**Network Layer: Data Plane**

**Networking Layer**

**Internetworking**: Routers forward packets from source to destination, crossing several networks along the way

The Network Layer transports segments from sending to receiving hosts.

* Network layer protocols are in every host, every router.
* Routers examine the header fields in all IP datagrams passing through it.

Two key network-layer functions:

1. **Forwarding**: Move packets from router’s input to appropriate router output.  
   (Getting through an interchange station)
2. **Routing**: Determine the route taken by packets from source to destination.  
   (Planning your trip from source 🡪 multiple stations 🡪 destination)

**Routing Algorithm** determines the end-to-end path through the network

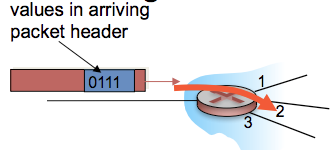
**Forwarding Table** then determines local forwarding at this router

* Packet arrives at Router
* Router uses forwarding table to determine which output link to forward the packet to **{ K=header val , V=output link }**

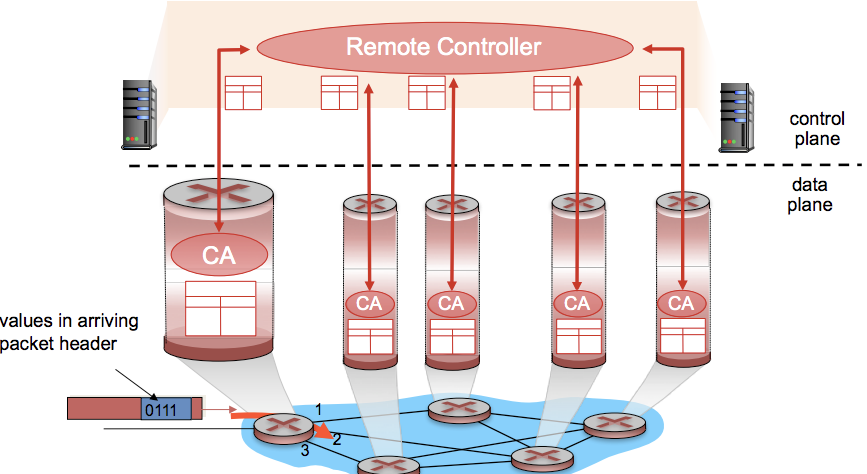
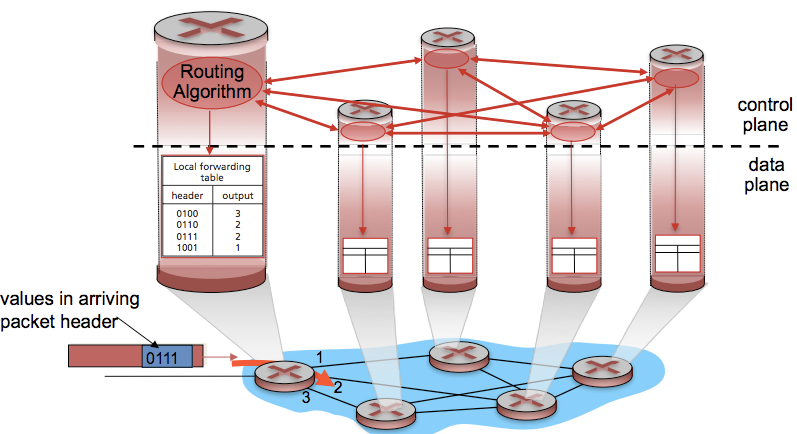
**Network Layer: Data vs Control Plane**

The **Control Plane** refers to the functions that determine how a packet is routed among routers in the end-to-end path.

The **Data Plane** refers to the functions that determine how packets are forwarded from a router input to its output port.



There are two Control Plane approaches:



**Per-Router Control Plane Logically Centralised Control Plane (SDN)**

**SDN: Software-Defined Networking**

Centralised servers.

A distinct controller interacts with local control agents (CA’s)

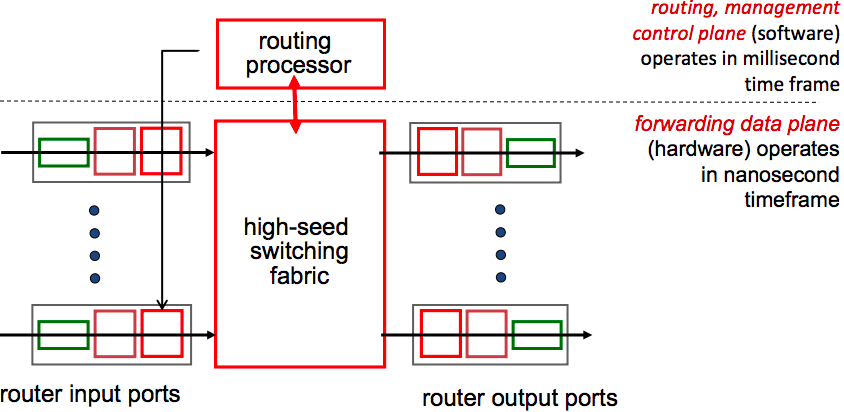
Individual Routing Algorithms in each and every router interact in the control plane.

**Network Layer: Service Models**

The N.L service model defines characteristics of the transport of data between one “edge” of the network to the other.

Example services include: *Guaranteed Delivery, Guaranteed Minimum Bandwidth to Flow, In-Order Deliveries etc.*

**Router Architecture Overview**



**Input Port Functions**

**Line Termination**

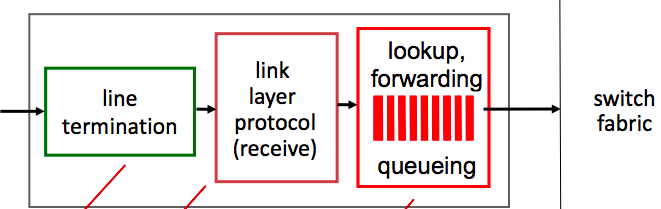
* Physical layer: bit-level reception

**Link Layer Protocol (Receive)**

* Data Link Layer e.g. Ethernet

**Lookup, Forwarding, Queuing**

* Decentralised Switching



**Decentralised Switching**

* Lookup the output port using header field values and forwarding table in input port memory. (*Match Plus Action*)
* Goal: Finish input port processing at line speed
* Queuing: if datagrams arrive faster than forwarding rate into switch fabric
* **Destination-based forwarding**: forward based only on destination IP address (traditional)
* **Generalised forwarding**: forward base on any set of header field values