AWS Data Center Tour 1

Uncovering Cloud Computing

Key Student Learnings

Phenomena Question

What is cloud computing and how has it changed the world?

Overarching Content Questions

How can I stream any show or movie whenever and wherever I want?

How have advances in computing technology changed people's lives?

career tours

amazon

Vocabulary

Stop 1: ‘Ancient’ Technology

Input:
Information or energy that is entered into or received by a computer

Processing:
The thinking work a computer does to turn an input into an output

Storage:
Saving information on a physical device so it can be used later

Output:
The information computers give to users, devices, or other computers (i.e. video, sound, images)

Stop 2: Computers as Systems

Output:
The information computers give to users, devices, or other computers (i.e. video, sound, images)

Data Centers:
Giant warehouses that house thousands of processing and storage devices

Internet:
A network of computer networks that can exchange information between devices

Server:
A computer whose function is to store, process, send, or receive data

Stop 3: Passing Information

Fiber Optic Cable:
A connection made of tiny glass tubes that uses light to pass information

Stop 4: Protocols

Protocol:
Established rules that determine how data is transmitted

IP address :
A number assigned to any device connected to the internet

URL (Uniform Resource Locator):
An easy to remember address for calling a specific IP address

DNS (Domain Name System):
A service that translates URLs to IP addresses

Intro

‘Ancient’ Technology

Watch this Tour Stop in: Video 1

What are we learning about on this tour?

The way people consume content has changed drastically over the years. To store photos, you used to have to print them and put them in photo albums. Documents were kept in bulky file cabinets. You even had to go to the store to buy or rent physical copies of music and movies.

So what changed? How are we able to stream movies from anywhere at any time? All of this and more will be answered on today's tour.

Standards

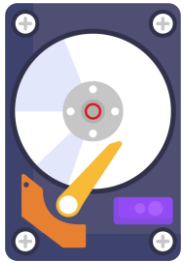
CSTA Standards

1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices.

NGSS Standards

N/A

Stop 1



Computers as Systems

Watch this Tour Stop in: Video 2, Video 3, Video 4 (career spotlight)

Trivia Poll

How big was the first programmable computer?

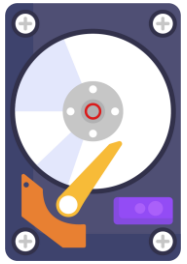
A. As long as a student's desk
B. As long as a semi-truck trailer
C. As long as a book
D. As long as a cell phone

Note: The first programmable computer, the ENIAC, was 50 ft long by 30 ft wide and took up the entire basement of The Moore School at the University of Pennsylvania.
Source: https://www.britannica.com/technology/ENIAC

What are the parts of an individual computing system?

To answer this question, we first must understand how an individual computer works.
A computer is an electronic device that stores, retrieves, and processes information. Computers have four main components: inputs, processing, storage, and outputs. Each component uses both hardware (physical stuff you can touch) and software (computer code) to do its job.

Stop 1



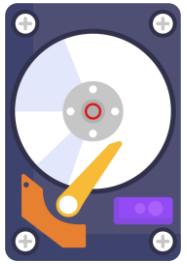
Computers as Systems

Watch this Tour Stop in: Video 2, Video 3, Video 4 (career spotlight)

A computer collects inputs from its environment. An **input** is information (or energy) that is entered into or received by a computer. A computer is designed with special hardware to collect inputs. Mechanical energy (a user clicking/typing) is input into a keyboard or mouse, electrical energy (to power the computer) is input through the electrical plug, and data can be input into the computer from hardware (keyboard or mouse) or from another device through the Internet.

Computers use inputs to begin **processing**, the thinking work to turn that input into an output. Every computer has a processor – a piece of hardware that does this “thinking”. After a computer receives an input, the processor uses computer code (software) to determine what to do. Examples: A user clicks on an X button in the corner of a program with their mouse. The processor uses software to determine what the user wants (to close the program) and does it. Or a gamer presses “jump” on their video game. The processor interprets their key click and uses software to “jump” the player in the game.

Stop 1



Computers as Systems

Watch this Tour Stop in: Video 2, Video 3, Video 4 (career spotlight)

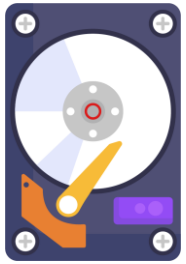
Mid-Stop Poll

A DVD is an example of which computing component?
A. Input **B. Storage** C. Processing D. Output

Computers don't only process information. They can also **store** it. Computers use two types of hardware for data **storage** (saving information for use in the future) – Memory and hard drives. Memory, or RAM, is a computer's short-term memory. Information is stored as needed, and it resets every time the system is rebooted. Information stored in tabs on your web browser or when you press "copy/paste" are examples of data stored in memory. Information that you want to save for the long term is saved on a hard disk, or hard drive. A hard drive is a piece of hardware that can store data – it's like a file cabinet for digital files.

Lastly there is an **output**, the information and energy computers give to users, devices, other computers, or the environment. The original electrical energy input is converted into thermal energy (heat), light (from the monitor), sound (speakers or noise from computer), electrical signals (to other devices), and more.

Stop 1



Computers as Systems

Watch this Tour Stop in: Video 2, Video 3, Video 4 (career spotlight)

Back in the ’90s, if you wanted to watch a movie, you first had to go get the movie where it was stored – on a DVD at a video store! You had to put the DVD (the physical file) into your computer to watch it. You'd press play, providing the input, then the computer would run code to process the data that was stored on the disc, and then output the video and audio from the movie for you to watch.

Review Questions

Which of the following are examples of outputs from a computing system?

A. Video plays on the screen, audio comes out of speakers

B. Talking into the microphone during online class, typing into a chat box

C. Typing words in a document, clicking on a link

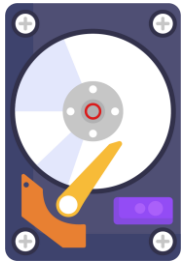
D. Clicking play to stream your favorite song, turning up the volume

A student enters 32 x 68 on their computer’s calculator. The computer must _____ what to do before displaying an answer.

A. Store
B. Input
C. Process
D. Output

CAREER VIDEO SPOTLIGHT:
Hardware engineer

Stop 1 Standards



CSTA Standards

2-CS-02 Design projects that combine hardware and software components to collect and exchange data. Collecting and exchanging data involves input, output, storage, and processing.

1B-CS-01 Describe how internal and external parts of computing devices function to form a system.

1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks.

NGSS Standards

Crosscutting Concept: Cause and Effect Events have causes, sometimes simple, sometimes multifaceted.

Crosscutting Concept: Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Crosscutting Concept: Energy and Matter Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

4-PS3-2 Energy Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

HS-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Stop 2

The Cloud

Watch this Tour Stop in: Video 5, Video 6, Video 7 (career spotlight)

Trivia Poll

The first computer with storage was available in 1956. It had enough storage to hold _____.

A. 1 or 2 songs B. 1 movie C. 5 million words D. 10 photos

Note: The first programmable computer, the ENIAC, was 50 ft long by 30 ft wide and took up the entire basement of The Moore School at the University of Pennsylvania.
Source: https://www.britannica.com/technology/ENIAC

What are the parts of the cloud computing system and how are they similar/different from an individual computer system?

In the 1990s and early 2000s, engineers had an idea. *Instead of having to go to the video store to retrieve a video, could we use the internet to get the video file for us?*

This is the idea behind cloud computing. **Cloud computing** is the delivery of information resources through the internet. Instead of carrying around hard drives full of photos or getting a video from the store, you can access that data when you want it from "the cloud". You still enter inputs and watch outputs on your computer, but the processing and storage are done somewhere else and delivered to you through the internet. But where is that somewhere else?

Stop 2

The Cloud

Watch this Tour Stop in: Video 5, Video 6, Video 7 (career spotlight)

That somewhere else is a data center. **Data centers** are giant warehouses that house thousands of processing and storage devices. Data centers are where the internet "lives". Rather than processing and storing tons of data on your own device, data centers store and process data for you. To use cloud computing, you have to be connected to the internet. The **internet** is a network of computer networks. Computers around the globe are connected to other computers (and to servers in data centers). This allows computers, with permissions, to talk to each other or pass information.

In a data center, data is processed and stored on **servers**. A **server** is a computer that can store, process, and send or receive data. Data centers house thousands of servers in a centralized location. Users at other computers (thousands of miles away!) can use the internet to connect to a server for a specific service, such as accessing a website or streaming a movie. Servers in data centers are extremely powerful and can run nonstop to ensure that users and businesses can access information at any time. They also allow many machines to connect to them at the same time through a large network of data pathways, so millions of people can access the same data at the same time. You may have heard people talk about this concept – someone might have said "It's stored on the cloud" or "I'm going to upload my pictures to the cloud." That means the information is stored on a server in a data center and can be accessed by devices, like tablets and phones, that are connected to the internet.

Stop 2

The Cloud

Watch this Tour Stop in: Video 5, Video 6, Video 7 (career spotlight)

Mid-Stop Poll

Is Dr. Nashlie in the cloud right now?

A. Yes B. No C. Kind of

So how has Cloud Computing changed the world? For everyday users, you're able to store your information in the cloud to access it on any device with internet access. If your device crashes or runs out of battery, you can still access that data on any other device that's connected to the internet. You can also access documents, movies, music, and more from others instantly. Businesses also benefit from the cloud by being able to store all of their data and information in a centralized place (a data center) and rent the equipment and services they need at that time. This saves companies money, they use less electricity and other resources, and they can instantly expand their server needs without having to buy new bulky equipment.

Stop 2

The Cloud

Watch this Tour Stop in: Video 5, Video 6, Video 7 (career spotlight)

Review Question

_____ allows the storage and processing of data to happen elsewhere instead of on an individual computer.

A. Outputs

B. Inputs

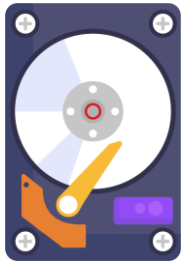
C. Processing

D. Cloud computing

CAREER VIDEO SPOTLIGHT:

DCO (Data Center Operations Engineer)

Stop 2 Standards



CSTA Standards

1B-IC-18 Discuss computing technologies that have changed the world and express how those technologies influence, and are influenced by, cultural practices.

2-IC-20 Compare tradeoffs associated with computing technologies that affect people's everyday activities and career options.

1B-CS-01 Describe how internal and external parts of computing devices function to form a system.

1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks.

NGSS Standards

Crosscutting Concept: Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Crosscutting Concept: Scale, Proportion, and Quantity In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Crosscutting Concept: Energy and Matter Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

4-PS3-2 Energy Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

HS-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-ETS1-3 Engineering Design Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Stop 3

Passing Information

Watch this Tour Stop in: Video 8, Video 9, Video 10 (career spotlight)

Trivia Poll

The total length of underwater cables that the internet runs through can _____.

A. be laid across 3 football fields.
B. stretch from New York to New Jersey.
C. reach from California to New York and back 3 times
D. wrap around the Earth about 32 times.

Source: https://www.submarinecablemap.com https://twitter.com/Rainmaker1973/status/1633486131609186305?s=20

How does my computer communicate with the data center? How does it pass information?

But how are all the computers connected to each other?

To pass data, computers encode data into electrical pulses and light waves. These electrical pulses and light waves can be passed through wires (conduction) or through waves (radiation). When another computer receives the electrical pulses or light waves, it uses processing to decode the message and interpret the information.

Stop 3

Passing Information

Watch this Tour Stop in: Video 8, Video 9, Video 10 (career spotlight)

Passing information through wires:

The first time wires were used to transmit information was with the invention of the telegraph in 1835. Samuel Morse used Morse Code to pass electrical pulses through a wire using sets of sounds to correspond to letters of the alphabet. This changed communication forever – instead of waiting weeks for a physical letter to be delivered through the mail, messages could be sent quickly from place to place! In 1866, an underwater cable was laid to connect the United States and Europe to send telegraph messages. This was revolutionary! In fact, most of the internet runs through underwater cables totaling about 800,000 miles – enough wire to wrap around the Earth about 32 times!

Today, we still use wires to transmit information. Copper cables called ethernet cables can connect computers and are still used inside some homes and businesses to create networks. The wires pass electrical signals to other computers using conduction. However, with the increased usage of the internet, copper wires could not keep up with demand from millions of global users.

Stop 3

Passing Information

Watch this Tour Stop in: Video 8, Video 9, Video 10 (career spotlight)

Mid-Stop Poll

What do you think is faster than electricity?

A. camels **B. light** C. sound D. wind

In 1952, a UK physicist invented a faster type of wire for transmitting information – fiber optics. A fiber optic cable is made of tiny glass tubes (the diameter of a piece of human hair!) wrapped in plastic coating. The glass tubes use light to transmit data (radiation). The light wave carries information and travels through the cable, constantly reflecting or bouncing off the glass walls until it reaches its destination. More data can move around the world faster on a fiber-optic network – at about the speed of light! They are also more durable and more secure than copper wires.

Stop 3

Passing Information

Watch this Tour Stop in: Video 8, Video 9, Video 10 (career spotlight)

Passing information through wireless:

Students may be wondering, why not just use WiFi? WiFi is a way to connect to the internet. When you use wireless, your information from your personal device is encoded onto waves but sent through the air to another device connected to the internet by wires. This other device is able to pass your information to and from data centers through fiber optic wires, and then back to your device through the air over radio waves. While wireless internet is convenient, wired connections are faster (less likely to be slowed down by outside traffic), more durable (not affected by building materials/building layouts or devices interfering with signals), and more secure (radio waves from wireless are easier to intercept).

Review Question

_____ are made of tiny glass tubes and allow information to be sent to and from data centers using light waves.

A. Ethernet Cables B. Servers C. Encoders **D. Fiber Optic Cable**

CAREER VIDEO SPOTLIGHT:
Fiber Splicer

Stop 3 Standards

CSTA Standards

2-CS-02 Design projects that combine hardware and software components to collect and exchange data. Collecting and exchanging data involves input, output, storage, and processing.

3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers.

NGSS Standards

Crosscutting Concept: Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

4-PS3-2 Energy Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS4-3 Waves and Their Applications in Technologies for Information Transfer Generate and compare multiple solutions that use patterns to transfer information.

MS-PS4-2 Waves and their Applications in Technologies for Information Transfer, develop, and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-PS4-3 Waves and their Applications in Technologies for Information Transfer Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

HS-PS4-2 Waves and their Applications in Technologies for Information Transfer Evaluate questions about the advantages of using digital transmission and storage of information.

HS-PS4-5 Waves and their Applications in Technologies for Information Transfer Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Stop 4

Protocols

Watch this Tour Stop in: Video 11, Video 12, Video 13 (career spotlight)

Trivia Poll

True or False: Every device on the internet is assigned a number as an address.
A. True B. False

How does the data know where to go? How does the data center find the right files?

Data is flying around the world via wires, but how does it know where to go? You wouldn't just get in a car and drive around aimlessly until you reach your destination, and it's the same way with data. Data needs to go to a specific address and there are established rules in place called protocols that determine how data is transmitted and ensure it gets to the right destination!

One of the most important protocols is the IP protocol. It assigns every computer an address so data knows where to go. Just like your school or other businesses have a street address, computers and servers have an address called an IP address. An IP address is a number assigned to any device that is connected to the internet that lets computers know the location of the device where the information is either located or needs to be sent.

Stop 4

Protocols

Watch this Tour Stop in: Video 11, Video 12, Video 13 (career spotlight)

Mid-Stop Poll

What do you think URL stands for?

A. User Request Link
B. Unicorns Running Loose
C. Uniform Resource Locator
D. U Really Lying
E. United Robotics League
F. Upload Routing Library

But when you visit a website or are browsing on an app, you don't enter in numbers – you enter in a **URL (Uniform Resource Locator)**, an easy to remember address for calling a specific IP address. It's much easier to remember Amazon.com than a long string of numbers! How does the computer know which URL goes with which IP address? With the **Domain Name System** (DNS) protocol.

The **Domain Name System** (DNS) protocol requires computers to use a Domain Name System server to match URLs to the IP addresses where the website or movie data is located. It's kind of like using a dictionary of URLs and IP addresses! This same process happens when you use an app on your tablet or phone to stream – the URL is just hidden in the code of the app.

Stop 4

Protocols

Watch this Tour Stop in: Video 11, Video 12, Video 13 (career spotlight)

After your computer has been given directions on where to go from a DNS server, it uses the internet to find the device that contains the information (the movie, the song, the website code) you want – perhaps that device is a server at a Data Center! And guess how that data knows how to get back to your computer? By using your IP address!

Review Question

Every device connected to the internet is assigned a number called a _____ so data knows where to go.

A. URL B. server C. processor **D. IP address**

CAREER VIDEO SPOTLIGHT:
Network Architect

Stop 4 Standards

CSTA Standards

3A-NI-04 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.

2-NI-04 Model the role of protocols in transmitting data across networks and the Internet.

3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers.

NGSS Standards

Crosscutting Concept: Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Stop 5

Recap

Watch this Tour Stop in: Video 14

Career Poll

Of the careers you saw today, which interests you most?

A. Hardware Engineer
B. DCO (Data Center Operations)
C. Fiber Splicer
D. Fiber Network Architect

How does the cloud allow me to watch movies on my device?

So let's put it all together. First, you click on a movie in a software application on a computer. The computer's software processes the request and uses protocols to locate where the movie is stored in an AWS data center. The movie file is transferred back to your device through fiber optic cables (and maybe some WiFi).

And remember, all of these steps happen in a fraction of a second because of how quickly electricity and light waves travel! Because of cloud computing, instead of going to the video store, millions of people can access a large library of videos at the same time from a data center using internet protocols. The video store now comes to you – anywhere, at any time!

Stop 5 Standards

CSTA Standards

3A-NI-04 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.

2-NI-04 Model the role of protocols in transmitting data across networks and the Internet.

3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers.

NGSS Standards

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4-PS4-3 Waves and Their Applications in Technologies for Information Transfer Generate and compare multiple solutions that use patterns to transfer information.

HS-PS4-5 Waves and their Applications in Technologies for Information Transfer Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Rapid Fire Review

Review

Hard drives are an example of _____ and allow people to save information for later use.

A. Storage

B. processing

C. input

D. Output

Instead of entering numbers, people enter easy to remember addresses called _____, like Amazon.com to go to a website.

A. data centers

B. IP addresses

C. URLs

D. servers

A student attending online class is typing words into the chat and speaking into the microphone. These are examples of computer _____.

A. outputs

B. inputs

C. storage

D. processing

_____ is a network of computer networks and connects users and computers from around the globe.

A. The output

B. The Uniform Resource Locator (URL)

C. The Domain Name System (DNS)

D. The internet

Rapid Fire Review

Review

Computing devices follow a set of rules called _____ to determine how data is transmitted.

A. URLs

B. protocols

C. servers

D. data centers

Businesses can store information on servers in _____ so customers and employees can access data in the cloud.

A. data centers

B. processors

C. IP addresses

D. fiber optic cables

When you enter a URL, a protocol called _____ matches the URL to the IP address so the computer knows where to send data.

A. DNS (Domain Name System)

B. outputs

C. the internet

D. cloud computing

Survey Polls

Poll

~~Overall~~, rate your tour experience on a scale of 1-5

5 – Extremely Satisfactory
4 – Satisfactory
3 – Neither Satisfactory nor Unsatisfactory
2 – Unsatisfactory
1 – Extremely Unsatisfactory

How interested are you in pursuing careers in technology?

5 – Very Interested
4 – Interested
3 – Neither Interested nor Uninterested
2 – Uninterested
1 – Very Uninterested

How did this tour affect your interest in pursuing careers in technology?

A. Increased
B. Decreased
C. No Change

Do you agree or disagree with the following statement: I feel like I belong in careers in technology.

5 – Strongly Agree
4 – Agree
3 – Neither Agree nor Disagree
2 – Disagree
1 – Strongly Disagree