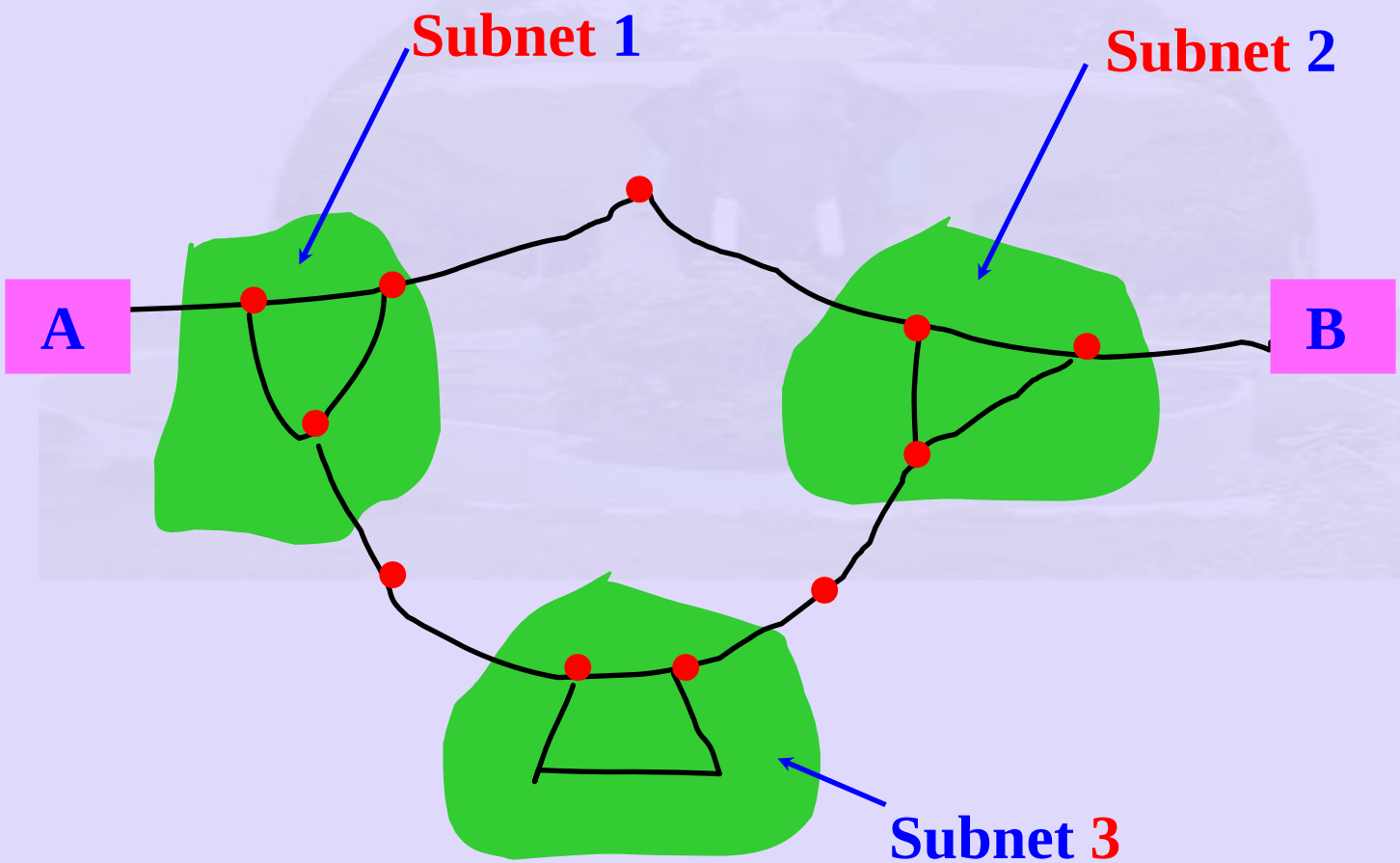
Network Layer

- Deliver a packet from a source to a destination across a WAN / LAN
- Best effort to deliver packet
- Internetworking

A Network Acros the Globe



Network Layer: Issues

- Network wide address
- Routing
- Load balancing, link failure
  - Reroute
- Diversity
  - Handle differences between subnet, maximum frame size
  - Ethernet – Token ring

Network Layer: Issues

- Policies
  - Security, Organisation,
- Rational policies
  - Different kinds of links
- Network Layer Services:
  - Connection Oriented
  - Connectionless

Network Layer (contd.)

- Connection Oriented:
  - (Telephone System View)
  - Consumer Carrier View
  - Setup
  - Transfer reliable packet stream
  - Disconnect

Network Layer

- Connectionless: (ARPANET View)
  - Send, Receive
  - No error checking or flow control
- Internally VC or DG
- Externally all possible

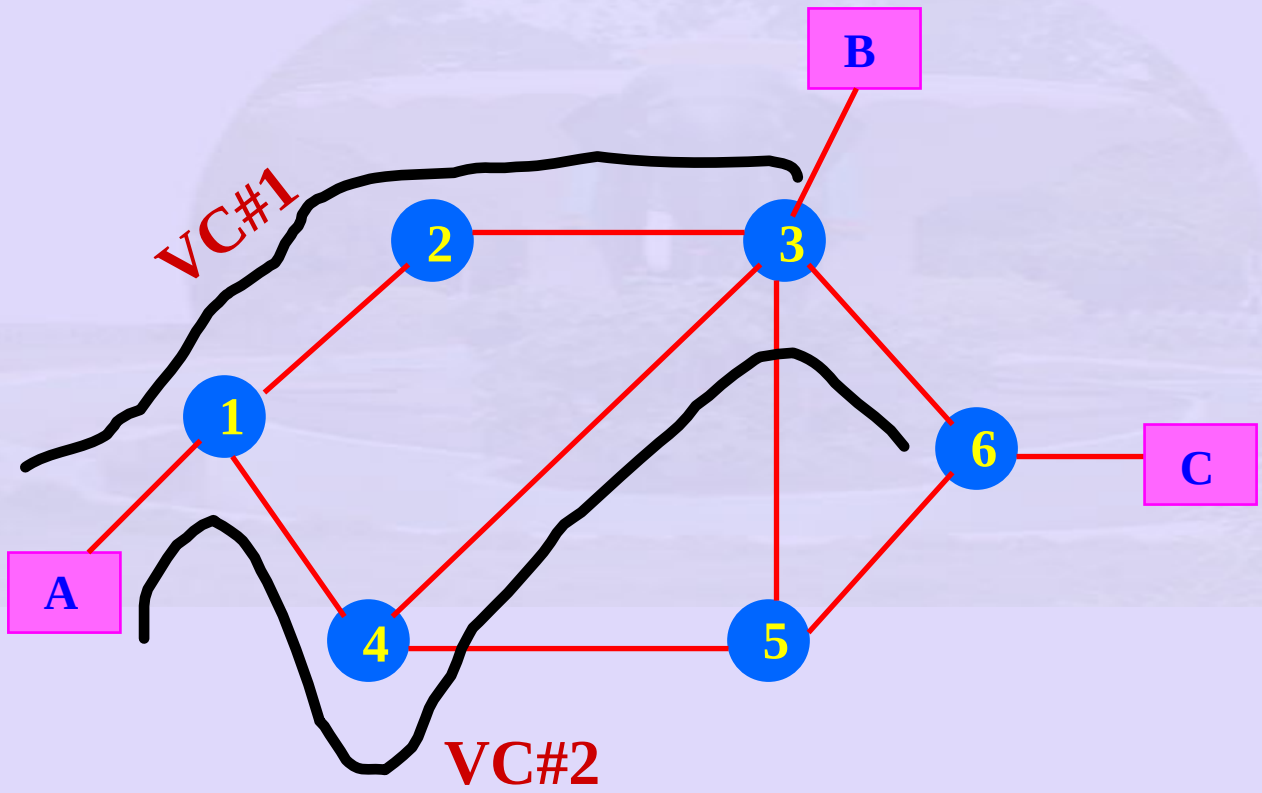
Network Layer (contd)

- VC VC DG DG
- VC DG DG VC
- VC – Avoids setting up a new route for every packet or cell

Comparison VC and DG services:

Issues	DG	VC
Circuit setup	Not required	Not required
Addressing	Every packet full source and destination	Check packet start VC no
Routing	Each packet	Route check, all packets follow route
Failure of route	Packets lost, no other effect	All VCs through router fail
Congestion control	Difficult	Easy if enough buffer space for each VC

Virtual Circuits



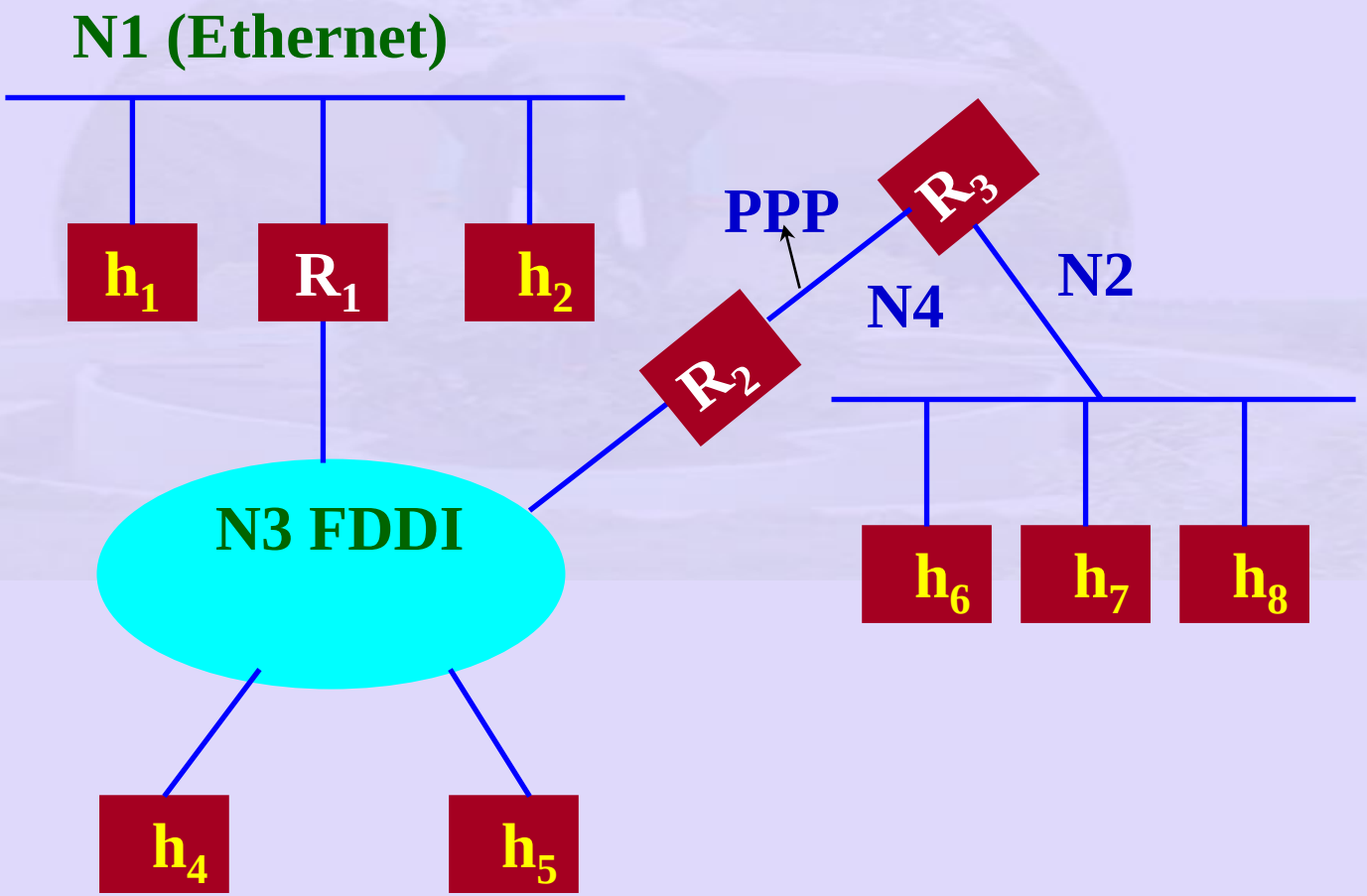
Virtual Circuits

- Virtual circuits maintained across the network
  - Router maintains host and VC number

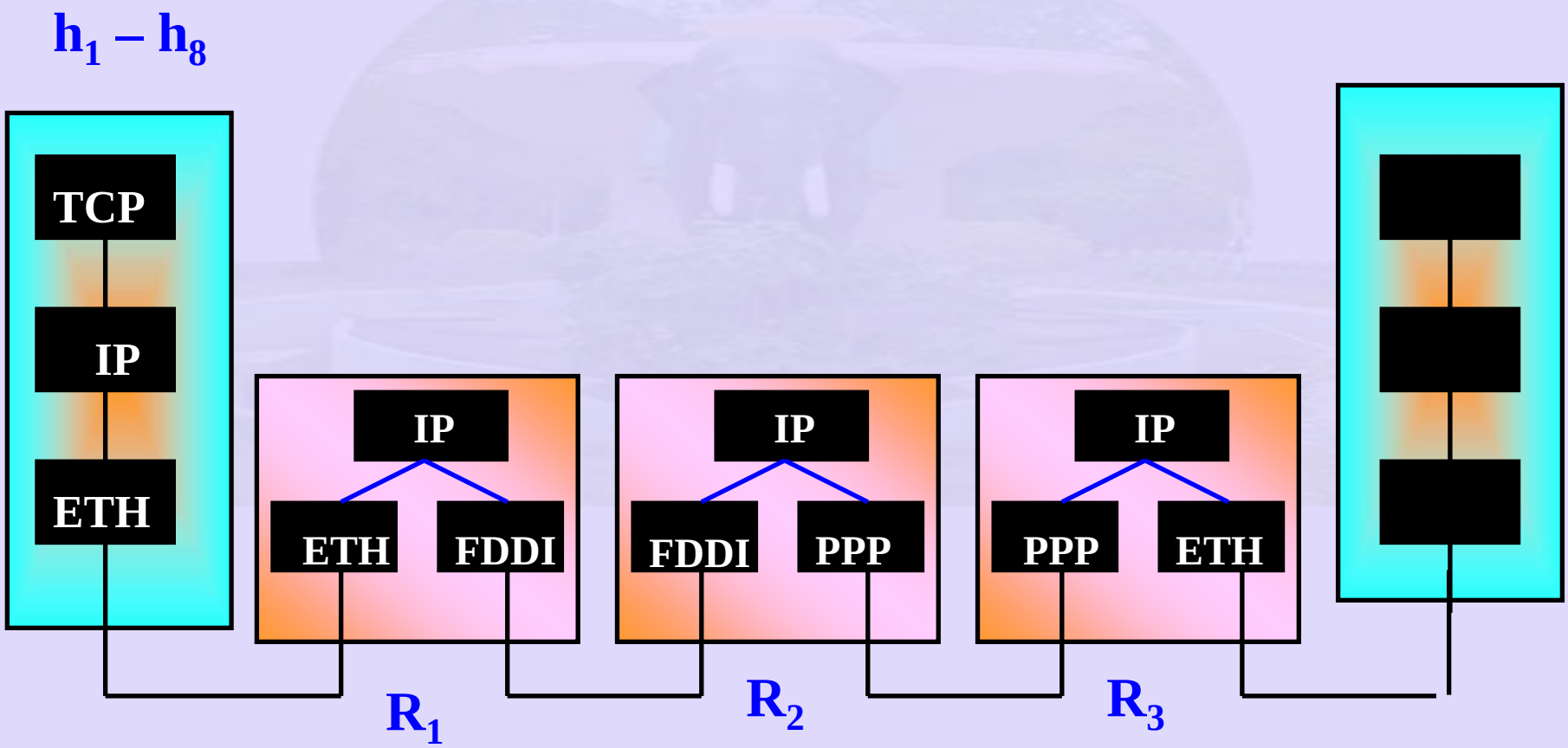
InterNetworking

- InterNetworking – interconnecting different Networks
- heterogeneity and scale
- addressing problem
- A logical network built over a collection of physical networks

Example of Internetworking



Issues in Internetworking



Issues in Internetworking

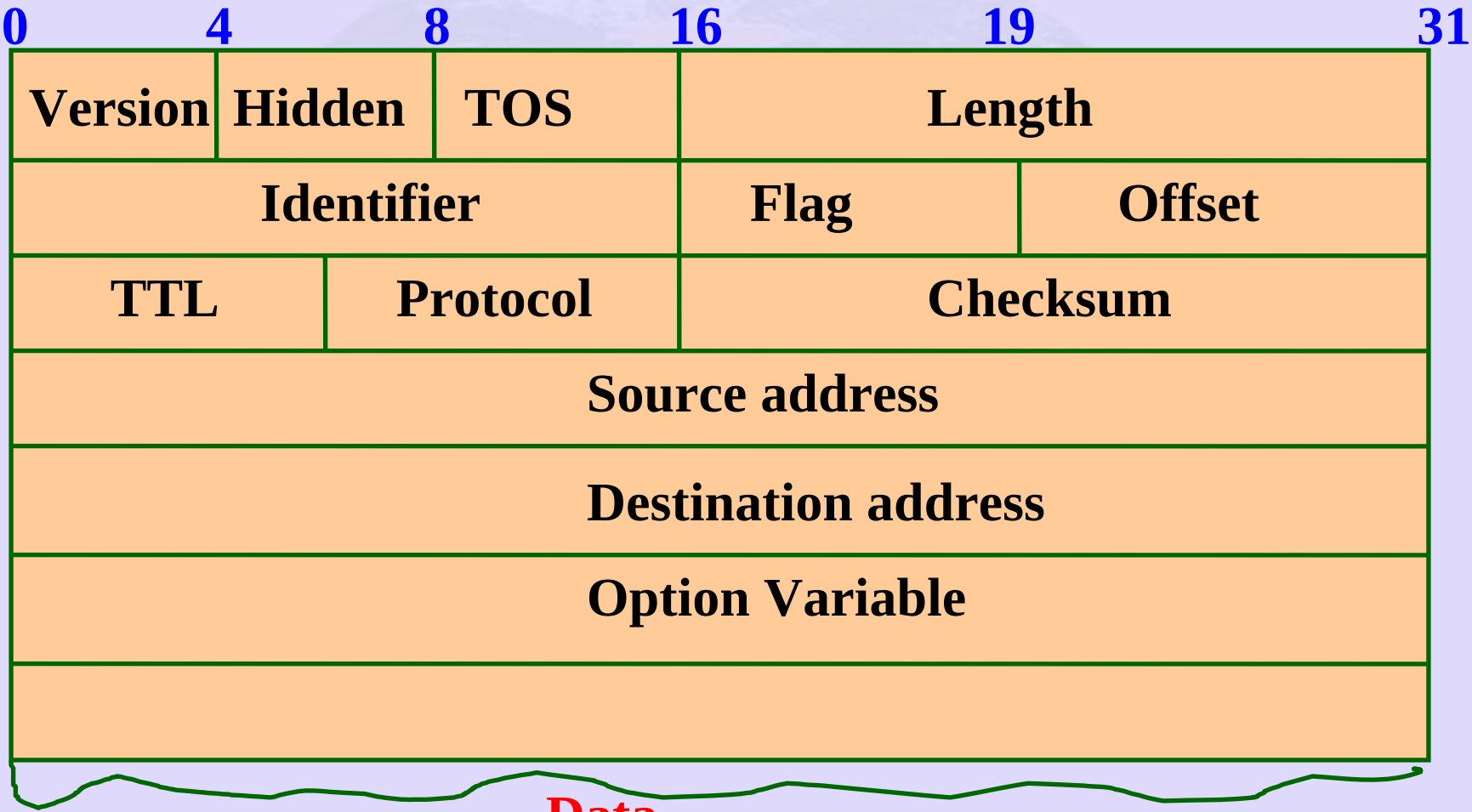
- Different packet sizes
- Different protocols
- Different packet formats

Network Layer in TCP/IP

- Connectionless
  - Best effort model
  - IP makes every effort to deliver datagrams
  - Carries enough information to let network forward the packet to its destination
  - Network makes a best effort
  - No effort made to recover from corrupted / erroneous/ misdelivered packets
  - IP – runs over anything!

IP Packet format

All packets align on 32 bit boundaries – to simplify processing



IP Packet Format

- **Identifier**
  - **Fragmentation ID**
  - **(all frags belong to same packet)**
- **RARP**
  - **Reverse Address Resolution Protocol**
  - **Useful for diskless workstation**
  - **Normally get IP address from etc/ system configuration/ network**
- **Host sends broadcast**
  - **Ethernet address to all reply an Ethernet address with IP**
- **address – unicast**
  - **Host issues TFTP for boot image**

IP Packet Format

- Multiple RARP servers for redundancy
  - Increased traffic on the network
  - Broadcast for RARP not forwarded by all routes (IP)
  - Use BOOTP (UDP)
    - Forwarded by router
    - Gets IP address of server with boot image
- Fragmentation Offset
    - Location of fragmentation in DG
- TTL
  - Limit packet life time
  - Support to count time in seconds
  - Maximum life time – 255
  - In practice hop count

IP Packet Format

- Protocol
  - When Network Layer assembles DL – it needs to know to which process to give it to?
  - TCP/ UDP – protocol – process not global across the entire Internet
- Header Checksum – verifies header only
- Options
  - Security
  - Strict source routing
    - Complete path source to destination
    - Loose source routing
      - Must pass through certain routers
    - Record route
    - Router append its IP address on packet
    - Record time stamp
      - Records IP address and time