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Engineering

24. IP Version 6

- IPv6 features and packet format
- IPv6 transition issues

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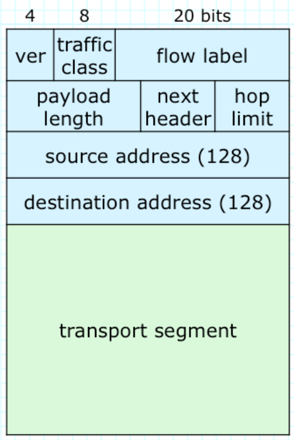
IPv6

- IPv4 address size limits growth of global internet
  - » 32 bit address supports only about 4 billion addresses
- Key features of IPv6
  - » expands address size from 32 to 128 bits
  - » allows senders to mark packets as belonging to common "flow"
  - » no support for fragmentation/reassembly
  - » no header checksum
  - » options replaced with more general "extension headers"
  - » integrated support for mobile IP and IPsec
- Getting from here to there
  - » large installed base of IPv4 inhibits transition, but IPv4 address exhaustion is imminent, making transition essential
    - last large block of IPv4 addresses was assigned in February 2011
  - » host operating systems and routers now support both

IPv6 Packet Format



- *Traffic class* similar to TOS field
- *Flow label* used by source to label stream of related packets
  - » no defined use, as yet
- *Payload Length* in bytes
- *Next header* specifies type of next header in packet
  - » may specify *extension header*, or upper level protocol (e.g. TCP or UDP)
- *Hop limit* similar to TTL in IPv4
- *Address fields*
  - » first 64 bits are hierarchically structured, similar to IPv4 addresses
  - » last 64 bits form an *interface identifier*
    - typically based on MAC address

IPv6 Addresses

- Addresses are associated with interfaces (like IPv4)
- Text representation – 8 groups of 4 hex digits
  - » 2345:0056:0789:0000:0000:abcd:ef01:0000
  - » drop leading 0s in a group – 2345:56:789:0:0:abcd:ef01:0
  - » compress pure zero groups – 2345:56:789::abcd:ef01:0
- Global unicast address
  - » first 64 bits divided between global routing prefix and subnet id
    - first hex digit of prefix in range [2,e]
    - boundary between prefix and subnet id may vary
  - » last 64 bits are interface identifier (based on MAC address)
- Link local addresses
  - » every interface has link-local address which is used only within its direct subnet – first 3 hex digits in {fe8,fe9,fea,feb}
- Multicast address range – first 2 hex digits are ff

Neighbor Discovery Protocol (NDP)

- ICMPv6 messages are identified by a next header field of 58 – include a message type and code similar to IPv4
- Five ICMPv6 message types are used to implement NDP, which take the place of ARP and (optionally) DHCP
  - *router advertisement* – sent periodically by routers; contain configuration info including prefixes associated with subnet
  - *router solicitation* – used by host to request an immediate router advertisement
  - *neighbor advertisement* – used to advertise a link layer address
  - *neighbor solicitation* – used to request a neighbor advert
  - *redirect* – used by router to inform hosts of better first-hop router for reaching desired destination
- Link local addresses are generated by hosts and global addresses may be – duplicate detection is included

Transitioning to IPv6

- To use IPv6, sender and receiver must be IPv6-capable and both must have access to an IPv6 router
  - » if a host has a globally connected IPv6 router on its local network, it can use it to send and receive IPv6 packets
  - » if not, a host can use a "tunnel" to exchange packets with a remote IPv6 router
    - put IPv6 packet inside an IPv4 packet and send it to the IPv4 address of the desired IPv6 router
    - the IPv6 router extracts the packet from its IPv4 "wrapper" and then handles it like a normal IPv6 packet
  - » tunneling works but adds processing with little clear benefit
- When will it happen?
  - » wireless providers are pushing IPv6 for mobile devices
  - » Google reports 2% of its users access it using IPv6
    - rate has doubled for several years; could reach 50% in five years