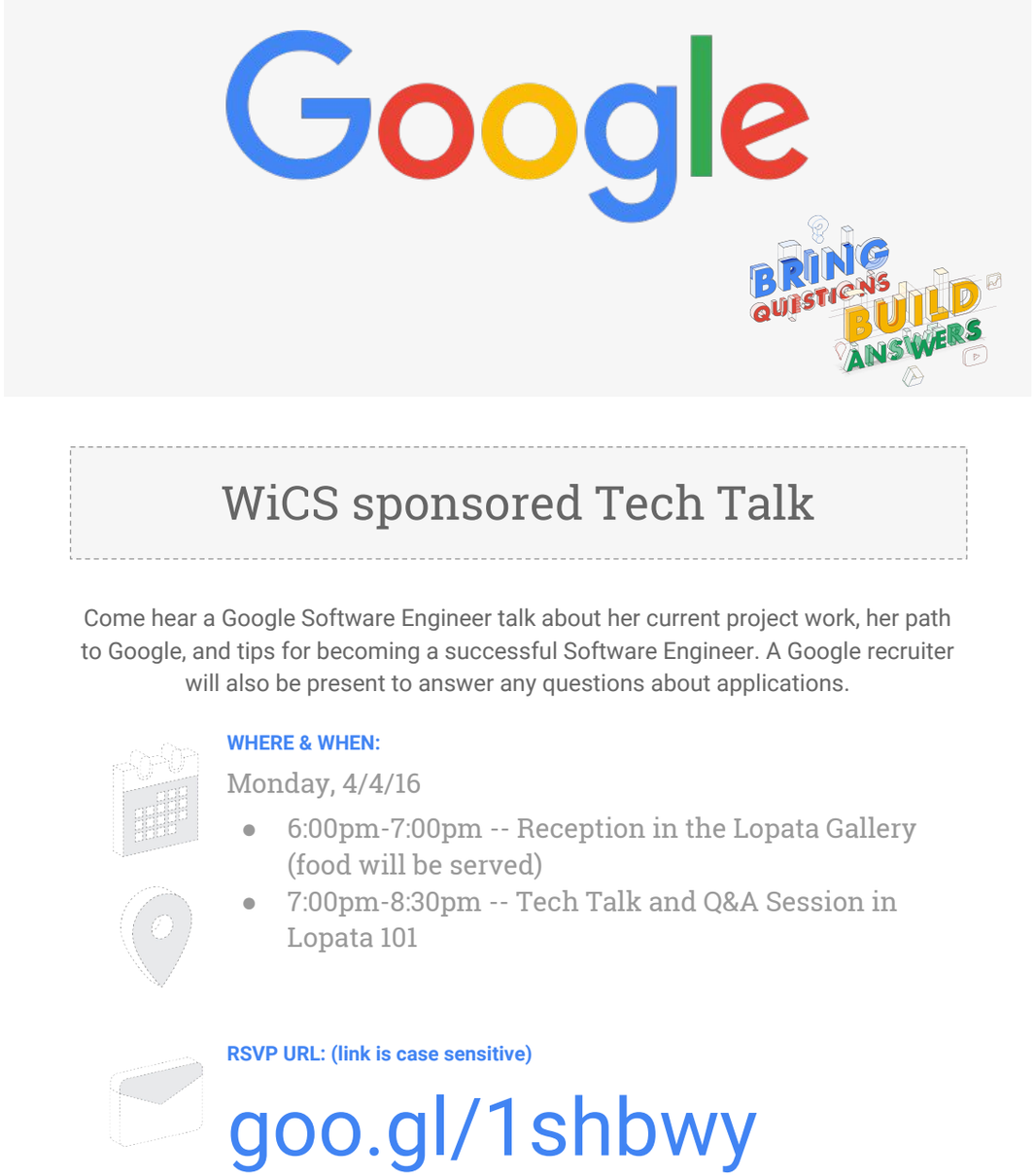
Network Programming

CSE 132 Spring 2016

Announcement

- WiCS is sponsoring a tech talk from HER perspective on Monday, 4/4/2016 (Tonight!)

- Everyone is invited



Agenda

- Networking protocols
    - Network Layer
    - Transport Layer
- How the Internet is addressed
- Domain Name System
- Ports
- Sockets
- What time is it?
- **Note**: You will be tested on this material on a quiz and on the final exam

Networking Protocols: IP

- Internet Protocol (IP)
  - Transmits *datagrams*
    - A datagram is a packet of data sent over the network whose arrival, arrival time, and content is not guaranteed.
  - This is called *best-effort delivery*, the same approach the USPS uses for letters.
  - *Out-of-order delivery* can occur. This is the delivery of datagrams in a different order from which they were sent.
    - This can be caused by the datagrams following multiple paths through the network.

Addressing the Internet

- Internet Protocol (IP) has “unique” ID for each machine on the network called an *IP address*

- IPv4 uses 32-bit (4-byte) address that is written as follows:

  a.b.c.d

  - where a, b, c, and d represent bytes with values between 0 and 255:

    128.252.165.10

- IPv6 uses 128-bit addresses for greater addressing range. This standard is becoming more popular but is still is used by less than 1% of networks.

An IPv4 address (dotted-decimal notation)

172 . 16 . 254 . 1

10101100 .00010000 .11111110 .00000001

One byte = Eight bits

Thirty-two bits (4 x 8), or 4 bytes

Domain Name System

- The Domain Name System is a network of computers that store records mapping domain names (like www.google.com) to IP address (like 212.179.154.216).
- Your computer automatically selects a server that provides this system and queries it any time you access a site you don't know the IP of. A complex system of caches means that DNS records can be traced back to a few central servers.

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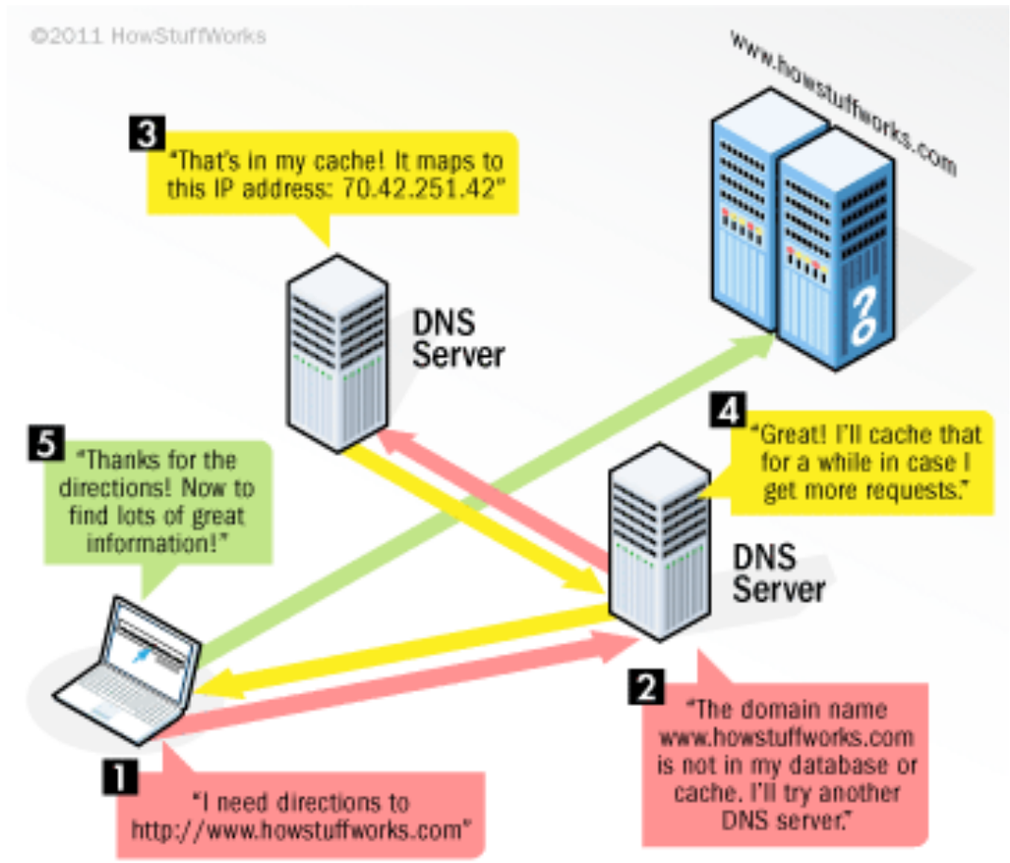

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- For “fun”: http://mxtoolbox.com/DNSLookup.aspx

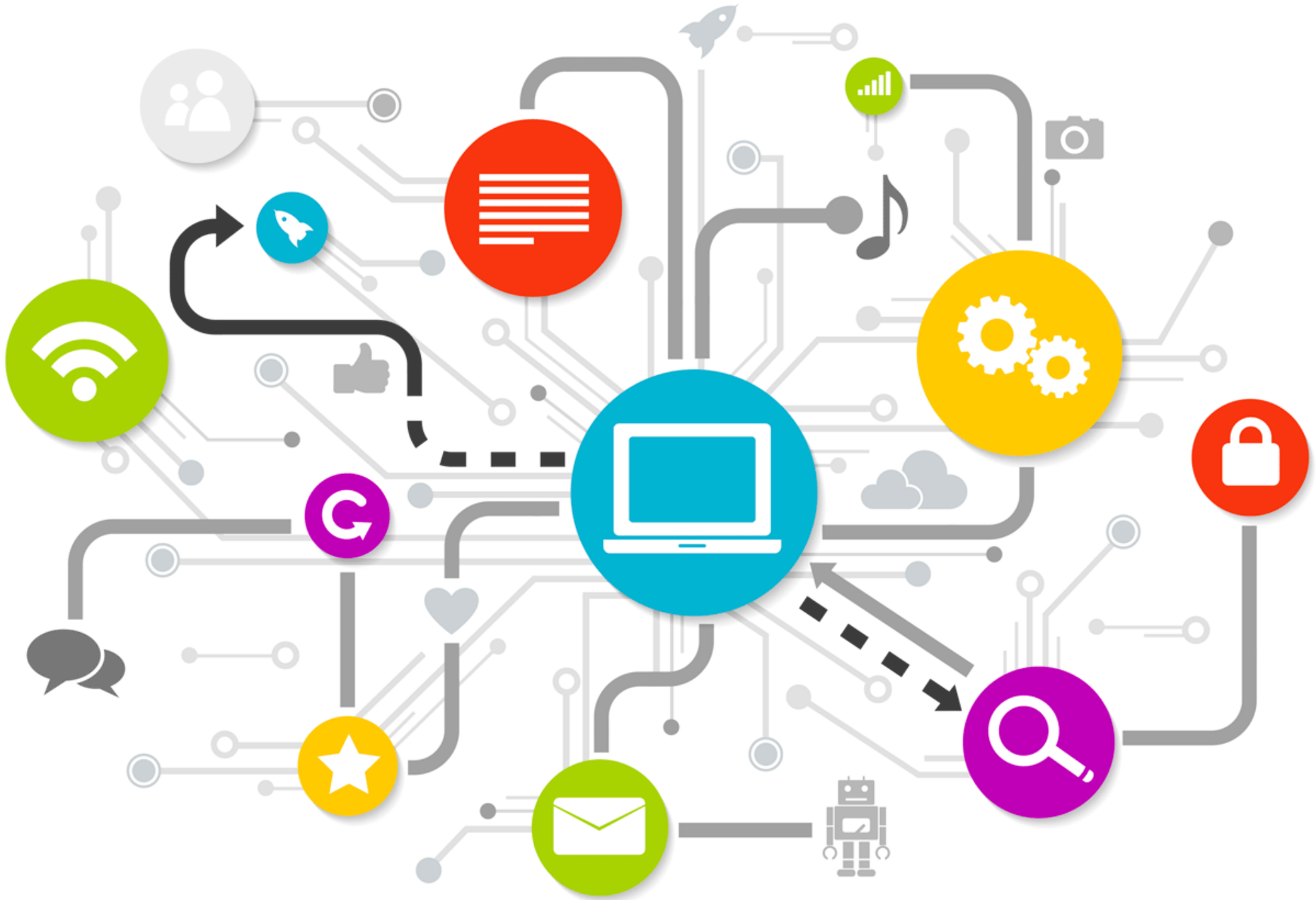
- Also for “fun”: Google “IP address” to see yours

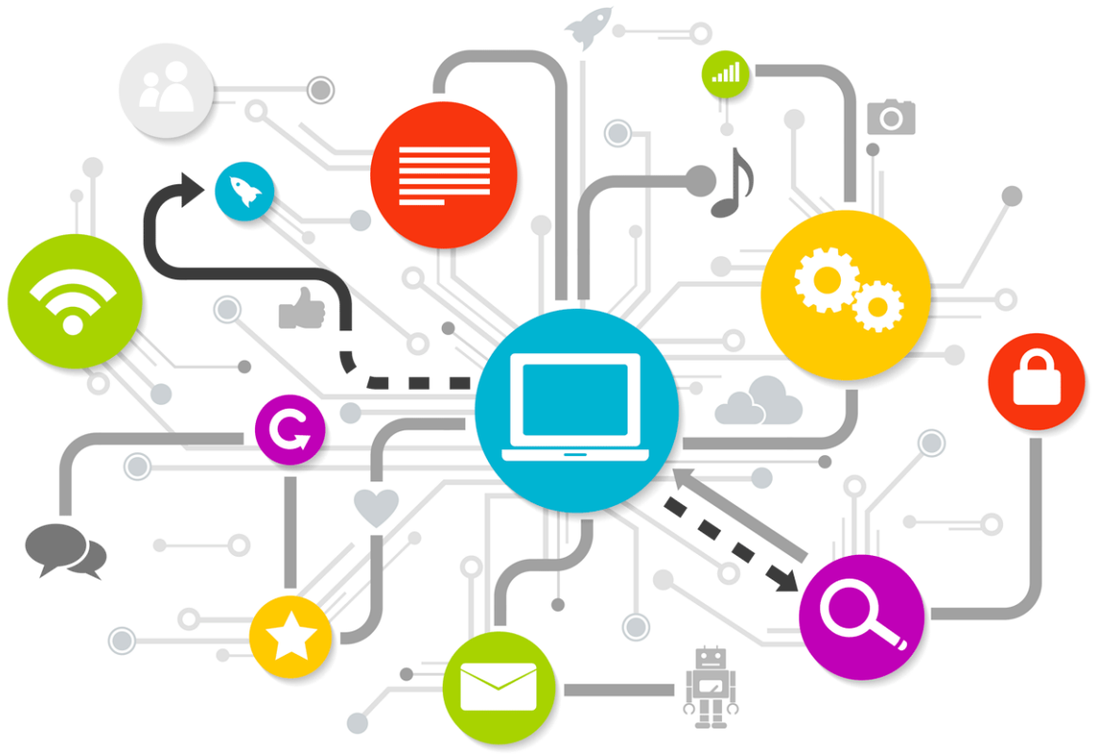
Networking Protocols: UDP

- User Datagram Protocol
  - UDP determines how to break application data into *packets* that networks can deliver and sends packets to and accepts packets from the *network layer* (IP). UDP, along with TCP, make up the *transport layer.*
- UDP provides two services not provided by the network layer (IP).
  - Port numbers to help distinguish different user requests
  - Optionally, a checksum capability to verify that the data arrived intact.
- It is used primarily for establishing low-latency and loss tolerating connections between applications on the Internet. UDP is an ideal protocol for network applications in which perceived latency is critical such as gaming, voice and video communications.

Networking Protocols: TCP

- Transmission Control Protocol is an alternative communications protocol to UDP.
  - TCP also determines how to break application data into *packets* that networks can deliver and sends packets to and accepts packets from the *network layer* (IP).
  - TCP detects the problems that are possible with IP (lost and out-of-order *datagrams*)
    - Requests retransmission of lost data
    - Rearranges out-of-order data (using sequence numbers)
    - It even helps minimize network congestion to reduce the occurrence of the other problems.





TCP/UDP breaks messages up into packets

IP tells the packets where to go. Each internet-connected device has an IP address

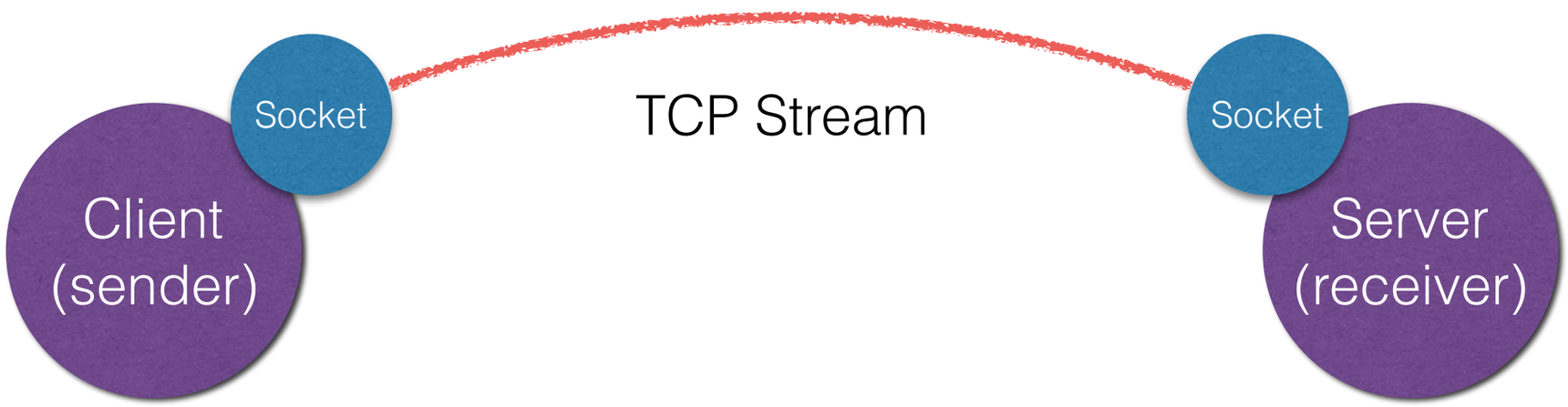
TCP/UDP reassembles the packets back into the original data

Ports

- A *port number* is a way to identify a specific process to which an Internet or other network message is to be forwarded when it arrives at a server.
- For TCP and the UDP, a port number is a 16-bit integer that is put in the header appended to a datagram.
- To transfer data to a port, you open a *socket* in your code.
- Analogy:
  - An IP address is the street address of the building.
  - A port number is an apartment number.
  - A socket is the door of an apartment.

Sockets

- The code-accessible connection between two computers is called a socket
- They are the stream abstraction for network communication
- Once established, you can use stream wrappers as with file I/O



Time Socket

- We’re going to use the National Institute of Standards and Technology (NIST)

- Internet Time Service (ITS)
  - time.nist.gov (and many other servers)

- Multiple protocols for reporting time
  - We’ll use the “DAYTIME” (RFC-867) protocol because it is provides more information.

“DAYTIME” (RFC-867)

- We need to open a socket to port 13 (as specified by the ITS)
- The server will respond with an ASCII string
- JJJJJ YR-MO-DA HH:MM:SS TT L H msADV UTC(NIST) OTM
  - JJJJJ is modified Julian date (started 17-Nov-1858)
  - YR-MO-DA and HH:MM:SS are what you expect
  - Daylight saving time code (50 in summer)
  - L Leap second coming, H health digit: 0=good
  - msADV milliseconds adjust for network delay
  - UTC(NIST) coordinated universal time
  - OTM on time marker

Time Demo

Logistics

- Today (Monday):
    - Attendance in studio is not required. The labs will be staffed with TAs to help you with your protocol lab.
- Tuesday:
    - Afternoon/Evening TA hours are **cancelled** because of the CSE 247 exam. This includes these sessions:
        - 4:00-6:30, 6:00-8:00, and 8:00-10:00 pm
- Wednesday:
    - Nothing is due. Again, labs will be staffed with TAs to help you with your protocol lab which is due a week from Wednesday.
- Grades:
    - Assignments 1-4, Studios 0-10, and Quizzes 1-3 should all be posted to BB by Wednesday afternoon. If you have any questions, please send me a private post on Piazza.