



# SURVEY OF QUALITY OF EXPERIENCE IN CLOUD GAMING

*Asif Ali Laghari et al.*

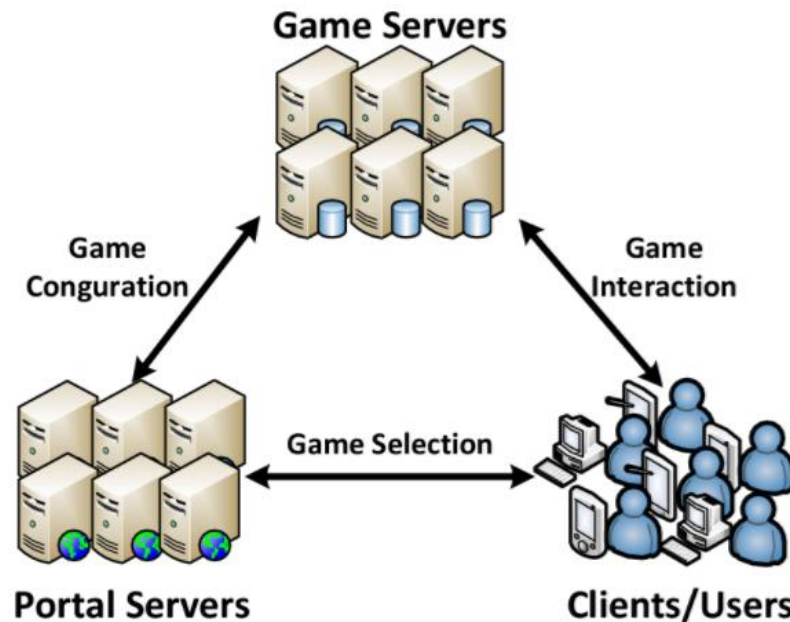
*CloudCom 2017*

# Introduction

- Popularity of cloud gaming has increased since late 2000's which attract the industry and academia
- 1. Survey and analyze the previous cloud gaming models and architectures
- 2. Provide aspects of future development, which will help to provide QoS according to SLA and increase user satisfaction level for cloud gaming

# Cloud Gaming

- Render the game at **cloud side** and the gaming video is forwarded to users via high speed network
- Users **send input data** to cloud server and **receive the video frames** for interaction



# QoE Provision Architectures

- Requirements need to be met
  - *High processing, high bandwidth network*
  - *Low packet delay and loss*
  - *Acceptable frame rate*
- Different parameter for assessment of QoE
  - *Video rate*
  - *Multiplayer platform performance*
  - *Bandwidth*
  - *Virtual machine placement*

# Popular Architectures

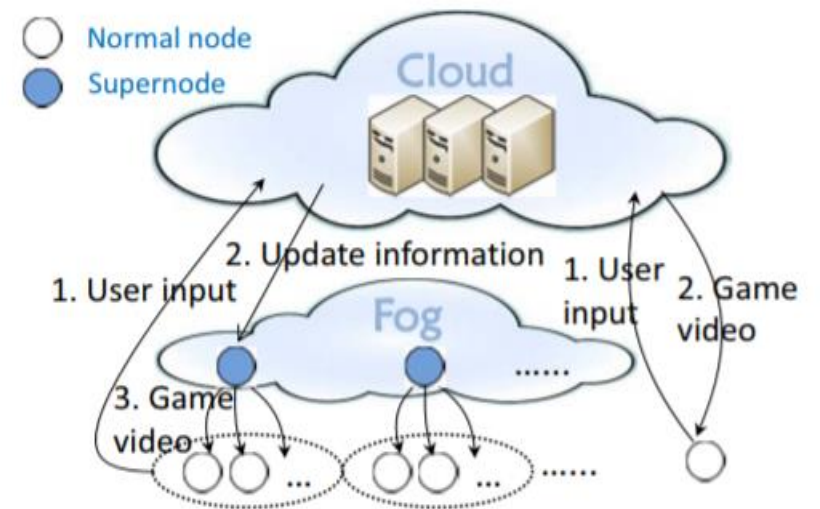
## ■ GamingAnywhere

- *An open source cloud gaming system*
- *Less network delay compared to the previous systems*
- *Network speed is still a major issue*



## ■ CloudFog lightweight system

- *Supernodes are used as fog based concept*
- *High QoE on low speed networks*
- *Increasing user coverage*



## Analytics

# Streaming Based Approaches

- An appropriate and efficient video codex used in streaming can improve QoE a lot
- Three related papers will be introduced in this section

2015

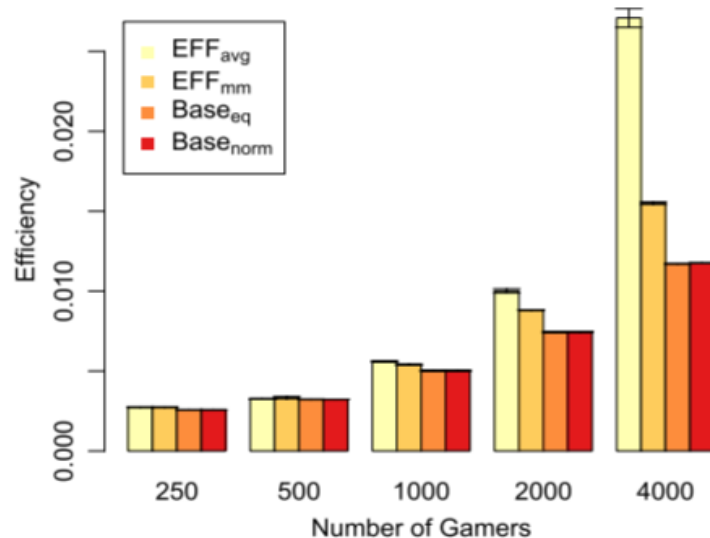
## Kairan et al.

- A new **bit allocation** scheme is proposed on MB layer based on ROI
- Important objects are detected and **ROI values of every pixel** can be generated along with rendered picture
- Can compress trivial areas of frame and **manage the bitrate for slow networks** but **not suitable for every user**
- This approach will not improve the overall QoE of game users

2015

# Hong et al.

- Subjective MOSs were collected on different games with different frame rates and bitrate
- 2 optimal and efficient algorithms were proposed to maximize the average ( $EFF_{avg}$ ) and the minimum ( $EFF_{mm}$ ) MOSs across all gamers



RUNNING TIME IN SECONDS

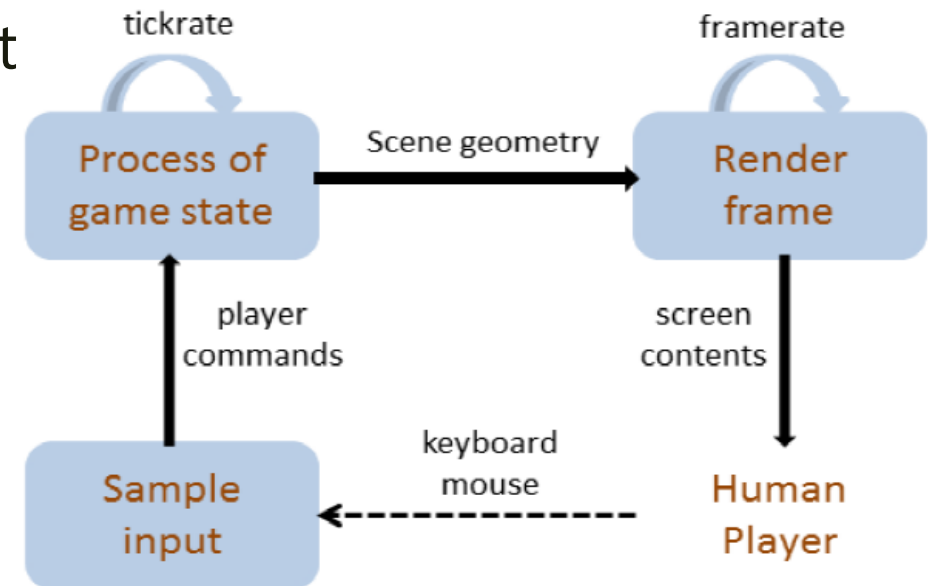
# of Gamers	$EFF_{avg}$		$EFF_{mm}$	
	Mean	Max	Mean	Max
500	0.181	0.183	0.179	0.184
1000	0.296	0.299	0.287	0.290
2000	0.523	0.531	0.520	0.533
4000	1.000	1.104	1.060	1.066
8000	1.677	1.681	1.654	1.661



2016

# Metzger et al.

- End-to-End (E2E) lag model for video games was presented
- Simulation results show that low frame rate has dominant influence on the game frame rate
- The model explains the lag of different type of games and is important for design of QoE assessment



## Analytics

# Network Based Approaches

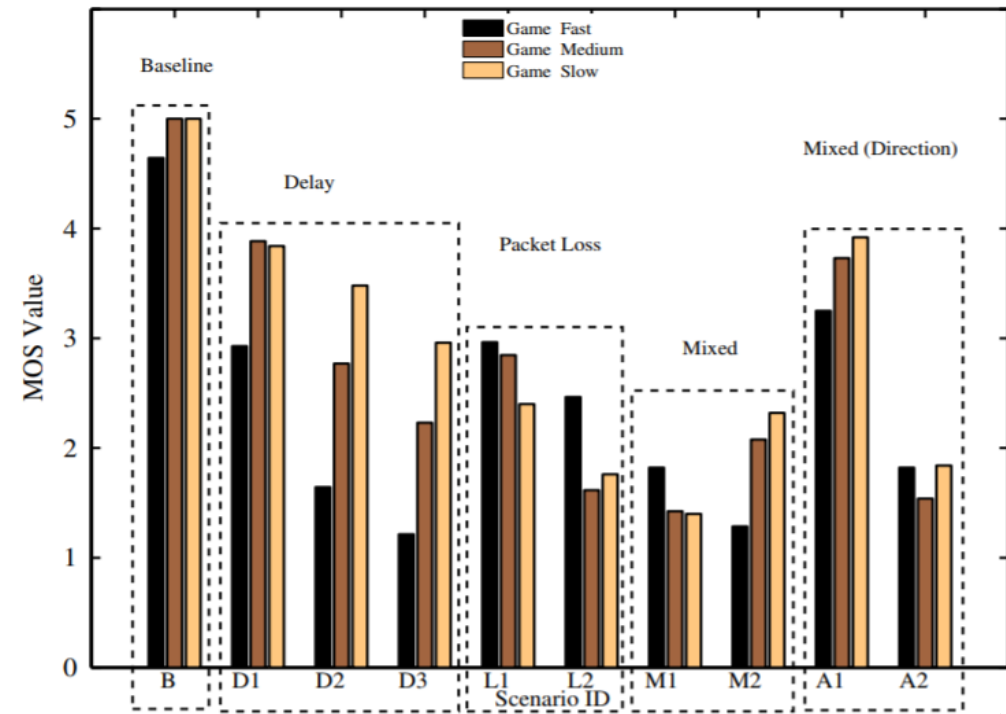
- Network is important for cloud gaming for it's a bridge between the client and cloud server for data transfer
- Another three related papers will be introduced in this section

2013

# Jarschel et al.

- Evaluate subjective QoE to analyze the effect of the **network delay** and **packet loss** during playing the cloud gaming

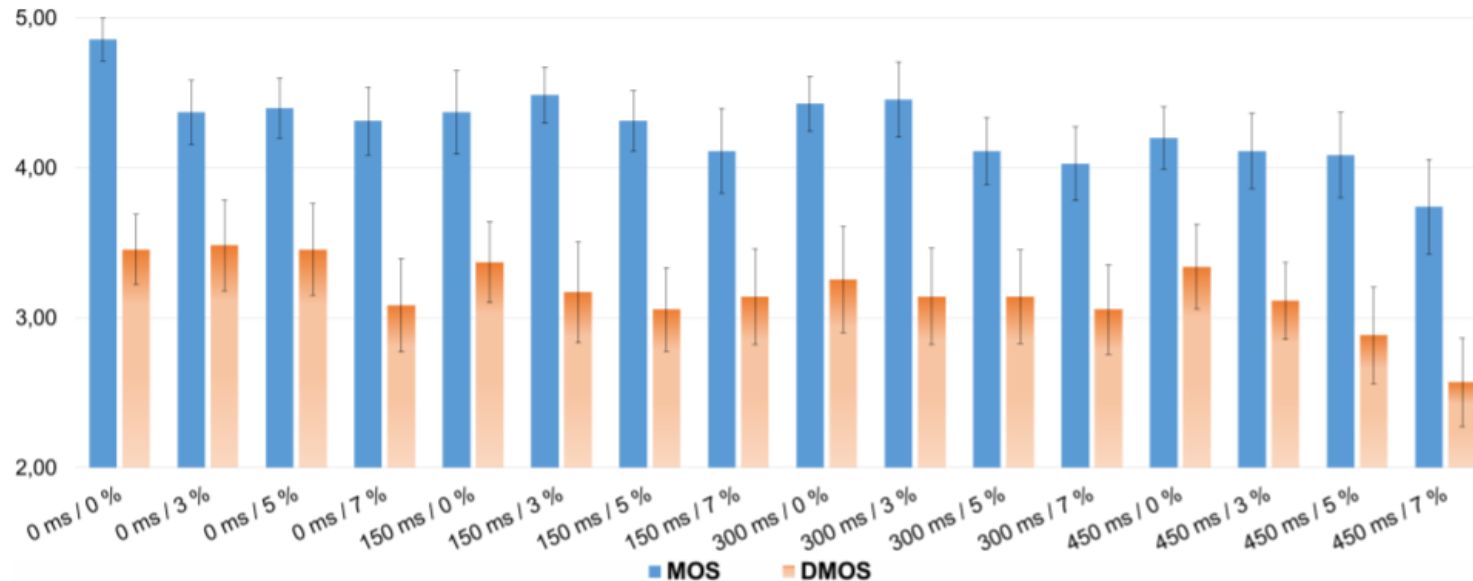
Scenario ID	Delay (ms)	Packet loss (%)	Direction
B	0	0.0	Both
D1	80	0.0	Both
D2	200	0.0	Both
D3	300	0.0	Both
L1	0	0.3	Both
L2	0	1.0	Both
M1	40	1.5	Both
M2	180	0.3	Both
A1	120	1.0	Client to server
A2	120	1.0	Server to client



2014

# Slivar et al.

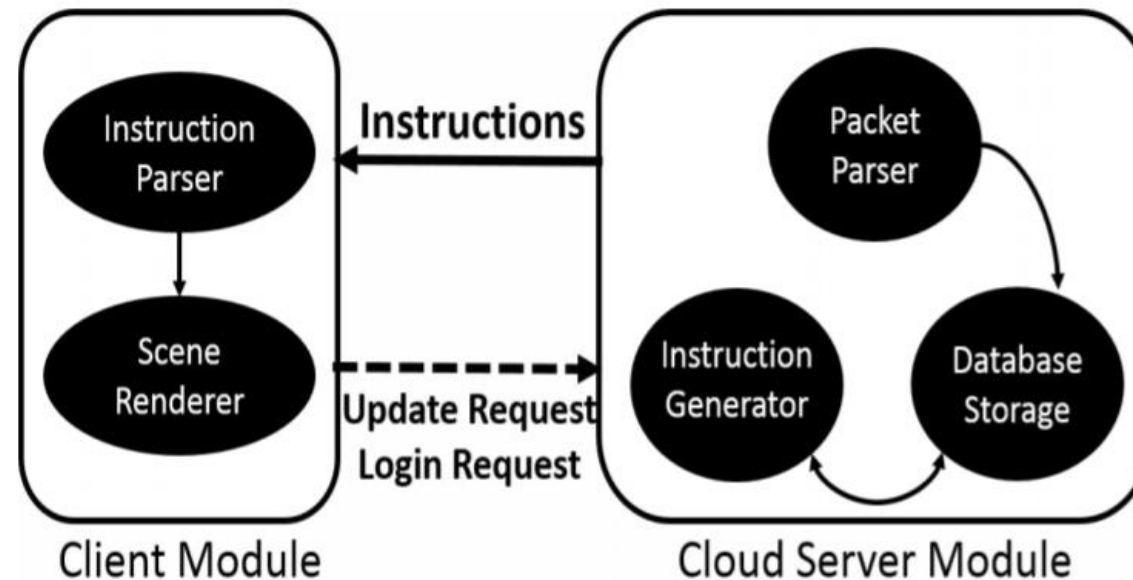
- Subjective QoE assessments of **traditional online gaming** and **In-home streaming** (GA) were proposed
- Widespread use of in-home game streaming is possible if adequate video quality is guaranteed



2017

# Muhammad et al.

- Cloud server **send/receive sets of instructions** instead of sending rendered frame data to client
- This model is good for cloud gaming under **low bandwidth for short time period**



# Considerations

- Following parameters will be considered in the future during the development of cloud gaming models and architectures:
  - *Design of QoE capture*
  - *Technical parameters*
  - *Heterogeneity*
  - *Mobility Management*

## Considerations

# Design of QoE Capture

- Only subjective QoE is considered in cloud gaming but still **objective QoE feature** are required as well
- Analysis of subjective and objective data can provide information about **QoE accuracy and SLA comparison**

## Considerations

# Technical Parameters

- Bitrate or data rate
- Frame Rate
- Throughput
- Network (Packet loss and Delay)



## Considerations

# Heterogeneity

- As the size of cloud increases the different type of hardware are added to provide more resources
- The future gaming model **need to support heterogeneous device** and utilize available resource for faster game rendering

## Considerations

# Mobility Management

- Most mobile users playing games via cellular networks and their location is changed due to mobility
- Data offloading, signal weakness and handoff are disturbing for cloud gaming
- Automatic switching among the different network without disturbing the game can be useful to players

# Future Directions

- Speculation-based technology
- Adjustable gaming frame rate depends on network conditions
- Cloud management to ensure QoS according to SLA
- Features of subjective and objective QoE/QoS
- Controlling QoE in runtime environment and QoE optimization

# Conclusion

- The paper provides review and analysis the cloud gaming models and architectures based on the QoE of video and network parameters
- Give the definitions of the key concept and background and types of QoE
- Studies and suggestions for future development of cloud gaming are also presented

THANKS FOR LISTENING

*Any Question?*