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0b11 - 0b101

How the Internet Works: DNS Activity



Unit 3. Information and the Internet

Revision Date: Jan 04, 2020

Duration: 2 50-minute sessions

Lesson Summary

Pre-lesson Preparation

This lesson will require some room setup or prep for best delivery of instruction. Some of the setup should have been done in the previous lesson.

Summary

In this lesson, students will expand their knowledge of how the Domain Name System (DNS) works by acting as a class to simulate the use of DNS to retrieve web pages.

Once the simulation is functioning students enhance its efficiency through the use of caching.

Poison the DNS cache by adding false DNS replies (DNS poisoning).

Students discuss with their groups how DNS works and how it supports Internet growth.

Then they explain in their journals how:

DNS works

Caching is both a benefit and a security risk.

DNS supports Internet growth.

In this lesson, students will expand their knowledge of how DNS works by acting out a simulation of DNS in action and using it to retrieve web pages. This is a two-session lesson. The first session is for students to get the simulation functioning, with the teacher serving as director. As students realize they need to "fix" their implementation of the simulation (modify their scripts), they record the insights in their journals.

In Session Two, students take on different roles and conduct a dress rehearsal that is entirely student-led. Teachers then introduce DNS caching and DNS poisoning. Once the simulation is functioning, students will address both increased efficiency due to DNS caching, and cybersecurity concerns associated with DNS.

Outcomes

- Students will explore how the characteristics of the Internet influence the systems built on the Internet.
- Students will understand that Domain Name Servers (DNS) are essentially the "address book" of the Internet and store information to help Internet systems route requests and replies.
- Students will be able to explain how DNS hierarchy supports scaling on the Internet.
- Students will identify existing DNS cybersecurity concerns and potential options to address these issues.

Overview

Session 1 - Acting the Simulation

1. Lesson Introduction (5 min) - Students assign the cast and collect necessary data.
2. Guided Activity (40 min) - The teacher directs the first rehearsal of the play and introduces changes in IP and DNS.
3. Closing (5 min) - Think-Pair-Share

Session 2 - Round 2 of Simulations

1. Dress Rehearsal with Improvisation (15 min) - Practice Play
2. Rehearsal with Video (30 min) - Perform Play and Discuss DNS Caching and Poisoning
3. Closing (5 min) - Summary Report

Learning Objectives

CSP Objectives

- *EU DAT-2 - Programs can be used to process data, which allows users to discover information and create new knowledge.*
 - LO DAT-2.C: - Identify the challenges associated with processing data.
- *EU AAP-3 - Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing them to write programs more quickly and with more confidence.*
 - LO AAP-3.F - For simulations: a. Explain how computers can be used to represent real-world phenomena or outcomes. b. Compare simulations with real-world contexts.
- *EU CSN-1 - Computer systems and networks facilitate how data are transferred.*
 - 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.E - For fault-tolerant systems, like the Internet: a. Describe the benefits of fault tolerance. b. Explain how a given system is fault-tolerant. c. Identify vulnerabilities to failure in a system.

- *EU IOC-2 - The use of computing innovations may involve risks to your personal safety and identity.*
 - LO IOC-2.C - Explain how unauthorized access to computing resources is gained.

Math Common Core Practice:

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

Common Core ELA:

- RST 12.3 - Precisely follow a complex multistep procedure
- RST 12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases
- WHST 12.6 - Use technology, including the Internet, to produce, publish, and update writing products
- WHST 12.7 - Conduct short as well as more sustained research projects to answer a question
- WHST 12.9 - Draw evidence from informational texts to support analysis, reflection, and research

Key Concepts

The characteristics of the Internet influence the systems built on it.

Domain Name Servers are essentially the "address book" of the Internet and store information to help Internet systems route transmission requests and replies.

A list of character protocols is provided as a resource. These may help students learn their roles.

Essential Questions

- How are vastly different kinds of data, physical phenomena, and mathematical concepts represented on a computer?
- 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**

This lesson requires extensive preparation.

Acquire:

24 envelopes per class – one or two per host per rehearsal and production.

Post-it Notes

One color for students to use to self-select roles.

One color for students to use to record DNS information.

One color for students to use to initiate requests.

Print:

One copy of character protocols for each student.

One copy of Routing Table.docx for each student router.

One copy of DNS cache for each root, TLD, ANS and local DNS server and each host.

Four copies of each device/character role page (web, router, root, TLD, ANS and local DNS and host).

Three or four copies of the first page web page, grouped by domain.

Lesson Plan

Session 1 - First Rehearsal (Part 3 of DNS Section)

Getting Started (5 min)

Warm Up:

Distribute post-it notes to each student.

- Students find their IP addresses and write their name and IP address on the post it note.
- Display the DNS device list on the board and use it to review the process by which DNS resolves domain names.

Casting Characters:

Beside each device listed on the board, there should be the number of students needed to play each role. As soon as students complete their post it notes, have them choose their role by placing the post it notes next to the device name.

Below are suggested numbers of actors per role for two class sizes. Students take their seats and add their name and IP address to their router table.

Device List	16 Students	30 students
Host	4	8
Local DNS	2	4
Root	1	1
Top Level Domain	2	3
Authoritative Name	4	6
Web Server	4	6

Once students select a role, each device group should meet briefly to discuss what information they have to collect from the post-it notes on the board. They will go and obtain either a script that informs them what to do during the play, (how their device works) or all the printed web pages from their server.

Gathering Data:

Post this list of directions and allow devices to go to the board and obtain the required IP address information.

Before the play can start, these seven sets of data still have to be collected.

1. Web servers (students) need to "advertise" their web pages by making a list on the board of the web pages (one word per page) they have to offer.
2. Hosts and DNS servers complete a routing table for their table and give the routing table to their router.
3. Local DNS servers need to share their IP address with hosts.
4. Top-level domain servers need to share their domain names and IP addresses with the root server.
5. Authoritative name servers need to share their domain names and IP addresses with the top-level domain servers.
6. Web servers need to share their IP addresses with their authoritative name servers.
7. Routers need to complete the routing table for their group using the routing table (Routing Table.docx) provided.

Guided Activity (40 min) - Guided Rehearsal

Part 1 (30 min) - Rehearsal 1

Notes:

- During Round 1, the director can stop the action, provide direction, and restart the action.
- Actors should make notes in their journals of any stage directions, and make any changes or corrections to their scripts/role sheets as needed.

Steps to complete the play:

1. Select one Host to start. Hosts:
 - a. Select a web page to request.
 - b. To get the IP address of the web server, the HOST writes the domain of the page requested on a post it note, placing the request in an envelope, **does not seal it**, addresses the outside of the envelope (both from and to IP addresses), and sends the envelope via the Internet router.
2. Routers:
 - a. Verify the address are correctly formatted and forward the envelope using their routing tables.
 - b. Return envelopes not addressed properly – during dress rehearsal.

3. When the root server gets the request, it:
 - a. Opens the envelope.
 - b. Reads the top-level domain.
 - c. Writes the IP address of the proper TLD server on the post-it note.
 - d. Uses the return address on the envelope to send it back to the local DNS server.
4. The local DNS server:
 - a. Opens the envelope.
 - b. Uses the IP address to readdress the question to the appropriate TLD.
5. The TLD server:
 - a. Repeats the process; writing the IP address of the proper ANS on the post it note.
 - b. Addresses the envelope back to the local DNS server.
6. The local DNS server:
 - a. Opens the envelope.
 - b. Uses the IP address to readdress the question to the appropriate ANS.
7. The ANS:
 - a. Writes the IP address of the desired web server on the post it note and circles it.
 - b. Sends the envelope back to the local DNS server.
8. The local DNS server:
 - a. Opens the envelope.
 - b. Upon finding a circled IP address, it sends the envelope back to the HOST.
9. The HOST:
 - a. Opens the envelope and replaces the post-it note with a request containing (only) the name of the web page desired.
 - b. Addresses it using the circled IP address.
10. The web server:
 - a. Receives the envelope.
 - b. Opens it and replaces the post-it note with a printed version of the requested page.
 - c. Readdresses the envelope to the HOST.
 - d. Sends the page back.
11. Simulation completed! Celebrate when the requested web page arrives. Have everyone take a bow.

Part 2 (10 min) - Changes in DNS

Explain: Both domain names rules name and IP address rules have changed over time.

Have students watch these two videos:

- Watch the video regarding one important change regarding domain names:
<https://www.youtube.com/watch?v=1kFcxf8KAjg> (<https://www.youtube.com/watch?v=1kFcxf8KAjg>) [0:55]
- Watch the video regarding IPv4 and IPv6. <https://www.youtube.com/watch?v=-Uwjt32NvVA> (<https://www.youtube.com/watch?v=-Uwjt32NvVA>) [2:20]

Afterwards, they should record responses to these two prompts:

- How are naming rules changing and why?
- How are IP address numbers changing and why?

Closing (5 min) - Think-Pair-Share

1. Before Round 2 (the dress rehearsal), have students make entries in their journals of any lessons learned. Have them share these lessons first with elbow partners, and then in groups.
2. Collect all scripts and web pages.
3. Present the DNS lesson summary project (DNS Summary).

Session 2 – Dress Rehearsal

Dress Rehearsal with Improvisation (15 min)

Set the stage:

Distribute scripts, envelopes, and post-it notes.

- The rehearsal process repeats from the previous session; however, students are to select a different role and to work out on their own the simulation/improvisation.

Note: Use the character protocols from the previous session during the dress rehearsal, especially if the students are struggling.

- Select a host at random to start by requesting an available web page. A little later, cue a second host. If the system is working, cue a third host. Go slower if needed.
- Return the web pages to the web servers. Before going live, give students a chance to ask any questions and to record any observations in their brain books.

Rehearsal with Video (30 min)

Part 1 (20 min) - Opening Night (If the show is ready)

This play is improvisational with Hosts requesting whichever pages they want. Restart the system with all Hosts online.

1. Video the full DNS-based Web system in action.
2. Make a second video of the system acting slowly with only one Host. In the second video, have students narrate their actions.
3. Introduce the use of DNS caching.
4. If time permits, add the use of DNS caching to the system. (Have students request a number of pages from the same domain, so pertinent cached values accumulate quickly. If time is short, brainstorm benefits students anticipate for DNS caching.)
5. Have students record the benefits of DNS caching.

Part 2 (10 min) - Attack

Introduce the security problems associated with plain text messages and with DNS poisoning:

- Have the students watch <https://www.youtube.com/watch?v=1d1tUefYn4U> (<https://www.youtube.com/watch?v=1d1tUefYn4U>) [start at 0:52].
- Have students record potential problems of DNS, including the lack of encryption and the DNS poisoning of DNS haches.

Students will research this topic and report on security issues (among other aspects of DNS) in their summary report.

Closing (5 min)

If the previous lesson has not been assessed, assign the entire summary in the document entitled "DNS Summary."

Options for Differentiated Instruction

The simulation will be acted out at least three times. Students should change to a new role each time.

Use the character protocols during the dress rehearsal.

Evidence of Learning

Formative Assessment

Students are to reopen their spreadsheets from the previous lesson.

Show the students how to create a simple "if statement" in a spreadsheet. The spreadsheet will become a tool where a user can type a domain name into a cell. If the respective IP address of that domain name is found, then that IP address is shown. If it is not then a "0" appears.

(See the sample spreadsheet in the Lesson Resources folder called "Sample Spreadsheet")

Summative Assessment

- A. Describe one rule change for names used on the Internet. Describe the rule before and after the change.
- B. Describe one rule change for IP addresses used on the Internet. Describe the rule before and after the change.
- C. Describe briefly the process by which the Domain Name System operates.
- D. Briefly describe one way the Domain Name System was not designed to be completely secure.
- E. Briefly describe one security concern and one coping strategy for the Domain Name System insecurity.



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