CS249i: The Modern Internet[1]

Stanford Computer Science

[1] Yes, the "i" stands for Internet. Thanks, Mehran.

Stanford University

CS249i vs. CS144 vs. CS244

CS144: Introduction to Networking ← **prerequisite!**

- Basic networking concepts (e.g., Ethernet, IP, TCP/UDP)

- Laboratory projects (e.g., implement TCP)

CS244: Advanced Topics in Networking ← **more research-y**

- Discuss recent research and some advanced topics

- Programming assignments + big research project

CS249: The Modern Internet ← **more real-world**

- How does the Internet *actually* work today?

- Investigative (Internet Measurement) projects

- Industry guest speakers

tl;dr: CS144 is a prerequisite. CS244 has only a little bit of overlap.

Example: Topology and Routing

CS144

Topics:
- What is routing?
  What types of routing is there?
- BGP vs. RIP vs. IGRP
- What is an autonomous system?
- What is a Tier-1 ISP?

Project:
- Implement IP router in an isolated environment

CS249i

Topics:
- What do peerings look like in 2024?
- How does IP peering differ from IP transit?
- How do you peer with an ISP?
- How much does Internet cost?
- Where do you peer?

Project:
- Peer onto the public Internet
- Analyze global routing table
- You tell me who the Tier-1s are using graph analysis

CS244

Not discussed. 😬

Course Administrivia

Bad News:

- Room doesn't support video capture. You have to show up.

- Some guest lectures will be remote over Zoom. Watch from home!

Good News:

- Dig Deeper in 2024 Projects! Guest Speakers should be fun!

- Class Size 70. Folks on waitlist may get in depending on drops

Grading:

- 3 Investigative Projects + Final Exam (25% each)

Other Notes:

- 🏡 https://cs249i.stanford.edu/. 📥 Gradescope. 📣 Ed. 🤨 Ed. 🤷 Canvas.

- 💁 Office Hours in Gates 432 after class on M and F — find and walk with me! 🚶

- 🧵 Waitlist is FIFO — Please don't email for an exception

👩🏼‍🏫 Who am I?

Assistant Professor of Computer Science

I research how the Internet and security work in practice. I like to measure the Internet.

How do you measure real-world networks and organizations? Highly distributed.

More information: esrg.stanford.edu

I've had the ~~unfortunate task~~ privilege of buying IP ranges, maintaining ASes, negotiating ISP contracts, racking router hardware in Internet Exchange Points, and having my BGP routes hijacked

View Your Associated Networks

You can filter your 9 associated networks by one or more of the attributes listed. You can enter partial information. Use spaces as separators.

- IP Address or Range, Net Handle, Net Name
- Org ID, Organization Name
- POC Handle, Name, and/or Email Address

Example: REGIS-123 cerf @ARIN.net

▸ **Network Summary**

🔍 [   ] Search

☐ Include the 0 networks you've reassigned in your search

Net Handle	Net Range	Net Type	Net Name	Org ID	
NET6-2607-F6D0-EC50-1	2607:F6D0:EC50::/48	Reassigned	SU-CS-V6	SUD-6	➕
NET6-2620-96-E000-1	2620:96:E000::/48	Direct Assig...	CENSY	CENSY	➕
NET-74-120-14-0-1	74.120.14.0/24	Direct Assig...	CENSY	CENSY	➕
NET-162-142-125-0-1	162.142.125.0/24	Direct Assig...	CENSY	CENSY	➕
NET-167-94-138-0-1	167.94.138.0/24	Direct Assig...	CENSY	CENSY	➕
NET-167-94-145-0-1	167.94.145.0 - 167.94.146.255	Direct Assig...	CENSY	CENSY	➕
NET-167-248-133-0-1	167.248.133.0/24	Direct Assig...	CENSY	CENSY	➕
NET-192-35-168-0-1	192.35.168.0/23	Reassigned	MICH-15324	CENSY	➕
NET-198-108-204-216-1	198.108.204.216/29	Reassigned	MICH-15328	CENSY	➕

Routing Review

☎️ **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)
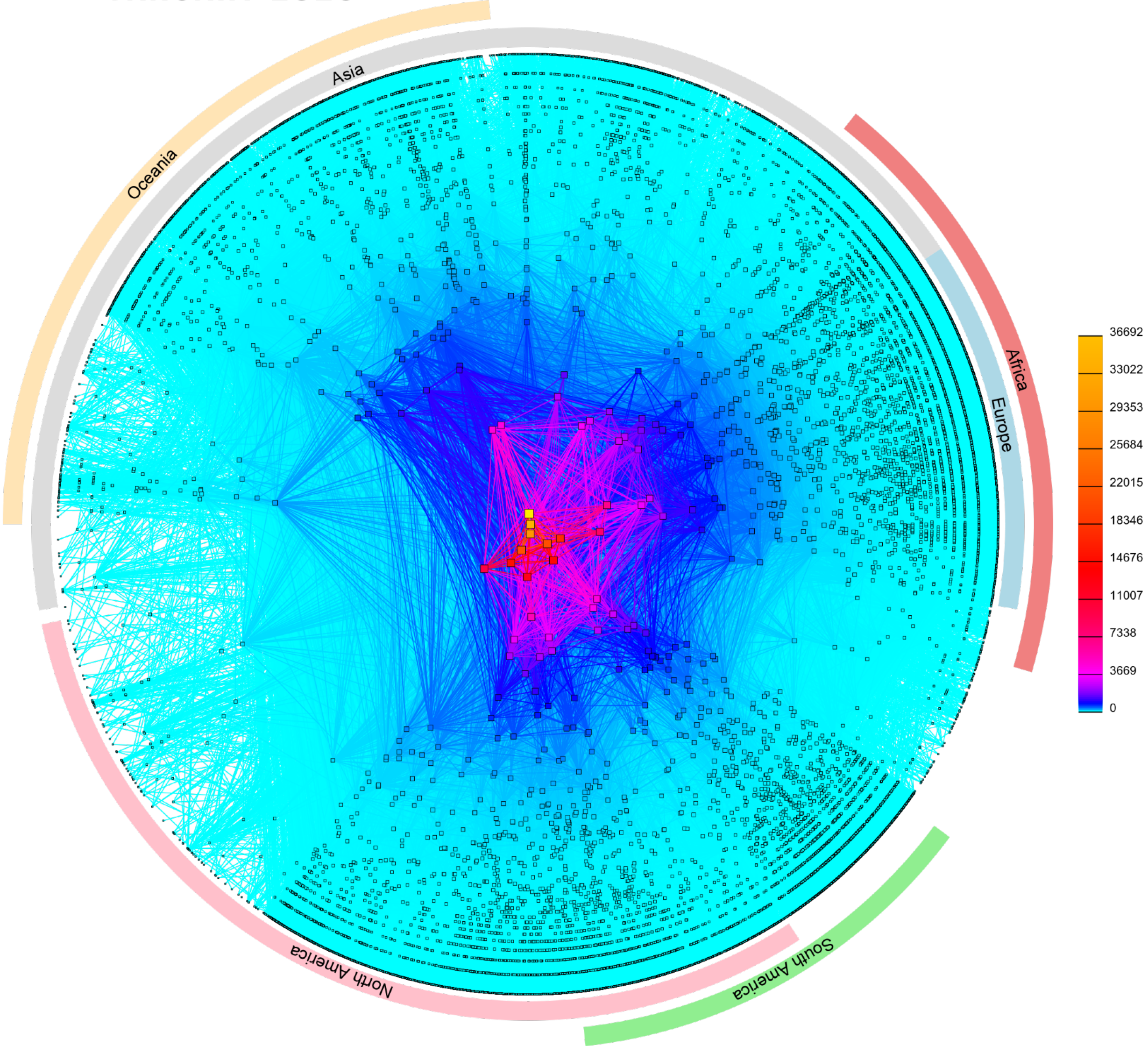
Solution: You need to <u>pay</u> someone to advertise your routes to the rest of the Internet and to provide you with a route to everyone else.

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)

CAIDA'S IPV4 AS CORE GRAPH
JANUARY 2020

Oceania
Asia
Africa
Europe
North America
South America

36692
33022
29353
25684
22015
18346
14676
11007
7338
3669
0

Conventionally....*

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

* We'll talk about how this isn't actually the case later

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 <u>BGP</u> Peering