Unit 1: The Internet

Content Area: **Science**
Course(s):
Time Period: **MP1**
Length: **25 days**
Status: **Published**

Rationale and Transfer Goals

This unit explores the technical challenges and questions that arise from the need to represent digital information in computers and transfer it between people and computational devices. Topics include: the digital representation of information - especially, numbers, text, and communication protocols. The first unit of this course purposefully addresses material that is fundamental to computing but with which many students, even those with computers at home or who have some prior experience with programming, are unfamiliar. This levels the playing field for participation and engagement right from the beginning of the course.

NJSLS - Science

8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
8.1.12.NI.1	Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
8.1.12.NI.2	Evaluate security measures to address various common security threats.
8.1.12.NI.3	Explain how the needs of users and the sensitivity of data determine the level of security implemented.
8.1.12.NI.4	Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use.
8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
8.1.12.IC.2	Test and refine computational artifacts to reduce bias and equity deficits.
8.1.12.IC.3	Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
8.1.12.DA.1	Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
8.1.12.DA.2	Describe the trade-offs in how and where data is organized and stored.
8.1.12.DA.3	Translate between decimal numbers and binary numbers.
8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

Enduring Understandings

- A variety of abstractions built upon binary sequences can be used to represent all digital data.
- There are trade-offs when representing information as digital data.
- Characteristics of the Internet influence the systems built on it.
- Computing enables innovation in nearly every field.
- A variety of abstractions built upon binary sequences can be used to represent all digital data.
- The Internet is a network of autonomous systems.
- Characteristics of the Internet influence the systems built on it.
- Compung has a global affect -- both beneficial and harmful -- on people and society

Essential Questions

- Why do computers use binary to represent digital information?
- How does data physically get from one computer to another?
- Are the ways data is represented and transmitted with computers laws of nature or laws of man?
- Who and what is “in charge” of the Internet and how it functions?
- How is information transmitted from one computer to the other when they are not directly connected?
- How can the Internet keep growing? How does that work?

Content - What will students know?

- Compung enhances communication, interaction, and cognition.
- Computing enables innovation in nearly every field.
- Compung has a global effect -- both beneficial and harmful -- on people and society.
- Computing innovations influence and are influenced by the economic, social, and cultural contexts in which they are designed and used.
- A variety of abstractions built upon binary sequences can be used to represent all digital data
- There are trade-offs when representing information as digital data
- Models and simulations use abstraction to generate new understanding and knowledge
- People use computer programs to process information to gain insight and knowledge.
- The Internet is a network of autonomous systems
- Characteristics of the Internet influence the systems built on it.
- Multiple levels of abstraction are used to write programs or create other computational artifacts
- Cybersecurity is an important concern for the Internet and the systems built on it.

Skills - What will students be able to do?

- Communicate with classmates about computing innovations in their lives.
- Describe the positive and negative effects of compound innovations.
- Create a device for sending a single bit of information - state A or state B - over a distance.
- Analyze the possibilities and limitations that arise when sending binary messages.

- Explain or demonstrate how to use a binary message-sending device to send messages that have more than two states.
- Explain how synchronization and coordination enable the transmission of binary messages.
- Develop a protocol for exchanging binary messages in two directions.
- Calculate the bit rate for a binary message.
- Define "bit" and relate it to the binary messages they have seen so far.
- Reason about permutations and symbols as arbitrary abstract concepts that can be used to represent numbers.
- Invent their own "number system" with symbols and rules for getting from one permutation to the next.
- Describe how to use bits to create a functioning number system
- Understand the relationship between the powers of 2 and the number of bits needed to express a number of a certain magnitude. e.g. How many bits do I need to represent the number "15" "32", or "1492"?
- Determine, for a given number of bits, both the number of possible numbers that can be represented and also the range of those numbers
- Calculate the range of values that can be represented and also the range of those numbers
- Invent a simple communication protocol for sending a list of numbers that represent coordinates on a cartesian grid.
- Use the Internet Simulator to send the list of points that make up the drawing to a friend.
- Describe the ASCII encoding scheme.
- Design/invent a protocol for sending formatted text using the Internet Simulator.
- Invent a text from language.
- Explain the connection between binary and more complex encodings of text
- Connect a personal experience to one challenge related to the idea that "The Internet is for Everyone".
- Cite one example of how computing has a global effect -- both beneficial and harmful -- on people and society.
- Explain that the Internet is a distributed global system that works on shared and open protocols.
- Explain why messages need to contain addressing information (sender/recipient identical).
- Invent an informal addressing protocol for use in the
- Recall that browsing the Internet entails computers sending each other requests and sending back data to satisfy those requests.
- Describe the redundancy of rounds between two points on the Internet.
- Evaluate the benefits and security concerns associated with the use of a routed system for sending packets.
- Send messages using a numeric addressing protocol with the Internet Simulator.
- Explain why protocols are necessary to overcome the underlying unreliability of the Internet.
- Jusfy the need for acknowledgments and packet numbering in TCP.
- Develop a protocol for reliable communication on the Internet.
- Give a high-level description of DNS as a name-to-IP-address mapping system used on the Internet
- Give a few reasons why DNS is useful and necessary
- Describe at least one vulnerability of DNS and how an attack on it works
- Explain how layers of protocols allow the Internet to function.
- Use developer tools in a modern browser to explore the HTTP traffic associated with visiting common websites.
- Idenfy abstractions used in the development of Internet protocols.
- Describe how a protocol or layer of the internet acts as an "abstraction" for other layers.
- Research the global impact of the Internet.
- Create and present a flash talk on the global impact of the Internet

- Analyze the relationship of Internet technology to impact.

Activities - How will we teach the content and skills?

- Unplugged Acvies
- Concept Invention
- Widget - Text Compression
- Group Problem Solving
- Reinforcement
- Research
- Individual and Group Discovery
- External Tools
- Exploration
- Performance Task
- Presentation

Evidence/Assessments - How will we know what students have learned?

- Select an innovation. Describe the positive and negative impacts it has had on the world. (A satisfactory answer reflects awareness and analysis of the effects on populations beyond the students' immediate locale.)
- Speculate on how students 25 years from now will answer, "What computing innovation has had a significant impact on your life?" (A satisfactory answer includes a non-trivial consideration of how technology will likely change from, and perhaps build upon, what is currently available.
- Can you send a message in binary to someone you've never before communicated with? if yes, how? If now, what does the person receiving a message need to know to successfully decode the message?
- A binary message consisting of four bits was sent to you by a friend. The message was supposed to be ABAB. Unfortunately, your friend n d set the bit on the wire once every 2 seconds, but you read the wire once every second. Assuming that the first bit was sent and read at the same time what message did you receive instead?
- If you just had a circle and a square, how many 3-shape permutations could you make?
- Reflection: in 50 words or less, describe the concept of a number system. Why are the rules required for a number system to be useful?
- The Activity Guide can be assessed, or generate similar questions asking students to translate back and forth between decimal and binary. Encourage students to try to do so without the assistance of their Flippy Do once they become comfortable.
- Develop a protocol that allows the user to send a calendar date (mm/dd). What is the minimum number of bits necessary?
- Develop a protocol that allows the user to send a time (use 24-hour military time hh:mm: ss) What is the minimum number of bits necessary? What problems arose in your efforts to create a working protocol? How did you think about the problems to solve them?
- Describe one instance in which collaboration with a partner influenced the final protocol your team produced.
- Explain one challenge raised by Vint Cerf in "The Internet is for Everyone" and give one example of it

that you know about.
- Even with a good protocol, what are some privacy and security challenges while playing Baleship on the Internet Simulator?
- Describe the relative benefits of round over a broadcast style of communication. Is round traffic more secure than broadcasting? Justify your answer.
- Can you know in advance the path a message will take between you and another computer on the Internet? Justify your answer.
- IN your own words, what were the primary obstacles you needed to overcome in today's challenge? How do these obstacles mirror actual problems encountered on the Internet?
- Why do computers need to periodically check the DNS for websites you have already visited?
- Why don't we need to know the IP addresses for our favorite sites?
- The definition of Http makes use of the ASCII character set, without reference to how these characters are encoded. Explain why this is an example of abstraction.

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Network topology is determined, in part, by how many devices can be supported. Each device is assigned an address that uniquely identifies it on the network. The scalability and reliability of the Internet are enabled by the hierarchy and redundancy in networks. • Network security depends on a combination of hardware, software, and practices that control access to data and systems. The needs of users and the sensitivity of data determine the level of security implemented.	• Computers send and receive information based on a set of rules called protocols. Protocols define how messages between computers are structured and sent. Considerations of security, speed, and reliability are used to determine the best path to send and receive data. • The information sent and received across networks can be protected from unauthorized access and modification in a variety of ways, such as encryption to maintain its confidentiality and restricted access to maintain its integrity. Security measures to safeguard online information proactively address the threat of breaches of personal and private data.	• Sending Binary Messages with the Internet Simulator • The Need for DNS

Key Resources

Unit 1 - Code.org Computer Science Principles Curriculum

Internet Simulator

Binary Widget

Career Readiness, Life Literacies, & Key Skills

9.4.12.CI	Creativity and Innovation
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
CAEP.9.2.12.C.7	Examine the professional, legal, and ethical responsibilities for both employers and employees in the global workplace.

Interdisciplinary Connections/Companion Standards

LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.