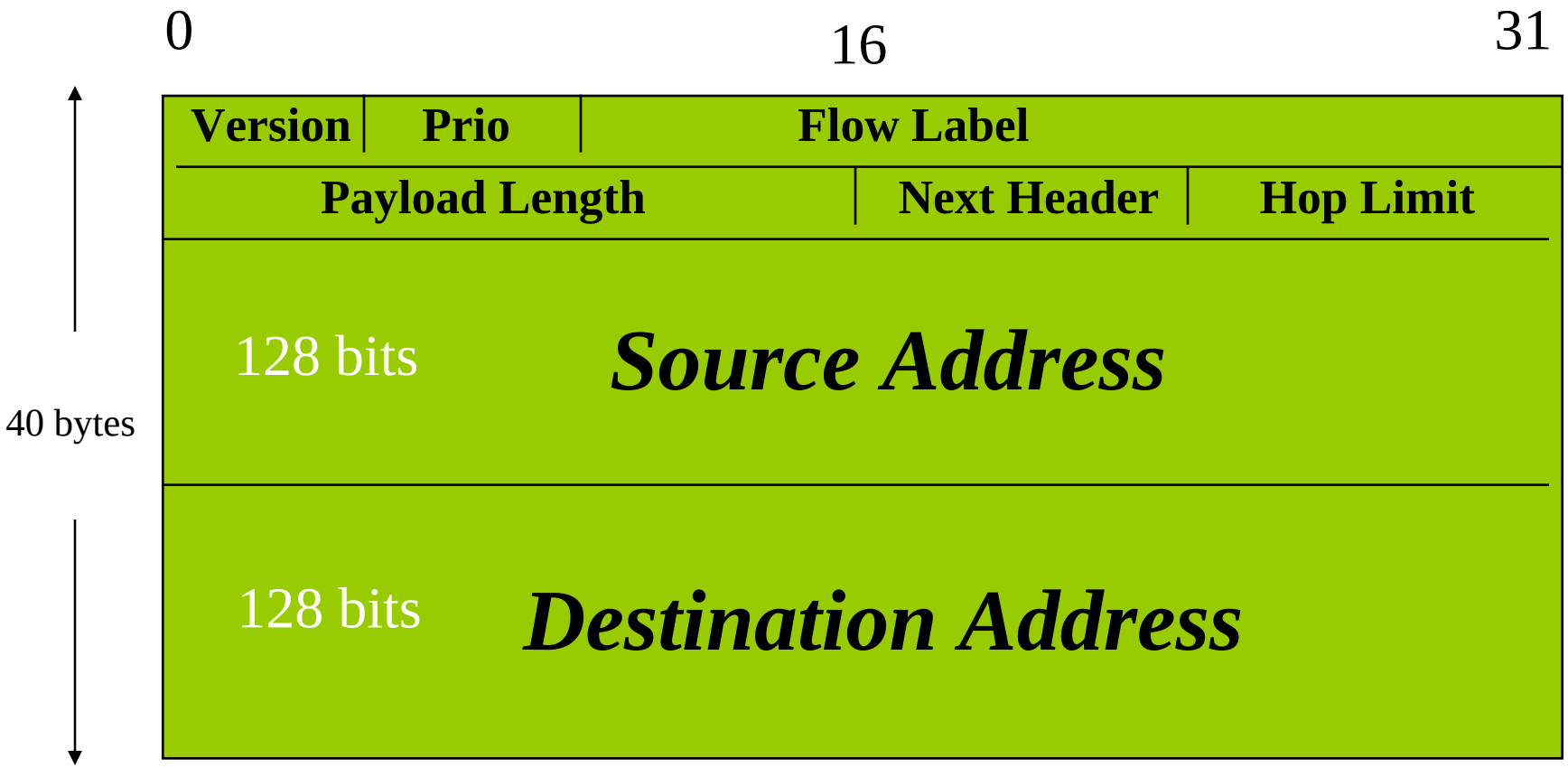
IPv6

The New Internet Protocol

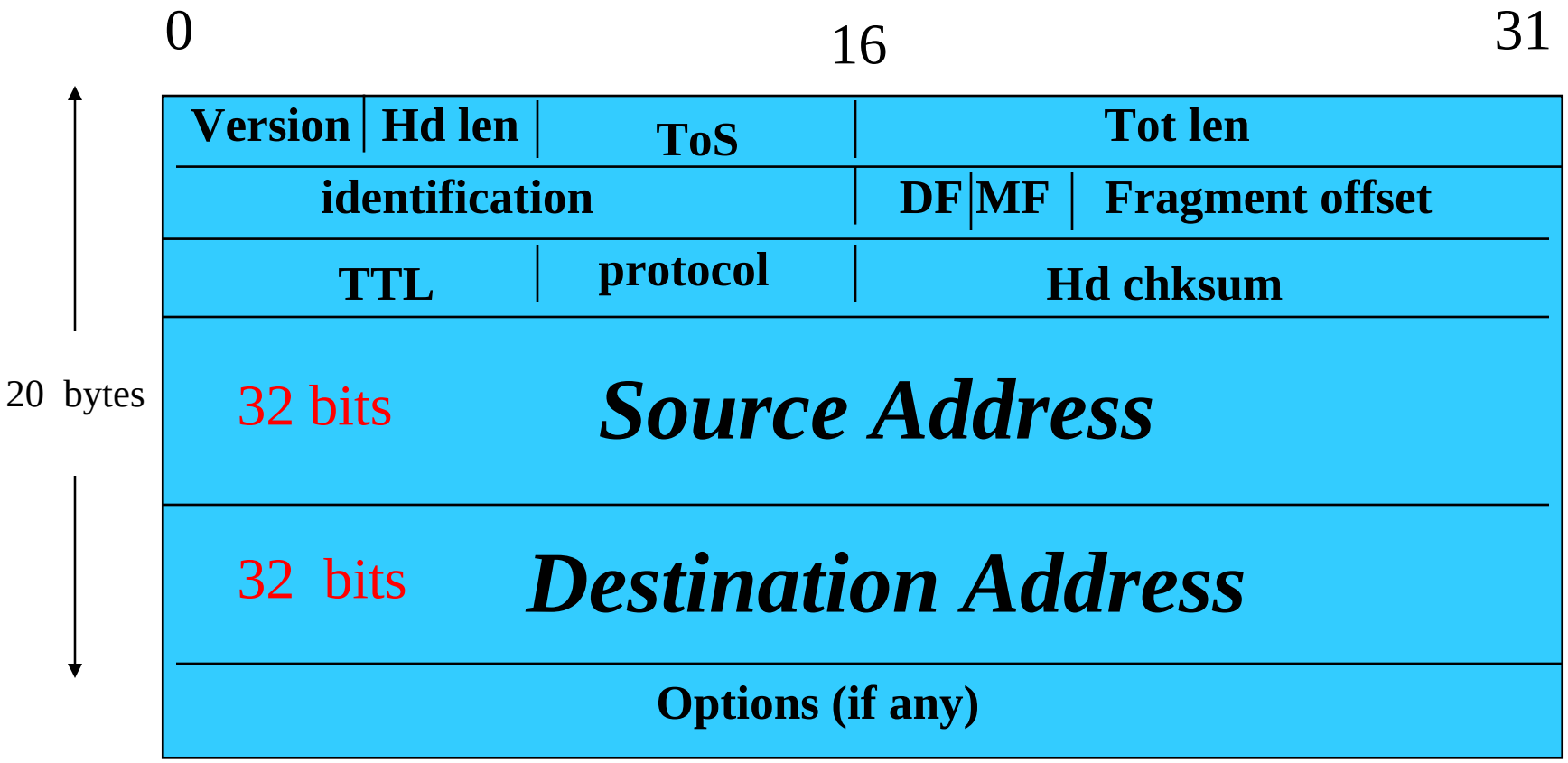
The Design of IPv6

- IPv4 design was very good IPv6 should keep most of it
- It could only increase the size of addresses and keep every thing the same
- Experience brought lessons for improvement

IPv6 Header (40 bytes)



IPv4 Header (20 bytes)



while

the IPV6 address are four times as large as the IPV4 address,

the header length is only twice as big.

Notations of IPv6 Addresses

128 bit is represented as

Eight 16-bit parts, separated by colons,

each part is represented by 4 hex digits

Example:

FEDC:BA98:7654:3210:FEDC:BA98:7664:3210

Simplifications

- Skip leading zeros
  - Example:1080:0000:0000:0000:0008:0800:200C:417A
  - is reduced to: 1080:0:0:0:8:800:200C:417A
- A set of consecutive nulls is replaced by :: (at most one :: inside an address)
  - the above address is reduced to:
    - 1080::8:800:200C:417A

Comparison of Headers

- V6: 6 fields + 2 addr
- V4: 10 fields + 2 addr + options
- **Deleted:**
  - Header length
  - type of service
  - identification, flags, fragment offset
  - Header Checksum
- **Added:**
  - Priority
  - Flow label
- **Renamed:**
  - length -> Payload length
  - Protocol -> Next header
  - time to live -> Hop Limit
- **Redefined:** Option mechanism

Simplifications

- Fixed format headers
  - no options -> no need for header length
  - options expressed as Extension headers
- No header checksum
  - reduce cost of header processing, no checksum updates at each router
  - minimal risk as encapsulation of media access protocols (e.g..., Ethernet, PPP) have checksum
- No segmentation
  - hosts should use path MTU discovery
  - otherwise use the minimum MTU (536 bytes)

Renaming

- Total Length → Payload Length
  - not include header length
  - max length 64Kbytes with provision for larger packets using "jumbo gram" option
- Protocol Type → Next header, can be set to:
  - Protocol type (UDP,TCP, etc..)
  - Type of first extension header
- TTL → Hop limit
  - "Truth in advertising!",
  - number of hops NOT number of seconds

New Fields

Flow label & Priority

to facilitate the handling of real time traffic

Options → Extension Headers

Routers treats packets with options as "second class citizens"

because it is slow to process,

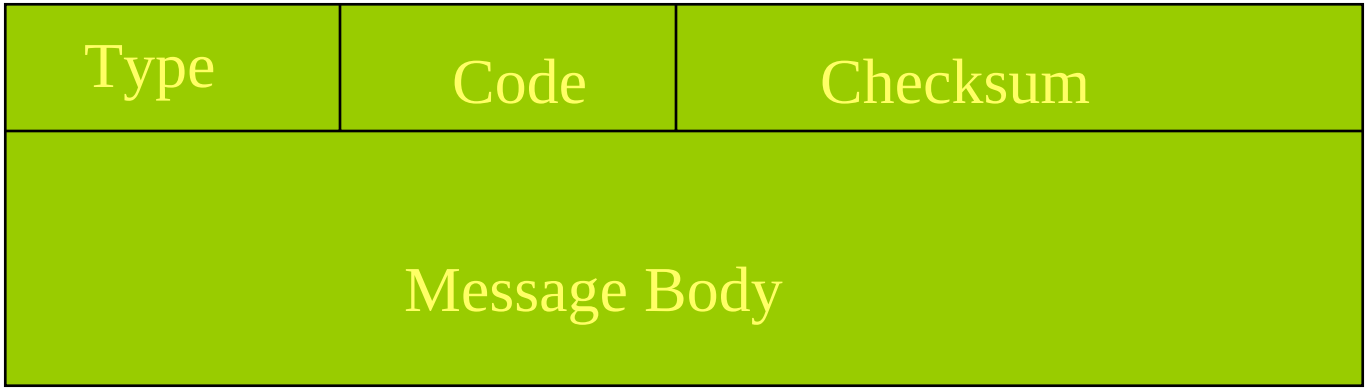
thus programmers tend not use them and options almost became obsolete.

IPv6 extension headers

- Hop-by-hop options
- Routing
- Fragment
- Destination options
- Authentication
- Encryption Security Payload

ICMP…. Streamlined

- Removed unused functions in ICMP of v4
- Incorporate IGMP of v4



ICMP Error Messages

1 Destination Unreachable. Codes:
- 0 No route to destination
- 1 destination prohibited
- 3 Address unreachable
- 4 Port unreachable

2 Packet Too Big

contain next hop MTU.

used for path MTU discovery

3 Time Exceeded. Codes:

0 Hop limit exceeded

1 Fragment reassebly time exceed

4 Parameter Problem

Other ICMP messages

128	Echo Request
129	Echo Reply
130	Group Membership Query
131	Group Membership Report
132	Group Membership Termination
133	Router Solicitation
134	Router Advertisement
135	Neighbor Solicitation
136	Neighbor Advertisement
137	Redirect

Domain Name Service

32-bit address to 128-bit address

Programming interface

Address data structures

AF_INET6, PF_INET6, in_addr6, sockaddr_in6

Name-to-address translation functions

Address conversion functions

Points of Controversy

- Do we need more than 255 Hops?
  - allowing hop count to be very large, looping packets will be relayed many times before being discarded
- Should packets be larger than 64K?
  - allowing very large packets increase the size of queues and the variability of queuing delays
- Can we live without checksum?
  - Some IPv4 routers started to cut corners by not verifying checksums to gain advantage over competition. By removing checksum altogether offers all routers the same advantage.

Real-time Support & Flows

- A proper handling of *flows* is required for high-quality *multimedia communications* in the new Internet
- A *flow* is a sequence of packets sent from a particular *source* to a particular (unicast or multicast) *destination* for which the source desires *special handling* by the intervening routers.

Transitioning the Internet

- At the beginning, all IPv6-capable hosts will also be IPv4-capable so as to retain *connectivity* with the existing Internet.
- To transform IPv4 into a *dual-stack* IPv6-capable host, it should include:
  - The IPv6 *basic code*
  - Handling IPv6 within *TCP & UDP*
  - Modify *socket interface* to support new addresses
  - Handling the interface with the *name service*

The 6-Bone

- The Similar to the M-Bone, Initially the connectivity is achieved by *tunneling*
- IPv6 packet will be *encapsulated* within IPv4 packets.