IPv6

sources:
- RFCs
- books
- presentations

Outline

- **Limitations of IPv4 and modern day Internet**
- **Features of IPv6**
- **Differences between IPv4 and IPv6**
- **IPv6 terminology**
- **Case for IPv6 deployment**

Quick Review of IPv4 vs IPv6

- **IPv4 has problems with address space, fragmentation overhead, Quality of Service, security, autoconfiguration, etc.**
  - **4-byte addresses**
  - **Default 20-byte header**
- **IPv6 addresses those problems**
  - **16-byte address**
  - **Flow labels for QoS support**
  - **No more fragmentation in routers or checksums**
  - **IPv4 Options become IPv6 Extension Headers**

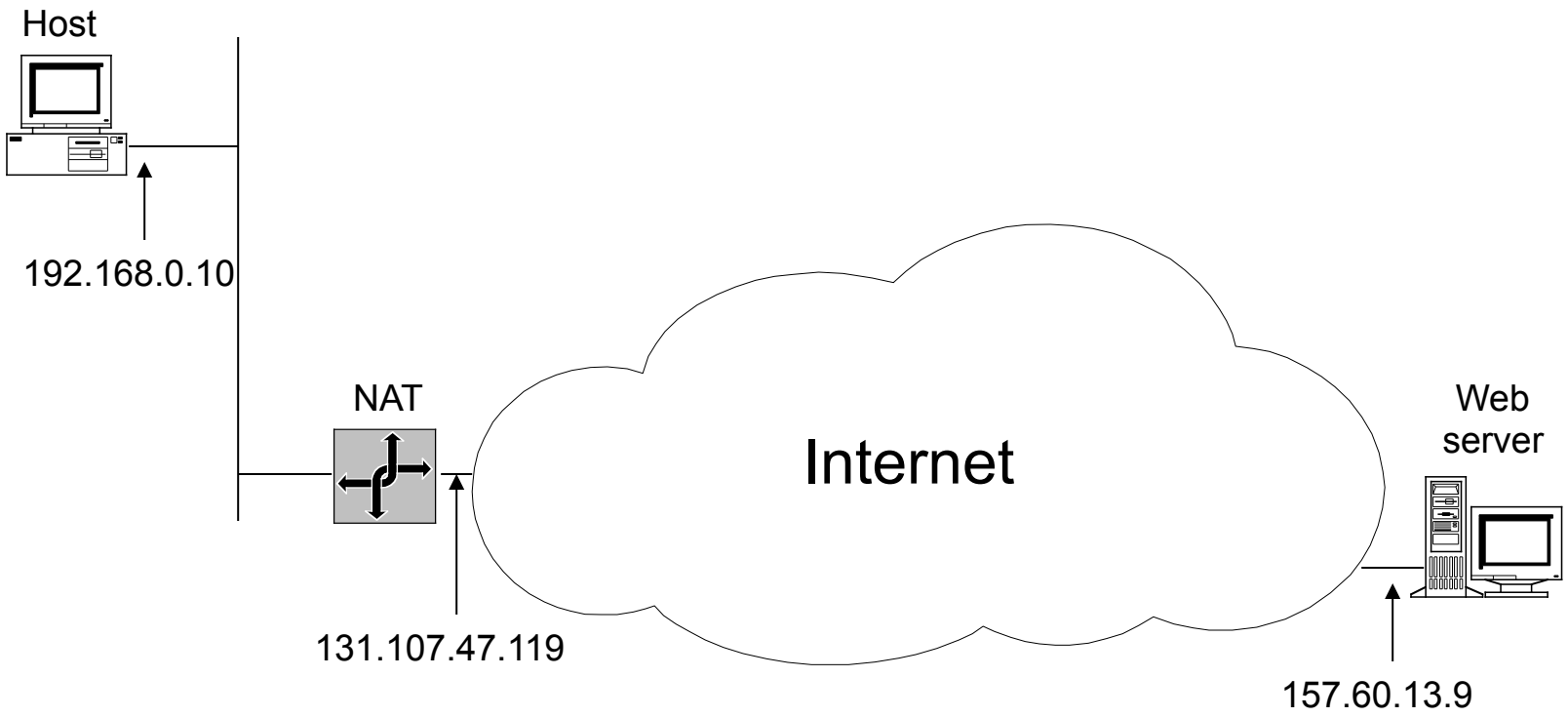
Limitations of IPv4

- Exponential growth of the Internet and the impending exhaustion of the IPv4 address space
- Growth of the Internet and the ability of Internet backbone routers to maintain large routing tables
- Mobile Computing
- IPv4 Missing Features
  - Need for simpler configuration - startup
  - Requirement for security at the IP level
  - Need for better support for real-time delivery of data—quality of service (QoS)

Competition from NAT Boxes

- One of the strongest perceived incentives for migration was the shortage of IPv4 addresses
- *Network Address Translators* helped to solve this problem by translating "official" external IP addresses into "private" internal addresses (10.x.x.x, etc.)
- Created a disincentive for migration

Consequences of the Limited IPv4 Address Space: NATs Impact peer to peer Applications



Remove End-to-End Nature of Internet

Features of IPv6

- New header format – faster processing
- Large address space – IP everywhere
- Efficient and hierarchical addressing and routing infrastructure – faster routing
- Stateless and stateful address config
- Built-in security
- Better support for QoS – use header fields
- New protocol for neighboring node interaction – new nodes, moble nodes
- Extensibility – Designed in

Quick Summary of IPv6

- **IPv6 still an unreliable connectionless datagram protocol**
- **IPv6 Base Header contains address, flow label (a QoS feature)**
- **Extension Headers handle fragmentation, security, etc. (referenced by Next Header field)**
- **Fragmentation avoided by Path MTU discovery**

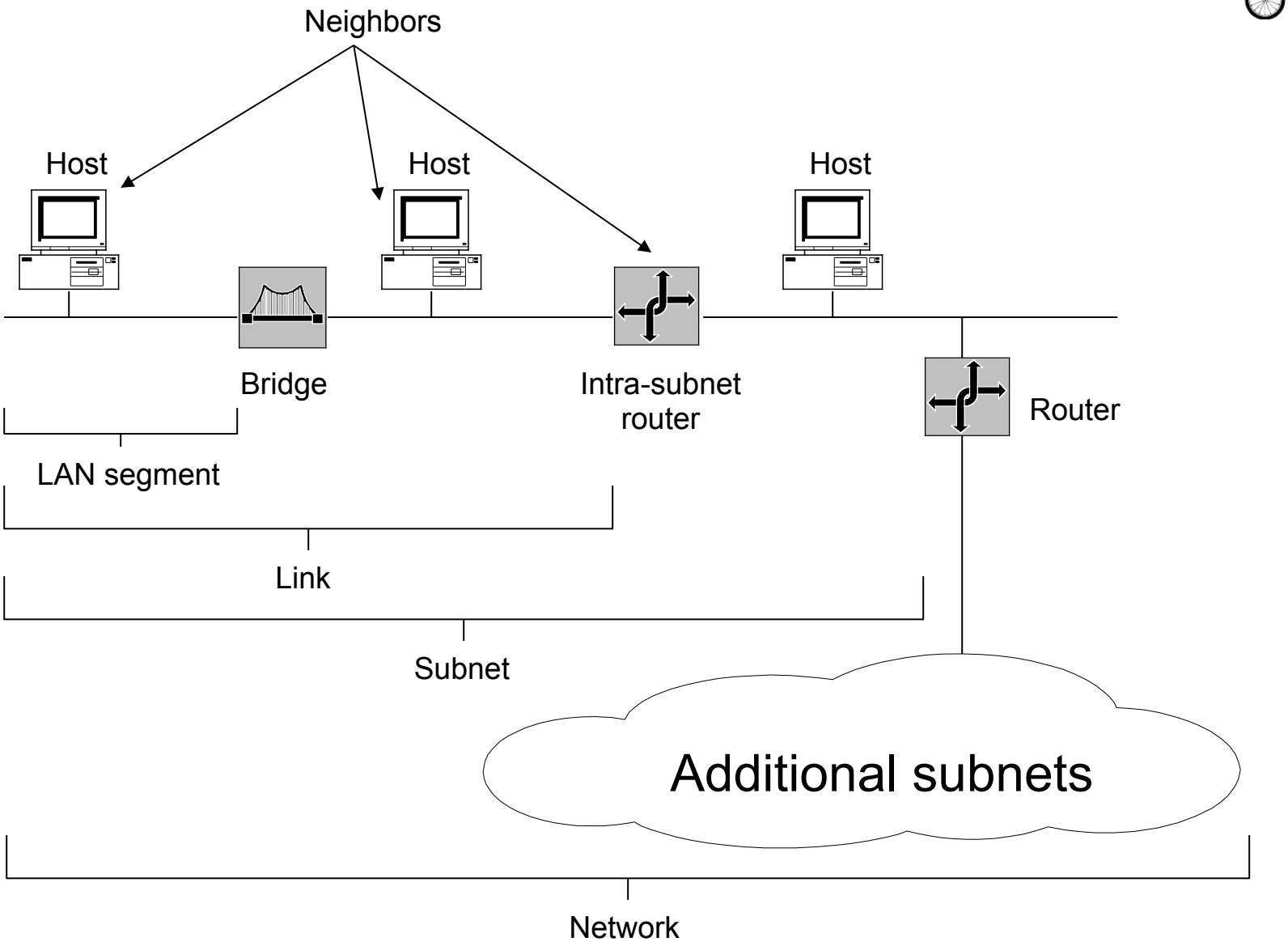
IPv6 Address Space

- **Number of possible 128-bit addresses = 340,282,366,920,938,463,463,374,607,431,768,211,456**
- **$(3.4 * 10^{38})$**
- **That's about 4×10^{18} per square meter of the Earth's surface**
- **Nevertheless, we could run short again if addresses are NOT allocated efficiently**

Differences Between IPv4 and IPv6

Feature	IPv4	IPv6
Address length	32 bits	128 bits
IPSec support	Optional	Required
QoS support	Some	Better
Fragmentation	Hosts and routers	Hosts only
Packet size	576 bytes	1280 bytes - Ethernet
Checksum in header	Yes	No
Options in header	Yes	No
Link-layer address resolution	ARP (broadcast)	Multicast Neighbor Discovery Messages
Multicast membership	IGMP	Multicast Listener Discovery (MLD)
Router Discovery	Optional	Required
Uses broadcasts	Yes	No
Configuration	Manual, DHCP	Automatic, DHCP
DNS name queries	Uses A records	Uses AAAA records
DNS reverse queries	Uses IN-ADDR.ARPA	Uses IP6.INT

IPv6 Terminology



The Case For IPv6 Deployment

- **IPv6 solves the address depletion problem**
- **IPv6 solves the international address allocation problem – assign chunks**
- **IPv6 restores end-to-end communication**
- **IPv6 uses scoped addresses and address selection**
- **IPv6 has more efficient forwarding**
- **IPv6 has built-in security and mobility**
- **Probably reached ‘standardization’ without enough implementation and testing...**

Migration Issues

- **The "Flag Day" problem**
  - **Cannot simply pull the plug on IPv4 at some prearranged date**
- **IPv4 will be around indefinitely**
- **Need to provide for a phased transition, but even more need to develop a 'need' to work that hard...**

IPv6 Products

- **Done deal**
- **All major players have IPv6 implementations for their OS's and routers**
  - **Cisco** – **Linux**
  - **Nortel** – **Solaris**
  - **Microsoft** – **HP-UX**
  - **Novell** – **Mac OS X**
  - **BSD (KAME)**
- **www.moonv6.org**
- **Renault car with Cisco router and Mobile IPv6 implementation**

Useful Books

- ***IPv6 Essentials*** **by S. Hagen (O'Reilly) (Best introduction)**
- ***IPng, The New Internet Protocol*** **by C. Huitema (Prentice Hall)**
- ***IPng, Internet Protocol Next Generation*** **by S. Bradner & A. Mankin (Addison-Wesley)**
- ***Internetworking with TCP/IP Vol. I, 5th Ed.*** **by D. Comer (Prentice Hall)**
- ***IPng and the TCP/IP Protocols*** **by S. Thomas (Wiley)**