Computer Networks COL 334/672

Data Plane

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Slides adapted from KR

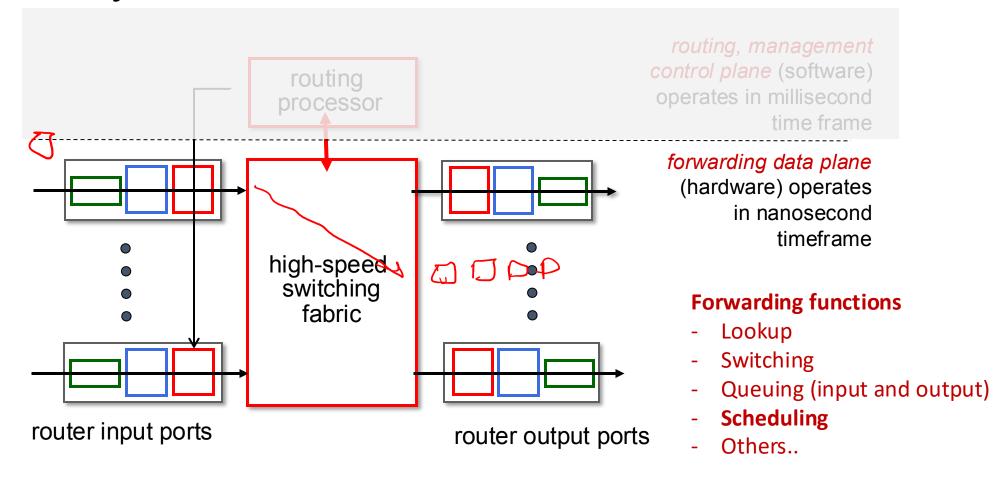
Sem 1, 2024-25

Quiz

baubles

Recap

Network Layer: Data Plane



Data Plane Functions

- Prefix lookup
- Switching
- Queuing
- Scheduling



Packet Scheduling: FCFS

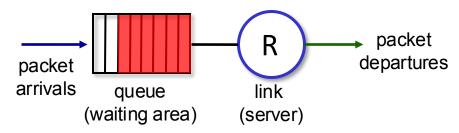
packet scheduling: deciding which packet to send next on link

Can you think of some queuing policies?

FCFS: packets transmitted in order of arrival to output port

also known as: First-in-firstout (FIFO)

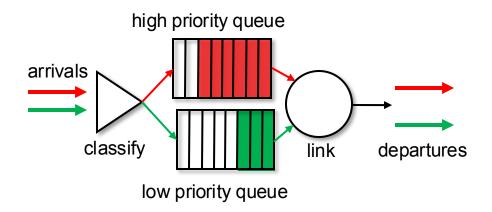
Abstraction: queue

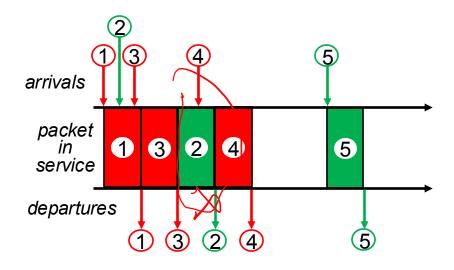


Scheduling policies: priority

Priority scheduling:

- arriving traffic classified, queued by class
 - any header fields can be used for classification
- send packet from highest priority queue that has buffered packets
 - FCFS within priority class

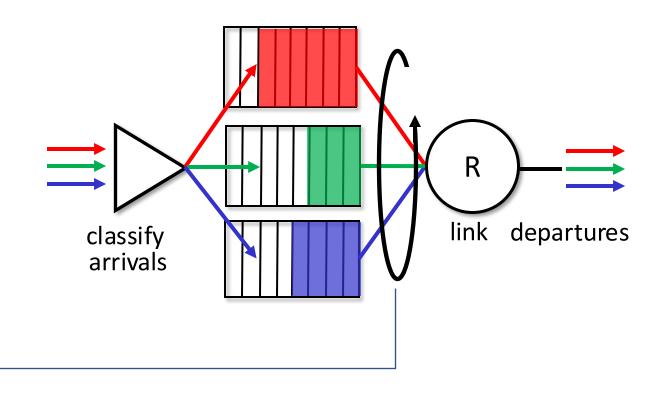




Scheduling policies: round robin

Round Robin (RR) scheduling:

- arriving traffic classified, queued by class
 - any header fields can be used for classification
- server cyclically, repeatedly scans class queues, sending one complete packet from each class (if available) in turn



Scheduling policies: weighted fair queueing



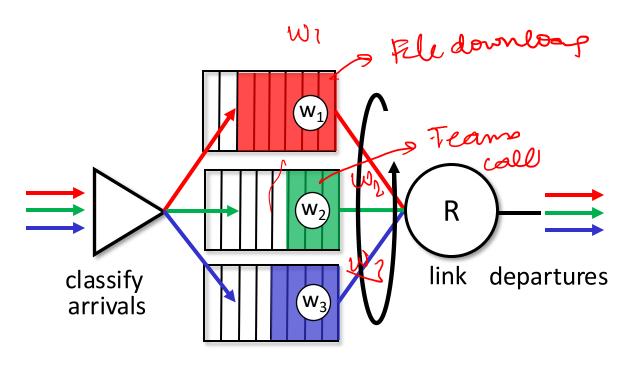
OSPF link annohuncemos

Weighted Fair Queuing (WFQ):

- generalized Round Robin
- each class, i, has weight, w_i, and gets weighted amount of service in each cycle:

$$\frac{\mathcal{W}_{i}}{\sum_{j} w_{j}}$$

 minimum bandwidth guarantee (per-traffic-class)



What about net neutrality?

Sidebar: Network Neutrality



What is network neutrality?

<u>Internet service providers</u> (ISPs) must treat all Internet communications equally regardless of content, website, <u>platform</u>, <u>application</u>, type of equipment

Different countries have different "takes" on network neutrality

Network Neutrality: India

ISPs Perspective

In February 2012, at the World Mobile Congress held in Barcelona, the CEO of Bharti Airtel, Sunil Bharti Mittal suggested that services like YouTube should pay an interconnect charge to network operators, saying that if telecom operators are building highways for data then there should be a tax on the highway.^[14] In July 2012, Bharti Airtel's Director of Network Services, Jagbir Singh suggested that large Internet companies like Facebook and Google should share revenues with telecom companies. According to him, Internet companies were making big profits from small investments, whereas the telecom companies were actually investing in building networks. He also suggested that the telecom regulator should establish interconnection charges for data services, similar to those applied to voice calls.^[15] In August 2012, *The Hindu* reported that according to data from M-Lab, You Broadband, Airtel, and BSNL were throttling BitTorrent traffic.^[16]

Facebook Free Basics AIB video on network neutrality:

Facebook's proposed Free Basics is a new avatar of its internet.org initiative which allows customers to access a slew of apps for free. However, activists are pushing back this initiative arguing that with Free Basics, Facebook would become a gatekeeper, deciding who would not be on the Free Basics platform and in the process, make or break fortunes of several startups.^[60] As a result, Facebook has challenged the TRAI after releasing its Free Basics zero-rating app "which provides access to a host of Internet services like Wikipedia, the BBC, health sites and weather reports, and, of course, Facebook. The services are lightweight versions of the originals that load quickly and perform well on less robust 2G and 3G networks."^[61] The TRAI blocked Free Basics on the basis that although the service is free, there are specific sites that cannot be accessed unless the consumer pays. Zuckerberg countered this argument by releasing a statement saying, "It's not an equal Internet if the majority of people can't participate."^[61] Towards the

Net Neutrality: India

In 2016, TRAI ordered in favour of Net Neutrality

In their latest ruling,^[10] they have stipulated that:

- 1. No service provider can offer or charge discriminatory tariffs for data services on the basis of content.
- 2. No service provider shall enter into any arrangement, agreement or contract, by whatever name called, with any person, natural or legal, that the effect of discriminatory tariffs for data services being offered or charged by the service provider for the purpose of evading the prohibition in this regulation.

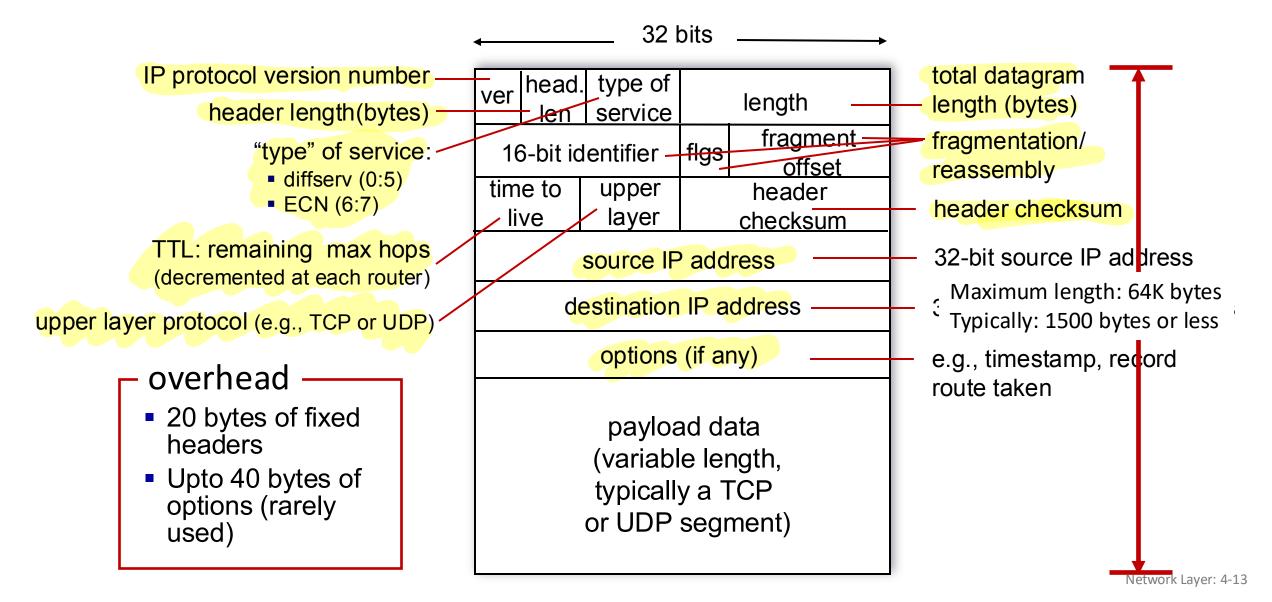
In July 2018, Department of Telecommunications approved TRAI recommendations

Since 12 July 2018 Net Neutrality has been in effect in India. These rules ban any form of data discrimination. ISPs which violate these rules can have their licenses cancelled. Though these rules do not apply to "critical IoT services" or "specialized services" such as autonomous vehicles and remote surgery operations. [69]

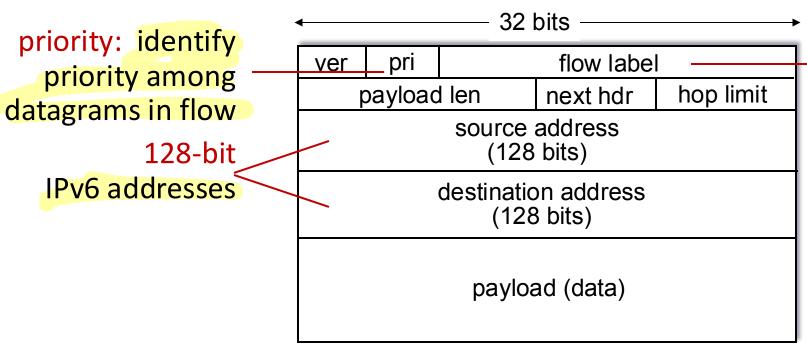
Summary

- Control plane functions
 - Inter-domain vs intra-domain routing
- Data plane functions
 - Prefix lookup
 - Switching
 - Buffering
 - Scheduling ..
- Future class: Per-router control plane vs centralized control plane [SDN]

IPv4 Datagram format



IPv6 datagram format



flow label: identify datagrams in same "flow." (concept of "flow" not well defined).

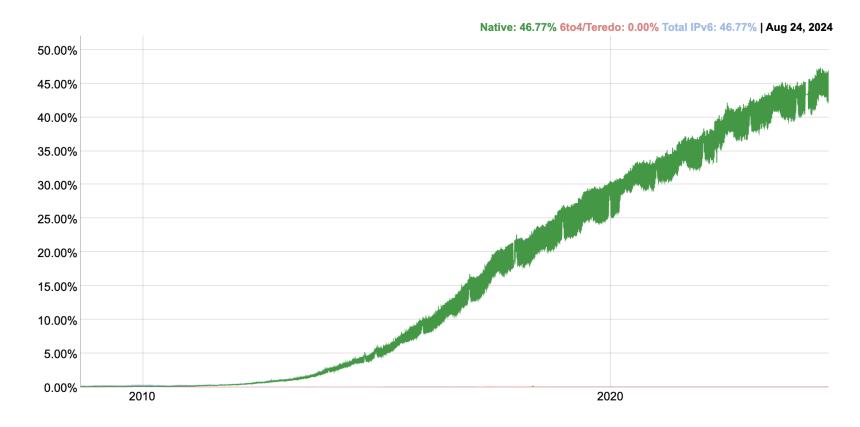
What's missing (compared with IPv4):

- no checksum (to speed processing at routers)
- no fragmentation/reassembly (let the host figure it out)
- no options (available as upper-layer, next-header protocol at

router)

IPv6 adoption

- Google¹: ~ 40% of clients access services via IPv6 (2024)
- India tops the world in IPv6 adoption rates (73% adoption)



Don't all routers in the network path need to be IPv6 compatible for this to work?

Transition from IPv4 to IPv6

- not all routers can be upgraded simultaneously
 - no "flag days"
 - how will network operate with mixed IPv4 and IPv6 routers?
- tunneling: IPv6 datagram carried as payload in IPv4 datagram among
 IPv4 routers ("packet within a packet")
 - tunneling used extensively in other contexts (4G/5G)

