

CS249i: The Modern Internet¹

Stanford Computer Science

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



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 ← Research Focused

- Discuss recent research and some advanced topics
- Programming assignments + big research project

CS249: The Modern Internet ← Real-World Operations Focused

- How does the Internet *actually* work today?
- Investigative (Internet Measurement) projects
- Industry guest speakers (e.g., Cloudflare, Apple, Stanford)

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

 <https://cs249i.stanford.edu/>.

 Your responsibility to read and follow posted policies!


 Gradescope.  Ed.  Ed.  Canvas.

 Office Hours in Gates 432 on Tuesday 4:00–5:00 PM

 Course Assistants: Catherine Han and Kimberly Ruth

 Grading: 3 Investigative Projects + Final Exam (25% each)

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

 No public lecture recordings — come to class and ask questions!

Investigative Projects

Every project in CS249I is like a mini research project

- No technical specification, auto-grader, or step-by-step instructions
- You will need to collect Internet data, conduct investigation, and write up answers supported by the data you collect
- We recommend using Python, but up to you how to you want to do investigations

Example: Project 1 (Routing and Topology)

- Setup Software Router (Step-by-Step Instructions Provided)
- Investigate the routes you receive from upstream providers to understand:
 - Stanford's Internet Access
 - Global Internet Topology
 - Who are the Tier-1 Internet Service Providers?

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.

[▶ Network Summary](#)

- 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

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...

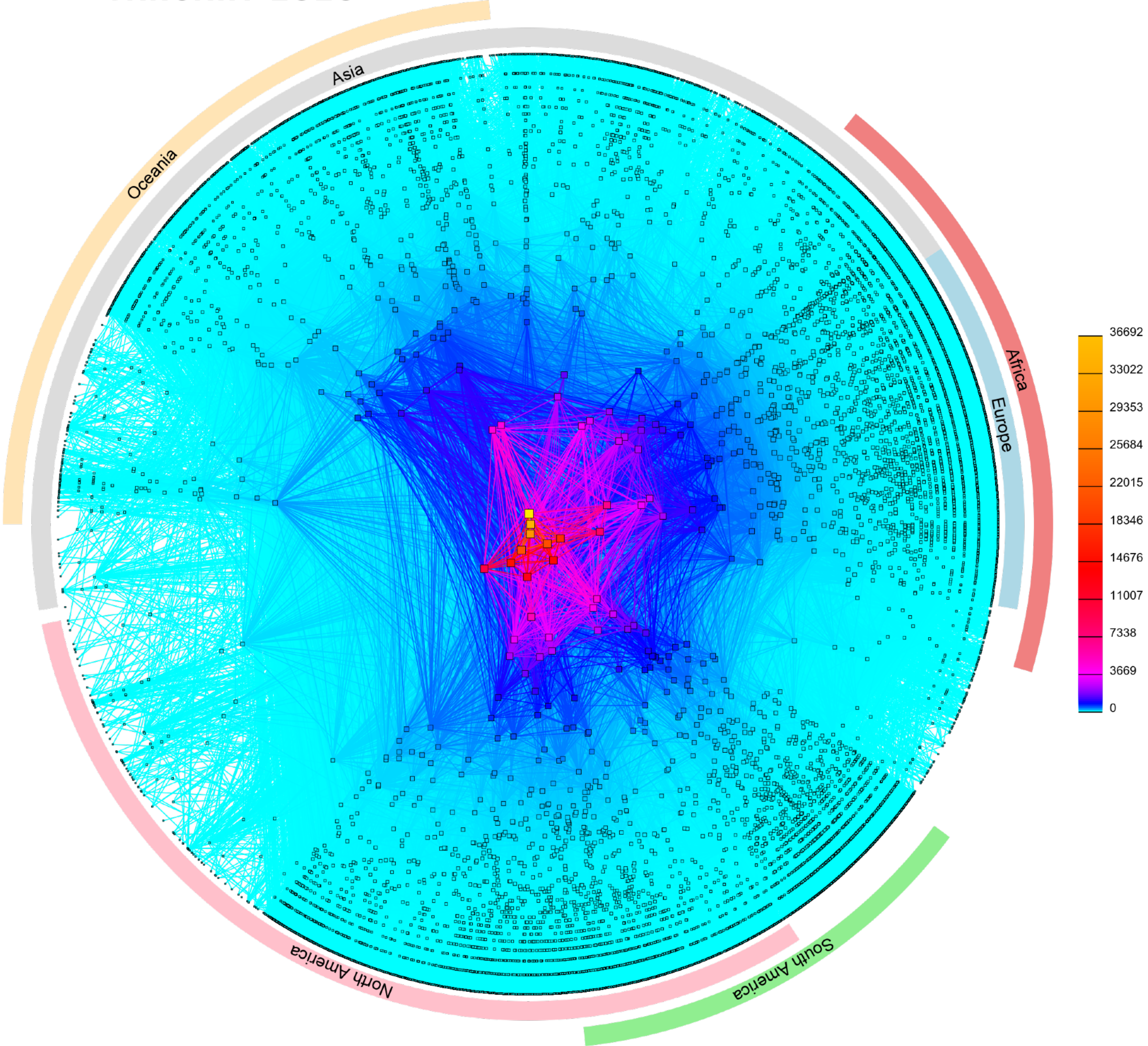
(Unfortunate) Reality: If you're small, there's zero incentive for any large network to peer with you. (Costs them money, nothing in return)

Solution: You need to 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)*

CAIDA'S IPV4 AS CORE GRAPH JANUARY 2020



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 [Settlement-Free] 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