

# ILMXLAB IMMERSIVE ENTERTAINMENT







## New Challenges In Mobile VR

- Explorable world with long sitelines
- More characters
- Longer and more interactive cinematics
- Variety of weapons, inventory, and collectables



#### Game Thread Challenges



- Moving complex component hierarchies
- Spawning/despawning hitches
- Non combat ticks during combat
- CPU stalls



#### **Component Hierarchies: General Case**



- Actor components instead of scene components
- Scoped movement
- Complex hierarchies should move at most a single time per frame
- Detach/Reattach when needed



#### **Component Hierarchies: Skeletal Meshes**



- Detachment Optimization:
  - Detach the skeletal mesh component
  - Use the anim graph to move the root bone where it should be
- Used on player pawn, all enemies, and all cinematic characters that appear during combat
- Drawbacks:

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- Some anim nodes need fixing
- Location of component not correct anymore

#### **Component Hierarchies: Overlaps**

- A lot of unneeded overlaps on by default
- Education on UE's physics/collision options
- Switch to keeping a list of targets, if possible





#### Hitches

- Most hitches come from spawning/despawning of actors & components
- Reuse objects through a pooling system
- Spawn everything ahead of time
- Use caps



#### Non-Combat Logic



- Adding a player distance system to reduce impact during combat
- Despawn placed items if player is too far



#### Game Thread Stalls



- Small number of cores on Quest
- Rendering, audio and gameplay simultaneously demanding
- Some are still solvable



#### Game Thread Stalls: Unreal Insights



- Helps pinpoint reasons for stalls
- Smaller impact on performance than stat capture
- Drawbacks:
  - $\circ$   $\,$  Tricky to set up on Quest
  - As of 4.24, no object names make interpretation tricky
  - No way to start/stop the capture

#### Game Thread Stalls: Tips

- Understand the task graph system
- Beware of tick prerequisites
- Parallel work could be forced to complete early, causing stall

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#### Miscellaneous Game Thread Tips



No blueprint ticks
No blueprint implementable/blueprint native events on ticks
Favor non-dynamic delegates
Beware of blueprint

timers/timelines



#### **Rendering Challenges**



- Memory
- GPU
- Draws Call
- Complex Shaders
- Complex Animations
- Complex Environments



# Mesh Occlusion





## **Precomputed Visibility**



Avoid visual pops

• High sample settings

Maximize Oclusion

• Small cells

Efficiency

- Setup / Maintenance
- Computation time



## PCV - Selective mesh placement



# PCV - Nav mesh cell placement



# PCV - Cell stacking



#### PCV - World settings exposed configurations

🕘 World Settings 🛛 🔍 Details	👐 Levels
Search Details	
▲ Precomputed Visibility	
Precompute Visibility	<b>2</b> 5
Selective Cell Creation	🗹 Þ
Exclude Invisible Hidden Objects	e 🖸
Exclude Editor Only Actors	2 5
Place Cells Only Along Camera Tracks	
Visibility Cell Size	80 🔽 🗅
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Cell Height	160.0 🖸 🤄
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Use Precomputed Visibility Id Map	2 9

- Number of stacked cells
- Sample settings
- Mesh quantity thresholds



# **CIN** Cameras



Scene	Worst Bottleneck		Bottleneck(s) - (% of frames over time)	Avg Overage - (height of spikes in ms)			Memory	
	% of frames over target	avg ms of overage	Game GPU Draw	Game	GPU	Draw	Used	Peak
Startup	0.2% - CPU (Game Thread)	2860.505	0.2% 0.0% 0.0%	(2860.505)	(13.9)	(13.9)	1245 MB	1075 MB
DRRtoHQS	64.2% - GPU	17.201	0.9% 64.2% 2.1%	(663.628)	17.201	(449.765)	1234 MB	1075 MB
HQS_ADV1_Top_environment	43.4% - GPU	16.368	0.1% 43.4% 0.3%	(22.166)	16.368	(22.578)	1964 MB	1723 MB
HQS_ADV1_Cave_Environment	37.2% - GPU	16.05	0.1% 37.2% 1.4%	(16.33)	16.05	(19.472)	2095 MB	1826 MB
HQS_ADV1_Tunnel_Environment	0.9% - CPU (Game Thread)	16.581	0.9% 0.0% 0.3%	(16.581)	(13.9)	(40.52)	2071 MB	1831 MB
HQS_ADV1_SpringsIntro_Environment	48.8% - GPU	17.183	0.3% 48.8% 2.6%	(18.188)	17.183	(18.242)	2091 MB	1831 MB
HQS_ADV1_CrashSite_environment_pathToVessel	100.0% - GPU	25.83	4.2% 100.0% 98.6%	(31.503)	25.83	15.545	2119 MB	1854 MB
HQS_ADV1_CrashSite_environment_pathToVessel_2	100.0% - GPU	22.512	0.8% 100.0% 56.0%	(16.35)	22.512	16.558	2119 MB	1854 MB
HQS_ADV1_Vessel_environment	98.8% - GPU	21.3	0.2% 98.8% 8.3%	(17.065)	21.3	(14.986)	2120 MB	1878 MB
HQS_ADV1_CrashSite2_environment_exit	36.3% - GPU	16.716	0.1% 36.3% 0.0%	(20.6)	16.716	(13.9)	2170 MB	1878 MB
HQS_ADV1_CrashSite3_environment_C3PO_reunite	27.3% - GPU	18.862	0.3% 27.3% 0.0%	(19.003)	18.862	(13.9)	2157 MB	1881 MB
HQS_ADV1_CrashSite2_environment_exit_2	25.0% - GPU	15.335	0.1% 25.0% 0.1%	(19.09)	15.335	(85.75)	2157 MB	1881 MB



#### Memory



















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# Hierarchical LODs

XX	World Outliner	
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Biueprints Cinematics VR Mode	Label	Type
	SM HOS AcidPoolB48	StaticMeshActor
	SM HOS AcidPool851	StaticMeshActor
	SM HOS AcidPoolB81	
	SM_HQS_AcidPoolB82	
	SM_HQS_AcidPoolB83	
	HLODClusterActor34	
	SM HQS AcidPoolB84	
	SM_HQS_AcidPoolB85	
	SM_HQS_AcidPoolB86	
	SM_HQS_SpringsIntro_AcidPool	
	HLODClusterActor39_X2	
	HLODClusterActor23	
	SM_HQS_AcidPoolA4	StaticMeshActor
and the second second	SM_HQS_AcidPoolA17	StaticMeshActor
	SM_HQS_AcidPoolA19	
	SM_HQS_AcidPoolB43	
	SM_HQS_AcidPoolB44	
	SM_HQS_AcidPoolB45	
	SM_HQS_AcidPoolB46	
	SM_HQS_AcidPoolB87	
	SM_HQS_SpringsIntro_AcidPool/	
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	SM_BTW_OutcropA72	
	SM_BTW_OutcropA74	
	0_ 3 M_BTW_RockCoverAHalfB51	
	HLODClusterActor112	
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	SM_BTW_CliffTopA135	
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# Customized HLODs









# Tiered HLODs



# Always on HLOD

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- Eliminate transition pops
- Eliminate lightmap LOD pops
- Remove source meshes
- Increase lightmap res
- Reduce PCV computation
- Maintains instanced collisions



## **Dynamic Resolution**

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- Dynamically adjusts the viewport size
- No incurred expense
- Leverages Oculus Rift dynamic resolution overrides



## Visual Enhancements

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- Stereo Layers for menus
  - PokeAHole
- Mobile Parallax Reflections
- Decals on forward rendering





## **Vertex Animation**



- Film ridgid solver tools
- 4000+ animated objects
- Interpolation
- Procedural Overrides



#### Vertex Deformation & Instancing



- Many instance
- Variations
- Emissive with baked light probe sampling



#### **Vertex Animation & Instancing**





- Film pipeline crowd tools
- 200 animated characters
- Extra variation through atlassing













# Conclusions



Detailed optimization approach

- Unlocks techniques for visual improvements
- Enhanced interactions and gameplay mechanics
- Significant performance gains on Quest 2



# **Special Thanks**

- Oculus
- Unreal Engine
- GDC
- The team at XLAB



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