Akraino White Paper

Edge Cloud Game based on Arm architecture high performance CPU

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Applicable Users

The current white paper is intended for the following readers

- Akraino blueprint owners and developers
- Akraino blueprint integrators
- Akraino platform owners
- Cloud execution environment providers

Abbreviations

FPS	frame per second
GPU	graphics processing unit
Guest OS	guest operating system
host OS	host operating system

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LF Edge Akraino Cloud Gaming Questionnaire

Overview and Structure of Questionnaire

Cloud computing, in the traditional sense (central cloud model), faces many challenges such as bandwidth, delay, connection quality, resource allocation, and security. To cope with the dilemma brought by applications and scenarios that traditional cloud infrastructure may not be able to meet, data can be collected, transmitted and processed more efficiently and in a more targeted manner on the device side, The concept of edge computing came into being. Cloud computing capabilities are migrated from "centralized" computer rooms to edge nodes for network access. In this way, a high-performance, low-latency, and high-bandwidth service environment are created, and the response speed of various content, services and applications in the network is accelerated, allowing consumers to enjoy an uninterrupted high-quality network experience.

As mentioned above, the biggest challenge for cloud gaming is real time (latency), which is closely related to the gaming experience. For the real time performance of cloud games to reach a level acceptable to players (about 50ms), it not only depends on the performance of the hardware and the network itself, but also requires sufficient bandwidth. Therefore, the combination of edge computing and cloud gaming is logical.

In the whole process, edge computing, as a supplement to computing resources, can effectively solve the delay, bandwidth, cost and other problems faced by cloud games.

Firstly, cloud game instances deployment on Edge to greatly reduce cloud game latency. Deploy cloud game instances on edge nodes widely distributed across the country and around the world. Through intelligent scheduling technology, according to the user's region, network, game computing power requirements, etc. the nearest cloud game instance is allocated to the user, so as to realize the nearest access, the nearest rendering, and reduce the transmission. This link greatly reduces the average latency of cloud gamers around the world.

Secondly, cost-effective edge bandwidth helps optimize cloud game traffic costs. Cloud gaming image quality is another key element of the cloud gaming experience. The higher the image quality requirements, the higher the requirements for resolution, frame rate, bit rate, etc., and the higher the requirements for network throughput, that is, the higher the requirements for network bandwidth. If the bandwidth is insufficient, packet loss will occur, resulting in screen freezes, tearing, and blurry screens. Only the network bandwidth ≥1.6×average bit rate can basically guarantee the cloud gaming experience. Taking "League of Legends" running at 1080P@144fps on a PC monitor as an example, at an average streaming bit rate of 30Mbps, a bandwidth of more than 48Mbps can provide a relatively stable and good picture experience.

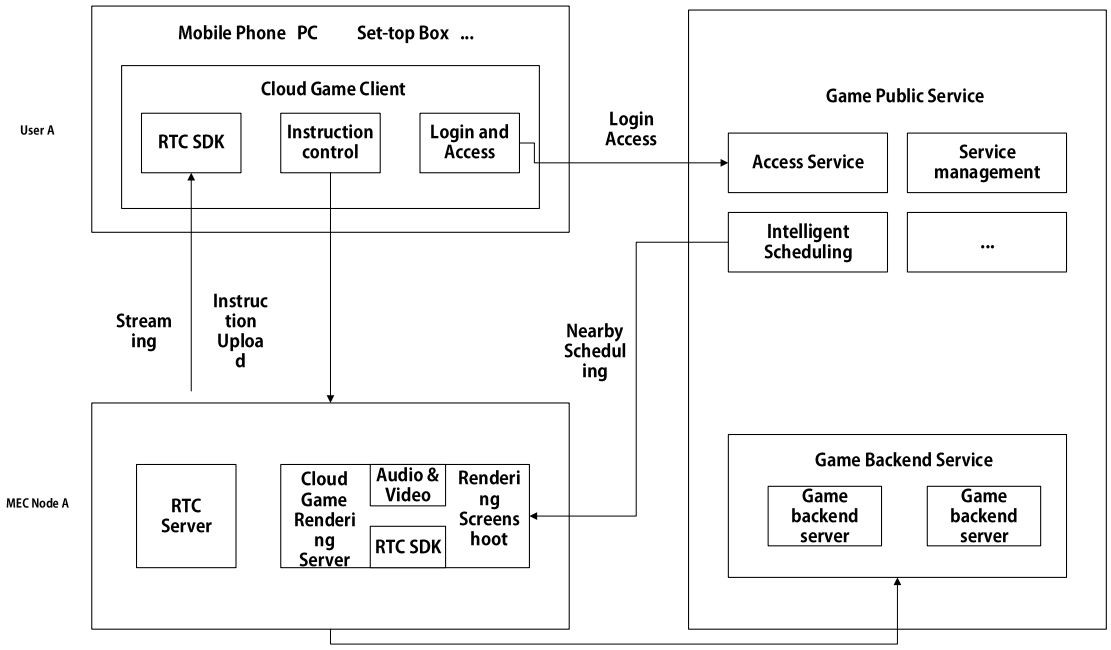
Bandwidth cost is one of the main expenses of cloud gaming service providers. From the perspective of the current bandwidth market, the bandwidth cost of edge nodes widely distributed in second-, third-, and fourth-tier cities is 1/6~1/10 of the bandwidth cost of the central cloud). Therefore, deploying cloud game instances through edge computing and utilizing edge bandwidth greatly reduces the demand for central cloud bandwidth, thereby effectively reducing cloud game bandwidth costs.

Thirdly, distributed deployment of edge computing to improve the overall concurrency capability. Similar to traditional games, cloud games will go through a start-up period, a growth period, a golden period and a recession period. Therefore, flexible on-demand resources are also required to meet business needs at different stages. At the same time, in unexpected scenarios such as big promotions, computing human resources and bandwidth resources can be quickly expanded on demand. At present, the edge computing services of various cloud service providers not only support daily and monthly resource billing, but also support more fine-grained billing methods, helping cloud game service providers to refine on-demand operations at the resource level.

Fourthly, the rich cloud services of edge computing help the efficient operation and maintenance of cloud games. Cloud games need to maintain a large number of edge computing nodes, games of different versions and types, and games are generally relatively large and frequently updated. Problems such as automatic game update distribution

and synchronization need to be dealt with in a timely manner. The rich cloud services of edge computing can help achieve efficient operation and maintenance of cloud games. For example, the grayscale release of cloud games can be accurately controlled through edge load balancing. With the help of edge custom mirroring and mirror preheating functions, multiple edge nodes can be specified to achieve rapid resource expansion, etc. Internet interoperability and other functions can quickly realize the update and distribution of cloud games.

Use Cases



The general cloud game business architecture is mainly composed of local clients, cloud game public services, cloud game back-end services, cloud game edge nodes, etc.

Client:

Users need to install a client that integrates cloud game-related decoding, user management, operation control and other capabilities on local devices such as mobile phones and PCs.What the client needs to do is:

- Realize user registration, login authentication, etc., and request the cloud game business platform to obtain the corresponding cloud game service.
- Send local control devices such as keyboard and mouse commands to the cloud game instance.
- Receive video and audio streams from cloud gaming platforms, and implement decoding and display.

What the Cloud game public services need to do is game access services, operation management, intelligent scheduling, etc., mainly deployed in the central cloud.

- User account opening and management, service subscription and settlement, etc.
- Operation of business scenarios, game applications, instance capacity management, etc.
- Appropriate cloud game instances are allocated to users from the cloud game instance resource pool according to the user's region, network, and game computing power.

Game background services are responsible for receiving the input of the cloud game server on the cloud game edge node for logical calculation, and returning the result to the cloud game server. Game backend services can meet the latency requirements of game services, and can be deployed on the central cloud or individually at each edge.

Cloud game edge nodes mainly use multi-region edge computing node instances as resource pools to provide a running environment for cloud games. The cloud game business platform intelligently schedules nearby cloud game instances for users based on information such as region, network, and game computing power. The platform provides instances such as X86+GPU, ARM, etc., and provides various instance specifications for different cloud games.

The game application runs on this instance. After parsing the user's local client-side instructions, it performs logical operations, rendering, screen capture, and encoding, and then pushes the stream to the user's local client through audio and video transmission such as RTC.

LF Edge Akraino Cloud Gaming business feasibility and business model analysis

Microsoft's record $68 billion acquisition of Activision Blizzard and its latest investment in Epic Games, which valued the company at $32 billion, underscore the rapid growth of the video game industry and its proliferation of consumer entertainment. Mobile gaming has become a platform for casual gaming and is poised to grow further with the help of 5G and edge computing to deliver new cloud gaming value propositions.

As mobile devices transition to the cloud, all the capabilities of the same Android smartphone you can hold in your hand can now be delivered from the cloud as a fully functional virtualized smartphone-as-a-service. Any app or mobile game that can be downloaded and played on a smartphone can now be delivered through the cloud. Just as Virtual Desktop Infrastructure (VDI) technology became the technology layer for Desktop as a Service and expanded in consumer and enterprise markets, Virtual Mobile Infrastructure (VMI) is now a definite reality and will be powered by Arm with GPUs Server acceleration, and 5G Mobile Edge Computing (MEC) technology.

Game developers and publishers no longer need to worry about the complexity of physical mobile devices and the fragmentation of the mobile OS versions needed to support their games in the marketplace. Game developers can focus on a single operating system with the best features to support the game that best delivers the intended gaming experience, regardless of the device or operating system the player is using. This simplifies development, testing, quality assurance, release and support. It also provides a "level playing field" experience for gamers. This balance means that gamers with relatively low-end or older devices will compete with rivals with the latest, advanced, high-end smartphones, while delivering the gameplay designed by developers and expected by gamers.

Streaming cloud gaming from the edge would eliminate the reliance on traditional app stores, transferring revenue-sharing models, in-game sales, inventory and marketing control to game developers or publishers. Games can be streamed directly to mobile browsers or custom players. No need to download through the app store front desk. Games are available directly from the channels players go to most, without distribution restrictions or paying storefront "taxes."

Today, mobile gaming generates more than $70 billion in global revenue, with traditional mobile smartphones and tablets growing 10% yearly. The shift to cloud gaming has the potential to go beyond casual gaming experiences, offering more games to a wider audience and delivering console gaming performance to any connected device.

Although there are multiple cloud gaming services available today, they still follow the traditional, subscription-based business model. So who can to create new business models around cloud gaming? Of course, there are also 5G mobile network operators, fiber/cable providers and even media companies that exist as cloud service providers. Bundling cloud gaming as a component of wireless, internet or media services can leverage existing infrastructure, billing systems, support and customer service. Cloud gaming can be a differentiated marketing tool for attracting new customers, and it can also be used as a loyalty tool to reduce churn.

There are other models that might leverage live sporting events to provide a real time interactive gaming experience, bringing fans closer to the action both live and remotely. These models can also step into stadium naming or broadcast partnership agreements, adding value to existing traditional brand marketing programs.

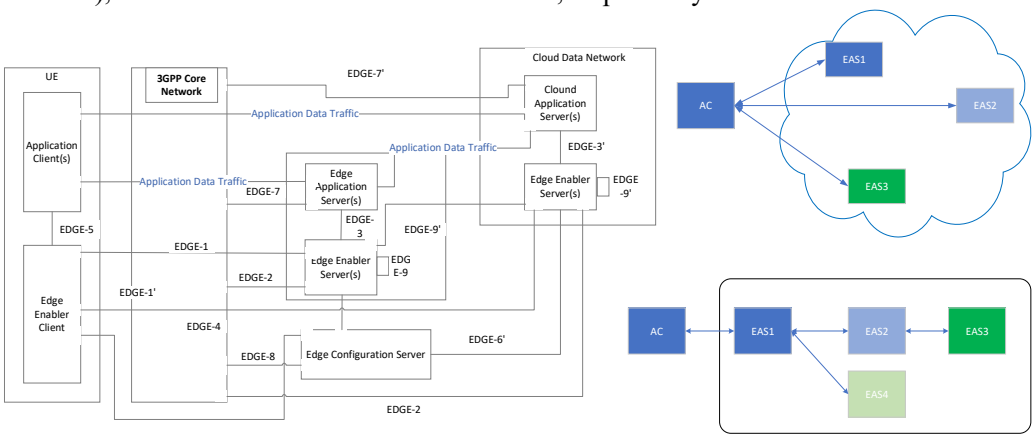
LF Edge Akraino Cloud Gaming Overall Architecture

As for 5G Advanced enhancements for enabling Edge Applications & Services, Edge Enabler Layer (EEL)procedures are designed such that Services like EAS (Edge Application Server) Discovery & Service Continuity support are performed per EAS, where individual EASs are uniquely identified using EAS endpoints (e.g. URI, FQDN, IP address).

To provide Services to the End-user a typical AC communicates with multiple endpoints i.e. multiple EASs. This creates an "EAS bundle", which impacts the support provided by the EEL. Taking an example of an Online Game where to support large Nr of Users, different Game Functions are split across Multiple Servers; like, a Game Engine for Game State &User Input Management, In-Game Chat Server for Communication between Players& a Capture Server for capturing rendered images, encoding, &transporting them to the Player's Device. If each of these EASs are
discovered, controlled, &relocated individually, it may impact the overall QoS. For e.g. ACR (Application Context Relocation) failing for the Game Engine should cancel the ACR of the capture server to maintain their proximity. In order for EAS to provide Services (e.g. Weather, Transportation, Maps, etc.) in partnership with other EASs, "EAS Context" processing & Composite EAS support may be required at Edge-compatible Layers. When ACR occurs due to UE mobility, a Method of re-arranging the Composite
EAS Context may be required to provide Continuous Service of the Composite EASs.

In addition, there may be a need for a Method for finding an EAS that provides Services to "composite EASs" within the EDN in which the UE has moved. Although EAS can discover and communicate other EAS APIs through CAPIF's functions, but for Service Continuity, it may be necessary to discover EASs providing composite EASs and relocation the context of EASs that provided composite capabilities.

The CAS (Cloud Application Server) & CES (Cloud Enabler Server) are Servers deployed in a Cloud Data Network (CDN) & EAS & EES are Servers deployed in an Edge Data Network (EDN). If certain EAS& EES in the Edge Data Network (EDN) are capable of supporting more UEs than regular Edge Server & can serve UE from anywhere (N6 routable), their roles become those of CAS&CES, respectively.



The architecture of cloud games is mainly divided into three parts: user local side, network transmission, and cloud side.

User's local terminal side:

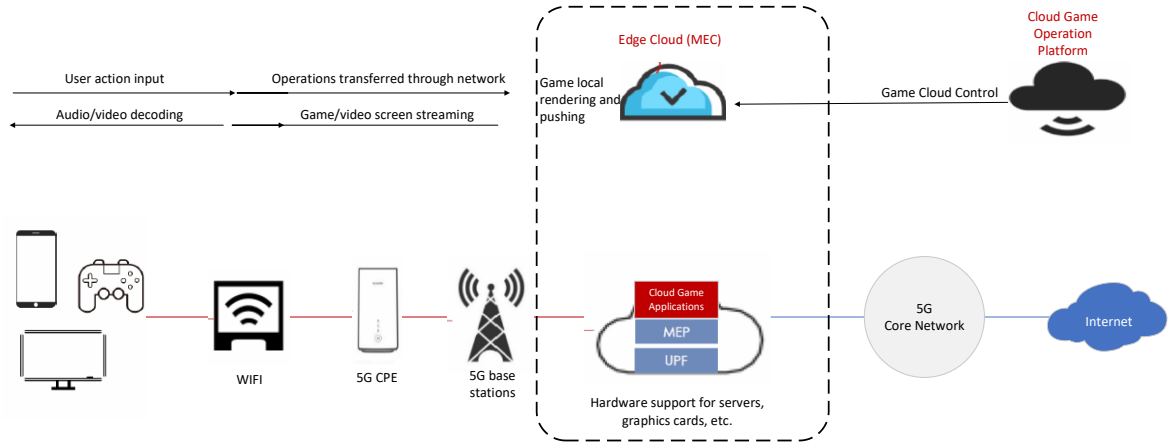
The user accesses the portal of the cloud game platform, mainly receives video streams and audio streams from the cloud game platform, and displays and presents them. at the same time, uploads the input instructions of the operating device to the cloud platform. The user's local terminal side includes a display device and an operation device. The display device mainly includes a mobile phone, a PC, a PAD, a large screen, etc.. the operation device includes a keyboard, a mouse, and a game handle.

Network transmission:

It mainly involves backbone network, metropolitan area network, access network and home network, 5G network, etc. The network transmission is responsible for connecting the cloud platform and the terminal, transmitting the real time audio and video in the cloud to the user terminal in real time and maintaining stability.

Cloud game platform side:

The cloud game platform side receives instructions from the client to implement logical computing, real time rendering, encoding, video streaming, audio streaming, etc.



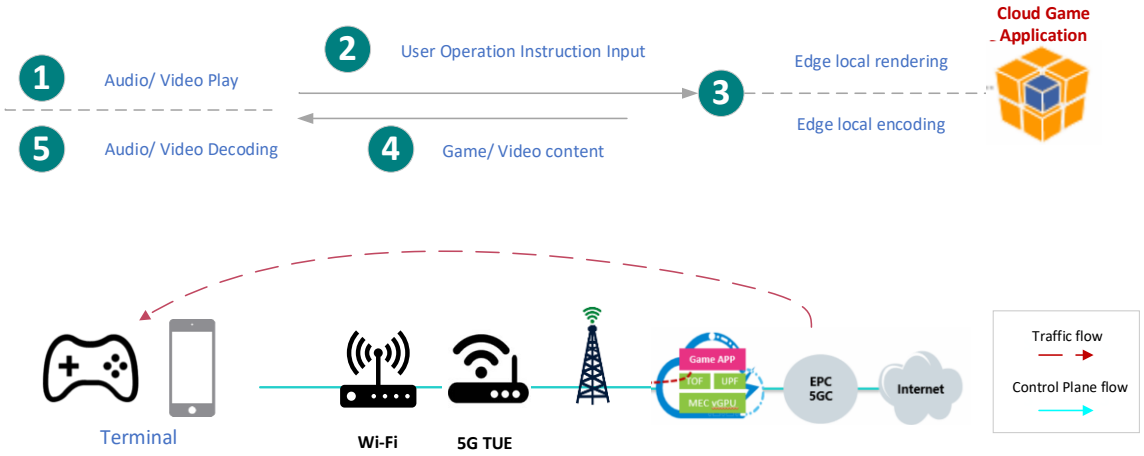
The terminal connects to the cloud game server through the 5G base station, and the cloud game server allocates game users to the nearest MEC according to the location information carried by the user. The nearest MEC provides game rendering acceleration services and provides game services with low latency and good experience.

Integrated Edge Cloud (IEC) is an Akraino approved blueprint family and part of Akraino Edge Stack, which intends to develop a fully integrated edge infrastructure solution. The project is completely focused on Edge Computing. This opensource software stack provides critical infrastructure to enable high performance, reduce latency, improve availability, lower operational overhead, provide scalability, address security needs, and improve fault management. The IEC project will address multiple edge use cases and industry, not just Telco Industry. IEC intends to develop solutions and support of carriers, providers, and IoT networks.

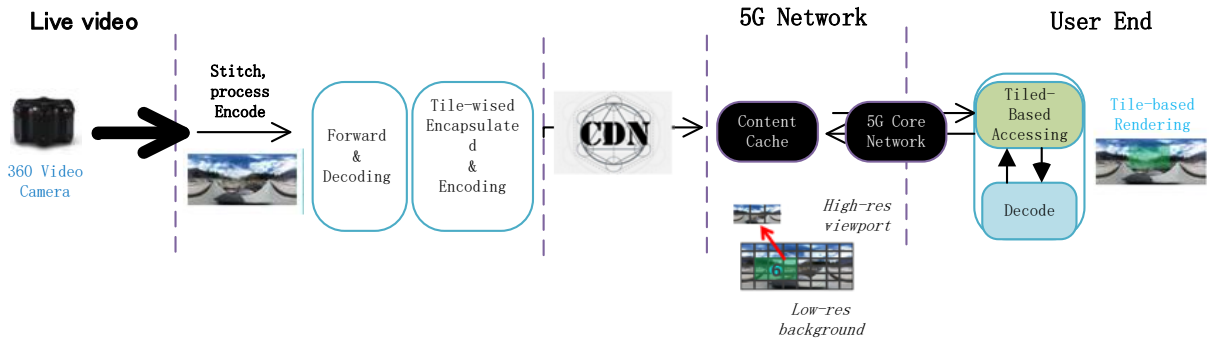
IEC Type3 mainly focus on Android Application running on edge ARM Cloud architecture with GPU/ vGPU Management. Also, ARM cloud games need to have the basic features of "cloud", such as flexibility, availability everywhere. Based on cloud infrastructure optimized for android application, providing ARM applications services such as Android cloud games and VR/AR live video.

Use Case

<use case 1: Android Cloud Game>

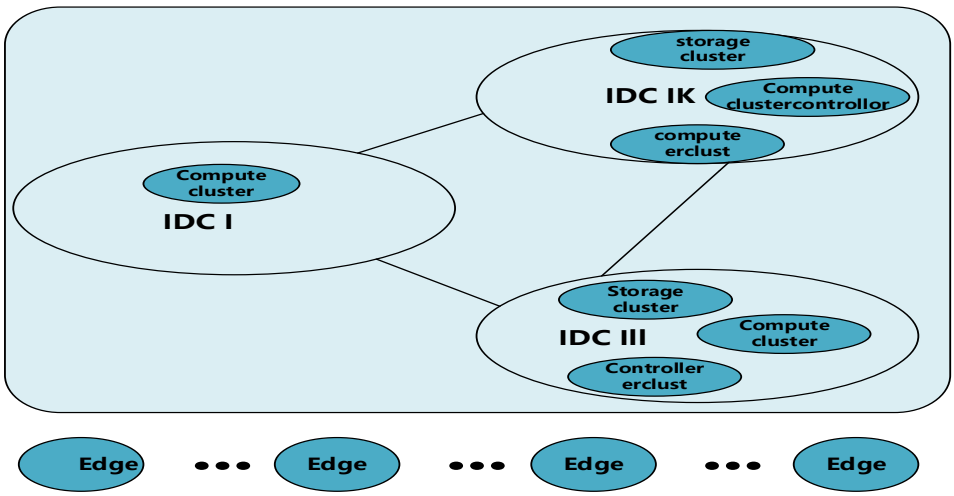


<use case 2: VR/AR Android Application> (to be discussed in the future)



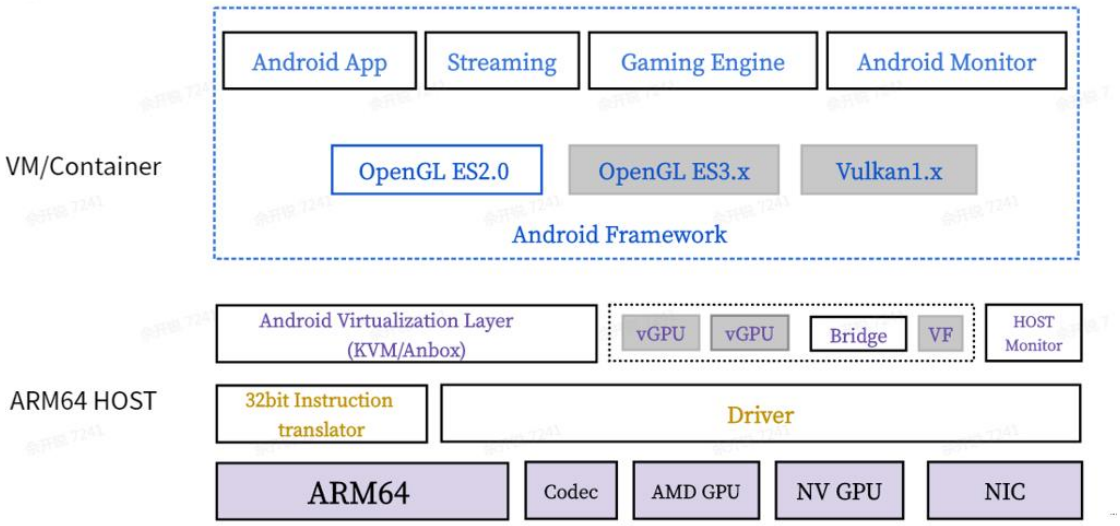
Business Drivers

- Edge cloud requires initiatives for cloud gaming on the Android platform
- 5G + edge brings low latency and high throughput for cloud gaming, which improves user experience
- More and more Android applications will migrate into the edge computing platforms. Building an android platform is necessary, and it's rigid demand.

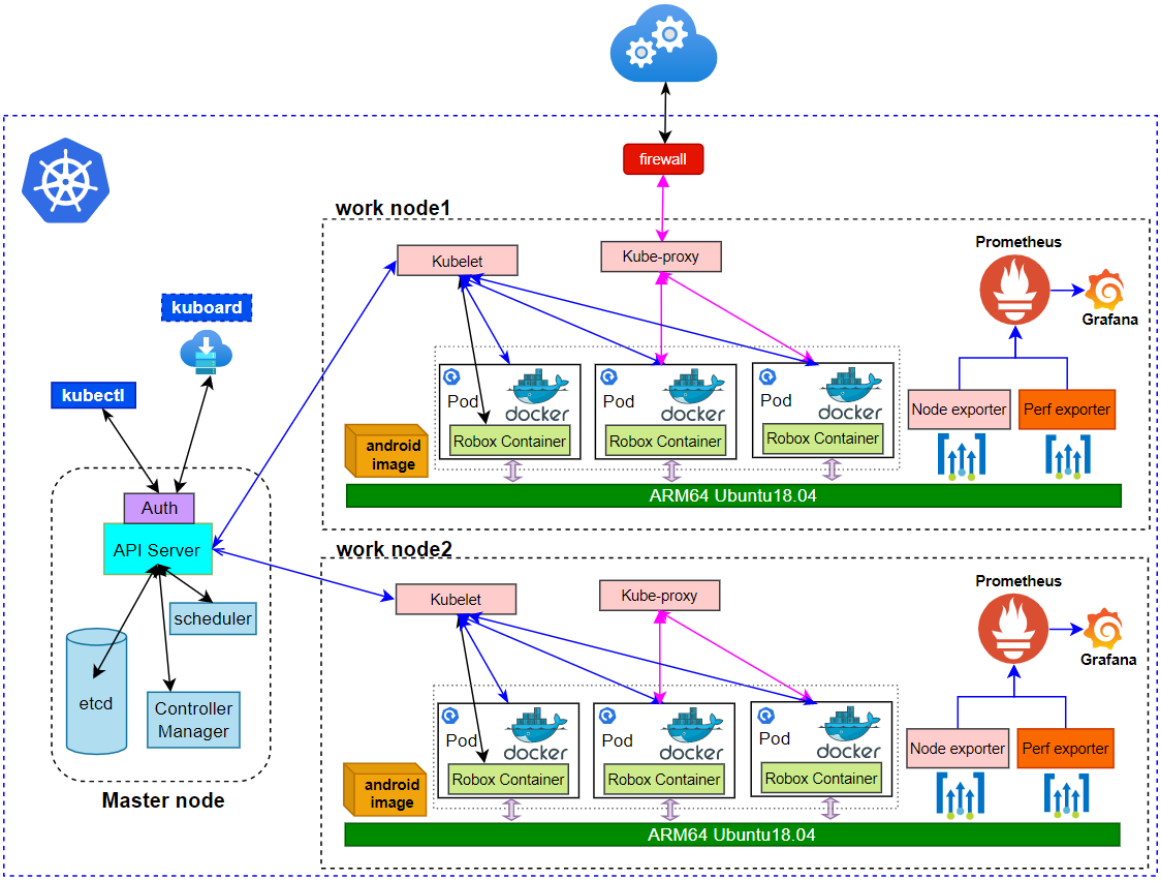


Platform Architecture

The cloud game platform architecture can be divided into two parts, the host side is a complete arm64-based Linux system, and the container side is a complete Android system image. Since the bottom layer of the Android system is a Linux system, the container is just an Android software stack, and the virtual peripherals provide the necessary environment for the Android system to run.



Anbox Cloud Game Framework



The core framework of the project is shown in the figure on the top: a cluster is composed of multiple hosts, and multiple robox pods can be deployed on the work node through the master node, and each pod is a container running anbox.

The whole project mainly includes the three major blocks on the left, the architecture foundation, pod node instance deployment and work node performance analysis.

1) For basic deployment, you first need to be familiar with the Android software stack, compile the Android firmware, After the robox components are ready, you can start the container firmware through the provided script, and finally the Android window will pop up on the desktop. At this point, you can install different Android applications on this container. You can start multiple containers. For the server, you need to connect remotely with VNC at this time, and access different containers through different ports.

2) To deploy node instances, we first need to build a k8s system, and then we can run robox on different pods through k8s by writing software. Then you can view the status of the cluster with the kuboard visualization component.

3) Performance analysis of nodes, each pod on a node can run an instance of an Android game. In order to get closer to the usage scenario, more than 20 instances are started here, and then various times of the system are extracted through perf, and then converted into a flame graph, the bottleneck of the system can be analyzed on the flame graph. At the same time, we use the popular promethues component here to monitor and analyze the system, and then use the grafana component to display the results in a better way to control the platform.

LF Edge Akraino Cloud Gaming User Experience Evaluation System

Cloud gaming can leverage sensor matrices from mobile devices to develop new gaming experiences that were previously too complex or impossible to achieve. The physical device in the gamer's hand becomes the remote sensor feed to the server-based virtual mobile device to execute the game in the data center.

Local cameras, GPS, inclinometers, and other hardware sensors are fed into the game running on a server-based virtual mobile device. For example, a gamer's physical phone GPS sensor could be the virtual location of thousands of gamers who are physically separated but actually in the same location. Even apps like Google Maps recognize GPS information on virtual mobile devices as real satellite GPS signals. This new concept of "sensor matrix" opens up a whole new realm of input for next-generation gaming experiences, as any sensor from any real or virtual phone can be used for gaming.

Gamers no longer sacrifice performance to capture their gameplay for distribution through media outlets. High-quality full-motion video can be streamed or stored in real time at no additional cost and with no latency impact on gameplay. Additionally, what was once a single-user experience can now become a multi-user experience. For example, professional gamers can coach novice clients in real time in the same mobile game. Professional players can control entire characters or parts of the game in real time, providing real time guidance to novice client players as they play together. This ability has never been offered in a mobile game before.

Many alternatives to the traditional storefronts or subscription services can change the gaming experience before a single title is played. Cloud gaming opens opportunities for game makers, publishers and virtually any digital brand to offer cloud games wherever they see fit. A beverage company could offer a seasonal sports game, accessible only by scanning a QR code placed on their product. The scan immediately opens a stream to the gameplay.

Next-generation Cloud-native ARM server chips help LF Edge Akraino Cloud gaming

Both cloud games and mobile cloud applications use ARM servers, and games and mobile applications are run on the ARM servers in the cloud.

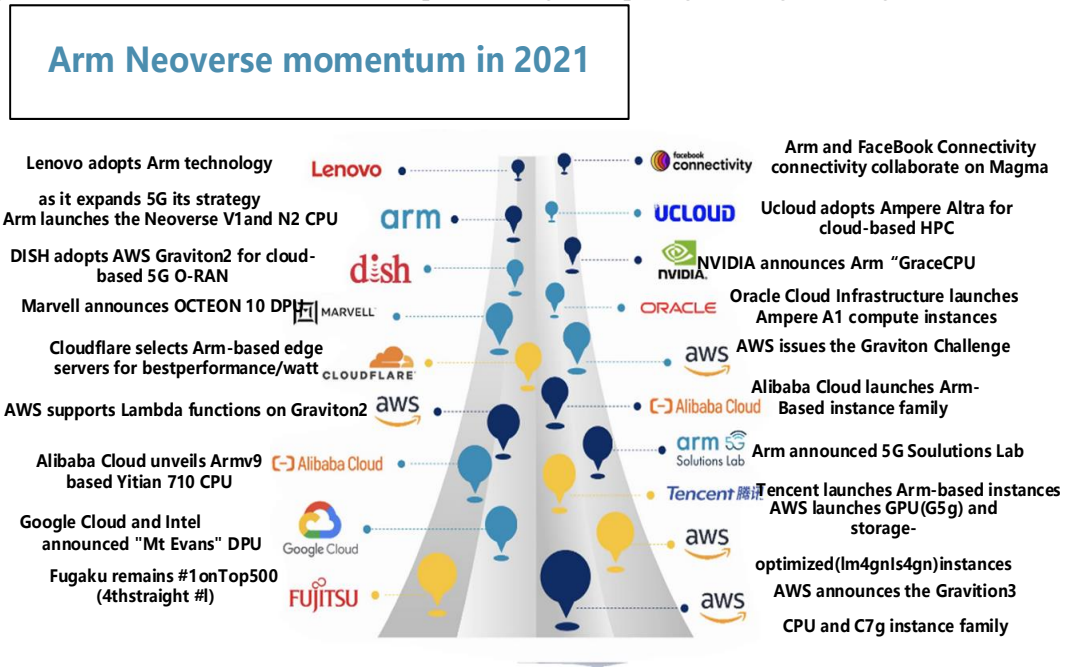
ARM general server is developed based on dedicated multi-core (32-core, 64-core, 80-core, etc.) ARM architecture server processors, and peripherals are equipped with PCI-e GPU Card, Memory Card and other IO Cards.

ARM array server (also known as ARM cluster server, Android cloud server) is designed in the server chassis with multiple (such as 60, 64, 128) based on high-performance ARM SoC to communicate with each other or externally through high-speed networks.

At present, cloud game and cloud mobile phone operators are using servers of these two architectures, including some leading Internet manufacturers. ARM general server processor manufacturers include Phytium, Kunpeng, Ampere, Amazon, etc. .

Neoverse N2 upgraded microarchitecture delivers +40% IPC uplift over Neoverse N1 at ISO process & frequency. Neoverse N2 is the first Armv9 core supporting SVE2, Arm's state-of-the-art vector ISA.Neoverse N2 architecture can support up to 256-cores and 512MB of system-level cache per die.

With the Neoverse N2 inside, next generation arm server cpu can achieve higher performance in edge computing and edge cloud game. there will be about 30%~40% uplift for edge computing and edge cloud game.



Platform of Edge Computing Cloud Game

Cloud game solutions include two categories. The first category is based on the X86 architecture, which mainly solves the cloudization of PC games, and the second category is based on the ARM architecture, which mainly solves the cloudification of mobile games. Compared with the ARM solution, the X86 solution has greater computing power, more content, lower latency, and a more mature architecture system.

The current mainstream cloud game solutions include X86+Nvidia GRID server/other servers, ARM server+AMD/Nvidia/other graphics card, embedded ARM array server.

On the whole, d PC cloud games are relatively mature, but they are highly dependent on GPU rendering, and the cost of GPU virtualization is relatively high, and it
is difficult to reduce the cost in the short term;

Android cloud games have more options for hardware architecture, there are some typical solutions like ARM server solutions, arm CPU array solutions, and X86 virtual machine solutions; X86 virtual machine solutions require transcoding and there will be a large performance loss, so Android cloud games based on the ARM architecture have natural advantages. In the case of resource shortage for some reason, and with the consideration of mature arm server ecosystem, choosing ARM server as a supplement to the PC/X86 cloud gaming solution would be a possible choice.

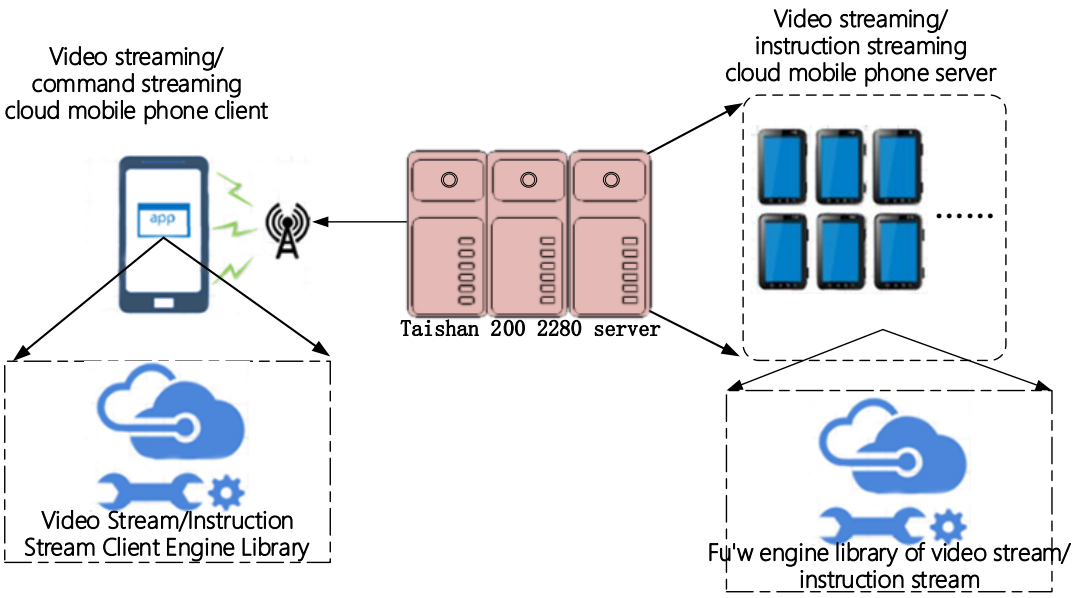
Edge Computing Cloud Game Performance

ARM cloud-native mobile phones are an emerging industry. Currently available test methods and tools include opensource test frameworks and test tools. It has CTS (Google's official website Android compatibility test suite), dEQP (drawElements quality plan (deqp) GPU test suite), Potplayer (third-party app), GFXBench (mobile graphics performance test
tool), Perfdog (mobile full-platform performance test analysis) tool) to conduct comprehensive testing for cloud mobile phone testing standards.

The GCC Alliance is mainly based on the server ARM native cloud mobile phone scenario test standard, covering basic function testing, performance testing, compatibility testing and experiential testing. The test network is shown in the figure below. The infrastructure is an ARM server. The basic cloud phone is virtualized in the underlying data center, and the instruction stream engine/video stream engine is deployed on the basic cloud phone to form the instruction stream/video stream cloud phone service.

At the same time, the user needs to deploy the command stream/video stream cloud mobile phone client APP on the terminal mobile phone, access the Internet after deployment, and click to enter the cloud mobile phone. Then use the relevant test tools on the server/cloud phone to test the single instance/cluster. The following tables and graphs list test architecture, test tools, and test result based on a typical hw config.

Cloud game test architecture



Cloud game test tools

Test tool name	purpose
Gfxbench	1. In this document, it is used to test the performance of images, videos, etc. displayed on the cloud mobile phone client
CTS	2. In this document, it is used to test the compatibility of cloud mobile phone system API
Deqp	3. Used in this document to test the compatibility of the graphics library API
Perfdog	Used in this document to collect cloud mobile phone fluency indicators
Potlayer	Used in this document to collect cloud mobile touch indicators

Cloud game performance test case

Number	Use case	Test indicators	Test requirements
1	Comprehensive performance test of cloud mobile phone	CPU usage	Run subway Parkour with 1 container started on the same GPU card
		Memory usage	Run subway Parkour with 1 container started on the same GPU card
		GPU occupancy	Run subway Parkour with 1 container started on the same GPU card
		Disk IO data	Run subway Parkour with 1 container started on the same GPU card
		Frame rate data	Run subway Parkour with 1 container started on the same GPU card
		Bandwidth data	Run subway Parkour with 1 container started on the same GPU card
2	Cloud mobile phone image performance test	Gfxbench performance score(high-level test)	Gfxbench does not crash and the container is normal
		Gfxbench performance score(low-level test)	Gfxbench does not crash and the container is normal
		Gfxbench performance score(special test)	Gfxbench does not crash and the container is normal
Number	Use case	Test indicators	Test requirements
3	Stress performance test of cloud mobile phone	720Cloud mobile phone deployment density under p/30fps display	Continuously increase the deployment density of cloud mobile phones, and each cloud mobile phone runs subway Parkour games until the server performance bottleneck
		720Cloud mobile phone deployment density under p/60fps display	Continuously increase the deployment density of cloud mobile phones, and each cloud mobile phone runs subway Parkour games until the server performance bottleneck

		1080Cloud mobile phone deployment density under p/30fps display	Continuously increase the deployment density of cloud mobile phones, and each cloud mobile phone runs subway Parkour games until the server performance bottleneck
		1080Cloud mobile phone deployment density under p/60fps display	Continuously increase the deployment density of cloud mobile phones, and each cloud mobile phone runs subway Parkour games until the server performance bottleneck

Cloud game performance test result

Test content	Test specifications	CPU	Memory	GPU	Disk IO	Frame rate	Bandwidth
Cloud phone comprehensive performance test	Solo GPU, 2 Containers, 3 cores(VCPU 1.5 cores)	0.60%	1.37%	4.28%	27/sec	30.02fps	691.68KB/s

Test content	Test Object	CPU	Memory	Bandwidth	Disk IO	Frame rate	Density
Cloud Phone Stress Performance Testing	720p/30fps	55.60%	33%	1G	667.8/sec	NA(Stress test to server bottleneck, frame rate is not an examination item)	112channels
	720p/60fps	60.07%	53.70%	1G	1113.1/sec		74channels
	1080p/30fps	62%	53.50%	1G	1026.7/sec		113channels
	1080p/60fps	61.10%	53.10%	1G	1099/sec		65channels

Indicator items	Data values
Average Frame Rate(fps)	30.2
Frame Jitter(fps)	1.9
Low Frame Rate(%)	0.7
Frame Interval(ms)	33.1
Jank(10 min numbers of jams)	40
Stutter(stall rate)	1.7
Cloud phone launch success rate(%)	100%
Cloud phone set-up time(ms)	2417
Cloud phone exit time(ms)	411
Click Sensitiy(%)	100%
Touch screen response time delay(ms)	195
Display Resolution	1080*1920 DPI480
Audio quality figures	PASS
Synchronization difference between sound and picture	-312
ARM Native Cloud Phone Experience Total Score	3.75

Test content	Test specifications	GFXbench test results								
Cloud Phone Image Performance Test	2 containers 3 cores (vcpu1.5 cores) cloud games	High level testing								
		Car Chase	1080p Car Chase Offscreen	Manhattan 3.1	1080p Manhattan 3.1 Offscreen	1440p Manhattan 3.1 Offscreen	Manhattan	1080p Manhattan Offscreen	T-REX	1080p T-REX Offscreen
		1775 Frames (30 FPS)	6095 Frames (109 FPS)	1861 Frames (30 FPS)	8401 Frames (136 FPS)	4783 Frames (77 FPS)	1862 Frames (30 FPS)	12234 Frames (197 FPS)	1681 Frames (30 FPS)	20105 Frames (359 FPS)
		Low level testing								
		Tessellation	1080p Tessellation Offscreen	Arithmetic logic unit 2	1080p Arithmetic logic unit 2 Offscreen	Driver Overhead 2	1080p Driver Overhead 2 Offscreen	Texturing	1080p Texturing Offscreen	
		902.5 Frames (30 FPS)	23428 Frames (390 FPS)	902.4 Frames (30 FPS)	24327 Frames (405 FPS)	901.8 Frames (30 FPS)	4459 Frames (74 FPS)	4390 Frames Mtexel/s	25269 Frames Mtexel/s	
		Special Tests								
		Rendering quality				Rendering quality (high precision)				
		4373 (mB PSNR)				4373 (mB PSNR)				

Conclusion

In the past 2-3 years, although the cloud game industry has developed rapidly, and the user scale and market scale have increased significantly, it still faces challenges such as further improvement of user experience and further reduction of operating costs. Through the advantages of widely distributed nodes, high-performance multi-type computing power, cost-effective large bandwidth, flexible on-demand, and rich cloud services, edge computing enables cloud gaming scenarios to improve the experience (low latency, high image quality), cost, and operation and maintenance. And other major optimizations to help the commercial feasibility and commercial take-off of cloud games.

Edge computing nodes can be created on demand and flexibly expanded, with sufficient inventory levels, supporting a variety of CPU, GPU, and other instance
specifications, which can meet the needs of different scenarios such as mobile games and client games.

Edge computing has multi-tenant instances and network security isolation, advanced automatic operation and maintenance capabilities, and complete monitoring and service systems. In addition, edge computing has rich functions such as load balancing, custom mirroring, and mirroring warm-up to help cloud games operate efficiently and maintain.

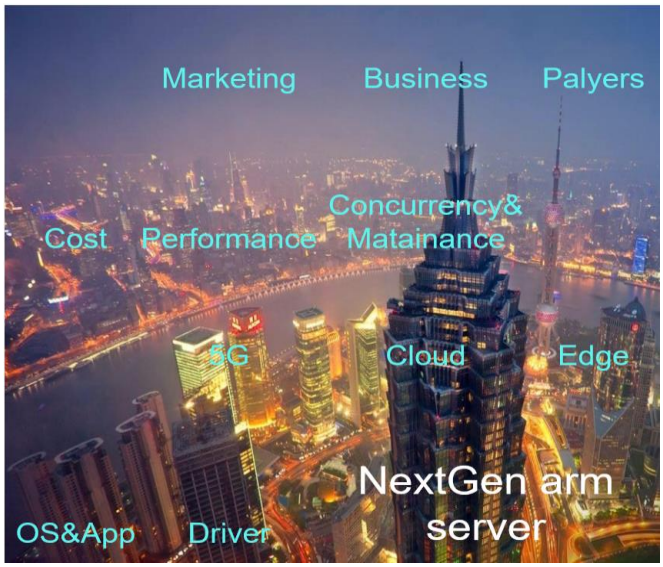
Edge computing applications, power consumption is indeed a key indicator due to the large number of devices deployed. ARM has always been known for its low power consumption, high energy efficiency ratio, and tailoring.

And for edge computing applications, power consumption is indeed a key indicator due to a large number of devices deployed. ARM has always been known for its low power consumption, high energy efficiency ratio, and tailoring. These advantages are just right for edge computing. Edge computing gateway adopts high-end processors based on ARM architecture, and there are suitable products for different selection requirements from optimal cost, optimal performance, and high-cost performance.

ARM cloud games need to have the basic features of "cloud", such as flexibility, availability everywhere. Based on cloud infrastructure optimized for android application to provide ARM application services such as Android cloud game and VR/AR.

Moreover, we can see standards for edge cloud gaming like cloud game reference architecture, general technical requirements, safety standards, cloud network resource capability evaluation and other standards are on the way of discussion and release.

And with the help of high performance next generation arm server chip and evolution of arm server architecture, edge cloud gaming will enter a new area, more and more players will join in this area.



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