Welcome back from Spring Break and Spring Break 2.

It looks like the rest of the course will be “on-line”, not “in-person”.

I trust that you are all well, and got home safely.

There will be a video version of the lectures in Sakai under the Panpop tool.

You will be able to view the video at any time not just the allotted course time.

The sound may be a little rough until my new microphone arrives.

If you have questions/comments on the lecture, email me.

Recap

Before break I lectured about Censorship.

The topic of censorship comes up often in discussions of Net Neutrality.

Currently topics like child porn, and hate speech are two things that are censored in the U.S.

But proponents of Net Neutrality fear that ISP’s will begin censoring other “things” when money is involved.

So what is this Net Neutrality thing, and why should Computer Scientists be concerned about it?

Net Neutrality: Background

Net Neutrality is the principle that computer networks should treat all traffic equally:

- No Blocking
  - ISPs should not block lawful content, applications, services, or devices
- No Throttling
  - ISPs should not purposefully slow down certain applications or services
- No Paid Prioritization
  - ISPs should not accept fees for favored treatment (ie. fast lanes)

What is Net Neutrality?

- Net neutrality (also known as the Open Internet) is the principle that all Internet connections should be treated equally.
  - If there’s no net neutrality, Internet service providers (ISPs) can discriminate against sites or services and regulate what users can and can’t see.
- The FCC first started talking about rolling back net neutrality rules in 2017.
  - By no longer classifying ISPs under Title II of the Communications Act of 1934, they could charge more for specific content, slow down their competitors’ services, or block Internet access altogether.
  - By the end of 2017, the FCC had revoked net neutrality and allowed ISPs to sell their users’ data without their permission.
  - In 2019, the House of Representatives attempted to reinstate net neutrality, but that effort is still underway.

Is Net Neutrality Good or Bad?

- Net Neutrality significantly affects both Internet users and ISPs in very different ways, so there are a lot of arguments for and against net neutrality.
  - From the consumers’ point of view, net neutrality is a guarantee that all connections are treated equally and ISPs won’t censor the Internet.
  - To ISPs, however, net neutrality means that the government will heavily control how they do their business.

Net Neutrality Pros

- Freedom of expression - As long as it’s legal, any blog or website or news service is available online under the concept of net neutrality.
  - Otherwise, Internet service providers could in theory block access to content they don’t want you to see, like a rival video streaming site or another site that competes with their own interests, or even content they deem as unsuitable.
  - Net neutrality lets all the many, diverse people in the world have a voice online, for better or worse.
- Promotes innovation and competition - An open Internet ensures that larger companies don’t have yet another advantage over a tiny startup.
  - It’s a level playing field on the Internet, where everything is delivered as fast as possible to the end user.
### Net Neutrality Pros

- **Unfettered access** - Google can’t pay for faster access to their websites, and a tiny video streaming service should in theory be as speedy and glitch-free as Netflix.
- Net neutrality squashes the potential for Internet fast lanes, where Internet service providers can charge content creators for enough bandwidth to deliver their service properly.
- It also prevents the possibility of providers charging end users an extra fee to access vital services, like online banking or email, or entertainment platforms like gaming networks (or of the owners of these services from passing their costs onto end users).

### Net Neutrality Cons

- **Less network innovation** - The rise of bandwidth-heavy web services like video streaming and content downloads means Internet service providers have less money to spend on upgrading their networks.
  - If they could charge Google, Microsoft, et al for carrying their resource-intensive services, they could invest in upgrading their networks and extending them further.
  - However, there is data that complicates this argument, with the FCC’s own industry-funded research showing that while investment fell 2% in 2015 and 3% in 2016 under net neutrality, the largest ISP increased spending, as did others.

- **Porn and objectionable content thrives** - Some opponents of net neutrality lament how easily accessible legal but age-sensitive content like pornography is.
  - While there are plenty of security vendors who allow families to restrict the sites available on a family computer, more children have smartphones and connected devices with which they can get online without adult supervision.
  - If an Internet service provider could block these services at a network-wide level, this would go a long way to solving this issue.
  - This is the case under the UK's Digital Economy Act, which will force people to verify their identity to access porn sites, and ISP-level blocking of non-compliant sites.
  - Providers could also crack down on peer-to-peer file-sharing, which is responsible for a lot of illegal downloads, thus preventing piracy.

- **No free Internet access** - Advocates for less oversight of Internet service providers say that allowing them to charge for access to some content would lead to free access to certain sites.
  - For example, they argue that if Internet service providers charged bandwidth-hungry companies like Netflix more for using their infrastructure, they would be able offer access to sites like Wikipedia or Facebook for free - even if you had no Internet contract.

### How do we implement Net Neutrality?

Major ISP’s and hardware vendors have come up with ways to implement Net Neutrality.

But the TCP/IP protocol is designed for “best effort” delivery, not differentiated service levels.

The TCP/IP stack does provide a method to provide Quality of Service (QoS) which is a minimalistic means of implementing Net Neutrality.

### Case Study: QoS

- Many home networking routers provide Quality of Service (QoS) features that let users prioritize certain traffic over others.
  - Quality of service (QoS) refers to any technology that manages data traffic to reduce packet loss, latency and jitter on the network.
  - QoS controls and manages network resources by setting priorities for specific types of data on the network.
- Why would this be beneficial to a home user?
- Could this be beneficial to the whole Internet?
- Why shouldn’t we allow this for the whole Internet?
Is QOS beneficial to home users?

- Quality of Service (QoS) is a feature of routers and switches which prioritizes traffic so that more important traffic can pass first.
  - The result is a performance improvement for critical network traffic.
  - QoS equipment is useful with VoIP phones or in LANs with high volumes of local traffic.
- You can’t see the melee caused by all of your devices fighting for bandwidth, but you can feel its impact.
- Without intervention, the strongest competitors—a BitTorrent download, for instance—will drink their fill, even if it’s not essential to their survival, while others—a VoIP call, a Netflix stream, or a YouTube video—are left to wither and die.

Is QOS beneficial to the Internet?

- The Internet has historically offered a single level of service, that of "best effort," where all data packets are treated with equity in the network.
- However, we are finding that the Internet itself does not offer a single level of service quality, and some areas of the network exhibit high levels of congestion and consequently poor quality, while other areas display consistent levels of high quality service.
- Customers are now voicing a requirement to define a consistent service quality they wish to be provided, and network service providers are seeking ways in which to implement such a requirement.
- This effort is happening within the umbrella called "Quality of Service" (QoS).

Is QOS beneficial to the Internet?

- QoS is possible in the Internet, but it does come at a price of compromise — there are no perfect solutions.
- In fact, one might suggest that expectations have not been appropriately managed, since guarantees are simply not possible in the Internet, at least not for the foreseeable future.
- What is possible, however, is delivering differentiated levels of best effort traffic in a manner which is predictable, fairly consistent, and which provides the ability to offer discriminated service levels to different customers and to different applications.

Is QOS viable on the Internet?

- Your public Internet provider will not treat ToS bits with any form of priority.
  - Yes, they could, but if they did then everybody would game the system to get an advantage and they would not have much meaning anyway.
- Is QoS over the Internet possible?
  - The answer is, yes, QoS on an Internet link is possible.
  - Call it “equalizing,” or behavior-based shaping: it involves monitoring incoming and outgoing streams on your Internet link.
  - Priority or QoS is nothing more than favoring one stream’s packets over another stream’s.
  - You can accomplish priority QoS on incoming streams by queuing (slowing down) one stream over another without relying on ToS bits.
Is QOS viable on the Internet?

- Although you can’t tell the Internet to send your VoIP packets faster, most people don’t realize the problem with congested VoIP is due to the fact that their VoIP packets are getting crowded out by large downloads.
  - Often, the offending downloads are initiated by their own employees or users.
  - A good behavior-based shaper will be able to favor VoIP streams over less essential data streams without any reliance on the sending party adhering to a QoS scheme.

Case Study: Comcast v FCC

- In 2007, Comcast was penalized by the FCC for throttling network traffic of its subscribers:
  - In 2010, the DC Circuit Court of Appeals, overturned this complaint because it ruled that the FCC lacked the authority to regulate ISP network management practices
  - Should Comcast be allowed to throttle subscribers?
  - Should the government be able to regulate the network management practices of ISPs?

Case Study: Verizon vs FCC

- In 2010, the FCC published new an "Open Internet Order" that forbade broadband services from blocking or slowing online services such as VoIP:
  - Verizon appealed these rules and asserted that the FCC did not have the authority to impose these rules
  - In 2014, the DC Circuit Court of Appeals agreed with Verizon (FCC could not regulate telecommunications companies under Title I of Communications Act)

Case Study: US Telecom vs FCC

- In 2015, the FCC published a new Open Internet Order
  - In previous case, FCC tried to classify telecoms under Title I as "information service" but this was ruled invalid
  - In new version, FCC would classify telecoms as common carriers under Title II who cannot "make any unjust or unreasonable discrimination in charges, practices, classifications, regulations, facilities, or services."

Trump’s FCC: Bigly Changes

- Ajit Pai’s (Chairman of the U.S. Federal Communications Commission) core stance is a traditionally Republican one: free market, minimal regulation.
  - He’s been opposed to requiring ISPs to implement stricter privacy protections for consumers, opposed to increasing broadband benchmarks to promote higher speeds, opposed to regulating mergers.
    - Closed investigation into zero-rating practices (allowing access without cost) of the wireless providers T-Mobile, AT&T and Verizon.
    - No longer defending a cap on prison phone call rates
    - Suspend broadband privacy rules which gave consumers the power to choose how their ISPs use and share their personal data.
    - The commission over the last month approved $2 billion to improve rural broadband access and $453 million to improve wireless connectivity in rural America and in tribal lands

Trump’s FCC: Restoring Freedom

- “The Internet is the greatest free market innovation in history,” Pai said before today’s vote. “What is responsible for the phenomenal development of the Internet? It certainly wasn’t heavy-handed government regulation.”
  - Going forward, home Internet providers and mobile carriers will be bound not by strict net neutrality rules but by whatever promises they choose to make. ISPs will be allowed to block or throttle Internet traffic or offer priority to websites and online services in exchange for payment.
  - Rules requiring greater disclosure of hidden fees and penalties for exceeding data caps have been eliminated, and the FCC is relinquishing its role in evaluating whether ISPs can charge competitors for data cap exemptions.
**Stakeholder: Consumer**

Consumers want fast, unrestricted, and low-cost network access to:
- Their favorite applications and services
- All the content available on the Internet

Consumers typically pay a flat fee for different tiers of broadband service:
- This fee is a subscription that allows network access
- Additional fees to specific services may be required

**Stakeholder: ISPs**

ISPs want to provide high quality network services with minimal costs:
- Pay for infrastructure and must maintain network
- Have monopolies and face minimal competition

**Stakeholder: Content Providers**

- Content Providers want fast, unrestricted, and low-cost network access to customers
- Pay for bandwidth at data centers
- Pay for Content Delivery Network (CDN) services to replicate data
  - A content delivery network, or content distribution network, is a geographically distributed network of proxy servers and their data centers.
  - The goal is to provide high availability and performance by distributing the service spatially relative to end users.
- Pay ISPs for local caches

**Stakeholder: Government**

- The government wants to encourage innovation and promote competition:
- Create rules and regulation to enable a level playing field for all businesses
- FCC wanted to enforce "Open Internet Rules", but now it wants to promote innovation
- Republican party wants to minimize government regulations and intervention

**Case Study: Netflix**

- In 2016, it was revealed that "Netflix throttles video on most mobile networks including AT&T and Verizon Wireless to bitrates of 600kbps, while making exceptions for Sprint and T-Mobile"
- Is it fair that Netflix can throttle, but ISPs cannot?
- Should consumers be allowed to control what bitrate their streams are set at?

**Case Study: Comcast + Time Warner**

- In 2015, the FCC and DOJ denied the proposed merge between Comcast and Time Warner Cable:
- Should we allow a single company or a handful of companies provide the vast majority of Internet service?
- Should the government have the power or exercise their ability to regulate the free market in the interest of preventing "anti-competitive" behavior?
Case Study: AT&T + Time Warner

Last year, AT&T was approved to merge with Time Warner (entertainment), but this decision is now under appeal:

- Should telecoms be able to also be media content companies?
- Should the government have the power to prevent such vertical integration?

Case Study: T-Mobile (Zero-Rating)

T-Mobile has a "Binge On" program that allows users to access certain media streams without that traffic counting towards their data limits

- Should ISPs be allowed to provide "zero-rated" services?
- Is this an uncompetitive practice or smart marketing?

Net Neutrality is dead. Now What?

https://www.youtube.com/watch?v=hIULk8G6t9A

Current News

- Ajit Pai wins (and loses) in court as net neutrality repeal is mostly upheld
- 99.7% Of Original Comments Opposed FCC Repeal Of Net Neutrality
- AT&T will slash $3 billion off its capital investments next year
- Washington State keeps enforcing net neutrality as it hails FCC court loss