IPv6

1

MUHAMMAD ZEN SAMSONO HADI, ST. MSC.

JARINGAN KOMPUTER 2
LAB. KOMUNIKASI DIGITAL
GEDUNG D4 LT. 1
EEPIS-ITS

IPv6 Terminology

- Node – A device that implements IPv6.
  - A node can be a host or a router
  - A node can be an entertainment system
  - A node can be a PDA or cell phone

IPv6 Strengths

- Larger Addresses
  - Allows billions of devices to be interconnected

*for example….. The Sony IP video camera**

Network Function

- Bluetooth Standard: Ver 1.1
- Email: SMTP, POP3
- Web Browser
- HTML: HTML3.2, Frame. JavaScript, SSL (V2/3)
- Image: GIF, JPEG, XBM, PNG

IPv6 Markets

- National Research & Education Networks (NREN) & Academia
- Geographies & Politics
- Wireless (PDA, 3G Mobile Phone networks, Car,...)
- Home Networking
  - Set-top box/Cable/xDSL/Ethernet-to-the-home
  - e.g. Japan Home Information Services initiative
  - Distributed Gaming
  - Consumer Devices
- Enterprise
  - Requires full IPv6 support on O.S. & Applications
- Service Providers

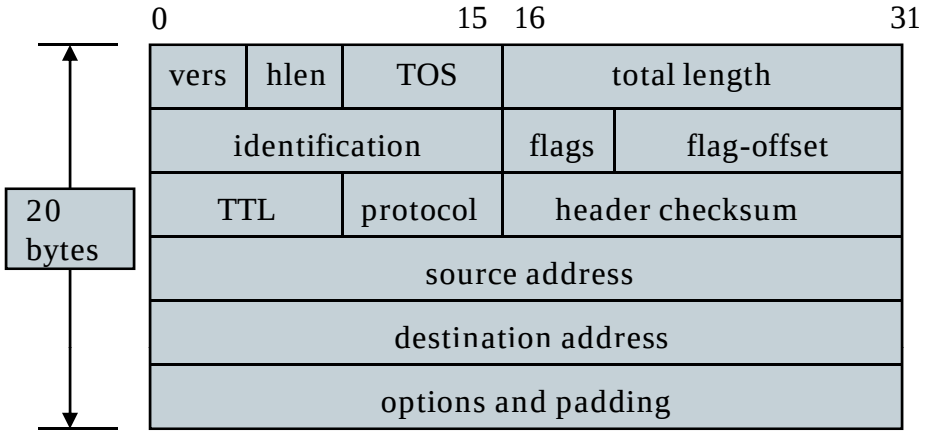
Techniques to reduce address shortage in IPv4

- Subnetting
- Classless Inter Domain Routing (CIDR)
- Network Address Translation (NAT)

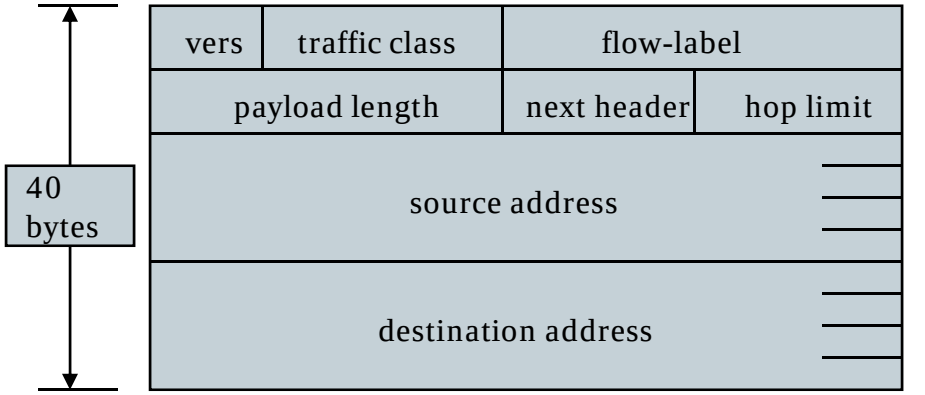
Features of IPv6

- Larger Address Space
- Aggregation-based address hierarchy
  - Efficient backbone routing
- Efficient and Extensible IP datagram
- Stateless Address Autoconfiguration
- Security (IPsec mandatory)
- Mobility

Header comparison



IPv4



IPv6

Removed (6)

- ID, flags, flag offset
- TOS, hlen
- header checksum

Changed (3)

- total length => payload
- protocol => next header
- TTL => hop limit

Added (2)

- traffic class
- flow label

Expanded

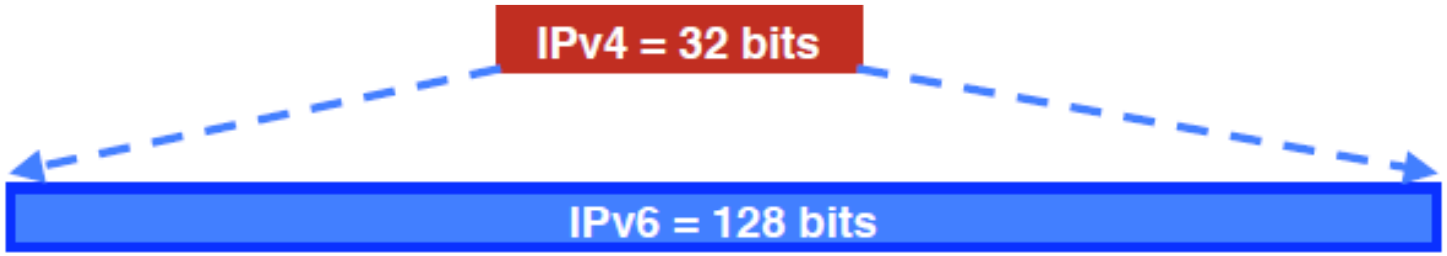
- address 32 to 128 bits

Major Improvements of IPv6 Header

- No option field: Replaced by extension header. Result in a fixed length, 40-byte IP header.
- No header checksum: Result in fast processing.
- No fragmentation at intermediate nodes: Result in fast IP forwarding.

Addressing

Larger Address Space



IPv4

32 bits

= 4,294,967,296 possible addressable devices

IPv6

128 bits: 4 times the size in bits

= 3.4×10^{38} possible addressable devices

= 340,282,366,920,938,463,463,374,607,431,768,211,456

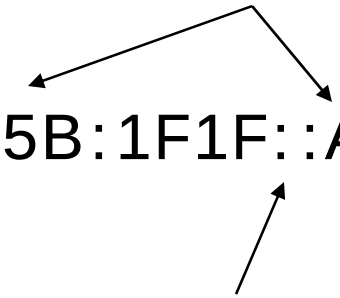
~ 5×10^{28} addresses per person on the planet

128-bit IPv6 Address

3FFE:085B:1F1F:0000:0000:0000:00A9:1234

8 groups of 16-bit hexadecimal numbers separated by “:”

Leading zeros can be removed



3FFE:85B:1F1F::A9:1234

:: = all zeros in one or more group of 16-bit hexadecimal numbers

Some Special-Purpose Unicast Addresses

- The unspecified address, used as a placeholder when no address is available:

  0:0:0:0:0:0:0:0

- The loopback address, for sending packets to self:

  0:0:0:0:0:0:0:1

Penulisan Alamat IPv6

- Yang menarik dari IPv6 adalah penjang alamat sebesar 128 bit. Notasi alamat IPv6 ditulis dalam hexadesimal yang dipisahkan dengan karakter ":". Contohnya sebagai berikut:
  - 3ffe:0501:008:1234:0260:97ff:fe40:efab
  - ff02:0000:0000:0000:0000:0000:0000:0001

  Angka nol didepan dapat diabaikan sehingga penulisan menjadi:
  - 3ffe:501:8:1234:260:97ff:fe40:efab
  - fe02:0:0:0:0:0:0:1

  Angka nol yang berurutan dapat digantikan dengan karakter "::", sehingga penulisan menjadi:
  - fe02::1

Penulisan Alamat IPv6

- Alamat IPv6 yang mempunyai panjang 128 bit dalam hexadesimal tentunya sulit dihafalkan karena itu alamat numerik jarang digunakan, lebih mudah menggunakan hostname, untuk itu DNS memegang peranan penting.

- Alamat IPv6 sendiri terbagi atas beberapa macam, berdasarkan RFC 3513 :
  - Unspecified dengan notasi ::/128
  - Loopback dengan notasi ::1/128
  - Multicast dengan notasi ff00::/8
  - Link local unicast dengan notasi FE80::/8
  - Site local unicast dengan notasi FEC0::/8
  - Global unicast

Penulisan Alamat IPv6

- Alamat yang akan digunakan untuk berkomunikasi dengan internet adalah alamat global unicast. Pembagian alokasi alamat global berdasarkan registrar (RFC 2928) adalah:
  - IANA 2001:000::/29 sampai 2001:01F8::/29
  - APNIC 2001:200::/29 sampai 2001:03F8::/29
  - ARIN 2001:400::/29 sampai 2001:05F8::/29
  - RIPE NCC 2001:600::/29 sampai 2001:06F8::/29

IPv6 Address Representation

- 16 bit fields in case insensitive colon hexadecimal representation

  2031:0000:130F:0000:0000:09C0:876A:130B

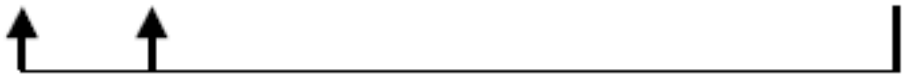
- Leading zeros in a field are optional:

  2031:0:130F:0:0:9C0:876A:130B

- Successive fields of 0 represented as ::, but only once in an address:

  2031:0:130F::9C0:876A:130B is ok

  2031::130F::9C0:876A:130B is NOT ok



  0:0:0:0:0:0:0:1 → ::1 (loopback address)

  0:0:0:0:0:0:0:0 → :: (unspecified address)

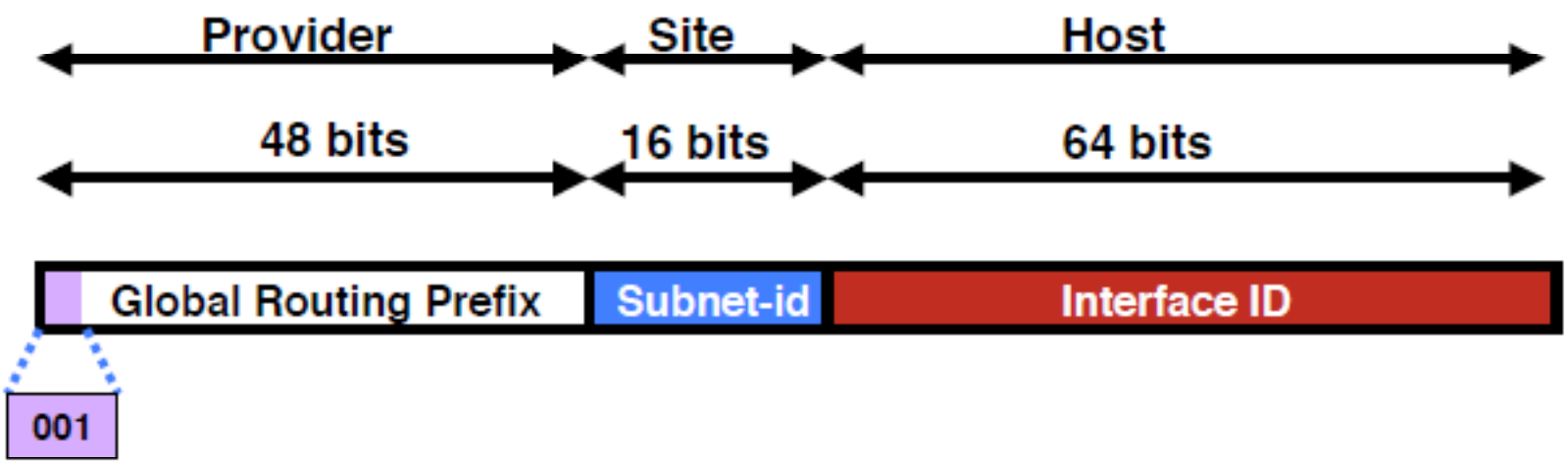
IPv6 Address Representation

- IPv4-compatible (not used any more)
  - 0:0:0:0:0:0:192.168.30.1
  - = ::192.168.30.1
  - = ::C0A8:1E01
- In a URL, it is enclosed in brackets (RFC3986)
  - http://[2001:db8:4f3a::206:ae14]:8080/index.html
  - Cumbersome for users
  - Mostly for diagnostic purposes
  - Use fully qualified domain names (FQDN)
- ⇒ The DNS has to work!!

IPv6 Address Representation

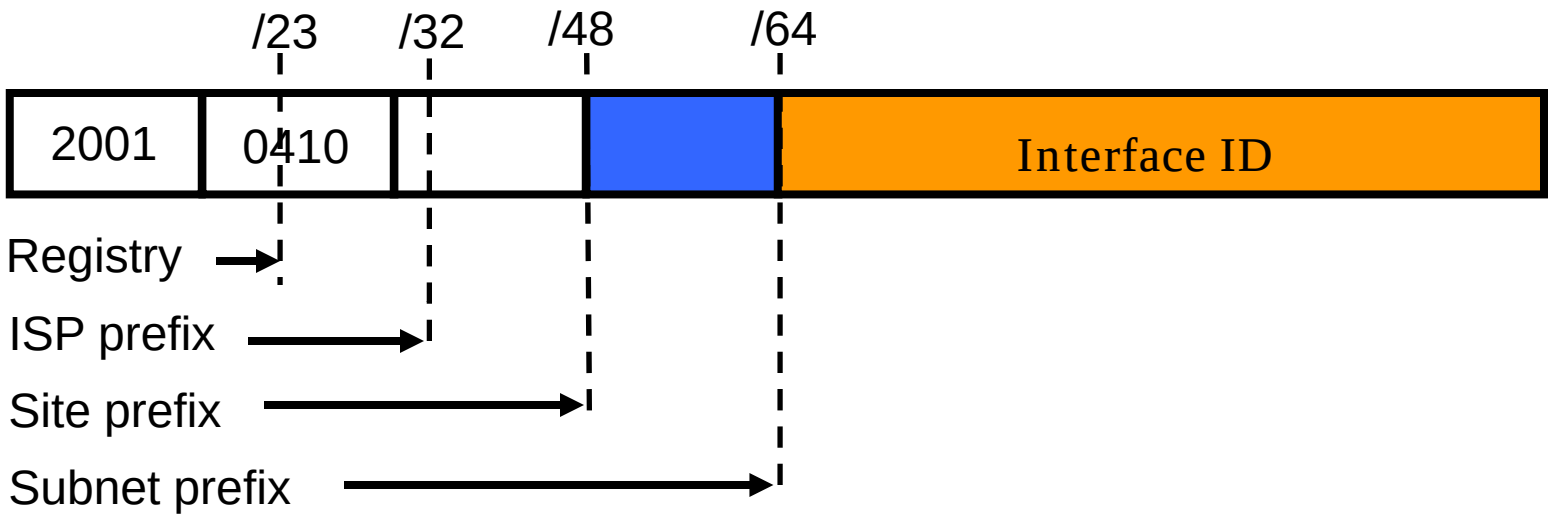
- Prefix Representation
  - Representation of prefix is same as for IPv4 CIDR
    - Address and then prefix length
  - IPv4 address:
    - 198.10.0.0/16
  - IPv6 address:
    - 2001:db8:12::/40

IPv6 Global Unicast Addresses



- IPv6 Global Unicast addresses are:
  - Addresses for generic use of IPv6
  - Hierarchical structure intended to simplify aggregation

Address Allocation



- The allocation process was recently updated by the registries:
  - IANA allocates from 2001::/16 to regional registries
  - Each regional registry allocation is a ::/23
  - ISP allocations from the regional registry is a ::/36 (immediate allocation) or ::/32 (initial allocation) or shorter with justification
  - Policy expectation that an ISP allocates a ::/48 prefix to each customer

IPv6 - Addressing Model

Addresses are assigned to interfaces

change from IPv4 model :

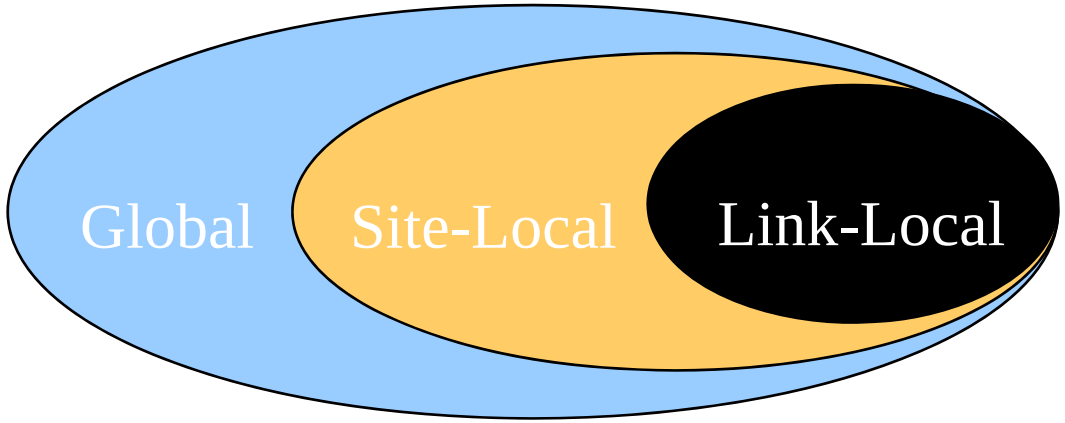
Interface 'expected' to have multiple addresses

Addresses have scope

Link Local

Site Local

Global



Addresses have lifetime

Valid and Preferred lifetime

Types of IPv6 Addresses

- Unicast
  - One address on a single interface
  - Delivery to single interface
- Multicast
  - Address of a set of interfaces
  - Delivery to all interfaces in the set
- Anycast
  - Address of a set of interfaces
  - Delivery to a single interface in the set

No broadcast addresses

Interface Address set

- Loopback (only assigned to a single interface per node)
- Link local (required on all interfaces)
- Site local
- Auto-configured 6to4 (if IPv4 public is address available)
- Auto-configured IPv4 compatible (operationally discouraged)
- Solicited node Multicast (required for neighbor discovery)
- All node multicast
- Global anonymous
- Global published

Alokasi Prefix

Prefix	Alokasi	RFC
2001::/16	Sub-TLA assignments: APNIC 2001:0200::/23 ARIN 2001:0400::/23 RIPE NCC 2001:0600::/23 RIPE NCC 2001:0800::/23 RIPE NCC 2001:0A00::/23 APNIC 2001:0C00::/23 LACNIC 2001:1200::/23	RFC 2450
2002::/16	6to4	RFC 3056
3FFE::/16	6bone testing	RFC 2471

Ekuivalensi IPv4 Address dan IPv6 Address

	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.149.252.76	Hexadecimal Notation: 3FFE:F200:0234:AB00: 0123:4567:8901:ABCD
Prefix Notation	192.149.0.0/24	3FFE:F200:0234::/48
Number of Addresses	2^{32} = ~4,294,967,296	2^{128} = ~340,282,366, 920,938,463,463,374, 607,431,768,211,456

Ekuivalensi IPv4 Address dan IPv6 Address

IPv4 Address	IPv6 Address
Kelas-kelas address internet	Tidak ada
Alamat broadcast	Tidak ada (digantikan multicast)
Unspecified address 0.0.0.0	Unspecified address ::
Loopback address 127.0.0.1	Loopback address ::1
Public IP address	Global unicast address
IP address Private (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16)	Address Site-Local (FEC0::/10)
Address Autoconfigure (169.254.0.0/16)	Address Link-Local (FE80::/64)

IPv6 Auto-Configuration

- Stateless (RFC2462)

  Host autonomously configures its own Link-Local address

  Router solicitation are sent by booting nodes to request RAs for configuring the interfaces.

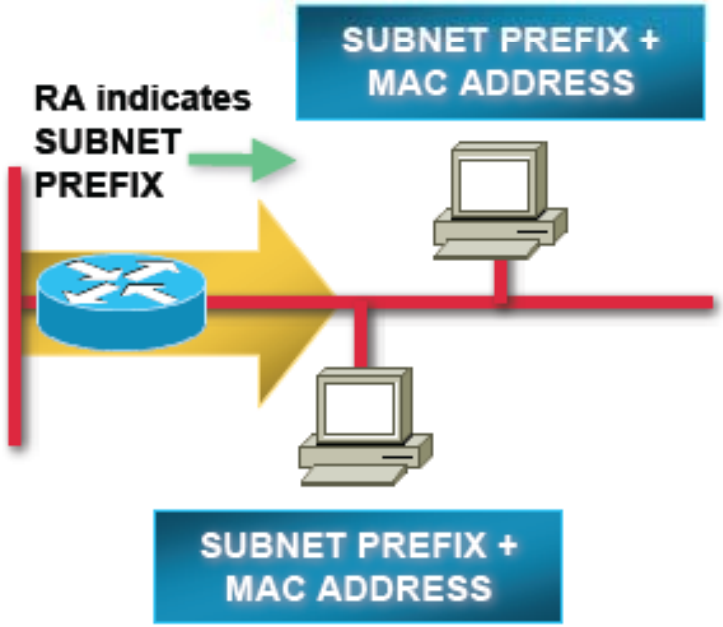
- Stateful

  DHCPv6 – required by most enterprises

- Renumbering

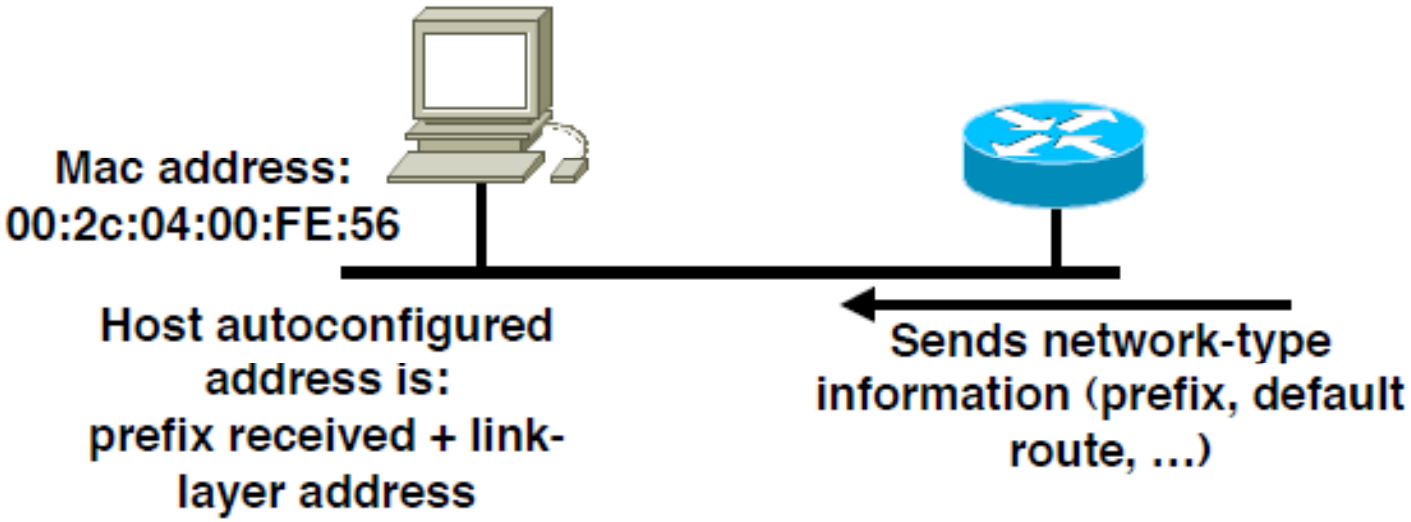
  Hosts renumbering is done by modifying the RA to announce the old prefix with a short lifetime and the new prefix

  Router renumbering protocol (RFC 2894), to allow domain-interior routers to learn of prefix introduction / withdrawal



At boot time, an IPv6 host build a Link-Local address, then its global IPv6 address(es) from RA

Auto-configuration



- Client sends router solicitation (RS) messages
- Router responds with router advertisement (RA)
  - This includes prefix and default route
- Client configures its IPv6 address by concatenating prefix received with its EUI-64 address

- Studi kasus pada Tugas Akhir