Exploration: Network Address Translation (NAT)

Introduction

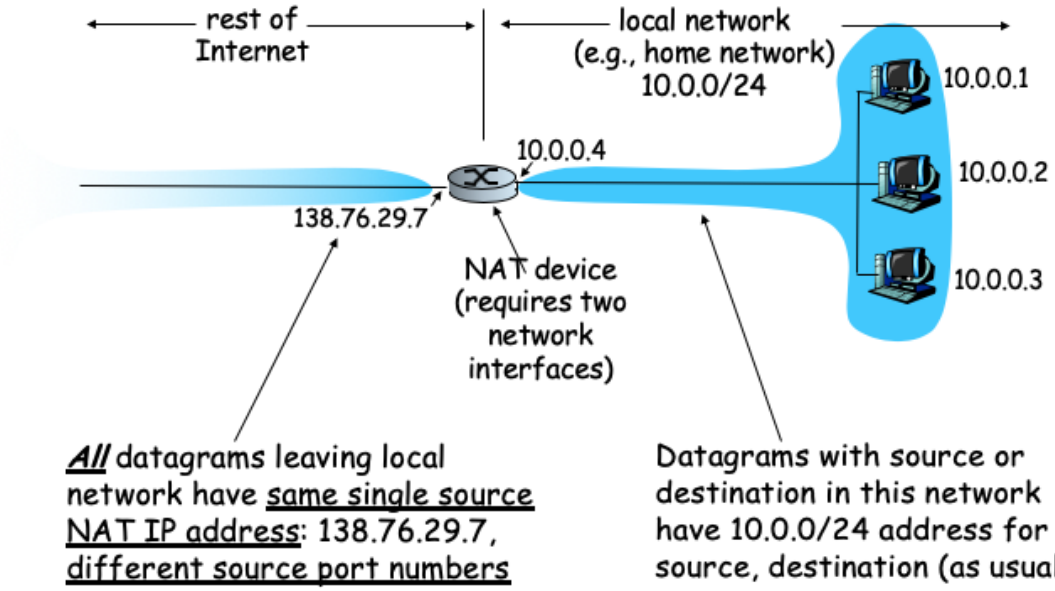
In this final exploration, we examine the main reason that we haven't run out of IPv4 network addresses to date. Network Address Translation (NAT) is a mechanism that allows multiple computers at one site to share a single global IP address (external IP address).

The idea of sharing an IP address space came about in the 90s with the phenomenal growth of the internet. The story goes that several MIT students came up with the idea of address sharing. Early experiments showed that you could have more than one computer with the same address, if each of these were on their own separate network with one computer on the network connected to the internet. This made it possible to conserve some of the resources of the internet.

This soon made its way to home networks and other small networks, small businesses and so on. With NAT, it was no longer necessary to have a unique IP address account with an ISP for each individual computer. NAT offers the following benefits:

- An entire local network uses just one external IP address
  - Theoretically, over 65,000 hosts
  - All internal addresses managed locally and can be changed easily
  - Easy to add/remove computers
  - Individual addresses are treated like global addresses for security/privacy
  - Transparent to all users
- ISP / external address can be changed without affecting local addresses
- Devices inside the local network cannot be explicitly addressed by external hosts, which is great for security.

Nat Implementation



In the figure above, we see NAT in terms of the local network and the rest of the internet. All incoming packets are destined for the globally unique address of the NAT device. The address and port on the incoming packets must somehow be translated to the 10.0.x,x address space, and most likely with a different port that will be valid on the LAN.

Outgoing packets, similarly, are translated to all have the address of the NAT device, no matter the internal source host. How does NAT accomplish this?

Network Address and Port Translation (NAPT)

NAPT is the most popular implementation of NAT. At one point it was separate from NAT, but now NAT effectively means NAPT. NAPT has the effect of forming a virtual private conn between a computer in a private network and a remote host. It does this by using unique outgoing port numbers mapped to IP/port pairs in the LAN. Thus, local host 10.0.0.125 with port 30000 is mapped to the IP address of the NAT device, 128.210.24.6 and the next available port, 40001.

Here is an example NAT table:

Direction	Initial Value	Translated	Unchanged
out	**Source** 10.0.0.125:30000	**Source** 128.210.24.6:40001	**Destination** 68.18.6.225:80
out	**Source** 10.0.0.77:30000	**Source** 128.210.24.6:40002	**Destination** 68.18.6.225:80
in	**Destination** 128.210.24.6:40002	**Destination** 10.0.0.77:30000	**Source** 68.18.6.225:80
in	**Destination** 128.210.24.6:40001	**Destination** 10.0.0.125:30000	**Source** 68.18.6.225:80

Objections

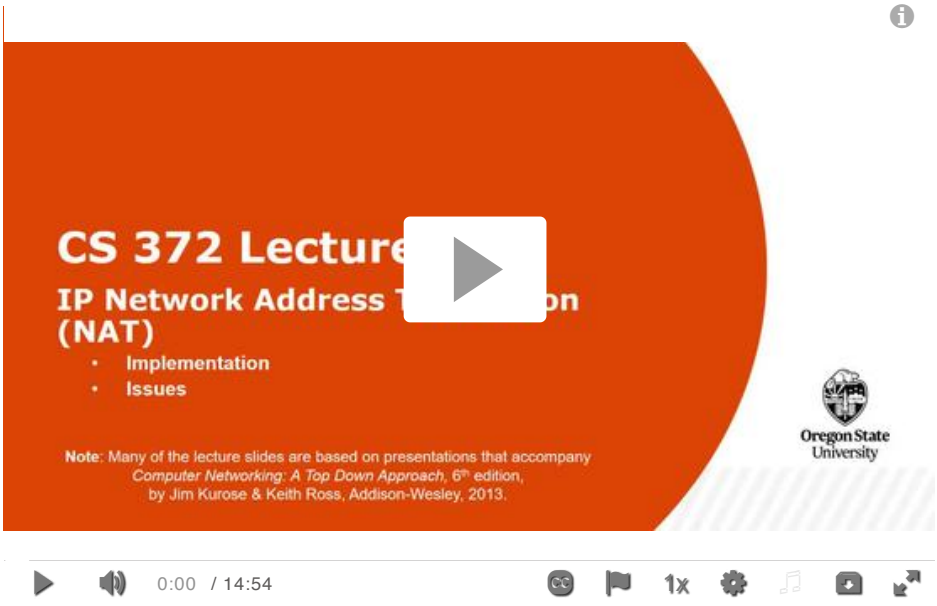
It should be noted that NAT is somewhat controversial. Objections include:

- ISP overload (NAT theoretically allows 65,000 simultaneous connections with a single external address
- Routers should only process up to the network layer, but NAT requires processing to the transport layer
- The address shortage should instead be solved by IPv6

This concludes our discussion of NAT. Be sure to watch the video lecture below for more details on NAT, including a discussion about NAT traversal and some of the issues that result from first contact. Then work through the included Self-Check exercises to test your knowledge.

Video Lecture

IP Network Address Translation



(PDF (https://oregonstate.instructure.com/courses/1798856/files/83165071/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165071/download?wrap=1) |PPT (https://oregonstate.instructure.com/courses/1798856/files/83165303/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165303/download?wrap=1))

Self-Check Exercises

What are some advantages of NAT?

Turn

Card 1 of 4

What does a NAPT device change in an outgoing TCP/IP datagram?

- [ ] Destination Port
- [ ] Destination Address
- [ ] Source Port
- [ ] Checksum

Source Address

Check

The computers in your network have addresses of the form 10.0.0.x/8, and your network uses a NAPT device as an internet gateway. The NAPT box has external address 68.34.201.55, and internal address 10.0.0.1 . The next available port number on the NAPT device is 12331. Suppose that the original sender at computer 10.0.0.16 uses port 300 to send a query to a remote host at 98.76.11.44 on port 80.

When the message from the original sender arrives at the NAPT device…
What is the source address:port?
What is the destination address:port?

Turn

Card 1 of 4

Reuse <> Embed

Resources

- **Network address translation** (https://en.wikipedia.org/wiki/Network_address_translation)
  "Network Address Translation." In Wikipedia, March 10, 2020.

- Animation of Network Address Translation Concept (NAT)