Lecture 33

CS625: Advanced Computer Networks
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IPv4 Address Exhaustion

• Exponential growth of the Internet
  – Address space exhaustion
• First fix: CIDR (Classless Inter-Domain Routing)
  – Further growth \( \rightarrow \) eventual address space exhaustion
• Network Address Translation (NAT)
  – Solution emerged out of need
  – Not standardized from inception

NAT: Pros and Cons

• Advantages:
  – Expands IPv4 address space
  – Site isolation: benefits provider and customer
  – Site can be attached to multiple ISPs, without appearing on the default-free BGP entries
• Disadvantages
  – Prevents peer-to-peer applications
    • No globally visible address
  – Port and address translation problems for many applications: e.g., H.323 or SIP
  – New application addition is difficult
  – Breaks end-to-end semantics

Topic for today

• IP Next Generation, IPv6
• IP Next Layer (IPNL) [FG01]
• Scribe for today?
Solving IPv4 Address Exhaustion

- Two possibilities
- NAT extended architecture
  - IP Next Layer (IPNL) [FG01]
  - Preserves “characteristics” of IPv4
  - May be acceptable
- IPv6
  - Much bigger address space
  - Other flexibilities as well
  - Need transitioning approach

IPNL Overview

- Features:
  - Hosts have long-lived, global addresses
  - Routers are stateless
  - Network address prefix is independent of location
  - Packets cannot be easily hijacked
- Implementation:
  - Changes to end-hosts and NAT-boxes
  - IPNL layer in-between IPv4 and transport
  - No changes to routers, or DNS

IPNL Architecture

- Some definitions:
  - Realms: private and global/middle
  - NL-routers: front-door, internal
- Routing based on FQDN (Fully Qualified Domain Name) or IPNL address
- IPNL treats IPv4 as a multi-access link-layer
  - At every NL-router, IPv4 address in packet is changed
  - IPv4 address does not have any meaning beyond a realm

Routing by FQDN

- DNS zone associated with a realm
- Zone-based routing information at NL-routers
  - Dynamic routing
  - Routing entries for all zones behind a front-door
- FQDN lookup at the beginning of connection
  - DNS record points to the middle-realm IP of front-door
Routing by IPNL Address

- IPNL Address:
  - 4 bytes of Middle-Realm IP (MRIP) of front-door
  - 2 bytes of Realm Number (RN)
  - 4 bytes of End-Host IP (EHIP)
- RN and EHIP are not globally unique
- NL-routers also know to route by RN
  - Similar to BGP

IPv6

- Larger address space: 128 bits
- Efficient and extensible IP datagram