Internet

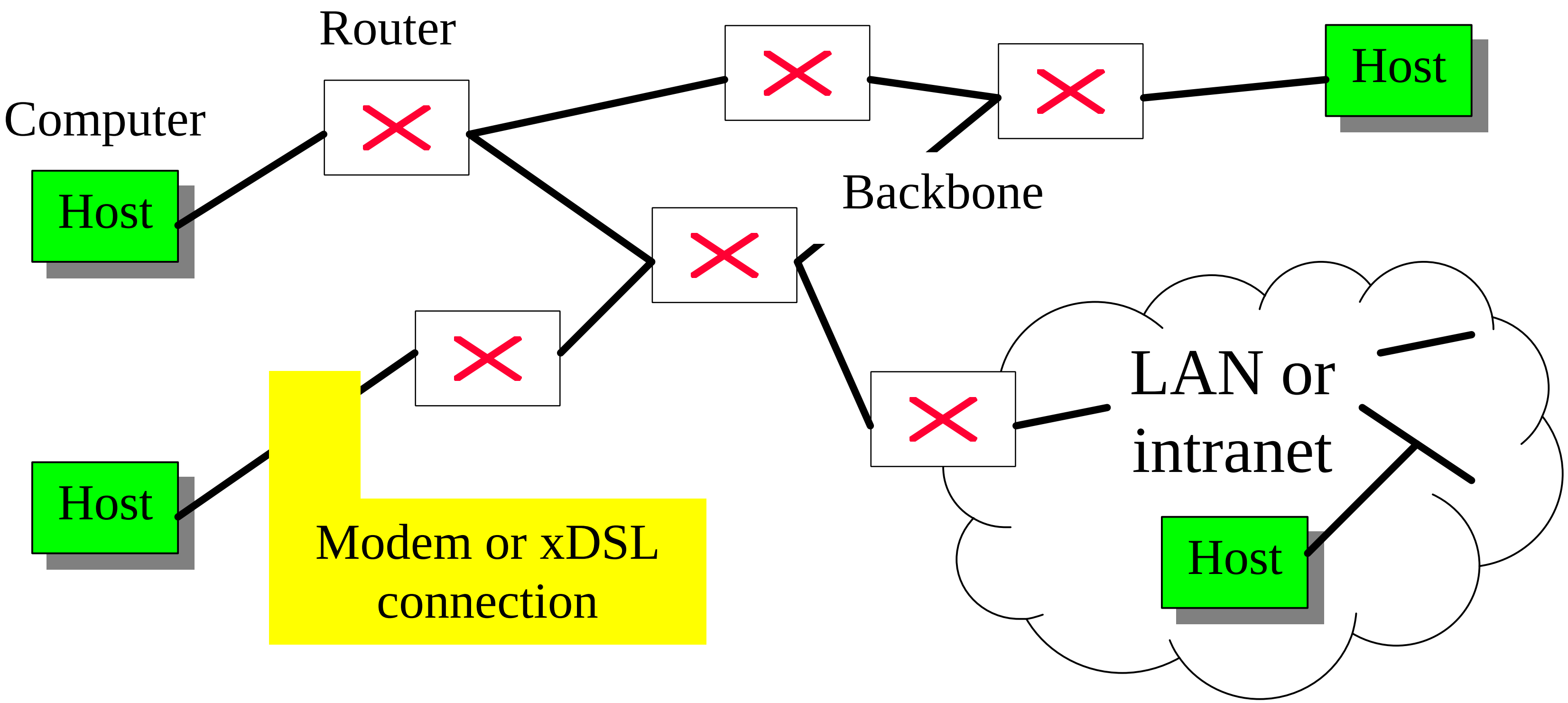
1) **Internet basic technology (overview)**

2) **Mobility aspects**

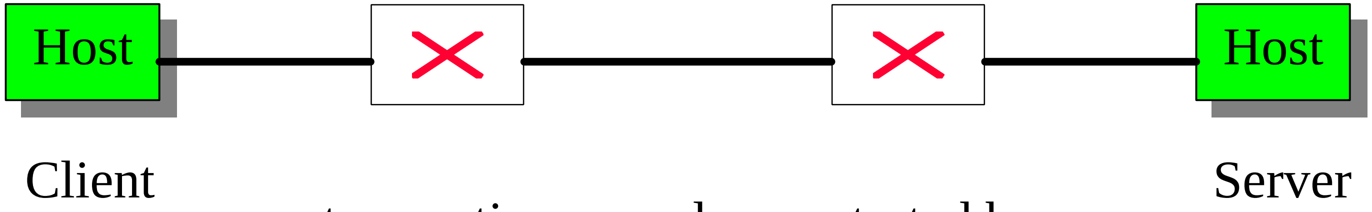
3) **Quality of Service (QoS) aspects**

Relevant information: these slides (overview)
course textbook (Part H)
www.ietf.org (details)

IP network architecture

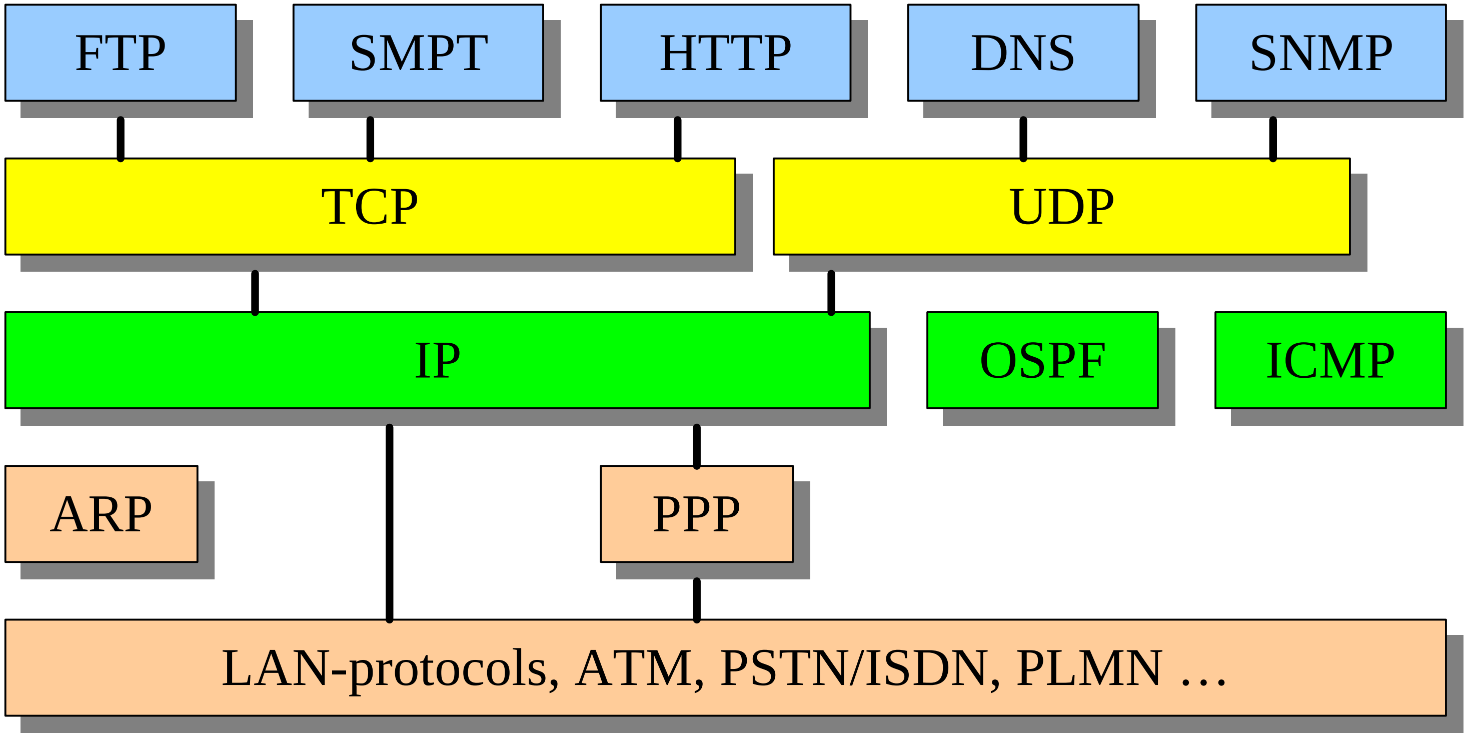


Server-client concept

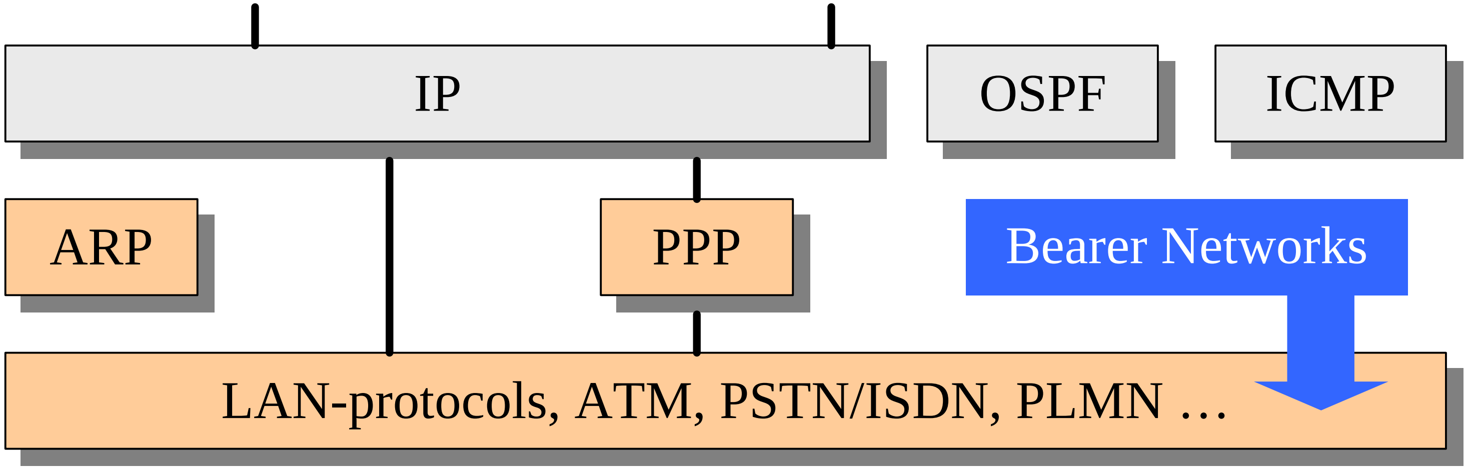


- transactions are always started by client
- network does not have to know IP address of client before transaction
- clients can be behind dial-up modem connections
- concept used in WWW applications

IP protocol suite



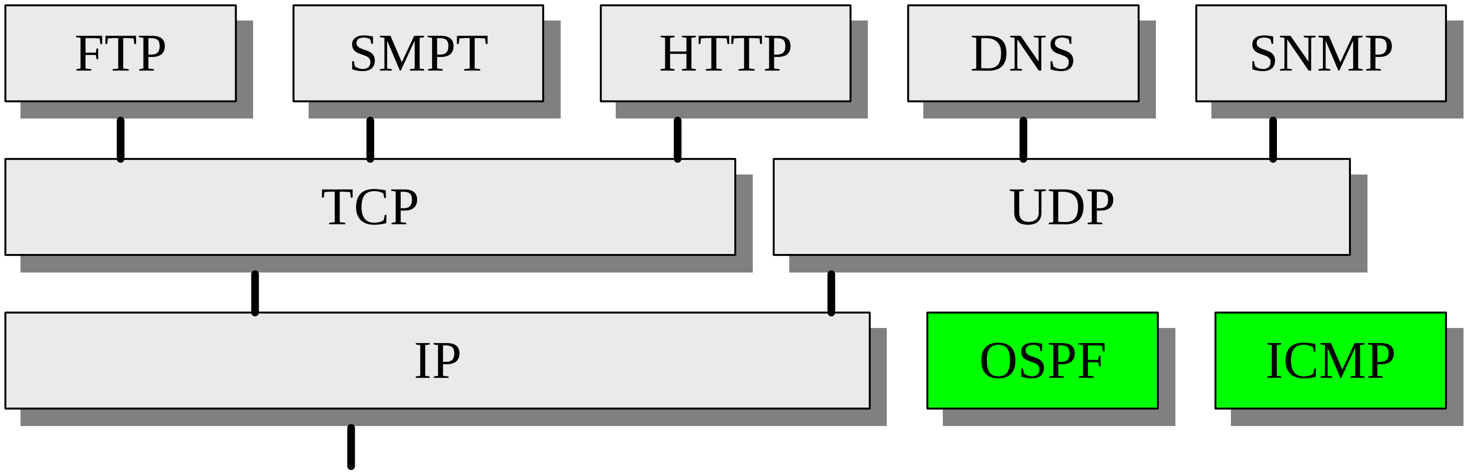
Lower protocol layers



ARP (Address Resolution Protocol) manages mapping between logical IP addresses and physical MAC addresses in LAN's

PPP (Point-to-Point Protocol) may be used for transport of IP datagrams over circuit switched connections (PSTN, ISDN, PLMN)

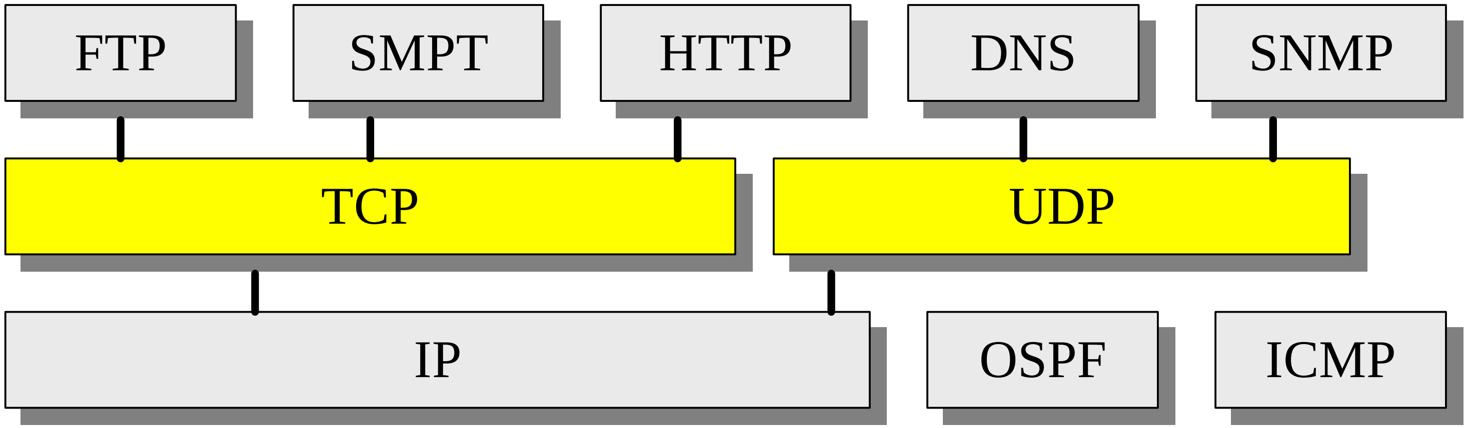
Assisting protocols at the IP-layer



OSPF (Open Shortest Path First) is the most famous of possible protocols used for dynamic routing of IP datagrams

ICMP (Internet Control Message Protocol) is a mandatory protocol used for informing hosts about problems in the network

Transport layer protocols



TCP (Transmission Control Protocol) takes care of end-to-end flow & error control + segmentation & reassembly of datagrams

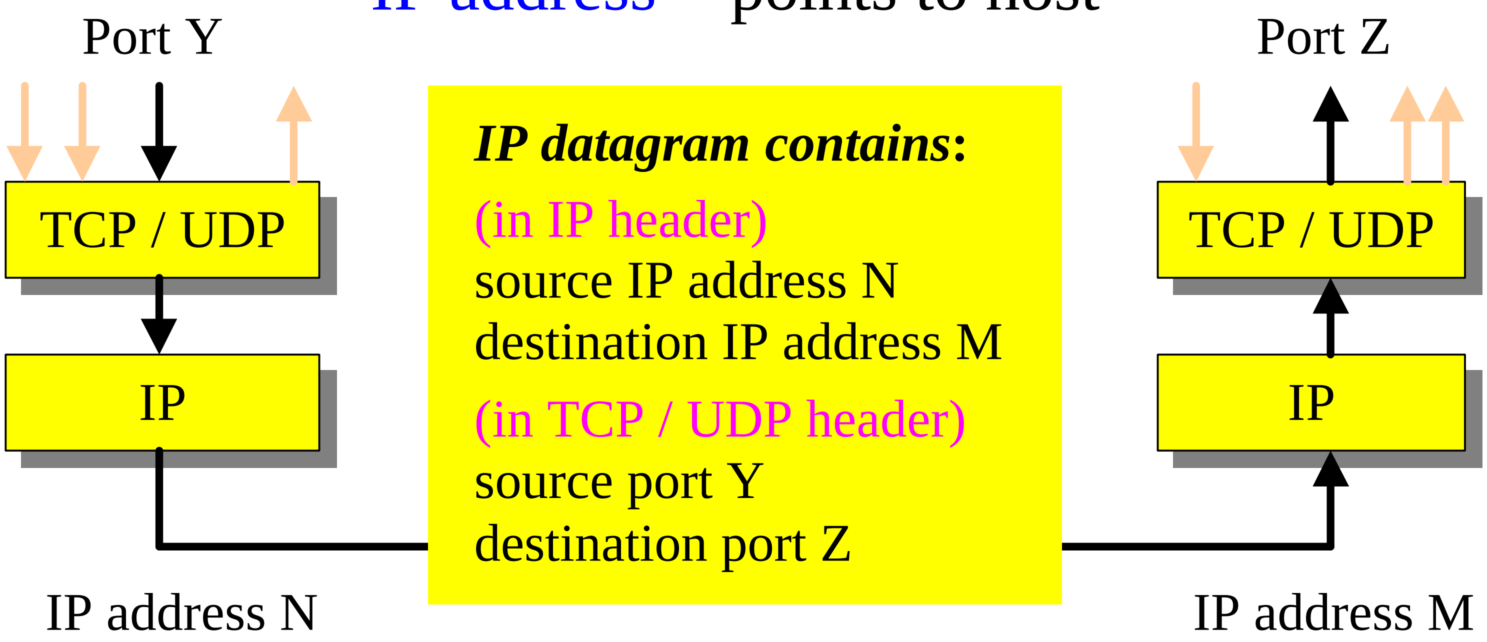
UDP (User Datagram Protocol) is used in the connectionless case

Addressing

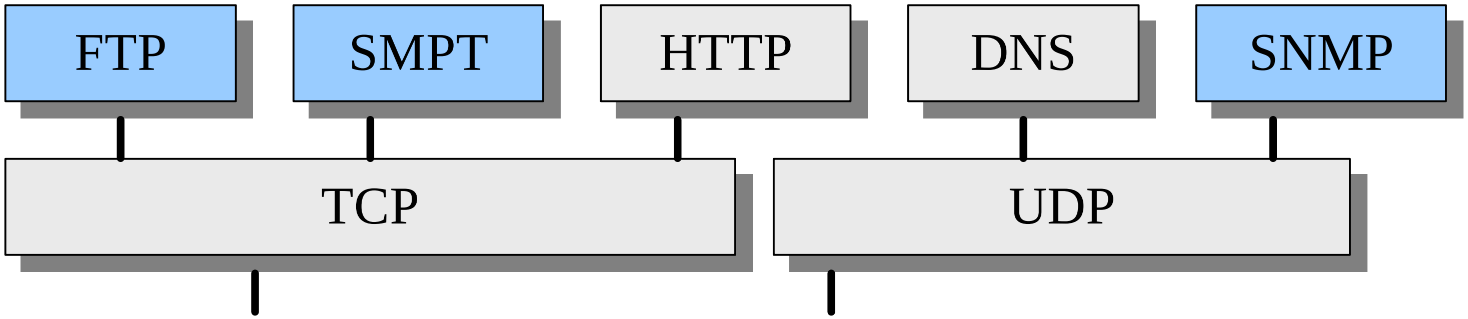
Host A

Port – points to application
IP address – points to host

Host B



Applications (1)

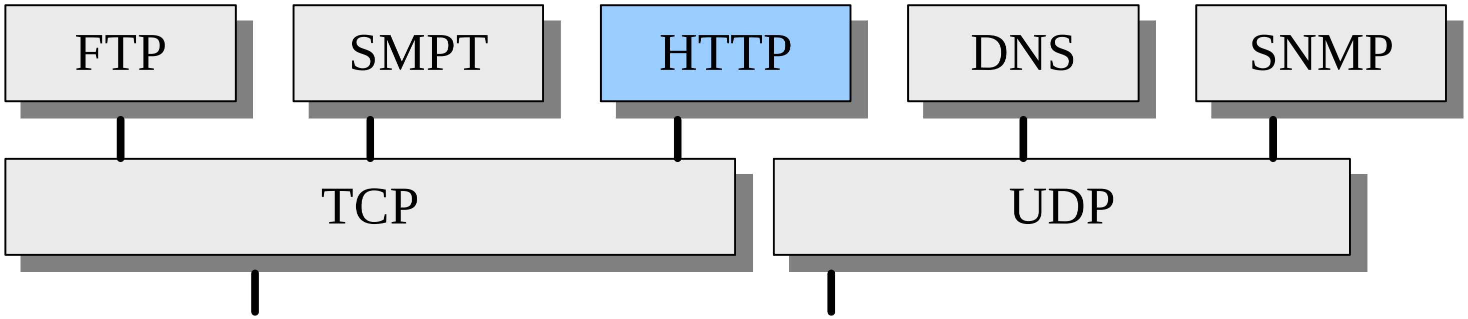


FTP (File Transfer Protocol)

SMTP (Simple Mail Transfer Protocol) for outgoing e-mail
POP (Post Office Protocol) for fetching e-mail from mailbox

SNMP (Simple Network Management Protocol)

Applications (2)

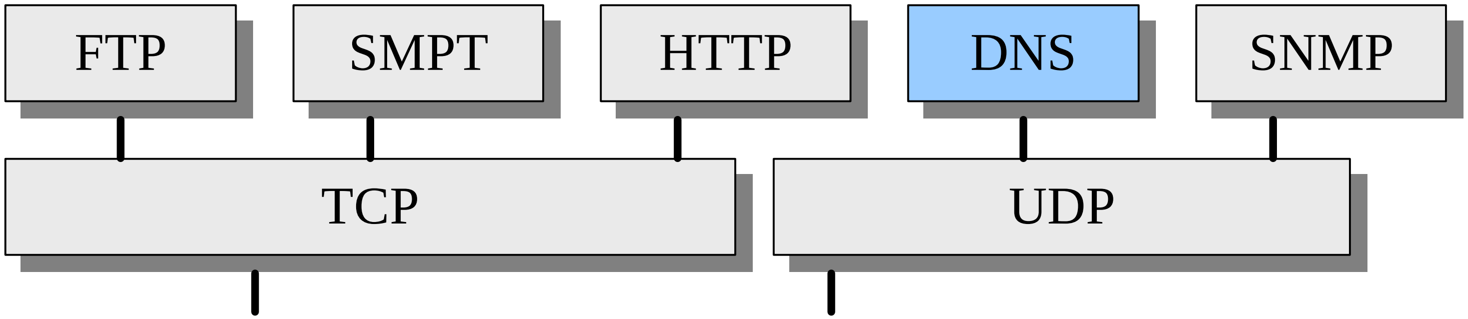


HTTP (HyperText Transfer Protocol) is used for client-server type of communication, and is the most popular protocol for transport of WWW content

http://www.ietf.org/overview.html ← Uniform Resource Locator (URL)

protocol: http://
host computer: www.ietf.org
content page written in HTML: overview.html

Applications (3)



DNS (Domain Name System) performs transformation between IP addresses and domain names

122.233.121.123 ⟷ thisnetwork.thishost.com

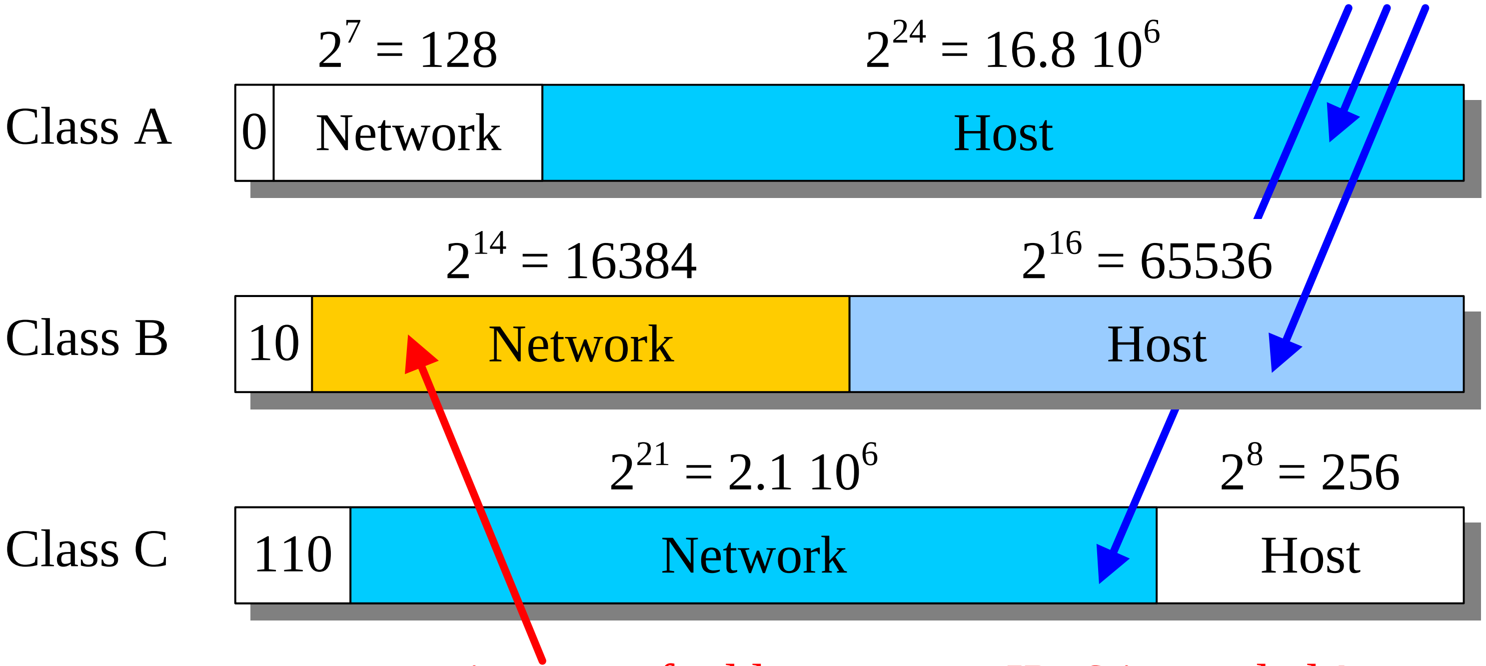
IP address must be used for routing through IP networks

however, domain names are more user friendly

IPv4 address structure

Hierarchical structure:

unnecessary capacity

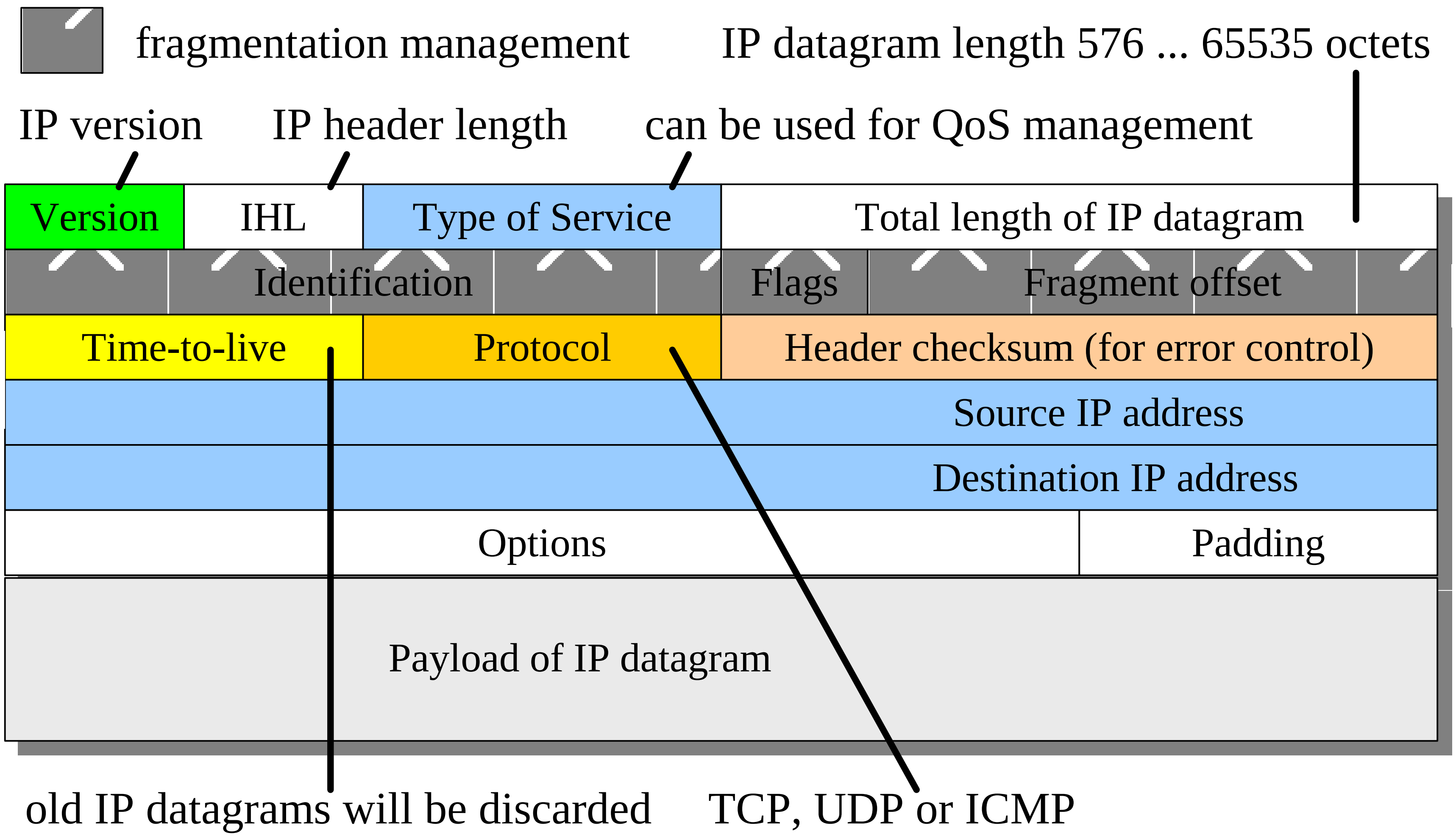


running out of addresses => IPv6 is needed !

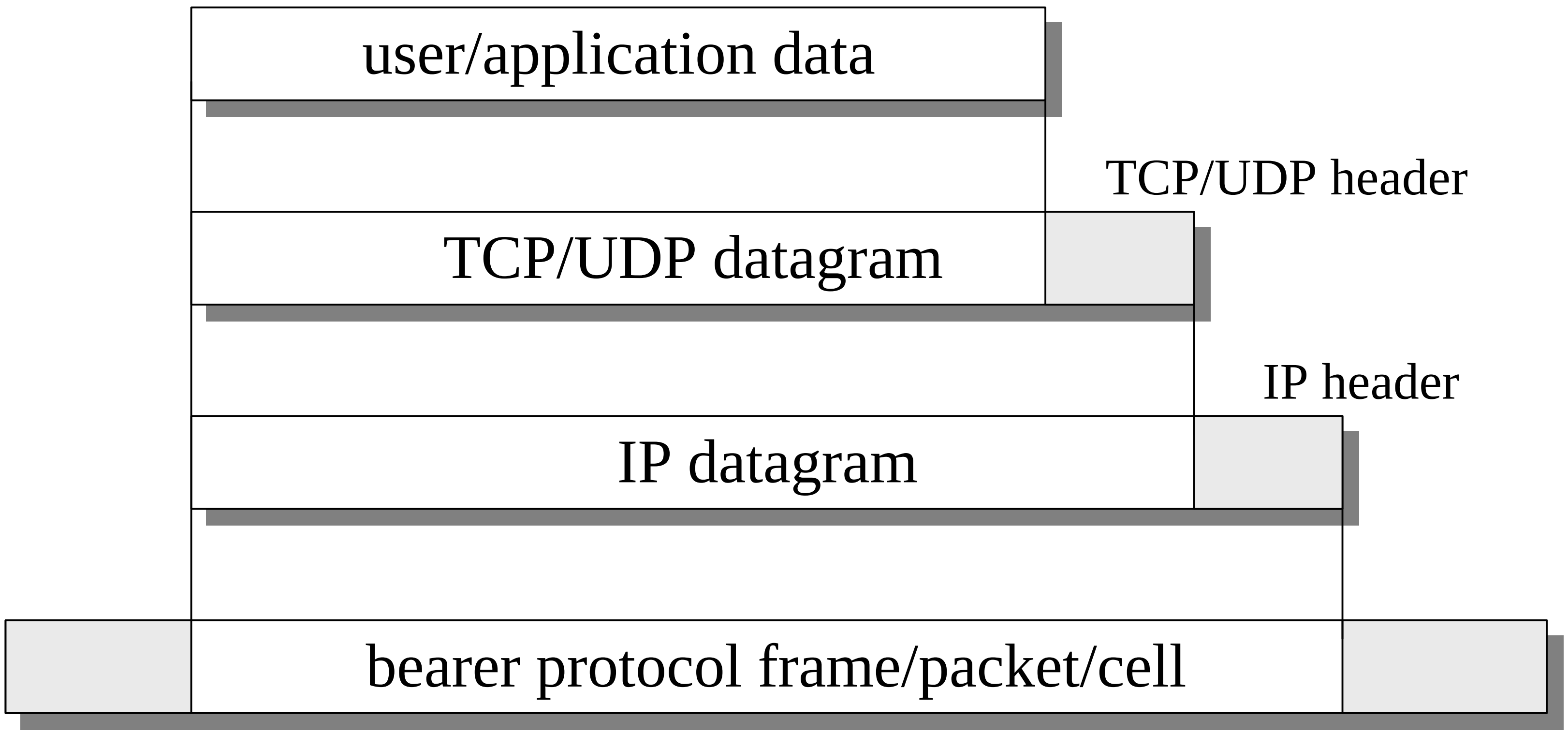
Flat structure would provide $2^{32} = 4.3\ 10^9$ IP addresses

IPv6 provides $2^{128} = 3.4\ 10^{38}$ IP addresses !

IP header structure (IPv4)



IP data unit structure



Mobility in IP networks

Mobility is not ”traditionally” supported in the Internet, but can (will) be implemented in the following ways:

PLMN -based solutions:

- GPRS (WAP or “real” HTML-based IP)
- 3G packet transport (solutions evolving)

IETF solutions (wireless WAN etc.):

- Mobile IP (described in IETF RFC 2002)

Potential problems:

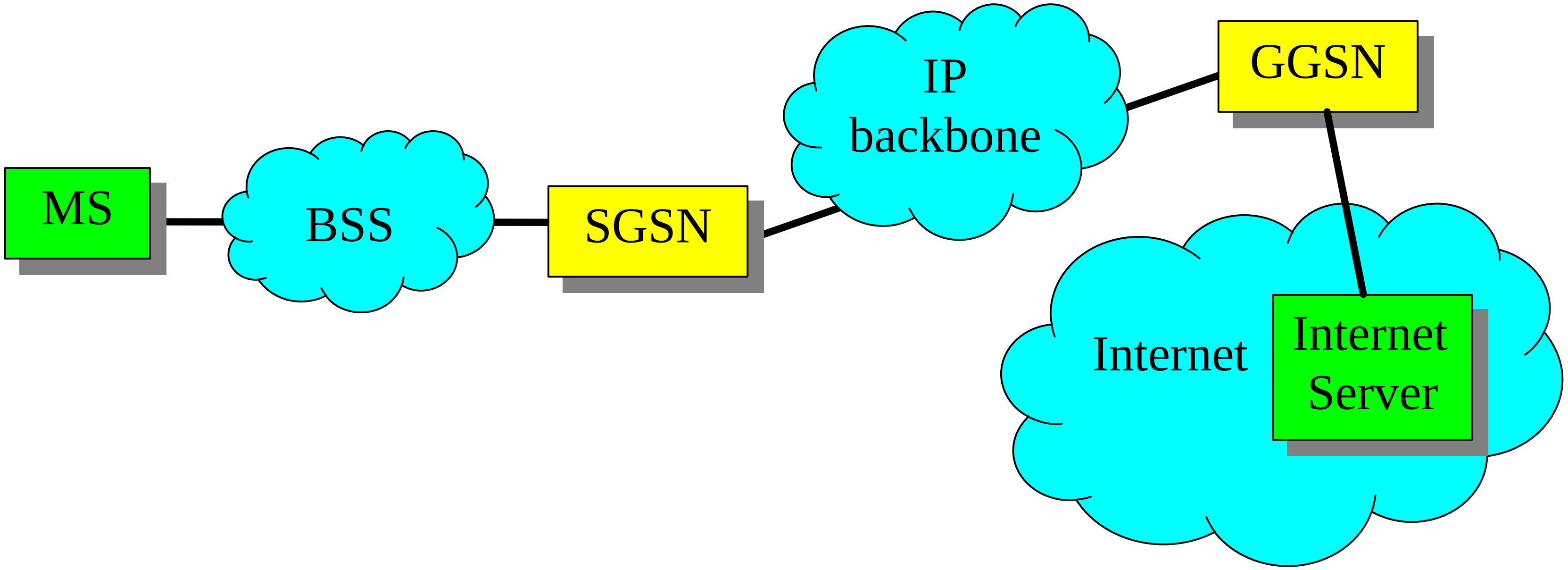
System inter-working

Security

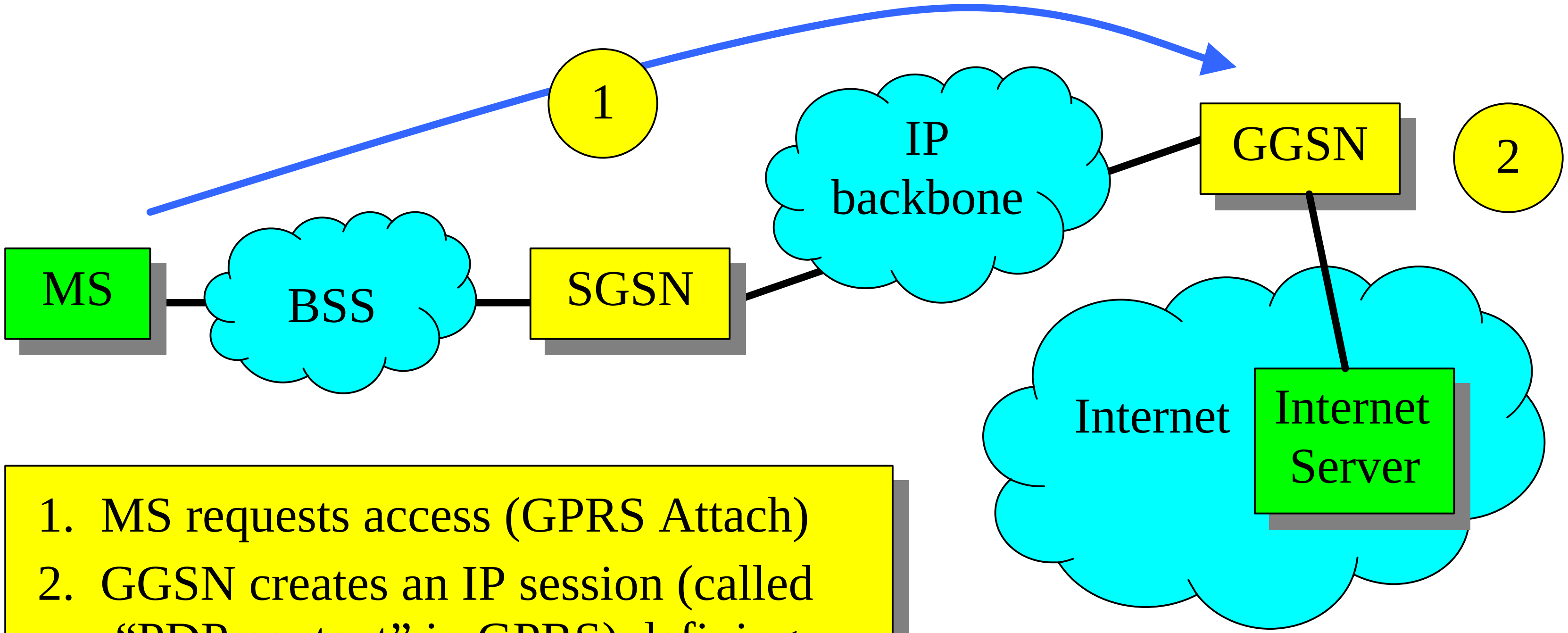
IP transport in GPRS

MT (Mobile Terminated) applications may not be supported (MS = server, client is on network side).

Typical application is MO (Mobile Originated), where MS is client and server is in network.

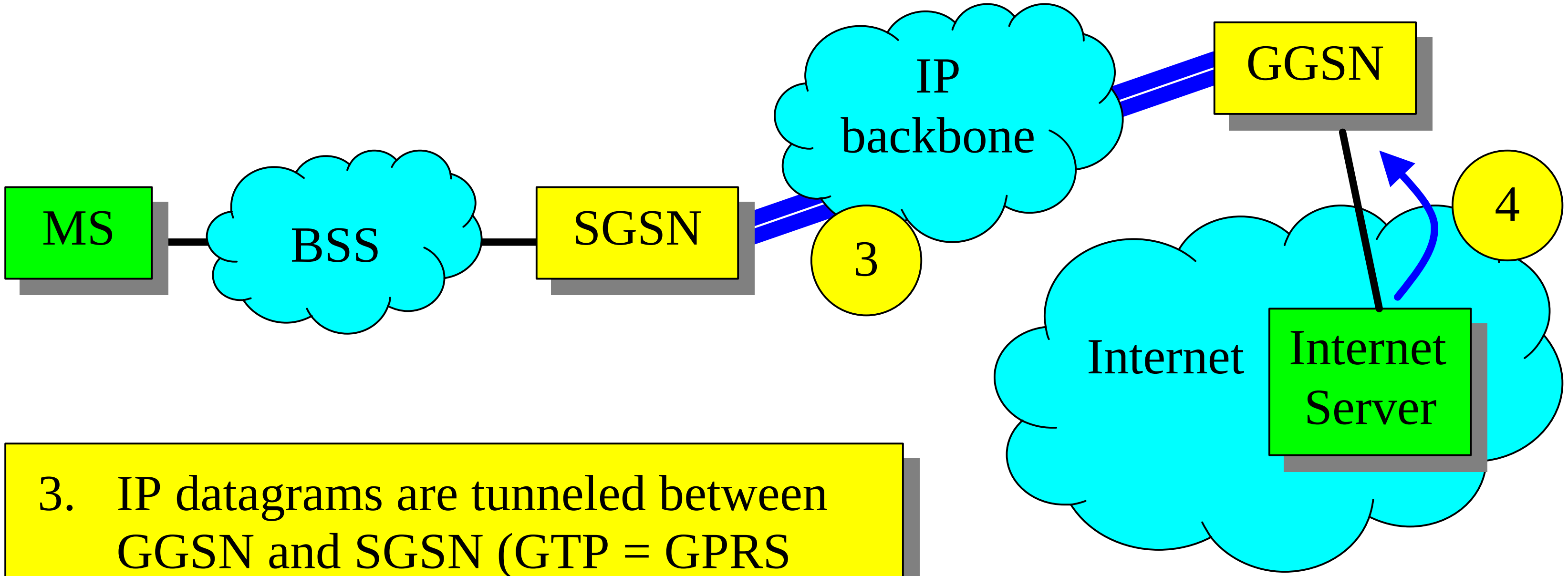


IP transport in GPRS (2)



1. MS requests access (GPRS Attach)
2. GGSN creates an IP session (called “PDP context” in GPRS) defining temporary IP address of MS, address of used GGSN, tunneling IDs ...

IP transport in GPRS (3)

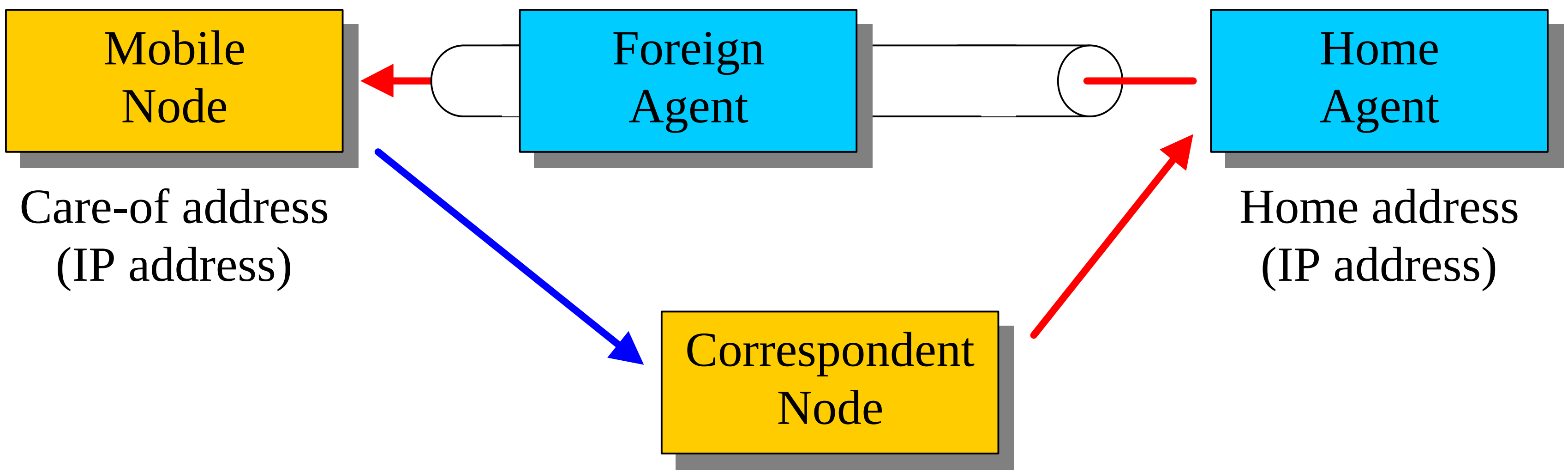


3. IP datagrams are tunneled between GGSN and SGSN (GTP = GPRS Tunneling Protocol)
4. IP datagrams from Internet server are always first routed to GGSN

Mobile IP

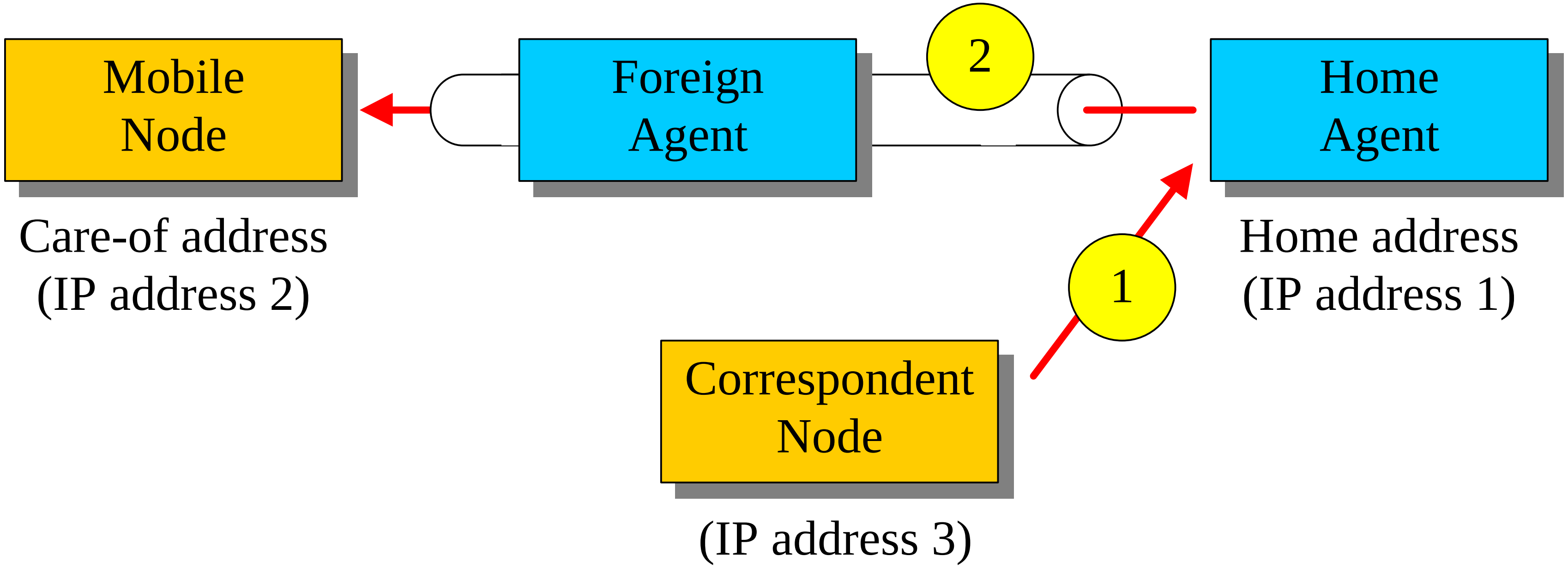
- IETF solution for wireless LAN –type applications
- breakthrough in conjunction with IPv6 ?

Basic architecture:



Mobile IP (cont.)

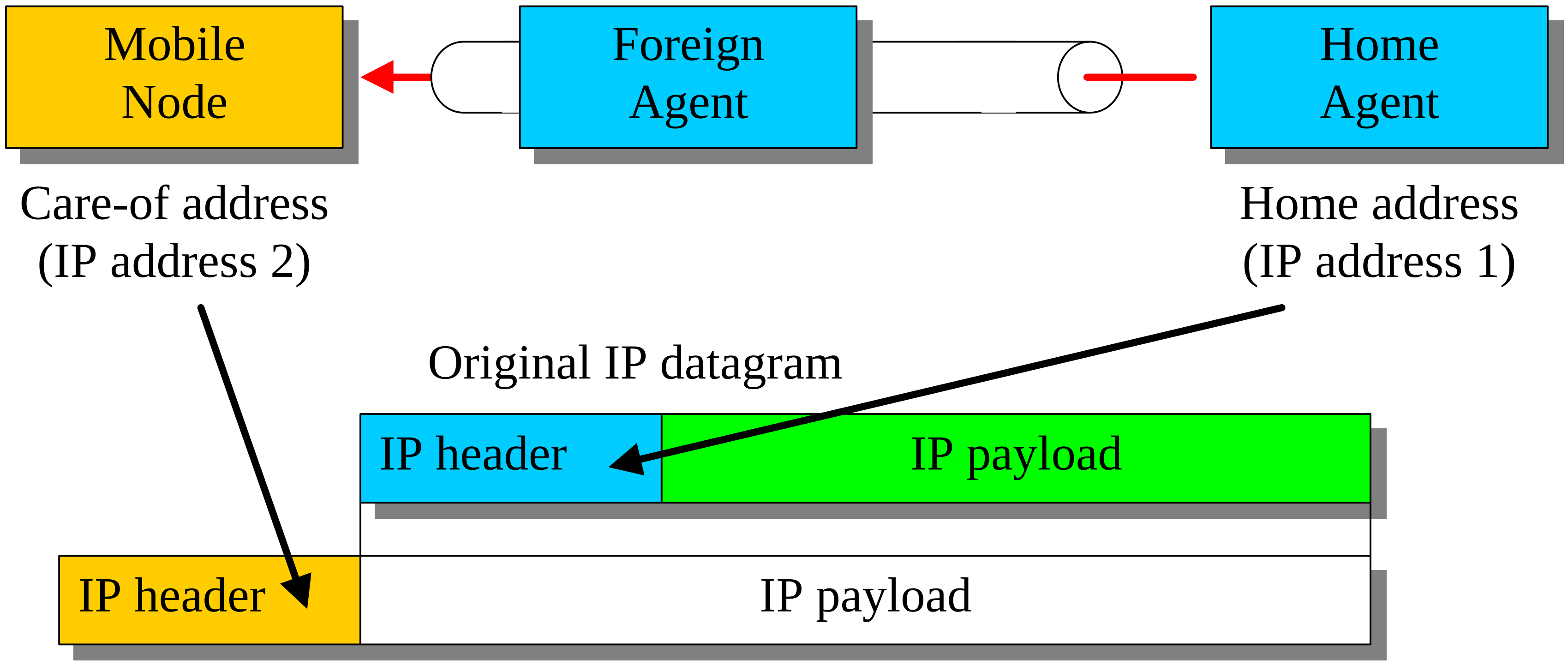
Mobile node terminated IP transport:



1. Correspondent node sends IP datagram to permanent home address
2. Home agent tunnels IP datagram to care-of address

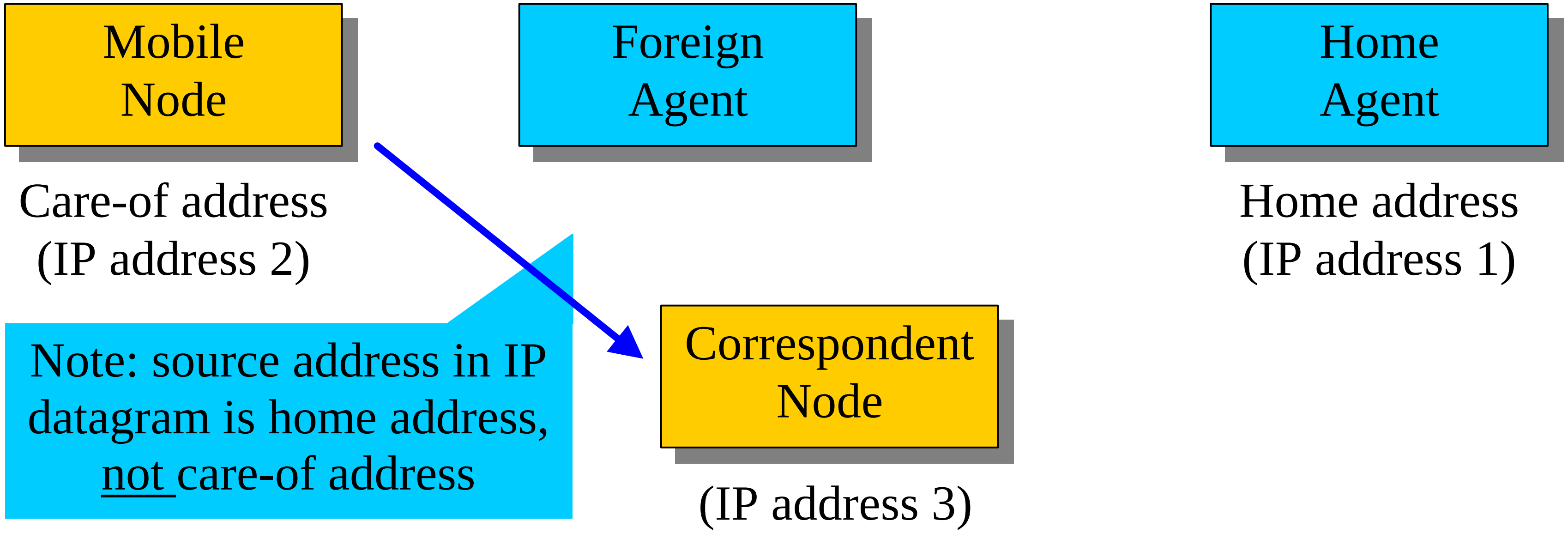
Mobile IP (cont.)

Tunneling in Mobile IP means encapsulation:



Mobile IP (cont.)

Mobile node originated IP transport:



Mobile node sends IP datagram directly to correspondent node (no tunneling required)

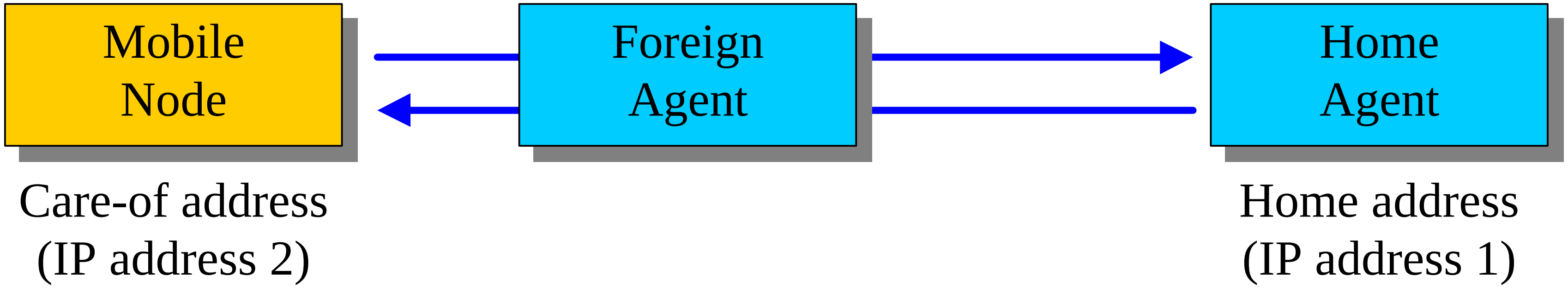
Mobile IP (cont.)

Mobility requires: (1) agent advertisements

1. Mobile node has no valid care-of address
2. Foreign agents continuously broadcast (at ≈ 1 s intervals) lists of free care-of addresses
3. Mobile node selects a care-of address and informs the foreign agent.

Mobile IP (cont.)

Mobility requires: (2) registration



1. Mobile node informs home agent about new care-of address
2. Home agent replies with ”ok”-message (or resolves the problem if situation is not ok)
3. From now on home agent can tunnel IP datagrams to mobile node.

QoS support mechanisms in IP networks

- Problems with "Best Effort" IP transport (the old way)

Existing and suggested alternatives for introducing QoS in IP backbone applications (situation year 2001):

Alternative 1: RSVP (Resource ReSerVation Protocol)

Alternative 2: DiffServ (Differentiated Services)

Alternative 3: MPLS (Multi-Protocol Label Switching)

Alternative 4: IP tunneling over ATM

QoS support mechanisms (2)

Problems with "Best Effort" IP transport service:

"Best effort" service is sufficient for traditional Internet applications like web browsing, e-mail, and file transfer.

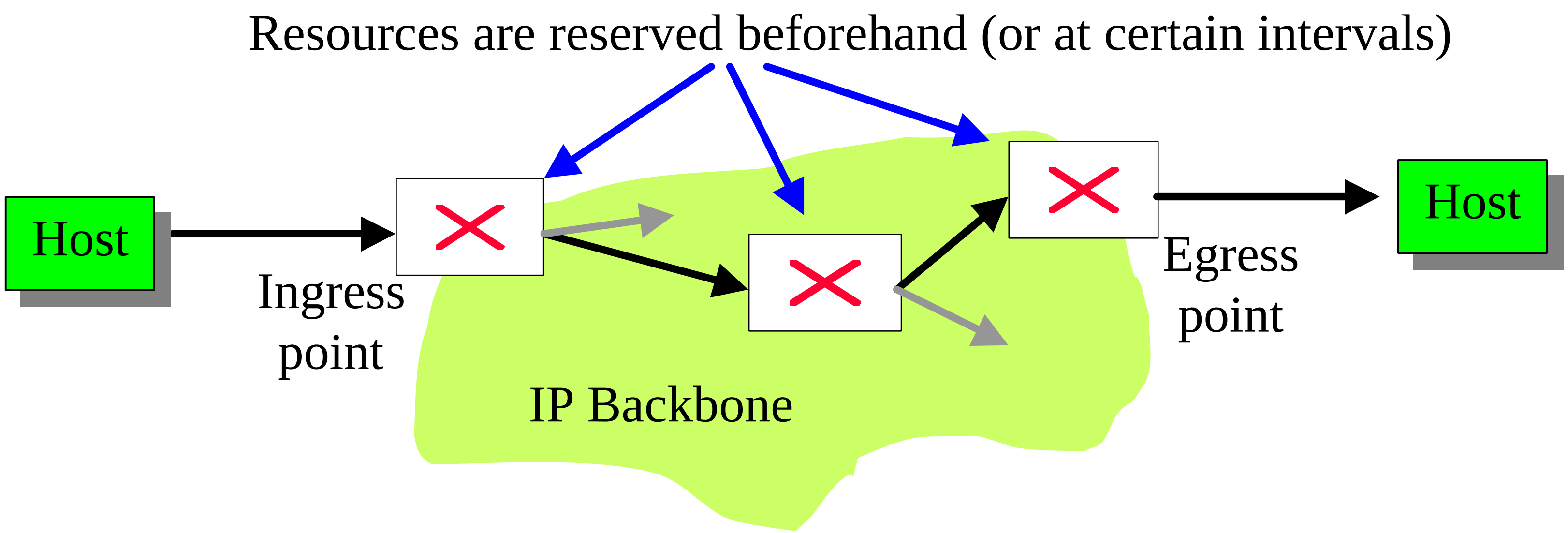
"Best effort" service is not sufficient for:

- Speech (Voice)
- Interactive Video
- Video / Audio Streaming

- Low delay
- High throughput
- Low delay variation
- Consistent throughput
- Low round-trip delay

QoS support mechanisms (3)

RSVP (Resource ReSerVation Protocol) (IETF RFC 2205)

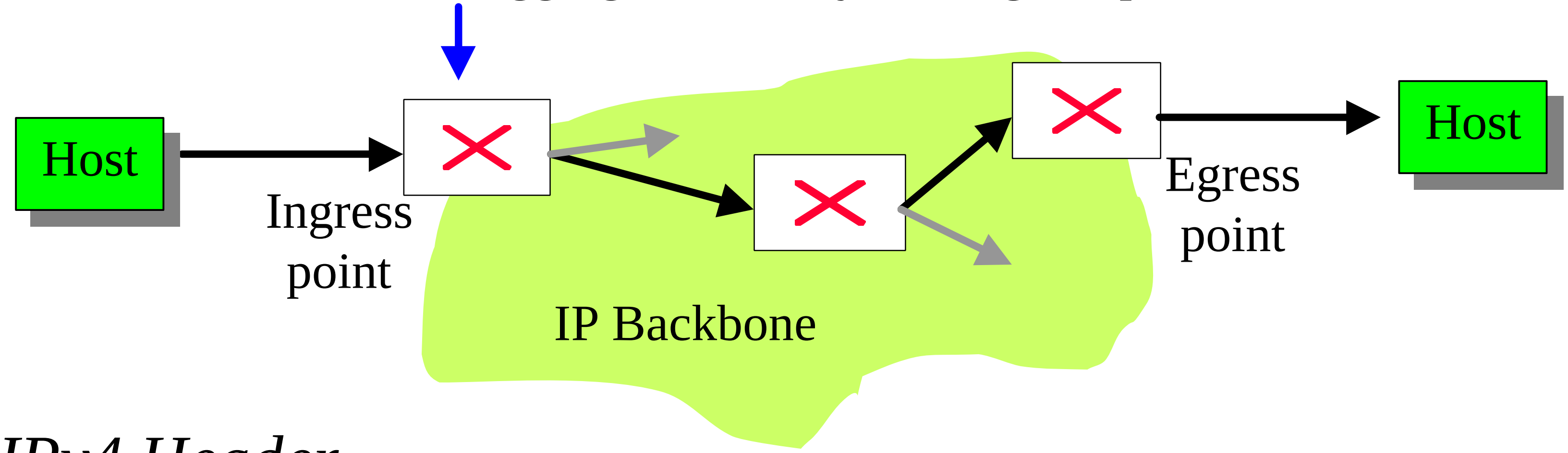


RSVP can be considered an example of the *integrated services* concept (compare with *differentiated services*)

QoS support mechanisms (4)

DiffServ (Differentiated Services) (IETF RFC 2475)

Service ”tagging” in ToS byte at ingress point



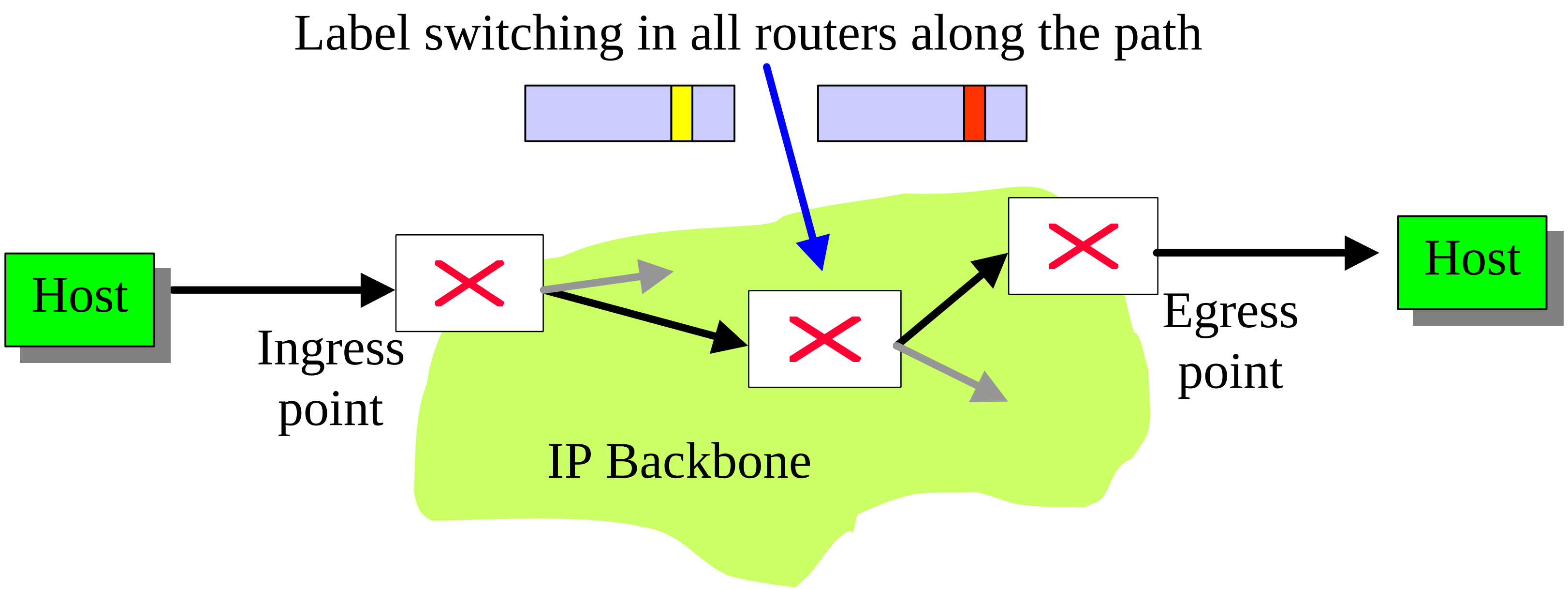
IPv4 Header

Version	IHL	Type of Service	Total length	
Identification			Flags	
Time-to-live		Protocol	Heade	

ToS byte = 8 bits
(2^8 = 256 priority levels could be used)

QoS support mechanisms (5)

MPLS (Multi-Protocol Label Switching) (IETF RFC 2702)

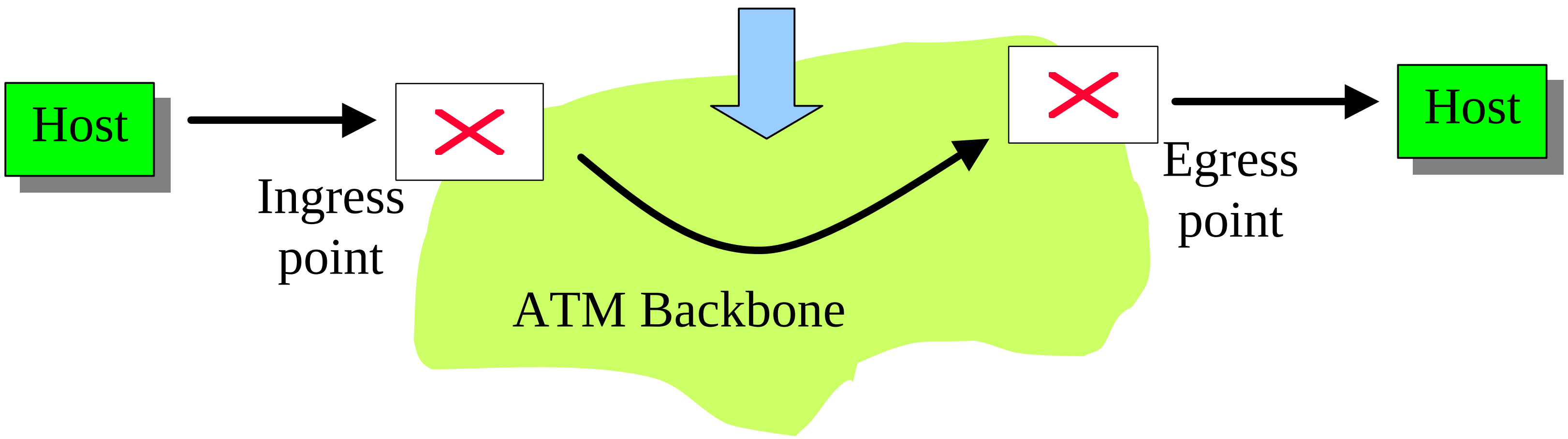


1. Virtual connection must be established first (using e.g. RSVP)
2. IP datagrams are encapsulated in MPLS frames and relayed through routers (i.e. only label, not IP header is used for routing)

QoS support mechanisms (6)

IP tunneling over ATM

IP datagrams are encapsulated in ATM cells and transported over ATM virtual connections



See lecture slides on ATM for protocol stacks involved