CSE 461: Computer Networks

Spring 2022

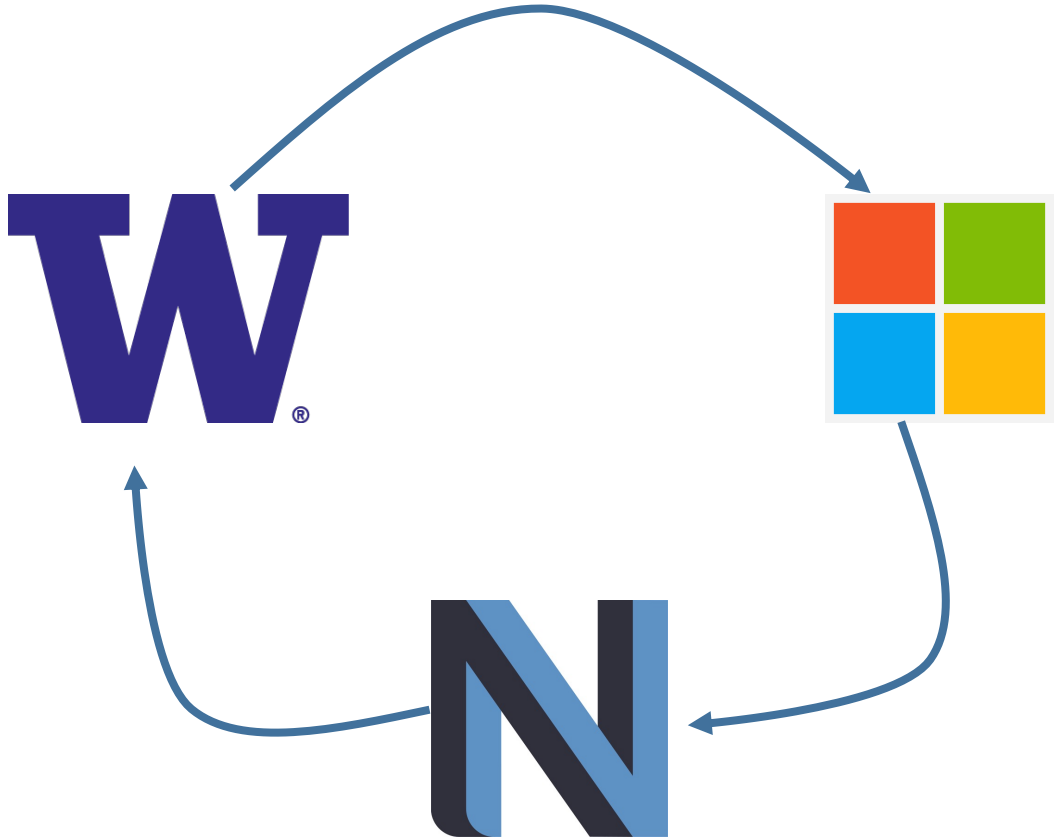
Ratul Mahajan

Jason Wyatt Miller, Monty Nitschket,

Edan Tessel Sneh, Mark Theeranantachai

Who we are

Ratul



Jason Miller

- Hometown: Mukilteo, Washington
- Year: Junior, graduating June 2023
- Some fun facts:
  - Double major in CS and math, minor in applied math
  - I like rock climbing
  - I went to Vancouver over Spring break
  - I have a cat named Cosmo:

Monty Nitschke

Hometown: Spokane, Washington

Year: BS/MS, graduating Autumn 2022!

Some fun facts about me:

- Transfer student from CC
- Fourth time TA :)
  - Previous TA for 332, 351
- Love to go hiking and camping
- Love board games and card games

Edan Sneh

Hometown: Palo Alto, California

Year: BS/MS, graduating Spring 2022!

Some fun facts about me:

Love rock climbing

Love all sorts of puzzles and strategy games

I enjoy eating food and cooking meals

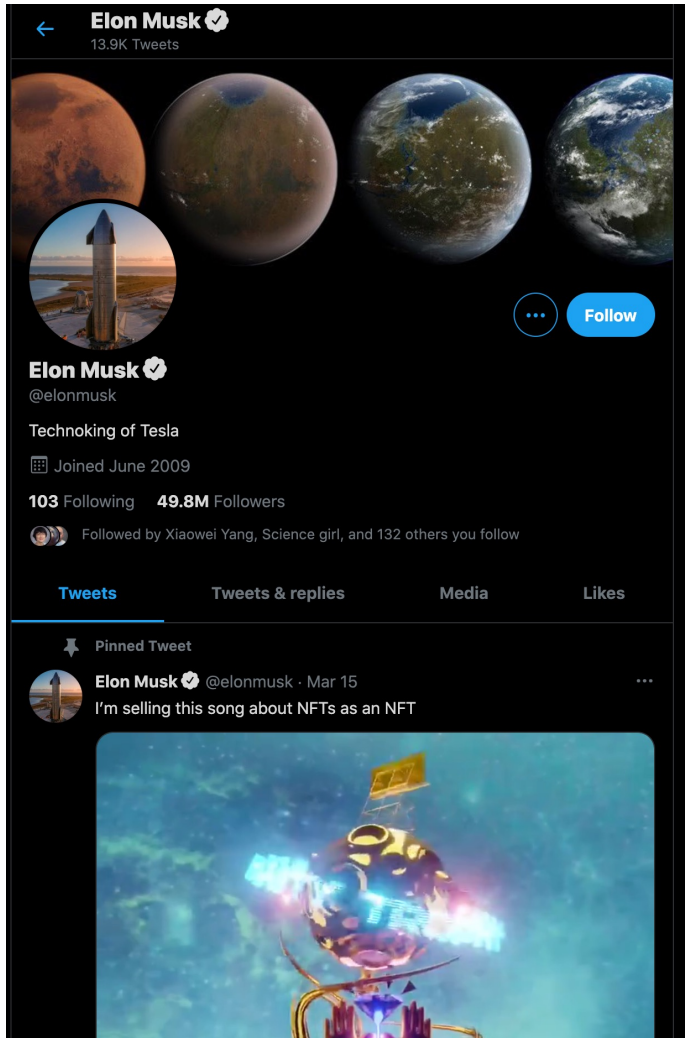
Absolutely hate flying but love traveling

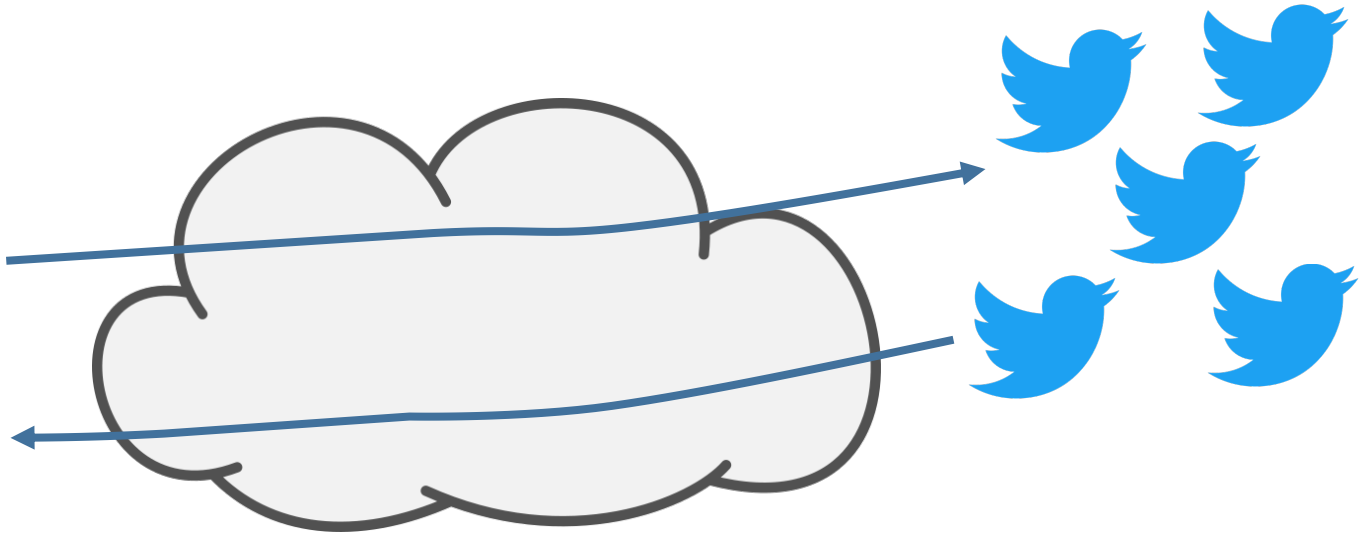
Mark Theeranantachai

- Hometown: Thailand
- Year: Undergraduate Senior
- Graduating June 2022
- Some fun facts:
  - Really love live music and jamming (usually rock/pop
  - Can play a lot of instruments but not so good at any :
  - Sony Fanboy, have used 5 Xperia phones
  - Love thriller and action films/TV shows
  - Enjoy snowboarding, tennis, photography, and cyclin
  - Thai foods are too spicy :(
  - Casual Dota2 player (900 hrs)
  - Currently work at the ICTD lab and pursuing a PhD.

CSE 461: Computer Networks

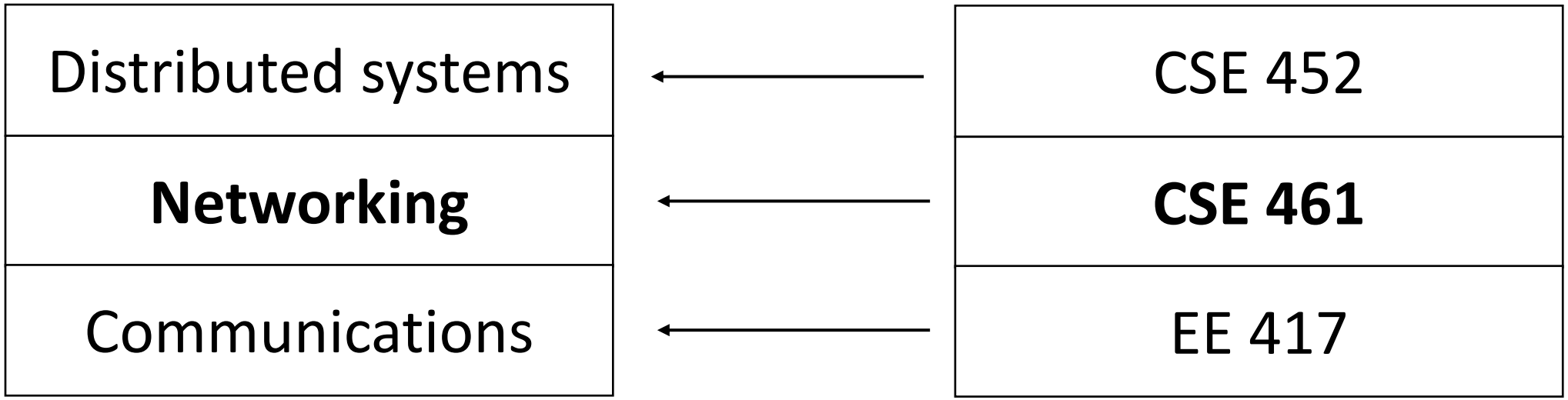
Focus of the course





Focus of the course (2)

Three “networking” topics:



Main goals

1. Learn the fundamentals of computer networks
2. **Learn how the Internet works**
   - What really happens when you “browse the web”?
   - TCP/IP, DNS, HTTP, NAT, VPNs, 802.11 etc.
3. Understand how and why of Internet design
   - SDN, Load Balancers, Architectures

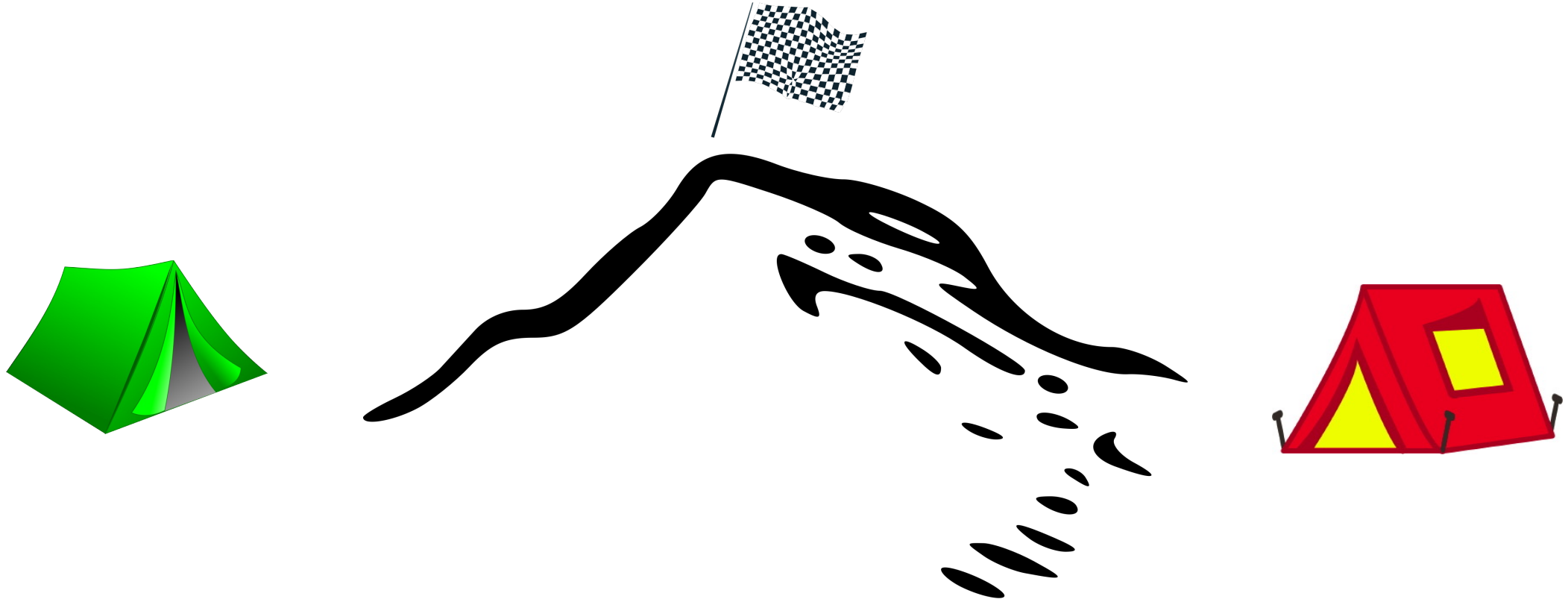
Why learn the fundamentals?

Intellectual interest

Reinvention, broad applicability

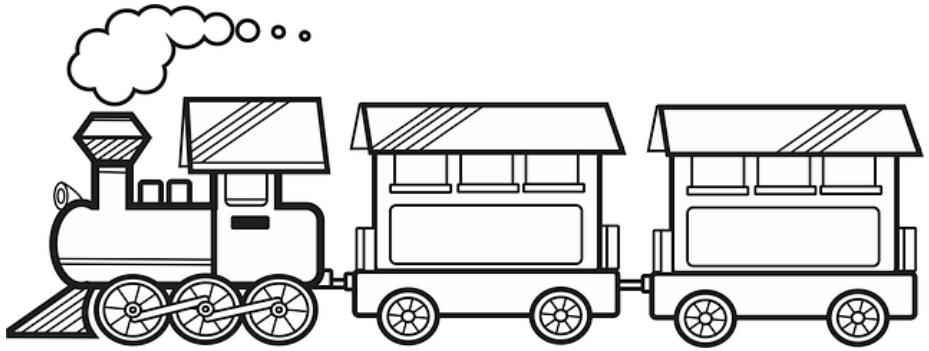
- Non-Internet networks
- Changing Internet

Fundamentals - Reliable communication



Fundamentals – Channel throughput

1 Gbps

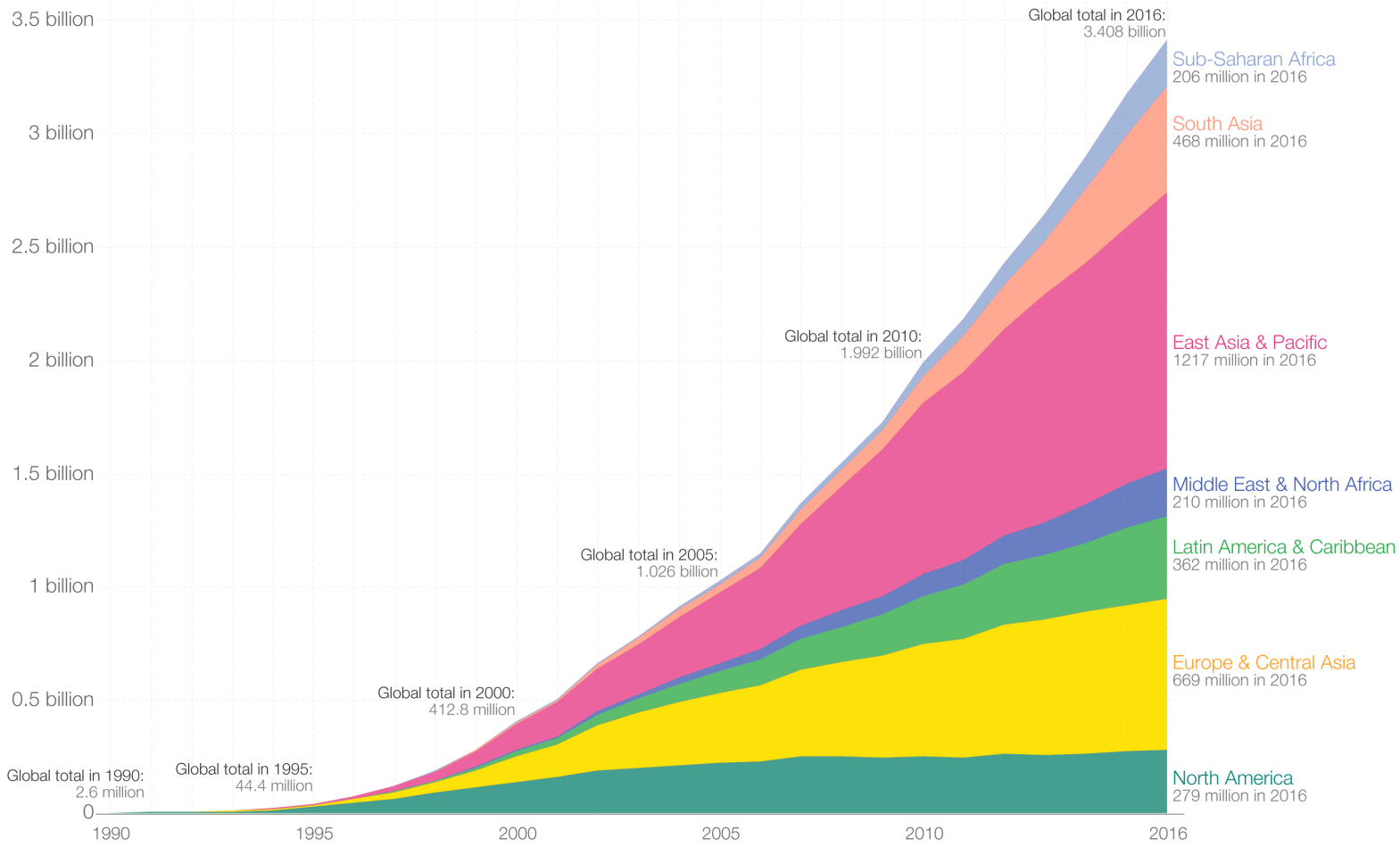


20ft container = 2,350,080 in^3 (240 x 96 x 102)
3.5in SSD = 23 in^3 (4 x 5.75 x 1)
SSDs / container = 50K (50% packing efficiency)
Container capacity = 25PB (512 GB per SSD)
Container speed = 100 mph
SEA <> NYC throughput = ~2000 Gbps

Fundamentals – Reinvention

- The Internet is constantly being re-invented!
  - Growth over time and technology trends drive upheavals in Internet design
- Today's Internet is different from yesterday's
  - And tomorrow's will be different again
  - But the fundamentals remain the same

Internet growth



Data source: Based on data from the World Bank and data from the International Telecommunications Union. Internet users are people with access to the worldwide network.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

Example upheavals

Change	**Enabling Technology**
Emergence of Web	Content Distribution Networks
Piracy	Peer-to-peer file sharing
Internet of Things	IPv6
Mobile Devices	Wireless, High bandwidth cellular
Cloud computing	Virtualization
Crypto currencies	Blockchains
….	….

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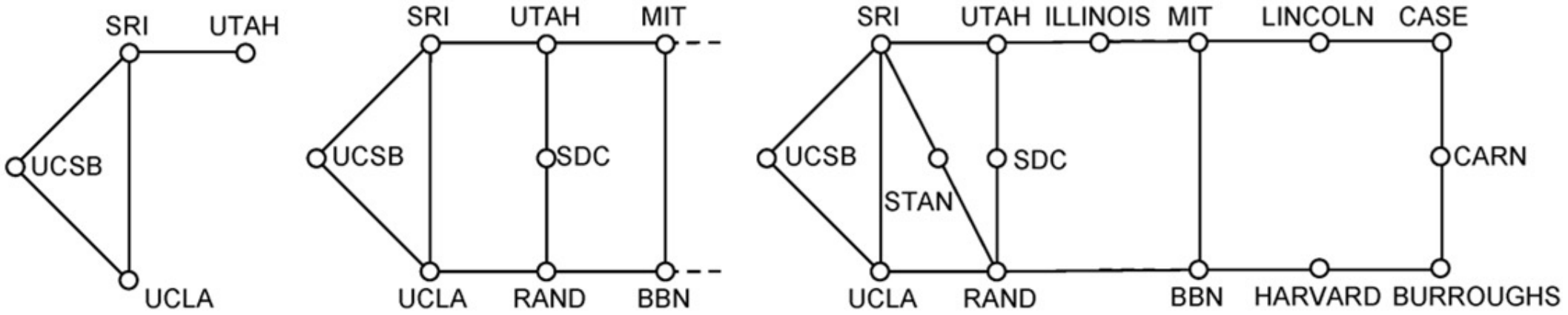
Who cares about the internet?

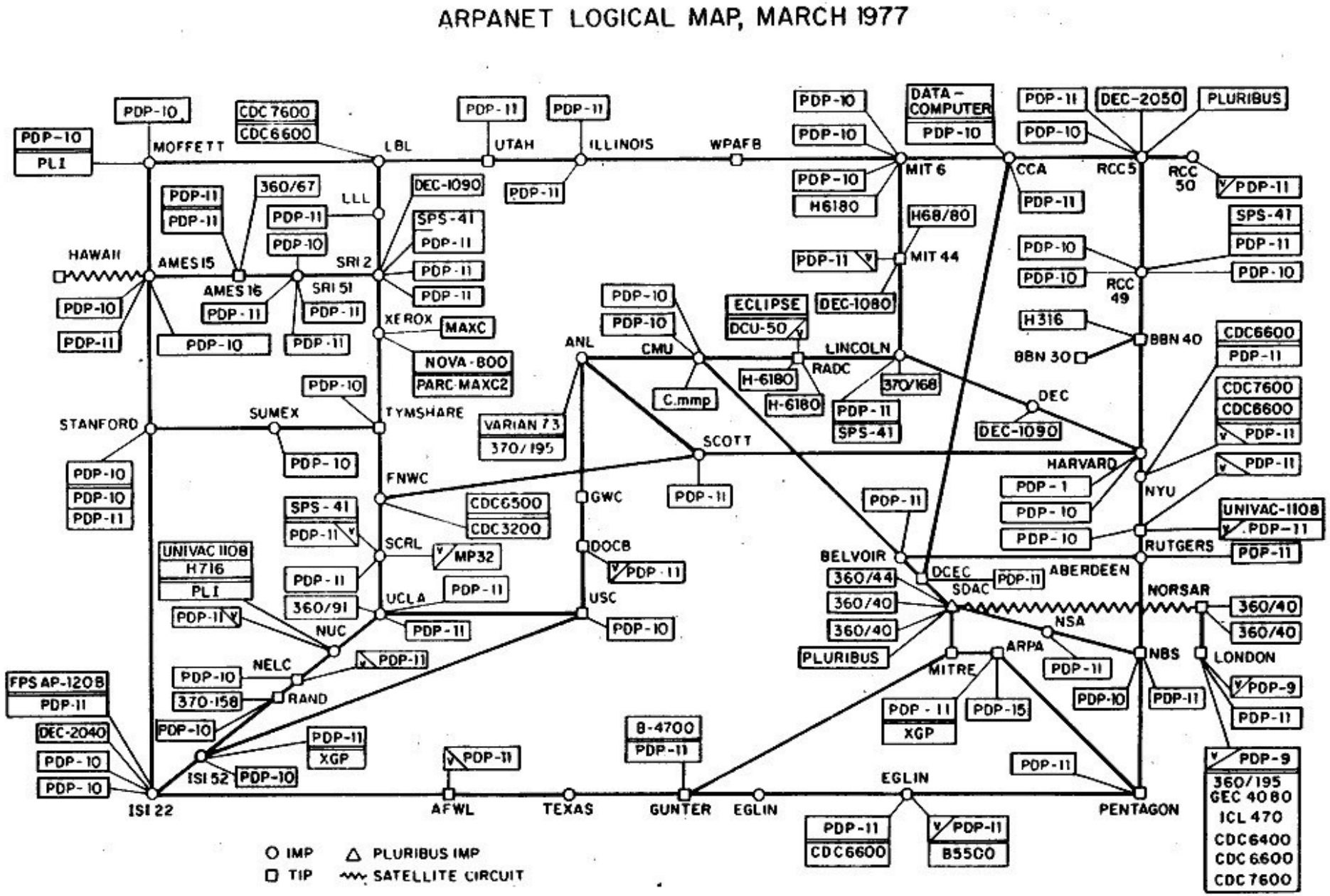
1. Curiosity
2. Impact on our world
3. Job prospects!

From this experimental network (~1970)…

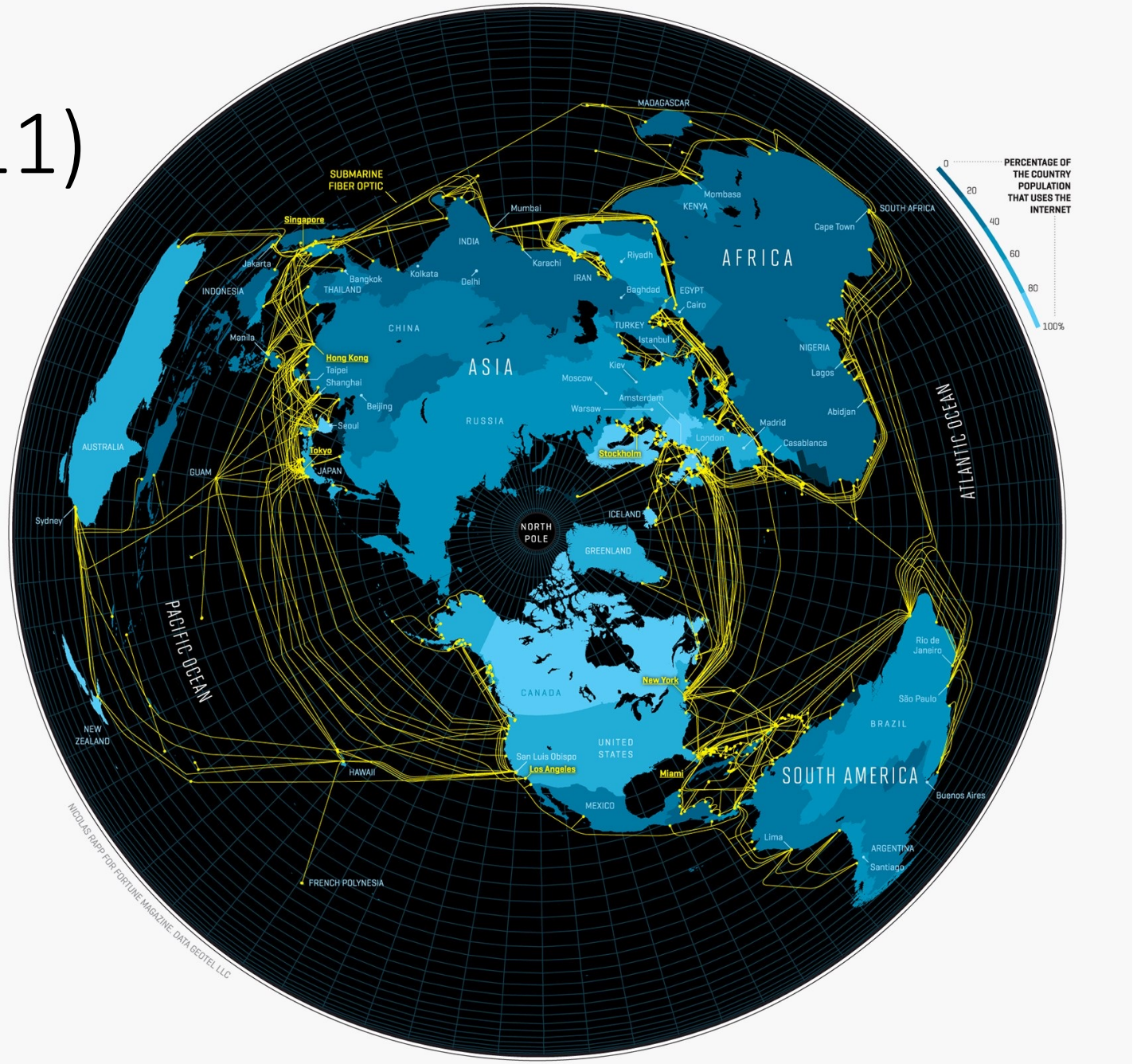


(a) Dec. 1969. (b) July 1970. (c) March 1971.

To this…

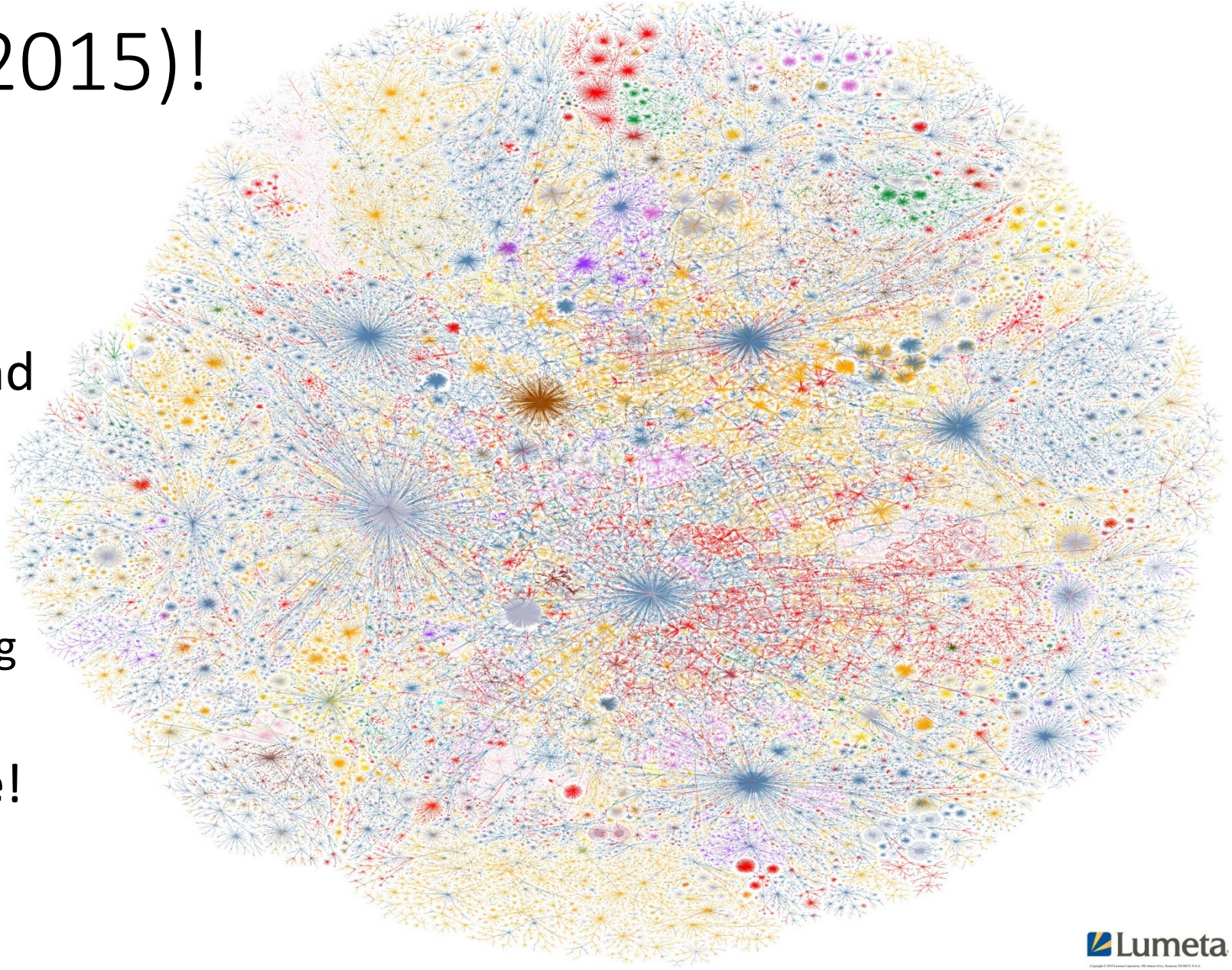

ARPANET LOGICAL MAP, MARCH 1977
MOFFETT
LBL
UTAH
ILLINOIS
WPAFB
MIT 6
CCA
RCC 5
RCC 50
HAWAII
AMES 15
AMES 16
SRI 2
SRI 51
LLL
XEROX
MAXC
NOVA-800
PARC-MAXC2
ANL
CMU
C.mmp
ECLIPSE
DCU-50
LINCOLN
RADC
MIT 44
H68/80
DEC-1080
H316
BBN 40
BBN 30
RCC 49
STANFORD
SUMEX
TYMSHARE
VARIAN 73
370/195
SCOTT
DEC
DEC-1090
HARVARD
NYU
RUTGERS
FNWC
SCRL
MP32
GWC
DOCB
CDC6500
CDC3200
UNIVAC 1108
H716
PLI
UCLA
USC
NUC
NELC
RAND
BELVOIR
DCEC
SDAC
ABERDEEN
NORSAR
NSA
ARPA
MITRE
NBS
LONDON
PLURIBUS
XGP
FPSAP-120B
DEC-2040
ISI 22
ISI 52
AFWL
TEXAS
GUNTER
EGLIN
PENTAGON
B-4700
B5500
CDC6600
360/195
GEC 4080
ICL 470
CDC6400
CDC 6600
CDC 7600
O IMP
△ PLURIBUS IMP
□ TIP
SATELLITE CIRCUIT
(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

To this! (2011)


SUBMARINE FIBER OPTIC
PERCENTAGE OF THE COUNTRY POPULATION THAT USES THE INTERNET
0
20
40
60
80
100%
MADAGASCAR
Mombasa
KENYA
SOUTH AFRICA
Cape Town
AFRICA
Singapore
Mumbai
INDIA
Karachi
Riyadh
IRAN
Jakarta
Bangkok
THAILAND
Kolkata
Delhi
Baghdad
EGYPT
Cairo
INDONESIA
CHINA
TURKEY
Istanbul
Manila
Hong Kong
Taipei
Shanghai
ASIA
Kiev
NIGERIA
Lagos
Moscow
Amsterdam
Beijing
Warsaw
Abidjan
RUSSIA
Madrid
Seoul
London
Casablanca
AUSTRALIA
Tokyo
Stockholm
JAPAN
GUAM
ATLANTIC OCEAN
ICELAND
Sydney
NORTH POLE
GREENLAND
PACIFIC OCEAN
Rio de Janeiro
New York
CANADA
São Paulo
BRAZIL
NEW ZEALAND
UNITED STATES
San Luis Obispo
Los Angeles
Miami
HAWAII
SOUTH AMERICA
Buenos Aires
MEXICO
Lima
ARGENTINA
Santiago
FRENCH POLYNESIA
NICOLAS RAPP FOR FORTUNE MAGAZINE. DATA GEOTEL LLC

And this (2015)!

- An everyday institution used at work, home, and on-the-go
- Visualization contains millions of servers
  - Red = .com, Yellow= .org
- Network now contains literally 3 billion **people**!



Lumeta

Internet – Societal Impact

- An enabler of societal change
  - Easy access to knowledge
  - Electronic commerce
  - Personal relationships
  - Private communications

Internet – Economic impact

- An engine of economic growth
  - Information sources
    - And lots of ethical questions!
  - Online marketplaces
  - Social media/Crowdsourcing

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Architectures

Lots of ways to build networks with different **tradeoffs**

- Internet -- open access
  - Flexibility++, Privacy++, Security--
- Cellular -- identity first
  - Flexibility--, Privacy --, Security++,

"On the Internet, nobody knows you're a dog."

Not a Course Goal

To learn IT job skills

- How to configure specific equipment or technologies
  - e.g., Cisco certifications,
  - Technical whack-a-mole
- But course material is relevant, and we use hands-on tools
  - Hopefully you'll be able to use these tools to build stuff at the end of class

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Questions?

Class Structure

Grading

Assignments: 10%

- Reading and homework from the book

Grading

Assignments: 10%

In-class Quizzes: 5%

- Short quizzes during the quarter
- Drop lowest

Grading

Assignments: 10%

In-class Quizzes: 10%

3 Projects: (15 + 15 + 15)%

- 3 coding exercises:
  - Socket programming
  - Link and Network layer behavior
  - Buffer bloat

Grading

Assignments: 10%

In-class Quizzes: 5%

3 Projects: (15 + 15 + 15)%

Midterm: 15%

Final: 20%

Participation: 5%

Grading

Assignments: 10%
In-class Quizzes: 5%
3 Projects: (15 + 15 + 15)%
Midterm: 15%
Final: 20%
Participation: 5%

Late Policy:

- 10% penalty for each late day
- Each **person** gets three late days

Administrivia

- Office hours
  - Opportunity to have more personal interactions with course staff.
- Tools
  - Canvas: Assignments, quizzes, and projects
  - ed discussion: Back and forth discussions on class content, announcements
  - Canvas Gradebook: Grades will be posted here
- Slides
  - Adapted from Kurtis Heimerl, who adapted from David Wetherall
  - I will be posting my own slides online

Questions?