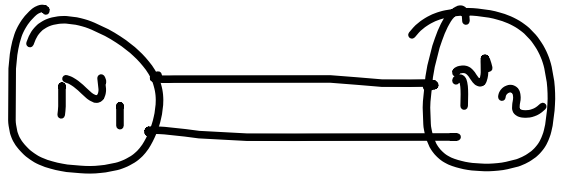
Unit-3.

Internet Protocol

- Internetworking need.
- Connection oriented vs connectionless
- IPv4.
- IPv6

* Connection Oriented Service.

- Connection establishment.
- Data Transfer.
- Connection Termination



Characteristics.

1. High reliability.
2. Slow data transfer mechanism.

* Connectionless Service.

- Data transfer takes place w/o any sort of connection establishment b/w the sender & receiver.
- Low reliability.
- Fast data transfer mechanism.

* New Layer in the Internet.

Principles. — RFC 1958

1. Make sure it works.
2. Keep it simple.
3. Make clear choices.
4. Exploit modularity.
5. Expect heterogeneity.
6. Avoid static options & parameters.
7. Look for a good design.
8. Be strict when sending & tolerant when receiving.
9. Think about scalability.
10. Consider performance & cost.

* Responsibility of N/w layer.

① Host-to-host delivery.

② Routing through routers/switches.

Note:- Internet (IP) protocol uses connectionless n/w or service.

Eg:- Post office.

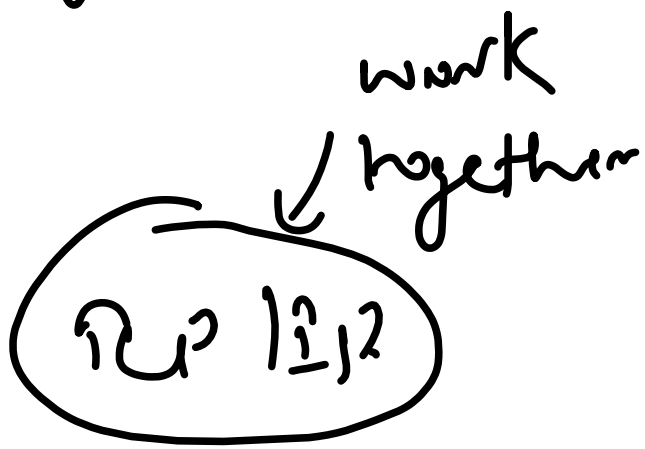
→ Comm^n at the n/w layer in the Internet is connectionless.

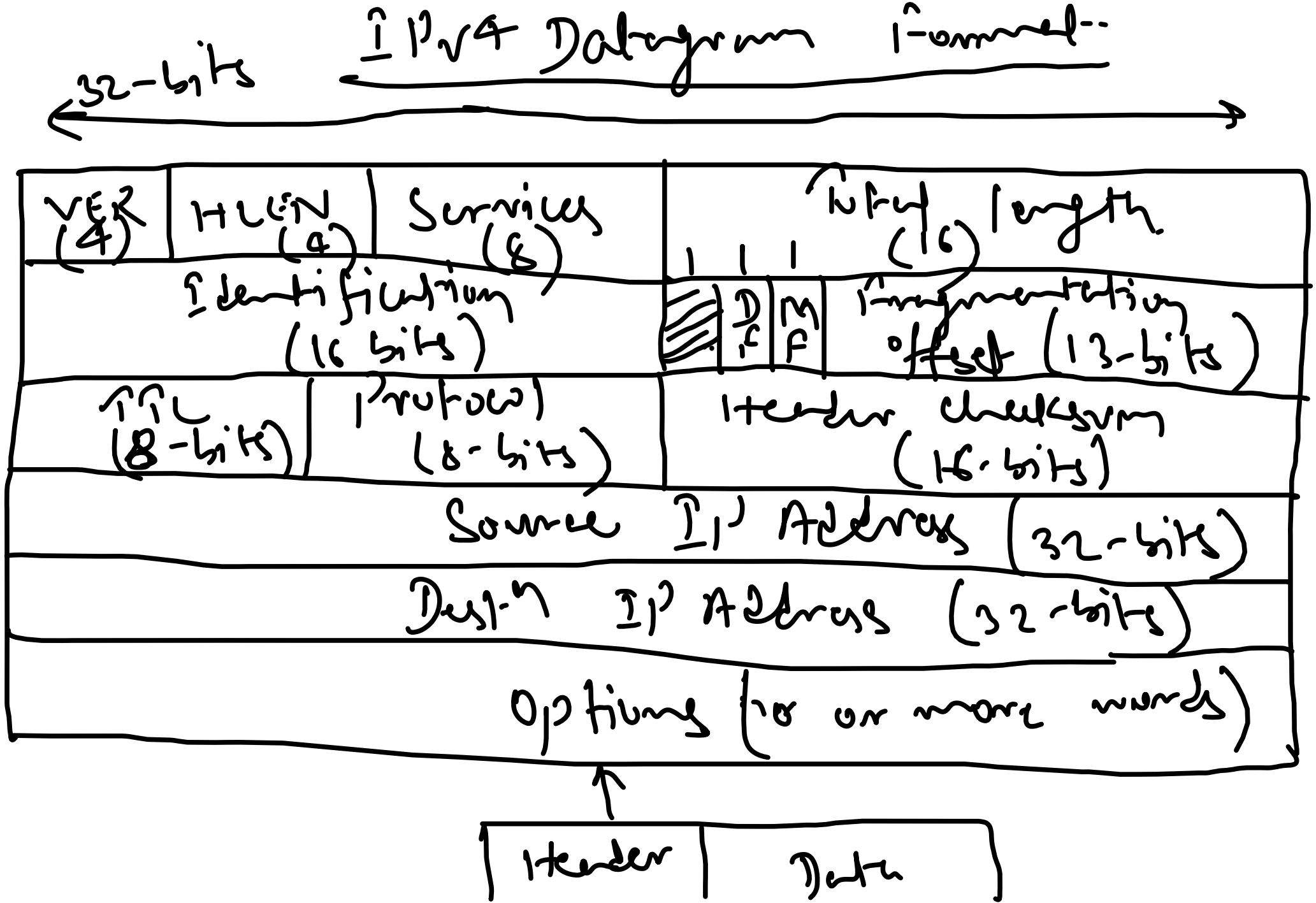
Internet

IPv4 + IPv6

IPv4. — Internet Protocol version 4.

- Unreliable, connectionless, uses Datagram Protocol.
- "Best effort delivery" service.
  - No error control
  - No flow control




IPv4 Datagram
32-bits
VER (4)
HLEN (4)
Services (8)
Total length (16)
Identification (16 bits)
1
DF
MF
Fragmentation offset (13-bits)
TTL (8-bits)
Protocol (8-bits)
Header checksum (16-bits)
Source IP Address (32-bits)
Dest-n IP Address (32-bits)
Options (0 or more words)
Header
Data

* Header — (20 to 60 bytes)

* Fields.

① VER — Version of IPv4 protocol

Current version — 4

Version 6 — IPng.

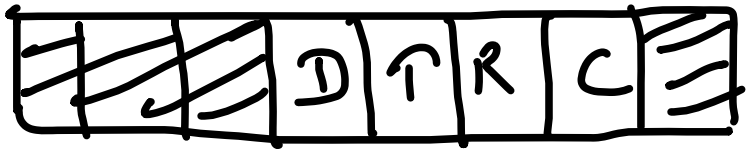
② HLEN — Header length

No options — 20 bytes (5 x 4 = 20)

Options — 60 bytes (15 x 4 = 60)

→ 5 - 15

③ Services - It is also known as Differentiated Services.



0000 — Normal (default)
0001 — C (min)
0010 — R (max)
0100 — T (max)
1000 — D (min)

D : Min. delay.
T : Max throughput
R : Max. Reliability.
C : Min. cost

Apps.

① Activities with immediate attention — min. delay.
↳ TELNET, FTP (control), SMTP (command), TFTP, DNS (UDP query)

② Send bulk data — max T.
↳ FTP (data), SMTP (data), DNS (zone)

③ Mgmt (n/w) activities — max R.
↳ IGMP, SNMP.

④ Background activities — min C
↳ NNTP.

④ Total length

Data length = Total length − Header length

⑤ Identification
⑥ Flags
⑦ Fragmentation offset

} — used in fragmentation

DF — Don't fragment
MF — More fragment

⑧ TTL — Time to Live — no. of hop's.

⑨ Protocol — SCTP, TCP, UDP, ICMP, IGMP, OSPF

6	17	1	2	89

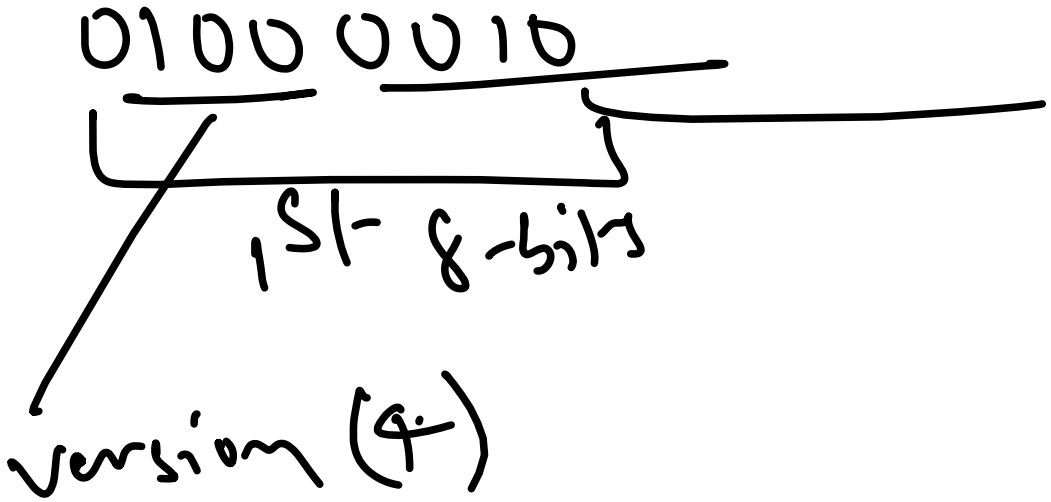
↳ RFC 1700 (iana.org)

(13) Options. — iana.org/assignments/ip-parameters.

- Single byte
  - No operation
  - End of options.
- Multiple bytes
  - Record Route
  - Strict source Route
  - Loose source Route
  - Timestamp

Q:- An IPv4 packet has arrived with first 8-bits as 01000010. The receiver discards it. Why?

Soln :-



$(2) \times 4$

$= (8)_{10} < 20_{min}$

* Limitations of IPv4.

1. Address depletion
2. Strategies & reservation of resources not provided in IPv4.
3. No encryption/authentication in IPv4.

↓↓ switch.

IPv6 (IPng)

↓

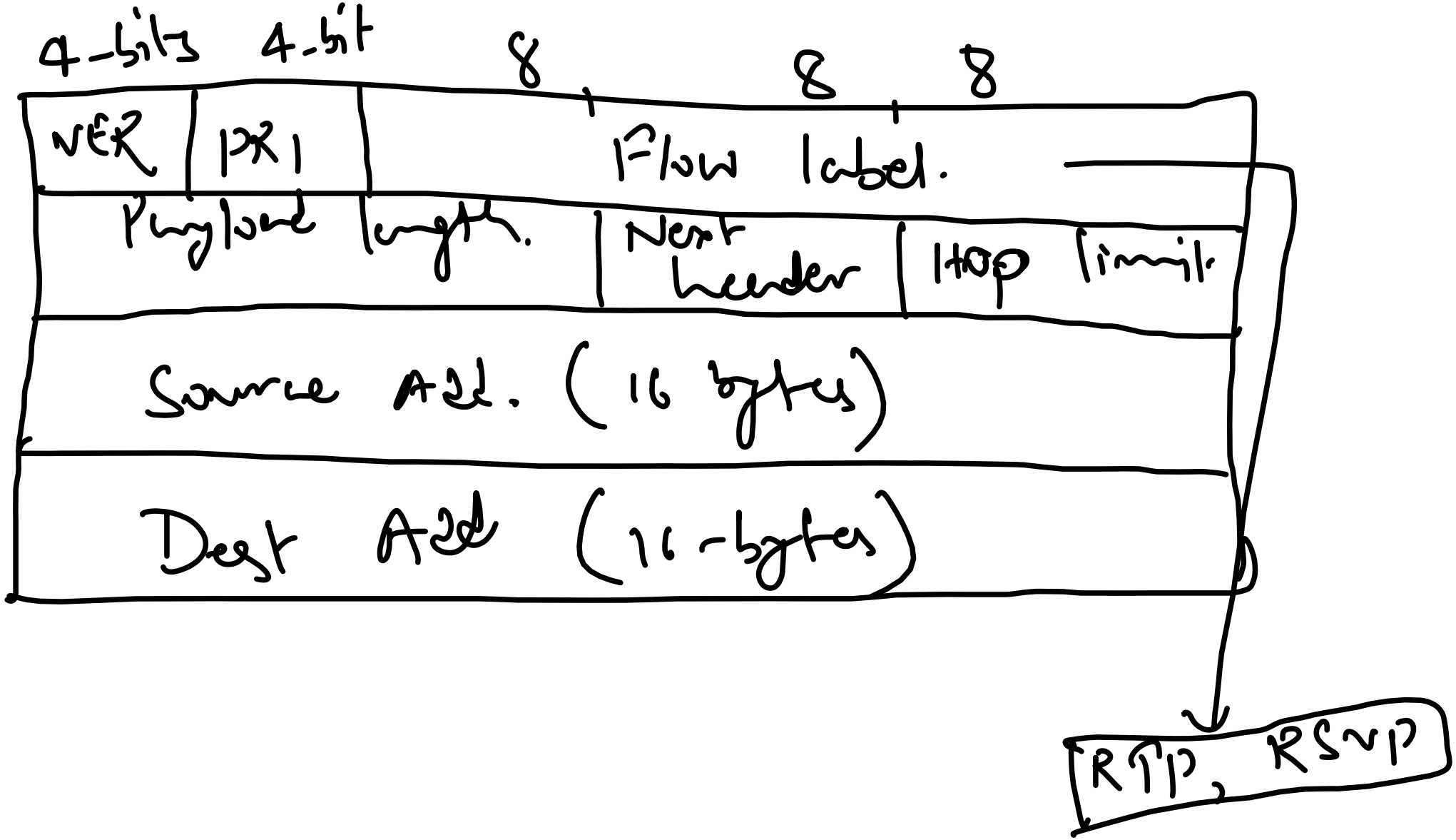
IP next generation.

IPv6.

* Advantages.

1. Longer address space.
2. Better header format.
3. New options.
4. Allows for extensions
5. Support for resource allocation.
6. Support for more security :— confidentiality
   Integrity.

Packet Format.



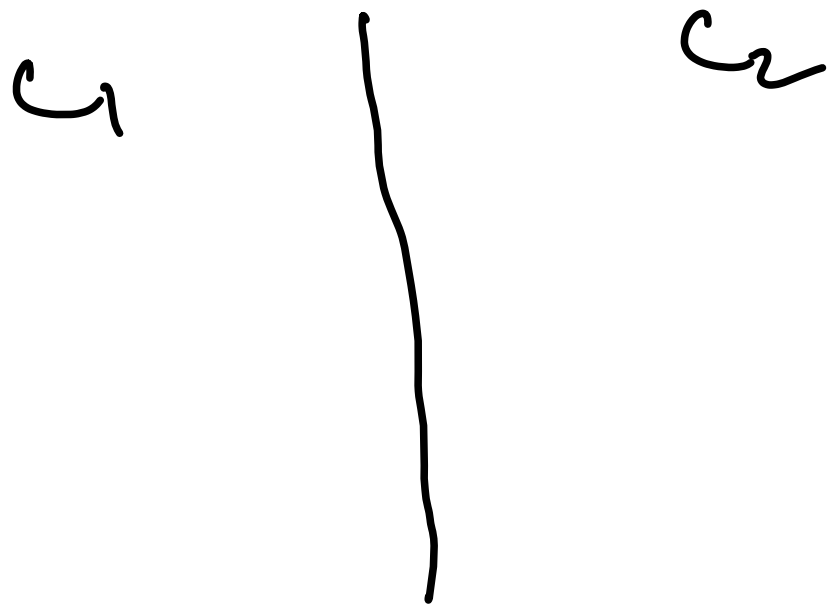
Priority — traffic congestion

- Congestion controlled traffic
- Non congestion controlled traffic (8 → 15) — least redundancy

Data with greatest redundancy

0 No specific traffic
1 Background data
2 Unattended data traffic
3 Reserved
4 Attended bulk data traffic
5 Reserved
6 Interactive traffic
7 Control traffic

Assignment — Compare b/w IPv4 & IPv6 packet-headers.



Transm from IPv4 to IPv6

1. Dual Stack
2. Tunneling — 4
3. Header translation

Address Mapping.

Physical Address (PA) ⟷ Logical Address (LA)

Need of two level addressing.

① Different physical nws. } cases.
② Different protocol at nw layer. }

Categories.

- Static mapping (table-based)
- Dynamic Mapping (ARP, RARP, BOOTP, DHCP)

Limitations.

1. NICs can change.
2. Local Talk (Apple) — IP changes with every boot.
3. Mobile devices change physical area.

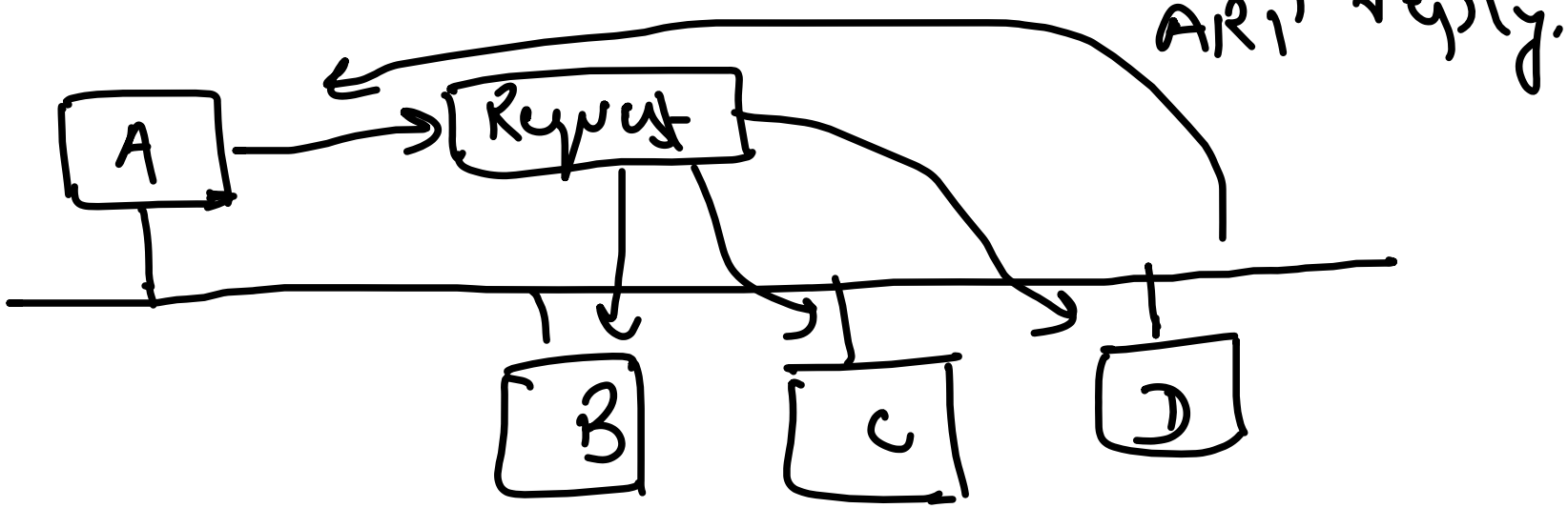
* ARP. — Address Resolution protocol.

↓

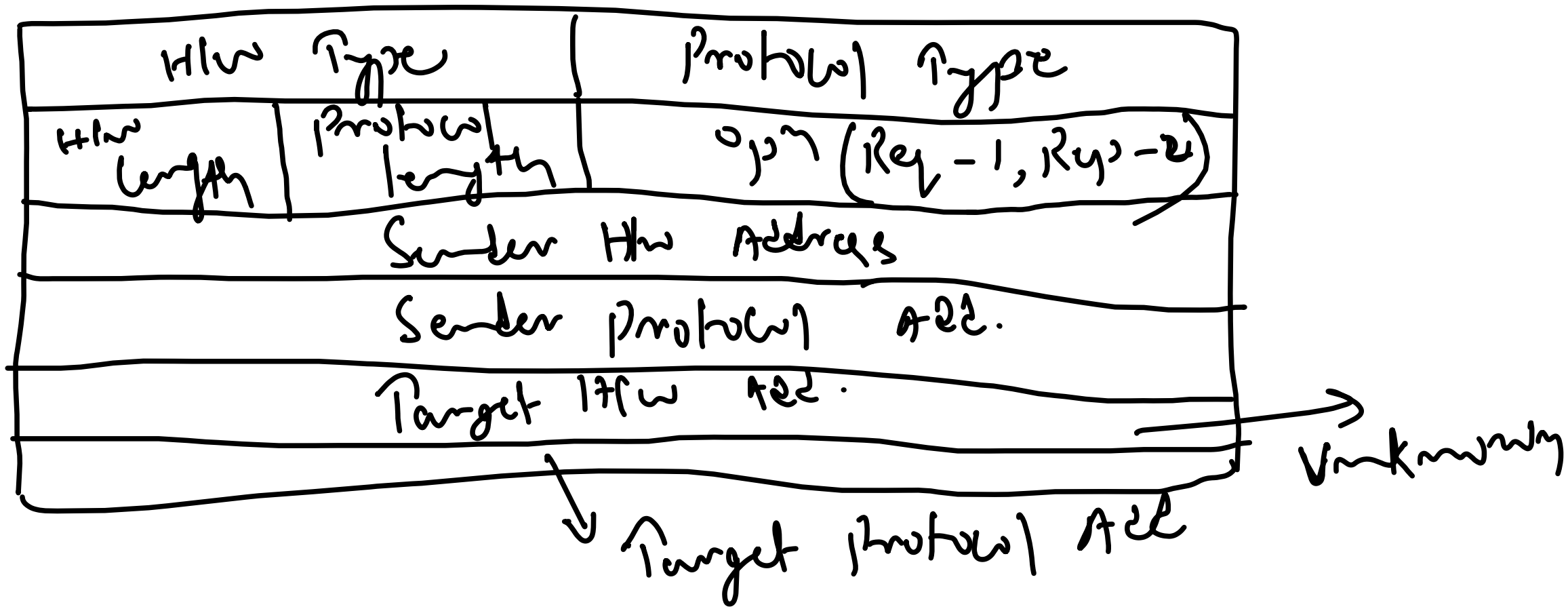
Logical → Physical.

Note:- ARP request → broadcast

ARP reply → unicast.



Packet format (ARP)



* Four Cases :- Target IP.

① Source & Dest^n are in same nw.
   ↳ IP datagram

② Source & Dest^n are on different nw.
   ↳ IP Add of router.

③ Router receives a packet from source
   ↳ IP address from routing table

④ Router is sending to another nw.
   ↳ IP datagram.

Mapping IP → L Addresses.

Condⁿ

① Diskless station

② Not enough IPs. (lease-based IP allocation)

* RARP. – Reverse ARP.

(client | server program)

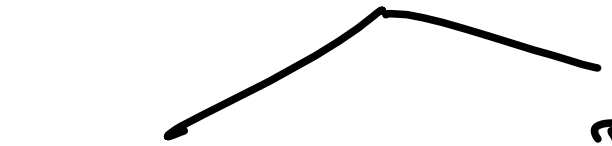
↓ RARP ↓ RARP

limitation

obsolete

Physical Addresses – NIC

· Replacement of RARP



* Bootp — Bootstrap Protocol

① Client/server application layer processes.

② Relay agent.

All the msgs are in same fmt.

↳ Bootp client & server are different msgs.

in relay agent

Limitation of BootP.

- Not a dynamic configuration protocol
  - Need of maintaining tables manually.

* DHCP - Dynamic Host Configuration Protocol
  - Static
  - Dynamic
    - Manual
    - Automatic

} configuration

ICMP.

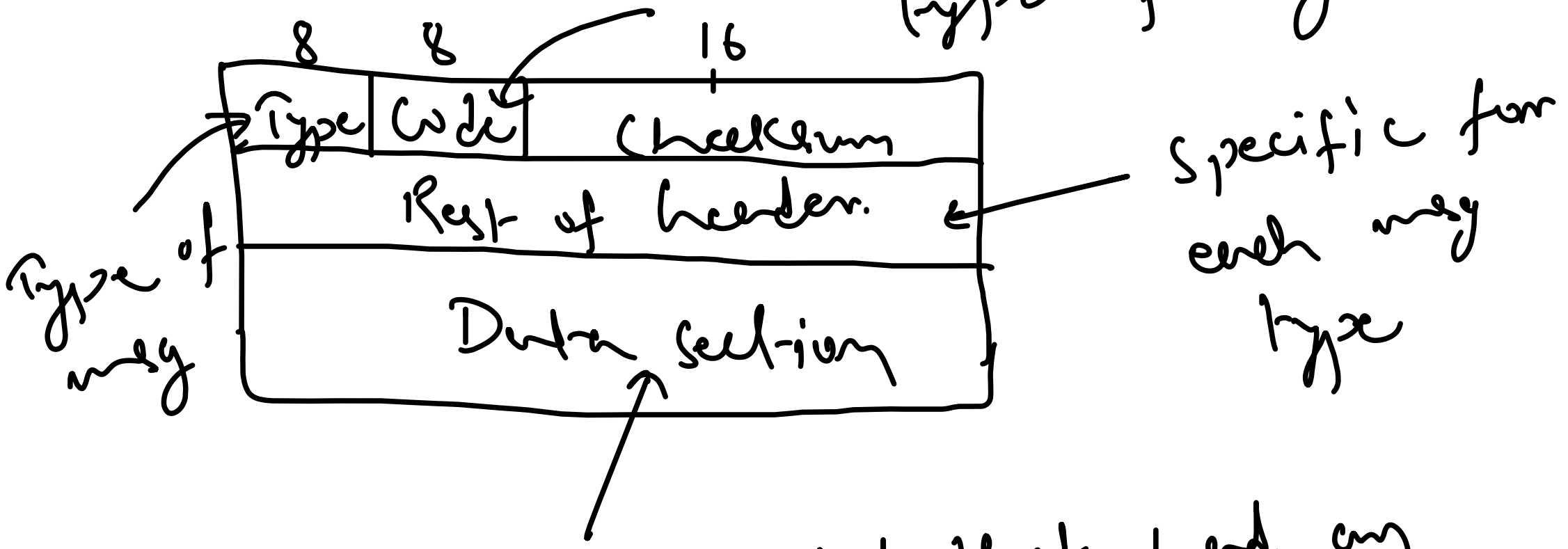
Internet Control Message Protocol

Two deficiencies of IP.

1. lack of error control
2. lack of assistance mechanisms.

* Types of messages — 1. error reporting message
2. query message

* Msg format:-

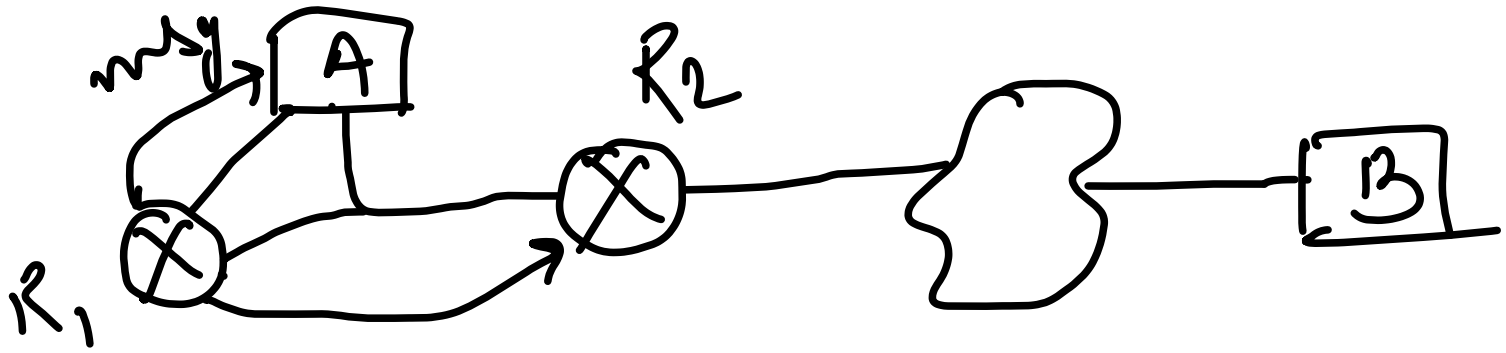


① find the original packet that led an error — error reporting

② Extra info about the type of query.

* Error Reporting — ICMP always reports the error msgs to original source.

1. Destination unreachable (3)
2. Source quenching (4)
3. Time exceeded (11)
4. Parameter Problems (12)
5. Redirection (5)



* Query. — diagnose the n/w problems.

① Echo request & reply. — diagnostic (8 & 0)

② Timestamp R & R — Round-trip time (13, 14)

③ Address Mask R & R — 25.0.1.2 (17, 18) — unknown 127

④ Router solicitation & advertisement (10 & 9)
↳ Address of router
↳ alive & functioning

TCP/IP Protocol Suite