The Relative Cost of Bandwidth Around the World


Over the last few months, there's been increased attention on networks and how they interconnect. CloudFlare runs a large network that interconnects with many others around the world. From our vantage point, we have incredible visibility into global network operations. Given our unique situation, we thought it might be useful to explain how networks operate, and the relative costs of Internet connectivity in different parts of the world.

A Connected Network

The Internet is a vast network made up of a collection of smaller networks. The networks that make up the Internet are connected in two main ways. Networks can connect with each other directly, in which case they are said to be “peered”, or they can connect via an intermediary network known as a “transit provider”.

At the core of the Internet are a handful of very large transit providers that all peer with one another. This group of approximately twelve companies are known as Tier 1 network providers. Whether directly or indirectly, every ISP (Internet Service Provider) around the world connects with one of these Tier 1 providers. And, since the Tier 1 providers are all interconnected themselves, from any point on the network you should be able to reach any other point. That’s what makes the Internet the Internet: it’s a huge group of networks that are all interconnected.

Paying to Connect

To be a part of the Internet, CloudFlare buys bandwidth, known as transit, from a number of different providers. The rate we pay for this bandwidth varies from region to region around the world. In some cases we buy from a
Tier 1 provider. In other cases, we buy from regional transit providers that either peer with the networks we need to reach directly (bypassing any Tier 1), or interconnect themselves with other transit providers.

CloudFlare buys transit wholesale and on the basis of the capacity we use in any given month. Unlike some cloud services like Amazon Web Services (AWS) or traditional CDNs that bill for individual bits delivered across a network (called “stock”), we pay for a maximum utilization for a period of time (called “flow”). Typically, we pay based on the maximum number of megabits per second we use during a month on any given provider.

Most transit agreements bill the 95th percentile of utilization in any given month. That means you throw out approximately 36 not-necessarily-contiguous hours worth of peak utilization when calculating usage for the month. Legend has it that in its early days, Google used to take advantage of these contracts by using very little bandwidth for most of the month and then ship its indexes between data centers, a very high bandwidth operation, during one 24-hour period. A clever, if undoubtedly short-lived, strategy to avoid high bandwidth bills.

Another subtlety is that when you buy transit wholesale you typically only pay for traffic coming in (“ingress”) or traffic going out (“egress”) of your network, not both. Generally you pay which ever one is greater.

CloudFlare is a caching proxy so egress (out) typically exceeds ingress (in), usually by around 4-5x. Our bandwidth bill is therefore calculated on egress so we don’t pay for ingress. This is part of the reason we don’t charge extra when a site on our network comes under a DDoS attack. An attack increases our ingress but, unless the attack is very large, our ingress traffic will still not exceed egress, and therefore doesn’t increase our bandwidth bill.

**Peering**

While we pay for transit, peering directly with other providers is typically free — with some notable exceptions recently highlighted by Netflix (http://arstechnica.com/tech-policy/2014/06/fcc-gets-comcast-verizon-to-reveal-netflixs-paid-peering-deals/). In CloudFlare’s case, unlike Netflix, at this time, all our peering is currently “settlement free,” meaning we don’t pay for it. Therefore, the more we peer the less we pay for bandwidth. Peering also typically increases performance by cutting out intermediaries that may add latency. In general, peering is a good thing.

The chart above shows how CloudFlare has increased the number of networks we peer with over the last three months (both over IPv4 and IPv6). Currently, we peer around 45% of our total traffic globally (depending on the time of day), across nearly 3,000 different peering sessions. The chart below shows the split between peering and transit and how it’s improved over the last three months as we’ve added more peers.
North America

We don’t disclose exactly what we pay for transit, but I can give you a relative sense of regional differences. To start, let’s assume as a benchmark in North America you’d pay a blended average across all the transit providers of $10/Mbps (megabit per second per month). In reality, we pay less than that, but it can serve as a benchmark, and keep the numbers round as we compare regions. If you assume that benchmark, for every 1,000Mbps (1Gbps) you’d pay $10,000/month (again, acknowledge that’s higher than reality, it’s just an illustrative benchmark and keeps the numbers round, bear with me).

While that benchmark establishes the transit price, the effective price for bandwidth in the region is the blended price of transit ($10/Mbps) and peering ($0/Mbps). Every byte delivered over peering is a would-be transit byte that doesn’t need to be paid for. While North America has some of the lowest transit pricing in the world, it also has below average rates of peering. The chart below shows the split between peering and transit in the region. While it’s gotten better over the last three months, North America still lags behind every other region in the world in terms of peering..

[Chart showing peering vs. transit in North America]

While we peer nearly 40% of traffic globally, we only peer around 20-25% in North America. Assuming the price of transit is the benchmark $10/Mbps in North America without peering, with peering it is effectively $8/Mbps. Based only on bandwidth costs, that makes it the second least expensive region in the world to provide an Internet service like CloudFlare. So what’s the least expensive?

Europe
Europe's transit pricing roughly mirrors North America's, so, again, assume a benchmark of $10/Mbps. While transit is priced similarly to North America, in Europe there is a significantly higher rate of peering. CloudFlare peers 50-55% of traffic in the region, making the effective bandwidth price $5/Mbps. Because of the high rate of peering and the low transit costs, Europe is the least expensive region in the world for bandwidth.

The higher rate of peering is due in part to the organization of the region's “peering exchanges”. A peering exchange is a service where networks can pay a fee to join, and then easily exchange traffic between each other without having to run individual cables between each others' routers. Networks connect to a peering exchange, run a single cable, and then can connect to many other networks. Since using a port on a router has a cost (routers cost money, have a finite number of ports, and a port used for one network cannot be used for another), and since data centers typically charge a monthly fee for running a cable between two different customers (known as a "cross connect"), connecting to one service, using one port and one cable, and then being able to connect to many networks can be very cost effective.

The value of an exchange depends on the number of networks that are a part of it. The Amsterdam Internet Exchange (AMS-IX), Frankfurt Internet Exchange (DE-CIX), and the London Internet Exchange (LINX) are three of the largest exchanges in the world. (Note: these links point to PeeringDB.com which provides information on peering between networks. You'll need to use the username/password guest/guest in order to login.)

In Europe, and most other regions outside North America, these and other exchanges are generally run as non-profit collectives set up to benefit their member networks. In North America, while there are Internet exchanges, they are typically run by for-profit companies. The largest of these for-profit exchanges in North America are run by Equinix, a data center company, which uses exchanges in its facilities to increase the value of locating equipment there. Since they are run with a profit motive, pricing to join North American exchanges is typically higher than exchanges in the rest of the world.

CloudFlare is a member of many of Equinix's exchanges, but, overall, fewer networks connect with Equinix compared with Europe's exchanges (compare, for instance, Equinix Ashburn, which is their most popular exchange with about 400 networks connected, versus 1,200 networks connected to AMS-IX). In North America the combination of relatively cheap transit, and relatively expensive exchanges lowers the value of joining an exchange. With less networks joining exchanges, there are fewer opportunities for networks to easily peer. The corollary is that in Europe transit is also cheap but peering is very easy, making the effective price of bandwidth in the region the lowest in the world.

**Asia**
Asia's peering rates are similar to Europe. Like in Europe, CloudFlare peers 50-55% of traffic in Asia. However, transit pricing is significantly more expensive. Compared with the benchmark of $10/Mbps in North America and Europe, Asia's transit pricing is approximately 7x as expensive ($70/Mbps, based on the benchmark). When peering is taken into account, however, the effective price of bandwidth in the region is $32/Mbps.

There are three primary reasons transit is so much more expensive in Asia. First, there is less competition, and a greater number of large monopoly providers. Second, the market for Internet services is less mature. And finally, if you look at a map of Asia you'll see a lot of one thing: water. Running undersea cabling is more expensive than running fiber optic cable across land so transit pricing offsets the cost of the infrastructure to move bytes.

**Latin America**

Latin America is CloudFlare's newest region. When we opened our first data center in Valparaíso, Chile, we delivered 100 percent of our traffic over transit, which you can see from the graph above. To peer traffic in Latin America you need to either be in a “carrier neutral” data center — which means multiple network operators come together in a single building where they can directly plug into each other's routers — or you need to be able to reach an Internet exchange. Both are in short supply in much of Latin America.

The country with the most robust peering ecosystem is Brazil, which also happens to be the largest country and largest source of traffic in the region. You can see that as we brought our São Paulo, Brazil data center online about two months ago we increased our peering in the region significantly. We've also worked out special arrangements with ISPs in Latin America to set up facilities directly in their data centers and peer with their networks, which is what we did in Medellín, Colombia.

While today our peering ratio in Latin America is the best of anywhere in the world at approximately 60 percent, the region's transit pricing is 8x ($80/Mbps) the benchmark of North America and Europe. That means the effective bandwidth pricing in the region is $32/Mbps, or approximately the same as Asia.

**Australia**
Australia is the most expensive region in which we operate, but for an interesting reason. We peer with virtually every ISP in the region except one: Telstra. Telstra, which controls approximately 50% of the market, and was traditionally the monopoly telecom provider, charges some of the highest transit pricing in the world — 20x the benchmark ($200/Mbps). Given that we are able to peer approximately half of our traffic, the effective bandwidth benchmark price is $100/Mbps.

To give you some sense of how out-of-whack Australia is, at CloudFlare we pay about as much every month for bandwidth to serve all of Europe as we do to for Australia. That's in spite of the fact that approximately 33x the number of people live in Europe (750 million) versus Australia (22 million).

If Australians wonder why Internet and many other services are more expensive in their country than anywhere else in the world they need only look to Telstra. What's interesting is that Telstra maintains their high pricing even if only delivering traffic inside the country. Given that Australia is one large land mass with relatively concentrated population centers, it's difficult to justify the pricing based on anything other than Telstra's market power. In regions like North America where there is increasing consolidation of networks, Australia's experience with Telstra provides a cautionary tale.

### Conclusion

The chart above shows the relative cost of bandwidth assuming a benchmark transit cost of $10/Megabits per second (Mbps) per month (which we know is higher than actual pricing, it's just a benchmark) in North America and Europe.

While we keep our pricing at CloudFlare straight forward, charging a flat rate regardless of where traffic is delivered around the world, actual bandwidth prices vary dramatically between regions. We'll continue to work to decrease our transit pricing, and increasing our peering in order to offer the best possible service at the lowest possible price. In the meantime, if you're an ISP who wants to offer better connectivity to the increasing portion of the Internet behind CloudFlare's network, we have an open policy and are always happy to peer.
Guest • 2 years ago
Africa is not on the map?
38 • Reply • Share

eastdakota Mod → Guest • 2 years ago
We don't operate data centers in Africa (or Russia or India or China or the Middle East) yet. As such, we don't have first hand data on bandwidth pricing or peering rates. We could speculate wildly, but that's not our style. We're working on our first data centers in these regions and, when we do, we'll be able to revisit this topic.
60 • Reply • Share

madAndroid → eastdakota • 2 years ago
Biggest problem in South Africa is the persistent domination of an unregulated telecoms provider which (presumably) bribes it's way into continuing its monopoly.
4 • Reply • Share

Xileer → madAndroid • 2 years ago
(Fellow?) South African here - Problem is indeed Telkom - For both us, and for everyone else :p
4 • Reply • Share

Roger → madAndroid • 2 years ago
How much is a piece of string ;)
• Reply • Share

Callum Williams → eastdakota • 10 months ago
Well how about Sweden?
1 • Reply • Share

Matteo Fabbri → Guest • 2 years ago
ahahahahahah no.
6 • Reply • Share

realtalk → Guest • 2 years ago
they dont even have power or water dude i dont think they care about bandwidth
13 • Reply • Share

Khalil Kacem → realtalk • 2 years ago
Well I live in Africa and here I am well-fed, hydrated and reading your ignorant comment
232 • Reply • Share
Unfortunately the common perception of Africa is basically dudes living in thatch huts in the jungle, when in reality most Africans, just like the rest of the world, live in urban areas.

There's a reason why Africa can't have nice things, and it's got nothing to do with Africa itself. Alas.

Interestingly Africa is quite well connected in places. I remember reading somewhere that in Somalia, a fairly poor country even by African standards, more people have mobile phones than have connected power.

In much of the developing world, and much of Eastern Europe as well, people have mobile phones, because it's much easier to deploy radio-based systems than install and maintain a wired infrastructure.

Yea, and you represent the average of Africa's population... right?

Pity most of your countrymen are not... or are you the reason they are not?

Welcome to "Africa"

Where did you get your data from?

Nigeria has power and the internet: I have loads of emails to prove that...

LOL, Nigerian lotto scams! DON'T BE THE FALLGUY!!!
Ludovic Fauvet ➔ realtalk • 2 years ago

Seeing ISP like liquidtelecom.com or zol.co.zw deploying optical fiber in some African’s countries, I can safely assume that some of them already have a better connection than you do ;-) 

shayneo ➔ Ludovic Fauvet • 2 years ago

You would not believe how much it hurts to read Zimbabwe is getting fibre when our conservative luddite government here in australia has made it a point of honor scrapping the fibre roll out because OMG BUDGET DEFICIT (we've one of the lowest deficits in the world)

I'll Be Frank ➔ realtalk • 2 years ago

I'm from Africa. I'm using a 65mbit connection to do some stock trading while updating my servers in the US. Later I'll drive to the office in my German car. I really hope I get some of that nice water.

Alex ➔ I'll Be Frank • 2 years ago

Would be good if there was a site that compared internet plans in Africa then we could compare it will nbn plans in Australia from http://nbncompared.com.au

Mike ➔ Alex • 2 years ago

Africa is 50 different countries, so collecting comprehensive pricing information on consumer services is hard. Typically, there is not much last-mile fixed copper, cable or fibre. Last-mile services are usually wireless, 3G, Wimax, etc. Africa has skipped the "copper" generation and gone straight to mobile.

There is lots of long-distance fibre being laid - see www.afterfibre.net for a map.

African peering is developing, with many new Internet Exchanges being set up across the continent.

PB ➔ I'll Be Frank • 2 years ago

Maybe you should share some of you apparent wealth?

I'll Be Frank ➔ PB • 2 years ago

Why don't you show others how to live rather than telling them?

Mark Wallace ➔ PR • 2 years ago
Why do you think that such insulting comments are useful? Maybe rich Americans should share some of their wealth with poor Americans. If you talk like an idiot, we'll assume you're an idiot.

yo ➔ realtalk • 2 years ago
Au contraire. I grew up in Kenya. People on the capital definitely do

Jerome ➔ realtalk • 2 years ago
They do care. CloudFlare is present at #AfpiF2014 right now to establish partnerships in Africa.

megabosx ➔ realtalk • 2 years ago
Your ignorance is astounding.

aijosh ➔ realtalk • 2 years ago
I hope you are actually joking. Please say you were joking.

madAndroid ➔ realtalk • 2 years ago
Staggering. After continuously exploiting Africa for natural resources, and not contributing in positive ways, it's not surprising that attitudes such as yours persist.

Patrick Mukora ➔ realtalk • 10 months ago
... actually i get my water from a solar / wind hybrid powered treatment plant that also provides electricity .... I have a 5 terabyte internet connection that you cannot get anywhere else in the world ... talking about Africa ?????

dev ➔ realtalk • 2 years ago
parts of places like south africa and egypt are actually very rich. i know a guy from a ritzy part of ZA.

TheTruth ➔ Guest • 2 years ago
Africa is all mobile, they are the future.

Kristian Puccio • 2 years ago
Thanks John Howard! And to think we started to fix this and the libs got in and did more deals with Telstra!
You are wrong in thinking it was Howard that is to blame. It was actually a Labor government which started the ball rolling. The Whitlam government. They were the ones who split the PMG into two government run companies, Australia Post and Telecom Australia.

Actually, it's the British. They’re the ones who decided to setup penal colonies here in the 18th century and then foolishly let us start governing ourselves in 1901.

Whitlam didn't create a private monopoly though did he? But I think we both agree that the current situation really sucks. The NBN was a good chance to fix it but seems not anymore.

You're quite right. The Whitlam government didn't do that. It was the Barton government of 1901 which created the public service monopoly, the PMG. Whitlam split the public service monopoly into 2 government run for profit companies, maintaining the monopoly. The Howard government in 1997, with the sale of the first tranche of shares, was the start of giving up government control of the monopoly, turning it private. And that process was completed under a Howard government in 2006. All the while, maintaining the monopoly.

These problems should have been solved before the sale, I think that's what he was referring to. Regulation became harder once it became a private company.

Now we have to incur the massive costs of the NBN to create a level playing field. The copper network buyback was going to be $30 billion last I heard, equal to the entire privatisation of Telstra.
rob 2 years ago

I think you are overstating the benefits of the NBN which is another government owned monopoly transit provider.

They aren't buying the copper either merely leasing duct access and agreeing not to provide an ADSL/HFC based data service or a POTS service on their last mile infrastructure for 20 years. There are copper based services that are exempt from the NBN turn down however your typical house hold is highly unlikely to utilise these.

The unfortunate fact is that some 2.9 million premises are already passed by a technology capable of providing NBN speeds today - HFC as it currently stands deployed by Optus and Telstra is at Docsis 3 and is capable of providing 100Mbps without breaking a sweating the the upcoming Docsis revisions show a path beyond a 1Gbps.

I understand the requirement for ubiquitous broadband access however both governments could do a better job at delivering it.

rob 2 years ago

And I bet you would think for the prices Telstra charges they would give good customer service? Hell flipping no.

And Australians wonder why no major game servers and other services want to operate out of Australia.

Josh Taylor 2 years ago

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Adam N 2 years ago

In Kenya it's double Australia's price for high quality transit (no oversubscription, BGP, etc...). That number comes down closer to Australia though at higher speeds. Luckily at Kili (http://kili.io) we've been able to get a flat tier for East African transit and only have to pay the exorbitant fees to get out of Mombasa.

FUCK Telstra Adam N 2 years ago

You're comparing Australia a developed country with individuals with the money and brainpower to both setup and maintain a 110% service to Kenya. The only reason we don't have 100% better quality in Australia is because we got bent over and the huge corporate d*ck is now firmly up our asse.

Damien Gardner Jnr Adam N 2 years ago

Australia just happens to be the most expensive on the list - hence the comparison.
The Relative Cost of Bandwidth Around the World

173x808 to 200x835

https://blog.cloudflare.com/the-relative-cost-of-bandwidth-around-the-world/