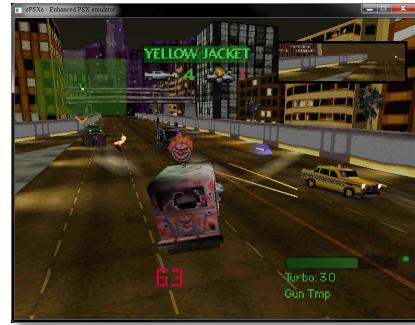




From Pixels to Reality – Thoughts on Next Game Engine

Hao Chen
Sr. Principal Engineer, Amazon
chenha@amazon.com





Twisted Metal- PSX
1995



Outwars - PC
1998



Links 2001 -PC
2000



AMPED-XBOX
2001



AMPED 2 – XBOX
2003

20 Years?....Why am I still here?.....😊



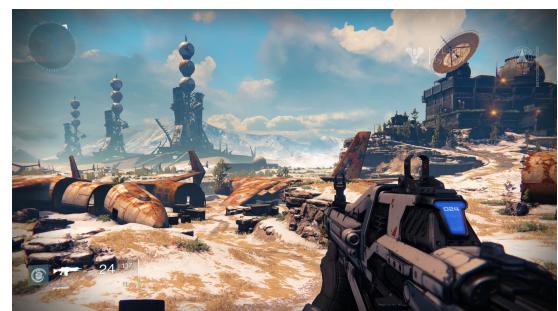
Halo 2– XBOX
2004



Halo 3– XBOX 360
2007



Halo Reach– XBOX 360
2010



Destiny– Xbox One PS4, PS3, 360
2014

Same Growth Story - GPU, API, Console, Fidelity



1994

1996

2000 2001

2005 2006

2013

2016



- It's Moore's law, stupid!

Game Engine 2016



Multi-threaded



PBR



Multi-Platform



Global Illumination



Modern API



Dynamic Environment



Deferred Rendering



60 FPS@1080P



lumberyard
BY amazon

Game Engine 2018?

What is NOT good enough?



Aliasing



Load Time



Shadow



Animation



Transparency



Performance



Content Production

What is new?



Community Based Gaming



E-Sports



User Created Content



Broadcast

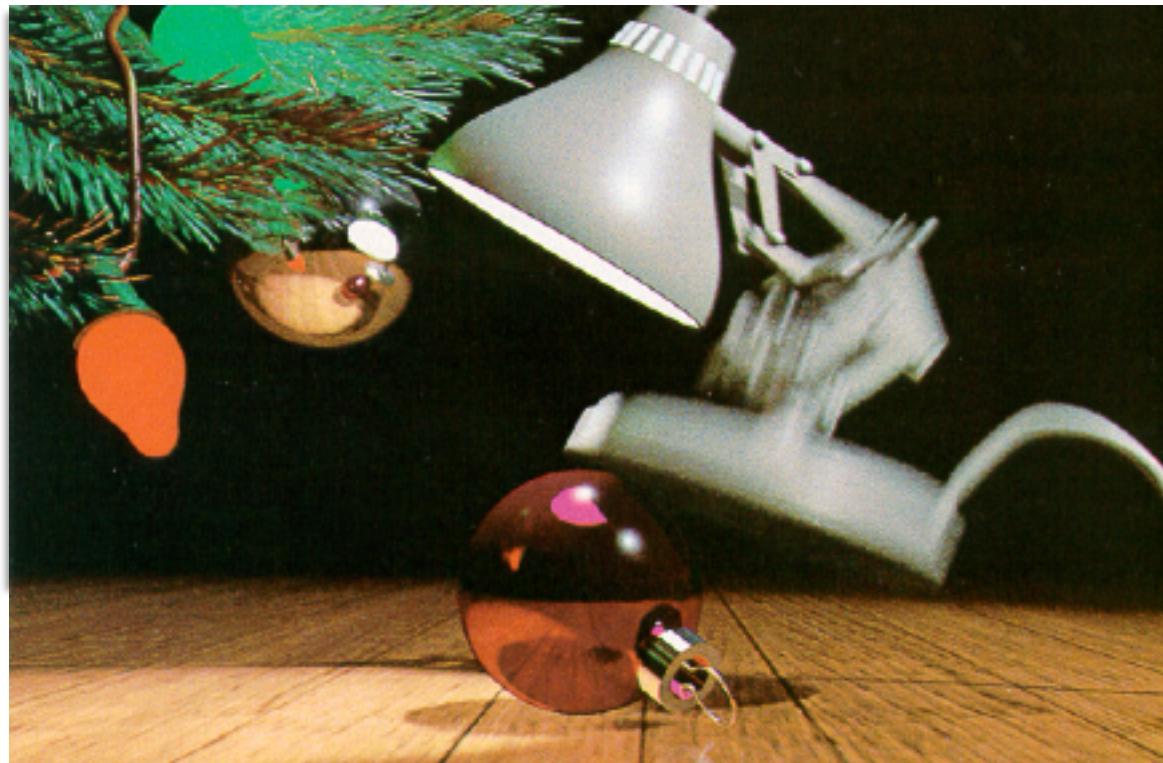


Mobile



VR/AR

Aliasing is by Design



“Image Quality. We eschew aliasing and faceting artifacts, such as jagged edges, Moire patterns in textures, temporal strobing, and highlight aliasing.”

[CookCarpenterCatmull87]

1986 Pixar Christmas Card by John Lasseter and Eben Ostby.

Film vs. Game



Reyes/Ray Tracing

Object Space Shading

Lots of Visibility Samples

Image Quality



Direct 3D / OpenGL

Screen Space Shading

Few Visibility Samples

Throughput

REYES/Ray Tracing for Games? -- Not Ready Yet



Make REYES work with GPU [\[Fatahalian10\]](#)[\[BurnsFatahalianMark10\]](#)
[\[Kunzhou09\]](#)

- Small Triangle Problem
- Scene Complexity
- Not fast enough



Real-time Ray-Tracing [\[Nvidia IRay\]](#)

- 4K now, 8K soon.
- Multiple-monitors/Stereo
- Not fast enough

Better Way: Borrow and Combine Ideas



Shade in Object Space = Inherently Stable
[CookCarpenterCatmull87] [Fatahalian10]

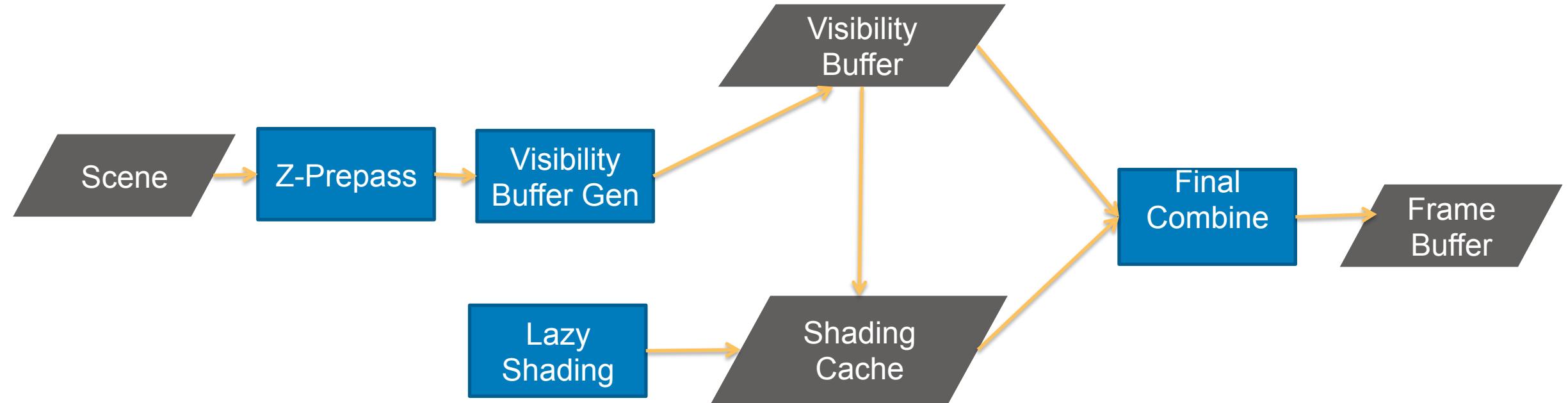


Decouple Visibility Sampling from Shading = Multi-Rate
[BurnsFatahalianMark10]



Visibility Buffer = Reduce Memory & Bandwidth
[BurnsHunt2013] [[SchiedDachsbacher15]]

Possible Rendering Pipeline



Go Further with Multi-Rate



Visibility Samples



AI



Shading Samples



Physics



Lighting Samples



Input



Light Transport Update

What about Other “Aliasing”?



Specular Aliasing

- Lean Mapping [[OlanoBaker 2010](#)]



Shadows

- Frustum Traced Raster Shadows
[\[WymanHoeltzleinLefohn15\]](#)



Transparency

- Order Independent Transparency

Load Time



Compression – 2X Better Than Z-LIB



Procedural Synthesis – Substance
<https://www.allegorithmic.com>



Wang Tiles [Wang61][Stam97][Liyi04]
<https://artomatix.com>

Cloud



Huge Worlds



Thousands of Inhabitants



Thin Clients



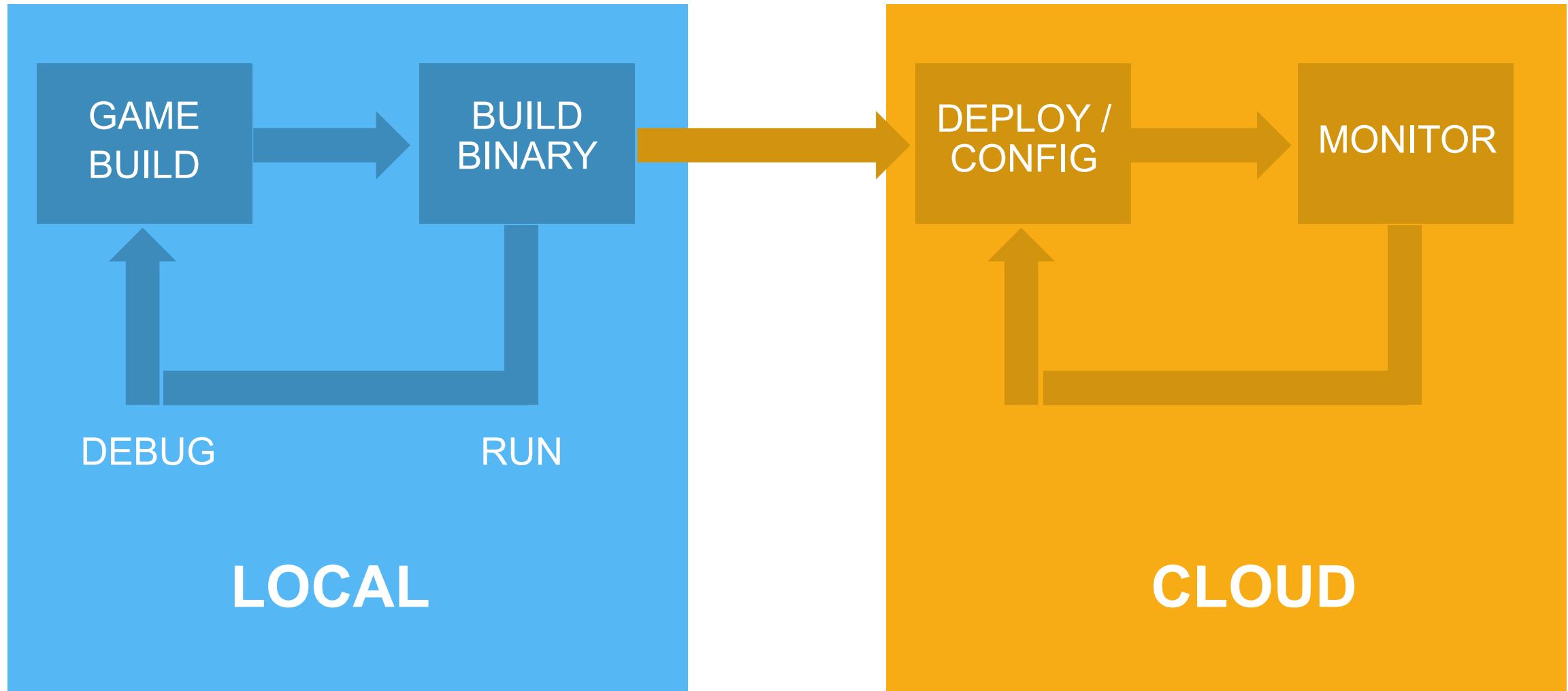
Studio In A Box



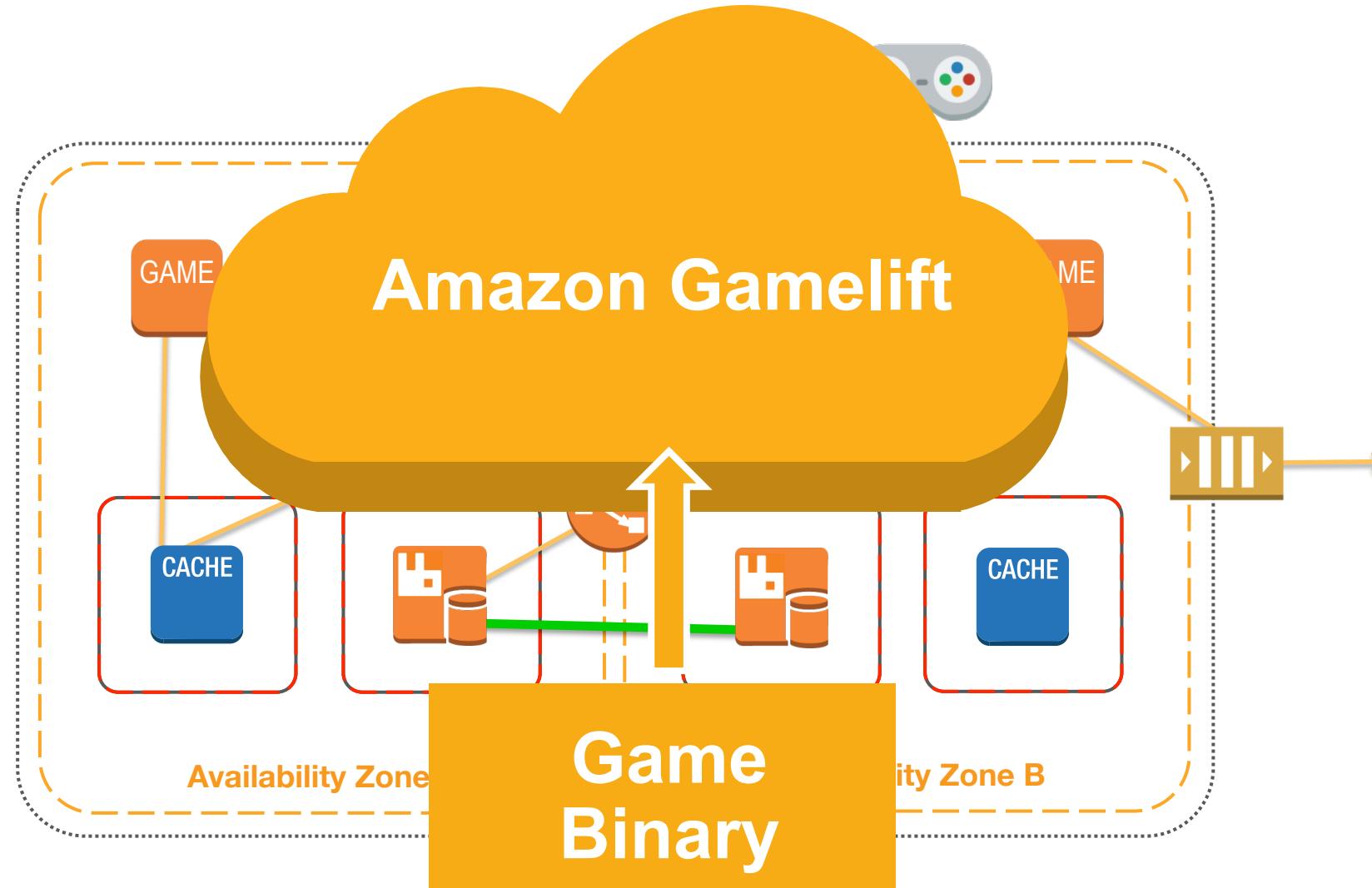
Content Production

Amazon Lumberyard - GameLift

Problem we are solving?

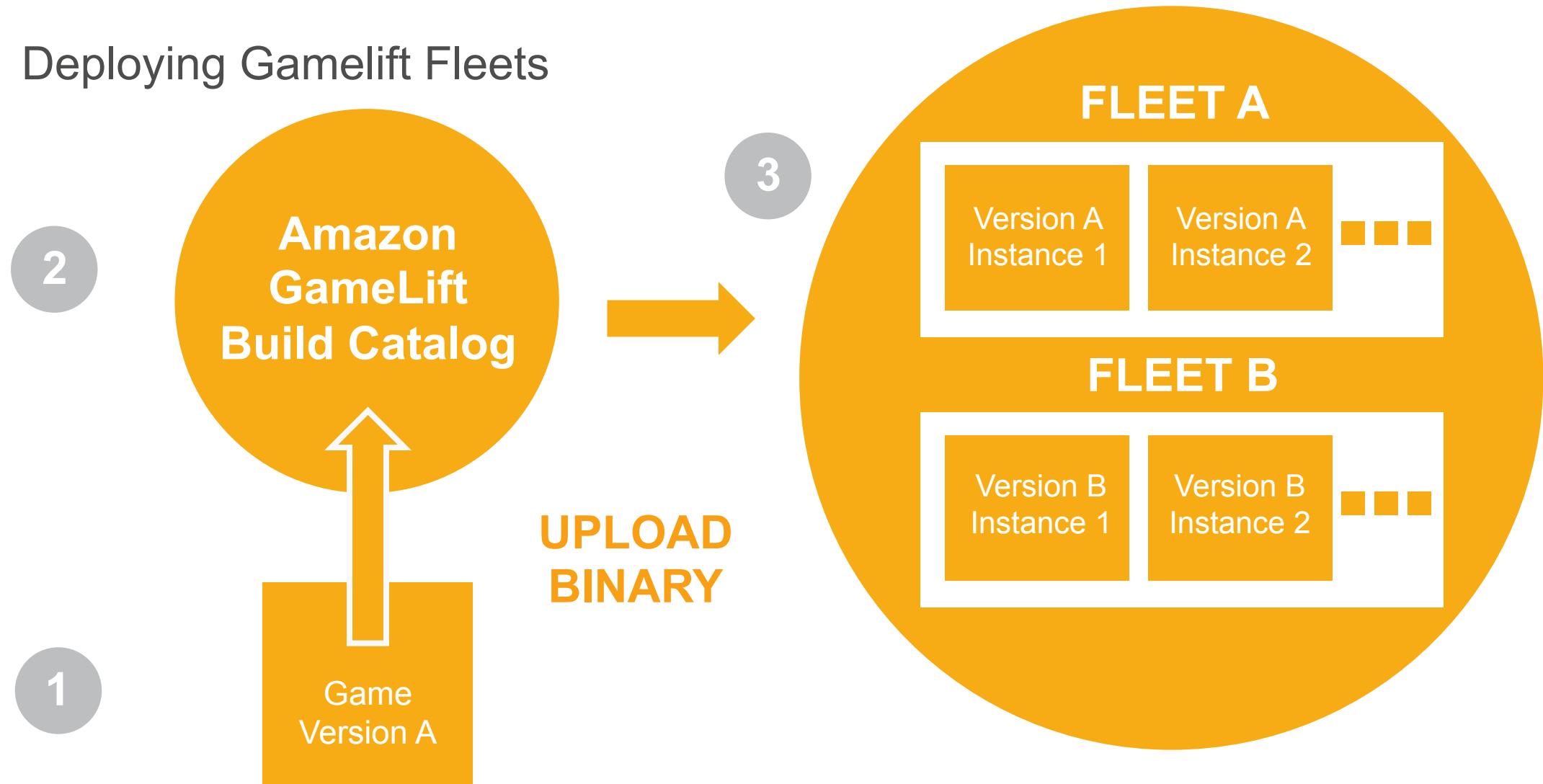


Get started in minutes, even with little backend experience



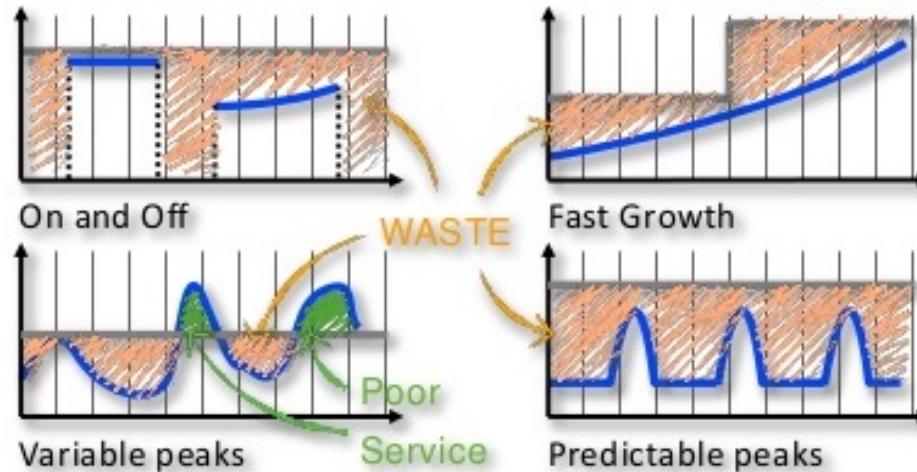
Reduced ongoing engineering and operational effort

- Deploying Gamelift Fleets

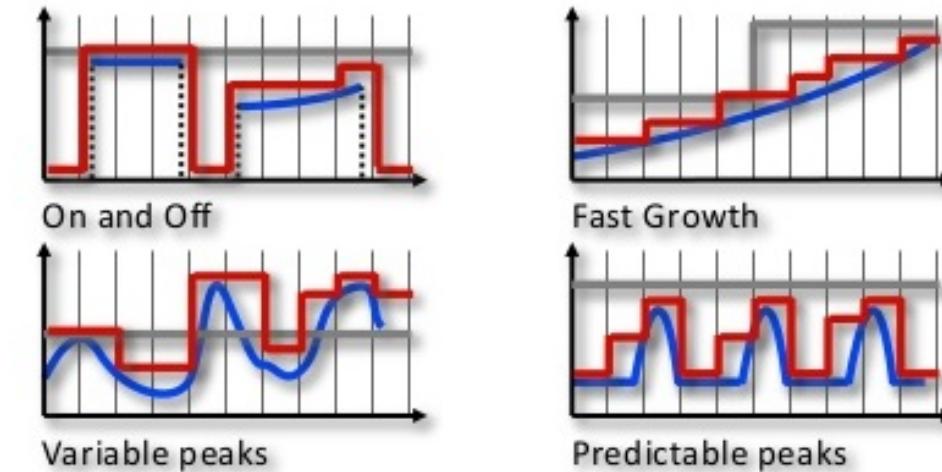


Scale based on player demand (coming soon)

Traditional dedicated servers

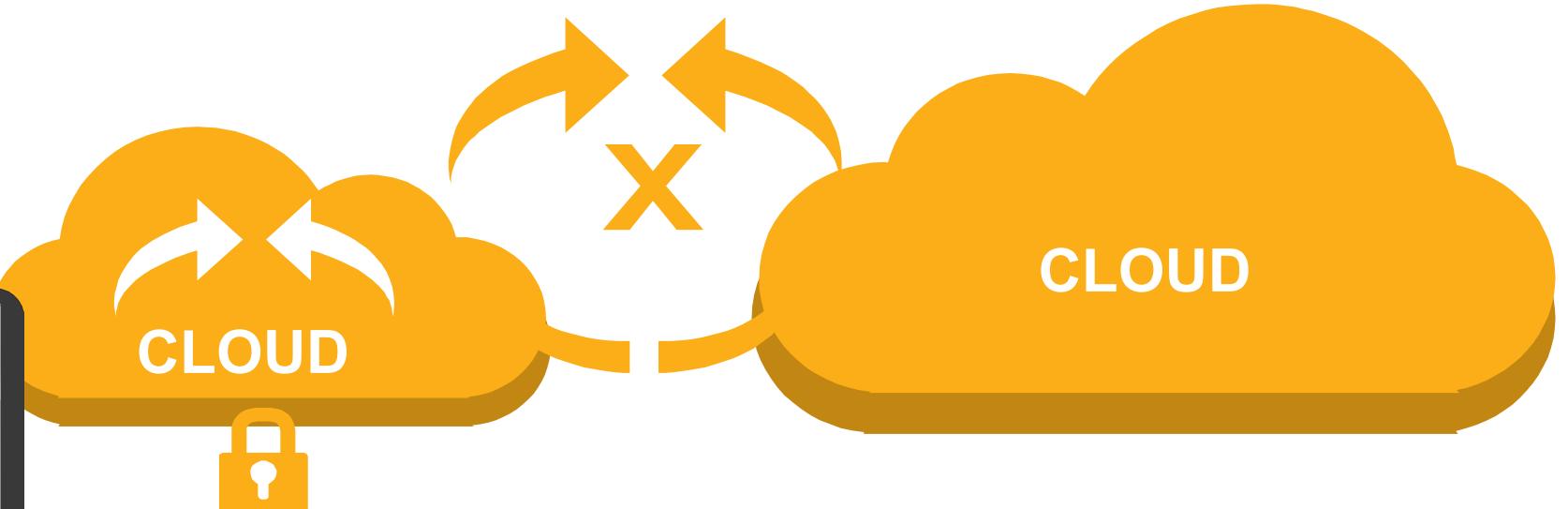
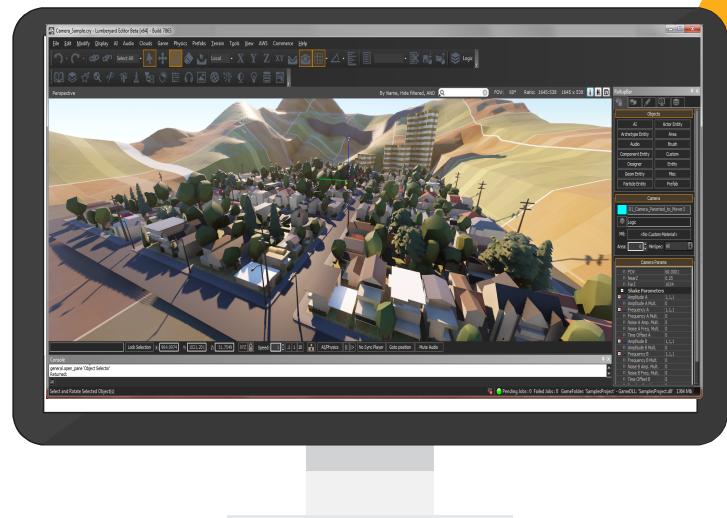


On-demand auto scaling



Amazon Lumberyard - Cloud Canvas

Problem we are solving?



Cloud Canvas - Details



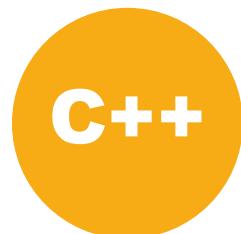
AWS Primitives

Cognito
S3
DynamoDB
Lambda
SNS
SQS



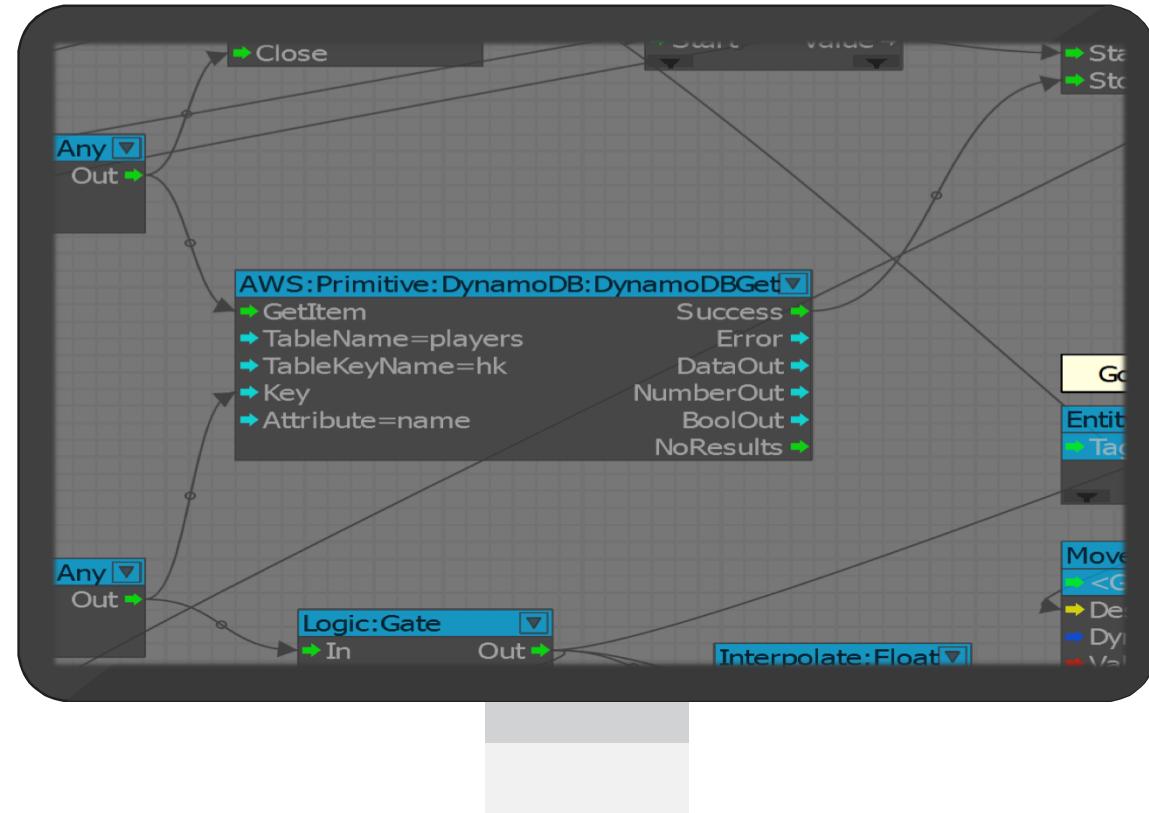
Callable from Script

Gifting system
Leaderboards
News Ticker

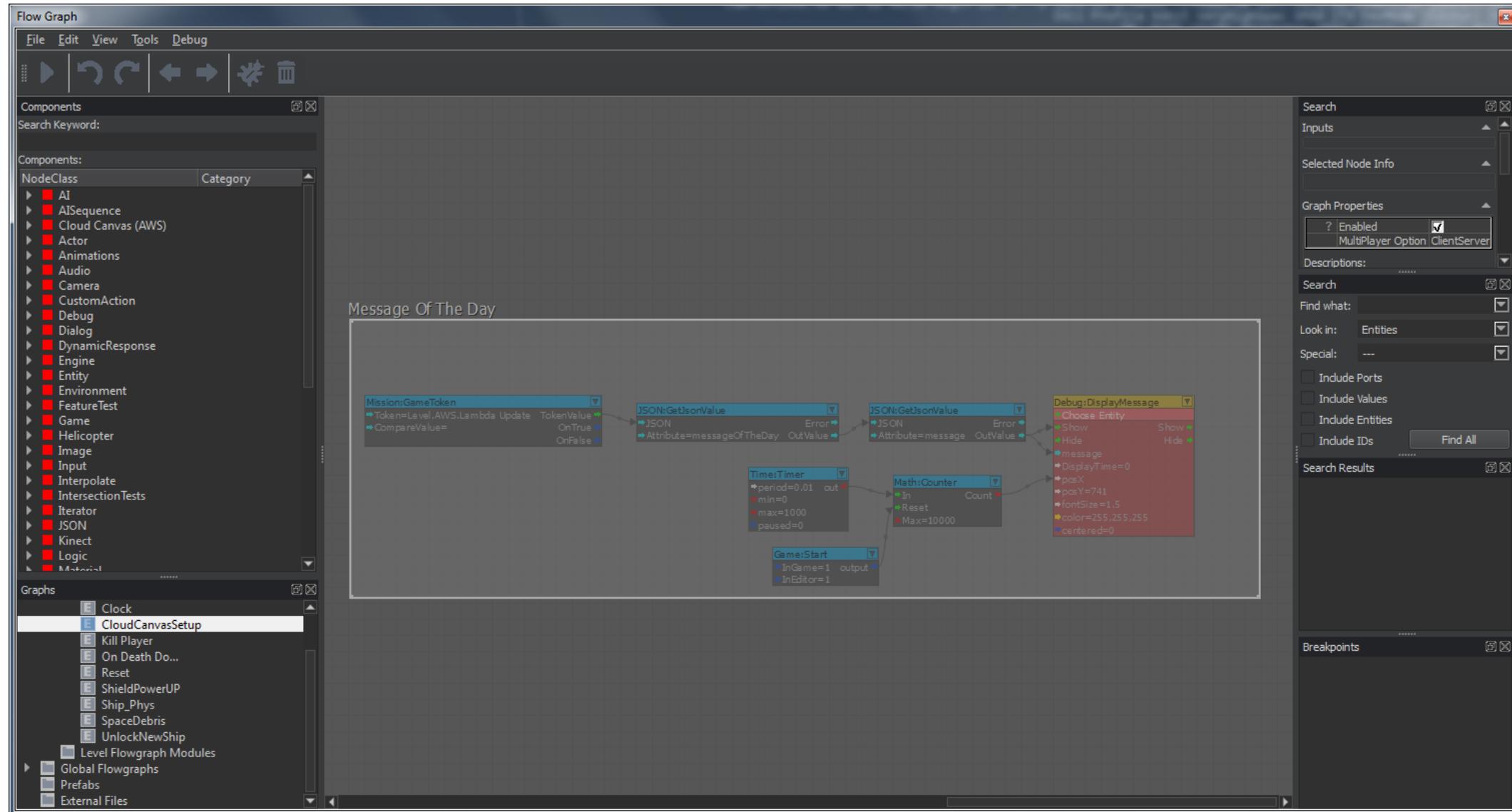


C++ SDK

Create your own nodes



Cloud Canvas – Visual Scripting



Game Engine 2018



Almost No Aliasing



Perception Guided “Importance”



Right Space



Procedural Content



Right Frequency



Cloud Connected



Right Place

Hot Research Topics



Procedural Synthesis



Multi-rate Rendering



Compression



Animation



3D Scanning



Distributed Physics/AI/Rendering



Perception Science



Q and A

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