POGIL-CSP: Internet III: What is an Address?

(15 min) A. Identification

start time:

1. In the US, every citizen has a unique **Social Security Number (SSN)**.

Historically, the first 3 digits are the **area number**, for the local Social Security Office, the next 2 digits are the **group number**, and the last 4 digits are the **Serial Numbe**r. Consider this sample SSN: 987-65-4321 (reserved for advertising). What is the:

|  |  |  |
| --- | --- | --- |
| a. | area number? |  |
| b. | group number? |  |
| c. | serial number? |  |

# INFORMATION

Similarly, on the Internet, every device (including laptops, phones, routers, etc) has a unique **Media Access Control (MAC) address**. Each MAC address is

**48 bits**, so there are 248 = 281,474,976,710,656 (≈ 280 x 1012) possible addresses, usually written as 6 pairs of **hexadecimal digits** (0-9,A-F):

00:21:5C:98:FD:19

The first 3 pairs are the **Organizationally Unique Identifier (OUI)**, assigned to a device manfacturer, which then assigns MAC addresses to individual devices.

00:00:00 Xerox Corporation 00:21:1B Cisco Systems, Inc. 00:00:0C Cisco Systems, Inc. 00:21:5C Intel Corporate 00:00:6D Cray Communications, Ltd. 00:21:70 Dell Inc.

1. For MAC address 00:21:5C:98:FD:19, what is the OUI and the organization?
2. If you have Internet access, choose several devices from different manufacturers, try to find their MAC addresses, and look up their OUIs online.

(You could use [http://www.macvendors.com](http://www.macvendors.com/) or [http://www.macaddresslookup.org](http://www.macaddresslookup.org/)). What do you find? Describe any surprises.

1. Does a person’s SSN or a device’s MAC address tell us where they are right now or how to reach them? Explain.
2. Different techniques are used to represent **locations**. For example, many countries assign unique labels to locations with **postal codes** (e.g. the US ZIP code, for Zone Improvement Plan). How might postal codes improve mail delivery?
3. Why are **longer** postal codes (e.g. 9 digits rather than 5 digit) better?

(15 min) B. Location

start time:

On the Internet, most devices have a MAC address (assigned by the manufacturer), and an **Internet Protocol (IP) address** (assigned by location).

In IP version 4 (IPv4, introduced in 1980), each address is 32 bits, so there are 232 = 4,294,967,296 (≈ 4x109) possible IPv4 addresses. An IP address is written

as a **dotted quad** - 4 numbers (each from 1-255) separated by dots. For example: 192.168.1.1

Usually an **Internet service provider** (ISP) receives a range of IP addresses which start with a common bit sequence, and then assigns values or subranges to its clients. For example, the 255 addresses starting with 192.168.1 are for private networks.

1. If you have Internet access, choose several devices from different manufacturers, and try to find their IP addresses. What do you find? Are they on the same networks? Describe any surprises.
2. In 2014 there were 7,000,000,000 (7x109) people in the world (although not all have Internet devices). What do you think people mean by **IPv4 address exhaustion**?
3. **Internet Protocol version 6 (IPv6)** will replace IPv4. Each IPv6 address is 128 bits, so there are 2128 = 340,282,366,920,938,463,463,374,607,431,768,211,456 (≈ 3x1038) possible values. Will this prevent address exhaustion?
4. The number of different Internet devices continues to grow.

**Individually**, choose a device that costs $100-$1000 and list 3 benefits of connecting it to the Internet. (For example: TV, printer, refrigerator, washer/dryer) **As a team**, share your most interesting or unusual ideas.

1. As costs decrease, the number will increase further.

**Individually**, choose a device that costs $1-$10 and list 3 benefits of connecting it to the Internet. (For example: light switch, coffee mug, sandals) **As a team**, share your most interesting or unusual ideas.

(If you have any brilliant ideas, file patents and start a business.)

1. Some people predict that by 2020 there will be 50x109 Internet devices. What do you think people mean by the **Internet of Things**?

(5 min) C. Postal Addresses

start time:

|  |  |
| --- | --- |
| Head Groundskeeper Taj Mahal  Agra, Utter Pradesh 282001, India | Manager, Sydney Opera House Bennelong Point,  Sydney NSW 2000, Australia |
| President, International Court of Justice Peace Palace  2517 KJ The Hague, The Netherlands | The President  1600 Pennsylvania Ave, Washington DC, USA 20500 |

1. Postal codes and IP addresses help computers manage locations and routing, but people generally prefer things that are easier to remember and understand. For example, most countries have similar conventions for postal addresses.

List parts **common** to most postal addresses (e.g. postal code).



1. If you send postal mail to a friend in another country, which parts of the address are:

|  |  |  |
| --- | --- | --- |
| a. | **most useful** to **your** local post office? |  |
| b. | **least useful** to your local post office? |  |
| c. | **most useful** to **your friend’s** local post office? |  |

1. Explain why every post office only needs to understand some parts of every address.

(10 min) D. Domain Names

start time:

|  |  |  |
| --- | --- | --- |
| [www.google.com](http://www.google.com/) [www.google.co.uk](http://www.google.co.uk/) [www.google.co.jp](http://www.google.co.jp/) | craigslist.org wikipedia.org 360.cn | cs.stanford.edu chemistry.stanford.edu [www.ox.ac.uk](http://www.ox.ac.uk/) |

The **Domain Name System** (DNS) keeps track of a unique name (and IP address) for Internet devices. Some **domain names** are shown above. Domain names have

parts (called **labels**), separated by dots. The **most general** labels (similar to countries) are called **top-level domains** (TLDs). Once there were 7 TLDs; now there are many.

Each TLD is subdivided into **second-level domains** (SLDs), and further subdomains. The most specific label (e.g. “www”) is often (not always) for a specific computer.

1. List the TLDs used in the table above.

# INFORMATION

DNS is like a phone directory - we can look up a domain name to find its IP address, and vice versa. (Actually, DNS keeps track of much, much, more data.)

DNS lookup results can contain several types of records. For example:

* + an **address** (A) record lists the IP address for a domain.
  + a **mailserver** (MX) record lists a server that can receive mail for a domain.
  + a **nameserver** (NS) record lists a server with current information for a domain.

**Domain Type TTL**

wikipedia.org. NS 86400

wikipedia.org. NS 86400

wikipedia.org. NS 86400

wikipedia.org. A 3600

**Answer**

ns0.wikimedia.org. ns1.wikimedia.org. ns2.wikimedia.org. 208.80.154.224

1. A **DNS lookup** for the domain **wikipedia.org** returns the info above.

|  |  |  |
| --- | --- | --- |
| a. | How many nameservers have info about wikipedia.org? |  |
| b. | What is the IP address for wikipedia.org? |  |

IP Location: United States San Francisco

Wikimedia Foundation Inc.

Whois Server: whois.arin.net IP Address: 208.80.154.224

Reverse IP: 14 websites use this address. Comment: [http://www.wikimediafoundation.org](http://www.wikimediafoundation.org/) RegDate: 2007-07-23

Updated: 2014-01-29

OrgName:

OrgId: Address: Address: City: StateProv: PostalCode: Country:

Wikimedia Foundation Inc.

WIKIM

149

3rd San CA

New Montgomery Street

Floor Francisco

94105

US

1. A **reverse DNS lookup** for IP address **208.80.154.224** returns the info above:

|  |  |  |
| --- | --- | --- |
| a. | How many other websites use the same IP address? |  |
| b. | When was this information last updated? |  |

1. If you have Internet access, do a **DNS lookup** on a domain name,

and do a **reverse lookup** (sometimes labeled with **pointer** or PTR) on an IP address. Describe what you find.

(5 min) E. Conclusions

start time:

Like the postal system, DNS is **distributed** and **hierarchical** -

information is spread out, but in ways that it can be found and used effectively. Every Internet device can contact a local DNS server it can ask for information. Every DNS server can contact the server for each TLD,

and each TLD server can contact the server for each of its SLDs.

1. Why might Amazon or Google or Wikipedia have many computers use the same domain name? Hint: could one computer handle all of the traffic?
2. Why might a small organization have several names for the same computer? (e.g. www.example.com, mail.example.com, ftp.example.com)

Hint: Suppose the organization expects to grow?

1. Does every Internet device need a DNS name? Why or why not?