Gaming as a Service for multiuser resource-demanding gaming environments with massive hardware requirement - A Reflection

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Abstract

Cloud Computing, often referred to as on-demand computing, is a technology that provisions the computing resources promptly and seamlessly through a web interface based on the discrete requirements of individuals and enterprises. Cloud Computing has gained a lot of popularity in the past ten years although the concept of cloud computing is not new. Cloud Computing complimented with Virtualization technology yields enormous benefits for organizations ranging from significant cost benefits to minimal administration overhead, elimination of resource procurement, resource planning, and estimation, to name a few. Cloud Computing comes with basic service architectures such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS); however, many other service architectures have been proposed in the past that provide discrete and unique services to a specific group of people or organizations. This research study proposes a cloud service architecture that may comprehensively meet the requirements of gamers especially those playing games that required rich computing resources for normal functioning and hence deprive those users who may not have high-end hardware & software resources. This research study proposes a service architecture called Gaming as a Service (GaaS) for resource-demanding gaming applications.

Introduction:

Cloud computing refers to the technology by which computer resources (e.g. hardware, software, infrastructures, storage, etc.) can be shared over the internet. It uses a technology called Virtualisation, which builds layers of abstractions to allow the cost-effectiveness of the cloud (What is IaaS, 2012). Virtualization also supports resource scalability and segregates the software and hardware. Abstraction represents essential information to users and hides the technical details to reduce hardware complexity (Khillar, 2020).

Today, multiple could architectures have been proposed (Bhat, Singh, & Singh, 2017) (Bhat, Kameshwari, & Singh, MathCloud: A Discrete Cloud Implementation to Enhance Learning Experience in Mathematics, 2020) (Bhat, Naidu, & Singh, 2019) (Bhat, Singh, & Mohsin, Cloud Implementation to Assist Teachers of English to Speakers of Other Languages in HEI's in Sultanate of Oman, 2021). Apart from these service models that have been utilized for a variety

of different specific purposes, three significant cloud service models are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS provides virtualized infrastructure components over the internet i.e. hosted by the cloud provider. PaaS provides a platform for developers to develop their applications over the internet. SaaS provides users with usable software applications like MS. Word etc.

Cloud computing has played a significant role in many areas, some of the areas that use and benefits from cloud computing are education, research, e-commerce, Internet of Things, Smart City establishment, enterprise networking, IT service, etc (Bhat A. , Role of Cloud Computing in higher education and implementation challenges in higher education establishments in Oman and India, 2018) (Bhat, Shuaibi, & Singh, Virtual private network as a service—A need for discrete cloud architecture, 2016). The gaming industry is currently providing a form of entertainment to over 2 billion people across the globe. Types of games today include real-time simulations, match-based games, Massively Multiplayer Online (MMO) games, Player versus Environment (PvE), Player versus Player (PvP), etc., available in multiple genres such as action, strategy, e-sports, and so on. Nowadays, these games are run on different platforms such as consoles, PCs, mobile phones, etc.

Taking the First-person Shooter (FPS) game 'Battlefield V' as an instance. The recommended system requirements for PC are – 64-bit Windows 10, AMD Ryzen 3 1300X or Intel Core i7 4790 processor, 12 GB RAM, 50 GB available memory, graphics card with at least 6 GB RAM (e.g. NVIDIA GeForce® GTX 1060 or AMD Radeon™ RX 580), and a DirectX 11.1 compatible video card. These requirements take the system cost above $650, and the game is updated every month or two with fixes, and new chapters every two to four months.

In addition to the high costs of compatible devices, recent mobile phones and low-end PCs do not fulfil the minimum system requirements of these graphically demanding games. A solution to this problem is to provide these games to players as a cloud service – Gaming as a Service (GaaS). By providing gaming as a cloud service architecture, players can stream games on low-end devices in the form of pre-rendered videos. User input is taken from the player's device (thin clients) and sent to the cloud gaming to be rendered, which is then sent as a video to the thin client.

This research concentrates on providing graphically demanding games to gamers as a service through the cloud to allow streaming these games on low-end devices. Not only will this provide a form of entertainment to people without the requirement of huge investments in high-end hardware devices, allow developers to get a chance to maximize recurring revenue through methods like microtransactions, virtual currency, pay-to-play services, etc. The purpose of the article is to propose a cloud service architecture of GaaS.

Related work

Computing cloud architecture can be split into two parts: the frontend and the backend. The most basic cloud architecture consists of three layers, that have three main service architectures in them, as shown in *Figure 1*. These services aim to manage on-site resources required by the user and provide them virtually to save customer costs that would otherwise be spent on hardware and management.

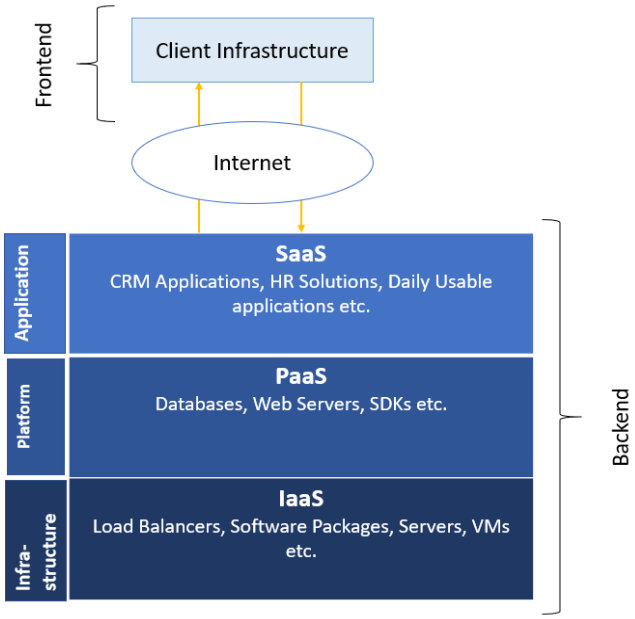

Figure 1- Basic Cloud Architecture

In their *Mastering Cloud Computing* book, Buyya, Vecchiola, and Selvi state that any service provided in cloud computing should have an autonomic behaviour for its availability and performance, which allows it to change adaptively (Buyya, Vecchiola, & Selvi, 2013).

Service architectures of cloud computing:

Figure 2 shows the resources that are managed by the customer and the service provider at each of these layers. IaaS provides virtualized servers, storage, and networks to users who can use these to handle the applications, data, operating system, middleware, and runtimes (Shea, Lui, Ngai, & Cui, 2013). This service contains the least amount of abstraction and can be used for cases like backup solutions, setting and testing development environments, etc. Examples of such service providers include AWS, Microsoft Azure, Google Cloud Platform, etc.

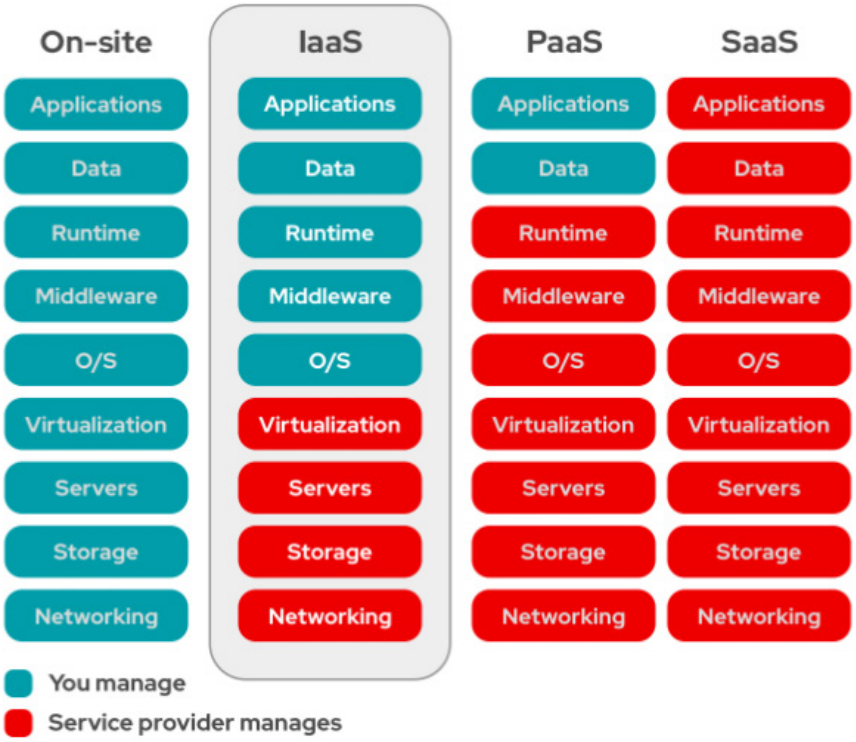

Figure 2 - Managed Service Resources

Service vendors of PaaS manage all on-site resources for their customers except for the actual application and data. It provides a platform for developers to develop, run, and manage applications without needing to build a complete infrastructure from scratch.

SaaS aims to allow users to use finished applications through the internet without needing to worry about the technical details of the resources used for the development and maintenance of that application. All resources are managed by the service provider and the customer only has access to the software application.

Use of services in cloud gaming

These services are currently being used in cloud gaming to allow users to play games through the cloud without needing high-end hardware for rendering support. Players can interact with game scenes through thin clients. Their responses are captured and sent to the cloud server to change and render these game scenes on devices that are hosted by the service providers. The newly rendered scenes are then sent to the thin client as compressed video frames that

are decoded and played to the user. A general framework for a cloud gaming platform (CGS) is described, as seen in *Figure 3* below (Shea, Lui, Ngai, & Cui, 2013).

The thin client of the cloud architecture consists of a User Interaction module that is responsible for capturing any control movements that are performed by the user (Gupta & Dutta, 2015). These can include any interactions done using any input device such as the keyboard or mouse. The thin client also includes a Video Decoder module i.e. responsible for playing video frames streamed by the server in accordance with the user input.

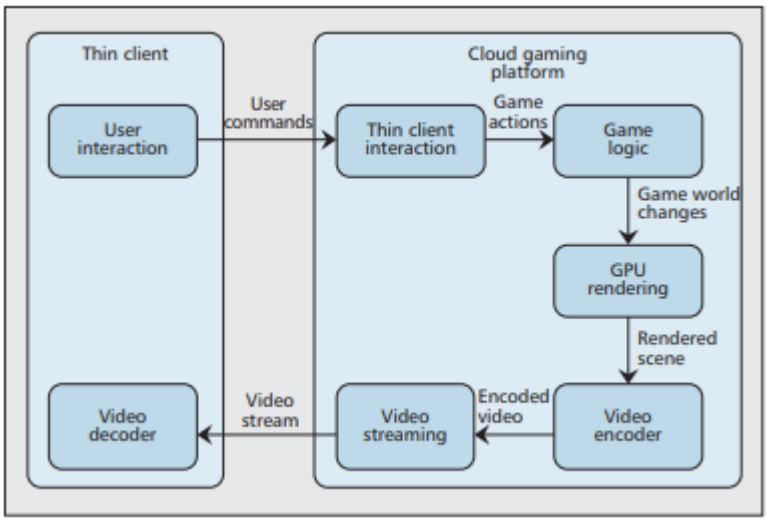

Figure 3 - General Framework of CGS

The cloud gaming platform uses a Thin Client Interaction module to convert messages sent by the client into game actions, that are then interpreted in the game world by the Game Logic module. The Game Logic module and rendered using the GPU Renderer module. The rendered scenes are then sent to the Video Encoder module that compresses the scenes and sends them to the thin client using the Video Streaming service. The thin client then decodes the video frames and plays them to the client.

Using these concepts of cloud computing and cloud gaming, the architecture of Gaming as a Service is proposed in the next section of this article.

Proposed Architecture

Gaming can be provided as a cloud service to eliminate the requirement of high-end devices for streaming graphics-intensive games. *Figure 4* shows the proposed service layers that can be used to provide gaming as a service. This service extends from the SaaS layer and includes a Backend as a Service layer for managing the game backend.

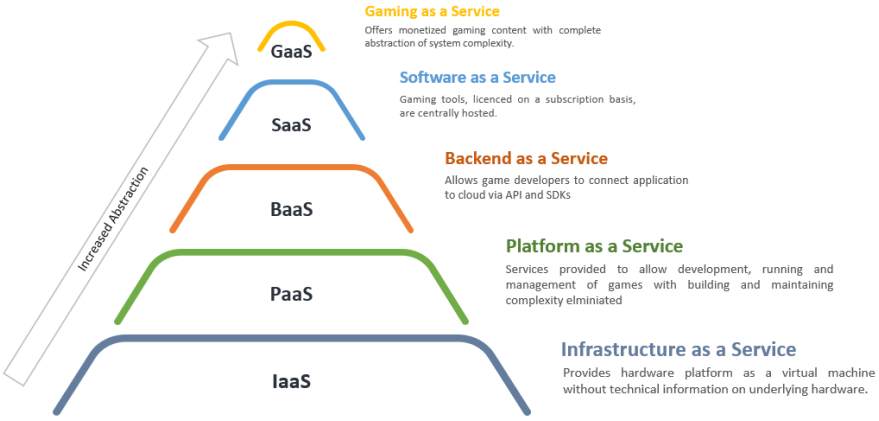

Figure 4 - Cloud Gaming Services

- **IaaS:** Infrastructure as a Service provides a combination of cloud hosting platforms and services for managing the run-time environment and application data of the game.
- **PaaS:** The Platform as a Service layer allows developers to develop and maintain games without needing to worry about the construction and management of the system infrastructure (i.e., handled at the IaaS layer)
- **BaaS:** Backend as a service provides database management, hosting, user authentication, etc. for gaming as a service. This allows developers to focus on the client-side features of the game such as User Interface and Client-Side Logic. It also helps remove redundancy for common features used in games (these features are developed at the PaaS layer).
- **SaaS:** Game developers use Software as a Service to host game tools (managed at the BaaS layer) that can be used by players in gameplay. These tools are generally licensed on a subscription basis. Not only does this layer allow hosting cost-effectively, but also accelerates the game management process (development, debugging, etc.). This allows the frequent release of game updates to keep players engaged.
- **GaaS:** Gaming as a Service provides gamers with a game application where all backend game processing and rendering is managed by the service provider. These games are hosted on devices owned by service providers and streamed on client devices allowing them to stream games on a variety of devices. GaaS also allows developers to monetize their games to earn profit.

The layers of services leading up to GaaS provide specified resources, as shown in *Figure 5*.

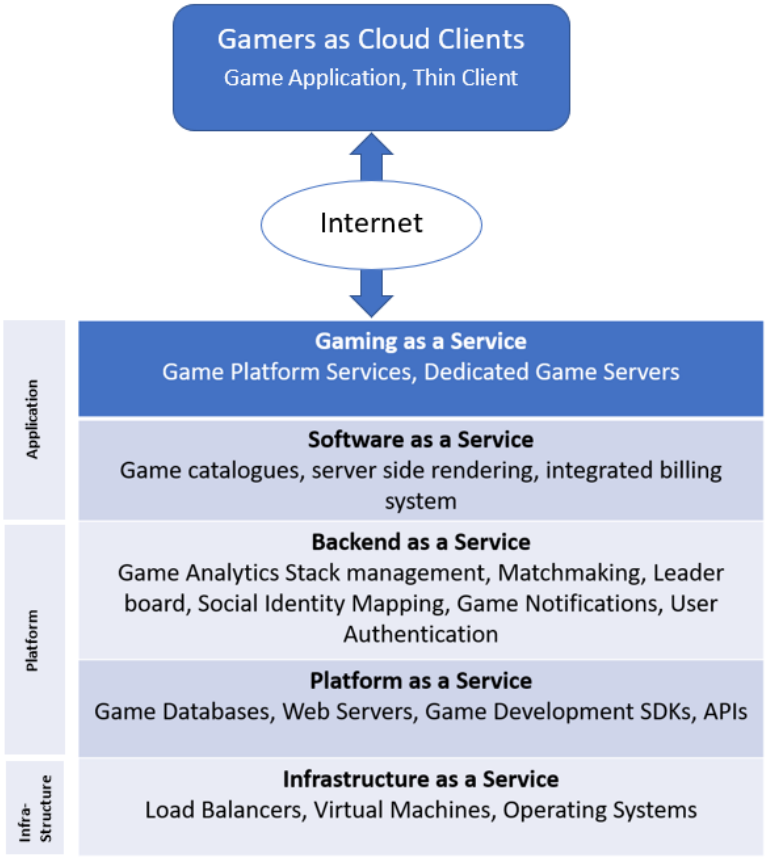

Figure 5 - Service Architecture for GaaS

This service architecture can be used to develop games and connect them to cloud clients through the internet.

Conclusion

Cloud computing has been utilized in a variety of fields to yield benefits that could not be perceived in the recent past without the availability of this incredible technology. The benefits of cloud computing are enormous, and it has completely changed the perception of how computing services can be availed and provisioned. The advent of this technology has given birth to new concepts and innovations and at the same time has also led to certain alterations that may enhance the efficiency and yield in a much better manner from this incredible technology of cloud computing. This research is an effort to provide an alteration to the cloud service architecture so that improved services can be delivered to a specific group of users. This research architecture provides specialized services to the gamers keeping in view the specific hardware and software requirements of a variety of online games. This research provides an out-an-out computing environment for gamers without the need for procuring high-end hardware or gaming & software application. The service architecture gaming as a service is expected to increase the access to resource-demanding games by 60-70 percent that otherwise were inaccessible to those users who were unable to afford the high-end

hardware and software. It is a mere effort and an idea to enhance the accessibility of gaming applications and also provides a good foundation for future research.

Acknowledgment

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