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An Integration of Cloud Computing Technology in Television Broadcasting

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Abstract:

The rapid development of Information Communication Technology(ICT) has made the significant change in Television Broadcasting Industry in terms of broadcasting content Ingest, Storage, Network, Scheduling, Playout Sytem including transmission system. The Television Broadcasting Industry is using automation system for the operation of Broadcasting that has reduced the operational and infrastructural cost significantly due to the lower market price of the Information Technology based Infrastructure in Comparision to the conventional Tape-based content storage and Playout Infrastructure. The further development in the field of Information Communication Technology is the advent of Cloud Computing which is going to be potential revolution in the Broadcasting Industry. The Integration of Cloud Computing in the Broadcasting is the Next Generation Broadcasting which is the Television Broadcasting Sytem without buying physical infrastructure by the broadcasters and they just need to buy required Cloud Services. The Broadcasters use remote Cloud Service for ingest, storage including network using Cloud Virtualization. The Broadcasters make the Service Level Agreement which is the short term commitment according to pay per use provision. This research project focusses on the technical integration of the Cloud Computing Technology in the existing Broadcasting Technology for the ingest, storage, scheduling and playout of the broadcasting content including the network system. The Broadcasters need not to buy on-premises equipment and all services will be available in the local server by Cloud Virtualization. The broadcasters need not to invest money on human resource for the maintenance of the Cloud Computing Sytem and invest minimum cost in operation. So, this study also focuses on the financial analysis of the expenditure of the Broadcasters how they leverage their profit using Cloud Computing Technology in Broadcasting. Since both hardware and software components of Information and Communication Technology (ICT) change rapidly and upgradation is needed regularly. It costs significant amount of money and skilled human resources. To avoid this investment in a short period of time, using cloud computing is only alternatives for the broadcasters. The cloud service providers upgrade and provide service as needed. In this situation, the broadcasters need not to focus on the technology upgradation and the service providers upgrade as per the technology changes. This helps the broadcasters to focus on the content to broadcast and customer relation. This also helps the broadcasters to avoid the cost of maintenance of equipment and integration. The broadcasters need to pay just monthly charge of the service which is genuinely reasonable. All required services for broadcasting like ingest of the content, storage, editing of the content using latest virtual hardware and software and playout are available using virtualization of cloud servers. It is only alternative for the broadcasters to choose the broadcasting technology for future.

Keywords: Cloud Computing, Television Broadcasting, Service Level Agreement, Virtualization, Cloud Service Providers

1. Introduction:

Cloud Computing is the emerging technology gaining popularity in the modern computing activities. It is the branch of ICT (Information Communication Technology) having remote servers, networking devices, clients and sufficient storage for the required data. There are basically four types of clouds on the basis of deployment named Private, Public, Community and Hybrid. The private cloud is owned and managed by a private small organization whereas the Public Cloud is owned and managed by Public Cloud Service Provider(CSP). Likewise, the Community Cloud is managed by different organizations and supported to the particular community of the same interest. The Hybrid Cloud is the cloud Infrastructure composed of private cloud and Public or Private and Community ((Turab et al., 2013).

Fig. 1(a)Deployment Models of Cloud Computing (Source: Stallings, 2016)

On the basis of Service Delivery Models, Cloud Computing is categorized as SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) (Prakash et al., 2013). Cloud Computing has been quite popular in the recent days for personal to Business purposes due to its different useful characteristics like infrastructure, working platform and software. The infrastructure and software provided in cloud computing services are of latest version and no need to upgrade and buy license to use.

Nowadays, Broadcasting Industries are using Cloud Computing infrastructure services, platform services and Software Services for storage of content, ingest, networking, scheduling and playout of the content for broadcasting purposes. The most beautiful part of using Cloud on Broadcasting Industries is available of latest versions of hardware, software and networking infrastructures. However, there could be limitations of network Bandwidth for the streaming of Broadcasting content from storage location to the playout system. So, high Bandwidth Optical Fiber Network or 4G/5G wireless network is preferable. The human resource for the system operation and maintenance will be drastically decreased and operational cost also will be reduced significantly. The broadcasters need not to purchase the hardware, networking and software infrastructure in their local station that reduces the manpower and cost of the infrastructure. The payment will be based on pay per use system and there will be no wastage of the infrastructure in broadcasting. Another important aspect of reduction of the system cost is use of required software from

cloud which does not need to buy license. The broadcaster just need to pay the amount as of the Service Level Agreement (SLA) (J et al., 2019).

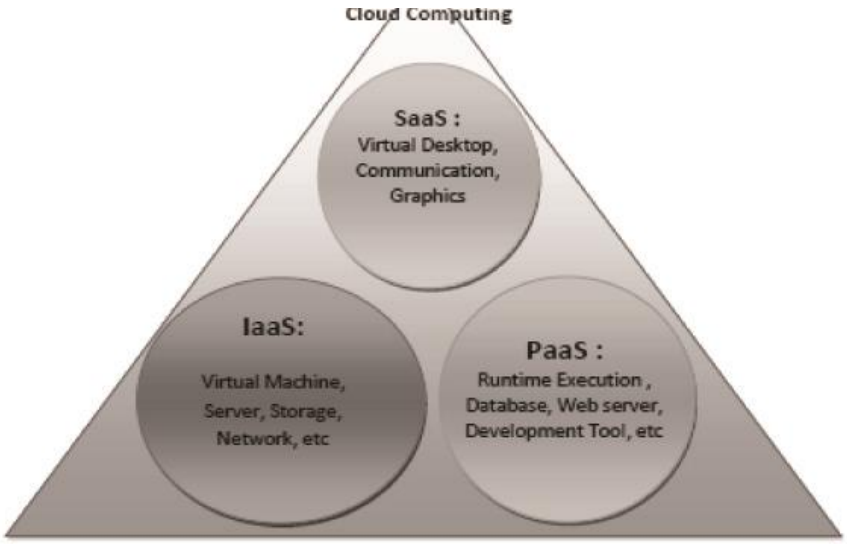

Fig. 1(b) Cloud Computing Services (Source: Prakash R. et al. 2013)

The different steps of Television Broadcasting are carried out in Cloud Computing environment like secured content storage after content creation, authentication of the content, Post Production, mixing special effects and subtitles, voiceover, final content archiving, Ingesting, scheduling, delivery and playout (Subramanian, 2017). The broadcasters manage most of the steps and activities of broadcasting process within the Cloud Computing Area and the just playout is carried out in the station location to uplink to satellite or streaming for the customer's home. In this process, the broadcasters need not to manage their own storage area, network and software themselves which are managed by Cloud Service Providers (CSP). The important thing of Cloud Computing is the broadcasting content can be used across the World for the real time transmission and Video on Demand (VoD) Service from the Cloud Storage. So, the broadcasters have no geographical boundary for the content collection and Post Production. From the broadcaster's point of view, the content will be the king and most of the other broadcasting activities are included within Service Level Agreement (Mirobi & Arockiam, 2016).

1.1 Literature of the Topic

Cloud Computing is the disrupting technology of modern era which is used in ICT (Information Communication Technology) for various purposes and fields. Several technologies are integrated with Cloud Computing Technology for the advantage of the integrated technology. In this research, Integration of Cloud Computing is with the Television Broadcasting Technology. It is the research how the Cloud Computing Technology is integrated with Broadcasting Technology and how it is effective in terms of technological and financial aspects of the Television Broadcasting.

Television Broadcasting is the transmission of audio-visual signal traditionally via electromagnetic wave using Terrestrial Technology and Broadcasting Satellite System for Direct to Home (DTH) and Direct to Operators (DTO) services for the distribution to households. Due to the advent of the Cloud Computing Technology, traditional Television Broadcasting System can be upgraded integrating Cloud Computing

Technology with the tremendous advantages in terms of coverage, access and cost (Prakash et al., 2013). The conventional Television Broadcasting System is quite expensive that needs to purchase the infrastructures for storage, ingest, networking and playout. Apart from that, the broadcasters need to purchase the licenses of software required and port licenses of the content flow for storage and playouts. Using Cloud Computing in Television Broadcasting, infrastructures required for content storage, networking system, playout, Post Production software are managed by the Cloud Service Providers under the cost of Service Level Agreement (SLA) with the Broadcaster. The customers receive live content as well as Video on Demand (VoD) in their premises via Cloud Computing. (Subramanian, 2017).

The use of Cloud Computing is the advent of new technology in modern Television Broadcasting System that makes Television Broadcasting cost effective, redundant playout by multiple broadcasters, no issue in terms of performance and scaling, having global access and quite easy for the deployment of the system (www.vset.tv). Due to the advancement of the Broadcasting video format from conventional SD to HD (High Definition) and UHD (Ultra High Definition), the storage and network bandwidth needs to be scaled up for the smooth delivery of the content and streaming of the content to the Customer for real time transmission. The Cloud based new media application have the commercial approach in Television Broadcasting Industries with technical support with the network integration with the Next Generation Broadcasting (NGB) Network. (Na, 2012). The Next Generation Broadcasting (NGB) Networks are the networks of IPTV, Smart TV and Cloud Computing.

Another important aspect of integrating Cloud Computing in Television Broadcasting is the Financial leverage that the Television Broadcasters benefit from. Using Cloud Computing in the Television Broadcasting is that they don't own it, they don't manage it, they don't maintain it, they don't upgrade it, they don't patch it, just they do use it. From research it is found that 29% financial leverage is obtained by the Television Broadcasters on using Cloud Computing in Television Broadcasting (Prakash, R., Lamdharia, S., & Chandra, D. G. 2013). The Cloud Computing is scalable so that the Clients make the payment as per "pay-as-you go" and get all the services mentioned in the service level agreement (SLA).

2. Literature Review

The Cloud Based Television Broadcasting System is entirely the Digital Television (DTV) that is received by the smart TV, Desktop or Laptop Computer or Smart Devices like Mobile Phone. The content production is carried out using Digital Cameras and Post production is carried out using Digital Editing System called Non- Linear Editing System. The content is then stored in Cloud based storage area and delivered using Cloud based Network Infrastructure. The ready content is distributed to the customer in real time and as VoD (Video on Demand). The viewing pattern recommended is the PDPR (Personalized DTV Program Recommendation) under cloud computing environment. The PDPR system is comprised of Media Storage Cloud (MSC), Private Computing Cloud (PCC), an Individual's Internet Terminal (IIT), a Recommendation Agent (RA) and Multimedia Broadcasting System (Lee et al., 2010).

To address the Bandwidth (BW) issue in multimedia and Television Broadcasting using Cloud computing is selecting the another network option of 5G Network as Network Infrastructure which has high BW for 4K/8K Ultra High Definition Television (UHDTV) content. International Telecommunication Union (ITU) has defined 5G based services like Enhanced Mobile Broadband (eMBB), Massive Machine Type Communication (mMTC), and Ultra Reliable and Low Latency Communication (URLLC). The 5G network will provide the efficient network infrastructure for future media transmission like 4K/8K Video including Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) (Gomez-Barquero et

al., 2019). So, the future multimedia and Television Broadcasting will not have significant issue in terms of network Bandwidth limitations due to the availability of 5G and higher version of Network.

Another important advantage of using Cloud Computing in Broadcasting is the broadcaster need not to update the required software and hardware over the time. The Service Level Agreement (SLA) maintains the QoS (Quality of Service) as required. The latest version of both hardware and software will be available using virtualization technique. Storage, Computing, Graphics, Network, Software etc. will be available as required in the Virtual Desktop as per the Service Level Agreement (J et al., 2019). So, the broadcasters need not to invest in on-premises infrastructure so that financial leverage will be advantage for the TV Broadcast Operators. Broadcasters' other ways to leveraging by using Cloud Computing are content flow from creators to broadcasters, Post Production Workflows, Content Delivery and Distribution Platform, Direct to Consumer Distribution mode etc. (Subramanian, 2017).

The most important aspect for the integration of Cloud Computing in Television Broadcasting is to integrate Cloud for storage of the Broadcasting Content, scheduling it, playout using the web-based technology in the premises of the Broadcasting station.

So, Integration of Cloud Computing is both technically and financially beneficial for the broadcasters in terms of ease in technical implementation and financial leverage including security, better efficiency, flexibility, greater agility, less expenditure, overcoming geographical limitations etc. For this purpose, the remote computer resources are used from the Cloud Service Providers in the local premises using the Cloud Virtualization Technology. This technology is the most useful to use remote computer resources in the local area in minimal cost. The SLA (Service Level Agreement) is performed in between the Television Broadcaster and Cloud Service Providers. From the virtualization, high end and state of art computer technology will be available virtually in the Broadcasting premises. For this the Broadcaster needs to hire the Cloud Service. This Virtualization Technique not only provides the latest computer resources in the local area but also reduces the operational and human resource cost of the operator ((J et al., 2019).

3. Methodology and Evaluation of the Results

The research has been designed using the following methodologies:

3.1 Technical Design of the Integration of Cloud Computing in existing TV Broadcasting Sytem:

The Cloud Computing Technology is integrated with the existing TV Broadcasters system to add the Cloud System for content ingest, storage and Network virtualization. The cloud service also includes the high end graphics and computing for the content editing using latest version editing software. The Service Level Agreement includes all that hardware and Software required for ingest, storage, editing and networking system using Cloud Virtualization Technique.

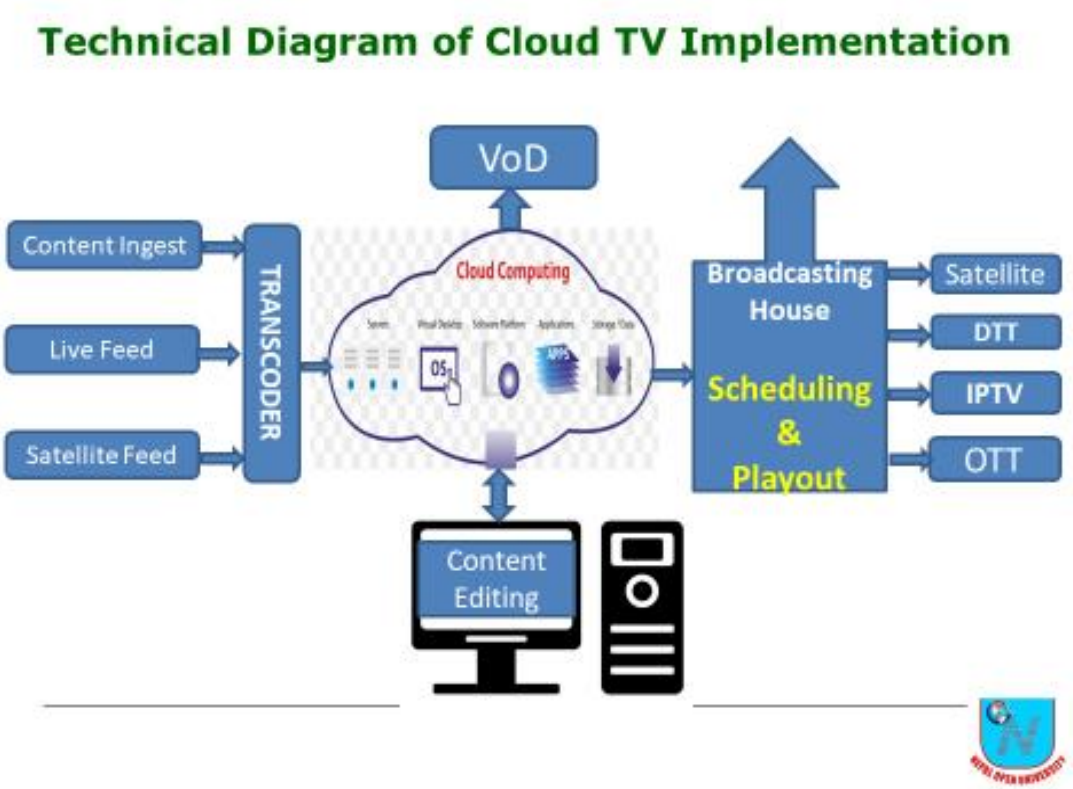

Fig 3.1a: Cloud Integration with existing Broadcasting Sytem. (Source: Author's Design)

Procedure:

The content is ingested via Transcoder from different sources like Internet, Live Feeds, Satellite Feeds and from different Production houses. The content stored in the Cloud is used for the Post Production Purpose using the Software provided by the Cloud Service Providers and stored back to the Cloud itself. The edited content will be available in the Broadcasting premises via Virtualization of Storage, compute and network. Then the content is used as per the broadcasting schedule in the Broadcasting house and played out for broadcasting. The broadcasting can be carried out simultaneously via Satellite, OTT (Over the Top), IPTV (Internet Protocol Television) and DTT (Digital Terrestrial Television) Network.

Implementation:

The author has configured and used subscribed MS-Azure Cloud to store the broadcasting content (Video) using MS-Azure Virtual Server. The Cloud Service Provider has provided the Cloud Infrastructure with virtual Storage, vCPUs, RAM, Network and required applications. After the configuration the local computer screen looks like as below:

(a) VM Configuration:

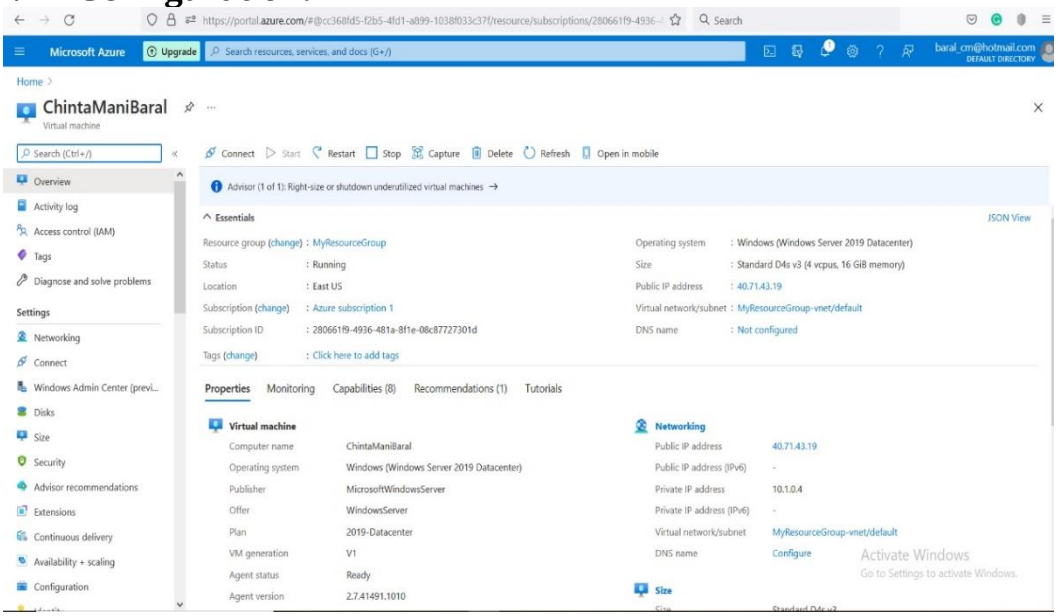

Fig 3.1b VM Configuration (Source: Screenshot from Practical Configuration)

The Virtual Machine (VM) configuration is significant part in this Research Project. The Virtual Machine (VM) is the utilization of Cloud Resources in the local computer including hardware like Storage, CPU, RAM, Graphics Card and software like latest Operating System (OS) and applications without any license issue. For this purpose, the author has hired the Microsoft Azure Cloud Computing System which has been configured using the local computer to utilize the required resources for content storage, vCPU, RAM and Graphics Card, which are available from VM configuration. The overall specification of Cloud Server available from VM configuration is as below:

VM (Virtual Machine) Status and Specification

A. General Specification:		
S.N.	**Particulars**	**Specification**
1.	Status	Running
2.	Subscription Charge	Azure Subscription
3.	Subscription ID	280661fg-4936-4819-8f1e-08c87727301d
4.	Computer Name	Chinta Mani Baral
5.	Operating System	Windows Server 2019 Data Center
6.	Publisher	Microsoft Windows Server
7.	Offer	Windows Server Plan 2019 Data Center
8.	VM (Virtual Machine Generation)	V1
9.	Agent Status	Ready
10.	Agent Version	27.41491.1010
11.	Public IP Address	40.71.43.19
12.	Virtual Network Subnet	My Resource Graph-vNet/default
13.	DNS Name	Not Configured
B. Network Specification		
SN	**Particulars**	**Specification**

1.	Public IP Address	40.71.43.19
2.	Private IP Address	10.1.0.4
3.	Virtual Network Subnet	MyResourceGroup-vNet/default
4.	IP Address Version	IPv4/IPv6
C. Hardware Specification		
1.	Size	Standard D4SV3
2.	Virtual CPU	4vCPUs
3.	RAM	16 GB Memory

Table 3.1 c Virtual Computer Specification: Source: From Virtual Screen

(b) Finding Remote Desktop:

Remote Desktop is available when connected using the Public IP Address of the Cloud Server which has been configured recently. The Public IP Address to connect the remote server is 40.71.43.19 which has been used as shown in the screen shot below. The remote desktop available is the desktop of the remote computer provided by the Microsoft Azure Cloud Service Providers (CSPs).

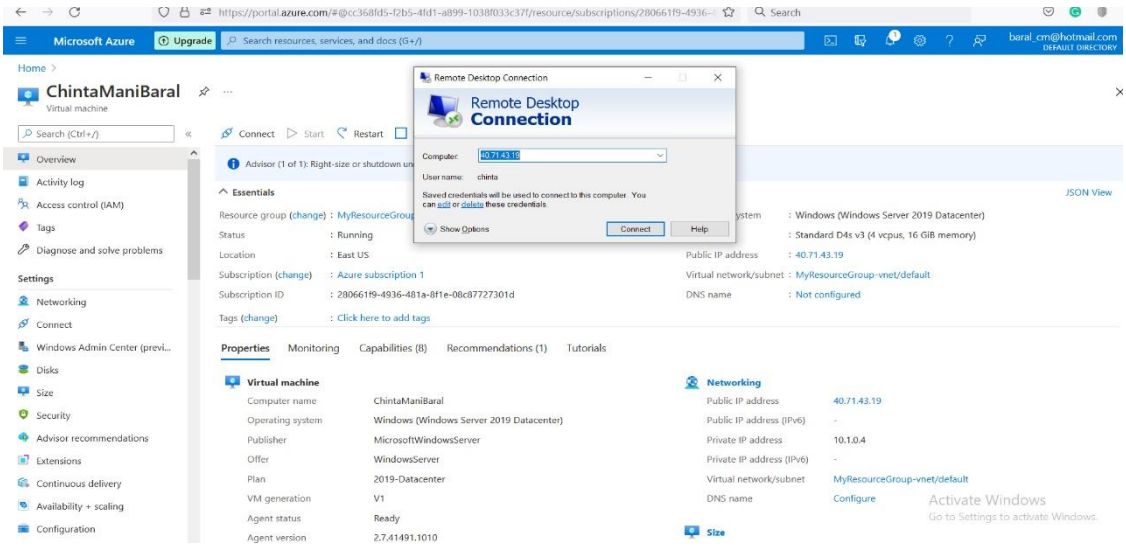

Fig 3.1d Configuration to find Remote Server Desktop

(c) The Remote Desktop Available:

After making the Cloud Server Connection using Internet, the remote desktop of the Computer is available on the local computer screen. This is the Virtual Machine (VM) available that can be operated and used by the local computer. The VM has all the facilities and resources required for the user who uses Cloud Computing for the Television Broadcasting purpose. It has its own Operating System (Windows Server 2019 Data Center), Web Browser to playout the video, high speed CPU (4vCPU), RAM (16GB) and its own Graphics Card and so on. So, the Virtual machine is powerful enough to store and playout the broadcasting content using required schedule from the local area. In this case, the Broadcaster need not to buy the latest hardware, software and Operating System which are available from the Cloud Service provider. Also, the Broadcaster need not to upgrade the software and hardware which are upgraded by the Cloud Service Providers when required.

Fig 3.1e Remote Desktop (Source: Screenshot after Configuration)

(d) Scheduling Broadcasting Content in Remote Desktop:

The video playout contents are scheduled using the HTML/XML document using the metadata as required. For the Project testing purpose, the author has selected five videos named as below in the HTML/XML document.

i. Dhurmus.mp4
ii. Cartoon.mp4
iii. Computer.mp4
iv. Logo.mp4
v. Rhyme.mp4

The code written to playout using the VM (Remote Server provided by the Cloud Service Provider) is as below:

```
<html>
<head>
<title>Video Playout</title>
</head>
<body bgcolor="red">
<h1>Play Video</h1>
 <video width="320" height="240" controls>
  <source src="Dhurmus.mp4" type="video/mp4">
Your browser does not support the video tag.
</video>
<p>
<font size="8">
<marquee bgcolor="green">Video Playing in Microsoft Azure Cloud Virtual Server</marquee>
<p>
```

```
<video width="320" height="240" controls>
  <source src="Cartoon.mp4" type="video/mp4">
Your browser does not support the video tag.
</video>
<p>
<font size="8">
<marquee bgcolor="green">Video Playing in Microsoft Azure Cloud Virtual Server</marquee>
<video width="320" height="240" controls>
  <source src="Computer.mp4" type="video/mp4">
Your browser does not support the video tag.
</video>
<p>
<video width="320" height="240" controls>
  <source src="Logo.mp4" type="video/mp4">
Your browser does not support the video tag.
</video>
<p>
<p>
<font size="8">
<marquee bgcolor="green">Video Playing in Microsoft Azure Cloud Virtual Server</marquee>
<video width="320" height="240" controls>
  <source src="Rhyme.mp4" type="video/mp4">
Your browser does not support the video tag.
</video>
<p>
<font size="8">
<marquee bgcolor="green">Video Playing in Microsoft Azure Cloud Virtual Server</marquee>
</font>
</body>
</html>
```

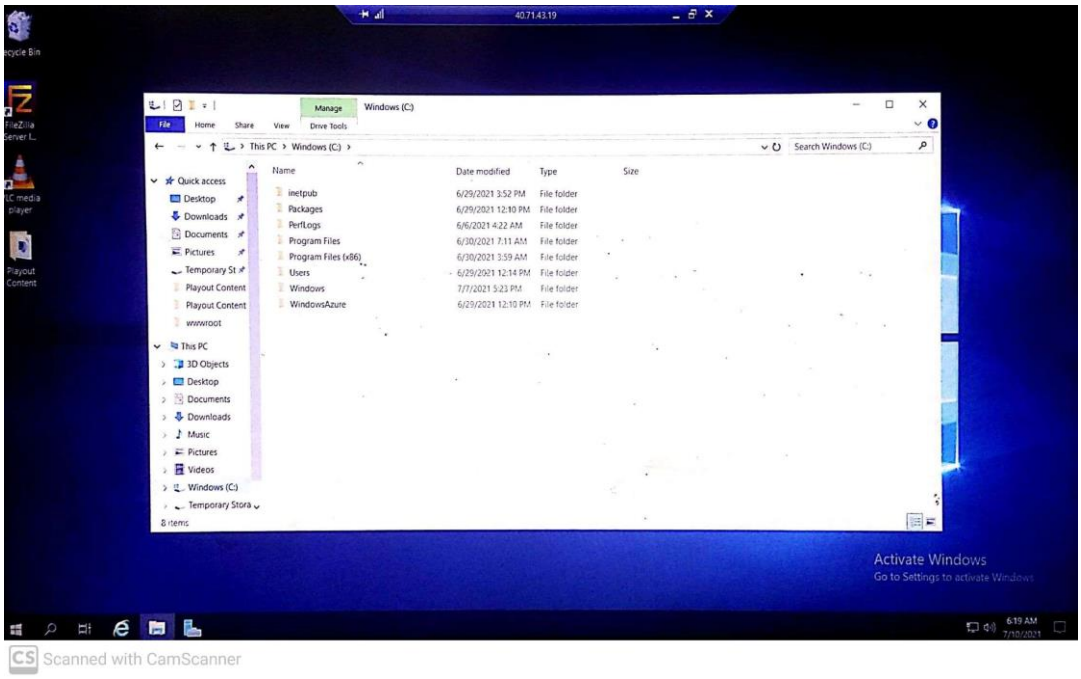

Fig 3.1f Scheduling Broadcasting Content in Remote Desktop (Source: Screenshot after Configuration)

(e) Video Playout from Cloud Storage:

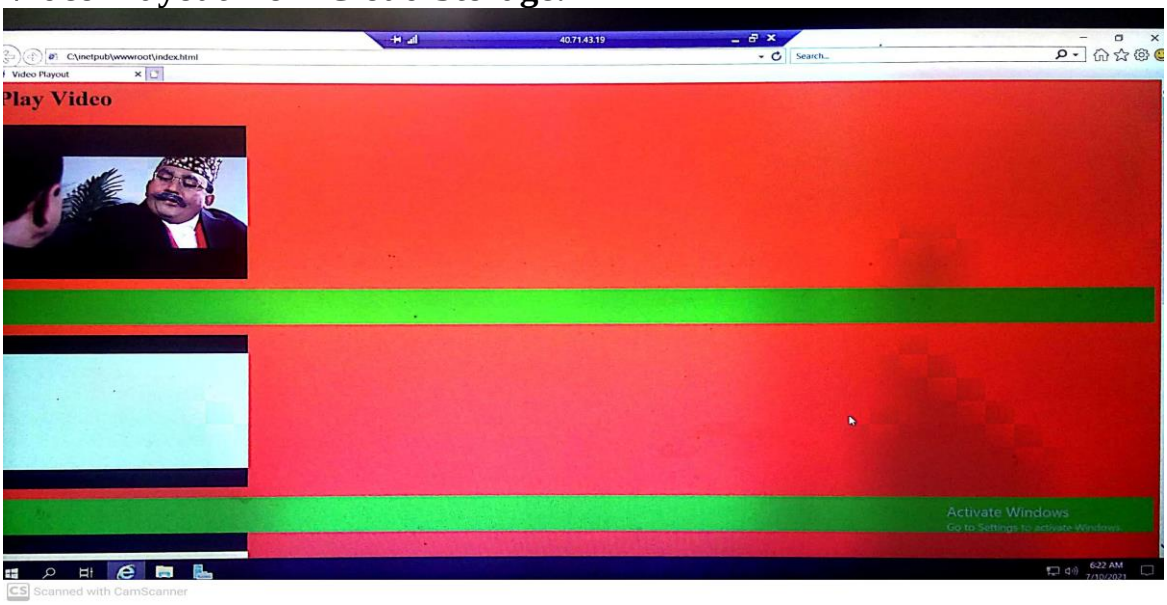

Fig 3.1g: Video Playout from Cloud Storage (Source: Screenshot after Playout)

The Television Broadcasting content stored in remote computer scheduled using HTML/XML document is played out from the local computer. The local operator can playout and control from the local computer. The operator can use play, pause, fast-forward and rewind buttons to control the video. The video is also played out automatically if no human interference is not required. IN this way, the Cloud Computing Service has been used to store, playout and scheduling the TV broadcasting content using Cloud Resources. So, the integration of Cloud Computing Technology in Television Broadcasting is technically valid. It is also financially much beneficial which will be discussed in Financial part of the Research Project.

Cloud Computing is latest Technology and it needs Internet connection to access the Computers from Cloud Service Providers. Accessing data from remote computers faces several issues. The Television Broadcasting is very sensitive job and interruption even a single second is also objectionable. So the Cloud Service Providers (CSPs) and the Broadcast operators both must be aware about the technical issues of the Cloud Computing. So, a research on technical issues is essential:

3.2Research on Technical and Security Issues:

There are different Technical issues in Internet and Cloud Computing Technology. Since the data used by the customers are quite sensitive in Broadcasting. So, the following issues are to be handled before using Cloud Computing Technology in Television Broadcasting:

(i) **Time Delay Issue:** There are different time delays to access the content from data center to the Broadcasting premises (Chadchankar, P. A. , 2018). The different time delay issues are:

(a) The propagation time delay (T_{prop})
(b) Transmission Time Delay (T_{trans})
(c) Route Processing Delay (T_{proc})
(d) The Route Queuing Delay due to traffic of network (T_{que})

Total delay time (T) will be: $T= T_{prop} + T_{trans} + T_{proc} + T_{que}$

So, it needs to minimize the delay issue for effective Television Broadcasting.

For 3D/FHD contents, there is a big load in network for data transfer to the Broadcasting Station. In this case, media asset is to be used that manages the scattered data and big data to collect together in the required speed in the network. So, using media asset is the solution for the big data content (Chadchankar, P. A. , 2018).

To provide video in the requirement of people in Video on Demand (VoD), the following process

- **Input**: As accordance to the encoder used in the system, MS Smooth Streaming Lining or Apple HLS (HTML Live Streaming) protocols are used.
- **Storage**: Disk Specified in HLS protocol chosen, the FTP path needs to be defined as:

  ftp://<ip-address>/live/disk/channel_name/for FTP (Soria-Cano & Ballesteros, 2016).

(ii) Security Issues:

The Cloud Service Providers (CSPs) for Television content storage, scheduling and playout needs to manage the Cloud Security otherwise the TV Broadcasting content will be unsecured. The security principles include confidentiality, integrity, availability and non-repudiation of the content. To reduce the Cloud Attack, the following security controls are used. (Bhardwaj & Sharma, 2017).

(a) Deterrent Controls
(b) Preventive Controls
(c) Detective Controls
(d) Corrective Controls

The following diagram provides the security algorithms of Cloud:

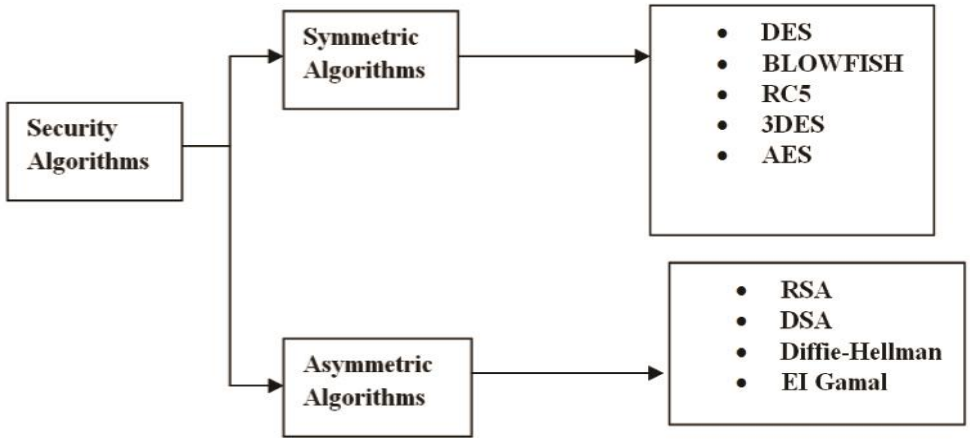

Fig 3.2a Security Algorithms of Cloud Computing Source: (Bhardwaj & Sharma, 2017).

3.3 Financial Data Collection:

(a) Cloud economics Survey of expenditure of Television Broadcaster with TCO (Total Cost of Ownership), Managed Service and using Cloud Service:

Particulars	TCO (US$)	Managed Services (US$)	Using Cloud Service(US$)
Capital Investment	40,000	0	0
Setup Cost	1000	5000	1000
Monthly Services	0	4000	2400
Monthly Labour	3200	0	1000
Cost Over three Years	1,49,000	1,29,000	1,06,000
Savings/Gained	0%	13%	29%

Table 3.2b: Source: Cloud Economics Survey of TCO, Managed Service and Cloud Service

(b) Data from Financial Overview Snapshot of Global Cloud TV Market Research:

Year	Cloud TV Market Share (Billion US$)
2016	40.0
2017	41.5
2018	43.6

Table 3.2c: Global Cloud TV Market Research :Source: Annual Report Press Release & MRFR Analysis (Cloud & Market, 2021)

(c) Comparision of Cost of Cloud of different Cloud Service Providers:

Cloud Name	Amazon S3 BLOB Storage	MS-Azure BLOB Storage	Google Cloud Storage	IBM Cloud Object Storage	Oracle Cloud Object Storage
Cost Per Month/TB	US$34.67	US$24.90	US$24.08	US$26.40	US$27.00

Table3.2d: Cloud Service Cost Comparision (Source: Corresponding Websites)

3.4 Data Analysis:

(a) Based on the data in Table 3.3a, using cloud computing for Television Broadcasting is quite economical in comparision of managed services and TCO (Total Cost of Ownership). From the analysis of data (Table 3.3a), use of cloud computing is quite less expensive in comparision of using conventional technology for Television Broadcasting. So, this analysis indicates that the future of cloud computing is useful for the sustainable television broadcasting system.

Financial Data

Particulars	TCO (US$)	Managed Services (US$)	Using Cloud Service(US$)
Capital Investment	40,000	0	0
Setup Cost	1000	5000	1000
Monthly Services	0	4000	2400
Monthly Labour	3200	0	1000
Cost Over three Years	1,49,000	1,29,000	1,06,000
Savings/Gained	0%	13%	29%

Source: Cloud Economics Survey

Table 3.4a Financial Data of using TCO, Managed Service and Cloud Service in TV Broadcasting

Cost Effectiveness: From the above Table 3.4a, it is found that there is 29% cost saving on using Cloud Computing Technology for Television Broadcasting in comparision to establish own infrastructure. So, it is financially beneficial drastically.

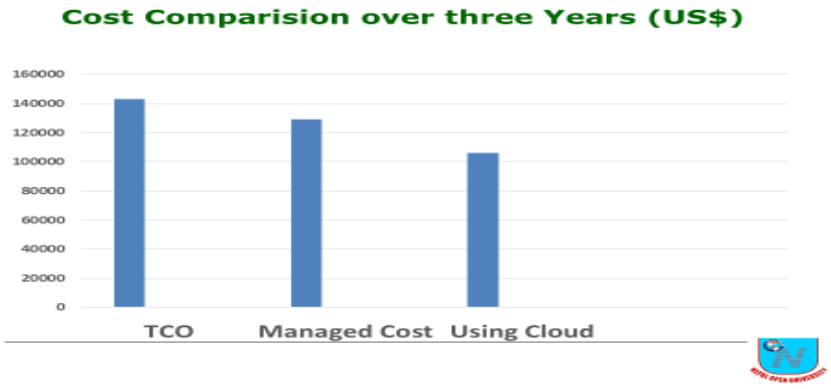

Fig 3.4b: Comparision of Cost of Cloud-Based Broadcasting System with TCO and Managed Cost.

(a) Based on the data in Table 3.4c, the scope of use of cloud market is increasing over time drastically. So, cloud technology has significant future scope for several applications including Cloud Integrated Television Broadcasting.

Cloud Market Data

Year	Cloud TV Market Share (Billion US$)
2016	40.0
2017	41.5
2018	43.6

Source: Annual Report Press Release & MRFR Analysis (Cloud & Market, 2021)

Table 3.4c: Cloud Market Data (Source: Cloud and Market, 2021)

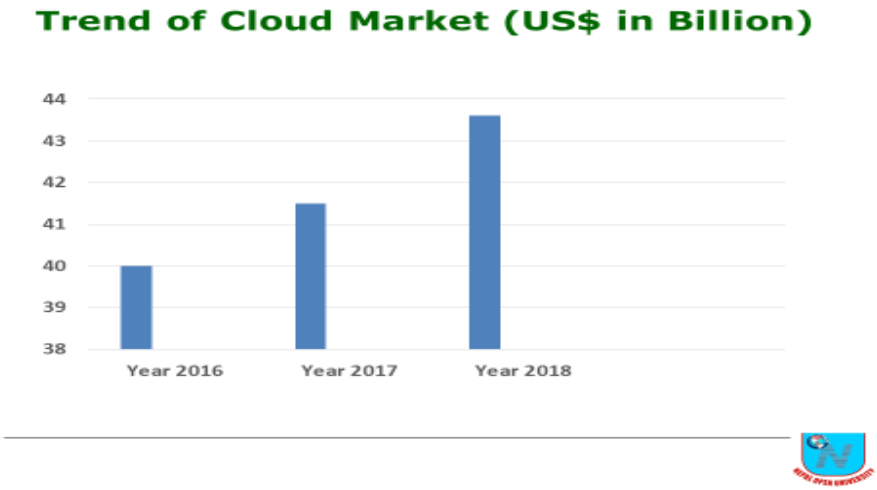

Fig. 3.4 d: Trend of Cloud Market (Source: Cloud and Market, 2021)

(b) Based on the data in Table 3.4e, different cloud service providers have offered their data storage rate in quite a competitive rate. Using own storage system, the cost of data storage per Terabyte is quite expensive. So, using cloud storage is quite economical in comparision of using own physical storage system at the local premises. The Media Asset Management (MAM) cost also included in the local storage. The lowest cost of Cloud storage is offered by Google.

Cloud Storage Cost Comparision

Cloud Name	Amazon S3 BLOB Storage	MS-Azure BLOB Storage	Google Cloud Storage	IBM Cloud Object Storage	Oracle Cloud Object Storage
Cost Per Month/TB	US$34.67	US$24.90	US$24.08	US$26.40	US$27.00

Table 3.4 e Cloud Storage Cost Comparision (Source: Related Webpages)

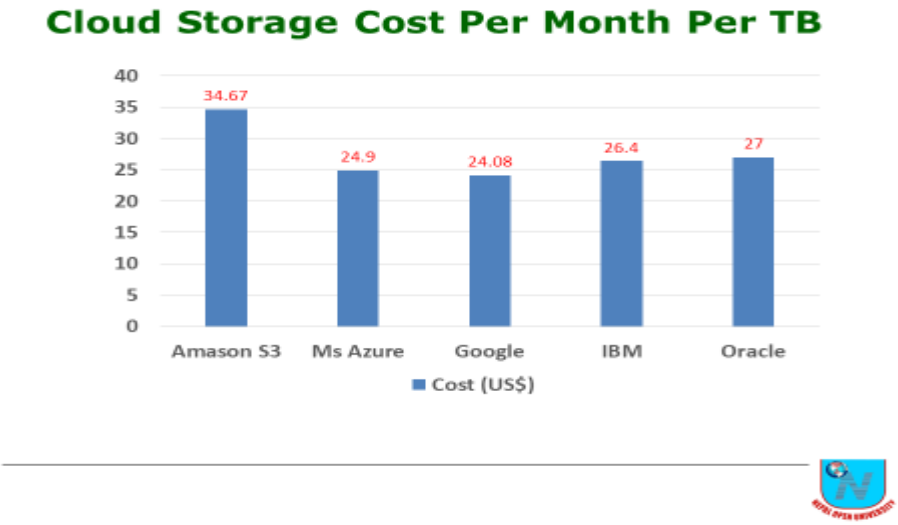

Fig 3.4f Cloud Storage Cost Per Month of different CSPs. (Source: Related Webpages)

4. Analysis of Research Work:

Based on data available from different sources, the integration of cloud computing technology is comparatively more beneficial in terms of expenditure than managed service or Total cost of ownership. The cost of software license to use in Cloud is too less than the license cost of full ownership. If the software is to use in the local computer, both hardware and software need upgradation in some time interval. However, if the broadcaster uses Cloud-based system, both hardware and software are upgraded by the Cloud Staff in the required time interval. The cost of physical hard drive space is more expensive than the virtual storage in the cloud. So, using Cloud Computing Technology is highly economical in terms of financial cost, staff cost and quality of technology. From the data available from the Cloud TV trend, the use cloud computing in the field of television broadcasting is drastically in increasing. This trend is never ending increment due to the popularity of the cloud computing technology and their incredible advantages. The broadcaster needs very less building space and rooms to run the broadcasting house which is also very beneficial in the modern era when we are facing lack of building infrastructure and space in the modern cities.

5. Implementation of Research Project:

The Television Broadcasters have best alternatives to use Cloud-integrated Broadcasting system for content ingest, storage, editing, scheduling and playout for broadcasting. The news reporters or content creators may produce their content from any corner of the World and ingest from anywhere in their cloud location so that the broadcasting end may get the content in their location for scheduling for the transmission of the program. The latest hardware like CPU, RAM, Graphics Card and required software can be used without any technical and license issues. Very less human resource is required in the broadcasting end due to the co-operation of cloud operators for almost all activities. The broadcasters need not to worry about hardware and software issues of the equipment and just need to pay as per the Service Level Agreement (SLA) with the Cloud Service Providers (CSPs). So, in the future, all broadcasters will use integrated Cloud computing system for their content ingest, storage, editing, scheduling, playout and all other content related activities including Video on Demand (VoD). The Television broadcasters using local infrastructure cannot compete all broadcasting activities with affordable price. So, it will be essential to migrate from conventional broadcasting to Cloud integrated system for the broadcasting in the near future.

6. Results and Discussion:

From the methodologies, the content is played from cloud based storage and applications, the video was played out on the local computer. The web based application is used to link the required video which is played from the local computer using web browser. All the hardware and software required for the playout of the content uses the cloud resources. Local computer and devices are required only for the access of the location of the content to play from the virtual resources. The format of the video content and resolution is important to manage to tradeoff the bandwidth of the internet and quality of the video. For Full HD (High Definition) video needs drastically more bandwidth than SD (Standard Definition) video. Likewise, the UHD (Ultra High Definition) 4K Video needs more bandwidth and HD whereas UHD (8K) needs highest level of Bandwidth. So, management of the video content format is significant issue in cloud integrated broadcasting system.

In this Research, the VM (Virtual Machine) available after configuration from Microsoft Azure Cloud is as below:

VM Specification:		
S.N.	**Particulars**	**Specification**
1.	Computer Name	Chinta Mani Baral
2.	Operating System	Windows Server 2019 Data Center
3.	Publisher	Microsoft Windows Server
4.	Offer	Windows Server Plan 2019 Data Center
5.	VM (Virtual Machine Generation)	V1
6.	Agent Status	Ready
7.	Public IP Address	40.71.43.19
8.	Private IP Address	10.1.0.4
9.	Virtual CPU	4vCPUs
10.	RAM	16 GB Memory

Table 6: Virtual Machine Specification (Source: From VM Configuration)

The scheduled content was copied in the Virtual Computer with high speed CPU (4vCPUs) and 16 GB RAM server. The local Internet connection was used to playout from the Cloud Server. The playout found to be very smooth for the HD Video as shown in fig. 3.1f. The remote Cloud Computer is very powerful in terms of hardware and software so that the resource is sufficient for high quality video playout however the Internet BW needs to be maintained for the uninterrupted and smooth playout of the Broadcasting content.

7. Conclusion

The Research has provided the technical design for the existing Television Broadcasting Technology based on Terrestrial, Satellite, Over the Top (OTT), IPTV (Internet Television) technologies for both real time transmission and VOD (Video on Demand) can be performed with the integration using Cloud Computing Technology. The Research also has shown the Cloud Computing Technology is more effective for the Television Broadcasting Industries in terms of the less human resource requirement, Service Quality and the operational cost. This Research proves that modern Cloud Computing Technology is valid for the storage of the Television Broadcasting content, Scheduling, Networking and Playout using the Cloud-based Application. This technology reduces the human resource of the Broadcasters and no issue of hardware and software obsolete problems. Use of this technology in Television Broadcasting drastically reduces the cost of hardware and software to operate the system and reduces the need of skilled human resource in the operational premises.

8. Further Works and Limitations:

- This Research is for the integration of the Cloud Computing Technology to Ingest, storage and editing of the Broadcasting Content.
- Unstable Internet Bandwidth could be the issue required for the smooth Playout of the Broadcasting content in the system. The playout could be disrupted in case of very low internet bandwidth.
- Additional internet Bandwidth is required for the multiple channels playout using Cloud integrated broadcasting system.
- The Research is for Single Channel scheduling from the content available in the Cloud.
- Further research is required to make the cloud integrated broadcasting system more efficient using more efficient virtual machines in terms of hardware and software.
- For effective scheduling of the broadcasting content, a suitable Database Management System is required.

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