

# Internet Engineering

241-461

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## CIDR

- ◊ Still running out of addresses
  - Clearly need new protocol
    - Eventually IPv6 developed
  - Interim
    - Need to extend lifetime of IPv4
- ◊ Classless Inter-Domain Routing
  - Remove Class concept from IP address
    - No more class A B or C
  - Until now remote networks identified by class
    - Automatically know which bits are network number
  - Now must explicitly send netmask with every network address
    - \* As mask or as mask length count
    - so network bits can be identified
  - Only not needed with host address
    - Always all 32 bits
- ◊ Now able to allocate any sized network block to organisation

## IPv6

- ◊ Need a protocol with more addresses
  - Otherwise quite like IPv4 which works well
- ◊ More addresses means more bits
  - How many bits?
- ◊ Want to allocate enough
  - so numbers never run out again
- ◊ 64 bits?
  - $2^{64}$  addresses - 8 bytes for each address
    - 18,446,744,073,709,551,616
  - $2^{32} * 2^{32}$
  - Is that enough?
    - Some addresses always wasted
      - Always allocate powers of 2 blocks
      - Netmask guarantees that
    - How many wasted?
      - Many
  - Maybe 64 bits not enough

## IPv6 (2)

- ◇ 80 bits?
  - $2^{80}$  addresses - 10 bytes for each address
    - ▷ 1,208,925,819,614,629,174,706,176
  - $2^{16} * 2^{64}$
  - This should be enough
    - ▷ But 80 is not a convenient size for computers
- ◇ 128 bits
  - $2^{128}$  addresses - 16 bytes for each address
    - ▷ 340,282,366,920,938,463,463,374,607,431,768,211,456
  - $2^{64} * 2^{64}$
- ◇ The clever part
  - Use 128 bits
    - ▷ 80 bits for network identification
    - ▷ 48 bits for local part
      - \* autoconfiguration (later)
  - Later changed to 64 + 64

## Other Network Layer requirements

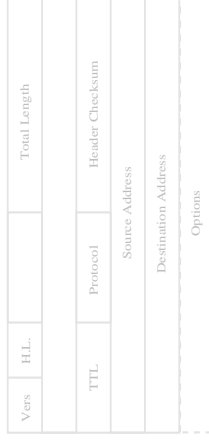
- ◇ Error Detection (some)
    - Checksum
      - ▷ Header only
      - ▷ Ensure packet delivered to correct destination
        - \* With unaltered source address
      - ▷ No verification of packet contents
    - ◇ Link Layer Interface
      - Deal with link layer restrictions
    - ◇ Packet Length
      - Header field
    - ◇ Protocol Identification
      - Header field
    - ◇ Packet Lifetime
      - Header field
        - ▷ Number of seconds packet can live
        - ▷ 8 bits - maximum value 255
- 4 1/4 minutes

## IPv4 header (simplified)



- ◇ Vers - IP version (4)
  - 4 bit field, values 0 .. 15
- ◇ HL - Header Length
  - 4 bit field, values 0 .. 15 words
    - ▷ That is 0 .. 60 bytes
    - ▷ Including fixed part of IP header
      - \* So minimum value is 5 (20 bytes)
- ◇ Total Length - packet size
  - 16 bit field (0 .. 65535)
    - ▷ Includes IP header
      - \* Note limit on UDP datagram size

## IPv4 header (simplified) (2)



- ◇ **TTL - Time To Live**
  - 8 bit field, values 0 .. 255
    - Seconds remaining before packet destroyed
- ◇ **Protocol**
  - 8 bit field, values 0 .. 255
    - Protocol that is data in IP packet
    - Heards that follows IP header (and is options)
  - List of numbers and protocols exists
    - 6 --> TCP
    - 17 --> UDP
    - 1 --> ICMP (later...)

## IPv4 header (simplified) (3)



- ◇ **Header Checksum**
  - 16 bit field
    - Checksum of the IP header (and nothing else)
    - Verifies addresses & protocol unchanged
      - Must be updated as TTL changes
- ◇ **Source Address**
- ◇ **Destination Address**
  - IP addresses (32 bits) of sender and recipient(s)
- ◇ **Options**
  - Extra stuff needed in header
    - Rarely used today