NAT (Network Address Translation)

Section 461

Jokes

- Seal
- Ghostbusters
- Bittorrent

Introduction to Nat

- Grew up in Lexington, KY
- Enjoy stargazing, cycling, and mushroom hunting
- Met Mario once (long time ago)

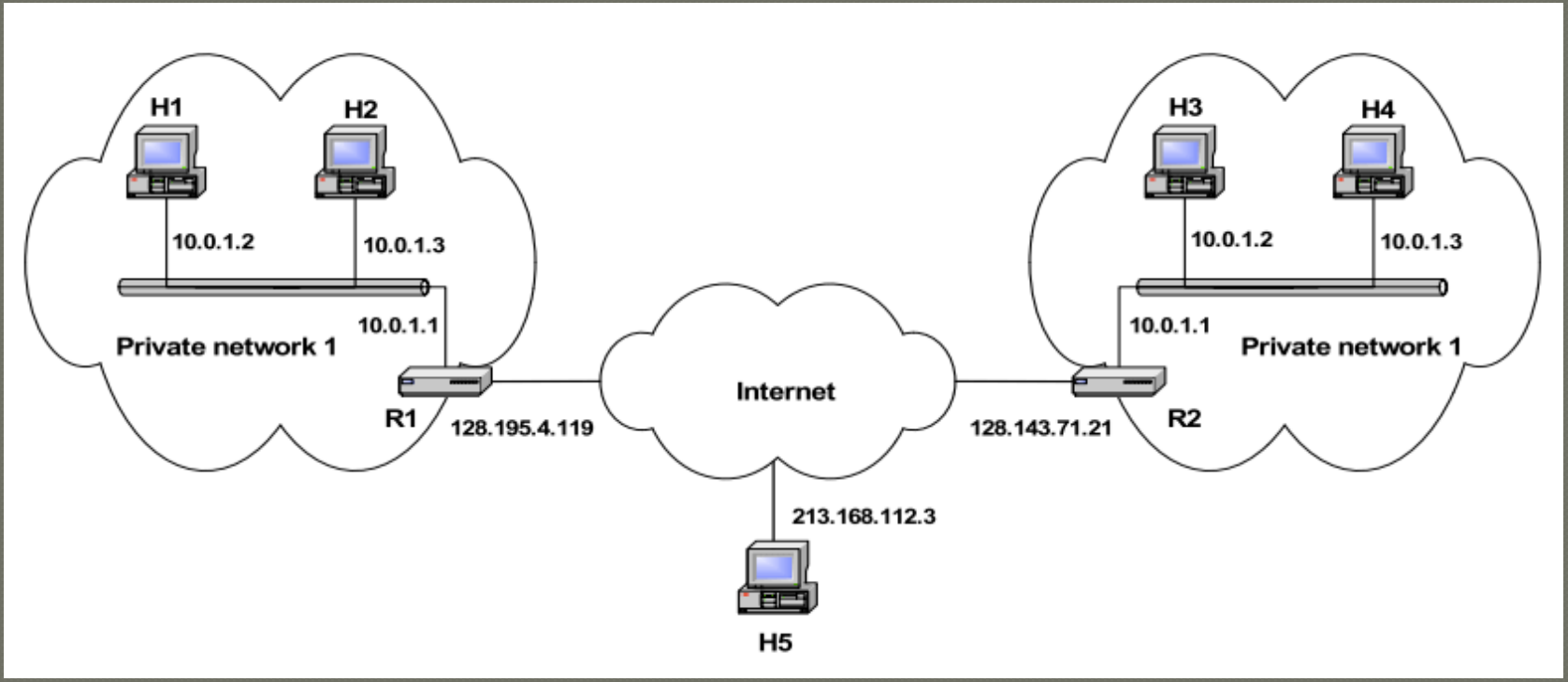
Introduction to NAT

- Network Address Translation
  - Not very old (heavy use since late 90s)
  - Maps from private addresses to public addresses, and vice-versa
  - Port numbers as secondary addressing information
  - Most common type of NAT is actually NAPT (Network Address Port Translation)
  - Other type of NAT is "Basic NAT" (which we won't really be discussing)

Private Networks

- Any IP network that isn't directly connected to the internet
- IP addresses can be assigned however we want!
- However, generally these ranges are used:
  - 10.0.0.0 – 10.255.255.255
  - 172.16.0.0 – 172.31.255.255
  - 192.168.0.0 – 192.168.255.255

NAT Diagram


H1
H2
10.0.1.2
10.0.1.3
10.0.1.1
Private network 1
R1
128.195.4.119
Internet
213.168.112.3
H5
128.143.71.21
R2
H3
H4
10.0.1.2
10.0.1.3
10.0.1.1
Private network 1

How's NAT work?

- How could we do this?

How's NAT work?

- Each NAT device (router) has an address translation table
- For outbound packets, a new table entry is made, choosing an arbitrary source port number (TCP/IP headers rewritten)
- For inbound packets, the table is consulted to rewrite the packet headers and re-route to an internal host
- Phone analogy

Why Do We Need NAT?

- Why is NAT necessary?

Why Do We Need NAT?

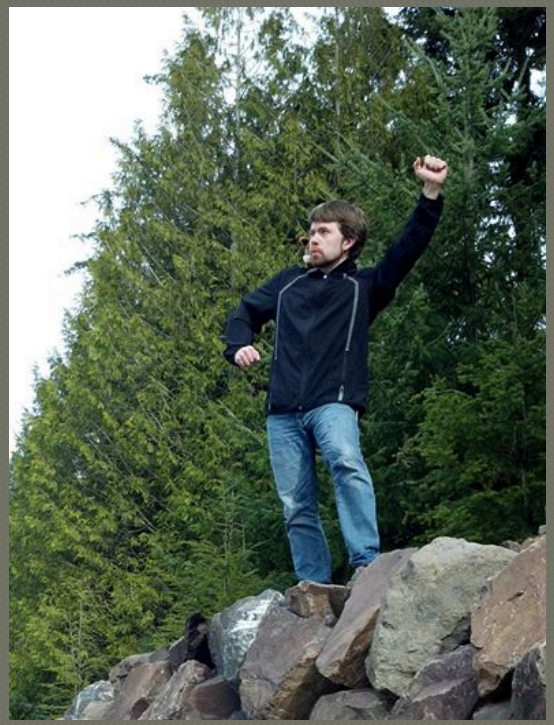
- Why is NAT necessary?
  - Not enough IP addresses to go around
  - We want some hosts *not* to be publicly accessible
  - Security concerns (NATs are used as firewalls)

Types of NAT

- Full-cone NAT
  - Accepts data through any previously used port
- Address-restricted-cone NAT
  - Only accepts data through previously used ports if the source IP matches a system we've already sent to
- Port-restricted-cone NAT
  - Like the above, but uses source ports too
- Symmetric NAT
  - Mappings are unique to external hosts: a different public port is used for each external host

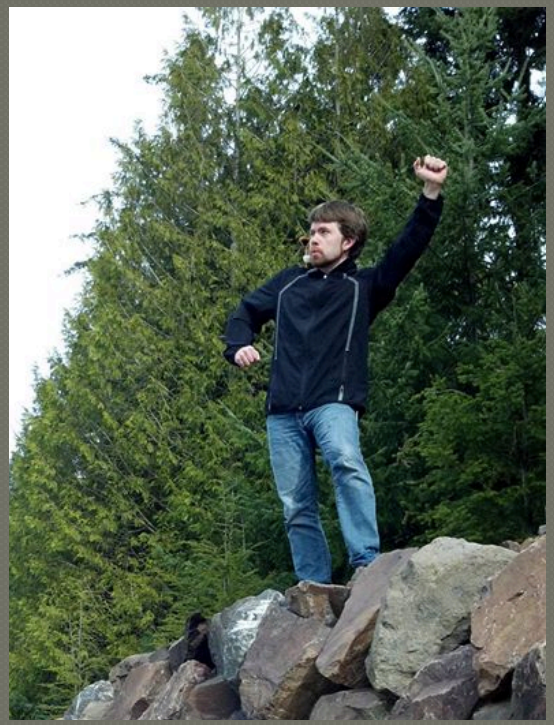
Problems with NAT

- NAT is great!
- But it has issues
- Like what?



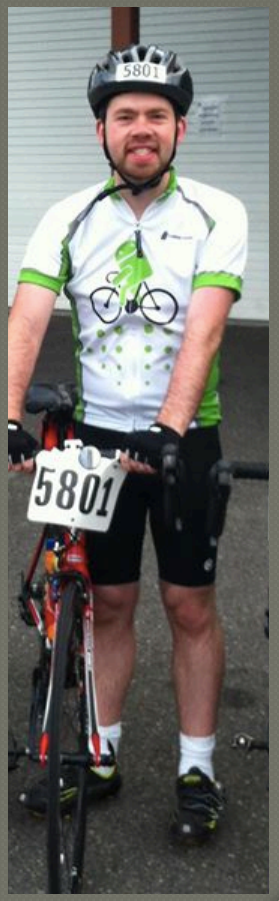
Problems with NAT

- NAT is great!
- But it has issues
- Like what?
  - Breaks "end-to-end principle"
  - Should just use IPv6
  - Rewrites packet headers
  - Even requires new TCP checksum!
  - Initial issue: how do you connect to a host behind a NAT if it hasn't talked to you first?



Running Services behind a NAT

- You're behind a NAT, and you need an external host's packets to get to you
- Example: running a web host behind a NAT
- You can't necessarily send an outbound packet first to write the NAT table
- Major issue for games and P2P
- Solutions?
  - Port forwarding (manually adding tables to the address translation table)



NAT Punchthrough

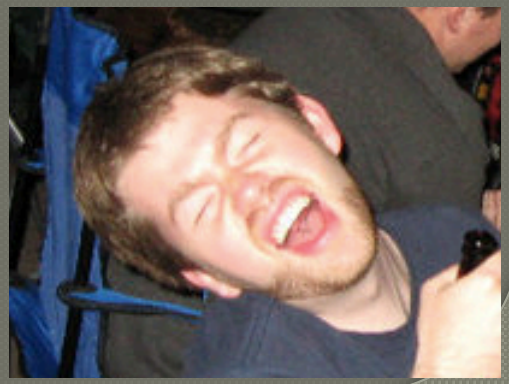
- Two hosts behind NATs need a way to exchange data directly
- They know each other's IPs, but not each other's communication ports
- They both connect to a known server that exchanges the data for them
- They can now communicate
- Often used for multiplayer games

UPnP and IGD

- UPnP: Universal Plug and Play
  - Protocols for networked devices to perform discovery automatically
- IGD: Internet Gateway Device protocol
  - NAT protocol that can perform automatic port mapping
  - Allows a host inside a network to tell the router which public port it wants to use for communication
  - Also gives mechanisms for finding public IP address and checking existing port mappings
  - Games can rely on this protocol to configure NAT tables such that users can be mapped with known ports and communication can take place

STUN

- Old Name: Simple Traversal of UDP through NAT
- New Name: Session Traversal Utilities for NAT
- Protocol for NAT traversal
- Hosts get their own public-facing IPs by asking an outside server



TURN

- Traversal Using Relays Around NAT
- Similar to earlier punchthrough algorithm
- A server sits between two hosts behind NATs
- The server relays data between the two hosts

ICE

- Interactive Connectivity Establishment
- Protocol that utilizes STUN and TURN to perform NAT punchthrough
- Used often in VoIP

Questions?