



AWS Data Center Tour 2

Keeping Data Safe and Sustainable

Key Student Learnings

Phenomena Question

How can I trust that my pictures will be safe in a data center?

Overarching Content Questions

How are data centers and “the cloud” designed to be as trustworthy and sustainable as possible?



Vocabulary

Stop 1: Keeping It Cool

Infrastructure:

The building and equipment that keep an operation running

Evaporation:

The process where heat energy turns liquid into gas

Stop 2: Back Those Things Up

Redundancy:

Backup equipment that can be used if the original equipment fails

Sensors:

Hardware that take in information from the environment and trigger a response

Stop 3: Security

Cybersecurity:

The protection of networks, data, and devices from unauthorized access or other digital threats

Malware:

Software designed to gain unauthorized access to a computer system

Stop 3: Security continued

Machine learning:

The science of getting computers to make their own predictions based on past data

Encryption:

Scrambling data into a code that only authorized computers or users can access

Stop 4: Sustainability

Sustainability:

The ability to operate without depleting Earth's resources and harming the environment

Carbon dioxide:

Gas released from the burning of fossil fuels

Carbon zero:

Not adding any more carbon dioxide into the atmosphere when systems are operating

Water positive:

Returning more water to the community and environment than is used



Intro

My Selfies!

Watch this Tour Stop in: [Video 1](#)



How can I trust that my data will be safe in a data center?

Introduce phenomena: The safety of storing files in “the cloud” (at data centers).

With cloud computing, file storage and big processing tasks are done elsewhere – not on your individual device. This means that you are trusting someone else to keep your files safe! You are also trusting them to be able to run your applications/games/movies whenever you ask.

Your most sacred files might be a book report, or a video of your dog. But some companies, hospitals, or government agencies have critically important information and tasks – they need to be 100% sure that data centers can keep their information available and secure. So, how do companies like AWS make sure “the cloud” and data centers are fail-proof? *How are data centers and “the cloud” designed to be as trustworthy as possible?*



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.

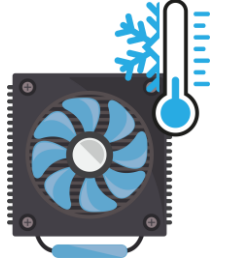
NGSS Standards

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.



Stop 1



Keeping It Cool

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

Trivia Poll

What causes computers to get hot?

- A. Electrical energy gets converted to heat energy
- B. Sunlight heats up the internal hardware
- C. Light carrying data produces heat
- D. Little fires inside computers power the processor

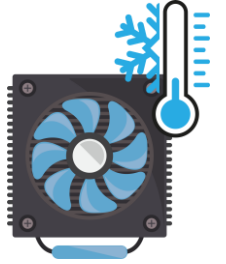
My individual computer gets hot when I'm running a lot of programs at the same time. Wouldn't a data center get hot if it has thousands of servers in it? If so, how do they keep it cool?

Computers need electricity to process and output information, and some of that electric energy is converted into **thermal energy (heat)**. Fans and vents keep an individual device cool, but in a data center, where you have a room full of thousands of processing and storing devices (servers) running at the same time, it can get hot! Too much heat can damage a server and cause a disruption in service – people wouldn't be able to access their information stored in the cloud. So *how do we keep giant data centers full of thousands of servers cool?* By using water!



Stop 1

Keeping It Cool



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

No, we don't pour water on the data center servers. We build complex **infrastructure** systems that use water to keep them cool. **Infrastructure** is the physical structures and buildings that keep an operation, such as a data center, running. Instead of spending millions of dollars and tons of energy on air conditioning, Amazon uses a natural process to keep servers cool – evaporation!

Mid-Stop Poll

What natural process do you think we use to cool down data centers?

A. Photosynthesis **B. Evaporation** C. Erosion D. Burning E. Pollination F. Decomposition

Data centers use a process called **evaporative cooling** to keep servers cool. When temperatures increase, especially in summer months, filters inside the air conditioning systems are dampened with water. Hot air from the outside is brought in and passes through the water-soaked filters. As air is pushed through the filters, the heat from the hot air evaporates the water on the filters. The air that was brought in is now cool because its heat was used to evaporate the water, and that cool air is sent into the server room using big fans. This lowers the air temperature inside of the data center. This is a similar process to how sweating cools down our bodies when we're hot! When you sweat, excess heat in your body is used to evaporate your sweat, leaving your body cooler.

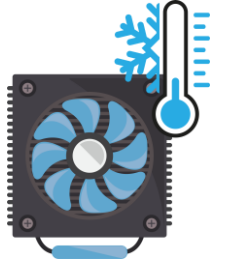


Stop 1

Keeping It Cool

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

The evaporative cooling infrastructure keeps the server room between 66 to 69 degrees Fahrenheit (19-21 degrees Celsius), the ideal temperature for a server to run efficiently, and keeps your data safe by preventing the equipment from overheating! Using evaporative cooling instead of regular air conditioning helps AWS Data Centers be more environmentally friendly. Evaporative cooling is cheaper and uses less harmful chemicals than other AC systems.



Review Questions

_____, such as the air conditioning and building systems, are designed to keep the servers at an ideal temperature.

- A. Evaporation
- B. Thermal energy
- C. Infrastructure**
- D. Computers

CAREER VIDEO SPOTLIGHT:

DCEO (Data Center Engineering Operations Technician)



Stop 1 Standards

CSTA Standards

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

NGSS Standards

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

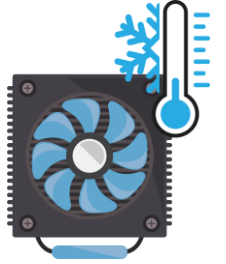
Crosscutting Concept: Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

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.

MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MS-PS3-3 Energy Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

HS-PS3-4 Energy Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).



Stop 2



Back Those Things Up

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

Trivia Poll

Which of the following issues must data centers be prepared for?

- A. Natural disasters (i.e. flooding and earthquakes)
- B. Spike in temperatures
- C. Power outages
- D. Equipment Failure
- E. Fire
- F. **All of the answers are correct**

But if everything is in a data center, what happens if a big storm comes? How do we keep the data safe in case of a disaster?

Because data centers need to run 24 hours a day, 7 days a week, it's important that they're prepared for anything. Whether it's a storm that knocks out power in the community where a data center is located, or something bigger like a natural disaster, data centers must be ready to respond and keep the servers running. *So how does a data center do that?*



Stop 2



Back Those Things Up

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

Data center infrastructure is designed with **redundancy**. **Redundancy** means you've built in lots of extra backups – just in case you need them! Redundant components aren't needed to make a system work, they're there in case part of a system fails or a natural disaster hits. So what does this look like? How does AWS design data centers with redundancy?

First thing to know is that your data isn't stored on just one server. It's stored on many different servers in different data centers! If something were to happen to one data center (flooding, extreme weather, and earthquakes), other data centers have it on their servers, too. That's redundancy! Businesses can choose to have their data in as many or as few data centers as they want to make sure their data is protected and available at all times.



Stop 2



Back Those Things Up

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

Mid-Stop Poll

Which other infrastructure at data centers do you think have redundancy (backups)?

- A. electrical systems
- B. water pumps
- C. fire suppression
- D. All of the answers are correct**

AWS carefully selects where to build each Data Center to mitigate risk of natural hazards – floods, earthquakes, storms, etc. But, accidents and disasters still happen! To keep each individual data center safe, AWS builds redundancy into its infrastructure systems. AWS uses **sensors** throughout its systems to automatically detect if something is wrong. Sensors are hardware that take in information from the environment and trigger a response.

- If the main energy source goes out, sensors trigger a switch to a redundant energy source. If an electricity circuit blows, power will be routed through a redundant circuit. The entire electrical system has redundant pathways and energy sources built in.



Stop 2



Back Those Things Up

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

- If a flood is detected where it shouldn't be, automatic pumps remove liquid and prevent water damage and equipment failure.
- If fire is detected, sensors trigger automatic fire suppression technology.

Because of redundancy and sensors, you can be sure that even if disaster strikes, it's safe to rely on the cloud and data centers for your file storage and processing.

Review Question

Data centers have lots of backup equipment like electrical and cooling systems in case technology fails. This is an example of _____.

- A. **Redundancy**
- B. electrical energy
- C. thermal energy
- D. infrastructure

CAREER VIDEO SPOTLIGHT:
Control Technician



Stop 2 Standards



CSTA Standards

2-NI-05 Explain how physical and digital security measures protect electronic information.

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.

MS-ESS3-2 Earth and Human Activity Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

HS-ESS3-1 Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.



Stop 3

Security

Watch this Tour Stop in: [Video 8](#), [Video 9](#), [Video 10 \(career spotlight\)](#)



Trivia Poll

The first software that could attack computers displayed the phrase _____ on computer screens.

- A. ILOVEYOU
- B. Fix Your Software
- C. Code Red
- D. I'm the creeper; catch me if you can**

Source: <https://thehill.com/blogs/pundits-blog/technology/91595-im-the-creeper-catch-me-if-you-can/>

How is my data kept safe from people trying to steal it?

The security of a data center is extremely important as the servers contain customer information and important assets that companies rely on to conduct business.

So, how does it keep my data secure?



Stop 3

Security



Watch this Tour Stop in: [Video 8](#), [Video 9](#), [Video 10 \(career spotlight\)](#)

Physical security of the buildings begins at the perimeter layer. AWS Data Centers have a number of security features including security guards, fencing, security video feeds, and intrusion detection. Access is restricted to only those that have a specific business reason at a data center (employees, repair technicians). This prevents a bad actor from getting into a data center and tampering with servers. *But, if information is passed through the internet, how does AWS keep it from getting stolen through the internet?*

Mid-Stop Poll

Does someone have to physically be at a data center to get access to servers?

A. Yes B. No C. I have no idea

Sometimes bad actors want to access that data through the use of **malware**, or software designed to gain unauthorized access to a computer system. People may try to attack systems and servers by sending a suspicious link to an unsuspecting user, which when clicked, installs the malware on an individual's computer, or may use devices connected to the internet and try to overwhelm servers with fake traffic.



Stop 3

Security

Watch this Tour Stop in: [Video 8](#), [Video 9](#), [Video 10 \(career spotlight\)](#)

AWS has many cybersecurity measures in place to protect customer data.

Cybersecurity is the protection of networks, data, and devices from unauthorized access or other digital threats.

Cybersecurity specialists implement many cybersecurity measures to ensure customer data is safe. Data transmission is constantly monitored for suspicious activity and abnormal patterns. **Machine learning** (the science of getting computers to make their own predictions based on past data) trains the computer system to look for abnormal activity in data transmission at data centers. For example, a sudden spike in data requests of a specific file on a specific device could signal that **malware** is trying to break in.



Stop 3

Security



Watch this Tour Stop in: [Video 8](#), [Video 9](#), [Video 10 \(career spotlight\)](#)

Data centers also keep data protected using **encryption**. Before data is accessible on the internet, it is **encrypted** (scrambled into a code) to prevent unauthorized users from making use of the data if they are able to breach, or access, the system. Only authorized computers are able to unscramble or decrypt the data and make it usable. It's like making up a secret code language that only your friend understands.

Cybersecurity specialists are on call 24/7, so if a breach were to occur, it can be detected and fixed immediately. Software is trained to automatically respond to incidents so security teams can analyze the cause and quickly fix the issue and secure data in near real-time.

Review Question

When data is protected with _____, it is scrambled so only authorized computers can read **the information**.

- A. Encryption B. machine learning C. malware D. evaporation

CAREER VIDEO SPOTLIGHT:

**Security Assurance Analyst or
Cloud Cybersecurity Specialist**



Stop 3 Standards

CSTA Standards

2-NI-05 Explain how physical and digital security measures protect electronic information.

3A-NI-05 Give examples to illustrate how sensitive data can be affected by malware and other attacks.

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.



Stop 4

Sustainability



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

Trivia Poll

Data centers are better for the environment than each individual company hosting and processing their own data? **A. True** B. False

Doing all this must take lots of energy. How can we build data centers that are sustainable for the environment?

All of this sounds like it takes a lot of electricity! I'm curious. Is this new way of computing – cloud computing with data centers – better or worse for the environment? What's Amazon doing about it?

Back before data centers, companies would host their data on their own servers, with each company pulling from the power grid. With millions of companies around the globe, that's a lot of power that came from the burning of fossil fuels. When companies move to data centers, it is a more sustainable option. When multiple companies can have their data stored in a centralized place, a data center, their data is in a building with infrastructure designed for efficiency, meaning designed to not waste excess resources



Stop 4

Sustainability

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

such as materials, energy, or money. The scale of data centers allows companies like AWS to continually innovate on ways to use less energy and resources while increasing storage and computing capacity. Utilizing efficient infrastructure like air conditioning systems and computer hardware (processors) are ways data centers can be more sustainable than companies hosting their own data. Even the location of data centers helps them be more efficient; they're built in locations with cooler climates so less energy is needed to cool the system in summer months.

Though data centers are designed to not waste resources, those servers still need power to run! In the past, most power in the energy grid came from the burning of fossil fuels, like oil, natural gas, and coal. These resources are limited and when burned, release a harmful gas into the environment, **carbon dioxide**, which is known to contribute to climate change. Amazon is committed to being **carbon zero** by 2040, meaning none of those harmful gasses will be released into the environment from running the data centers.



Stop 4

Sustainability

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



Mid-Stop Poll

What do you think carbon zero means?

- A. Catching carbon dioxide in a net so it doesn't go into the atmosphere
- B. A soda with 0 carbon dioxide in it
- C. Carbon dioxide that is 0 degrees Celsius
- D. Releasing zero carbon dioxide when producing electricity

How will we do this? By switching to **renewable resources** such as sunlight and wind, that can easily be replenished and don't harm the environment. In fact, Amazon is on a path to power all of its operations, including AWS data centers, with 100% renewable energy sources by 2025 via wind and solar farms.



Stop 4

Sustainability

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

What about water? That's a natural resource that we know is used to keep data centers operating efficiently by staying cool. Water scarcity is a major issue around the world and Amazon is working to help communities. As part of this commitment, AWS will be **water positive** by 2030, returning more water to communities than it uses in its direct operations. This will be done by using water from sustainable sources, using technology to monitor water use and making changes to increase efficiency, replenishing water that was used in certain communities, and reusing water. Let's look at an example in Oregon: In Oregon, where some data centers are located in a farming community, water that was used for cooling is re-used by farmers to water crops like alfalfa, wheat, and soybeans. To make sure that water is safe, sensors monitor water quality by collecting data, uploading data to the cloud, and data is automatically analyzed for any safety issues.

So yes, while data centers do use a lot of energy, the efficiency of infrastructure, use of renewable energy, and water positivity projects help make data centers sustainable for the environment.



Stop 4

Sustainability



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

Review Questions

Using renewable energy instead of fossil fuels reduces _____ released into the environment.

- A. evaporation
- B. malware
- C. **carbon dioxide**
- D. Water

AWS makes sure more water is returned to the community than is used to cool a data center. This is an example of being _____.

- A. **water positive**
- B. carbon zero
- C. cyber secure
- D. redundant

Watch this video to close out the tour: [Video 14](#)

CAREER VIDEO SPOTLIGHT:
Sustainability Specialist

Career Poll

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

- A. DCEO (Data Center Engineering Operations Technician)
- B. Electrician or Control Technician
- C. Security Assurance Analyst or Cloud Cyber Security Specialist
- D. Sustainability Specialist or Sustainability Program Manager



Stop 4 Standards

CSTA Standards

3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. Computing may improve, harm, or maintain practices. Equity deficits, such as minimal exposure to computing, access to education, and training opportunities, are related to larger, systemic problems in society. Students should be able to evaluate the accessibility of a product to a broad group of end users, such as people who lack access to broadband or who have various disabilities. Students should also begin to identify potential bias during the design process to maximize accessibility in product design.

NGSS Standards

4-ESS3-1 Earth and Human Activity Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

4-ESS3-2 Earth and Human Activity Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

5-ESS3-1 Earth and Human Activity Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

MS-ESS3-3 Earth and Human Activity Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4 Earth and Human Activity Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-ESS3-5 Earth and Human Activity Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.



Stop 4 Standards continued



NGSS Standards continued

MS-ETS1-1 Engineering Design Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

HS-ESS3-1 Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4 Earth and Human Activity Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

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.



Rapid Fire Review

Review

Cybersecurity protects against software called _____ that could access customer data or damage servers.

- A. encryption
- B. malware**
- C. sustainability
- D. carbon dioxide

Cyber security specialists train systems using _____ so they can identify threats and immediately respond.

- A. machine learning**
- B. efficiency
- C. infrastructure
- D. evaporation

Cooling systems in data centers use water and the natural process of _____ to prevent servers from overheating.

- A. redundancy
- B. evaporation**
- C. encryption
- D. water positivity



Rapid Fire Review

Review

If flooding or a fire occurs in a data center, hardware called _____ trigger automatic responses to protect data.

- A. thermal energy
- B. malware
- C. sensors**
- D. carbon dioxide

_____ measures, such as machine learning and encryption, keep data protected and secure.

- A. Redundancy
- B. Malware
- C. Infrastructure
- D. Cybersecurity**

By using renewable energy and reusing water, data centers become more _____ and don't harm the environment.

- A. infrastructure
- B. thermal energy
- C. sustainable**
- D. carbon positive



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

