4793 Computer Networking

"Flash boys" recommended book

TA: Keval Jayesh Lakhani

keval.lakhani@nyu.edu

Chapter 1, PowerPoints are avaliable online:

Terminology

Internet: the network of networks view: interconnected ISPs

protocols control sending and receiving messages: TCP, IP, HTTP, Skype, 802.11

internet standards: RFC: Request for comments; IETF: Internet Egnineering Task Force

"nuts and bolts" view

hosts (IP address, devices) = end systems; running network apps (interacts through wiires)

communication links ( fiber, copper, radio, satellite) transmisssion rate: bandwidth. (speed)

Moore's Law: bandwidth is never enough because of the speed that technology increases

Service view:

infrastructure that provides services to applocations: Web, VoIP, email, games

provides programming interface to apps: hooks that allow sending and receiving app programs to "connect" to internet; provides service options analogous to postal service

behaviors matter more than platforms

Protocols: define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

Network protocols: machines rather than humans; all communication activity in Internet governed by protocols. How to start/end/common language communication?

Network edge: hosts: clients and servers; servers often in data centers

access networks, physical media: wired, wireless communication links (to reduce interferece EMI)

network core: interconnected routers; network of networks

twisted wires to reduce interference by EMI created by voltage and air (floor of light) signals

How to connect end systems to edge router? residential, insititutional, mobile

bandwidth (bits per secion) of access network (Shared(wifi) or dedicated (fiber))

wire vs wireless: speed is "dependable"; it depends on how it is used.

Moore's Law, purchasing newer technology: entwork where 30ms \* # of trades = money

Access network:

digital subscriber line (DSL);

cable network(frequency division multiplexing; HFC (hybrid fiber coax);; delay when changing materials

Enterprise access networks (Ethernet): companies now run their own servers

Hosts: sends packets of data: capacity, aka link bandwidth

packet transmission delay = time needed to transmit L-bit pakcet into link = L (bits) / R (bits/sec)(transmission rate)

Physical Media; coacial, fiber(# of twist), radio link types: terrestrial microwave LAN

The network core: packete-switching: hosts break application-layerr messages into pakcets

each packet transmitted at full link capacity: one gaint one or multiple small ones (CWDM; DWDM)

packet-switching: store-and-forward: entire packet must arrive at router befor eit can be transmitted on next link

end-end delay = 2L/R (assuming zero propagation delay)

Queuing and los: if arrival rate (in bits) to link exceeds transmission rate of ink for a period of tome: packets will queue

or packets can be dropped (lost)if memory (buffer) fiills up

routing: determines source-destination route taken by pakcets: routing algorithms (matching protocols)

forwarding: move packets from router's input to appropriate router output (exit to take)

forwarding depends on routing!!! and routing needs forwarding to move packets based on the algorithms

routing algorithms is determined based on user-information and application purposes

forwarding does not have protocols, they have functionss inside the route

end-end resources allocaed to, reserved for "call" between source and destination

packet switching technology, put packets on wire and reassemble them later on.

Reserved a specific path with certain bandwidith: tranditional telephone networks: a lady that connects to phones

path is promised to get delivered and protected

Circuit switching: FDM vs TDM: 4 users FDM (1/4 of the path) TDM (one packet at a time) time(delay)? depends

packet switching allows more users to use network!!

circuit-switching: 10 users~ vs packet switching

why with 35 users, the probablilty of having 10 active memebrs is 0.0004? how? what about >35 usesrs?

however: when constantly active, causes transmission delay: buffer overflows; fixed by buying more router/bandwidth

circuit-switching: requires additional time to setup, it ddoes not come free

ISPs(Internet Service Providers): evolution was driven by economics and national policies

Net neutrality; ISPs have to treat each packet the same regardless of source (what controls?)!!!!!

ISP connets ISP? each to each = does not scale O(N^2)

Global ISP? countries inside countries? not happening

But if one global ISP is viable business, there will be competitors which must be interconnected

Peering link among ISPs, which aer different than the ISPs connecting to consumers (regional net from nets to ISPs)

AT&T (was taken away telephone right because of law protecting monopoly)

IXP connecting ISPs sets with each ISP to consumers

if consumers are paying to ISP, the ISP sets are charging individual ISP based on traffic (net neutrality)

Content provider network, content matters because webpages act differently than Netflix

AOL value is lost, the value is because because of content!

Google is an ISP, because it's cheaper and sell consumer to other ISP sets to generate values from consumer content

Netflix content is located on Amazon servers, streaming from Amazon servers; has not infrastructure

government is always the wealthiest ccorporation because it can always print out more money

Tier 1 ISP to IXP (other Tier 1 or Google) to regional net (other regional net or IXP) to consumers

Delay, loss and throughout in networks

Packets queue in router buffers: packet arrival rate to link (temporarily) exceeds output: link capacity

Packets queue, wait for turn: delay!

How does router manage congestion: they do not! We need to code to resend

Free buffer for arriving packets (loss) is no space

Four source of packet delay:

Processing delay: check bit errors, determine out link; typically < msec

Queueing delay: time waiting at output link for transmission; depends on congestion level of router

What determines: routing table! (previous notes)

Transmission delay: L: packet length(bits) R:lnk bandwidth(bps) L/R

Propagation delay: d: length of physical link; s: propagation speed in medium; d/s

Transmission: 1’s and 0’s; propagation is the length of wires (long/short)

Caravan Analogy: car transmission and propagation

Highway is hard to get on and get off

Bottleneck Is local: multiple end-points to router-> getting out of the router-> package switching->fast now (the road clears out)

SDM: software defined networking: one central console (NO more algorithms, the network is aware of where the packets are going) getting more stupid but only on engineer to manage (intelligence)

Different type of link layer: wifi to router (one link layer) drop and add a new one (from router to net)

Every router is switched and changes linked “layer”

Router only speakers network layer; link linked layer has a switch (only integrated ones)

Network security: DDoS overload with requests and resources

Application Architecture: main frames (old way but its coming back with cloud computing)

Google sheet(Google server, some location) compare to excel( on your laptop,, on a client, offline version)