(http://csmatters.org)   3 - 4

0b11 - 0b100

How the Internet Works: Domain Name System

Unit 3. Information and the Internet

Revision Date: Jul 22, 2019
Duration: 1 50-minute session

Lesson Summary

Pre-lesson Preparation

Students must complete the pre-reading assignment: Blown to Bits (pages 303 - 306 in the PDF). They should read the sections about DNS, Protocols, and IP Addresses.

Summary

The purpose of the Domain Name System is to resolve domain names to IP address for computers on the Internet.

For the next two lessons, students will investigate the workings of the Domain Name System (DNS). They will then design and enact a simulation of DNS. Students will use their simulation to request and receive web pages, implement DNS caching, and investigate DNS poisoning.

Outcomes

- Explain the abstractions in the Internet and how DNS supports Internet functions.
- Explain the hierarchical characteristics of DNS.
- Explain how IPv4 and IPv6 addressing are used to identify and connect computers on the Internet.

Overview

Session 1 - Introduce DNS

1. Lesson Introduction (5 min) - Introduce DNS.
2. Guided Activity (40 min) - Students investigate elements of DNS and sketch its components.
3. Closing (5 min) - Watch improvisation video.

Session 2 - Create DNS Improvisation

1. Introduce Simulation/Improvisation (5 min).
2. Guided Activity (40 min) - The roles and scripts for the next lesson's activity are set up.

3. Closing (5 min) - Journaling about the characteristics of DNS and the Internet.

Learning Objectives

CSP Objectives

- *EU CRD-1 - Incorporating multiple perspectives through collaboration improves computing innovations as they are developed.*
  - LO CRD-1.A - Explain how computing innovations are improved through collaboration.

- *EU CRD-2 - Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.*
  - LO CRD-2.A - Describe the purpose of a computing innovation.

- *EU CSN-1 - Computer systems and networks facilitate how data are transferred.*
  - LO CSN-1.A - Explain how computing devices work together in a network.
  - LO CSN-1.B - Explain how the Internet works.
  - LO CSN-1.C - Explain how data are sent through the Internet via packets.
  - LO CSN-1.D - Describe the differences between the Internet and the World Wide Web.

Math Common Core Practice:

- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.

Common Core ELA:

- RST 12.2 - Determine central ideas and conclusions in the text
- RST 12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases
- RST 12.10 - Read and comprehend science/technical texts
- WHST 12.6 - Use technology, including the Internet, to produce, publish, and update writing products
- WHST 12.9 - Draw evidence from informational texts to support analysis, reflection, and research

NGSS Practices:

- 1. Asking questions (for science) and defining problems (for engineering)
- 2. Developing and using models
- 3. Planning and carrying out investigations

Key Concepts

Students describe characteristics of the Internet that influence the systems built on it.

Students explain how computers can be used to get a web page from a new web server.

Students work as part of a collaborative group using effective communication to accomplish a task.

Essential Questions

- What is the Internet, how is it built, and how does it function?
- What aspects of the Internet's design and development have helped it scale and flourish?

Teacher Resources

Student computer usage for this lesson is: **required**

Blown to Bits (either electronic or hard copy)

- http://www.bitsbook.com/excerpts/ (http://www.bitsbook.com/excerpts/)

Access to the Internet for these sites:

- https://www.youtube.com/watch?v=72snZctFFtA (https://www.youtube.com/watch?v=72snZctFFtA)
- http://computer.howstuffworks.com/dns2.htm (http://computer.howstuffworks.com/dns2.htm)
- http://pingtool.org (http://pingtool.org) or use the command line prompt.

Excel or similar software

"DNSWorksheet" document and "Favorite Domains (Sample List)" spreadsheet in lesson resources folder

Addtional Resources

https://studio.code.org/s/netsim (https://studio.code.org/s/netsim) Code Studio Internet Simulator

Student friendly explanation of DNS https://studio.code.org/s/netsim (https://studio.code.org/s/netsim)

Lesson Plan

Session 1 - DNS Introduction

Getting Started (5 min) - Introduction of DNS

1. Students will watch this video https://www.youtube.com/watch?v=72snZctFFtA (https://www.youtube.com/watch?v=72snZctFFtA) from 0:47 to 3:22 to introduce the function of DNS.

2. Students should consider the video and the pre-lesson reading to answer the following question: "What is the purpose of the Domain Name System?"
3. After the students have finished journaling, the teacher should give these explanations to clarify DNS and further set up the lesson:
    - The purpose of DNS is to resolve domain names to IP address for computers on the Internet.
    - Our purpose as a class is to understand what DNS means, how it works, what benefits it provides, and some challenges it faces.

Guided Activity (40 min)

Part 1 (30 min) - Investigation

Version 1 - If students have access to the system console window, use it to complete the following steps.

Directions for Host Configuration and DNS in Action Using the Console Window:

1. Console Based Use: (cmd prompt)
2. Find your host's IP address: (ipconfig)
3. Find the IP address of the default gateway (ipconfig)
4. Find the physical address of the default gateway (arp –a)
5. Resolve domain names: (nslookup)
    - google.com
    - umbc.edu
    - domain.name
6. Domain names recently resolved: View the HOST DNS cache (ipconfig /displaydns)
7. Unknown domain names: Find the IP address of the local DNS server: (ipconfig /all)

Version 2 - If the Console is blocked for your students, you can still demonstrate most of the console commands on your computer. If it is blocked for you as well, use a web site such as http://pingtool.org (http://pingtool.org) and the prompts below.

Note: If the Console is blocked, students will need a way to obtain unique IP addresses. A document named "DHCP Simulator" (in the lesson folder) contains 30 unique IP formatted addresses. Print and cut out the blocks and allow a student dubbed DHCP to give them out at random.

Directions for Host Configuration and DNS in Action Activity Without the Console Window:

1. Find your host's IP address: (just search for get ip address). Survey student results and explain that the values are the often the same because the network uses one computer to make connection outside the local network.
2. Watch the first 40 seconds of DNS Cache Poisoning (https://www.youtube.com/watch?v=1d1tUefYn4U (https://www.youtube.com/watch?v=1d1tUefYn4U))
3. Use traceroute to find the number of routers (hops) involved in getting to apcsprinciples.org.
4. Resolve domain names: (nslookup)
    - google.com

- umbc.edu
- domain.name

5. Domain names already resolved: Copy the IP addresses to a browser's web address bar and visit two of the domains from number 4.
6. Unknown domain names: Review the traceroute results to each domain. What is the IP address of the default gateway?

During the investigation, students should answer the following questions in their journal:

Journal Questions for Version 1:

Students should attempt to answer these questions based on the previous activity:

1. How do you access a command prompt?
2. What console command do we use to find our IP address and the IP address of the default gateway?
3. How can we find the physical address of the default gateway?
4. How do Internet bound packets get to the default gateway?
5. How can we look up (resolve) unknown IP addresses from the console?
6. How can we see a list of the domain names and IP address already resolved by our host computer?
7. How does your computer resolve unknown domain names into their addresses?
8. The number of devices that could use an IP address has grown so fast that a new protocol (IPv6) has been established to handle routing of many more devices. How do you think IP addresses have changed?

Suggested Answers

1. In Windows, click Start>run then type cmd.
2. At a console prompt, type ipconfig.
3. At a console prompt, arp -a.
4. IP packets are sent inside physically addressed frames.
5. Use nslookup followed by the domain name.
6. At a console prompt, ipconfig /displaydns
7. The computer obtains the IP address by requesting it from the local DNS server.
8. The world officially ran out of the 4.3 billion available IPv4 addresses in February 2011. Yet, hundreds of millions of people and devices are coming online. IPv6 is what will allow this, providing enough addresses (2^{128} to be exact) for everyone and all of their various devices. from the Internet Society http://www.internetsociety.org/what-we-do/internet-technology-matters/ipv6 (http://www.internetsociety.org/what-we-do/internet-technology-matters/ipv6))

Journal Questions for Version 2:

Students should attempt to answer these questions based on the previous activity:

1. The Console is just one tool that can be used to find a computer's actual IP address. How is the Console accessed on your computer at home, if you have one?
2. Why does pingtool.org (http://pingtool.org) not give us our real IP address?
3. What is the role of the local DNS server?
4. What is the purpose of the routers on the Internet?
5. Why did domain.name not resolve to an IP address?

6. What do we call the list of domain names and IP addresses already resolved by our host computer?
7. How does a computer resolve unknown domain names into their addresses?

Part 2 (5 min) - Video

1. Students will watch this video https://www.youtube.com/watch?v=72snZctFFtA (https://www.youtube.com/watch?v=72snZctFFtA) to show the function of DNS.
2. Give students a copy of the DNS worksheet.

Closing Activity (5 min) - Journal

Have students pick one or more of the following questions to answer in their journals:

- Just as the original Internet developers did, we are using a trust model - assuming everyone is cooperating. Why do you think we used a trust model?
- The Internet's end-to-end architecture makes connecting to it simple. Why do you think an end-to-end architecture encourages invention and innovation of Internet-based systems?

Optional Activities:

Diagram (10 min)

Put the following list of DNS and other devices on the board. As a class, students are to create a diagram of the way devices 1 – 5 interact to resolve domain names (similar to the last picture in the overview (http://www.edline.net/pages/North_Point_High_School/Classes/1415_14-15-P79060-001/Textbooks/7502160004216717474/DNS_Overview).) Have students draw the picture on the board and agree that it is correct before they write it in their journals.

1. Host
2. Local DNS
3. Root
4. Top Level Domain
5. Authoritative Name
6. *Web Server*
7. *Router*

All the world is a stage, and all the men and women merely players (55 minutes)

Getting Started/Introducing Activity (5 min)

The teacher will explain the following activity to the students:

1. We are going to simulate the function of DNS as used to obtain web pages on the Internet, creating a sort of improvisational play.
2. Just as the original developers did, we will use a trust model:
    - Assume everyone is cooperating.
    - Use an "end-to-end architecture" that keeps the center of our network as simple as possible.
    - **(Have students record both of these characteristics of the Internet in their journals.)**
3. Together with DNS, web servers, and Internet routers, students playing the role of each device will request, resolve, and deliver web pages.
4. Along the way, we will likely run into several problems and failures (learning opportunities). As we do, we will resolve them together and record our insights in our journals.

Show DNS explained (https://www.youtube.com/watch?v=72snZctFFtA (https://www.youtube.com/watch?v=72snZctFFtA)) 3:20 - 5:39.

Guided Activity (40 min) - Improvisation Activity

Part 1 (30 min) - DNS Device Roles

1. Have students watch "The Way of Improvisation" https://www.youtube.com/watch?v=MUO-pWJ0riQ (https://www.youtube.com/watch?v=MUO-pWJ0riQ)
2. In small "author" groups, have students prepare scripts for students who will play a device.
    - Each group creates a card or page for their device.
        - One side of the page contains the device name and an explanation of its role. (The explanation is to be brief – fewer than 25 words but enough to give a non-expert the general idea of the role of the device.)
        - The other side of the paper contains a more detailed explanation of the service the device provides, including the devices with which it communicates, a list of the data required for the server to function, and an explanation of how the data is initially acquired.
3. Each group should print one draft copy of their scripts. Students share (rotate) their device scripts with another group.
4. Each group makes constructive criticisms and returns scripts to their authors. (If time permits, you may want to repeat this round.) Review groupwork norms that encourage respect of multiple perspectives.
5. "Author" groups make revisions and print 4 copies of each device page. (Use front and back of the paper if possible.)
6. Collect these and keep them sorted by device.

Part 2 (10 min) - Web Servers

Teachers will explain that the Internet is much bigger than the Web, but for our simulation purposes, we will only be trying to access web pages from web servers.

1. Depending on the size of the class, pick two or three domain names to simulate, such as .com and .net. Select two domains from each top-level domain. (For instance, for .com, you might select google.com and amazon.com.)
2. Divide the class into groups such as the "google group", the "amazon group", and the other subdomains selected.

3. Each student in each group finds a unique page from their second-level domain and prints two copies of the first page of the web page each student selects.
4. Have students write a one-word title for their page on the top of the paper and submit it to you, placing the pages in piles by subdomain.

Options for Differentiated Instruction

When pairing up students in "Think - Pair - Share," use a random generator such as random.org (use list tool) to randomly pair students.

Evidence of Learning

Formative Assessment

Students create a list of things in their lives that are identified by unique numbers.

Summative Assessment

1. End to End Architecture 6.1.1B
A. Describe the "end to end" architecture of the Internet.
B. Explain how the "end to end" architecture facilitates connection of new devices.

2. Internet Names and Address Rules 6.1.1 E
A. Describe how computers are uniquely identified and connected on the Internet.

3. DNS Function 6.1.1 G
A. Briefly explain the primary use of the Domain Name System made by users of the Internet.

4. DNS Hierarchy 6.2.1 B
A. Describe the hierarchy of the Domain Name System.

(http://www.umbc.edu/) (http://www.umd.edu/)

(http://www.nsf.gov/)

Authored by: CS Matters in Maryland

Website: csmatters.org (http://csmatters.org)

Email: csmattersinmaryland@gmail.com (mailto:csmattersinmaryland@gmail.com)