CS249i: The Modern Internet

Stanford Computer Science

Yes, the "i" stands for Internet. Thanks, Mehran.
Internet Transit

(Connecting to the Edge)
Basic Internet Access

Let's suppose you start a business and want Internet access...

(Unfortunate) Reality: If you're small, there's zero incentive for any large network to peer with you. (Costs them money, nothing in return)

Solution: You need to pay someone to advertise your routes to the rest of the Internet and to provide you with a route to everyone else.

Known as Internet Transit or IP Transit. IP Transit is a commodity.

You buy IP Transit ("Internet") from a Transit Provider, which are colloquially referred to as Internet Service Providers (ISP)
Companies pay small, regional ISPs for Internet transit

Small ISPs pay medium sized ISPs for Internet transit

Medium ISPs pay large ISPs for Internet transit
Quick Terminology Note

⚠️ The word "peering" can mean multiple things

**IP/Internet Transit**: Customer pays Provider for Internet access

**IP/Internet Peering**: Two "peers" (i.e., equals) agree to exchange traffic with one another with no transit costs (in either direction)

**BGP Peering**: Protocol-level BGP connection between two autonomous systems. Happens for both IP Transit and Peering.

Assume we mean Internet Peering unless we say **BGP Peering**
Choosing an IP Transit Provider

Except for residential access, Internet Transit is a metered service. Different providers have different costs, different assurances.

If you're small, you're probably choosing from a limited number of regional providers — it's expensive to lease fiber to connect to someone far away from you.

Not necessarily a direct correlation between price and quality. ISPs have different reputations. Knowledge is shared through industry groups like NANOG (North American Network Operators' Group).
Pre-Commit + Burst Rate + Port Size

Generally, you negotiate two costs:

- **Commit ("Flat Rate")** — how much you pay each month regardless of whether you use less than the committed amount (at a discounted rate)

- **Burst Rate** — how much you pay per megabit between commit and 95th percentile. Typically more expensive than or tied to flat rate.

For example, you could commit to 3 Gbit on a 10 Gbit port.

As part of this negotiation, you also define an SLA (Service Level Agreement). This quantifies acceptable downtime, max packet drop rate, transit times within the ISP.

"SLAs are widely dismissed by operators as merely insurance policies"
— William Norton (Co-Founder of Equinix)
95th Percentile Pricing (aka 95/5 pricing)

Calculate usage every 5 minutes (max of inbound and outbound). Line up from lowest to highest. Charge based on 95th percentile.

Allows small bursts without affecting overall costs. Big bursts of traffic throw off averages — demonstrated problem in late 90s early 2000s.

Bandwidth can be used at a higher rate for up to 72 min/day with no penalty.
Basic Internet Access

Do you need to BGP peer with anyone for Internet access?

If you're not a large organization, you're likely not going to BGP peer with your ISP

Why No?
- Tremendous room for error in BGP configuration
- Minimum size of routed prefix is /24 = 256 addresses
- Router needs sufficient memory to store Internet routing table ($$)
  - Can sometimes ask for your ISP to provide only default route

Why Yes?
- You want to advertise an AS to multiple upstream providers
- You want to control your own AS and IP blocks