Internetworking: Overview of IPv6

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Outline

- IPv6 addressing and IPv6 forwarding
- IPv6 packet format
- Advanced capabilities

IPv6: Major Features

- 128-bit addresses
- Multicast
- Real-time service
- Authentication and security
- Auto-configuration
- End-to-end fragmentation
- Enhanced routing functionality, including support for mobile hosts

IPv6 Addresses

- Classless addressing
  - Similar to IPv4 classless (CIDR)
- 128 bits/16 bytes in length

IPv6 Address: Notation

- IPv6 Notation: a human friendly text representation
- x:x:x:x:x:x:x:x where x is a 16-bit (or 2-byte) hexadecimal number, e.g.,
  - `47CD:1234:4422:ACO2:0022:0022:1234:A456`
- Contiguous 0s can be compressed, e.g.,
  - `47CD:0000:0000:0000:0000:0000:A456:0124`
  - can be written as
  - `47CD::A456:0124`

IPv6 Addresses with Embedded IPv4 Addresses

- IPv4-mapped IPv6 address
  - Prefixing with 2 bytes of all 1's and then zero-extending to 128 bits, e.g, :
  - `::FFFF:150.174.2.101`
- IPv4-compatible IPv6 address
  - *Deprecated*
  - Zero-extending IPv4 addresses to 128 bits, e.g.,
  - `::150.174.2.101`
- See https://tools.ietf.org/html/rfc4291

IPv6 Address Types

Address Type	Binary Prefix	IPv6 Notation
Unspecified	00…0 (128 bits)	::/128
Loopback	00…1 (128 bits)	::1/128
Multicast	1111 1111	FF00::/8
Link-local Unicast	1111 1110 10	FE80::/10
Global Unicast	Everything else	

IPv6 Address Assignment

- Provider-based
  - Assign an address prefix to a direct provider
  - The direct provider assigns longer prefixes to its subscribers
  - The scheme allows the provider to aggregate prefixes and advertise a single prefix for all of its subscribers
  - At present, however, provider-based addressing is necessary to make routing work efficiently.
- Geographic
  - Provider-based scheme creates a challenge for a subscriber to change its provider
  - Still ongoing research due to efficiency concern

Provider-based IPv6 Address Assignment

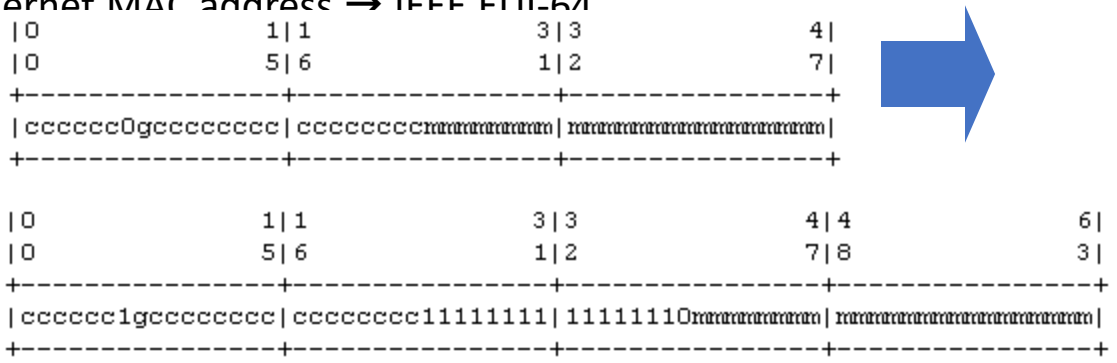
- The scheme allows the provider to aggregate prefixes and advertise a single prefix for all of its subscribers

IPv6 Autoconfiguration

- IPv4 autoconfiguration: via DHCP
- IPv6 autoconfiguration: can be done via “stateless” autoconfiguration, no server needed
  - How?
    - Obtain an interface ID that is unique on the link to which the host is attached
    - Obtain the correct address prefix for this subnet
    - Prefix + a number of 0’s + interface ID

IPv6 Autoconfiguration: Example

- Creating a link-local IPv6 address from Ethernet address
  - Obtain an interface ID that is unique on the link to which the host is attached
    - Ethernet MAC address → IEEE EUI-64



Example: an Ethernet adapter has hardware address: 00:1E:C9:2E:F4:6D → 02:1E:C9:FF:FE:2E:F4:6D

  - Obtain the correct address prefix for this subject
    - e.g., Link-local prefix = FE80::/64
  - Prefix + a number of 0's + interface ID

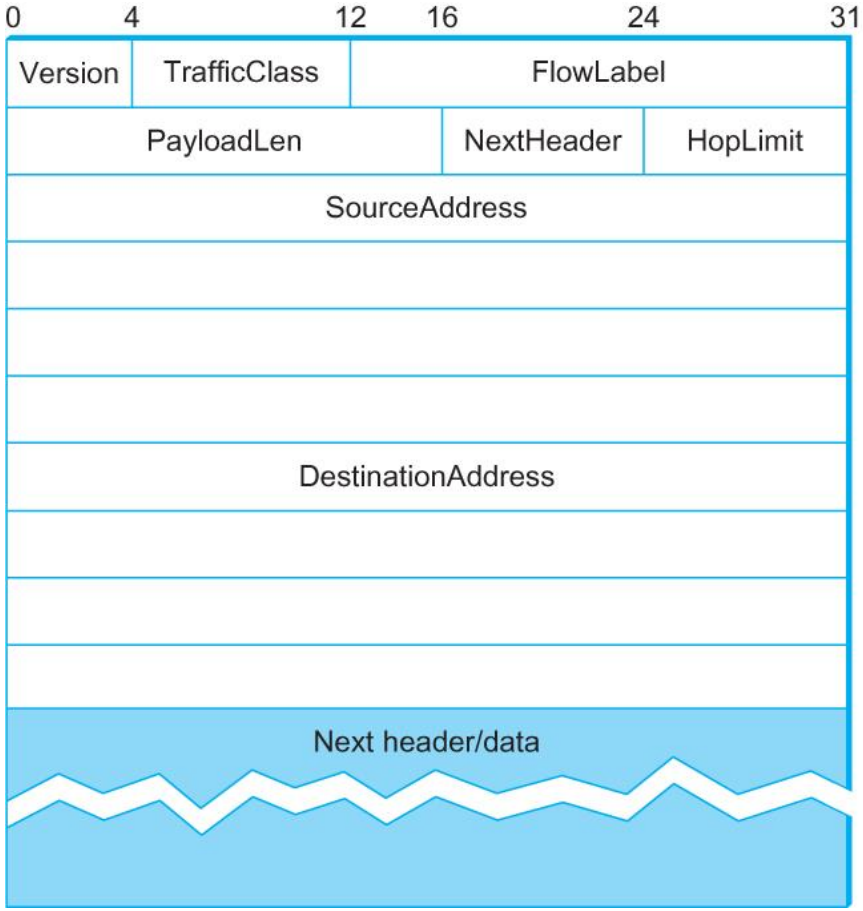
    FE80::021E:C9FF:FE2E:F46D/64

Questions?

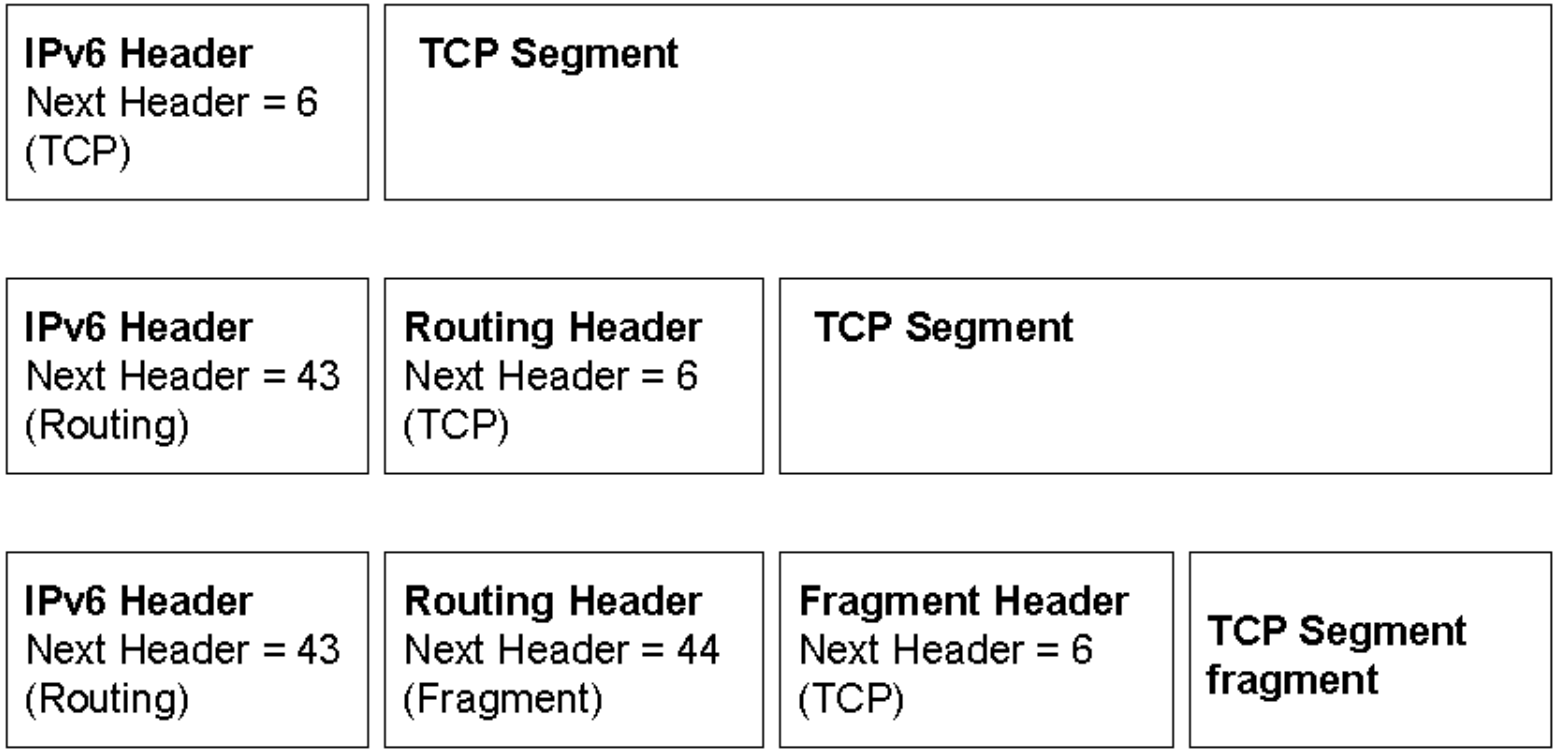
- IPv6 address space
  - Number of bits?
  - Human readable notations?
  - Address space allocation (types/use)?
  - Address assignment?

IPv6 Packet Header

- Header
  - 40-byte “base” header
- Extension headers
  - fixed order, mostly fixed length
    - hop-by-hop options
    - destination options
    - routing header
    - fragment header
    - authentication header
    - encapsulating security payload header
    - other options



IPv6 “Next Header” Example



Questions?

- IPv6 packet format
  - What are the functional areas that it supports?

Summary

- IPv6 addressing/forwarding
- IPv6 packet format
- Discuss a set of advanced capabilities and supporting packet header fields in future lessons