Prime Video Sports: Behind the Streams

Key Student Learnings

Overarching Content Questions

What software and hardware are required to bring live sporting events to millions of people worldwide in real-time?

How do people and technology monitor and respond to real-time issues that may arise during live sports streams?

How does Amazon leverage machine learning and computer vision to enhance the broadcast experience?

career tours
amazon

CSTA
Computer Science Teachers Association

Vocabulary

Stop 0: Intro

Streaming
Delivering content, such as live sports, over the internet in real-time without having to download the entire file.

Stop 1: The Pathway of Data

Infrastructure
Hardware, software, and people that work together to deliver a service.

Hardware
The physical part of the infrastructure that makes up a computing system.

Encode
The process of converting data into a digital format that can stream over the internet.

Content Delivery Network (CDN)
A system of computers and servers spread out around the world that deliver content to users in different locations.

Latency

The delay between the live event happens and when an audience views it.

Decode
Using a device or software to convert a digital format into video and audio in real-time.

Network Traffic
The number of user accessing the data at one time.

Stop 2: Troubleshooting

Buffering
Pre-loading bits of data to ensure a smooth video watching experience.

Troubleshooting
A systematic approach to finding and resolving a problem solving.

Redundancy
A system design in which a component is duplicated, so if it fails, there will be a backup.

Vocabulary

Stop 3: Building New Features

User Stories
An explanation of a feature from the perspective of the customer.

Artificial Intelligence
using algorithms and machine learning to perform tasks that typically require human intelligence.

Machine Learning
The science of getting computers to perform or make predictions based on examples or past experiences.

Computer Vision
A type of machine learning that enables a computer to interpret and understand information from images and videos.

Intro

Prime Video Sports:
Behind the Streams

Watch this Tour Stop in: Video 1 and Video 2

Pre-Stop Trivia Poll

What was the first major U.S. sport to stream a regular season game?

A. baseball
B. football
C. soccer (fútbol)
D. basketball

Intro

Prime Video Sports:

Behind the Streams

Watch this Tour Stop in: Video 1 and Video 2

How do computer science, artificial intelligence, and people work together to bring reliable, high-quality sporting events to millions of people around the globe in real-time?

In 1911, the landscape of sports changed forever when one thousand fans gathered in Lawrence, Kansas, for the first sports broadcast via telegraph. Broadcasting, the transmission of content over radio, television, or the internet, has since evolved dramatically. Today, fans around the world can stream high-definition sports events from anywhere, thanks to platforms like Amazon Prime Video Sports.

Streaming, which delivers content over the internet in real-time, has become the most popular way to consume video media. No longer do you have to be in a place with a TV and cable subscription to watch your favorite games. Whether you're in an airplane, driving in a car, or in the middle of nowhere, if you have an internet connection, you can still watch your favorite sports!

Intro

Prime Video Sports:

Behind the Streams

Watch this Tour Stop in: Video 1 and Video 2

Live sports events reach our devices through a complex network of hardware, software, and teamwork. The sports industry offers a wide range of career opportunities beyond just being an athlete, including roles in data analysis, engineering, broadcasting, and software development. Each role is essential in delivering the live sports experience to audiences worldwide.

By understanding these processes and exploring various career paths, students can see how their unique skills and interests can contribute to the sports industry, showing that there's a place for everyone, regardless of athletic ability or identity. In today's tour, students will learn how Amazon Prime Video Sports uses computer science, technology, artificial intelligence, and dedicated professionals to bring live sports to millions of viewers across the globe.

Stop 0 Standards

CS Standards

Computing Systems:

2-CS-01: Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices.

2-CS-02: 6-8: Design projects that combine hardware and software components to collect and exchange data**.**

Networks & the Internet:

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

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

CS Standards (Continued)

Impacts of Computing:

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

2-IC-22: Collaborate with many contributors through strategies such as crowdsourcing or surveys when creating a computational artifact.

Stop 0 Standards

Next Generation Science Standards (NGSS) Standards

Science and Engineering Practices

Asking questions and defining problems.

Constructing explanations and designing solutions.

Cross Cutting Concepts:

Cause and effect

Systems and system models

Disciplinary Core Ideas:

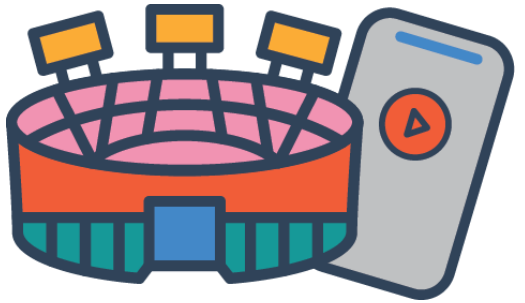
4-PS4-3 Waves and Their Applications in Technologies for Information Transfer Generate and compare multiple solutions that use patterns to transfer information.

NGSS Standards Continued

3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

MS-ETS1-2 Engineering Design Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Stop 1



The Pathway of Data

Watch this Tour Stop in: Video 3 and Video 4

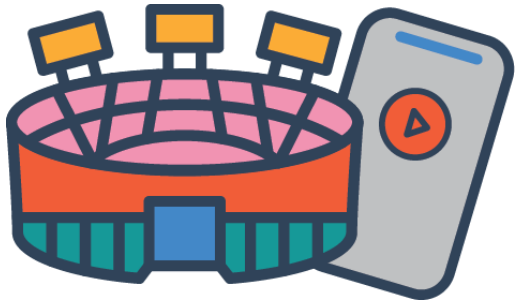
Pre-Stop Trivia Poll

True or False: Streaming allows you to watch sports from anywhere in the world, as long as you have an Internet connection.

A. True

B. False

Stop 1



The Pathway of Data

Watch this Tour Stop in: Video 3 and Video 4

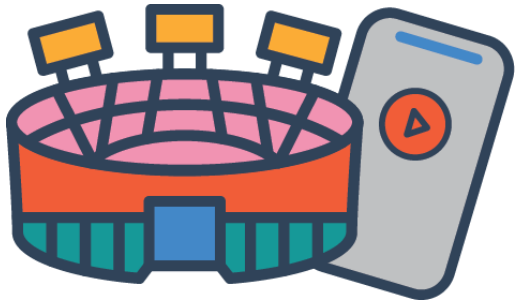
What is the pathway of data from the stadium to devices?

Streaming sports isn't as simple as just showing up with a camera, microphone, and hitting a button to start. Before you can watch a live sports game on your device, a lot of work happens behind the scenes. Prime Video Sports has a dedicated team that sets up and operates the **infrastructure**—a combination of hardware, software, and skilled people—to ensure the game streams smoothly.

Think of streaming a sports game online like putting together a big puzzle. Infrastructure is the complete system that makes live sports streaming possible. It includes **hardware**, such as servers and physical equipment, **software** that manages critical tasks like encoding and streaming, and the people who design, manage, and troubleshoot the system. Together, these elements work to deliver a seamless viewing experience without interruptions.

The **hardware** serves as the physical foundation of the system, including powerful computers, servers, cameras, and microphones. These components handle critical tasks like processing and transmitting video and audio data. Software acts as the "brain" of the operation, ensuring that all the hardware works together. It manages tasks such as encoding (converting video and audio into a digital format), data compression, and real-time streaming. It also keeps the video and audio synchronized and prevents buffering or delays. Skilled professionals are essential to this process, from setting up equipment at the stadium to managing servers and solving problems to ensure everything runs smoothly.

Stop 1



The Pathway of Data

Watch this Tour Stop in: Video 3 and Video 4

What is the pathway of data from the stadium to devices?

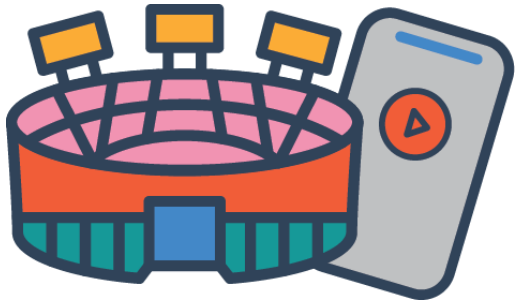
The process begins with multiple cameras and microphones capturing the action at the stadium. These devices collect video and audio from different angles and perspectives. The raw footage is sent to an on-site truck, where it is combined and synchronized to create a cohesive feed. From there, the video and audio are transmitted to Amazon's data centers, massive facilities filled with powerful servers. At the data center, the servers **encode** the video and audio, converting it into a digital format that can be efficiently streamed over the internet.

The encoded data is then transmitted to your device through satellites, fiber-optic cables, and the internet. Once it reaches your device, software decodes the digital format, turning it back into the video and audio you see and hear in real-time. By bringing together hardware, software, and skilled people, Prime Video Sports delivers a seamless live sports experience, ensuring viewers enjoy every moment of the action without interruptions.

Mid-Stop Review Question

The ____ behind sports streaming includes hardware, software, and teams of people working together.
A. scoreboard **B. infrastructure** C. hardware D. careers

Stop 1



The Pathway of Data

Watch this Tour Stop in: Video 3 and Video 4

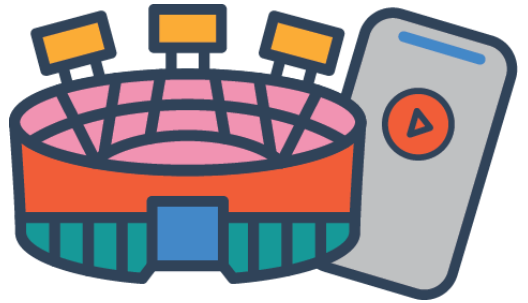
What is the pathway of data from the stadium to devices?

Content Delivery Networks (CDN) plays a critical role in delivering live events to audiences worldwide. A CDN is a system of computers and servers distributed across the globe, designed to speed up content delivery. Imagine it as a global highway system for data, ensuring that information travels quickly and smoothly to reach its destination.

When you're watching a live event, reducing **latency**—the delay between when the event happens and when you see it—is crucial. No one wants to find out their favorite team scored a touchdown, goal, or basket ten minutes after it happened! By using multiple CDNs worldwide, Amazon minimizes latency. These additional "highways" mean less network traffic congestion, so the content gets to you efficiently and in real-time, no matter where you are.

Once you press "play" on your app or website, the data travels from the CDN to your device. The software then takes over, **decoding** the digital data into the vibrant images and crisp audio you see and hear. All of this happens live and seamlessly, creating an experience where you feel like you're right in the middle of the action. From the field to your screen, it's a technological journey powered by innovation and precision.

Stop 1



The Pathway of Data

Watch this Tour Stop in: Video 3 and Video 4

Vocabulary Review Question

Engineers work to reduce ____, the delay between the action at the game and what viewers see on their devices.

A. latency

B. infrastructure

C. Content Delivery Networks (CDNs)

D. hardware

Vocabulary Review Question

Software on your device _____ the audio and video data into a format that you can watch and/or hear.

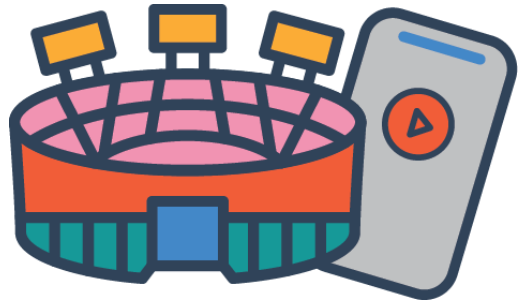
A. copies

B. deletes

C. records

D. decodes

Stop 1 Standards



CS Standards

Computing Systems:

3B-CS-01: Categorize the roles of operating system software.

3A-CS-02: Illustrate ways computing systems implement logic, input, and output through hardware components.

Networks & the Internet:

3B-NI-05: Use data analysis tools and techniques to identify patterns in data representing complex systems.

3B-NI-06:Select data collection tools and techniques to generate data sets that support a claim or communicate information.

CS Standards (Continued)

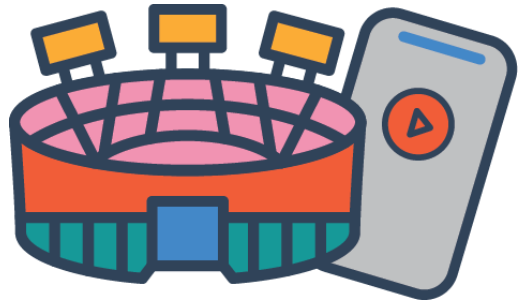
Algorithm & Programming

3B-IC-24: Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems.

Impacts of Computing

3A-IC-26: Demonstrate ways a given algorithm applies to problems across disciplines.

Stop 1 Standards



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Cause and effect

Systems and system models

Disciplinary Core Ideas:

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

Stop 2

Troubleshooting

Watch this Tour Stop in: Video 5 and Video 6

How do engineers manage and ensure high quality of broadcasting and troubleshoot if issues arise?

People love watching sports! With millions of fans cheering for their favorite teams, no one wants to miss a second of the action. However, because it's a live event, issues like blurry pictures or lag can sometimes occur. One common issue is **buffering**, which happens when the software pre-loads bits of data to ensure a smooth video-watching experience.

When you stream a video, your device (like a computer, phone, or tablet) downloads small parts of the video to play it smoothly. If your internet connection is slow or a lot of people are using the internet simultaneously, your device may struggle to download the video quickly enough. If the internet can't keep up, you'll see the spinning circle—this means it's buffering, or waiting to gather more of the video before it continues playing.

In live sports, even a few seconds of buffering can cause you to miss a big play, like a goal, a touchdown, or the game-winning basket! To prevent this, Amazon Prime Video has built systems with **redundancy**. This design means that multiple backups are in place, so if any equipment fails, there's always another system ready to step in and ensure the game continues streaming seamlessly.

Stop 2

Troubleshooting

Watch this Tour Stop in: Video 5 and Video 6

Mid-Stop Poll

How do you think Prime Video supports issues that happen on the customer's end, like high network traffic? (Select all that apply)

A. They open up more "highways" for the data to travel.

B. They send the data through space for a gravity boost

C. They hack your phone to force the stream to work.

D. They kick everyone else in your neighborhood off the Internet.

E. They kick everyone else in your neighborhood off the Internet.

Prime Video Sports also addresses issues with a dedicated team monitoring the event in real-time from a control room. If problems like high network congestion arise, Amazon uses **troubleshooting**—a systematic approach to identifying and resolving problems. For example, they might temporarily reduce the video quality, allowing the stream to require less data and continue playing without interruptions. Once the congestion clears, the system automatically switches back to the highest-quality video.

In some cases, Amazon might reroute the stream to a different Content Delivery Network (CDN) to maintain smooth, high-quality broadcasting. This proactive troubleshooting, combined with advanced technology, ensures viewers experience a smooth and uninterrupted game. From buffering to backups and redundancy, Prime Video Sports works tirelessly to bring fans the best possible viewing experience.

Stop 1

Troubleshooting

Watch this Tour Stop in: Video 5 and Video 6

Vocabulary Review Question

Software pre-loads bits of data to ensure your video-watching experience is smooth. This is called _____.

A. redundancy

B. decoding

C. buffering

D. infrastructure

Vocabulary Review Question

Thanks to ____, there is always backup equipment so the game stream can continue, even if one component fails.

A. latency

B. encoding

C. streaming

D. redundancy

Stop 2 Standards

CS Standards

Data & Analysis

3B-NI-05: Use data analysis tools and techniques to identify patterns in data representing complex systems

3A-DA-11: Create interactive data visualizations using software tools to help others better understand real-world phenomena.

3B-DA-06: Select data collection tools and techniques to generate data sets that support a claim or communicate information.

Impacts of Computing:

3A-IC-26: Demonstrate ways a given algorithm applies to problems across disciplines.

Next Generation Science Standards (NGSS) Standards

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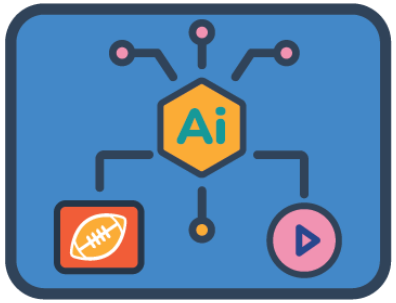
Stop 2



Building New Features

Watch this Tour Stop in: Video 7 and Video 8

How do product managers and applied scientists incorporate Artificial Intelligence into game viewing features to enhance the viewing experience for sports fans?

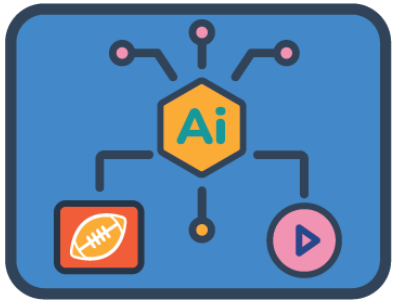
With technology constantly evolving, Amazon is continuously finding innovative ways to enhance the sports viewing experience. Prime Video Sports gathers customer feedback and collaborates with teams to identify new features viewers want—ideas captured in user stories, which explain features from the customer's perspective. For example, fans might request features like alerts for a defensive blitz during an NFL game or highlights of key plays.

Imagine you want to watch a game but need to finish your chores first. When you finally press play, the game is already halfway over! Your favorite team is winning, but how did they score? In the past, you might have had to tape the game and start from the beginning, missing the live action, or rely on a friend to explain what happened.

Mid-Stop Review Question

Product managers write ____ from the perspective of a customer to identify what features to build in the future.
A. Artificial Intelligence B. redundancy C. poems **D. user stories**

Stop 3



Building New Features

Watch this Tour Stop in: Video 7 and Video 8

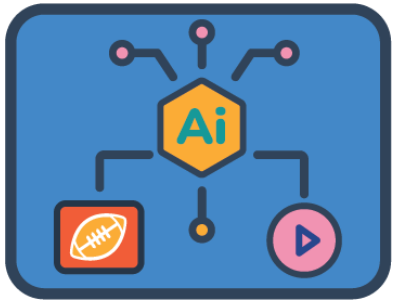
To address this, product managers worked with applied scientists to introduce Rapid Recap, a feature that provides a quick summary of significant moments so viewers can catch up to the current game progress.

How does Rapid Recap work? Through **Artificial Intelligence (AI) and Machine Learning (ML)!** Engineers trained computers with thousands of plays across multiple games, tagging key moments like touchdowns, goals, or big defensive stops. From these examples, the computers learned to recognize which plays are important for a recap.

During broadcasts, **computer vision**, a type of machine learning that allows computers to interpret and understand images and videos, enables the software to "see" and analyze the game in real-time. It detects significant moments, compiles them, and generates a summary that fans can quickly watch before rejoining the live event.

By leveraging these advanced technologies, Amazon delivers a more engaging and personalized viewing experience, making it easier for fans to stay connected and enjoy the action, no matter when they tune in.

Stop 3 Standards



CS Standards

Computing Systems:

3A-CS-02: Illustrate ways computing systems implement logic, input, and output through hardware components.

Data & Analysis:

3A-DA-09: Translate between different bit representations of real-world phenomena, such as characters, numbers, and images.

3A-DA-11: Create interactive data visualizations using software tools to help others better understand real-world phenomena.

3B-DA-06: Select data collection tools and techniques to generate data sets that support a claim or communicate information.

CS Standards (Continued)

Algorithms & Programming:

3B-AP-21: Develop and use a series of test cases to verify that a program performs according to its design specifications.

3B-IC-24: Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems.

Polls

Poll

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

A – Producer
B – Technical Operations Manager
C – Live Events Support Engineer
D – Product Manager
E – Applied Scientist

Rate your overall tour experience on a scale of 1-5

1 - Extremely Unsatisfactory
2 - Unsatisfactory
3 - Neither Unsatisfactory or Satisfactory
4 - Satisfactory
5 - Extremely Satisfactory

How interested are you in pursuing careers in technology?

1 - Very uninterested
2 - Uninterested
3 - Neither interested nor uninterested
4 - Interested
5 - Very interested

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

1 - Decreased
2 - No change
3 - Increased

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

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

Stop 4

Conclusion

Watch this Tour Stop in: Video 9

How does Prime Video Sports enable millions of people from around the globe to stream a sporting event at the same time?

Watching sports today involves a lot more than just tuning into a game. We learned that from the early days of sports broadcasting in 1911 to today's high-definition streams, technology has transformed how we enjoy sports. Amazon Prime Video Sports uses a combination of advanced technology and teamwork to deliver live sports to millions of viewers around the world.

Infrastructure - including hardware, software, and people - work together to bring the game from the field onto devices. People and software work together to monitor and troubleshoot when issues arise to provide the best experience for customers. Artificial Intelligence and Machine Learning are used to build new features that innovate on sports broadcasting and enhance the stream for sports fans around the world.

There are many exciting careers in sports beyond being an athlete. From data analysis and engineering to content creation and software development, there’s a place for everyone with diverse skills and interests in the world of sports media. Whether you’re passionate about technology or sports, you can find a role that fits you!

Rapid Fire Review

Review

Examples of ____ used in producing sports streams include high-definition cameras and microphones.

A. encoding
B. software
C. hardware
D. rules

Hardware and software _____ video and audio data so it can be sent to devices over the Internet.encoding

A. encode
B. troubleshoot
C. buffer
D. save

When viewers report streaming issues, the tech team begins _____ to identify and fix the problem quickly.

A. troubleshooting
B. celebrating
C. advertising
D. coaching

When there is a lot of network traffic, engineers can open up more _____ so data can get to fans without delays.

A. software
B. Content Delivery Networks (CDNs)
C. tickets
D. latency

A type of Artificial Intelligence called _____ tags exciting moments from games to create a custom recap for fans.

A. buffering
B. troubleshooting
C. computer vision
D. athletes