



ILMxLAB

IMMERSIVE ENTERTAINMENT





STAR WARS

TALES FROM THE GALAXY'S EDGE



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:**
 - 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

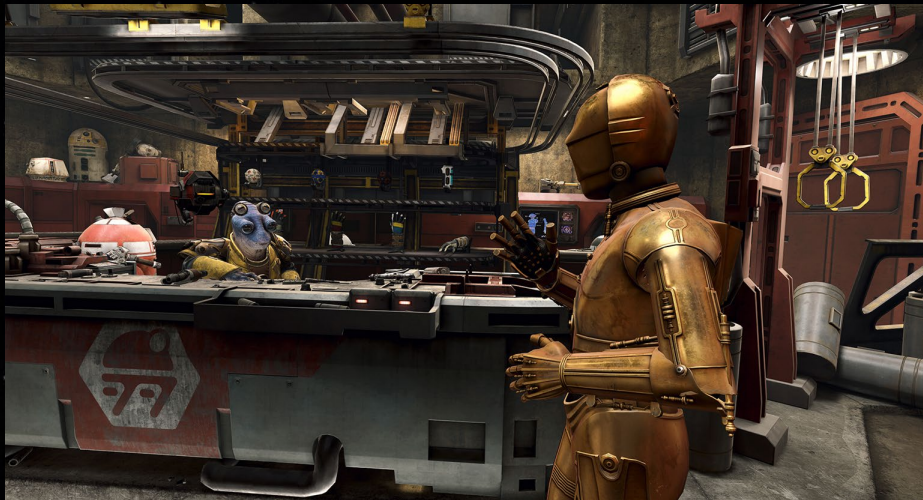


Non-Combat Logic



- 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

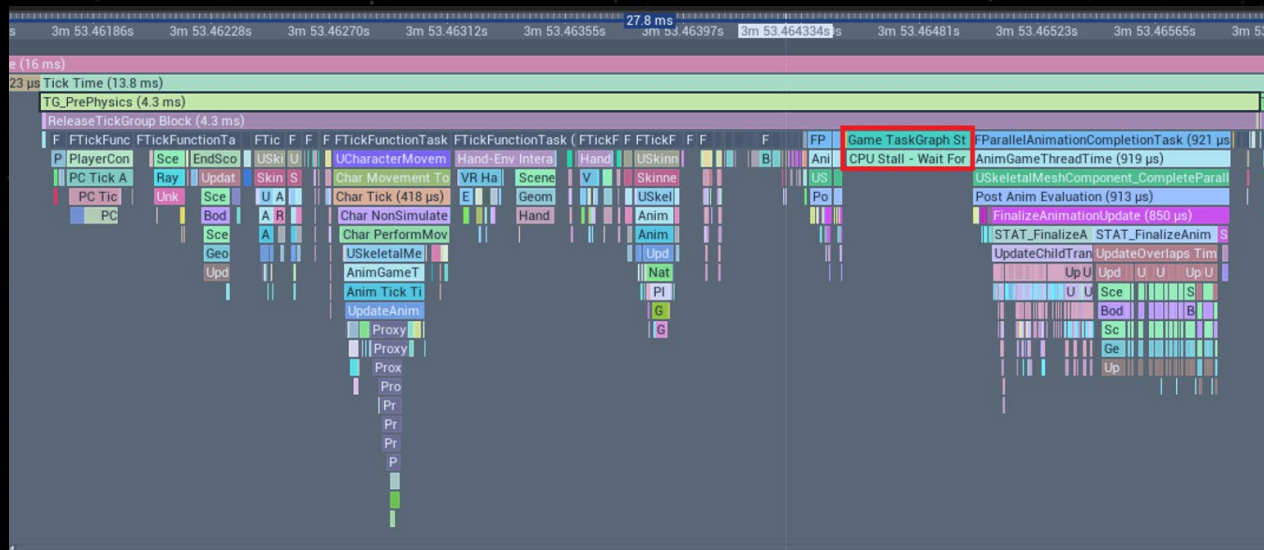
Game Thread Stalls: Unreal Insights



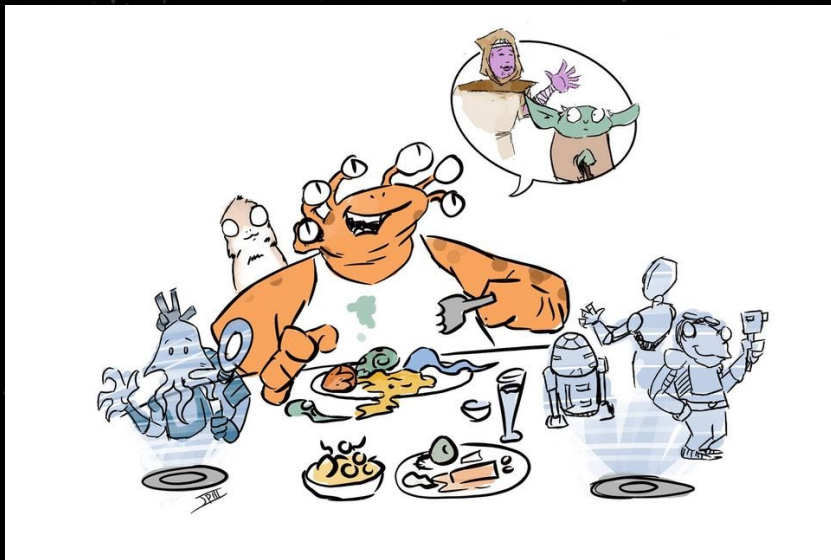
- Helps pinpoint reasons for stalls
- Smaller impact on performance than stat capture
- Drawbacks:
 - Tricky to set up on Quest
 - As of 4.24, no object names make interpretation tricky
 - No way to start/stop the capture

Game Thread Stalls: Tips

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



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

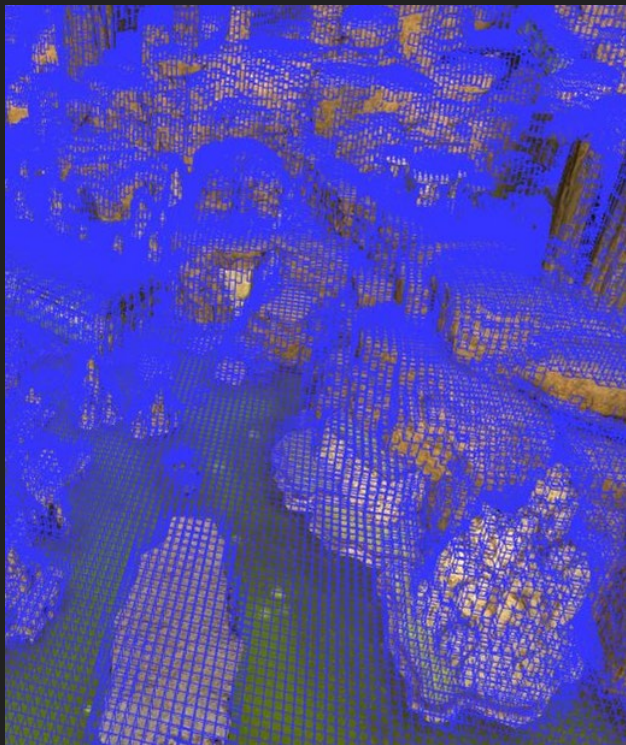


- Memory
- GPU
- Draws Call
- Complex Shaders
- Complex Animations
- Complex Environments

Mesh Occlusion



Precomputed Visibility



Avoid visual pops

- High sample settings

Maximize Occlusion

- Small cells

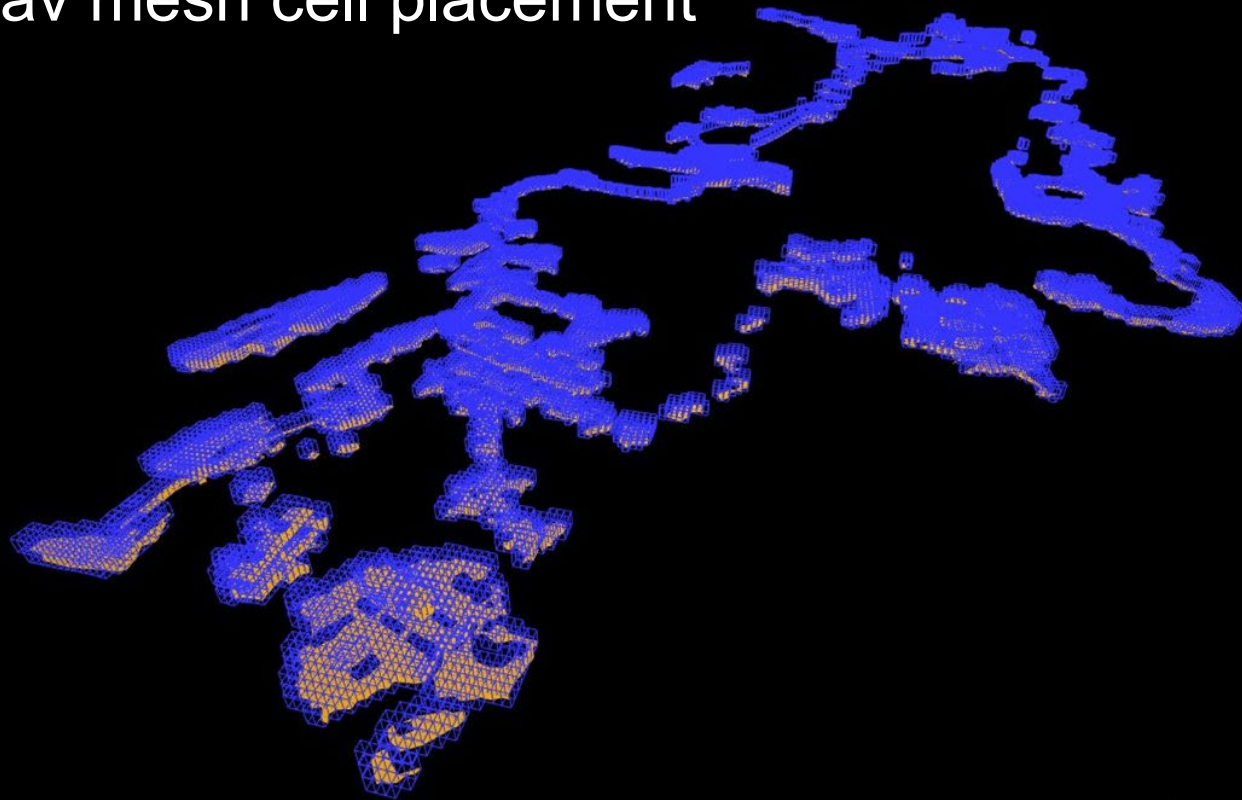
Efficiency

- Setup / Maintenance
- Computation time

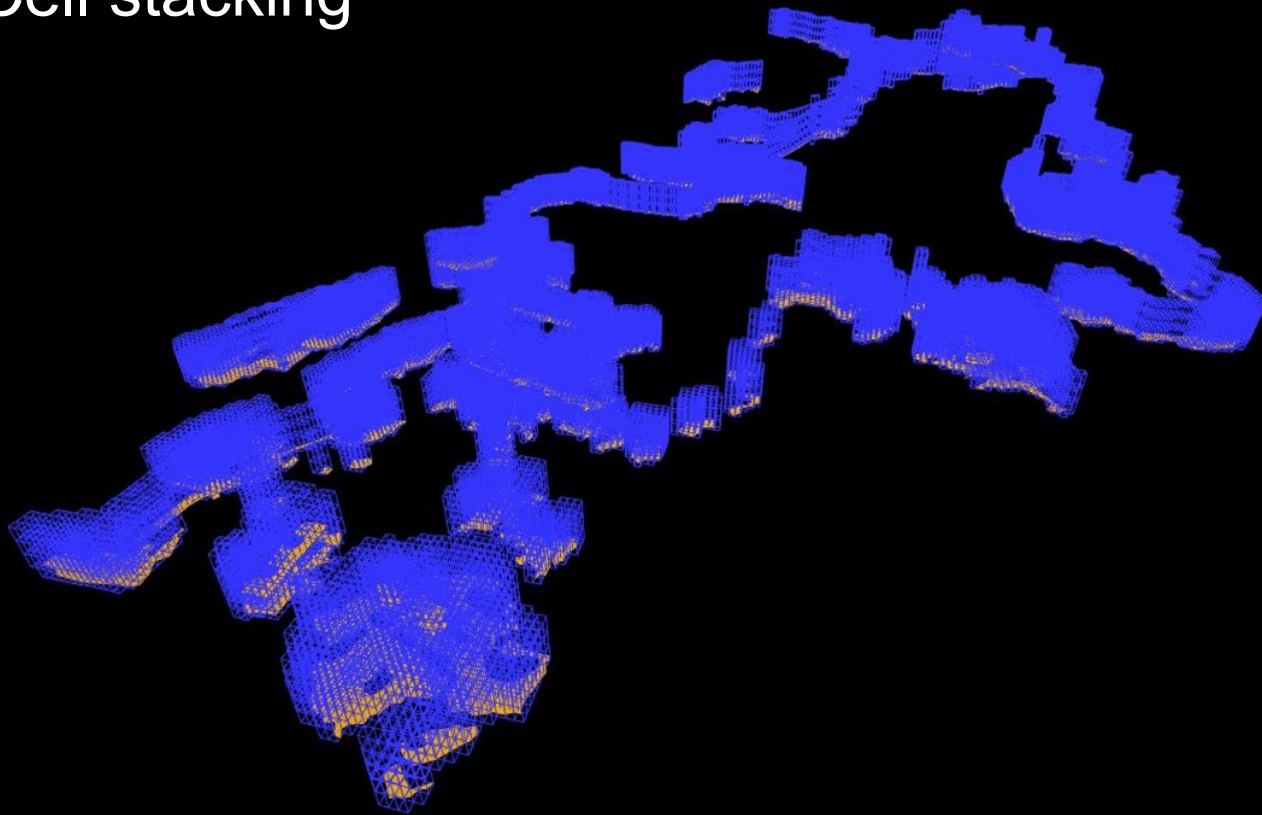
PCV - Selective mesh placement



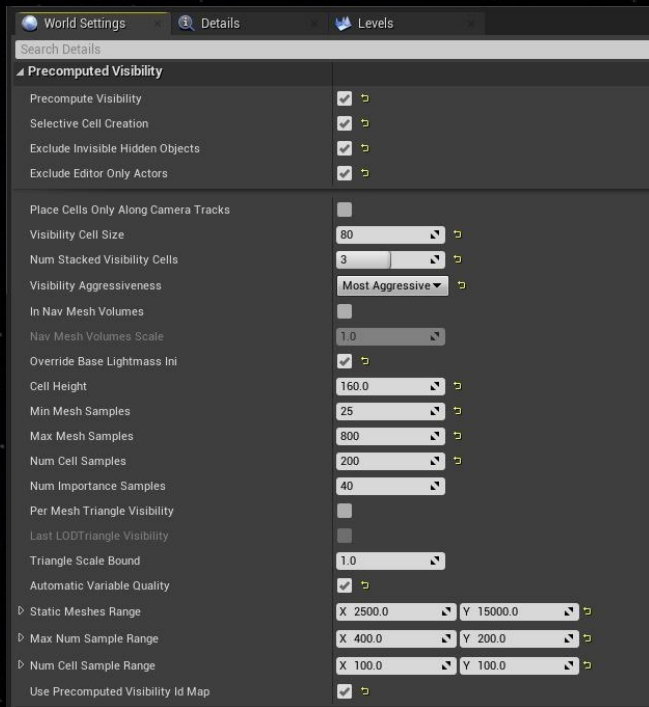
PCV - Nav mesh cell placement



PCV - Cell stacking

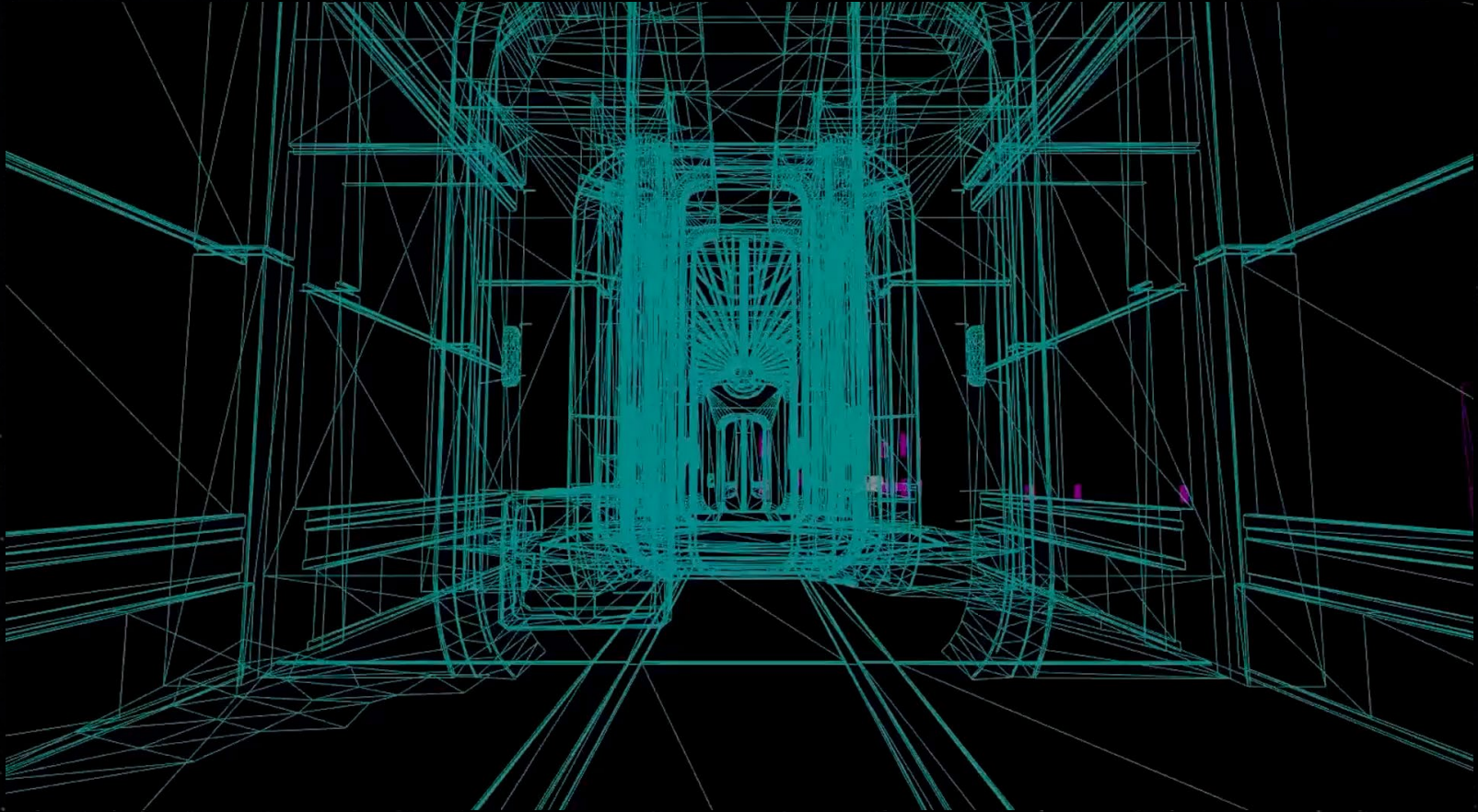


PCV - World settings exposed configurations



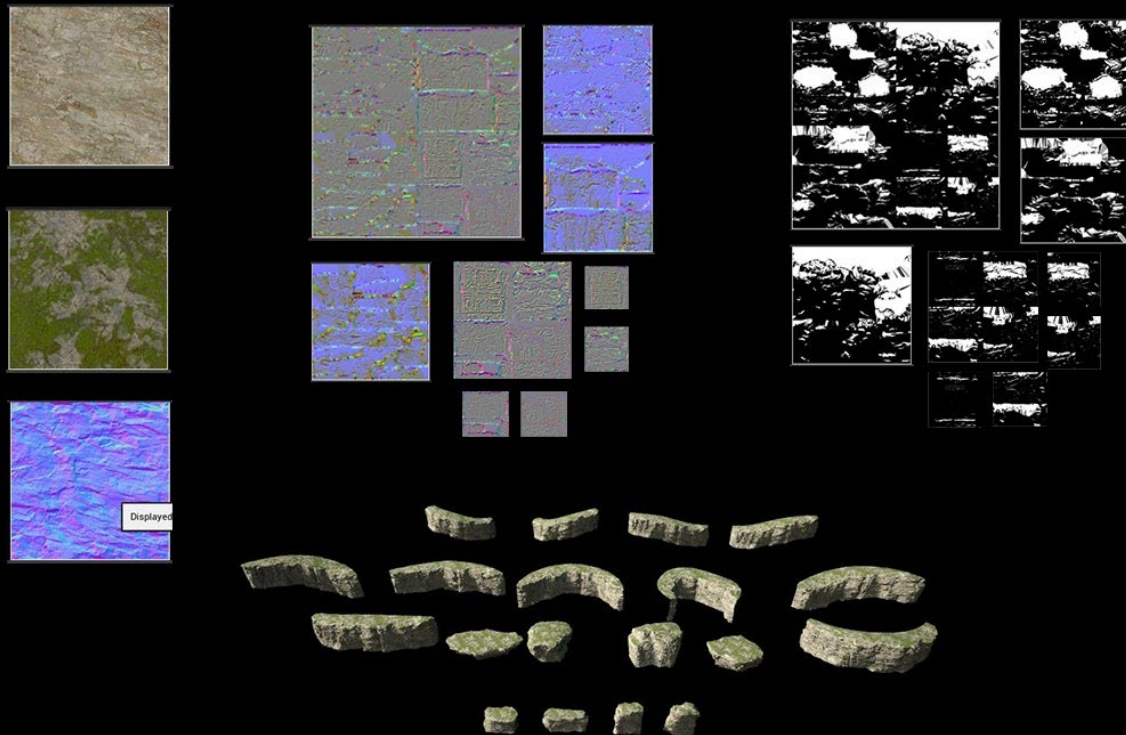
- Number of stacked cells
- Sample settings
- Mesh quantity thresholds

CIN Cameras

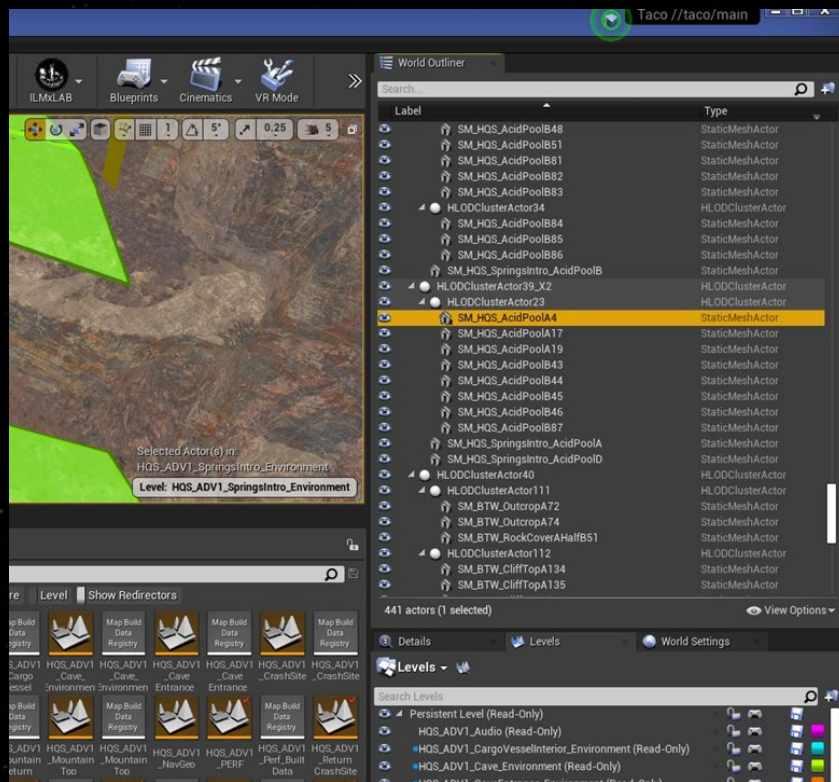


Scene	Worst Bottleneck		Bottleneck(s) - (% of frames over time)			Avg Overage - (height of spikes in ms)			Memory	
	% of frames over target	avg ms of overage	Game	GPU	Draw	Game	GPU	Draw	Used	Peak
Startup	0.2% - CPU (Game Thread)	2860.505	0.2%	0.0%	0.0%	(2860.505)	(13.9)	(13.9)	1245 MB	1075 MB
DRRtoHQS	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

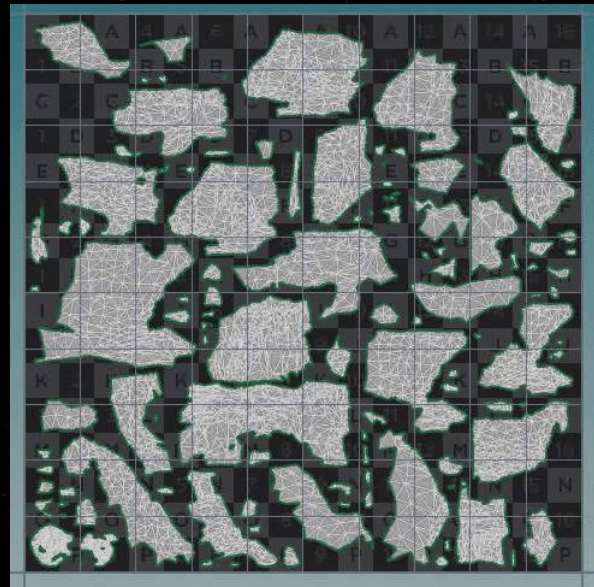
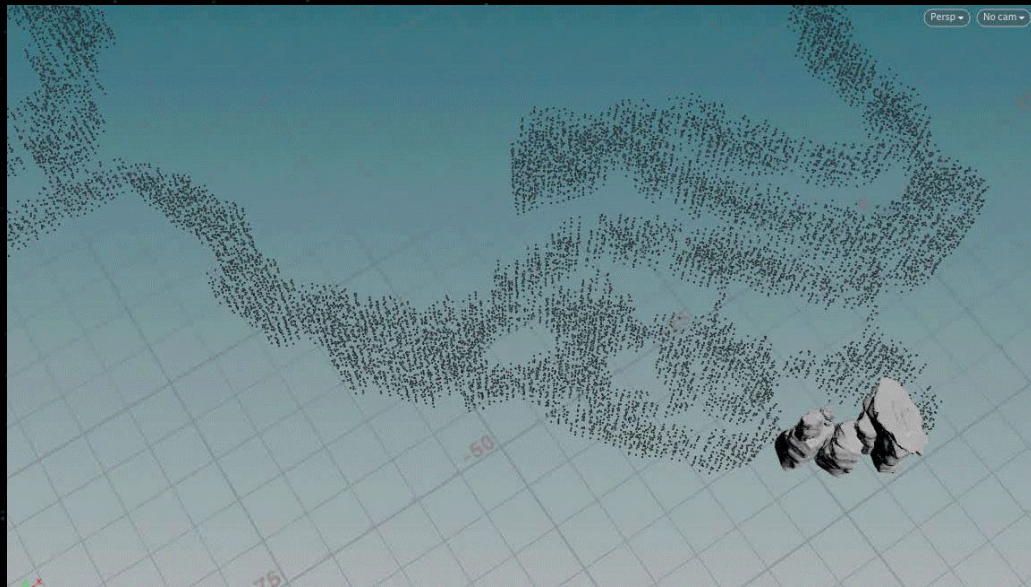
Memory



Hierarchical LODs



Customized HLODs





Tiered HLODs



Always on HLOD

INDUSTRIAL
LIGHT & MAGIC

Taco

Shot: hlod
Task: ELEMENT - Take 000000
Frames: 0-499 (cut: None)
Lens: no lens data
Date: 12/25/20 03:03AM PST
PTS #: CGTAC-000000

Notes:

HDR.hlod\XKWek;

YCGMRB

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

Dynamic Resolution

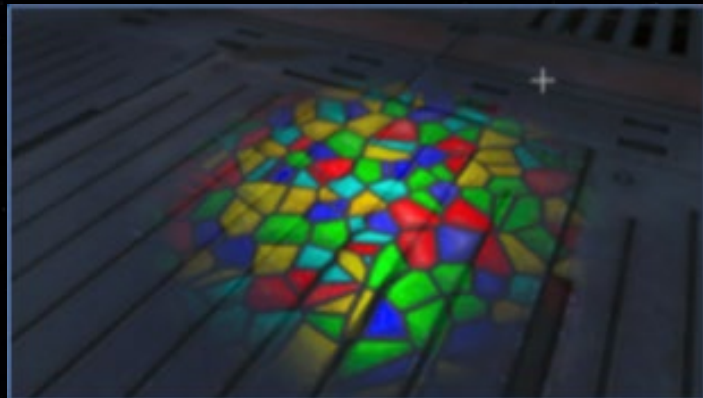


- Dynamically adjusts the viewport size
- No incurred expense
- Leverages Oculus Rift dynamic resolution overrides

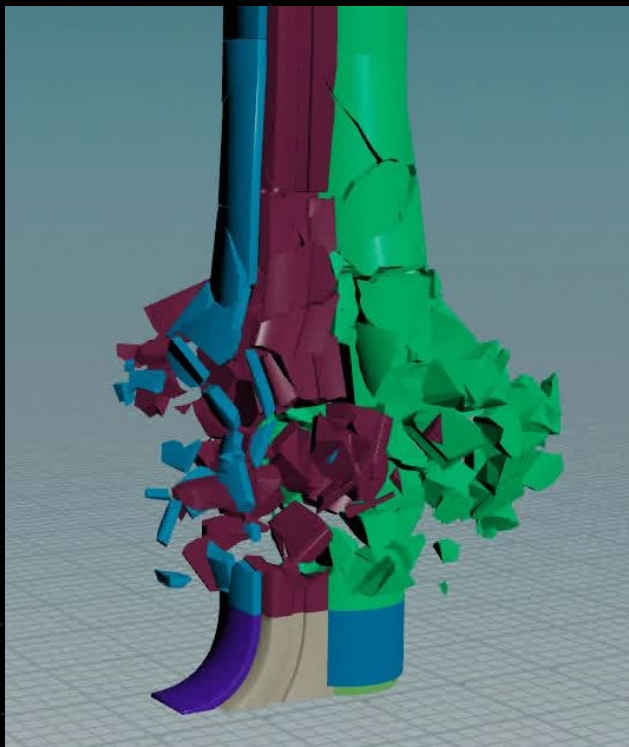
Visual Enhancements



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



Vertex Animation



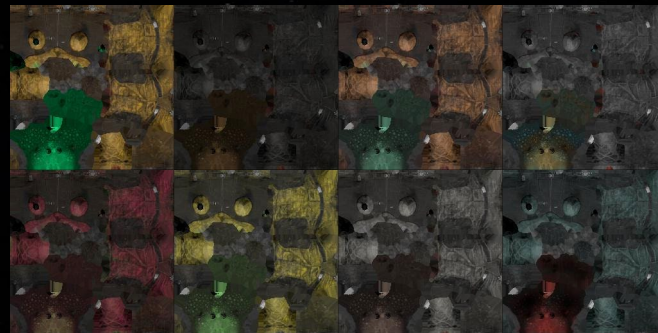
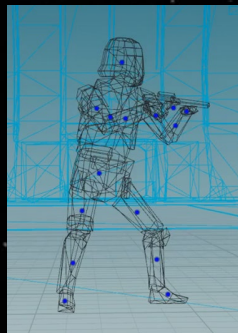
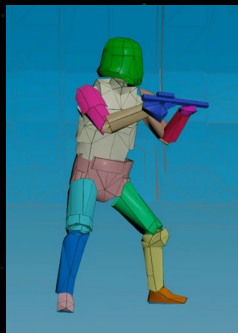
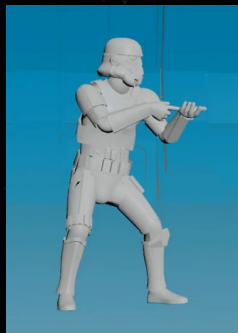
- Film rigid solver tools
- 4000+ animated objects
- Interpolation
- Procedural Overrides

Vertex Deformation & Instancing



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

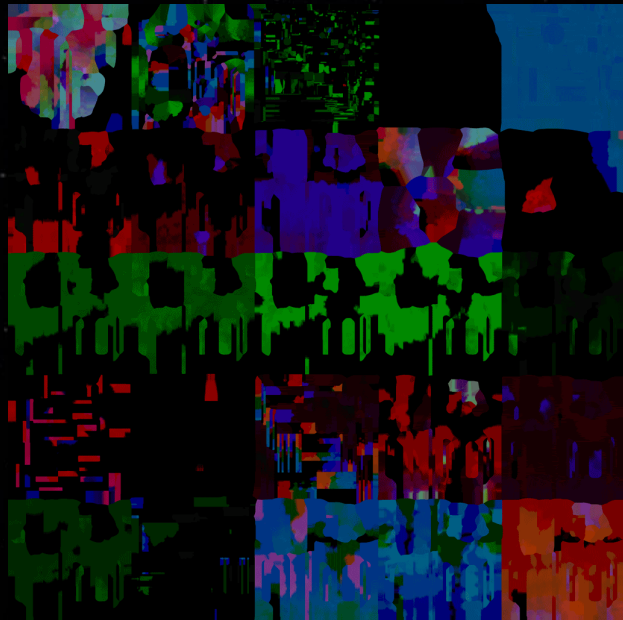
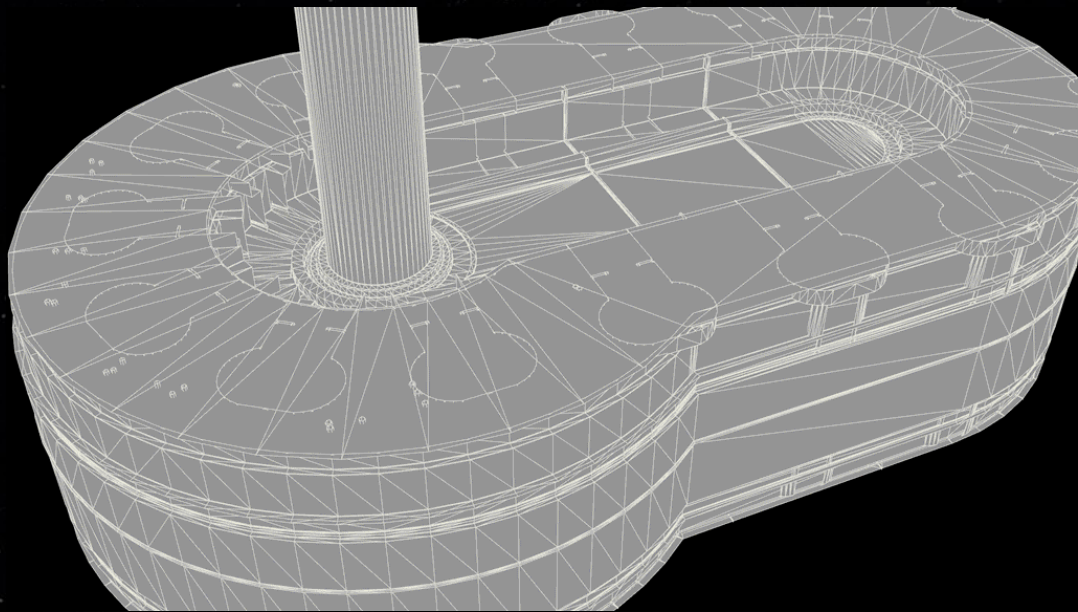
Vertex Animation & Instancing

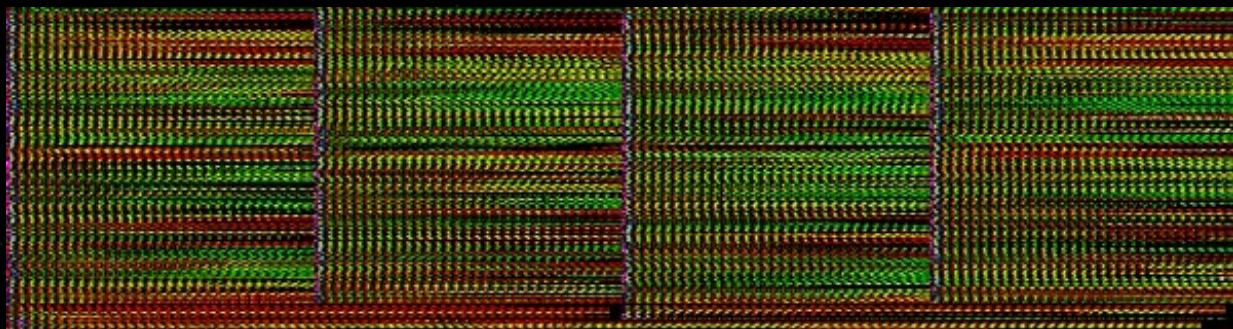
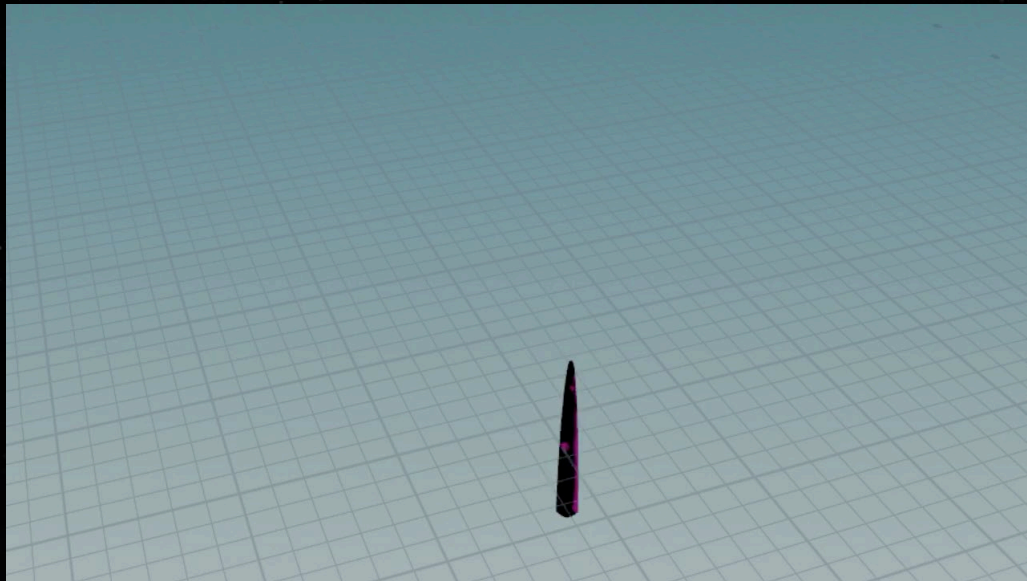


- Film pipeline crowd tools
- 200 animated characters
- Extra variation through atlassing









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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