Ultra-Low Latency Video Streaming using Verizon 5G and AWS Wavelength

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Abstract

2020 has been the year of pandemic where many businessesaccelerated their move toan online format. Activities and businesses that needed in-person participation were adversely impacted, especially in media industry. For example: Live performances in entertainment industry, Live in-person jam sessions in music, in-person dance classes etc. Some of the businesses started to use solutions like zoom, google hangout& skype etc. However, these tools came with a major challenge which is network lag. Music jam sessions and complex dance moves need precision of coordination with video and music. Having a micro sec of lag can cause a distorted experience to viewers, in-turn causing dissatisfaction to artists. In this paper we will talk about a solution using 5G and Amazon Webservices Wavelength that will solve this problem.

Keywords:

AWS Wavelength;
Video Streaming;
Ultra-low Latency;
No-lag video audio;
Seamless Live Session.

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1. Introduction

The latency of an output of the system is defined as the delay between the instance a sample is entered in the system and the instance it is output from the system. Poor network and system architecture lead to high latency for larger Audio/Video (AV) interactions. The latency increases even more when the sources are spread across multiple physical locations. The latency also varies depending on the frame rate or frames per second(fps). Following table shows different latency depending on the video format. [1]

	Latency of 1 frame (millisecs)	**Latency of 1 line (millimes)**
720p 50fps	20	0.0278
1080p 30fps	33.3	0.0309
UHD 60fps	16.7	0.0078

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Growing expectations from the customers have led to the need for ultra-low latencies. In pre-pandemic times, it was acceptable for latency to be below 30 millisecs. Current times demand for micro and nano second latency.

Audio video solutions can be built on-premise or in the cloud. For a cloud solution, Amazon Web Services(AWS) has Internet of Things(IoT) and Audio/Video services that enable technologists of small and large enterprises to build desktop, mobile and SaaS based applications for video streaming. The two off the shelf live video streaming solutions in AWS are live streaming with AWS and live streaming with MediaStore.[2]These solutions provide multiple formats for different players or clients. It supports live rewind and restart. All these services have a round trip latency issue, which includes processing time and sample delivery time. Amazon's Chime SDK provides real time communication that can be used in applications for adding audio, video and screen sharing sessions[4].

Unfortunately, most companies establish their data centers in area where electricity, land and water are least expensive[3].Multi-access edge computing (MEC) brings technology resources closer to the end user. Data is stored and processed at network edge. AWS wavelength provides infrastructure that will allow the services to be configured within communications service providers (CSP) like Verizon's datacenters at the edge of 5G network. Applications traffic from 5G network can reach application server without leaving telecommunication network. This can avoid multiple hops across the internet, in-turn leading to ultra-low latencies. These infrastructure deployments are called Wavelength Zones. Wavelength zones are available in ten cities of U.S. with Verizon, in Tokyo and Osaka, Japan with KDDI, and in Daejeon, South Korea with SKT.[7]

2. Research Method

Use cases researched for the problem are :

1. Media live performances:

   Artists are remotely located and are providing seamless experience to audience who are located in different geographical locations. Artists find it very challenging when the audio are lagging or not in synch with each other. Audience have a distorted experience as well. During covid, artists like Norah Jones have only been giving solo live performances on social media platforms like Facebook or Instagram. Famous dance groups like Team Naach have done performances at their own homes and used editing tools to combine their performances digitally using tools like iMovie and photoshop to make it look like they are dancing together.

2. Tele-Medicine

   Remote medical consultations between patient and doctor for consultation for out of hospital or between multiple hospitals located in different locations. Imagine a doctor assisting a couple on an emergency live birth remotely. It will becrucial to have low latency on audio and video that are being exchanged.

3. Remote Learning

   Low latency remote learning experience. Students often get distracted when there is poor quality audio and video, leading to frustration to both teachers and students. Having a good quality of audio and video will help them focus on learnings rather than struggle with latency. Institutions like Kaplan Test Prep provide pre-recorded direct instructions for students. Having a plugin to provide a real time classroom experiencecan add value for the students.

After researching various solutions, we came up with a solution that can be used for multiple use cases. The solution is a plugin that is deployed in AWS wavelength zone.

AWS Services used for this plugin development . Amazon webservice official website has detailed information on these services.[5]

1. Chime API and Media Services
2. Lambda Serverless
3. Cloud 9
4. Simple Storage Solution (S3)
5. CloudFront (Amazon's CDN)
6. CloudWatch
7. CloudTrail
8. Amazon's Elastic Search
9. Kibana
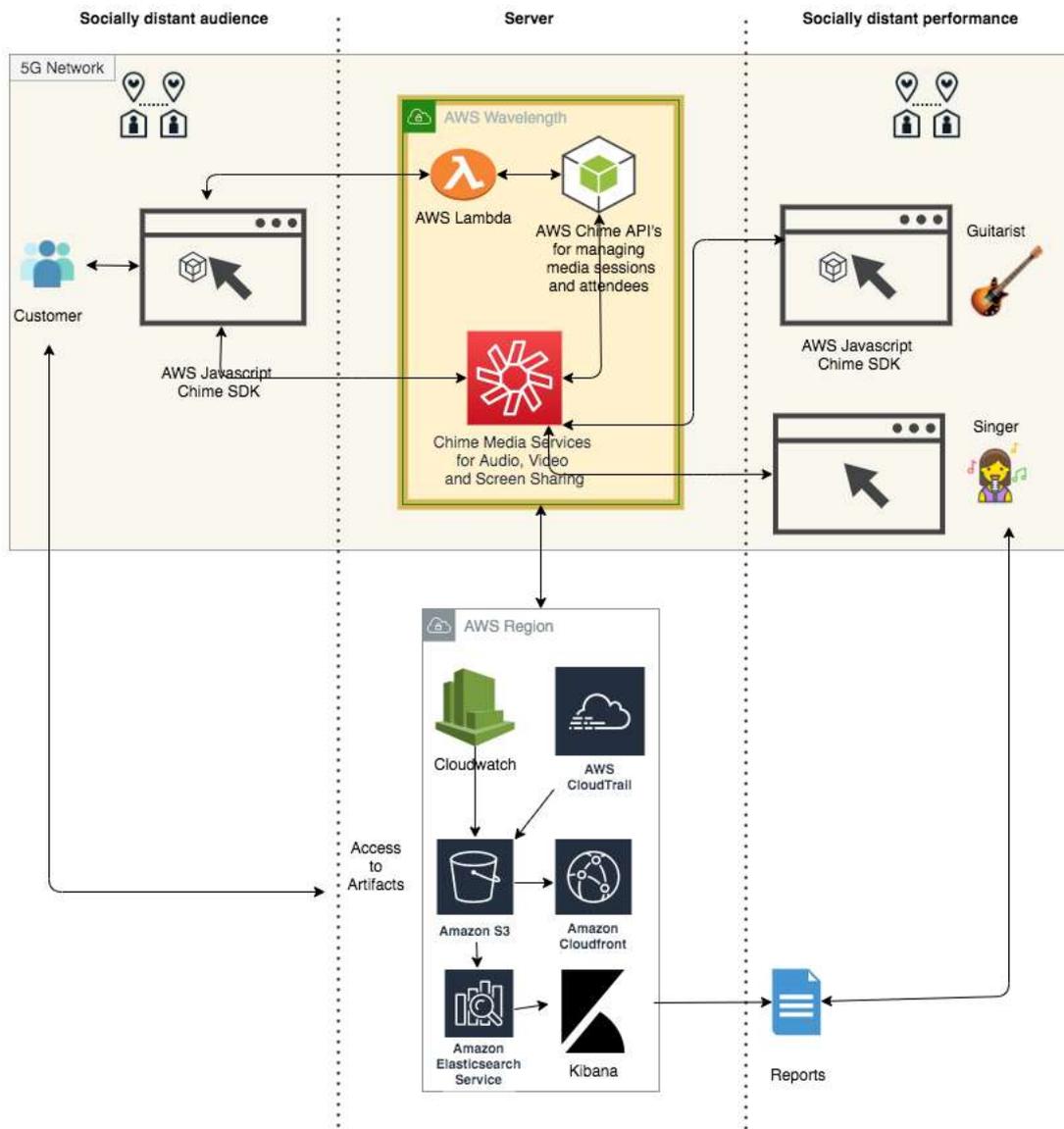
Thisarchitecturecan enable two way sharing of video audio and screen sharing. The solution uses Chime application programming interface (API) and Media services for serverless solution of streaming. The media sessions are managed through the Chime API and lambda functions. The media services are accessed from the browser using AWS JavaScript chime software development toolkit (SDK) through Lambda service. This is the core service for streaming and needs to have very good performance and delivery rate. The core services are launched in AWS wavelength zone. AWS wavelength is an extension of AWS region. AWS Wavelength services can be part of a subnet within aVirtual Private Cloud (VPC).

In the subnet outside of wavelength zone, Amazon's Simple Storage Service(S3) can be used, where the artifacts of live performances can be stored and accessed. These videos can be viewed later and may not need ultra-low latency. Setting up cloud front with S3 as origin can improve the delivery speed of these videos. CloudWatch can help troubleshoot any issues that happened during performances for improving the solution and API calls. CloudTrail logs can be stored in S3. The logs can be indexed in elastic search. Kibana can then be used to generate meaningful reports of accurate analytics of any drop or increase in audience number which will help give good insights about the performances to.

Cloud 9 was used to develop the application using a sample demo application from git. This application was deployed in the an EC2 instance which is part of the Amazon Wavelength zone. The command gives a URL at the end which can be used for the live session. The application was built following the instruction of an existing code base in GitHub[6].

3. Results and Analysis

In order to compare the performance and experience the latency, we deployed the same application one in wavelength zone and other in non-wavelength zone. We conducted an experiment where we had a singer and musician in different locations do a performance using this application. Audience noticed visible difference in the performance lag. The latency of non-wavelength zone application deteriorated with time. The latency of the application deployed in wavelength zone was mostly staying low resulting in excellent experience to the audience.
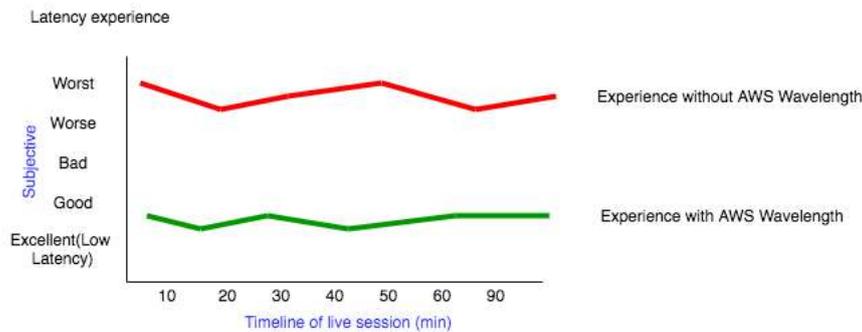
Time(min)	Latency(microsecs)with AWS Wavelength	Latency(millisecs) without AWS Wavelength
10	5	30
20	10	40
30	5	50
40	10	10
50	5	30
60	5	25
70	5	<Video Stuck>
80	4	46
90	5	< Video Stuck>

4. Conclusion

Covid-19 brought pandemic and caused significant losses for several businesses. These struggles brought in new technology innovationstoimprove virtual audio video experiences. The combination of AWS wavelength infrastructure with 5G is transformational. The technology can bring in huge differences in experience of virtual events. Companies and artists thatadopt to these technologies will give their customers better experiences and help retain them. Live online teaching sessions can benefit from this approach too.

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