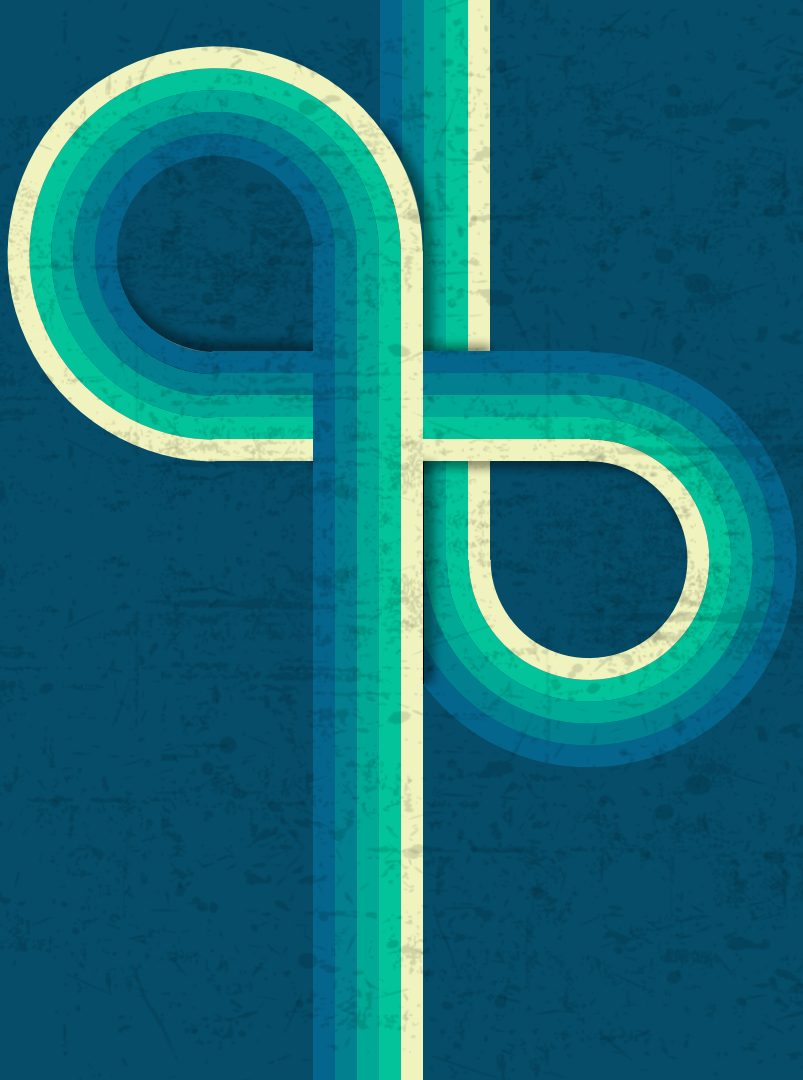


What Even is the Internet, Really?

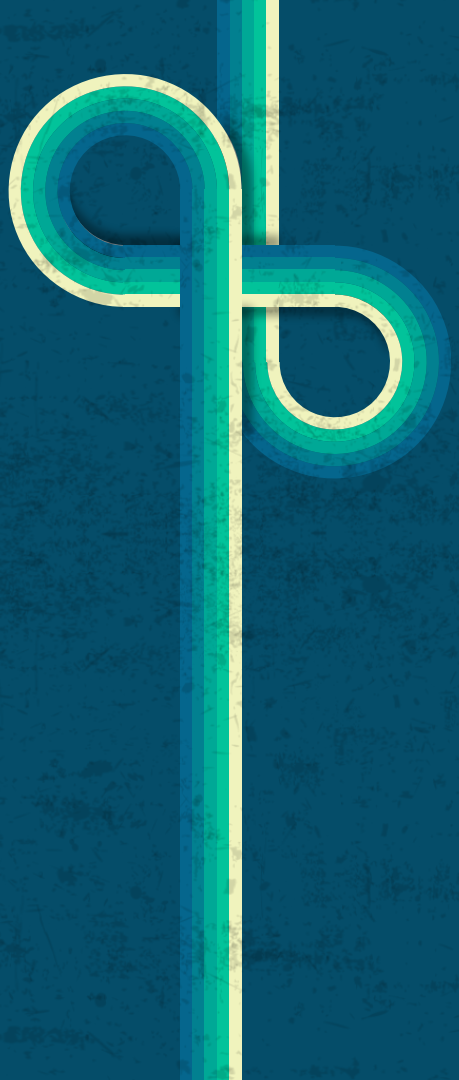
Ian Foster
AS22296

$ whoami

Ian Foster

AS22296

Cosplay as a Network Operator



This Talk

- I hope to answer the question:
  - How does your ISP get the internet which they then sell to you?

- This can be complex. In the interest of time, I'll be glossing over some complex issues and skipping some rabbit holes.

- People pay ISPs good money to not know any of this!

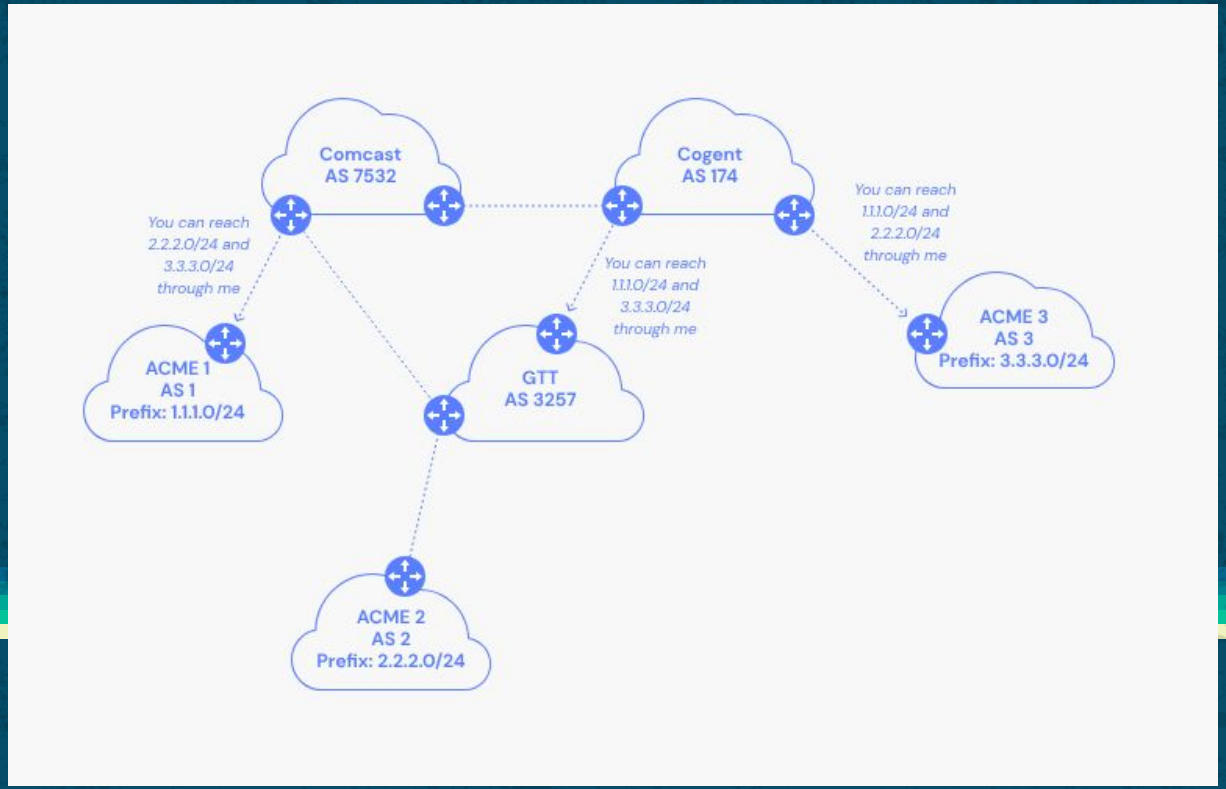
Why would I do this?

- Learning and Tinkering
- Save $$$
  - Some of the projects I run would cost > 80k/mo in a cloud provider
- Self Reliance
  - Minimal reliance on 3rd party services
  - You are the SLA!
- Offer services to others
- Take self-hosting to the next level

The Internet

- At its core, the Internet is an interconnected fabric of separate networks.
- Each network is operated independently
  - Only connected to other networks in defined places
- Smaller networks, like your home you get connected through an ISP
  - Often provide you a modem/route to provide access
  - Run "last-mile" cabling

Interconnected Networks



Internet Routing

- Get ASN & IPs
- Finding hosting facility
- Set Up BGP routing
- Find peers and peer with them
- Find upstream transit provider(s)

ISP: Internet Service Provider

- IP space allocated by a regional internet registry (RIR)
- Your own ASN to uniquely identify your network
- At least one router connected to another ASN speaking BGP
  - Tell the rest of the internet how to reach your IP space
- Real legal company

Types of Networks

- Eyeball
  - Home Users
  - Most office networks
- Content
  - Cloud Providers
  - Video streaming, ecommerce, etc..
- Carrier
  - Connect other networks together

ASN: Autonomous System Number

- Unique identifier for your network
- Issued by regional internet registries (RIR)
- 16 or 32 bit number
  - We ran out of 16-bit ASNs
    - Now issuing 32bit
  - Compatibility issues with 32 bit ASNs

BGP: Border Gateway Protocol

- A protocol for networks to inform each other about the reachability of their address space and adjacent networks.
- Is a set of rules that determine the best network routes for data transmission on the internet
- Can dynamically get routes from other networks/ASNs
- Additional "business logic" can be used to influence routing decisions

IP: Internet Protocol Address

- Also issued by internet numbering organizations
- Can request IPv6 /36 easily
  - >200M /64 networks
- IPv4...
  - Waitlist to buy
  - Rent/buy from 3rd party marketplace
- Can "Use" rented IP subnets with LOA
- Setup RPKI and IRR for "security"...

LOA: Letter of Authorization

- Document that authorizes one ASN to advertise some of another network's IP space.
- "Very official letter"
- Ex:

```
Dear Sirs
Please accept this letter of authority on behalf of
[IP SUBNET OWNER] to permit the BGP announcement of
[IP SUBNET] by [YOUR NAME HERE].
Regards.
```

Routing "Security"

Internet Routing Registry (IRR)

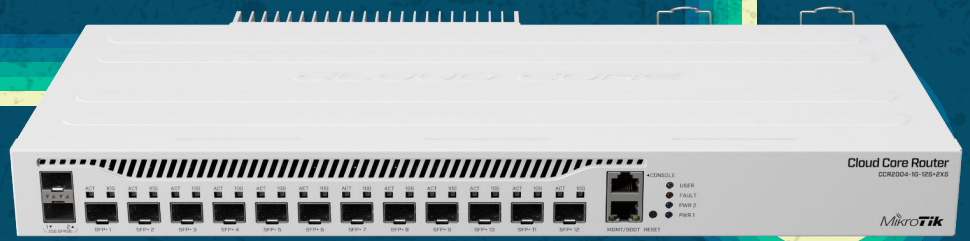
- Private and public RIR DBs
- Defines what networks are allowed to use what IPs

Resource Public Key Infrastructure (RPKI)

- CA & DB run by RIRs
- Certifies ASNs authorized to advertise networks
- Like IRR but with Crypto

Getting a Router

- Not the same as your home "router"
- Needs to be beefy enough to handle multiple copies of the entire internet routing table in ram
  - > 1.4M routes
- Makes routing decisions based on configured policies
  - No default gateway
- Mikrotik/Juniper/Cisco
- Want to offload as much as possible to routing ASIC
  - CPUs are slow!
- Can also use a Linux box with open source routing software



Data center

- Somewhere to put all your routers/servers/etc
- Provides power, cooling, physical security
- Offers cross-connects to other networks
- Transit providers available in building


DATACENTER
Let's go. In and out. 20 minute adventure.
8 HOURS LATER
imgflip.com

Peering

- A direct connection between two networks
- Want to offload as much traffic as possible from transit providers for performance and cost optimization
- Peering with a network that is large enough to effectively reach the entire internet is called "transit"
    - You need at least one of these

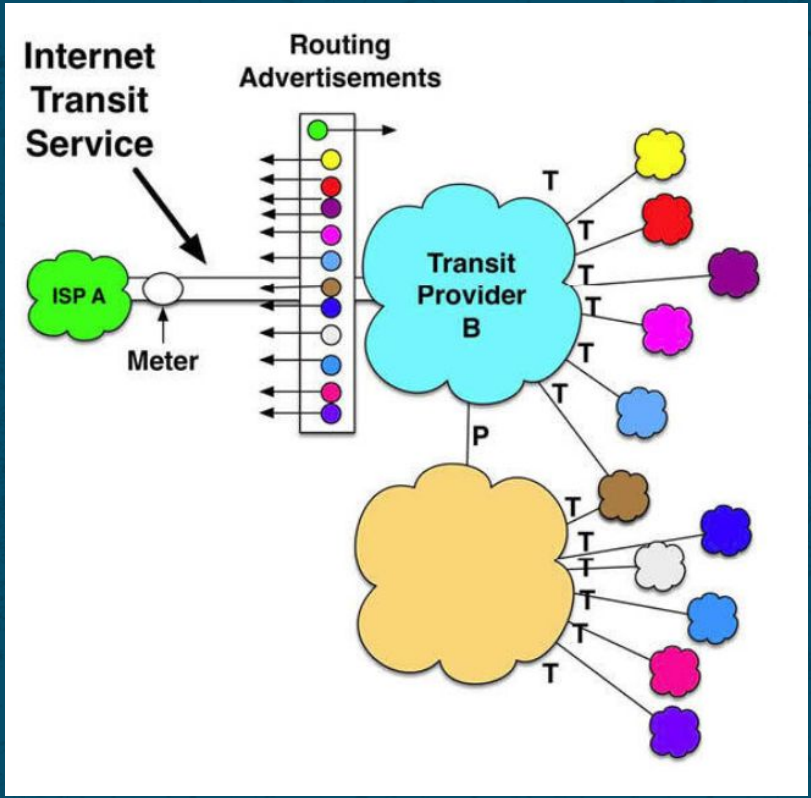
Connecting to Other Networks

Peering

- Mutually beneficial
- Only send traffic destined for eachother
- Optimize for speed & cost

Transit

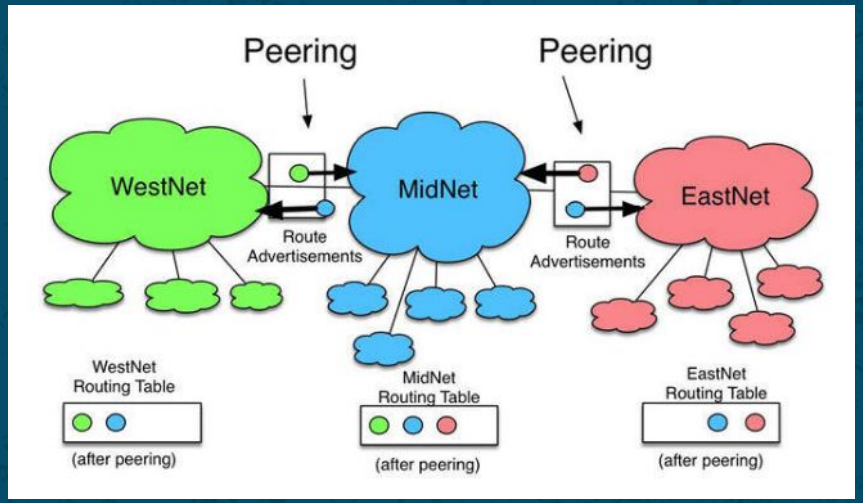
- Transports traffic from you to other networks
- The more you have, the more resilient your network is
- Ensure you can reach everywhere, path of last resort

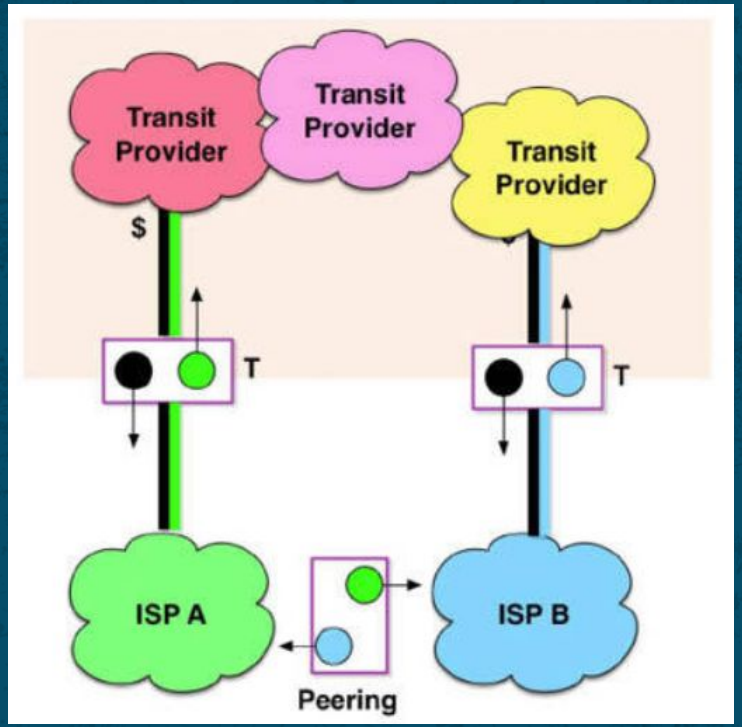


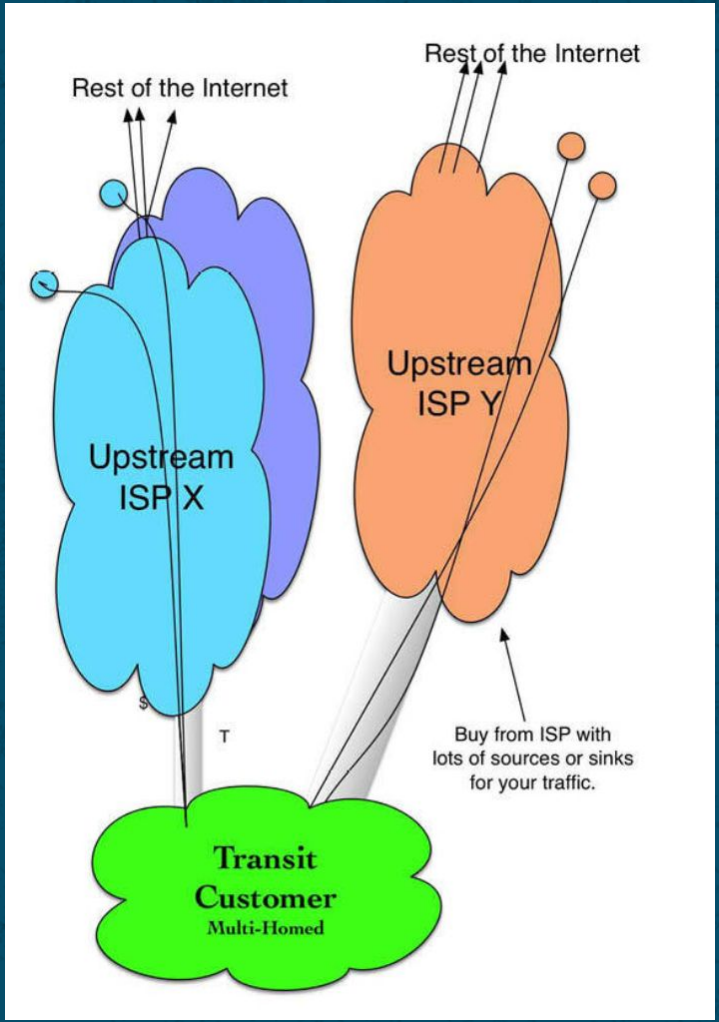
Transit Routing

Transit providers exchange your routes with all other connected networks

Peering is not a transitive relationship



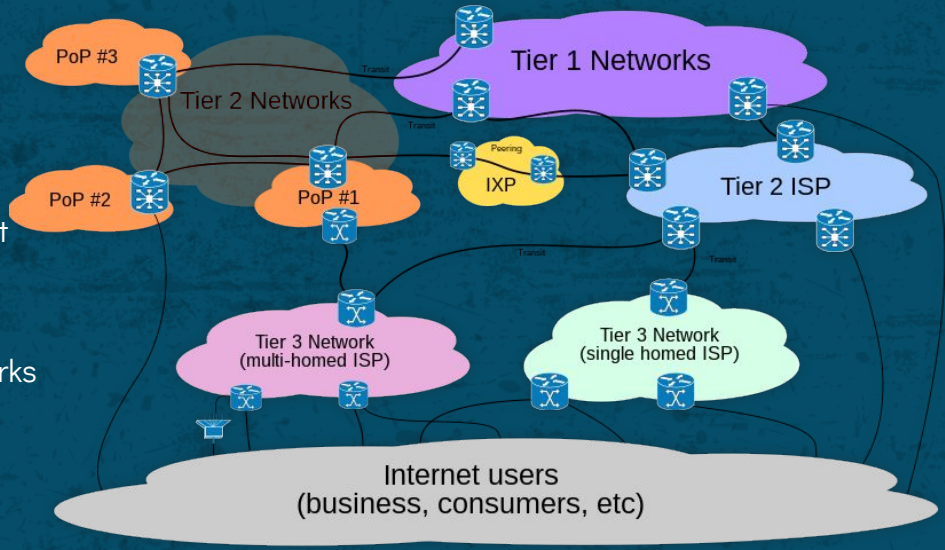




Multi-homing

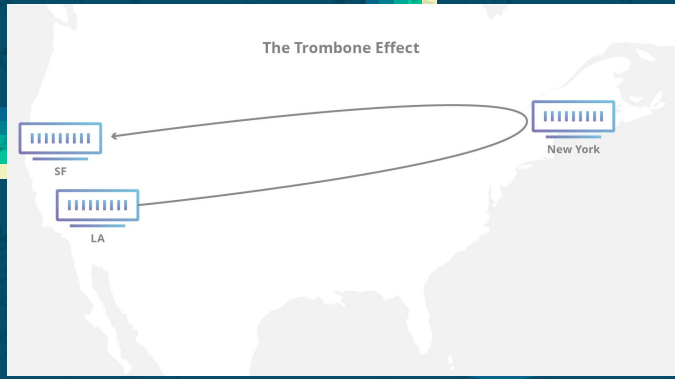
Network Tiers

- **Tier 1**
  - A network that can reach every other network on the Internet solely*
  - Does not pay anyone for "internet"
- **Tier 2**
  - A network that connects with some networks, but still purchases IP transit or pays for peering to reach at least some portion of the Internet.
- **Tier 3**
  - A network that solely purchases transit from other networks to participate in the Internet.
  - We are here!

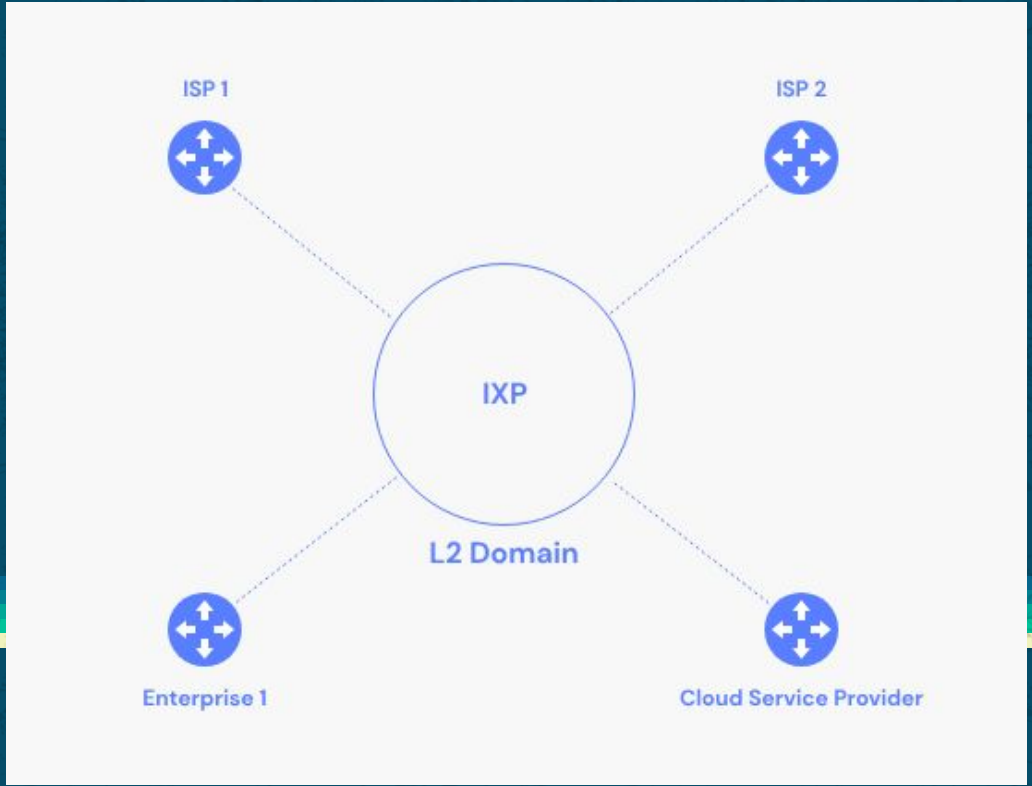


IX: Internet Exchanges

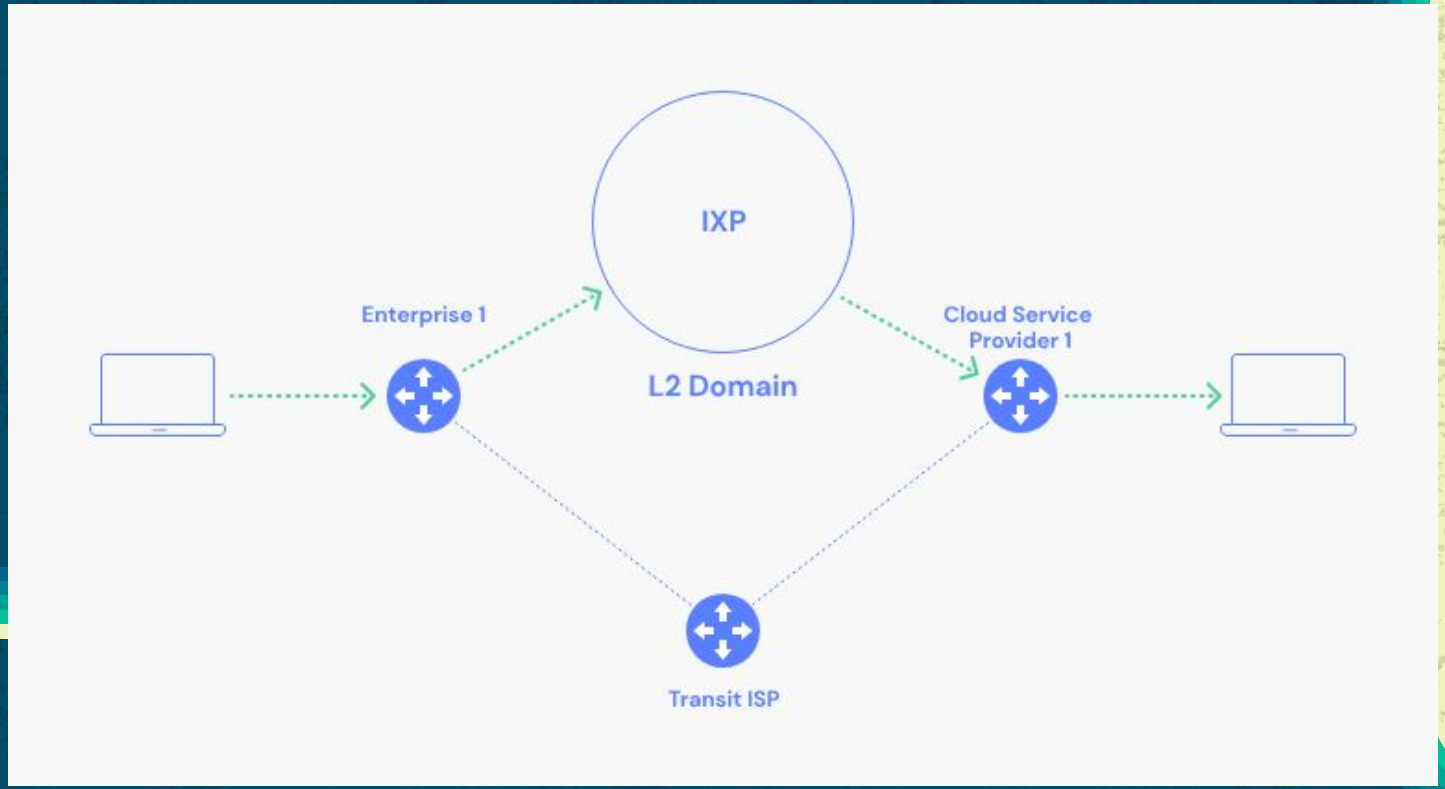
- A collection of peers who exchange routes with each other for mutual benefit
- Keep traffic local to a region
  - Avoids the trombone effect
  - Reduces latency
- More efficient than using a dedicated cross connect for each network
- Often run route servers so that a single BGP session can be used to get routes from all peers



Internet Exchanges

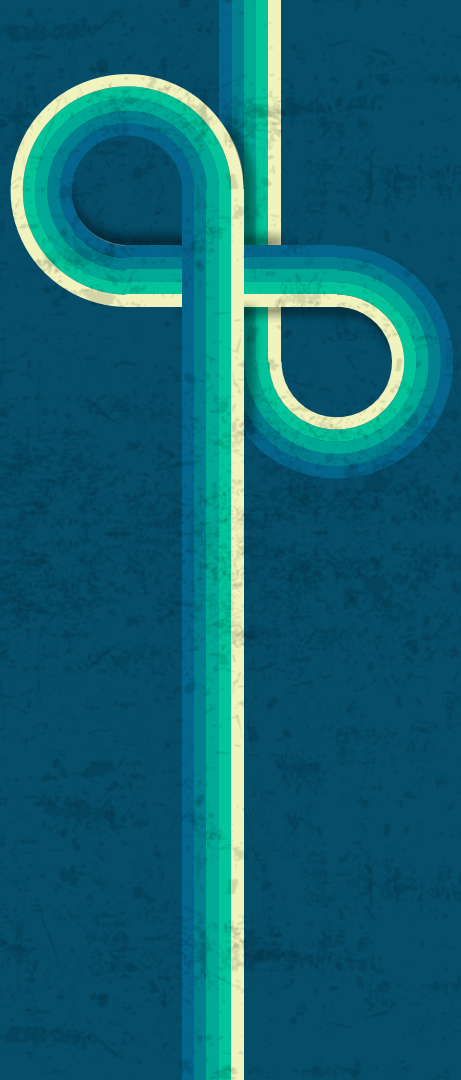


Internet Exchanges: Routing



IPv6

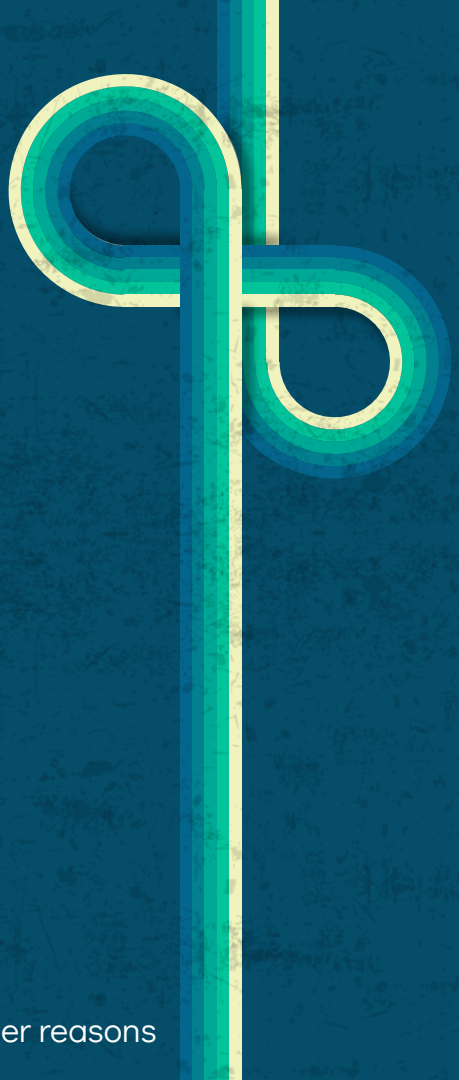
Why is it still so broken?



IPv6

Why is it still so broken?

Drama!*

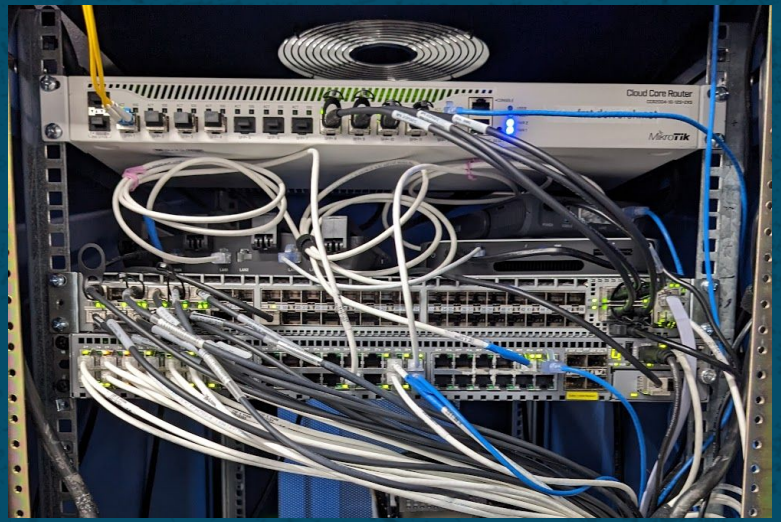


*among other reasons

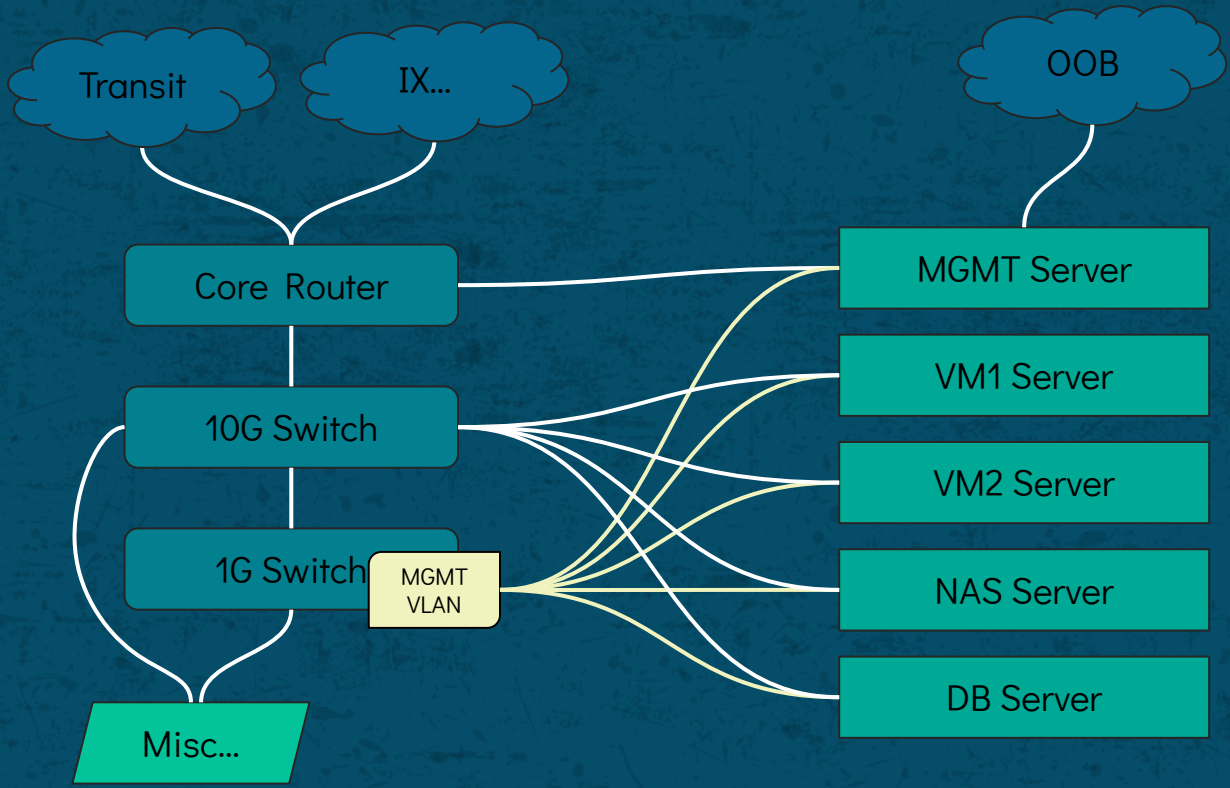
IPv6 Islands

- The two largest IPv6 networks, HE & Cogent don't peer with eachother!
  - Cogent wants HE to pay to access their half of the internet
  - HE wants a mutually beneficial peering agreement
- The result:
  - In order to reach the full IPv6 internet, you need to buy transit from 2 providers instead of just one.
  - Many ISPs don't do this, fragmenting the internet

The Network



The Network


Transit
IX...
OOB
Core Router
10G Switch
1G Switch
MGMT VLAN
Misc...
MGMT Server
VM1 Server
VM2 Server
NAS Server
DB Server

What's Next?

- Continue to build out and expand the network and services

- We host your cool projects!
  - https://toor.sh
  - projects@toor.sh

Special Thanks

Mike Damm

Knowledgebase

UNIXSurplus

Hardware

Hurricane Electric

Data Center

ToorCon

non-profit org

Thanks!

AS22296

https://peerwith.me/22296

https://toor.sh
projects@toor.sh