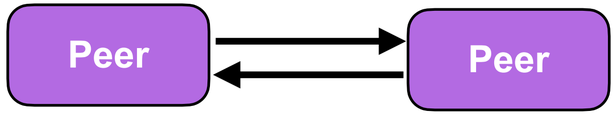
Peer-to-peer Connections

- Peer-to-peer connections and Network Address Translation

BY ND

Peer-to-peer Connection Establishment

- The Internet is conceptually a peer-to-peer network – any device can, in principle, talk to any other
- You should be able to run a TCP server on any device
- You should be able to run a TCP- or UDP-based peer-to-peer application



- In practise peer-to-peer connection establishment is difficult, due to **network address translation** (NAT)

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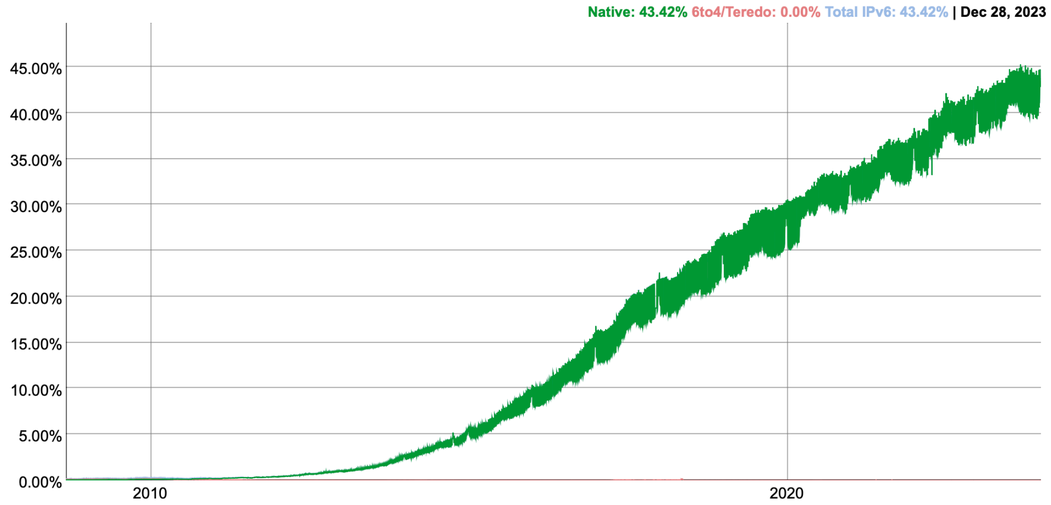
Network Address Translation (NAT)

- IPv4 address space is exhausted
- IPv6 is the long-term solution, but the transition is taking many years
- Network address translation (NAT) is a work-around for the shortage of IPv4 addresses; it allowing several devices to share a single IP address



IPv6 growth, as measured by Google

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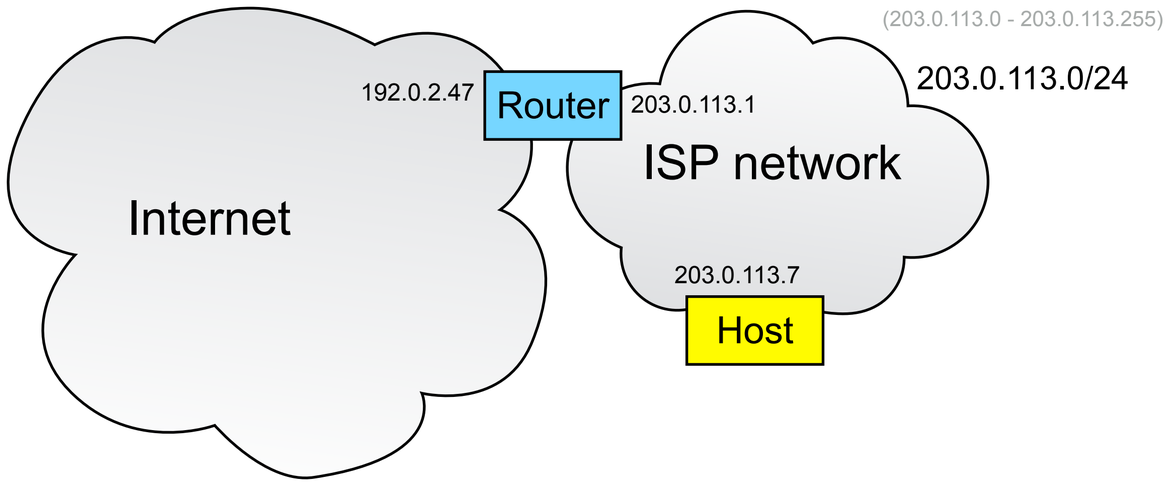
Connecting a Single Host



- An Internet service provider (ISP) owns an IP address prefix
- They assign a customer a single address for a single host

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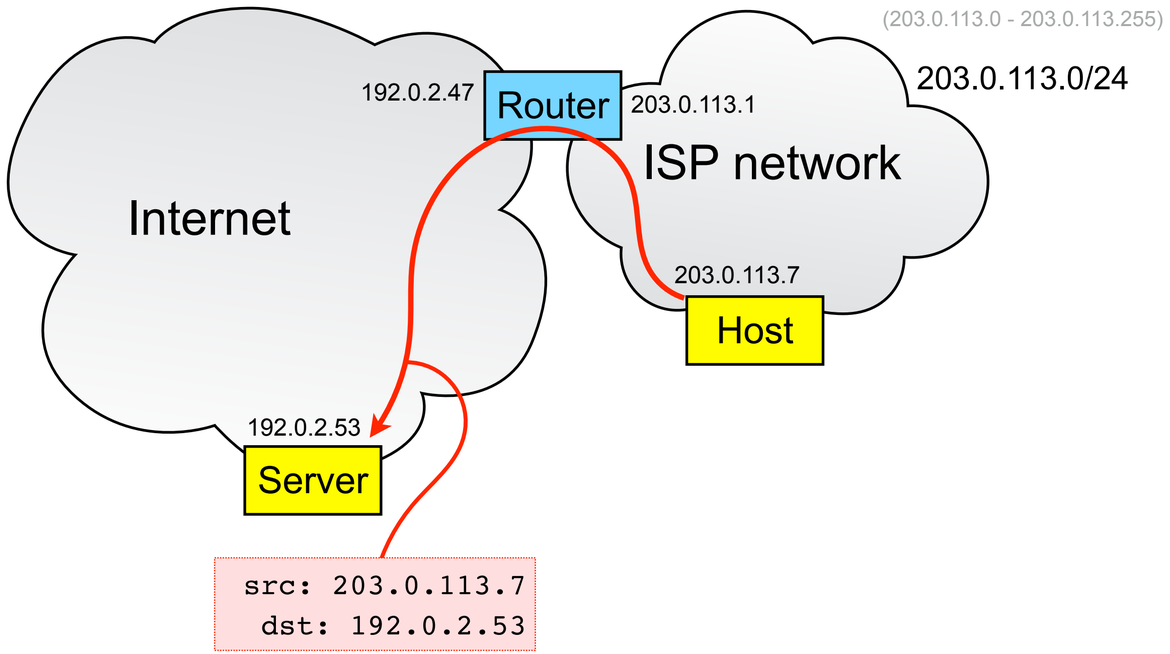
Connecting a Single Host



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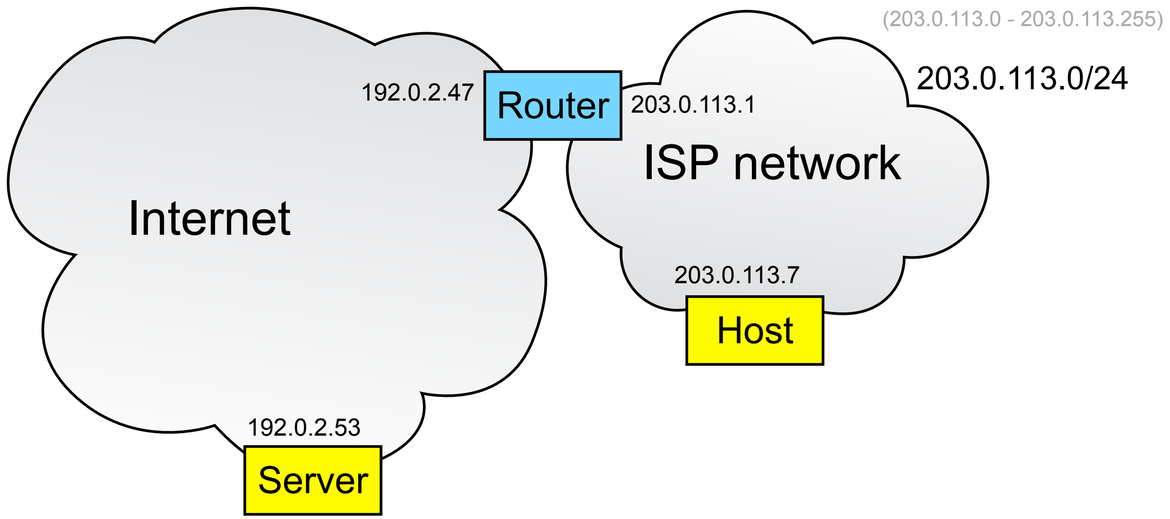
Connecting Multiple Hosts



- The customer buys another host
- How does it connect?

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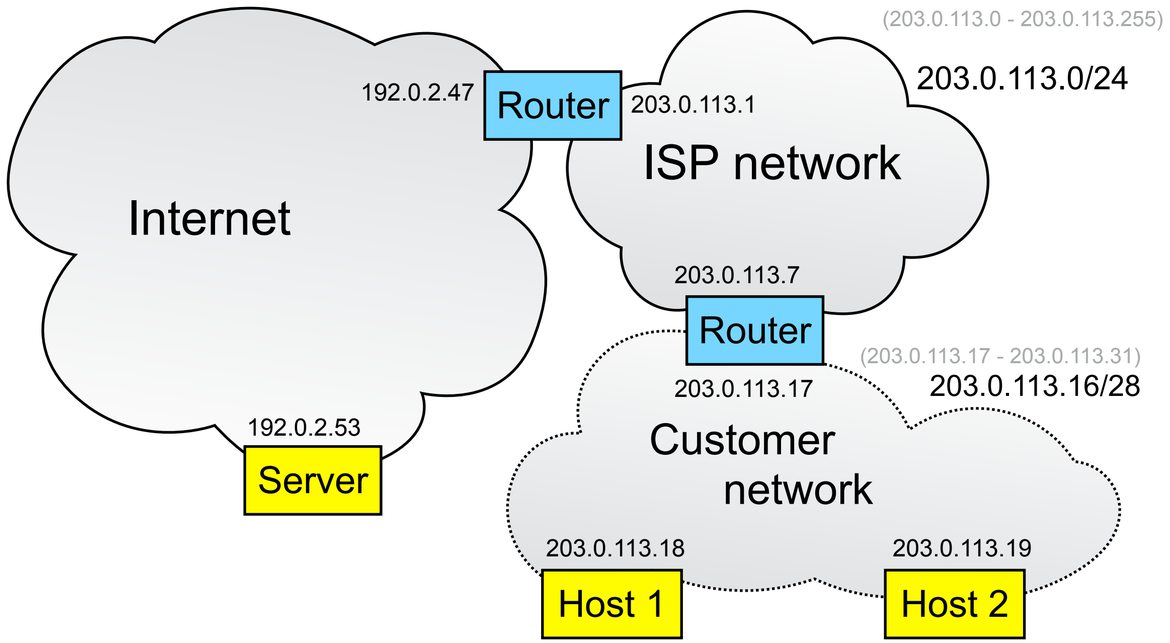
Connecting Multiple Hosts



- The customer buys another host
- How does it connect?
- What's supposed to occur:
  - Customer acquires a router, which gets the customer's previous IP address
  - ISP assigns new range of IP addresses to customer (from the ISP's prefix)
  - Customer gives each host an address from that new range

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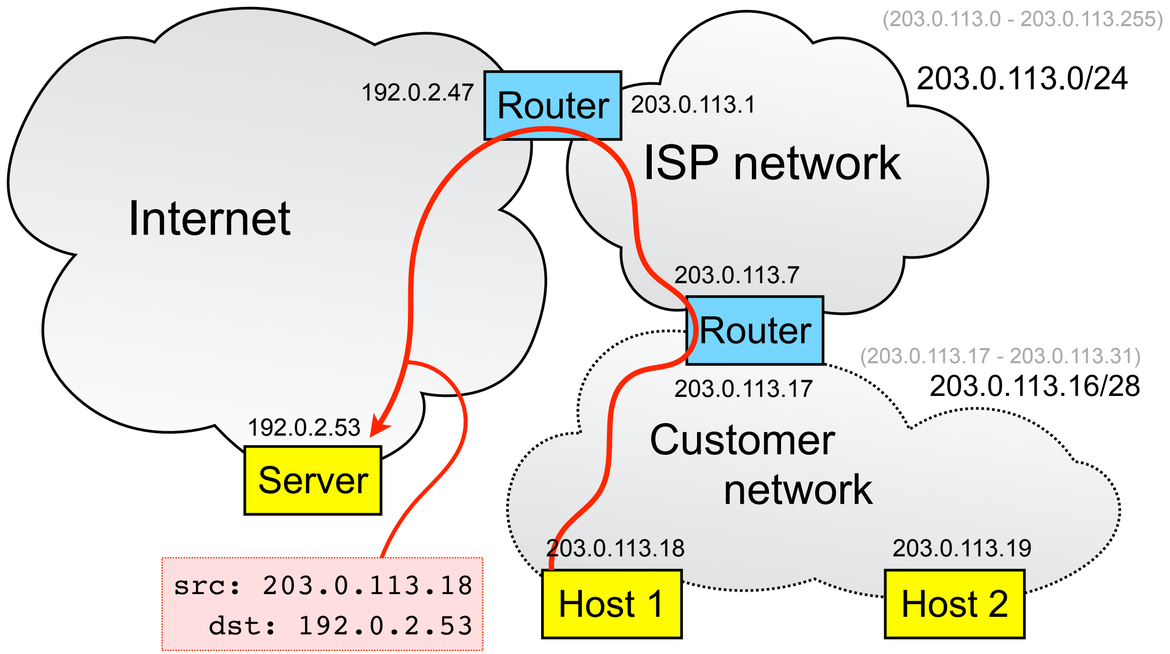
Connecting Multiple Hosts



- The customer buys another host
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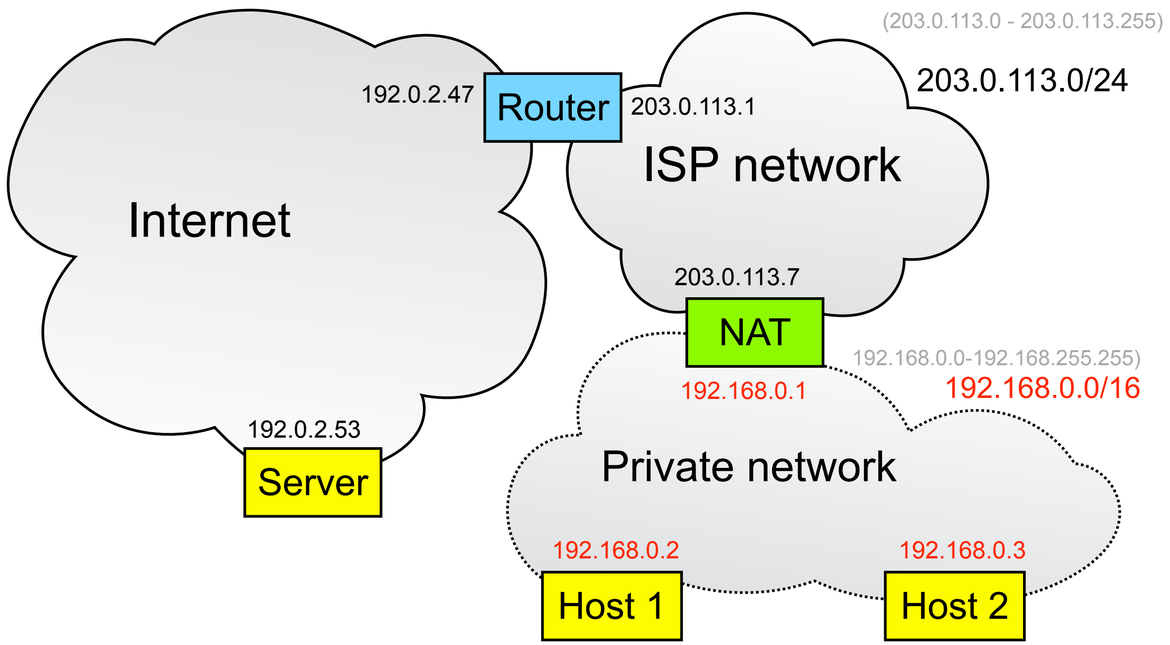
Network Address Translation



- The customer buys another host
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- What actually happens:
  - Customer acquires a NAT router, which gets the customer's previous IP address
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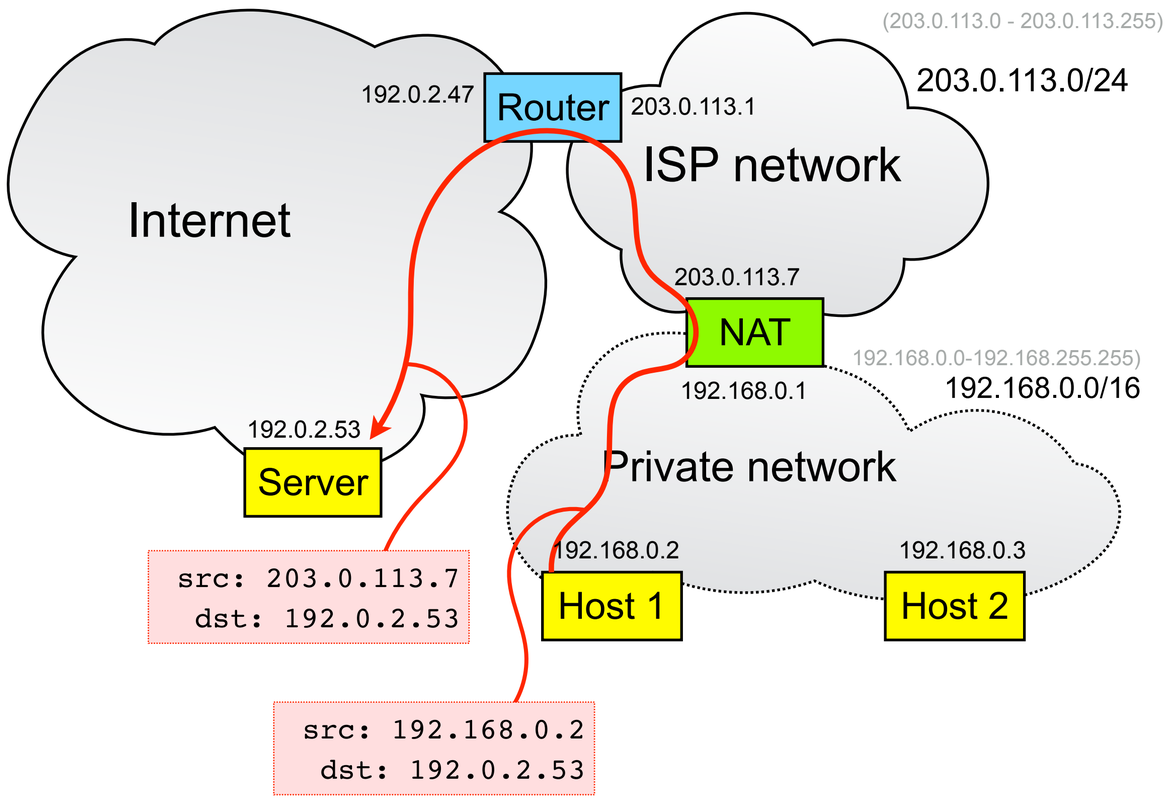
Network Address Translation



- The customer buys another host
- How does it connect?
- What actually happens:
  - Customer acquires a NAT router, which gets the customer's previous IP address
  - Customer gives each host on their network a private address
  - NAT performs address translation on packets traversing it:
    - Change source IP address in packet header to match external address of NAT
    - Change source TCP/UDP port in packet header to some unused value
    - Records the mapping, so the reverse changes can be made to any incoming replies as they traverse the NAT in the reverse direction

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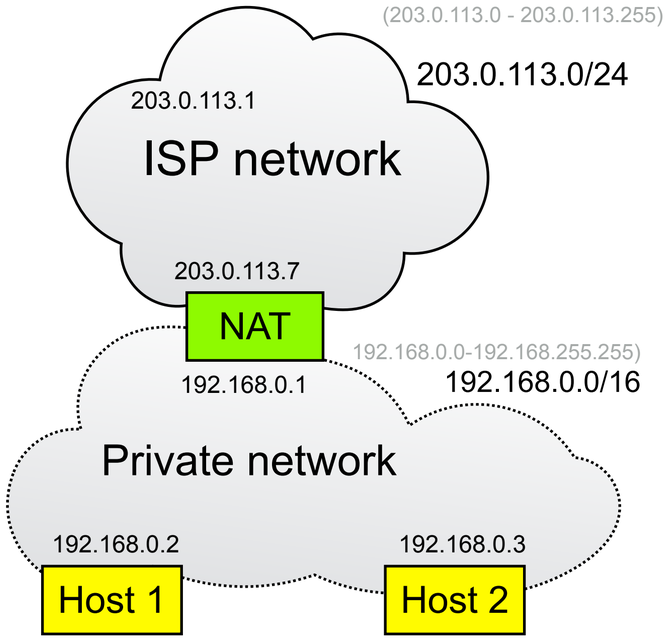
NAT and Private Address Ranges



- The NAT hides a private network behind a single public IP address
  - The private IP network address ranges are 10.0.0.0/8, 176.16.0.0/12, and 192.168.0.0/16
- Gives the illusion of more address space, by reusing IP addresses in different parts of the network
  - e.g., most home networks use 192.168.0.0/16

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Peer-to-peer Connections

- Peer-to-peer connections
- Network Address Translation
- Private IPv4 address ranges

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