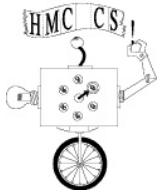
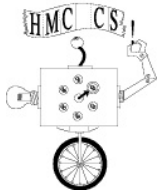


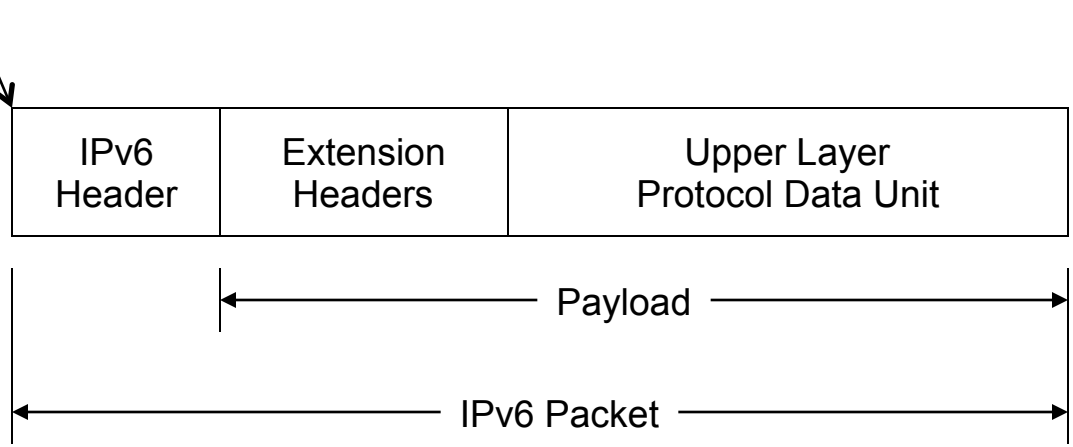
The IPv6 Header



IPv6 "Under the Hood"

Structure of an IPv6 Packet

router based header, key design



Basic Headers

- **IPv6 – focused on fast/easy routing**

Version	Class	Flow Label	
Payload Length		Next Header	Hop Limit
Source Address			
Destination Address			

IPv4

Version	IHL	Type of Service	Total Length	
Identification			Flags	Fragment Offset
Time-to-live		Protocol	Header Checksum	
Source Address				
Destination Address				
Options				Padding

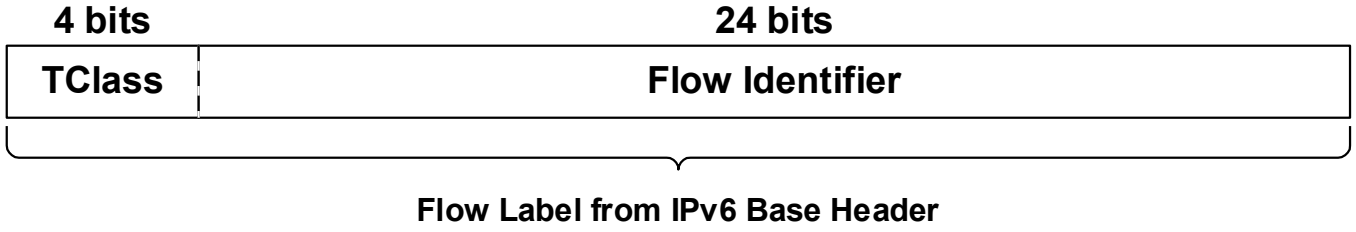
Basic Headers

- **Fields**
  - **Version (4 bits) – only field to keep same position and name**
  - **Class (8 bits) – was Type of Service (TOS), renamed - QoS related**
  - **Flow Label (20 bits) – new field – QoS related**
  - **Payload Length (16 bits) – length of data, slightly different from total length (extension headers)**
  - **Next Header (8 bits) – type of the next header, new idea**
  - **Hop Limit (8 bits) – was time-to-live, renamed**
  - **Source address (128 bits)**
  - **Destination address (128 bits)**

Resource Allocation (Flows)

- ***Flow*** **- a sequence of packets sent between two nodes for which the source requires special handling**
- **Designed to allow an application to reserve resources end-to-end, e.g.,**
  - **Guaranteed data rate**
  - **Maximum delay**
- **Intended to exploit underlying *Quality of Service* features in technologies that first occurred in technologies such as Frame Relay and ATM and are now needed by many applications**

Flow Label Subfields

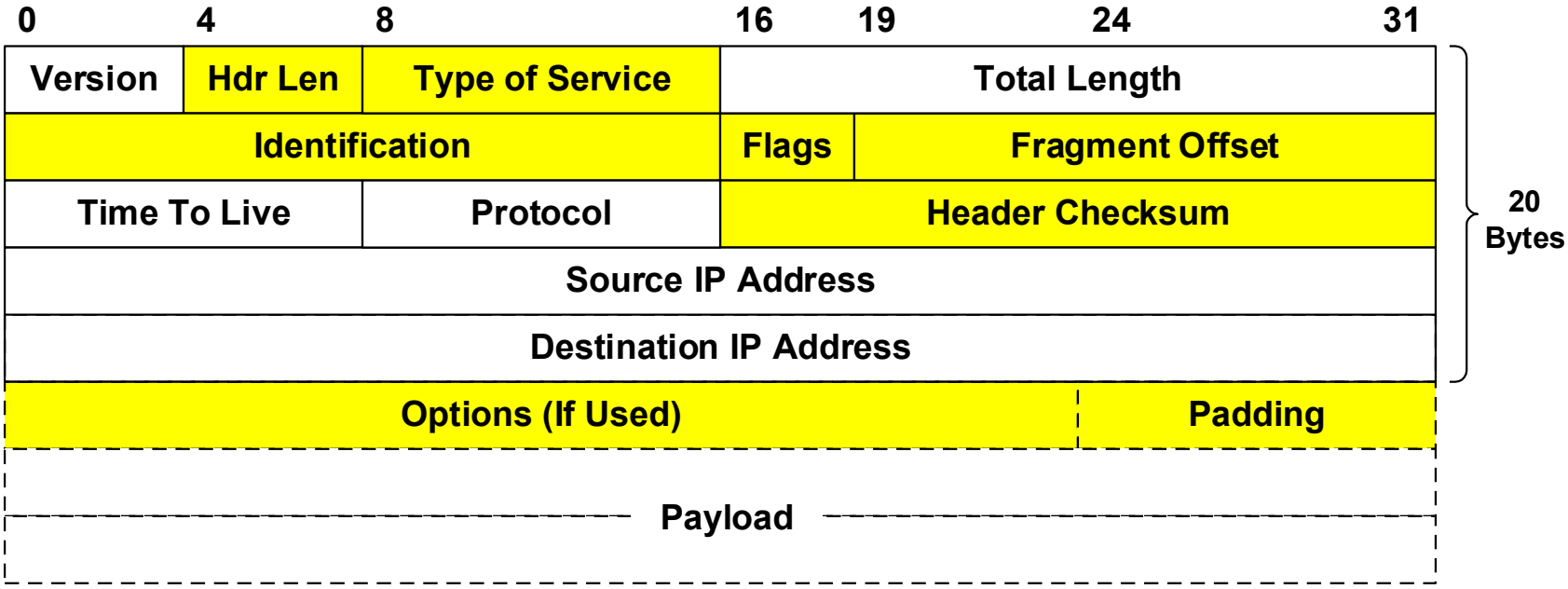


- **Traffic Class** (TClass)
  - Packet priority (lower number = lower priority)
  - Range is 0 - 7 when source provides congestion control (TCP)
  - Range is 8 - 15 for traffic that needs QoS and wants the network to support QoS (UDP/RTP/video/voice)
- **Flow Identifier** is a number that associates the packet with an established flow
  - How will the router manage flows?

Basic Headers

- **Simplifications**
  - **Fixed length of all fields, not like old options field**
  - **Remove Header Checksum – rely on checksums at other layers**
  - **No hop-by-hop fragmentation – fragment offset irrelevant – MTU discovery required of source**
  - **Add extension headers – next header type (sort of a protocol type, or replacement for options)**
  - **Basic principle: Routers along the way should do minimal processing**
  - **64-bit alignment**
  - **No more checksum**
    - **Redundant with error checking in other layers (and too much overhead in router)**
  - **40 bytes long – twice as large as the default IPv4 header**

IPv4 Header Fields Missing in the IPv6 Base Header



The yellow fields in the IPv4 header do not appear in the IPv6 Base Header

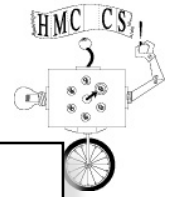
Summary: Changes from IPv4 to IPv6

- **Expanded addressing capabilities**
- **Header format simplification, i.e., fast processing and specific headers.**
- **Improved support for extensions and options**
- **Flow labeling capability**
- **Authentication and privacy capabilities**

Header Types

- **Look in packet for next header, but always the same location….mask**
  - **Can be Extension Header**
  - **Can be a Protocol Header, i.e., ICMP, TCP, UDP, or other normal types**

Values of the Next Header Field



Value	Header
0	Hop-by-Hop Options Header
6	TCP
17	UDP
41	Encapsulated IPv6 Header
43	Routing Header
44	Fragment Header
50	Encapsulating Security Payload
51	Authentication Header
58	ICMPv6
59	No next header
60	Destination Options Header

Parsing Extension Headers

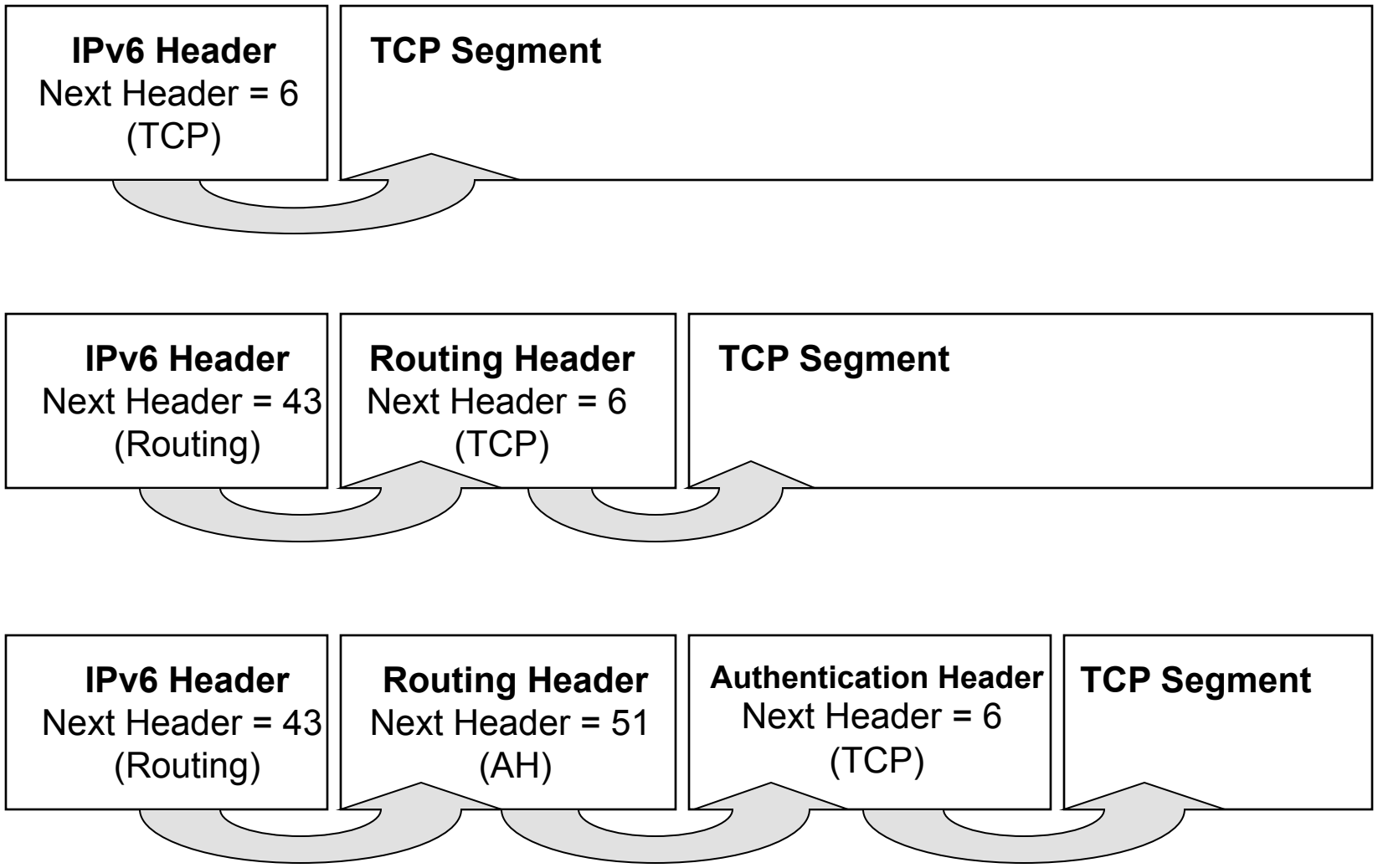
- The **Next Header** field in a base header or extension header indicates what header/data segment follows
- The standard IPv4 protocol codes still indicate Transport protocols (TCP = 6, UDP = 17)

Base Header Next Hdr = TCP	TCP Segment

Base Header Next Hdr = Route	Route Header Next Hdr = TCP	TCP Segment

Base Header Next Hdr = Route	Route Header Next Hdr = Auth.	Auth. Header Next Hdr = TCP	TCP Segment

The Chain of Pointers Formed by the Next Header field

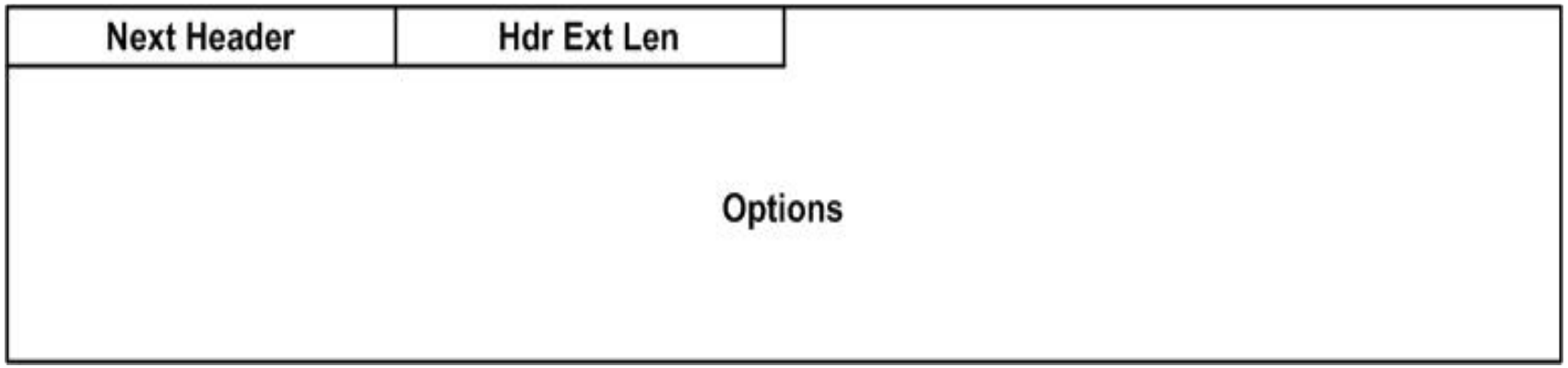


Extension Headers Order

1. **Hop-by-Hop Options header**
2. **Destination Options header (for intermediate destinations when the Routing header is present)**
3. **Routing header**
4. **Fragment header**
5. **Authentication header**
6. **Encapsulating Security Payload header**
7. **Destination Options header (for the final destination)**
8. **Upper Layer Header, e.g., TCP, UDP**

Extension Headers

- **Header Options in General**
  - **The usual next header and length fields**
  - **Any options that might be defined**



IPv6 Extension Headers vs. IPv6 Options

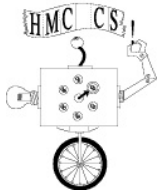
- **Most Extension Headers serve one specific function (fragmentation, routing, etc.)**
- **Two special Extension Headers serve as containers for multiple (unspecified) Options**
  - **The *Hop-by-Hop Options -* Extension Header includes options that must be processed by each router**
  - **The *Destination Options -* Extension Header includes options that are only processed at the destination**

Extension Headers

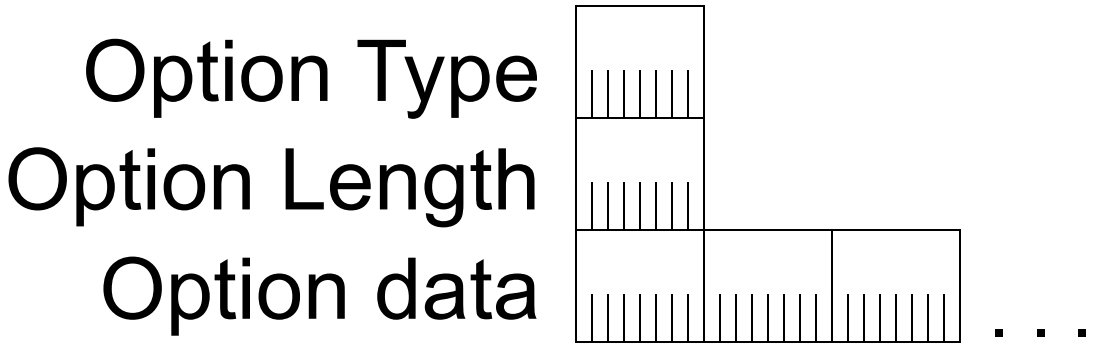
- **Hop-by-Hop Extension Header**
  - **The usual format of an options header**
  - **An example is the jumbo packet**
    - **Payload length encoded**
    - **Can't be less than 65,535**
    - **Can't be used with fragmentation header**

Next Header	Hdr Ext Len	194	4
Jumbo Payload Length			

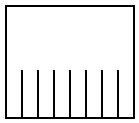
Structure of an Option



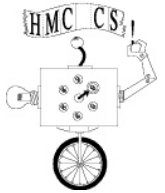
note: type, length, value

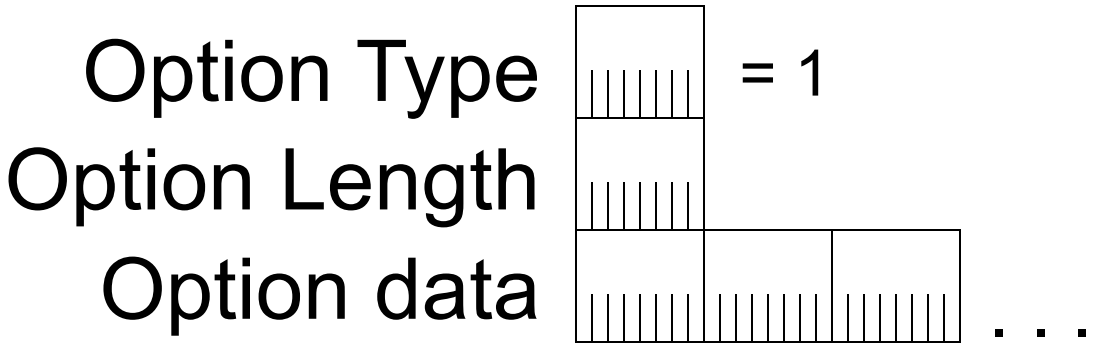


Ex: Structure of the Pad1 Option

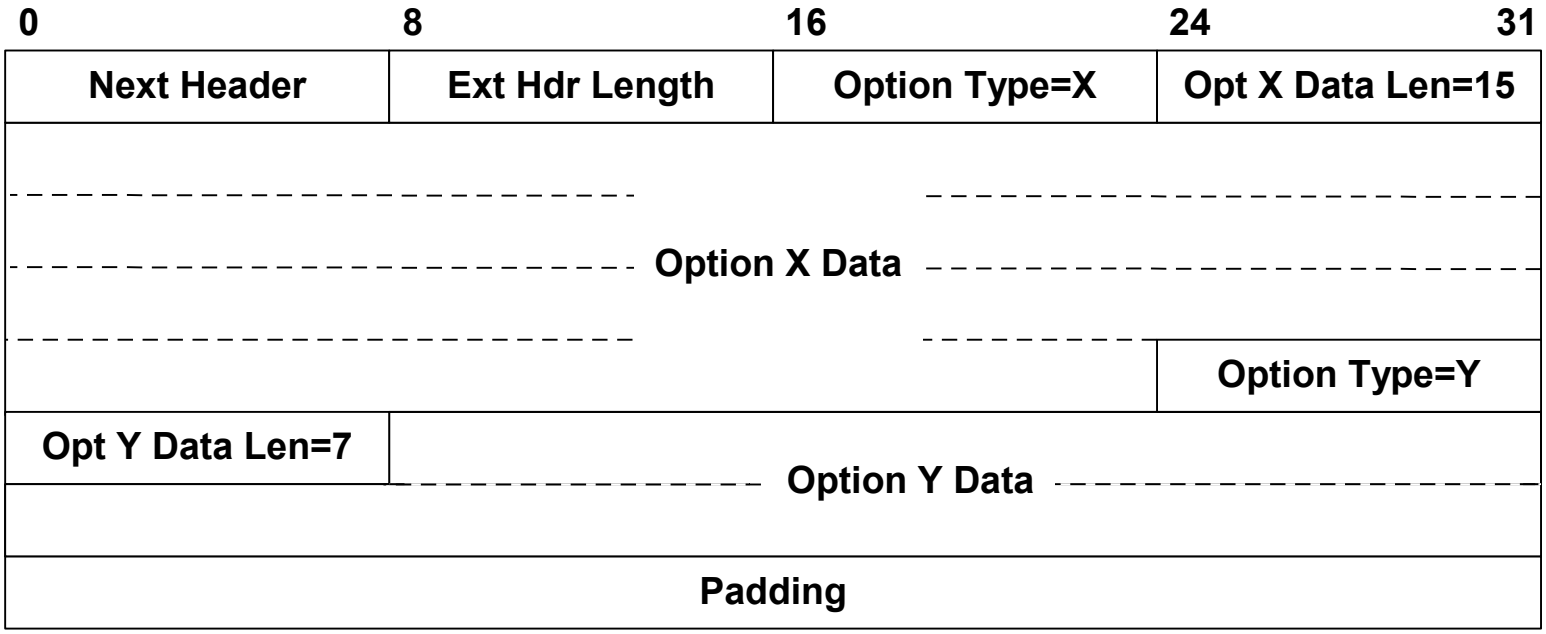
Option Type  = 0

Ex: Structure of the PadN Option

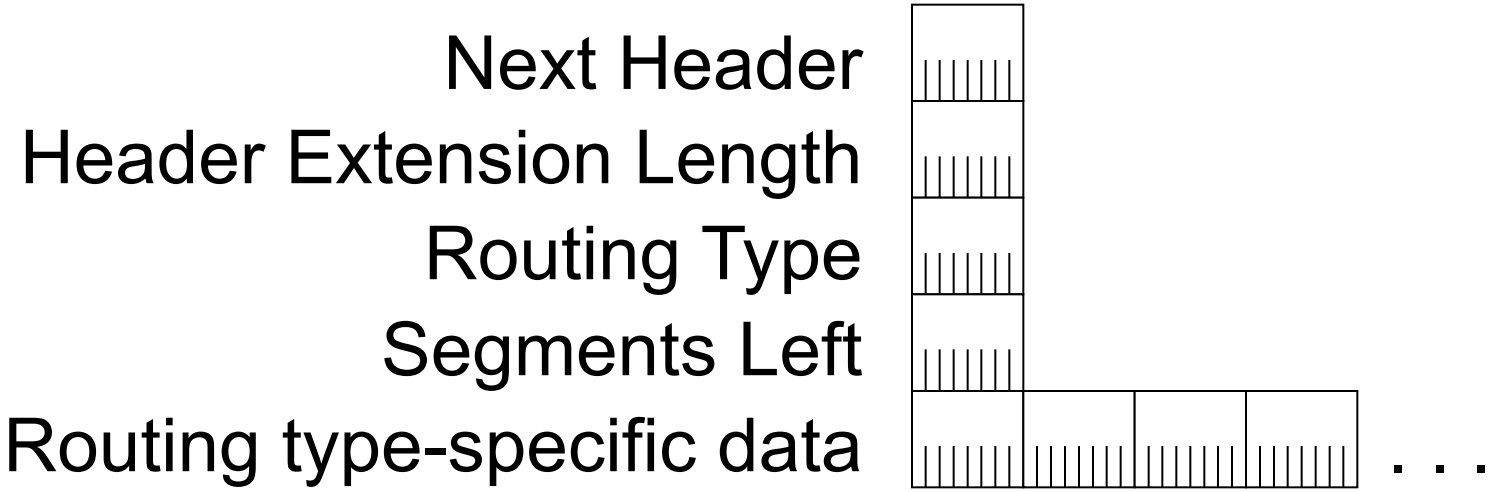




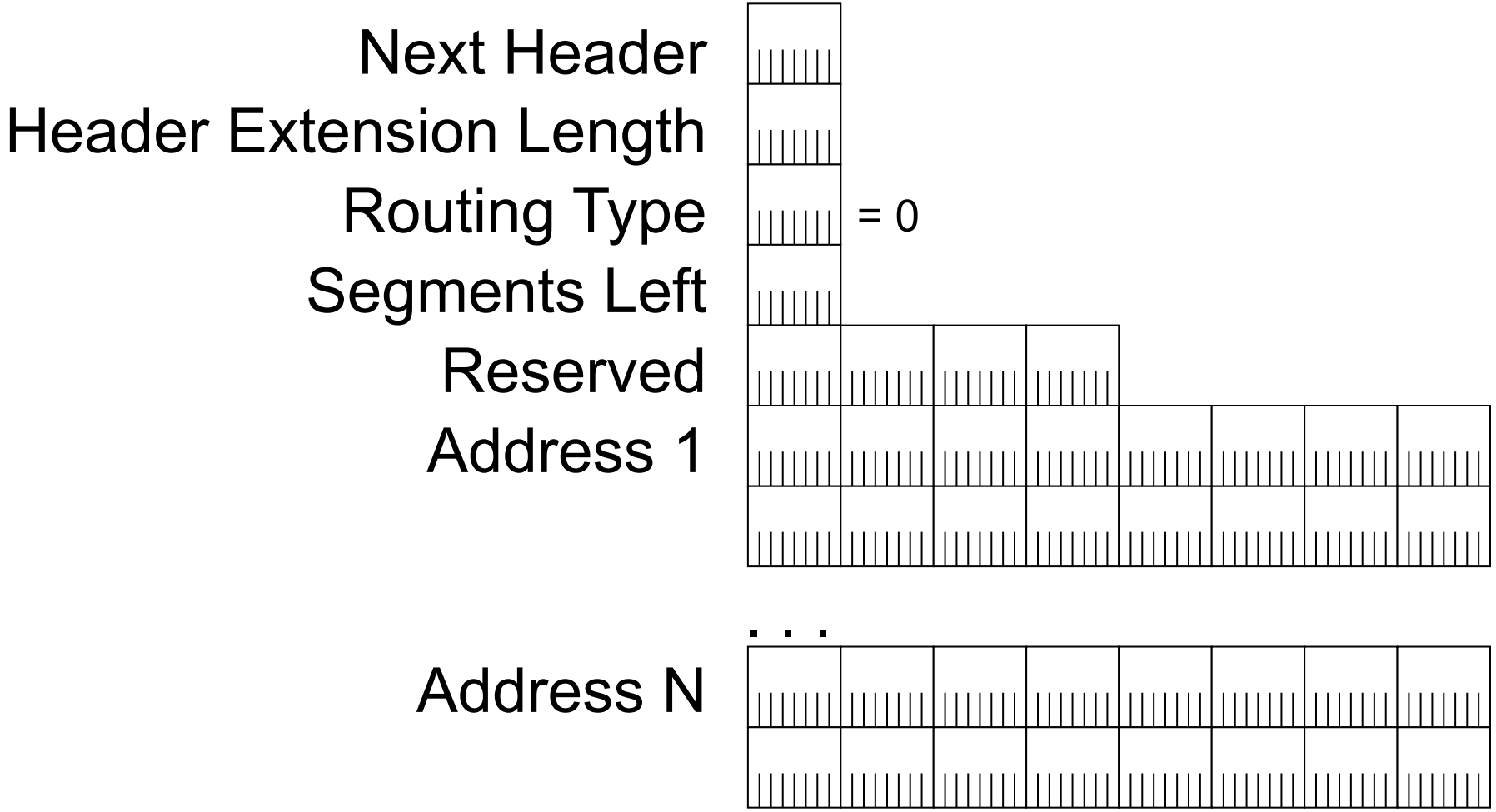
Extension Header Containing Two Options



Structure of the Routing Header

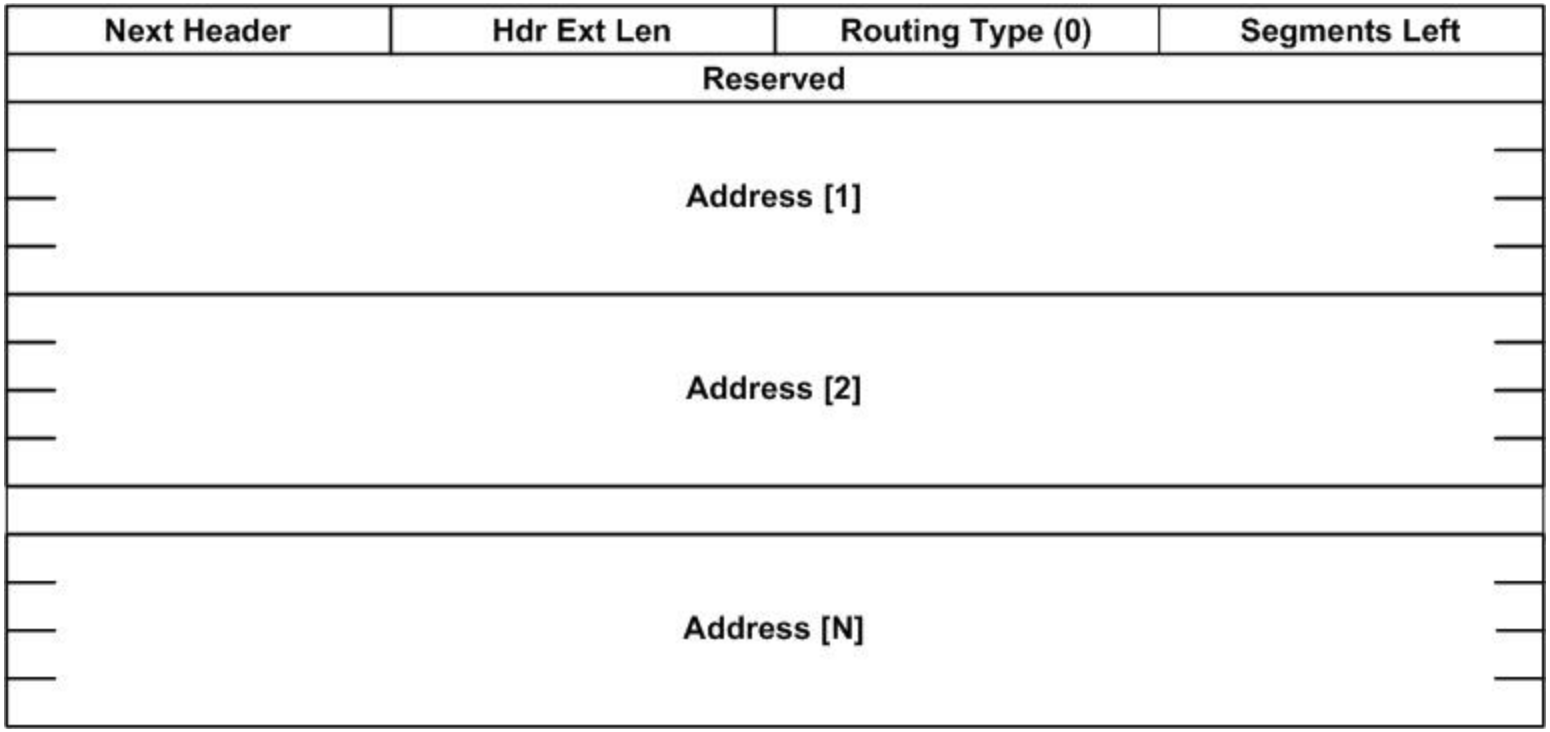


Structure of the Routing Type 0 Header

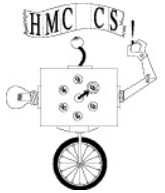


Extension Headers

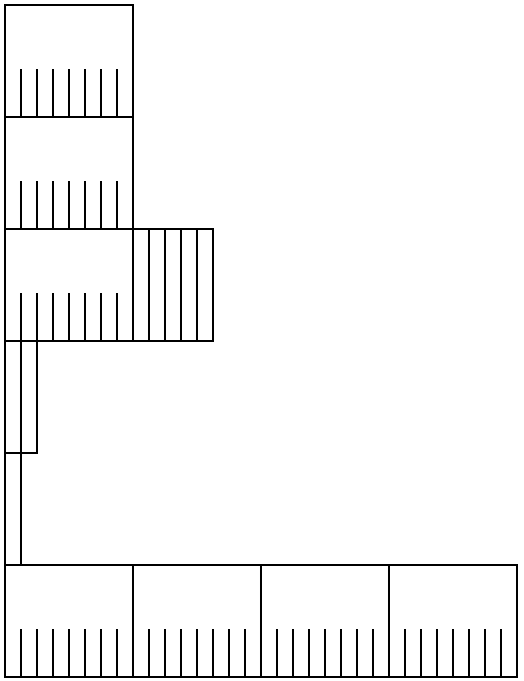
- **Routing Header**



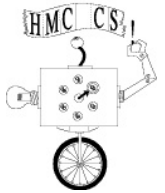
Structure of the Fragment Header

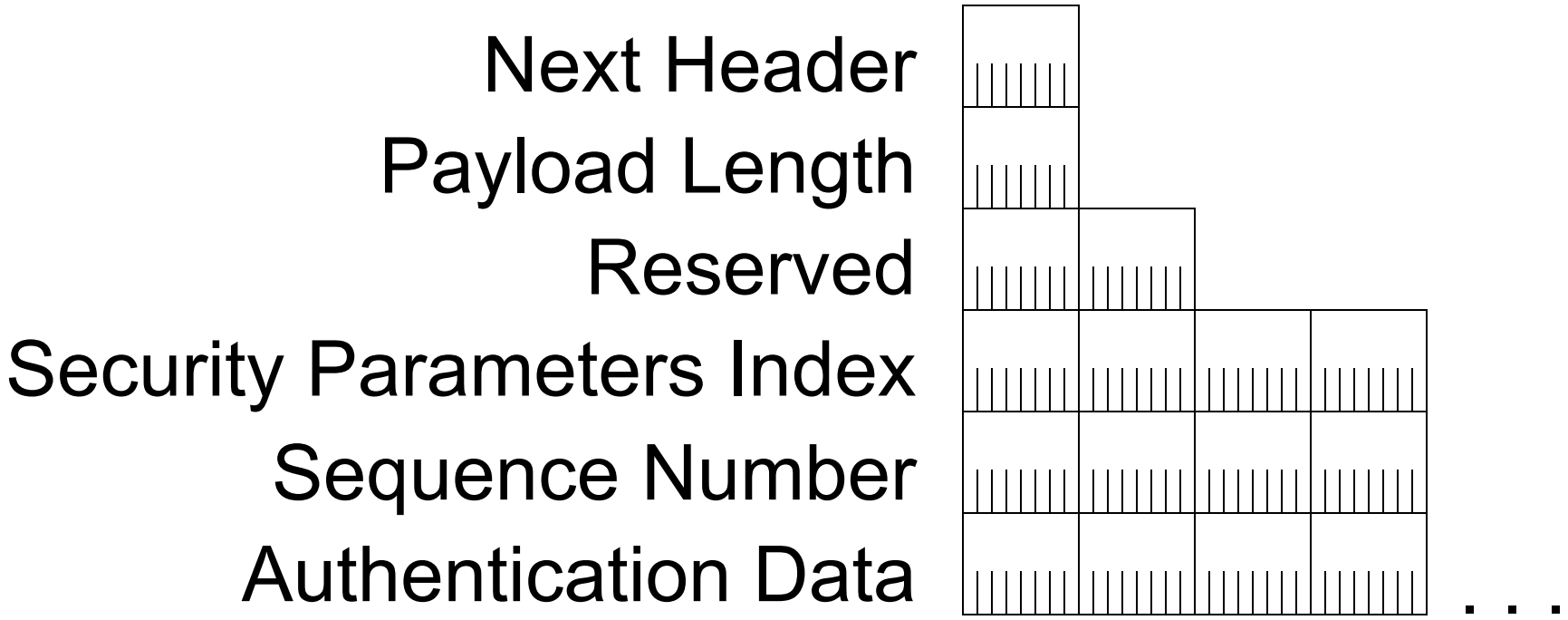


Next Header
Reserved
Fragment Offset
Reserved
More Fragments Flag
Identification



Structure of the Authentication Header

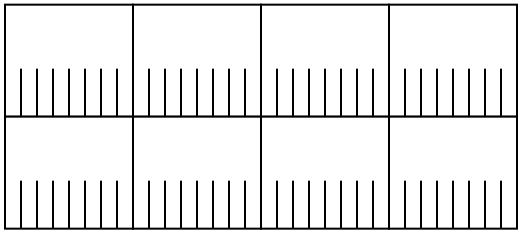




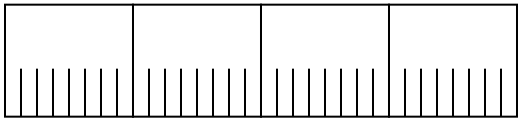
Structure of the ESP Header and Trailer

Security Parameters Index

Sequence Number

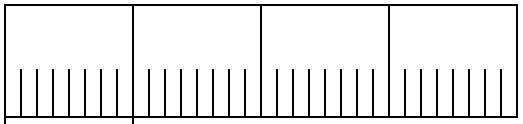


Payload Data



. . .

Padding

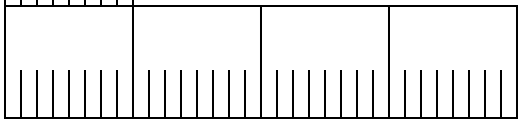


. . .

Padding Length

Next Header

Authentication Data



. . .