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Cloud Gaming: Current Trends and Future Prospects

Chhaya Porwal[1*], Sonu Airen[2], Puja Gupta[2]

[1]Data Specialist, Larsen & Toubro InfoTech (LTI) USA
[2]Assistant Professor, Shri G.S. Institute of Technology & Science, Indore, M.P. India

Abstract
Cloud gaming is a new way to deliver high-quality gaming experience to gamers around the world with any time-zone restrictions. In cloud gaming, a new sophisticated software often an emulator or simulator catering to the game's actual files runs on powerful remote servers in data centres, and rendersthe game scenes which are streamed to gamersover the Internet in real-time, as if gamers are playing the game on their own machines. Gamers use light-weight software executed on heterogeneous devices to interact with thegames. Due to the proliferation of high-speed networks and cloudcomputing, cloud gaming has attracted tremendous attentions inboth the academia and industry since late 2000's. In this paper,we survey the latest cloud gaming research from different aspects,spanning over cloud gaming platforms, optimization techniques,and commercial cloud gaming services. The readers will gain an overview of cloud gaming research and get familiar with the recent developments in this area.
The research analyses critical elements that will influence the industry's future by examining a variety of cutting-edge products and services, including Microsoft XCloud, Nvidia GeForce Now, and Google Stadia. The report ends with recommendations for resolving technical and commercial issues as well as forecasts for the upcoming wave of cloud gaming platforms.

Keywords: Cloud gaming, distributed computing, computer graphics, Nvidia GeForce Now, Google Stadia, XCloud

I. INTRODUCTION

Cloud gaming has emerged as one of the most populartechnology in the gaming industry. With the proliferation of high-speed internet and advanced cloud computing capabilities, gaming now doesn't requires expensive PC's. Gamers can now play games directly on their minimalistic devices using cloud similar to watching videos onNetflix.Startups including OnLive, Gaikai, G-Cluster, and Ubitus began to provide cloud gaming services in the late 2000s. We also saw the acquisition of Gaikai by SONY, a significant game console developer. This was followed by rivalry in the cloud gaming business between Nvidia's Grid Game Streaming Service and Sony's PlayStation Now (PS Now).

Background and context:

The gaming industry has grown tremendously over the past few years as advancement in technology has led to the gaming experience. Previously, the game was limited to consoles and PCs, requiring limited

access and significant investment in hardware. However, with the advent of mobile devices and the development of high-speed internet, the game has become accessible to a wider audience.

Problem Statement

Cloud gaming is not as fascinating as it first appears because of a number of problems, including expensive infrastructure costs, latency, bandwidth restrictions, and data privacy. These difficulties cast doubt on cloud gaming's scalability and capacity to displace established gaming platforms.

Significance of the Study

Understanding present trends and laying the foundation for future advancements in cloud gaming thus providing valuable insights of the technology's future are the major objectives of this study. By examining technological breakthroughs and industry constraints, the paper seeks to throw some light on the trajectory of cloud gaming platforms.

Research Objectives

The key objectives of this study are:

- To identify the current trends and technologies in cloud gaming.
- To identify the loopholesof the cloud gaming platforms.
- To provide a way for future advancements and develop new technologies in the industry.

This research paper is broken up in various sections. The following section, section 2, examines the body of research on cloud gaming and its applications as well as current developments in the field. Section 3 delineates the research technique employed. The study's findings are presented in Section 4. The consequences of these findings are covered in Section 5, and future study prospects are discussed in Section 6, finally the conclusion and the references sum up the paper.

II. THE HISTORY OF VIDEO GAMES / Literature Review

Evolution of Cloud Gaming

Console games became increasingly popular in the early 2000s with the introduction of Sony's PlayStation 2 and Microsoft's Xbox. Three companies were now competing for the annual market revenues, Microsoft with their Xbox, Sony with their PlayStation, and Nintendo with their GameCube. While consoles were becoming increasingly more popular for video gameplay. Computer-based games were still the most frequently used medium to play video games. The technology was now rapidly developing, leading to the introduction of the PlayStation 3, the Xbox 360 and Nintendo's Wii, which

were all announced in the middle of the 2000s. During this decade there was a revolution within the video game industry which came in three stages. The first change was the massive development of internet bandwidth and connectivity. This led to the rise of Massive Multiplayer Online games (MMOs) and at the same time the rise of downloadable games which decreased the popularity of cartridge and CDs.

The second change was the unexpected rise of casual games. Web-based games such as Bejewelled became mesmerizing for web users. This happened in 2001 but it was not until Nintendo's release of the Wii that it really became popular. The last part of the revolution that happened in the 2000s came with the mobile phone. Apple's introduction of the iPhone quickly became a phenomenon and it rapidly became the phone every mobile game was played on.

The 2020's and beyond

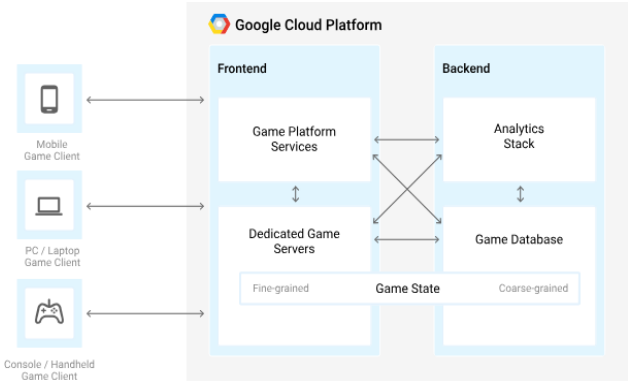
With the beginning of a new decade, we can take a sneak peek into how the video game industry will shape itself in the coming years. The technological development that might affect the video game industry the most is probably cloud gaming platforms and the ability to stream games. Microsoft and Google want to make video games as easy to stream as songs and movies. They have therefore started the projects XCloud which is Microsoft's project and Stadia which is Google's project. However, Microsoft and Google are not the only companies that want to bet on the cloud gaming platforms. Sony and Nvidia have also launched their own cloud gaming platforms, named the PlayStation Now and the Nvidia GeForce Now.

Major Actors

The video game industry can be divided into a software and hardware side. There are many major actors when it comes to the software side of the video game industry, but here the focus is on the major actors on the hardware side of the industry, due to the cloud gaming platforms being regarded as threats to consoles. The major actors on the hardware side of the industry are Nintendo, Sony, Microsoft, with Nintendo being the oldest company in this industry and Microsoft being the youngest. Every major actor has one console each that is dominant in the video game industry and has been dominant for over many decades.

Nintendo

Nintendo entered the video game industry back in 1986 just a few years after the great videogame crash and quickly became a dominant company in this industry. The reason for this is because they entered the industry when it was "new" and there were therefore no competitors in the industry at that time. However, Nintendo is now the smallest of the three dominating companies on the hardware side even though they are the oldest company. The main reason for Nintendo's loss in advantage in the video game industry is due to the size of the companies that entered the industry after Nintendo. Sony and Microsoft were already behemoths in their own industries prior to entering the video game industry.



Current Scenario of Cloud Gaming

Infrastructure as a Service for Cloud Gaming (IaaS):

Infrastructure as a Service (IaaS) is a cloud service model in which cloud service providers provide virtualized services to users over the Internet. In the context of cloud gaming, IaaS supports the deployment of virtual machines with high-performance GPUs and CPUs for work and games. Cloud gaming providers use IaaS to build powerful databases with custom gaming hardware capable of running resource-intensive games at scale.

Platform as a Service (PaaS) for Game Development and Distribution:

Platform as a Service (PaaS) is another cloud computing platform that simplifies the development, testing, and deployment of applications without requiring complex processes to be managed. In the context of cloud gaming, PaaS allows game developers to focus on building a gaming experience without worrying about hardware limitations. Cloud gaming platforms often provide PaaS solutions to game developers, providing tools, development tools, and libraries to develop game code for one round of gaming in the cloud (I. Saraswat & Tripathi, 2020)

Software as a Service (SaaS) for Game Delivery:

Software as a Service (SaaS) is a cloud computing model in which software applications are delivered over the Internet on a subscription basis. In the cloud gaming world, SaaS is the final step in the process of delivering games to end users. Cloud gaming services leverage SaaS to give gamers access to their favourite games without needing to copy or download them.

Streaming technologies and protocols used in cloud gaming:

Cloud gaming platforms rely on a variety of streaming technologies and protocols to provide smooth and responsive gameplay. Thistechnology is designed to reduce latency, improve video quality and adapt to changes in the network.
Some popular streaming technologies used in cloud gaming include:

Adaptive Bitrate Streaming: This tool adjusts the video quality in real time based on the user's internet connection. It delivers the best performance without interruptions or buffering, ensuring a consistent experience.

H.264 and H.265 (HEVC) video codecs: These video codecs are mainly used to compress and decompress video streams (2. Barman & Martini, 2021). They effectively encode video data, reducing bandwidth shouldn't have a positive effect.

WebRTC (Web Real-Time Communication): WebRTC is a collection of communication protocols and APIs that provide real-time communication between people interacting on the web (3. Di Domenico et al., 2021). Used more in cloud gaming for low latency, real-time interaction. QUIC (Fast UDP Internet Connection)

Overall, cloud gaming technology represents the convergence of cloud computing, streaming and gaming experience. It gives gamers access to a huge library of games across multiple devices without the cost of hardware upgrades.

III. CLOUD GAMING SERVICESAND PROVIDERS

In recent years, a lot of attention has been paid to cloud gaming, which has led to the emergence of many cloud gaming services and service providers. These platforms provide gamers with a large library of games that can be sent directly to their devices, eliminating the need for expensive hardware.

In this section, we'll cover some of the best experiences in cloud gaming and service providers by discussing their features, business models, and business practices.

Google Stadia: Google Stadia is one of the most famous cloud gaming platforms released by the tech giant Google in November 2019. Stadia allows players to play high quality videos on various devices such as smartphones, tablets, computers, and smartphones (Iqbal et al., 2021). TVs. The service has both free and paid versions; the latter offers an extensive library of games and improved streaming quality. Google Stadia uses Google's global data centres to provide excellent gameplay and performance.

NVIDIA GeForce Now: Developed by NVIDIA, GeForce Now is a cloud gaming service that allows gamers to access their current game library from popular digital distribution platforms such as Steam and the Epic Games Store. Users can stream their games to a variety of devices, including PCs, Macs, and NVIDIA Shield devices. GeForce Now offers free and paid memberships where premium customers get unlimited access and longer playtime.

Microsoft Xbox Cloud Gaming (formerly Project XCloud): Xbox Cloud Gaming is a cloud gaming service integrated with Microsoft's Xbox Game Pass Ultimate subscription. It allows gamers to stream various Xbox games to the device, with support for other platforms planned in the futureXbox Cloud Gaming provides access to a growing library of games and is tightly integrated with Microsoft's Xbox ecosystem.

PlayStation Now: PlayStation Now is Sony's cloud gaming service available on PlayStation consoles and Windows PCs. It has a large library of PlayStation games that can be watcheddirectly or downloaded for offline play. PlayStation Now allows users to access a variety of old and modern PlayStation games, making it an attractive option for fans of Sony's exclusive games.

Amazon Luna: Amazon Luna is a cloud gaming platform created by Amazon that gives gamers access to its diverse catalogue of games through subscription channels (4. Wibowo & Duong, 2021). Luna+ is a simple channel with a variety of games, while other channels have exclusive content from publishers like Ubisoft. Luna is compatible with various devices such as Fire TV, PC, Mac and iOS devices via the web app.

Tencent START: Tencent START is a cloud gaming service provided by Tencent, one of China's leading technology conglomerates. The platform gives players access to a variety of games from various developers and publishers. Tencent START aims to develop trade in China, one of the largest and most powerful countries in the world.

Sony PlayStation Remote Play: Sony has a remote play station that allows users to stream PlayStation games from their consoles to compatible devices such as smartphones, tablets and PCs. While not a full-fledged cloud gaming service, Gaming Remote allows gamers to enjoy PlayStation games on a larger screen without a TV.

Parsec: Parsec is a cloud gaming platform that allows users to stream games from gaming PCs to other devices. It offers low-latency streaming and supports multiplayer gaming, making it popular with gamers who want to expand their games to different screens. These are just a few examples of cloud gaming services and providers available in the market. As the demand for cloud gaming continues to grow, more companies and gaming platforms may enter this space to offer gamers more choice. Each service has its own unique features, pricing model and library of games to suit different interests and gaming needs. Competition in the cloud gaming industry is promoting new and improved technologies, and as a result, gamers benefit from improved accessibility and a better gaming experience.

IV. Results Of Cloud Gaming on the Gaming Industry

Cloud gaming has impacted the gaming industry by changing the way games are presented, accessed and played. This chapter explores how the cloud gaming industry is impacting all aspects of the gaming industry, from hardware manufacturers and game developers to distribution and gaming experiences.

Impact on gaming hardware manufacturers: Cloud gaming is both a challenge and an opportunity for gaming hardware manufacturers. On the other hand, cloud gaming reduces reliance on high-end gaming PCs and consoles, which will impact demand for upgraded gaming hardware. Players may prefer lower hardware as computing functions are performed by cloud servers (6. Oliver, 2022), (7. Moser et al., 2019). But hardware companies can also adapt to the cloud gaming model by exploring new opportunities.

Impact of Game Development Design: Cloud gaming brings unique opportunities and challenges to game developers. Developers can leverage the capabilities of the cloud to create a wider game world without the limitations of native operating systems (9. Kalmpourtzis, 2019). This opens up new creative possibilities for game design, such as larger playgrounds, more artificial intelligence and updated content. However, cloud gaming also presents challenges in optimizing the game for various devices and

network conditions (10. Kultima, 2021). ensure integrity and minimize bandwidth requirements (8. Johnson & Woodcock, 2019).

Role of cloud gaming in supporting competitive gaming: Cloud gaming is a support for competitive gaming, allowing players to switch between different products while managing promotion and success. Cross-platform play has become themost sought after game in the gaming community, encouraging interaction and breaking down platform barriers living room TV.

V. User Experience and Feedback User experience (UX)

UX is an important aspect of cloud gaming as it directly affects how players perceive and interact with the service. A good user experience can lead to engagement, retention, and word of mouth, while a bad user experience can lead to frustration and abandonment. Cloud gaming service providers constantly strive to improve the user experience based on user recommendations and industry standards. User experience and feedback in cloud gaming are summarized below:

Performance and Latency: Performance and latency are the foundation of good cloud gaming. Players expect lower and lower trading strategies during the game. High latency can cause slow responses, making fast games unplayable. Cloud gaming providers are constantly working to improve their infrastructure and streaming technologies to deliver high quality gaming with low latency. User Comments: Gamers often give feedback on latency issues, buffering, and overall streaming quality. Providers use this feedback to identify network conflicts, improve data transfer, and improve server performance.

Video Quality and Resolution: Video quality directly affects the visibility of the game. Cloud gaming services attempt to deliver high-quality graphics while maintaining visual fidelity while controlling bandwidth usage. Adaptive streaming algorithms dynamically adjust the video resolution according to the user's internet connection to deliver the best quality. User Comments: Users often share their thoughts on video quality, including concerns about graphics, blur and pixelation.

Game Library and Availability: The number and availability of games in the cloud game library make users happy. A wide variety of popular and niche games appeal to a wider audience, while partnerships with private brands and game developers increase the platform's appeal. User Comments: Players frequently express their preferences for certain games, mods or game updates. Providers take this information into account to expand their games and enter into licensing agreements with developers.

VI. Future trends and prospects for cloud gaming:

Cloud gaming has made great strides in the gaming industry, but its full potential has yet to be reached. As technology continues to evolve and user preferences change, many futures and prospects have to shape the challenges of cloud gaming.

Here is a breakdown of some of the highlights and expectations:

5G and edge integration: The rollout of 5G networks is expected to transform cloud gaming by providing faster and more reliable internet connectivity. The low latency and high bandwidth features of 5G can reduce input lag and improve the overall gaming experience. Additionally, the integration of edge computing and 5G can bring cloud gaming servers even closer to users, further reducing latency and improving responsiveness.

Expansion of game libraries: cloud game providers will continue to expand their game libraries, offering a wider range of games and more game genres. Exclusive collaborations with producers and publishers will become more common, providing users with access to exclusive content and creating great value across platforms.

Integration with gaming hardware: cloud gaming services can be more seamlessly integrated with gaming hardware. This may include working with console manufacturers to enable cloudgaming directly on consoles, or smartphone manufacturers to pre-install cloud gaming apps on devices.
Cloud Gaming Subscriptions and Bundles: Subscription-based cloud gaming services such as Xbox Game Pass and PlayStation Now are expected to increase. Providers may offer additional subscription levels by offering different levels of access to games and benefits such as exclusive content or discounts on purchases.

Cloud Gaming on Smart TVs and IoT Devices: As Smart TVs and Internet of Things (IoT) devices become available, cloud gaming providers will focus on expanding their services across platforms. This will allow gamers to access cloud gaming services directly on smart TVs or IoT-enabled devices without the need for special gaming hardware.

Augmented Reality and Virtual Reality in Cloud Gaming: Cloud can explore gaming, augmented reality (AR) and virtual reality (VR) experiences. As VR and AR technology matures, cloud gaming providers can deliver similar gaming experiences that combine virtual content with the real world.

Cloud gaming via web browser: The cloud gaming platform can create a web-based client that allows gamers to access games directly from a web browser without installing additional software. This could open cloud gaming to a wider audience with less equipment.

Cloud Gaming Integration with Social Media:
Cloud gaming providers can integrate most of the gaming experience with social media platforms. Gamers can create a connection between the gaming community by sharing the importance of the games, achievements and challenges directly on their social media channels.

Cloud gaming applications in education and training: Cloud gaming technology can be used for more than just entertainment. It can be used for education and training purposes, creating interactive and educational experiences. Gamified learning content and virtual learning simulations will become more common.

Hybrid Cloud Gaming Model: The hybrid cloud gaming model may emerge, providing a combination of local operation and cloud streaming. This approach optimizes the gaming experience according to the game's requirements, the user's internet connection, and the device's capabilities.

VII. Conclusion

All in all, cloud gaming is a transformative technology that is reshaping the gaming industry and revolutionizing the way games are accessed, played and enjoyed. It uses the power of cloud computing and high-speed Internet to provide users of various devices with a seamless, seamless gaming experience. As we've discovered throughout this discussion, cloud gaming has many advantages and promises for the future of gaming.

The introduction of cloud gaming has lowered the barrier to entry for gamers who no longer need expensive gaming equipment to access quality games. This accessibility opens up gaming to a wider audience, including those who previously couldn't afford to buy high-end gaming gear. Cross-platform compatibility is another benefit of gaming in the cloud. Players can start the game on one device and continue on another, with unmatched ease and convenience. These features improve gameplay by allowing players to stay connected and engaged across multiple screens. In addition, cloud gaming provides game developers the opportunity to use the flexibility and power of cloud servers to create global and more complex games. It also allows developers to apply regular updates and patches that improve the overall gaming experience without the need for users to download or install the update.

However, cloud gaming also faces some challenges, especially latency and bandwidth requirements. The success of cloud gaming largely depends on the security and speed of the user's internet connection. High latency and slow internet speed cause input lag and poor visibility, affecting gameplay.With continued research and technology to address these issues, the future of cloud gaming looks promising. Advances in 5G, edge computing, advanced streaming algorithms and machine learning will further strengthen the performance and accessibility of cloud gaming. As cloud gaming continues to evolve, it will pave the way for more immersive experiences, interactive and virtual reality, and new games. It also goes beyond entertainment and finds use in education, training and other fields.

Finally, to conclude, cloud gaming represents a paradigm shift in the gaming industry and provides a promising vision for the future of gaming. Thanks to continuous research, technological advances and a user-centered approach, cloud gaming is a great place to provide a more integrated experience, practical and enjoyable gaming experience to gamers around the world. As cloud gaming becomes mainstream, it has the potential to shape the gaming landscape and influence the way we play and interact with games for years to come.

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