INTRODUCTION

COMP 30650: NETWORKS AND INTERNET SYSTEMS

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COMP 30650 HOUSEKEEPING

Lectures

- Monday 10:00 (G-24 AG)
- Thursday 11:00 (B0.04 CS)

Practical Session

- Tuesday 13:00 – 14:50 (E2.16 SCE)
- Commencing Week 2

Study Break: March 11th – March 24th
No lecture on Monday April 22nd (Easter Monday – Public Holiday)
Note: University also closed Friday 19th April

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- Practical Lab Sessions
  - 10 Practical Sessions
  - Weekly commencing Week 2
    - Formative feedback in the lab/via Moodle
    - In-Lab assessments (15%)– April 23rd
  - Assignment (10%) – Given 9th March - Due April 12th
- Mid Term In-Class Assessment (during lecture time)
  - February 28th (15%)

COMP30650 uses the UCD CS Mark-Grade Mapping:
https://www.cs.ucd.ie/Grading/

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Plagiarism

- According to UCD, plagiarism = the copying of another person's writings or works or ideas in any thesis, essay, project, laboratory report, oral, poster or slide presentation or other exercise, which forms part of the assessment requirement for a module or programme of study without due acknowledgement either wholly or in part of the original source of the material through appropriate citation.

- Plagiarism includes presenting work authored by a third party, including other students, friends, family, or work purchased through internet services; Presenting work copied extensively with only minor textual changes from the internet, books, journals or any other source; Improper paraphrasing, where a passage or idea is summarised without due acknowledgement of the original source; Failing to include citation of all original sources;

- Representing collaborative work as one's own.
- https://csiweb.ucd.ie/files/csi-plagiarism-policy_august2015.pdf

Plagiarism is a serious academic offence

- [Student Code, section 6.2] or [UCD Registry Plagiarism Policy] or [CS Plagiarism policy and procedures]
- Our staff and demonstrators are proactive in looking for possible plagiarism in all submitted work
- Suspected plagiarism is reported to the CS Plagiarism subcommittee for investigation
- Usually includes an interview with student(s) involved
- 1st offence: **usually** 0 or NG in the affected components
- 2nd offence: referred to the **University disciplinary committee**
- Student who enables plagiarism is equally responsible
  - http://www.ucd.ie/governance/resources/policypage-plagiarismpolicy/
    http://www.ucd.ie/governance/resources/policypage-studentcode/
    http://libguides.ucd.ie/academicintegrity

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Respect each other, lecturers, demonstrators and teaching assistants

https://www.ucd.ie/equality/support/dignityrespect/

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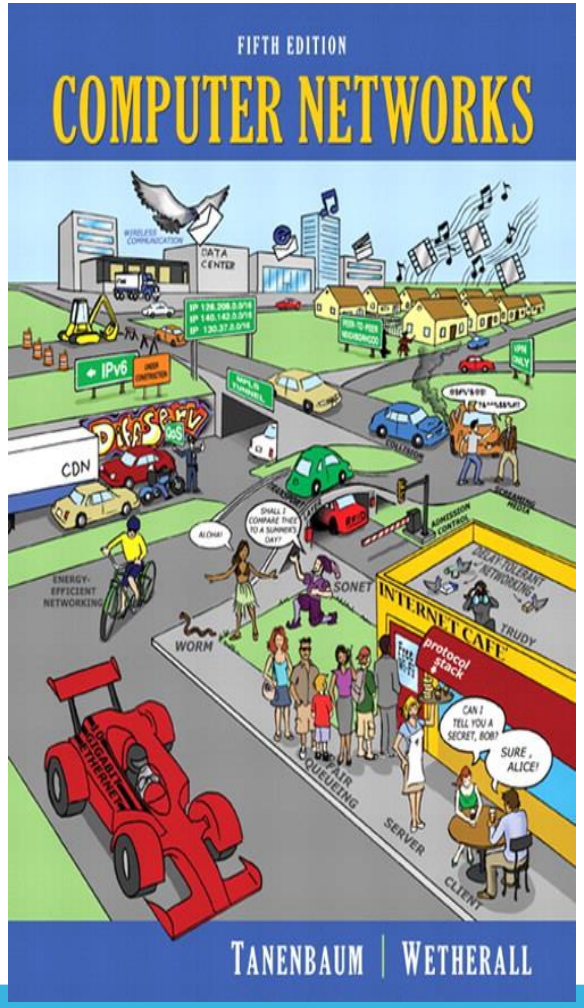
Course Book

- Computer Networks
- By Andrew S. Tanenbaum, David J. Wetherall
- Published by Pearson

Any introductory computer/data networking textbook covers similar topics, with other examples



COMP 30650 HOUSEKEEPING

Moodle COMP30650 Networks and Internet System 2018-2019

Enrolment key: COMP30650z19

Find and use supplementary material

- The Book
- Peer Learning
- Online tutorials
- Computer Science Support Centre
- Online Videos - Wetherall Videos of slides for the book.

OBJECTIVES OF COMP30650

Learn how Computer Networks and the Internet work!

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Learn how Computer Networks and the Internet work!

Well we will learn about some of it anyway.

TODAY'S PLAN

- Goals and Motivations for COMP 30650
- Use of Computer Networks
- Impact of Networks
- Considerations for Designing Computer networks

OUTCOMES

Learning Outcomes

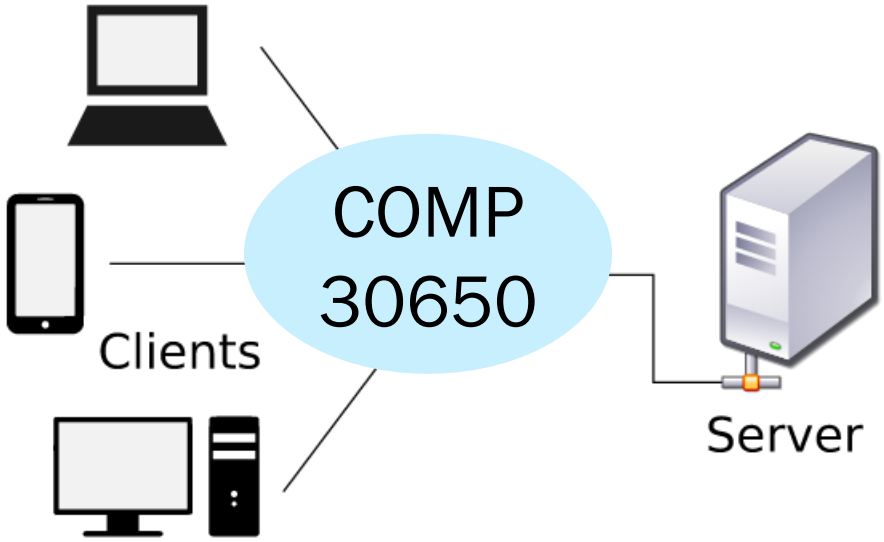
- Appreciate the different and varied uses of computer networks
- Begin to think about how the Internet might work
- Begin to understand some of the problems for designing computer networks

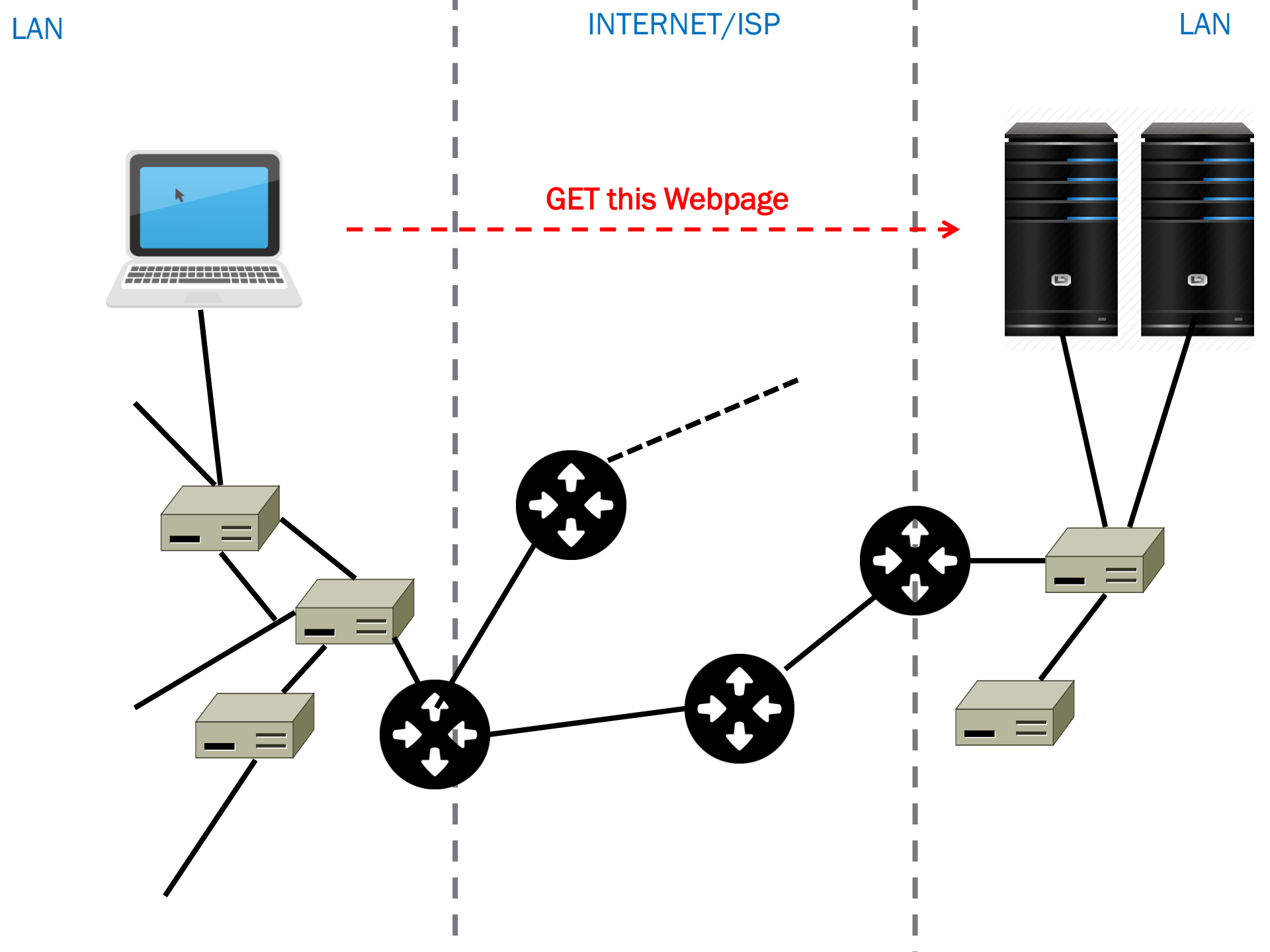
A NETWORK

Definitions of a network

- An interconnected collection of autonomous **nodes**
  - Interconnected = able to exchange information
- A set of **nodes** connected by media **links** node
  - Any device capable of sending &/or receiving data to &/or from other nodes in the network &/or from other nodes in the network
- A connected collection of hardware and software that permits information exchange and resource sharing
  - Information = data, text, audio, video, images,
  - Resources = printers, memory, link bandwidth

FOCUS OF THE COMP 30650




LAN
INTERNET/ISP
LAN
GET this Webpage

WHAT DO WE USE NETWORKS FOR?

WHAT DO WE USE NETWORKS FOR?

- Business
- Home
- Personal
- Leisure
- Entertainment
- Convenience
- Mobile Uses

BUSINESS APPLICATIONS

Email

Voice over IP

Desktop Sharing

Remote Monitoring

- Equipment
- Machinery
- Patients

E-commerce Applications

HOME APPLICATIONS

Homes contain many networked devices, e.g., computers, TVs, connected to the Internet by cable, DSL, wireless, etc.

- Access to remote Information via the Internet

Home users communicate

- Social networks
- Instant messenger
- Transactions
  - Home shopping
- Consume media content
  - Video, movie

HOME APPLICATIONS

Ubiquitous computing/Internet of Things

- Smart Fridges
- Smart Heating Controls
- Smart Meters
- Cameras
- Alarms
- Amazon Echo

MOBILE USES

NFC (Near Field Communication)

- RFID (Radio Frequency Identification)
- For payment, sharing data

Sensor Networks

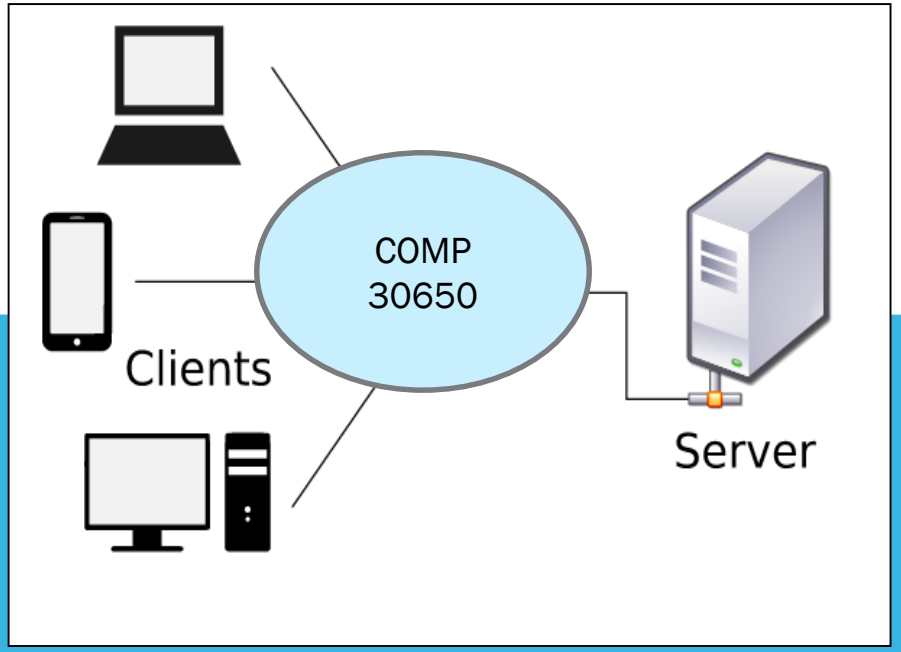
- Environmental Monitoring
- Monitoring processes in vehicles

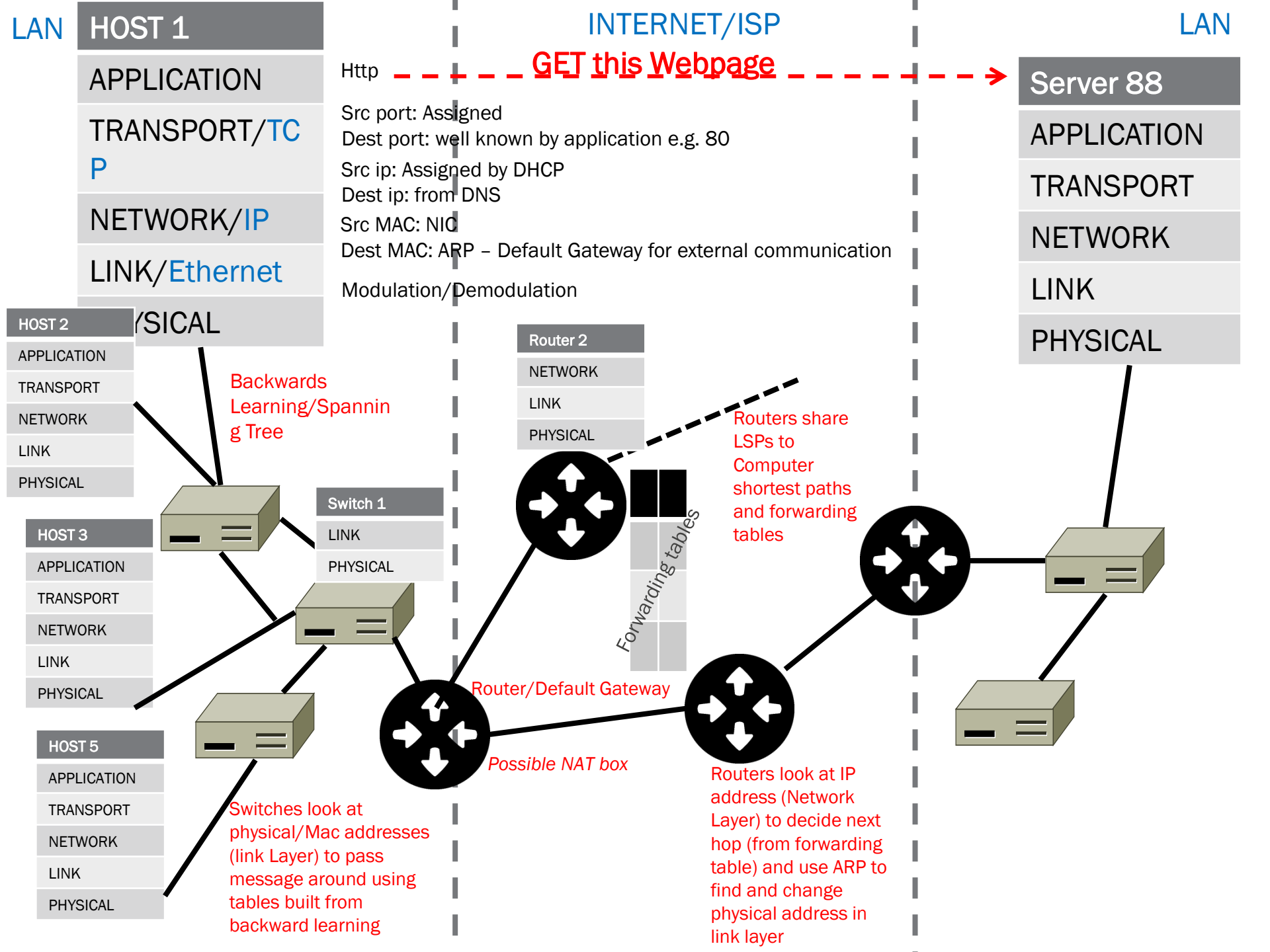
Wearable Computing

- Health Sensors
- Fitness
- Google Glass

WHAT HAPPENS IN A NETWORK

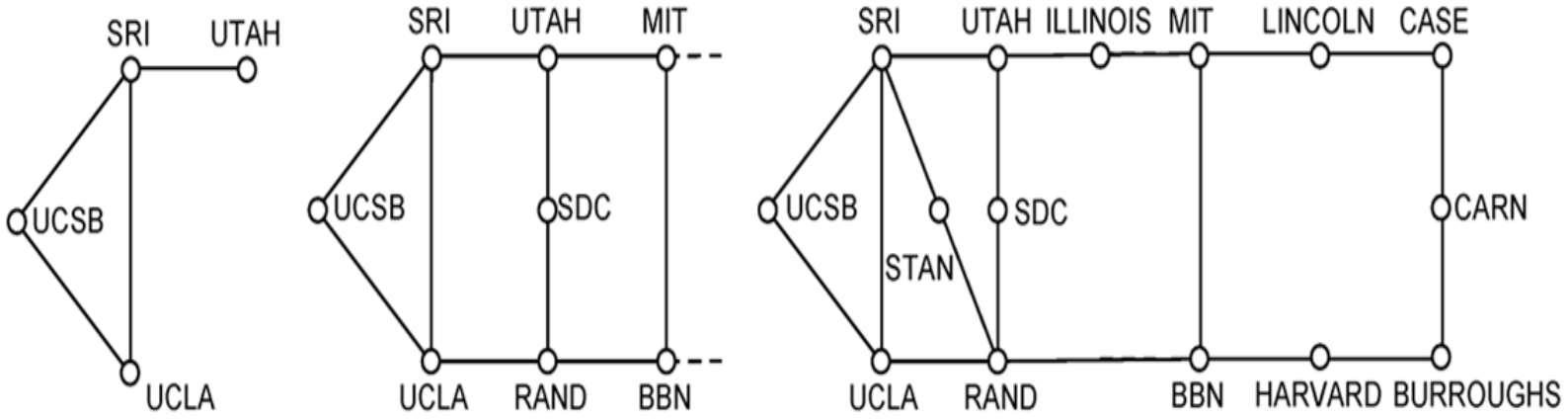
- Imagine:
  - You have a new laptop.
  - You bring it to UCD and turn it on.
  - Within a few minutes, you are using Facebook, Gmail, Youtube, Messenger….
- What's happening, what are all the things we are taking for granted?
- What do we need to consider?
- What really happens when you "browse the web"`, download music, watch videos online?




LAN
HOST 1
APPLICATION
TRANSPORT/TCP
NETWORK/IP
LINK/Ethernet
/SICAL
INTERNET/ISP
LAN
Http
GET this Webpage
Server 88
APPLICATION
TRANSPORT
NETWORK
LINK
PHYSICAL
Src port: Assigned
Dest port: well known by application e.g. 80
Src ip: Assigned by DHCP
Dest ip: from DNS
Src MAC: NIC
Dest MAC: ARP – Default Gateway for external communication
Modulation/Demodulation
HOST 2
APPLICATION
TRANSPORT
NETWORK
LINK
PHYSICAL
Backwards Learning/Spanning Tree
Router 2
NETWORK
LINK
PHYSICAL
Routers share LSPs to Computer shortest paths and forwarding tables
Switch 1
LINK
PHYSICAL
HOST 3
APPLICATION
TRANSPORT
NETWORK
LINK
PHYSICAL
Forwarding tables
Router/Default Gateway
HOST 5
APPLICATION
TRANSPORT
NETWORK
LINK
PHYSICAL
Possible NAT box
Switches look at physical/Mac addresses (link Layer) to pass message around using tables built from backward learning
Routers look at IP address (Network Layer) to decide next hop (from forwarding table) and use ARP to find and change physical address in link layer

EXPERIMENTAL NETWORK

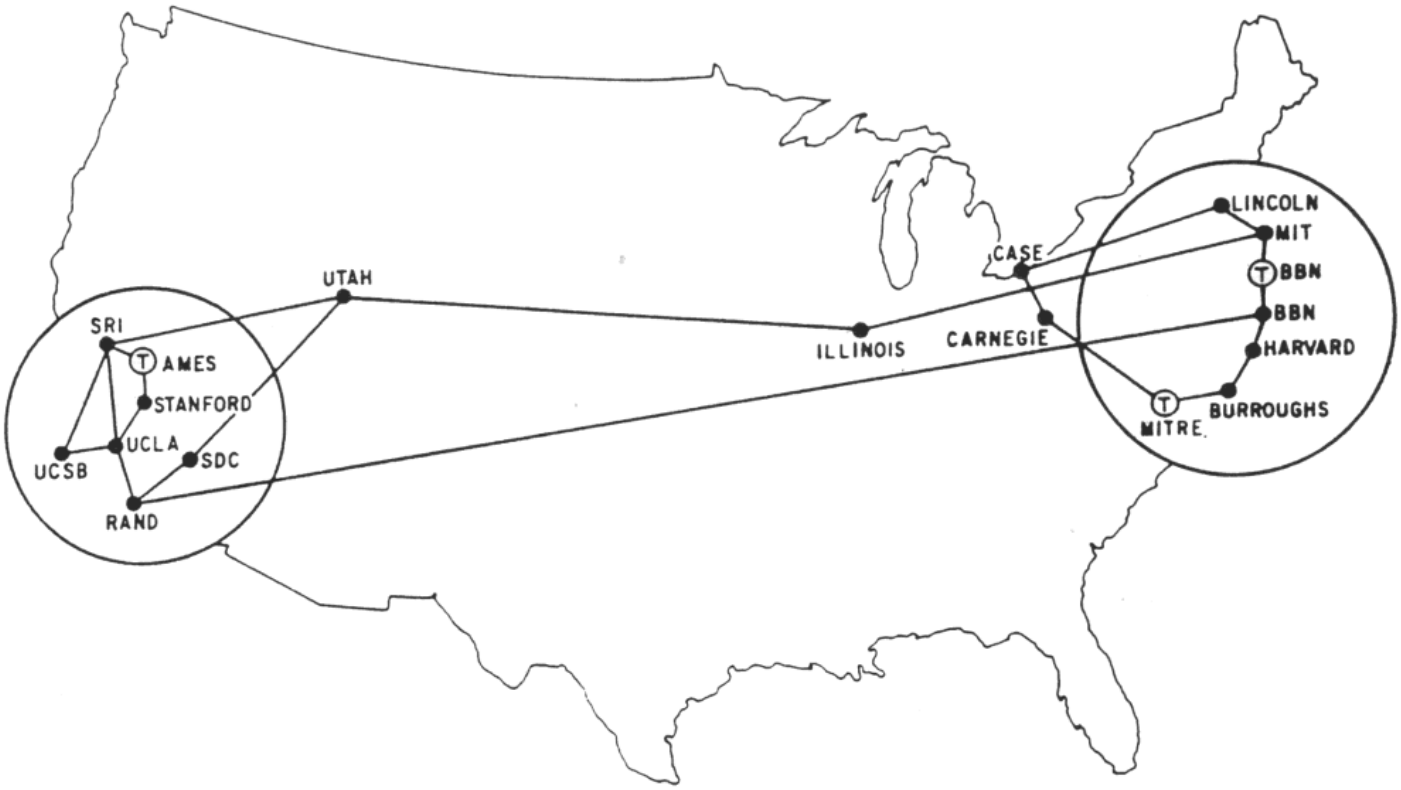
ARPANET ~1970



(a) Dec. 1969. (b) July 1970. (c) March 1971.

The Advanced Research Projects Agency Network

EXPERIMENTAL NETWORK



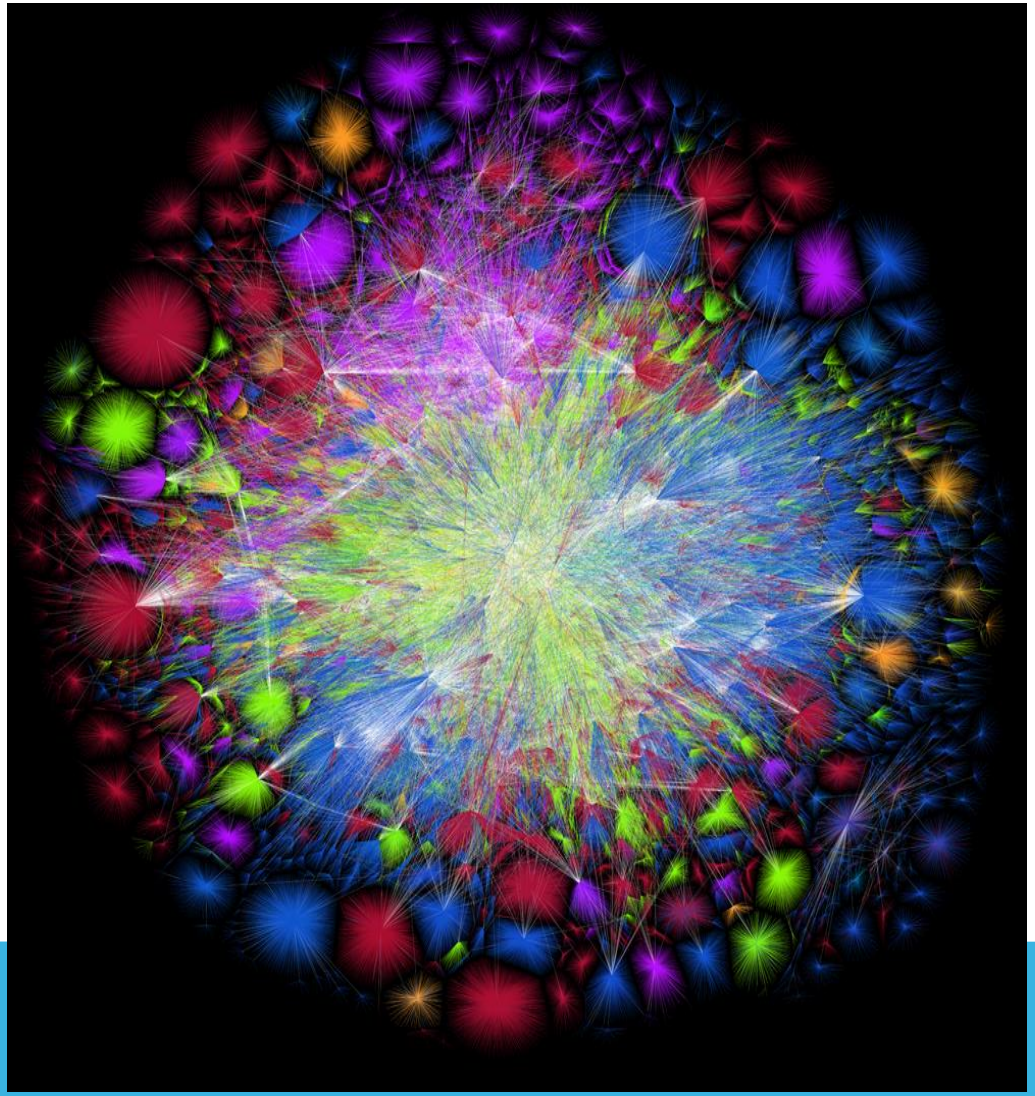
MAP 4 September 1971

THE INTERNET

Internet 2015

An everyday institution used at work, home, and on-the-go

Visualization contains millions of links



Barrett Lyon / The Opte Project
Visualization of the routing paths of the Internet.

INTERNET – SOCIETAL IMPACT

An enabler of societal change

- Easy access to knowledge
- Electronic commerce
- Personal relationships
- Discussion without censorship
- Education

INTERNET – ECONOMIC IMPACT

An engine of economic growth

- Advertising-sponsored search
- Online marketplaces
- Crowdsourcing

amazon $860 billion

Google $765 billion

$444 billion

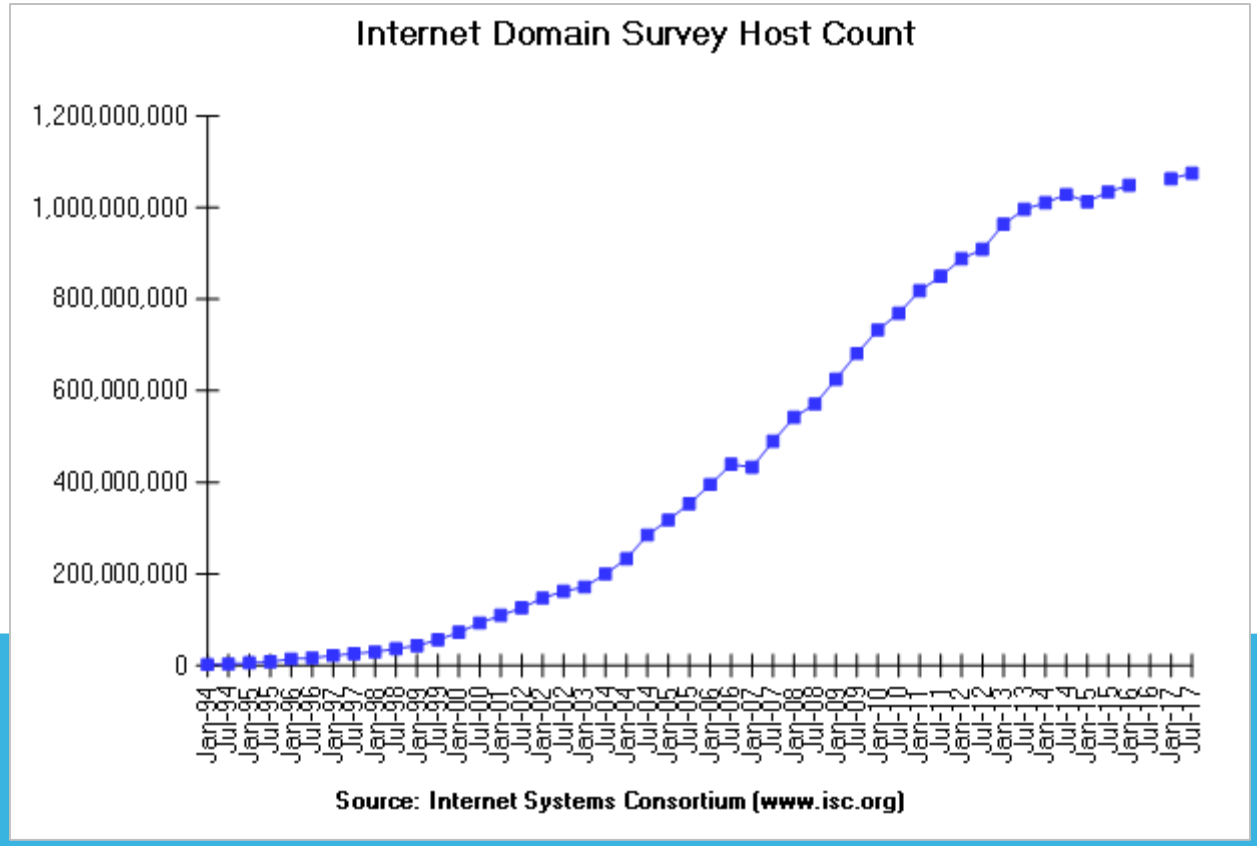
https://www.investopedia.com/articles/active-trading/111115/why-all-worlds-top-10-companies-are-american.asp

INTERNET SOCIAL ISSUES

- Network neutrality no network restrictions
- Content ownership
  - Digital Millennium Copyright Act (DMCA) takedowns
- Anonymity and censorship
  - Snooping
- Privacy
  - Web tracking and profiling
- Theft/scams
  - Botnets and phishing

CHALLENGES

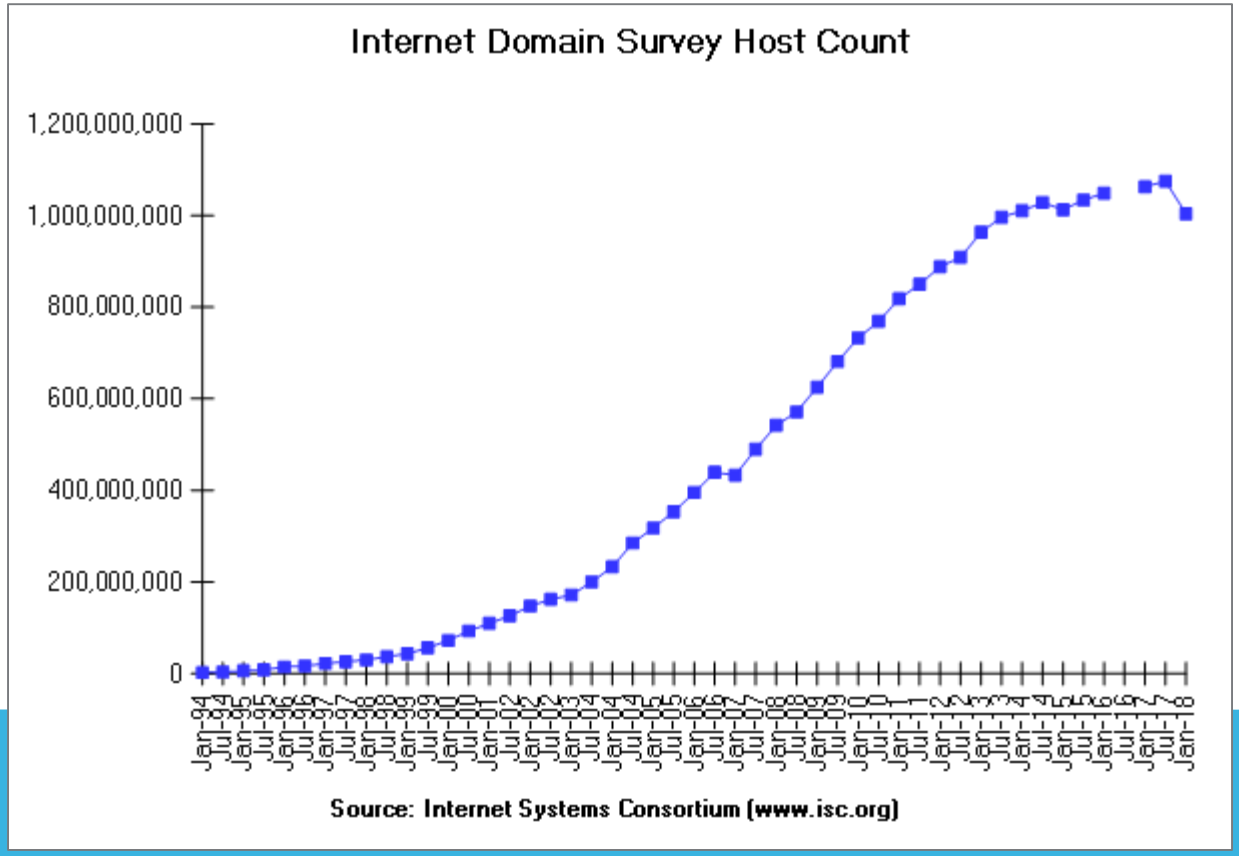
At least a billion Internet hosts and growing …



CHALLENGES

At least a billion Internet hosts and growing ??

The most recent survey available online is dated July 2018. Complete ISC Domain Survey results, in-depth data, and information are available for purchase at the ISC store. Data for January 2018 is flawed and is included here for amusement purposes only. We have not finished researching the 5% drop from July 2017 to July 2018 but we tentatively believe that it is the result of some ISPs moving their customers to IPv6.



CHALLENGES

Example key problem: Reliability!

- Any part of the Internet might fail
- Messages might be corrupted
- So how do we provide reliability?

Reliability solutions

- Codes to detect/correct errors
- Routing around failures …

CHALLENGES

Key problem	Example solutions
Reliability despite failures	Codes for error detection/correction Routing around failures
Network growth and evolution	Addressing and naming Protocol layering
Allocation of resources like bandwidth	Multiple access Congestion control
Security against various threats	Confidentiality of messages Authentication of communicating parties

CHALLENGES

Examples of upheavals in the past 1-2 decades

Growth / Tech Driver	Upheaval
Emergence of the web	Content Distribution Networks
Digital songs/videos	Peer-to-peer file sharing
Falling cost/bit	Voice-over-IP calling
Many Internet hosts	IPv6
Wireless advances	Mobile devices