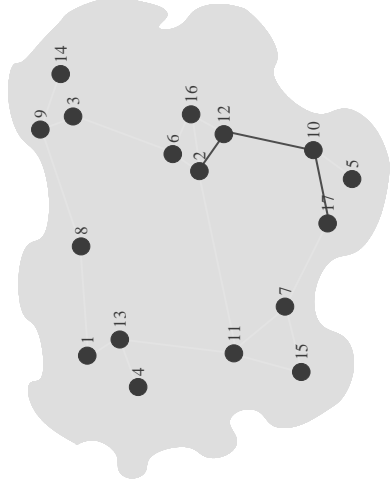


# Impact of Assignment Method

- ◇ And for other destinations
  - From node 2



- To reach node
  - ▷ 1: send to node 11 (it will forward)
  - ▷ 3: send to node 6
  - ▷ 4: send to node 11

# Routing impact

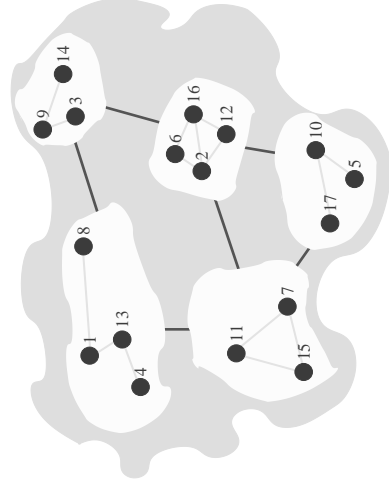
- ◇ Node 2:

to	via	to	via
1	11	3	6
4	11	5	12
6	6	7	11
8	6	9	6
10	12	11	11
12	12	13	11
14	6	15	11
16	16	17	12

- ◇ Each node needs
  - list of all other nodes
  - and next hop to use
    - ▷ to reach the other node

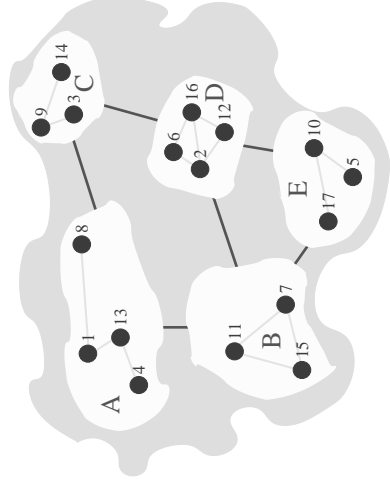
# Net Development

- ◇ Service Providers appeared



- Simplify nodes routing
  - ▷ Know routes to neighbours
  - ▷ Everything else
    - Send to ISP

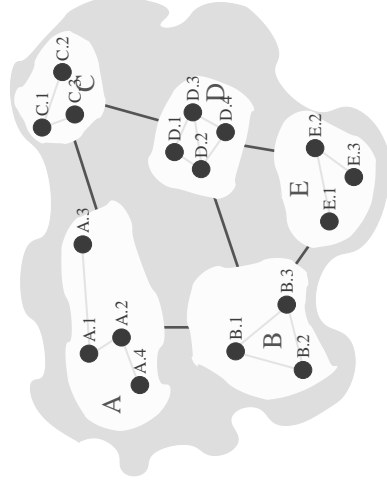
# Service Provider Routing



- ◊ Service Provider
  - most know location of
    - every network node
    - which ISP to send to

# Better Method

- ◊ Reassign all addresses



- ◊ Now
  - Address makes it clear
    - which ISP it belongs to

# Hierarchical Addressing

## IPv6 - Why?

- ◊ IPv4 running out of addresses
  - $2^{32}$  ==> 4 Billion addresses max
  - But many "wasted" because of allocation policy
  - 2 million connected organisations max
- ◊ IPv4 routing tables becoming unmanageable
  - ~50K routes
    - now ~200K routes
  - needs recalculating frequently

# IPv6 - Answers

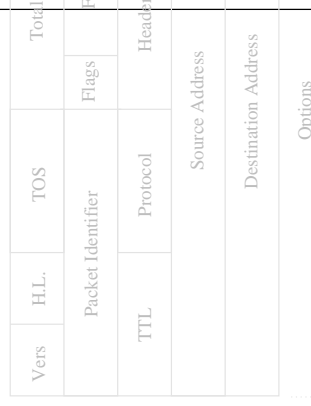
- ◊ IPv6 addresses 128 bits
  - $2^{128}$  ==> too big for words to describe
  - 340282366920938463463374607431768211456
    - (39 digits)
    - Very many will be wasted

- ◊ Routing
  - Later...

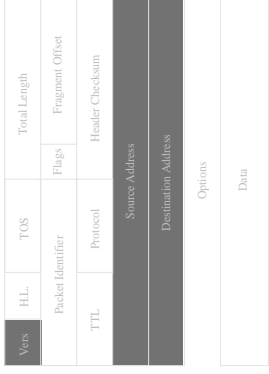
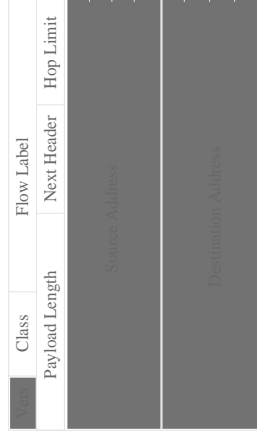
## IPv6 Header



## Header Comparison

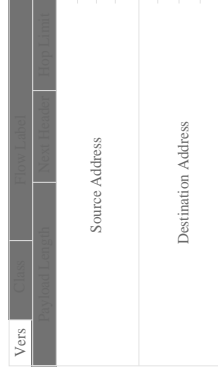


# Equivalent fields



- ◇ Version
  - 4 for IPv4
  - 6 for IPv6
  - ▷ Hence the names...
- ◇ Version identification is one way to allow upgrades

# Modified Fields



# The Modified Fields

- ◇ Time to Live
  - Hop Limit
- ◇ Total Length
  - Payload length
- ◇ Protocol
  - Next Header
- ◇ TOS
  - Traffic Class (DSCP) & Flow Label
  - ▷ Currently not well defined

# Missing Fields

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

Vers	ILL	TOS	Total Length
Packet Identifier		Flag	Fragment Offset
TTL	Protocol	Header Checksum	
Source Address		Destination Address	
Options		Data	

# The Missing Fields

- ◇ Header Length
  - IPv6 header is fixed length ==> not needed
- ◇ Options
  - Exist in a different form
- ◇ Fragmentation fields (ID / Offset / Flags)
  - Exist in a different form
- ◇ Header Checksum
  - The controversial change - gone completely

# An IPv4 Packet

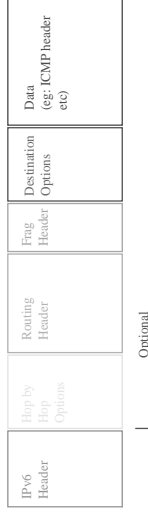
```
0:10:a4:f:41:cf 0:1:3:40:8a:e5 0800 98:
172.30.0.77 > 172.30.0.161:
  icmp: echo request
4500 0054 7e24 0000 ff01 e459 ac1e 004d
ac1e 00a1 0800 a334 0d82 0000 b613 3a3b
5ff7 0c00 0809 0a0b 0c0d 0e0f 1011 1213
1415 1617 1819 1a1b 1c1d 1e1f 2021 2223
2425 2627 2829 2a2b 2c2d 2e2f 3031 3233
3435 3637
```

# An IPv6 Packet

```
0:10:a4:f:41:cf 0:1:3:40:8a:e5 86dd 70:
3ffe:8001:2:181:210:a4ff:fe0f:41cf >
3ffe:8001:2:181:201:3ff:fe40:8ae5:
icmp6: echo request

6000 0000 0010 3a40 3ffe 8001 0002 0181
0210 a4ff fe0f 41cf 3ffe 8001 0002 0181
0201 03ff fe40 8ae5 8000 e8a3 0d9c 0000
7616 3a3b d908 0700
```

# IPv6 Header Chains



- ◊ Each Header (before data) contains a "Next Header" field
  - Specifies the type of the header that follows
  - The first header is always an IPv6 header
- ◊ Each Header is of fixed length, or provides a mechanism to allow its length to be determined
  - Length field in most headers

# Header Processing

- ◊ Headers are processed "left to right" through the packet
  - Unrecognised header is an error,
    - ICMP error report
    - Drop packet
- ◊ Routers look only at IPv6 header, and Hop-by-Hop Options
  - Easy to tell if HBH is present
    - Next Header field in IPv6 Header (0)