166

69 Body of European Regulators and Electronics Communications, "BEREC's Comments on the ETNO Proposal for ITU/WCIT or Similar Initiatives Along These Lines," November 14, 2012, https://berec.europa.eu/eng/document_register/subject_matter/berec/others/1076-berecs-comments-on-the-etno-proposal-for-ituwcit-or-similar-initiatives-along-these-lines.

In the Korean context, the options for content providers are to pay for termination, in the form of an interconnection fee for the "privilege" of providing a cache server to peer with the ISP domestically, or to force the ISP to pick up the content provider's traffic abroad. The latter option introduces 30 milliseconds of latency, which somewhat reduces the quality of the service from the perspective of the content provider's Korean customers. This increased latency may put foreign content providers at a disadvantage relative to domestic content providers. So, some content providers do elect to pay termination or interconnection fees, as a way to pay for latency improvements. Of course, needing to pay for latency improvements indicates a contravention of network neutrality principles, as has been observed in South Korea since the 2016 SPNP policy.

Korean services such as Naver reportedly paid 73.4B Won ($56.5M) in 2017 alone for delivering traffic to Korean ISPs. That's a lot of money for latency improvements related to a single service.

Network Usage Fees Place Korean Content Creators at a Disadvantage

Korean content has grown in popularity around the world and is now sold globally. Whether it is K-Pop, Korean soap operas, Korean computer games, or Korean gamers streaming their eSports matches, this content is distributed around the world and watched by hundreds of millions thanks to the global reach of the internet. But before global success must come national success as a general prerequisite. For Korean content, this means that content must be distributed nationally over Korean broadband networks.

Introducing a network usage fee makes it more expensive to distribute new content in Korea or to develop a new distribution model to reach users around the world. A Korean competitor to TikTok will have a hard time starting up and handling traffic costs in Korea before it can expand globally. A Korean content maker is financially better off placing content on a global content platform than on a Korean one. For the global platform, the costs of delivering to Korea are shared over a wider base and therefore lower than for a Korean content platform. The prices demanded by Korean ISPs for delivering traffic make it impossible for new online services and applications to be created, homegrown and developed successfully in Korea.

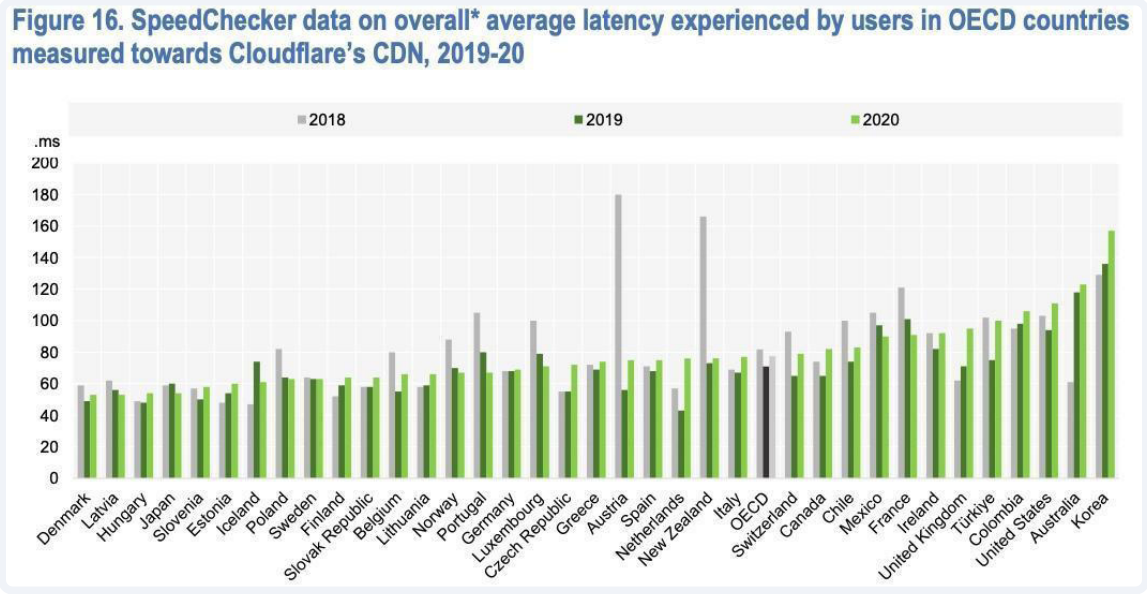
Streaming online games, for example, uses 35Mbps for 4K streaming quality to the consumer. At the rate demanded of Netflix, $23 million for 1.2Tbps, it would only take about 34 thousand peak streaming players to equal the same data traffic. At that rate, if a Korean games developer developed such a game that has massive appeal to Korean gamers, the costs to the developer of traffic alone

would exceed €52 euro/month ($56 USD/month) per peak gamer. The developer would have to recoup these costs from players. For comparison, a PC Game Pass costs only $9.99 per month for a gamer.

That money would go to the broadband provider who has built a network that can handle 1000Mbps with ease and would have to only upgrade its interconnection with the streaming service, but not the rest of its network. For example, if 1M gamers were on the same service at the same time at 35Mbps, traffic for Korean ISPs would increase 35Tbps, or 20-25%. However, the average traffic per subscriber only increases 1 Mbps/household. Despite this small increase, Korean ISPs would, if we apply the network usage fee that was demanded from Netflix, expect to receive $56M/month, or $0.7B per year, from the gaming firm. That amount is almost as much as each of the three leading Korean ISPs currently receives in subscription fees from fixed broadband customers.

Note also that latency in the Korean network has been getting worse since SPNP. According to the OECD, Korea now has the worst latency in the OECD. For comparison, nearby Japan has the fourth-best latency in the OECD. Why the large latency gap between neighbors? Due to SPNP, a large share of Korean traffic is picked up or exchanged abroad, adding 30 milliseconds of latency to a large fraction of network traffic.

Exhibit 24: Exhibit X: Korean Latency Has Become the Worst in the OECD Following SPNP

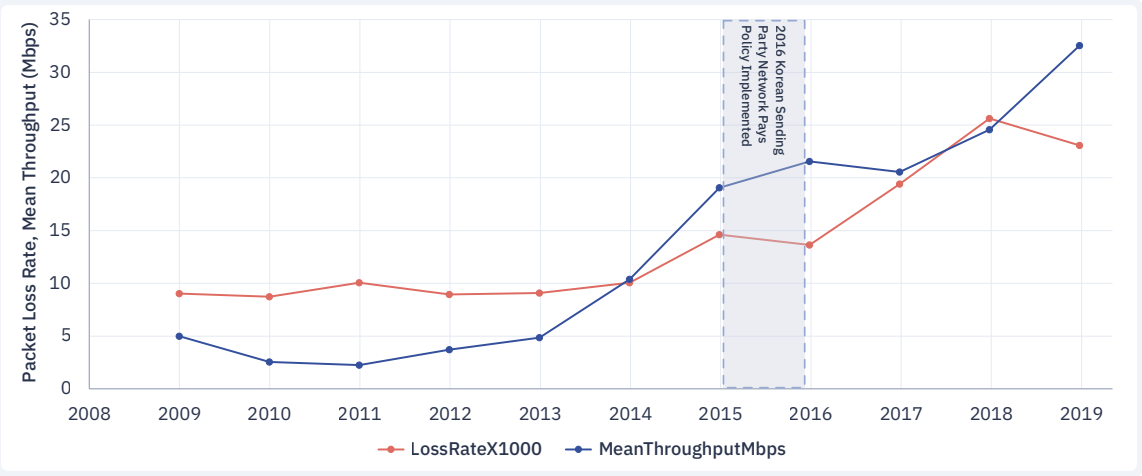


Notes and Sources: From OECD, "Broadband Networks of the Future," July 2022.[70]

70 https://www.oecd-ilibrary.org/docserver/755e2d0c-en.pdf?expires=1699920151&id=id&accname=guest&checksum=0B9A36FE253803FA9B88441D8FE3167F

Since SPNP in 2016, M-Lab data suggests that packet loss became a larger problem for Korean network users, and mean throughput for a typical connection degraded for several years. Both of these outcomes were likely due to inefficiencies introduced by ISP responses to SPNP incentives, such as network-inefficient (but cost-saving or revenue-enhancing) routing techniques.

Figure 21: M-Lab Data Suggests Korean Network Quality Degraded After the 2016 SPNP Policy



Notes and Sources: Author's calculations, data from M-Lab.

Network Usage Fees Advantage Korean ISP-Owned Pay TV Over Streaming Video Competitors

Korean ISPs are major players in the content space. According to the April 27, 2023 Form 20-F filed with the U.S. Securities and Exchange Commission, the Annual Report from SK Telecom[71] for the fiscal year ended December 31, 2022, p. 5: "Furthermore, our IPTV and cable TV services are facing an increasing level of competition from global operators of online video streaming platforms, such as YouTube, Netflix, Disney Plus and Apple TV, leading domestic video streaming platforms such as TVING, Wavve, Coupang Play and Watchaa, and the video services offered by leading domestic online and mobile search and communications platforms including NAVER and Kakao, as such services continue to become increasingly popular to serve as a substitute to traditional television programming. As of December 31, 2022, our market share of the broadband internet market was 28.5% in terms of number of subscribers compared to KT with 41.3% and LG U+ with 21.0%. As of December 31, 2022, our market share of the pay TV market (which includes IPTV, cable TV and satellite TV) was 25.6% compared to KT with 36.6% (including its IPTV, cable TV

71 https://www.sec.gov/ix?doc=/Archives/edgar/data/0001015650/000119312523120018/d408889d20f.htm

and satellite TV services) and LG U+ with 24.8% (including its IPTV and cable TV services), and the collective market share of other pay TV providers was 13.1%."[72]

Exhibit 25: Exhibit X: Korean ISPs Control 86% of the Korean Pay TV Market

The following table shows the market share information, based on number of subscribers, as of December 31, 2022, for the following markets.

	Market Share (%)			
	SK Telecom	KT	LG U+	Others
Wireless Service(1)	43.2%	30.9%	25.9%	—%
Fixed-Line Telephone (including VoIP)	15.6	55.0	18.7	10.7
Broadband Internet	28.5	41.3	21.0	9.2
Pay TV(2)	25.6(3)	36.6(4)	24.8(5)	13.1

Notes and Sources: From U.S. Securities and Exchange Commission.[73]

The incentive to behave strategically with respect to network usage fees vis-à-vis both domestic and foreign content providers is strong, as media and content are often larger revenue drivers than fixed-line broadband internet access services for leading Korean ISPs.

Exhibit 26: Exhibit X: KT Earns More From Media and Content Services Than Broadband Internet Access Services

Our Services

The following table sets out our operating revenue by principal product categories and the respective percentage of total operating revenue in 2020, 2021 and 2022.

	For the Year Ended December 31,					
	2020		2021		2022	
Products and services	Billions of Won	%	Billions of Won	%	Billions of Won	%
Mobile services	₩ 6,805	27.8%	₩ 6,936	27.5%	₩ 7,014	26.7%
Fixed-line services:						
Fixed-line and VoIP telephone services	1,464	6.0	1,465	5.8	1,378	5.3
Broadband Internet access services	2,256	9.2	2,344	9.3	2,505	9.5
Data communication services	1,107	4.5	1,152	4.6	1,173	4.5
Sub-total	4,827	19.7	4,960	19.7	5.057	19.3
Media and content services	2,638	10.8	2,801	11.1	3,100	11.8
Financial services	3,494	14.3	3,662	14.5	3,837	14.6
Others	3,084	12.6	3,313	13.1	3,834	14.6
Sale of goods (1)	3,593	14.7	3,533	14.0	3,394	12.9
Total operating revenue	₩ 24,441	100.0%	₩ 25,206	100.0%	₩ 26,234	100.0%

(1) Primarily related to sale of handsets for our mobile service and miscellaneous telecommunications equipment, as well as sale of residential units and commercial real estate developed by KT Estate.

Notes and Sources: From U.S. Securities and Exchange Commission.[74]

If the Korean government adopts policies requiring network usage fees, it will amount to favoring particular Korean content providers—the Korean ISPs—over both domestic and foreign content providers. All content providers not owned by the Korean ISPs would either have to pay Korea's ISPs for latency improvements or face a quality-of-service degradation that will make the Korean ISPs' content relatively more attractive. The conflicts of interest and likelihood of competitive harm are self-evident, especially when the Korean ISPs name foreign content providers as key competitors in securities filings.[75]

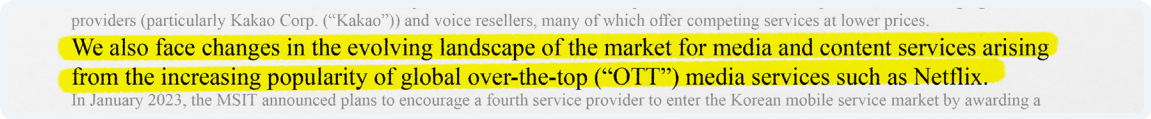
72 https://www.sec.gov/ix?doc=/Archives/edgar/data/0001015650/000119312523120018/d408889d20f.htm

73 https://www.sec.gov/Archives/edgar/data/1015650/000119312523120018/d408889d20f.htm

74 https://www.sec.gov/Archives/edgar/data/892450/000119312523123967/d436251d20f.htm

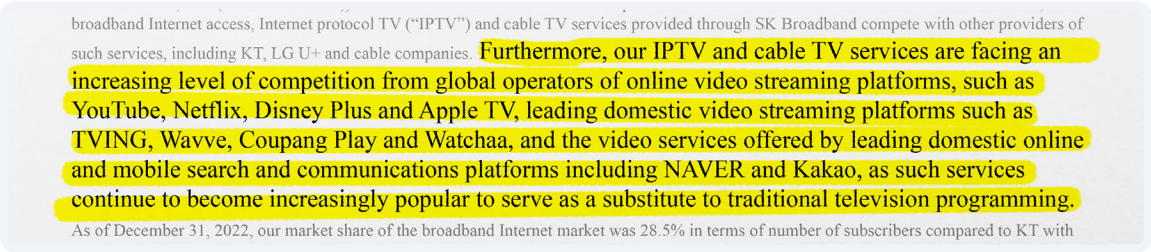
75 https://www.sec.gov/ix?doc=/Archives/edgar/data/1015650/000119312523120018/d408889d20f.htm

Exhibit 27: KT Acknowledges That It Competes With OTT Content Providers Like Netflix


providers (particularly Kakao Corp. ("Kakao")) and voice resellers, many of which offer competing services at lower prices.
We also face changes in the evolving landscape of the market for media and content services arising from the increasing popularity of global over-the-top ("OTT") media services such as Netflix.
In January 2023, the MSIT announced plans to encourage a fourth service provider to enter the Korean mobile service market by awarding a

Notes and Sources: From U.S. Securities and Exchange Commission.[76]

Exhibit 28: SK Acknowledges That It Competes with Online Video Streaming Platforms


broadband Internet access, Internet protocol TV ("IPTV") and cable TV services provided through SK Broadband compete with other providers of such services, including KT, LG U+ and cable companies. Furthermore, our IPTV and cable TV services are facing an increasing level of competition from global operators of online video streaming platforms, such as YouTube, Netflix, Disney Plus and Apple TV, leading domestic video streaming platforms such as TVING, Wavve, Coupang Play and Watchaa, and the video services offered by leading domestic online and mobile search and communications platforms including NAVER and Kakao, as such services continue to become increasingly popular to serve as a substitute to traditional television programming.
As of December 31, 2022, our market share of the broadband Internet market was 28.5% in terms of number of subscribers compared to KT with

Notes and Sources: From U.S. Securities and Exchange Commission.[77]

Excessive Reliance on Foreign Interconnections Risks Korean National Security

An overlooked part of this usage-fee debate is that Korean policy on network usage fees has made the Korean internet very fragile. The 2016 interconnection and SPNP policy creates significant financial incentives that discourage ISPs from exchanging data traffic domestically and reduce the incentives for content providers to provide local cache servers with domestic copies of programs and content. If a ship with an anchor were to sail around the Korean peninsula and cut all nine major submarine cable systems, the country's economy and society would be significantly crippled, with the only option for internet access being via satellite. Further, there would be relatively few domestic copies of many programs and much content, and the network architecture would not be designed for efficient dissemination of programs and content that were cached domestically between ISPs.

Unfortunately, cable cuts are very common around the world. There are typically over 100 cable faults per year, most of which are unintentional cuts from fishing vessels and ships dragging anchors.[78] For context, there are about 550 submarine cable systems, of which about 485 were in-service as of June 2023. and about half of these systems have multiple segments or branches that offer

76 https://www.sec.gov/Archives/edgar/data/892450/000119312523123967/d436251d20f.htm

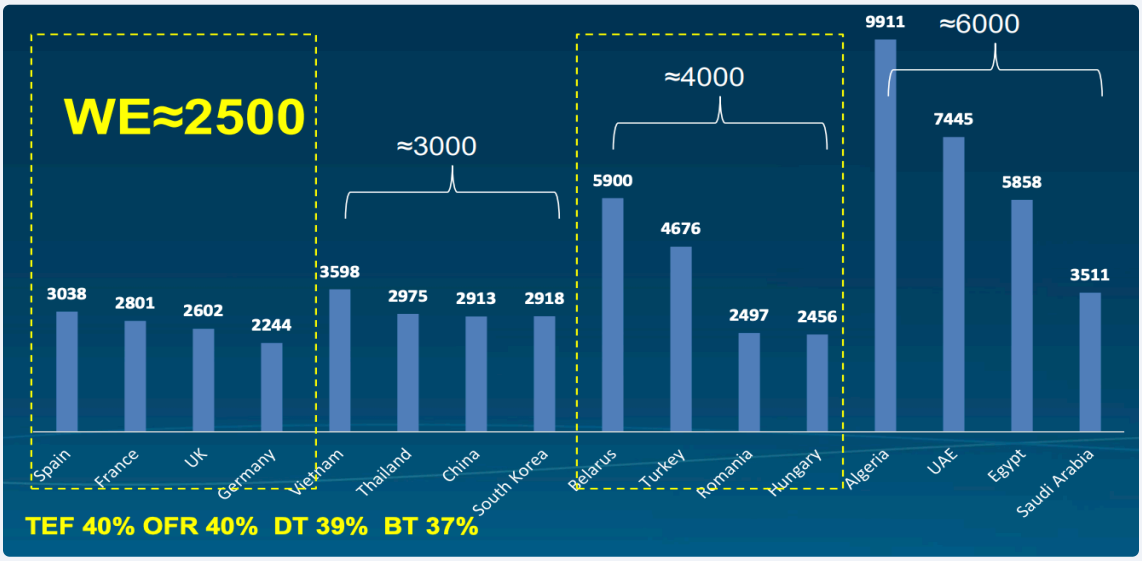
77 https://www.sec.gov/Archives/edgar/data/1015650/000119312523120018/d408889d20f.htm

78 https://www2.telegeography.com/submarine-cable-faqs-frequently-asked-questions, https://blog.telegeography.com/what-happens-when-submarine-cables-break

some degree of redundancy in the event of a cable cut.[79] Korea's geopolitical circumstances, which include close proximity to three potentially hostile countries and no land borders with friendly countries, result in a situation in which Korea's nine major submarine cable systems are responsible for nearly all connectivity with the outside world. If they were cut, it can take weeks to repair a link even in the absence of hostile actors seeking to prolong infrastructure outages. Korea is under direct threat from hostile actors and should factor that threat into the way it designs its networks.

A presentation from 2019[80] at the RIPE NCC meeting in Kyiv and a presentation at the RIPE NCC meeting in Berlin 2022[81] show how the Ukrainian internet and Korean internet networks differ, specifically why Korea's internet infrastructure is vulnerable to DDOS attacks: Korea's telecom market is highly concentrated, especially relative to Ukraine, another country with a hostile neighbor along a major land border.

Exhibit 29: South Korea's Telecom Industry is Much More Concentrated Than Ukraine's



Notes and Sources: From RIPE NCC.[82]

According to the Herfindahl-Hirschman Index (HHI), which is calculated using the market shares of each individual market participant, the Ukrainian internet access market in 2019 was 500 out of 10,000 (10,000 being the most highly concentrated), while Korea was 2,918 out of 10,000. The low concentration in Ukraine shows the diversity and dynamism of its ISP and interconnection market, which ensures resilience, unlike the highly concentrated telecom

79 https://blog.telegeography.com/how-many-submarine-cables-are-there-anyway#:~:text=TeleGeography%27s%20Submarine%20Cable%20Map%20recently,depicting%20over%20550%20cable%20systems.

80 https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/ripe-ncc-days-kyiv/2019-09-26%20NCC%20Days,%20State%20of%20Internet_v3_b0e1fc0b-eed7-417b-813c-0dbc83f3e82c.pdf

81 https://ripe84.ripe.net/wp-content/uploads/presentations/23-ukraine-internet.emileaben.ripe84.pdf

82 https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/ripe-ncc-days-kyiv/2019-09-26%20NCC%20Days,%20State%20of%20Internet_v3_b0e1fc0b-eed7-417b-813c-0dbc83f3e82c.pdf

market in Korea. Korea's telecom market concentration reduces its resilience to a small number of critical points of failure, which increases vulnerability because it could easily be exploited by nefarious actors. Moreover, Ukraine has 19 IXPs, with none clearly dominant, in sharp contrast to South Korea with its single IXP, KINX.[83] Outside analysts note that Ukraine's decentralized ISPs and IXPs facilitate traffic exchange that is overwhelmingly local , whereas Korea's relatively concentrated ISPs and single IXP with low domestic data traffic are associated with much more foreign exchange of domestic traffic and foreign pickup of domestically consumed content.

A Global Network Usage Fee Norm Would Disadvantage Korea's Leading Firms

A significant problem with the proposed Korean network usage fee policy is that it sets a precedent that would be disadvantageous for Korean companies if other countries followed suit. For example, if Samsung would have to pay similar fees to telcos around the world, their costs would sky rocket. Samsung's smartphones generate quite a bit of traffic to Samsung's services and in periodic updates: there are nearly one billion Samsung smartphones in use around the world today.

Samsung frequently alerts users to install large updates, sometimes over one gigabyte in size, over the internet, including critical updates for security purposes. It is plausible that a large fraction of users update their Samsung smartphones at roughly the same time the night a security update is released. If even just 10% of all Samsung users' large software updates take place at partially overlapping times, that would cause over (1 gigabyte/update * 100 million smartphones to be updated) = 100 million gigabytes = 800 million gigabits = 800,000 terabits of peak data. Even if the peak period were spread over a full hour, or 3,600 seconds, Samsung would still send over 222 terabits per second of total peak traffic. 222Tbps is nearly enough traffic to replicate Netflix's "Squid Game" peak traffic in every single UN member state simultaneously.

Should Samsung have to pay over $5.1 billion USD [222Tbps * ($23 million/1.2Tbps)] each year in network usage fees to telcos around the world? What about other leading Korean companies that produce products with regular updates or service access over the internet? Samsung alone would have to pay more than a hundred times what Korean ISPs want to collect from Netflix each year.

83 https://ripe84.ripe.net/wp-content/uploads/presentations/23-ukraine-internet.emileaben.ripe84.pdf, https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/ripe-ncc-days-kyiv/2019-09-26%20NCC%20Days,%20State%20of%20Internet_v3_b0e1fc0b-eed7-417b-813c-0dbc83f3e82c.pdf

Korean ISPs Benefit from Traffic Due to Price Discrimination

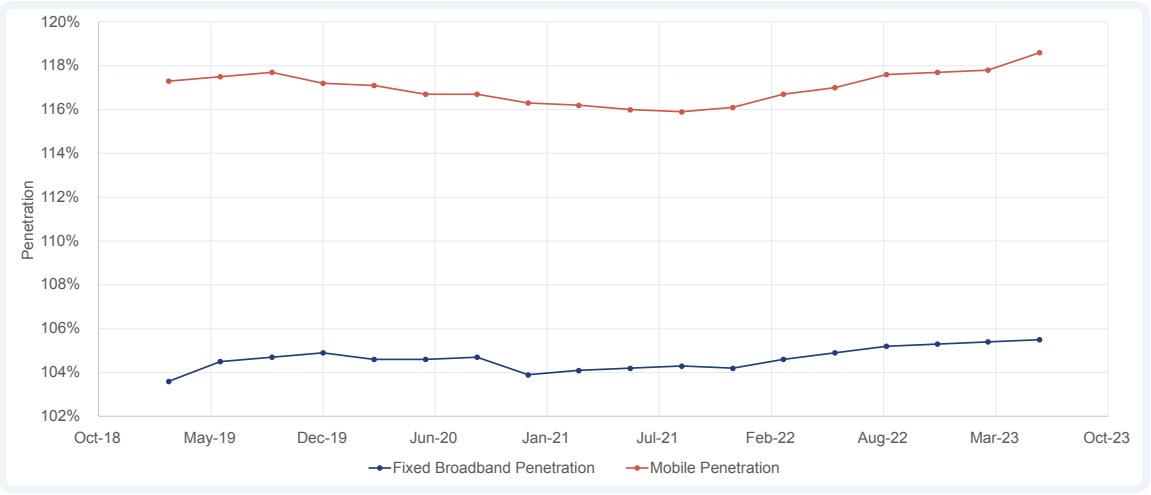
South Korea's three leading three telcos have healthy revenues and growing EBITDA margins. Their operating costs are flat—collectively, opex was lower in 2022 than it was in 2019, and almost identical to opex back in 2014. Opex has been range bound between about $33 billion and $37 billion for at least a decade. During the same time period, data traffic has increased linearly at a steady rate, tripling over the past six years, while operating costs have stayed flat. Clearly operating costs are not rising proportionately with data traffic, nor should they: core network operating costs increase very slowly with higher traffic, and last mile operating costs do not increase with traffic.

However, building out the initial infrastructure to accommodate traffic, especially last-mile fiber to the home or 5G cell sites, does involve some initial, one-time capital expenditures. The fiber networks were essentially completed years ago, and are expected to last decades, so capex on fixed broadband networks is largely limited to small amounts of occasional repair work and buildouts to small numbers of new neighborhoods, and is not a major factor in ongoing capex considerations for leading Korean telecoms. Much of South Korean telcos' ongoing capex is related to 5G buildout for mobile service.

These three South Korea telcos have spent between $4 billion and $7 billion per year on capex every year since at least 2010, indicating a very range-bound capex without any clear upward trend across time. The leading Korean telcos spent about $6.3 billion dollars on capex in 2022, less than they spent in 2012, 2019, 2020, or 2021, and only slightly higher than most other years over the past decade. While these capex amounts are flat across time, they amount to about $10 per month per South Korean inhabitant, in a country that already has above 100% penetration for both fixed and mobile broadband.

So why are South Korean telcos spending so much on expanding 5G infrastructure? Is it because mobile data growth is outstripping fixed broadband traffic? No, fixed broadband traffic continues to account for about ten times the total traffic of mobile in Korea. Rather, it is because Korean mobile and fixed penetration are already above 100% and have plateaued. There is little room to grow revenues or profits from selling service to the few Koreans who lack internet access – virtually every Korean already has both fixed and mobile access. That leaves data traffic volumes as the primary option for increasing telco revenues and profits, particularly price discrimination based on consumers' data-traffic needs.

Figure 22: South Korean Fixed Broadband and Mobile Penetration Have Plateaued After Exceeding 100%



Notes and Sources: Author's calculations, data from Telegeography.

Analyzing Korean telecoms' offerings, it is clear that price discrimination is a major profit driver. For plans utilizing the same infrastructure—fiber to the home, or 5G—there is little incremental cost for allowing more traffic from the same user once the infrastructure is built for last-mile connectivity. However, the range of prices on display for plans from the same carriers, varying only in data rates, is enormous. In Korea, 5G plans from the same carrier can range from $34 per month to over $98 per month, with differing speed tiers as the primary differentiating factors for the different tiers. For fixed broadband, price discrimination allows for at least $36 per month per *household* in increased revenue capture, or about $10 billion per year in potential fixed broadband price discrimination markup. For mobile, the opportunity space is much larger, about $64 per month per *user*, adding up to about a $47 billion per year opportunity for price discrimination markups in mobile. Price discrimination is a key revenue driver for Korean ISPs, as SK Telecom acknowledged in securities filings emphasizing the importance of "higher-priced 5G plans" to increased ARPU.[84]

Exhibit 30: Exhibit X: Price Discrimination Drives ARPU Increases For Korean ISPs

> Our ARPU increased by 0.1% to Won 30,546 in 2022 from Won 30,517 in 2021, which represented an increase of 0.7% from Won 30,314 in 2020. Our ARPU including MVNO increased by 0.3% to Won 28,582 in 2022 from Won 28,485 in 2021, which represented an increase of 2.1% from Won 27,895 in 2020. The increases in our ARPU and our ARPU including MVNO in both 2022 and 2021 were primarily due to an increase in the number of subscribers who subscribe to our higher-priced 5G plans.

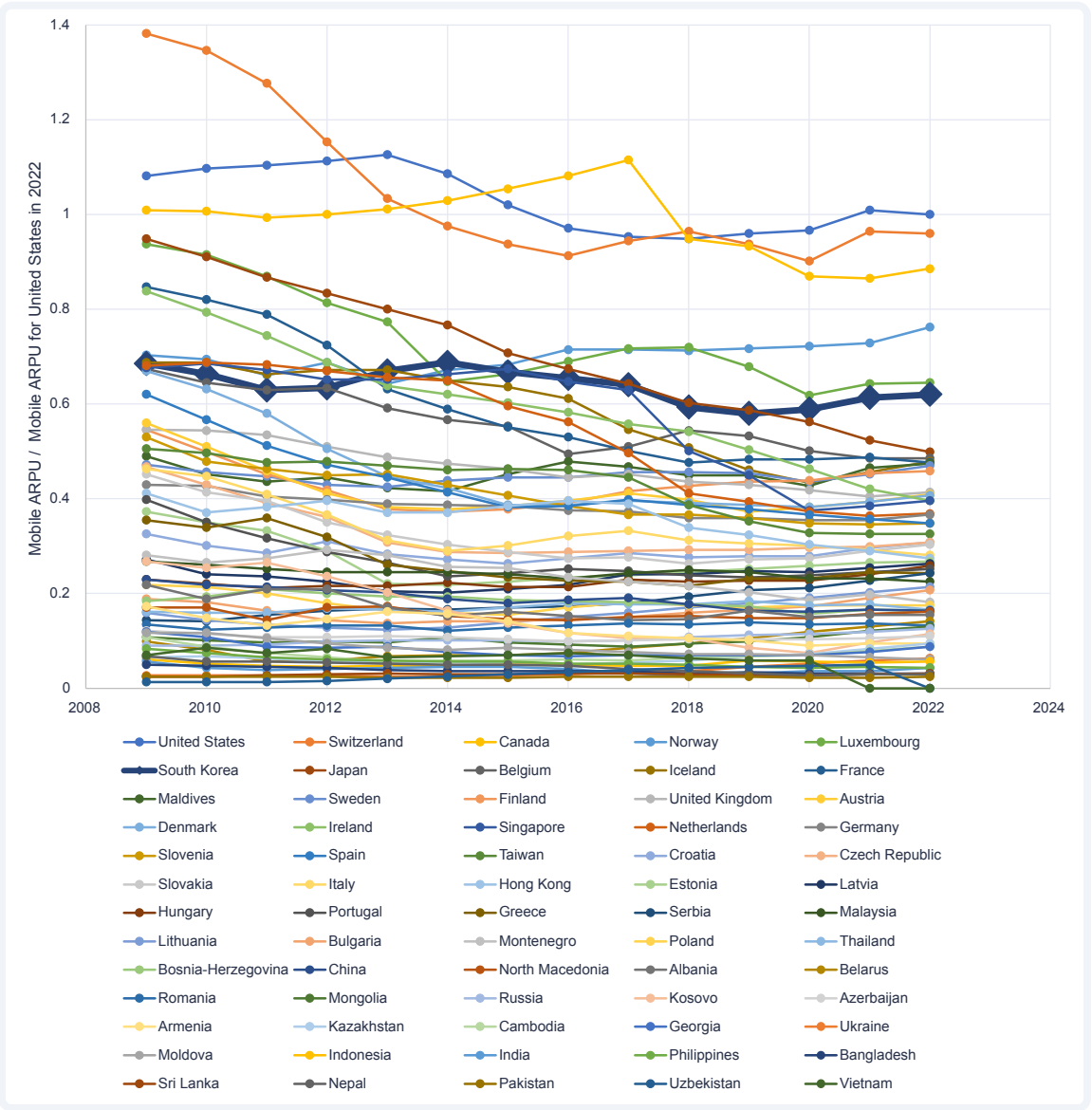
Notes and Sources: From U.S. Securities and Exchange Commission.[85]

84 https://www.sec.gov/Archives/edgar/data/1015650/000119312523120018/d408889d20f.htm

85 https://www.sec.gov/Archives/edgar/data/1015650/000119312523120018/d408889d20f.htm

South Korea already has the 7th-highest mobile ARPU of any of 66 countries in Asia, Europe, the U.S.A, and Canada. South Korean fixed data service ARPU is average for the 66 measured countries in Asia, Europe, the U.S.A., and Canada. South Korean telcos would like to increase ARPU further, however, and their capex is designed to achieve that ARPU increase via price discrimination by marketing higher tiers of plans focused on offering higher speeds.

Figure 23: Korean Mobile ARPU Is Quite High Relative to Global Peers



Notes and Sources: Author's calculations, data from Telegeography and SEC Filings.

Given the flat nature of the telecoms' operating costs as data traffic has grown, the takeaway is clear: increased data traffic, especially on mobile devices, is desirable for telecoms, and is their intended profit driver going forward. Capex of $6 billion per year is extremely rational as part of an induced demand strategy:

the telcos are building out the infrastructure to allow every South Korean to purchase the most expensive, highest data plan for mobile and fixed broadband, so they can earn nearly $60 billion per year in higher revenues, with de minimis opex increases. Such price discrimination is not necessarily problematic, as price discrimination can allow for ISPs to offer service to consumers with a willingness to pay below the equilibrium price in the absence of price discrimination. However, the expectation that operating costs will barely increase with traffic and hence almost all of this incremental revenue from price discrimination will turn into profit does debunk Korean ISPs' claims that they "need" any additional contributions from other funding sources.

Market analysts broadly agree with this assessment. For example, in one report, analysts note that Korean telcos are not yet rolling out their planned, maximum-speed 5G service, because the demand is not there yet. App makers have not brought to mass market services like autonomous driving that would require more firepower. Customers can watch Netflix and surf the net well enough with existing 5G technology." At the moment, data demand is growing linearly," said Hyundai Motor Securities analyst Kim Hyunyong, who provided the analysis.[86] Likewise, Ericsson assessed that "The rapid growth of 5G subscriptions, supported by the availability of more 5G device models, has positively impacted service providers' financial performance" in North East Asia, including Korea. "Major service providers in leading 5G markets, such as mainland China, Taiwan and South Korea, have reported a positive impact of 5G subscribers on service revenues and ARPU."[87]

The data and economics simply do not support the demands issued by telcos in Korea and elsewhere that digital services be compelled to pay network usage fees. Lawmakers' focus should turn to incentivizing network efficiency and best practices to maximize use of existing facilities and ensure appropriate, financially sound further investment where internet traffic truly outstrips capacity.

86 https://www.reuters.com/business/media-telecom/skoreas-high-speed-5g-mobile-revolution-gives-way-evolution-2022-05-13/

87 https://www.ericsson.com/4ae28d/assets/local/reports-papers/mobility-report/documents/2022/ericsson-mobility-report-november-2022.pdf