CAPTURING ASSETS IN THE FIELD

REFERENCE PHOTOGRAPHY AND PHOTOGRAMMETRY

UNREAL ENGINE

Biome

- Themed for Isle of Skye, Scotland

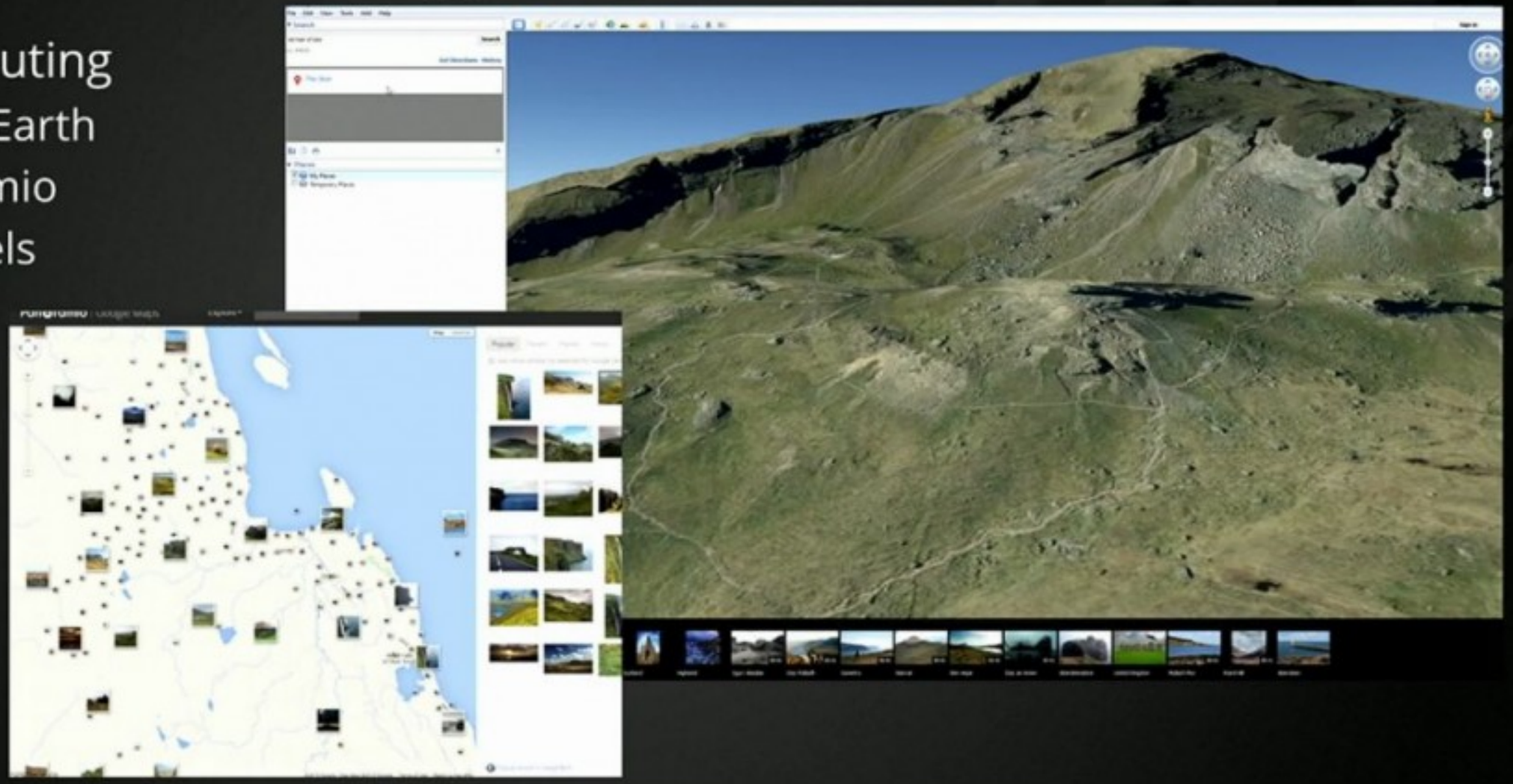
Striking contrast between rock and plant life.

Motivation

- Goal is photorealism so capturing reality for our Biome makes sense
  - This means shooting in the field
  - Phot scanning and reference photos

Picking a location

- Virtual Scouting
  - Google Earth
  - Panoramio
  - 500 Pixels
  - Flickr



Asset Breakdown

- Breaking down into individual components

Large Rocks	SCN	4	Large freestanding boulders which broke off from their original location. Above ground						
				Dark Rock	Boulder	Boulder	Boulder		
Terrain Rocks	SCN	6	Rocks that add shape to the terrain and are mostly underground with a small portion exposed by soil erosion. Partially underground.						
				Flat revealed	Rocks peeking out	Large rock partial	Huge erosion rocks	Tiny erosion Rocks	Med erosion rocks
Small Rocks	SCN	4	Small-sized rocks, above ground						

Component Types

Ground Dirt

Ground Cover

Large Rocks

Terrain Rocks

Small Rocks

Vegetation

Paths

Cliff Faces

Medium Rocks

Logistics

- We decided on:
  - 2 person team in NZ shooting for 7 days
    - 12 hours of Daylight
    - Flora in bloom
    - Sunny
  - 2 person team in EGUK ongoing
    - Miserable weather but..
    - Injects authentic UK assets

Capture Categories

Reference Photography

Plants, Bushes, Flowers, Water, Distant Objects, Landscapes

Photogrammetry

3D mesh

2D ground tile

Tree bark

Reference Photography

- Chromakey backer board
- Color checker
- Circular Polarizer
- Tripod
- Deep depth of field
- BRACKETED!!

UNREAL ENGINE

Front and back

Show Turntable Settings
Project: GDC_Demo
Lighting Scenario 3 of 3 : EPIC Quad
Author: francoisantoine

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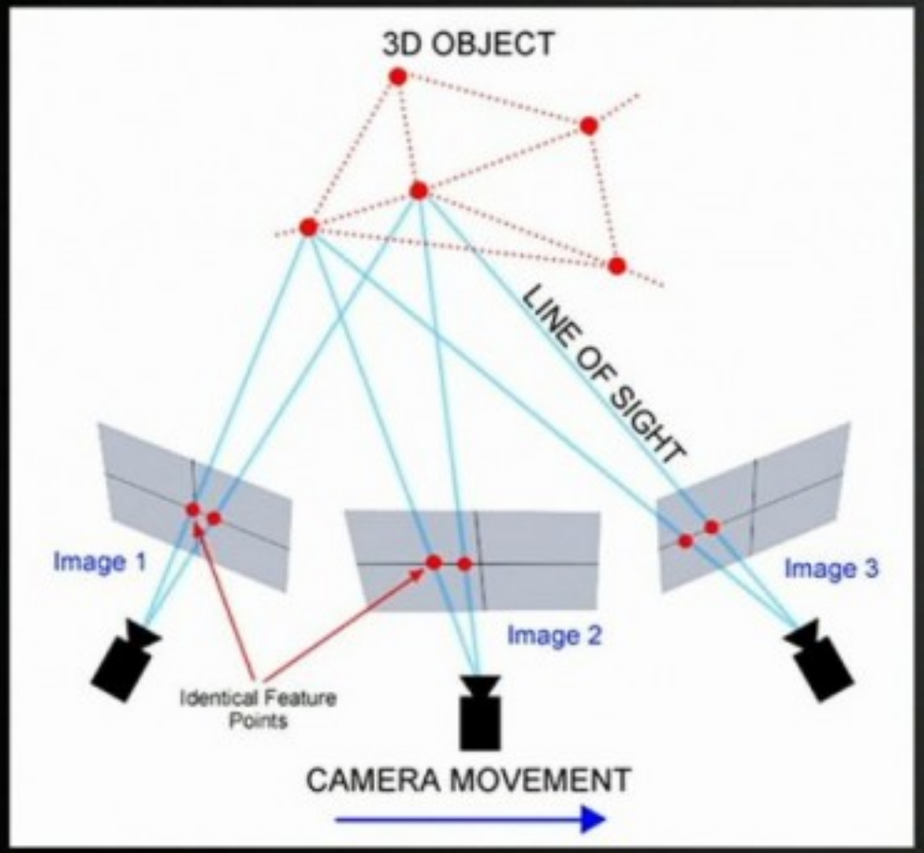
Photogrammetry



Reconstructing a 3D asset from photographs

Gear

- 3 Canon 5D MKIII
- Sigma 8mm f/3.5
- Canon 24-70mm f/2.8L
- Color Checker
- Roundshot VR Drive
- Monopods
- Telescopic Pole
- Remote Live View
- Custom gray and chrome balls rig

Shoot Process

Shooting a ref picture

Shoot Process

Shoot Process

Custom bracketed panoramic HDR

Shoot Process

UNREAL ENGINE

Get full photographic coverage

Processing

- Captured 1.06 TB of pictures in 7 days
  - 28,517 photos
  - 248 total assets
- Reconstruction done by a team of 10 across sites
  - EGUK, EGP, EGHQ
- Massive amounts of data to be sent across the network for each asset.
  - Between 7GB-45GB per Asset

Handling Massive Data

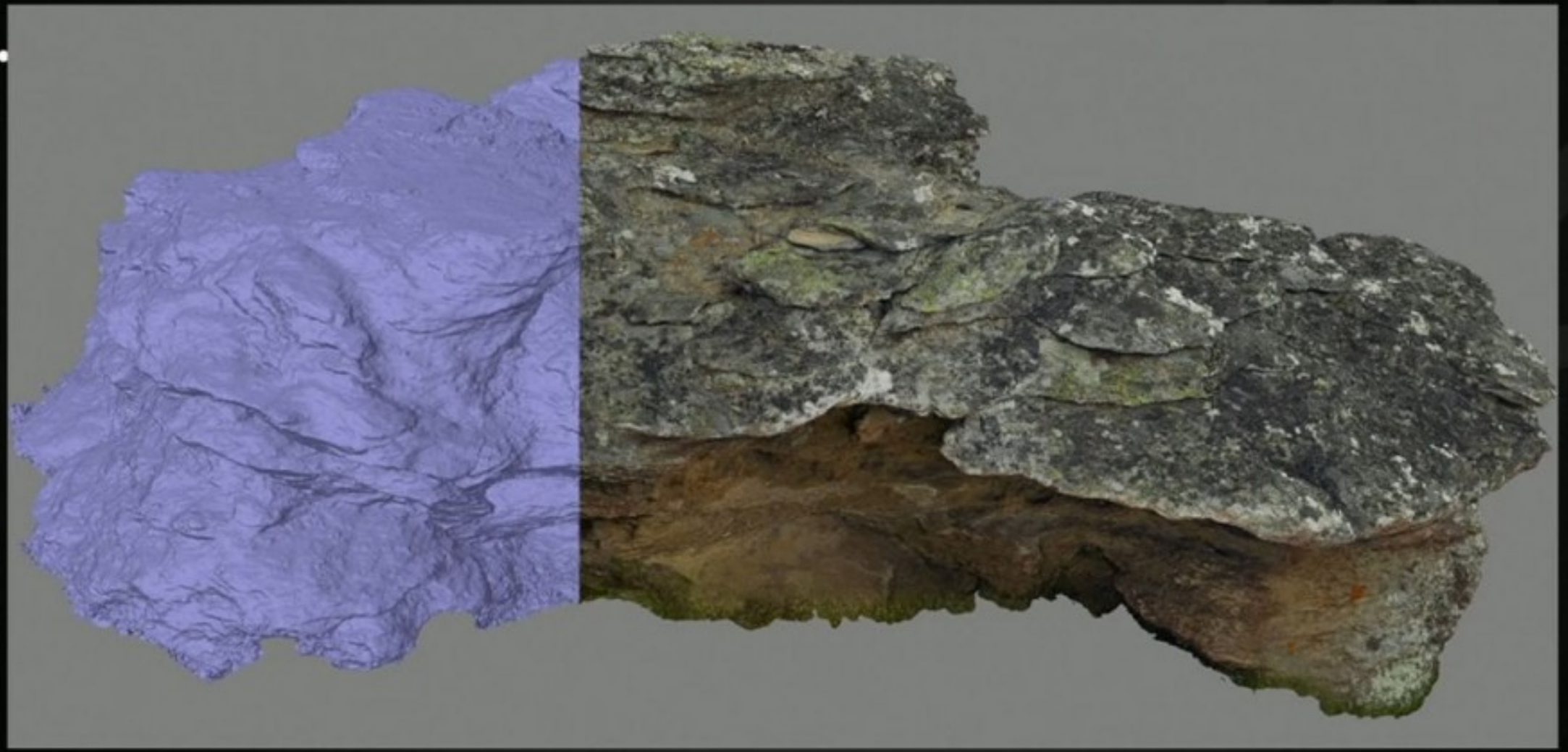
- GDC Asset Photo Ripper
  - Minimized network traffic and storage
  - Handles image format conversion
  - Working directories

Processing

- Working image format
  - Tif 16
  - Linear Colorspace
  - Baked in sRGB tonemapping for reconstruction and texturing

Epic custom tonemapp linear image

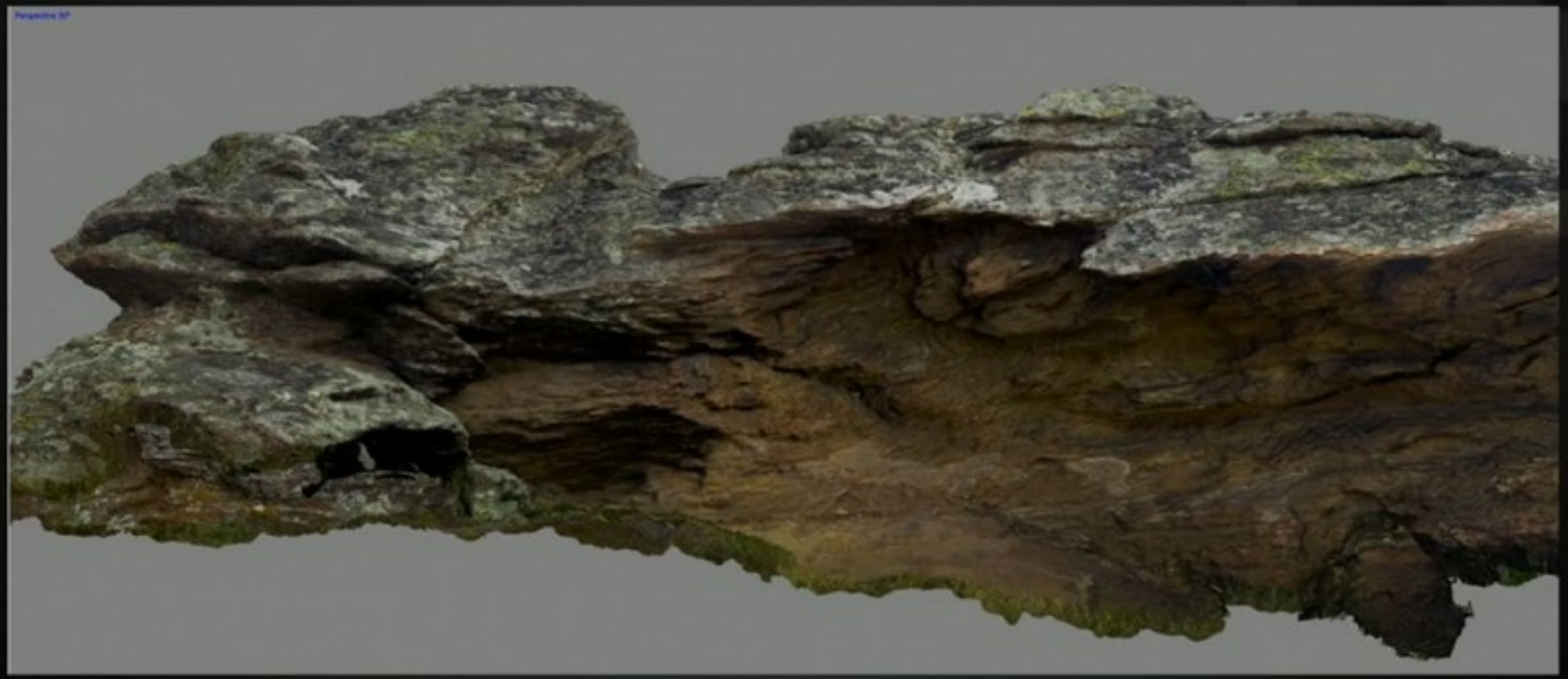
Photoscan Reconstruction



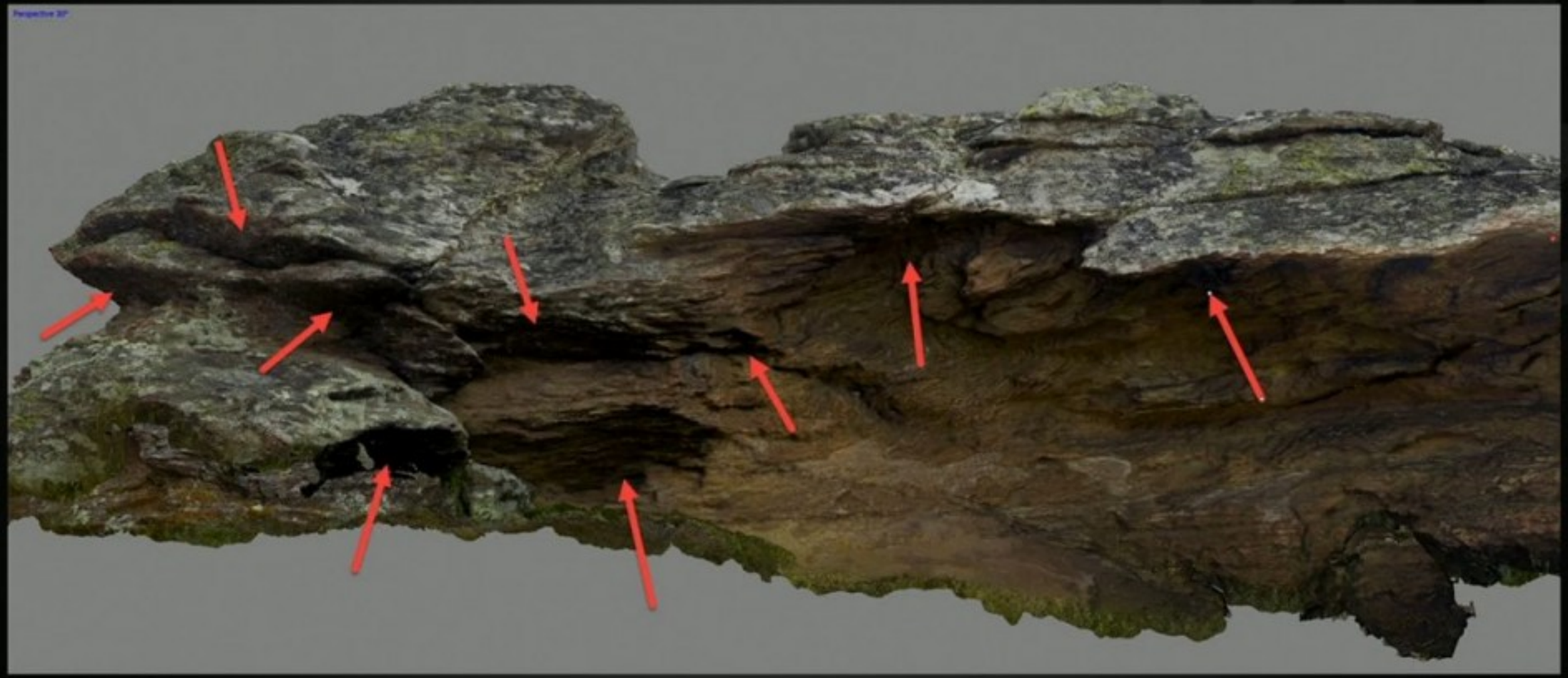
7-20m polys, 16K texture

Process

- But asset has baked in lighting
  - Not desirable for game assets



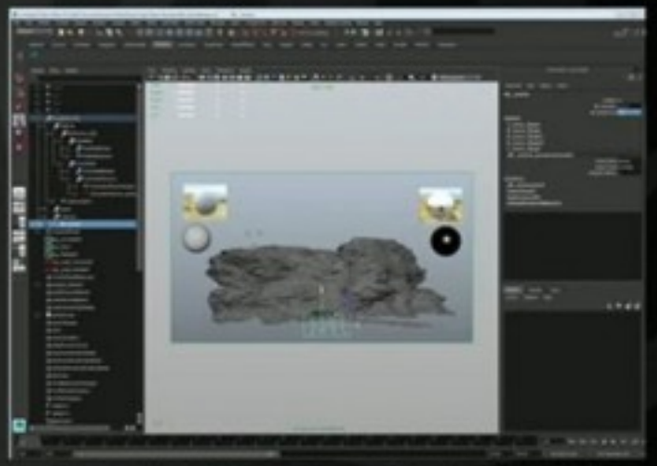
Process



Dark shadow areas

Delighting

- We recreate the lighting at the time of the shoot



Using a scripted semi-automated process

Delighting

- And we remove it from the photogrammetry texture

Resulting texture is called diffuse albedo

Show Turntable Settings

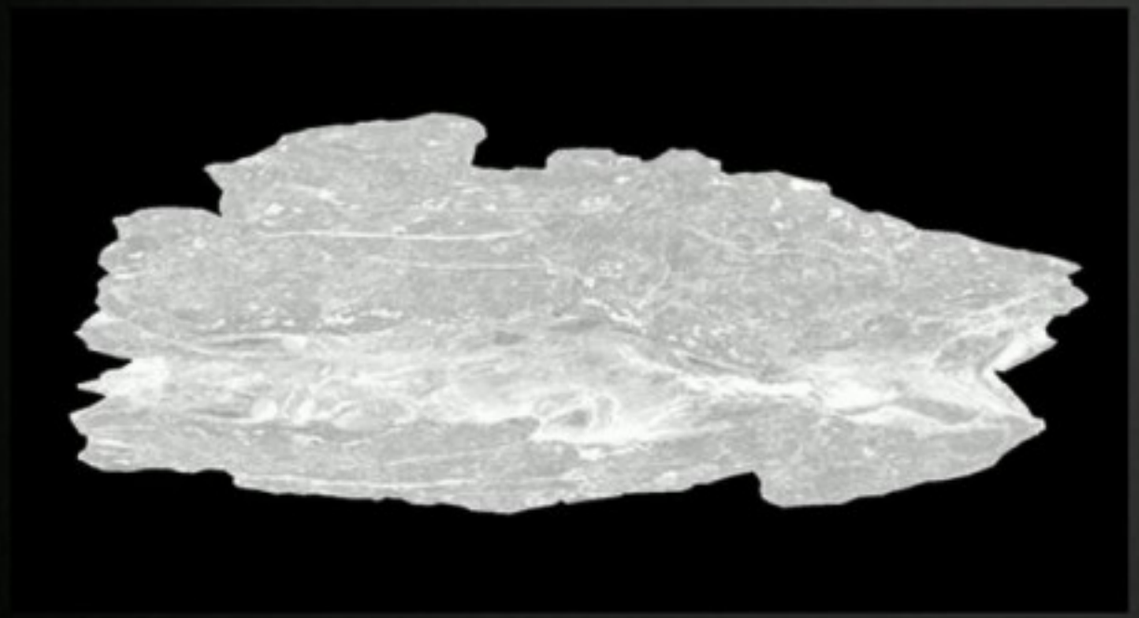
Project: GDC_Demo

Lighting Scenario 1 of 5 : GDC15 Sunlight

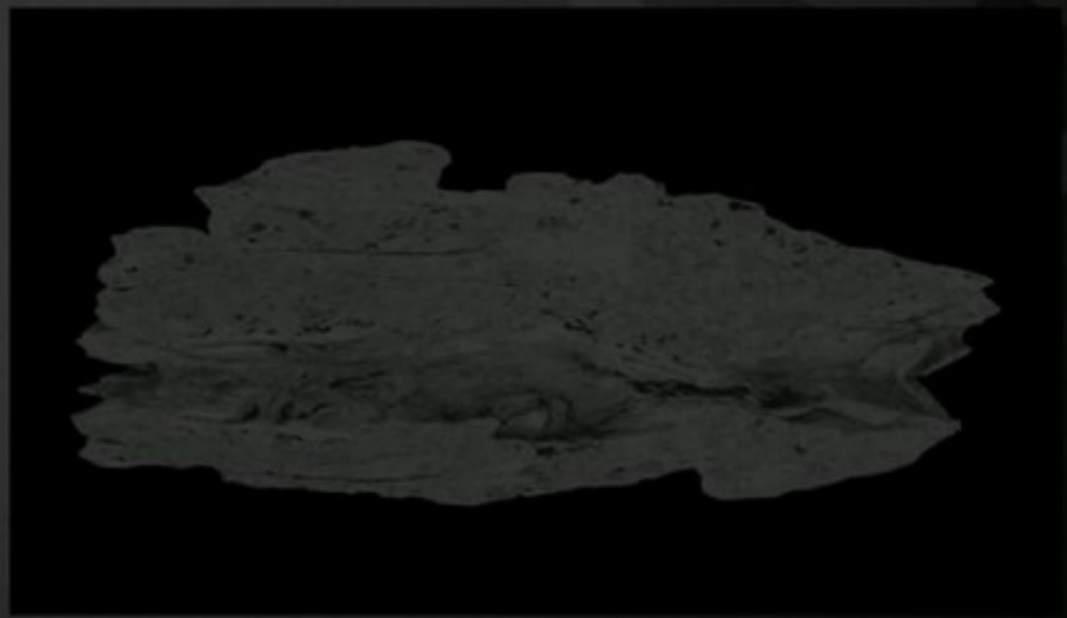
Author: francoisantoine

PBR Maps

- Unreal Engine 4 has a PBR renderer
  - To get the most realism we need to create extra maps



Roughness map



Specular map

Game Asset

- Process the mesh into a game-compatible asset
  - Low-polygonal version
  - 3 Level of detail versions (LOD)
  - Texture Cleanup
  - Capped version of the mesh

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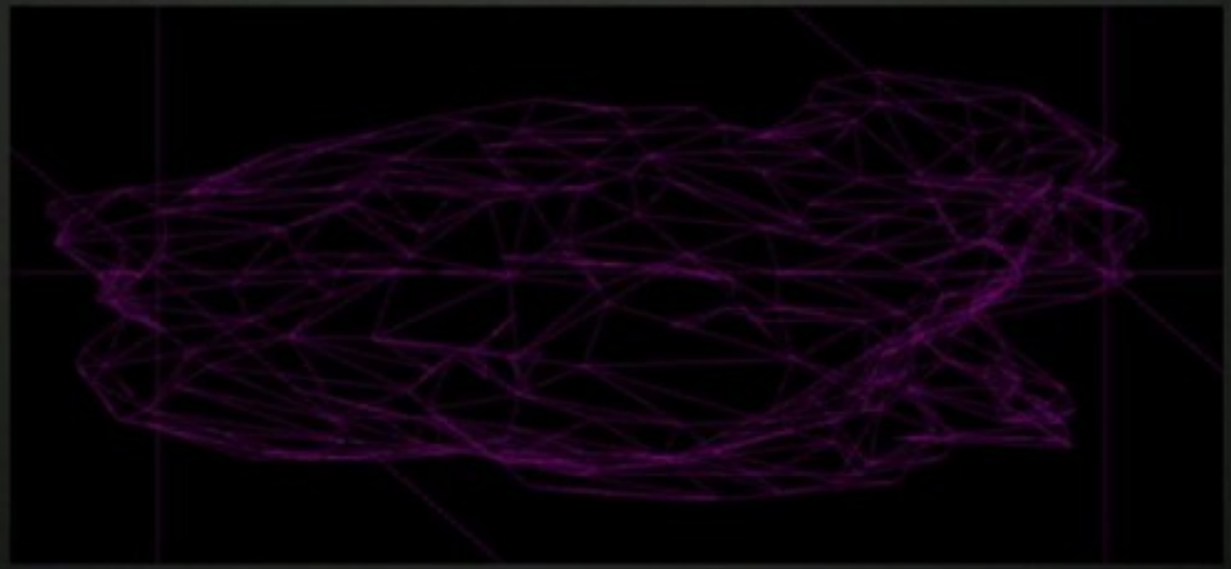
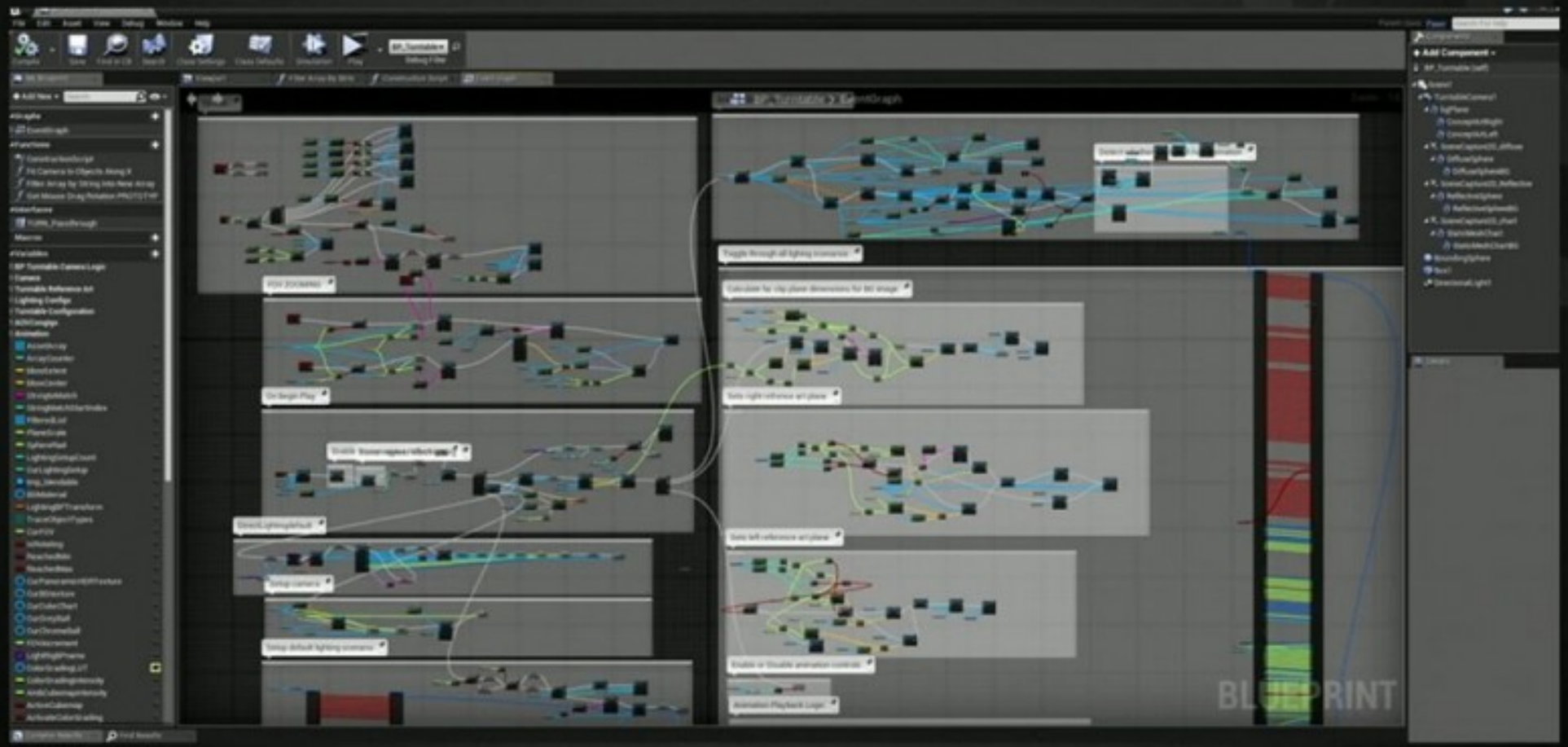


Asset Review

- Built a custom Real-time Asset review in Unreal Engine 4



UNREAL ENGINE

Entirely using UE4's Blueprints

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Asset Team

LIGHTING

Lighting

- Fully dynamic lighting for
  - Huge outdoor world
  - Time of day changes
  - Instant modifications (no build times)
  - Large view range

Lighting

- 3 main components of outdoor lighting we had to solve

Sun Direct Lighting

- Cascaded Shadow Maps (CSM) near camera
  - Supports foliage animation
  - Large cost from triangles

CSM ⟶

Sun Direct Lighting

- Ray Traced Distance Field shadows (RTDF)
  - 3x more efficient for huge view range
  - Maintains detail at all distances

RTDF Shadows →

CSM →

Sun direct lighting

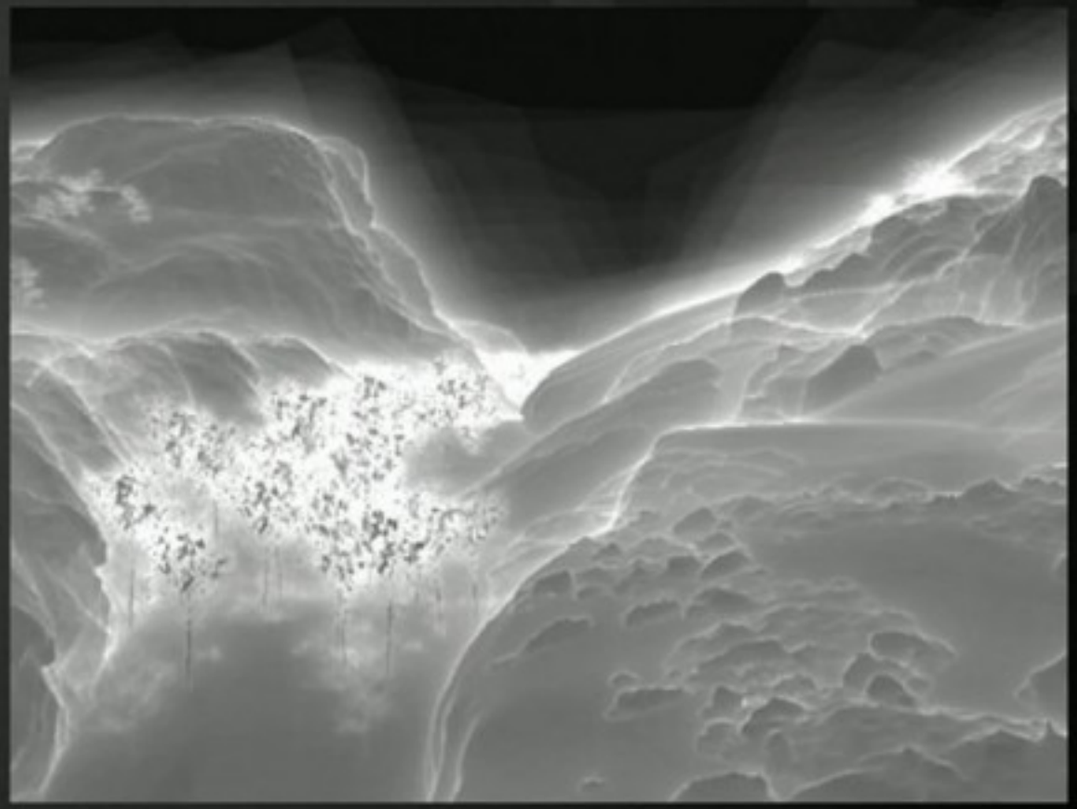
- A Distance Field stores distance to the nearest surface at every point

Mesh Distance Field

Sun direct lighting

Triangle scene

Mesh Distance Field scene



Sun direct lighting

- Ray intersection skips through empty space based on distance to surface!
  - If the ray intersects, light is shadowed

Mesh Distance Field

Ray Trace to light

Sun direct lighting

- Bonus: Approximate cone intersection for free!
  - Area shadows

Mesh Distance Field

Ray Trace to light

Cone intersection

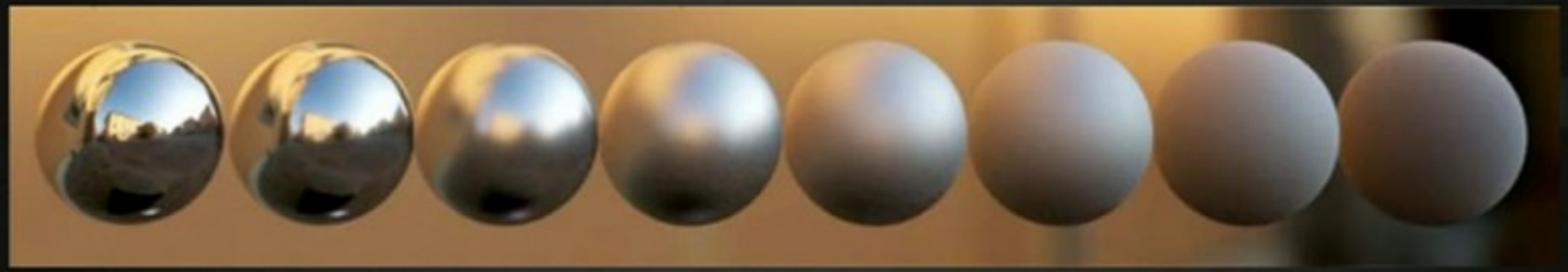
Sun bounce lighting

Sky lighting only

Heightfield GI

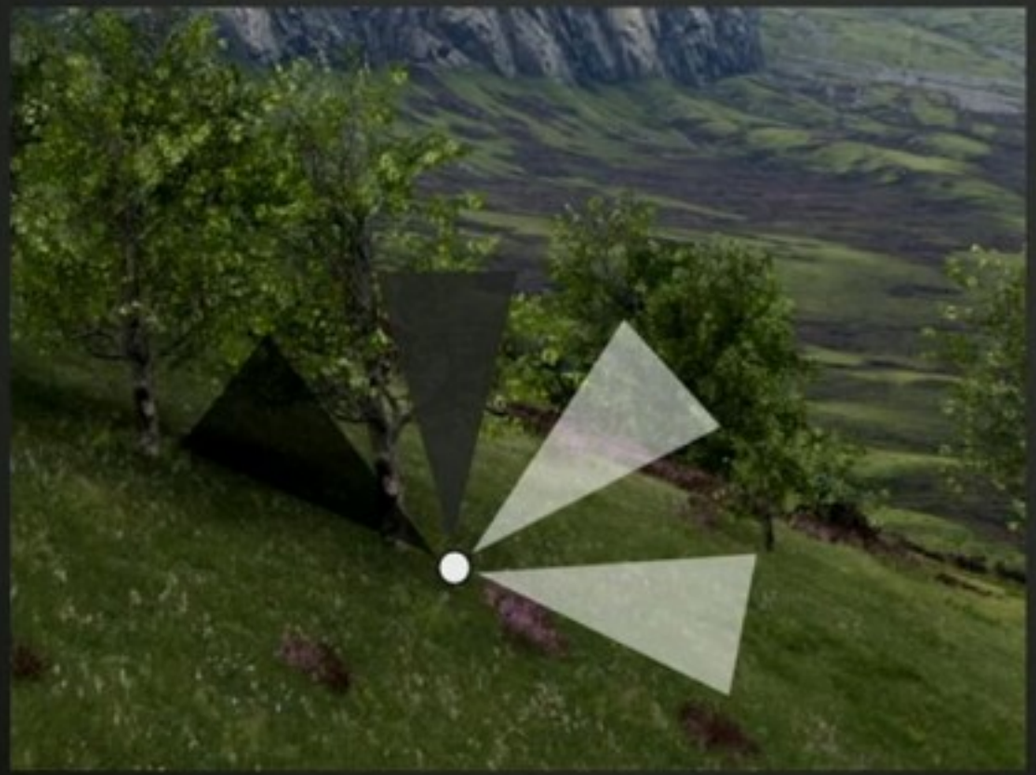
Sky lighting

- HDR cubemap preprocessed for different roughness levels



Sky lighting

- Distance Field Ambient Occlusion
  - Traces cones against mesh distance fields to determine sky visibility
  - Computed with world space occluders, no screen space artifacts!



SHADING AND POST

Two sided shading model

- Models light transmission through thin surfaces
- Used for leaves and kite fabric

Subsurface scattering

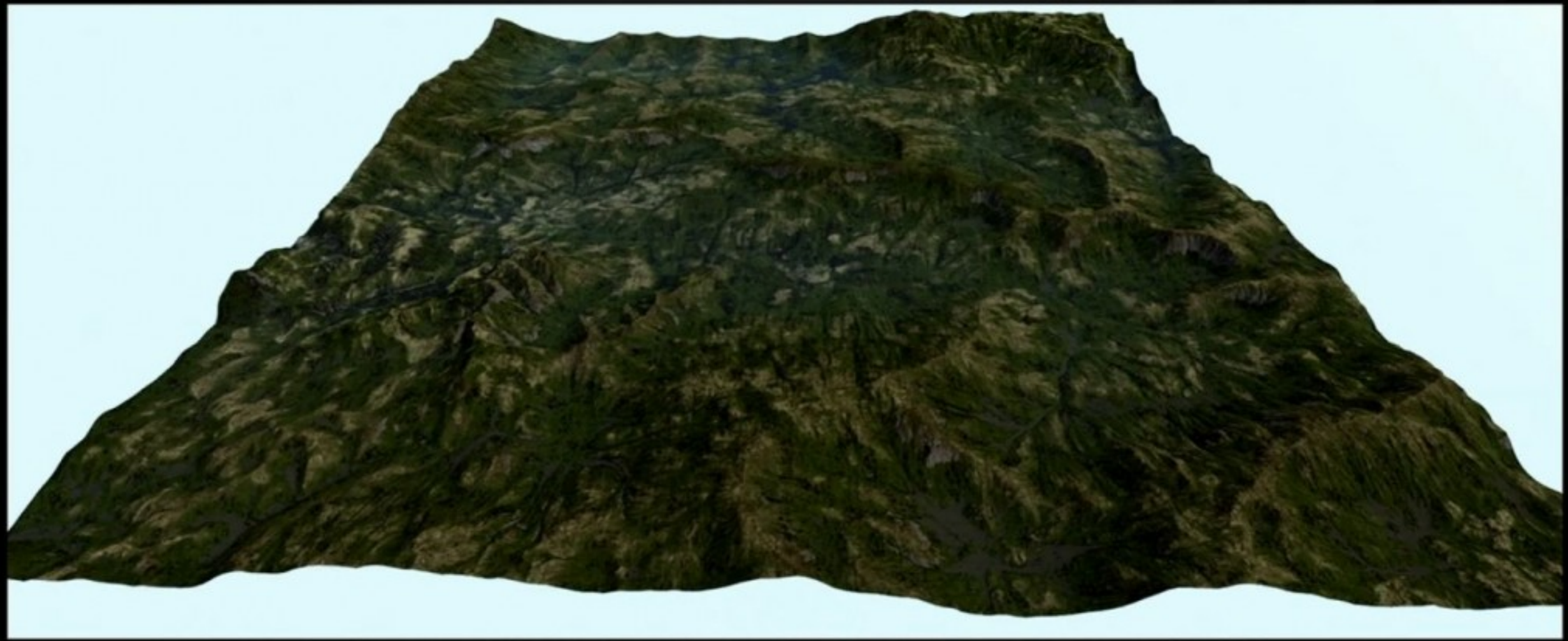
- Screen space
- Controlled with diffusion profiles. Not skin specific.

Depth of field

- Scatter as gather approach
  - Combined near and far
  - Circular bokeh
- Smooth transitions from in⇔out of focus
  - Full and half resolution sampling
  - No soft focus artifacts!
- Controlled with physical camera parameters
  - Aperture
  - Focal length
  - Focal distance

LANDSCAPE & FOLIAGE

Landscape



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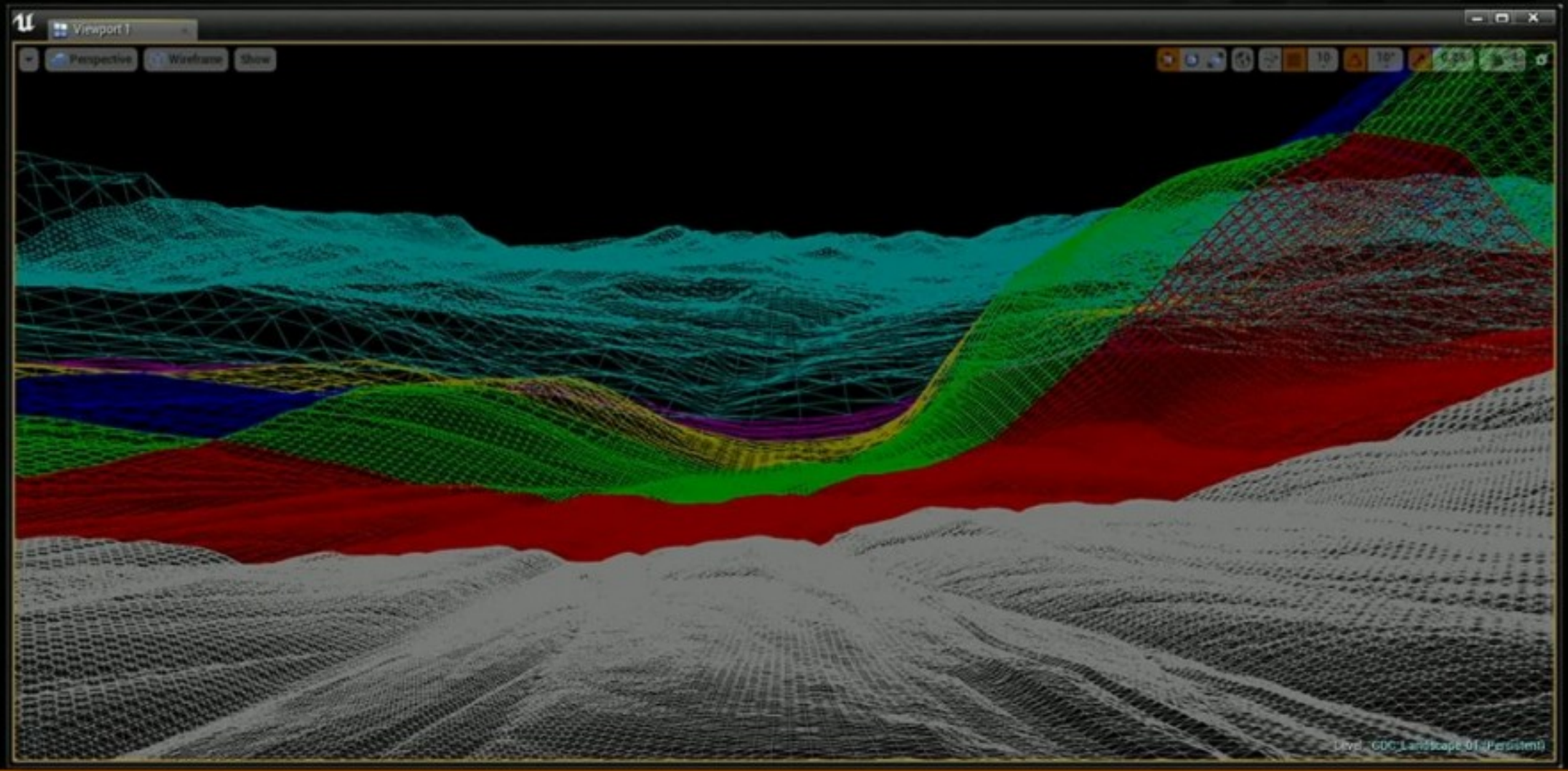
10 x10 miles, 1m resolution

Landscape



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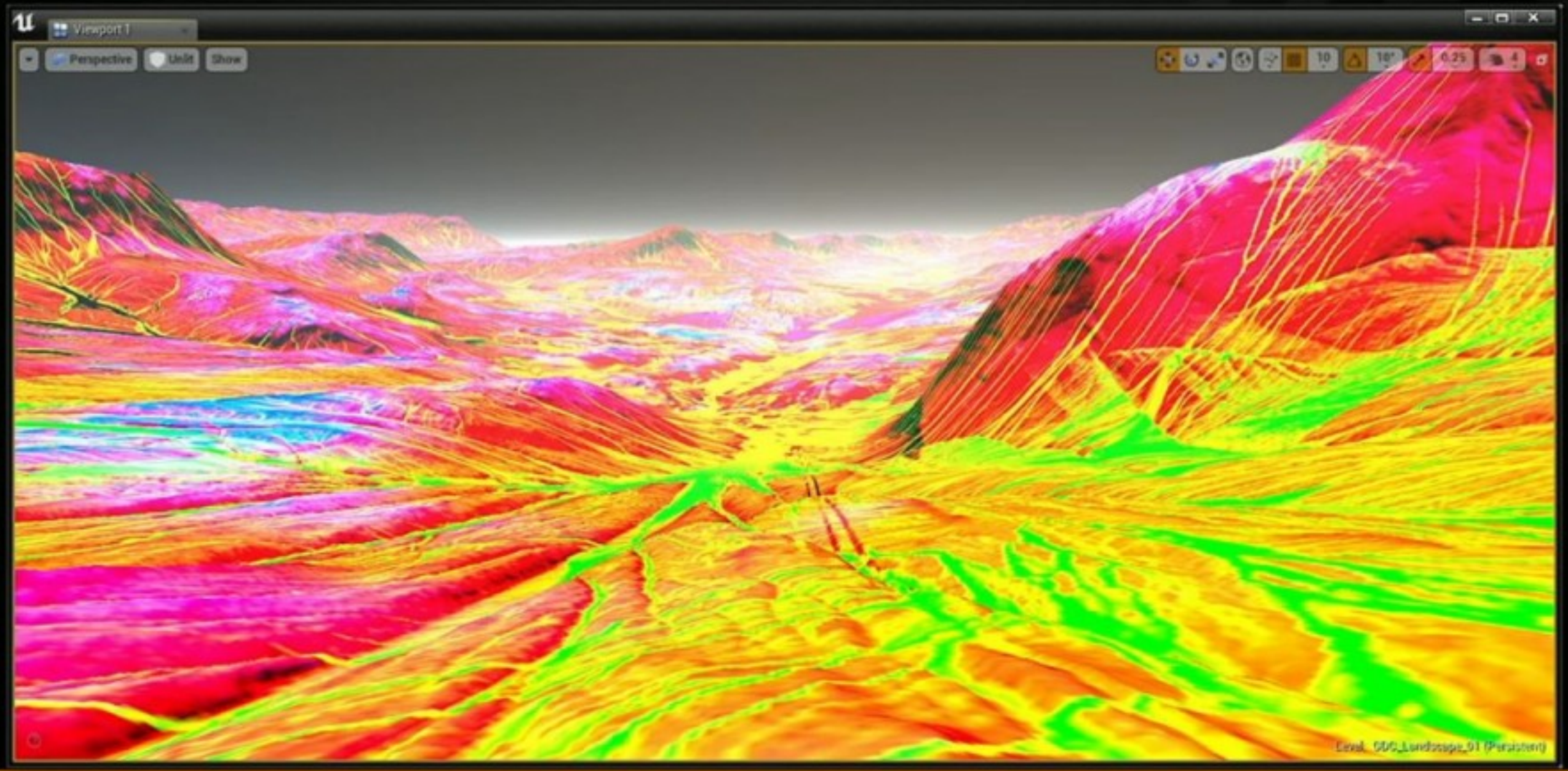
Continuous LOD system with streaming

Landscape



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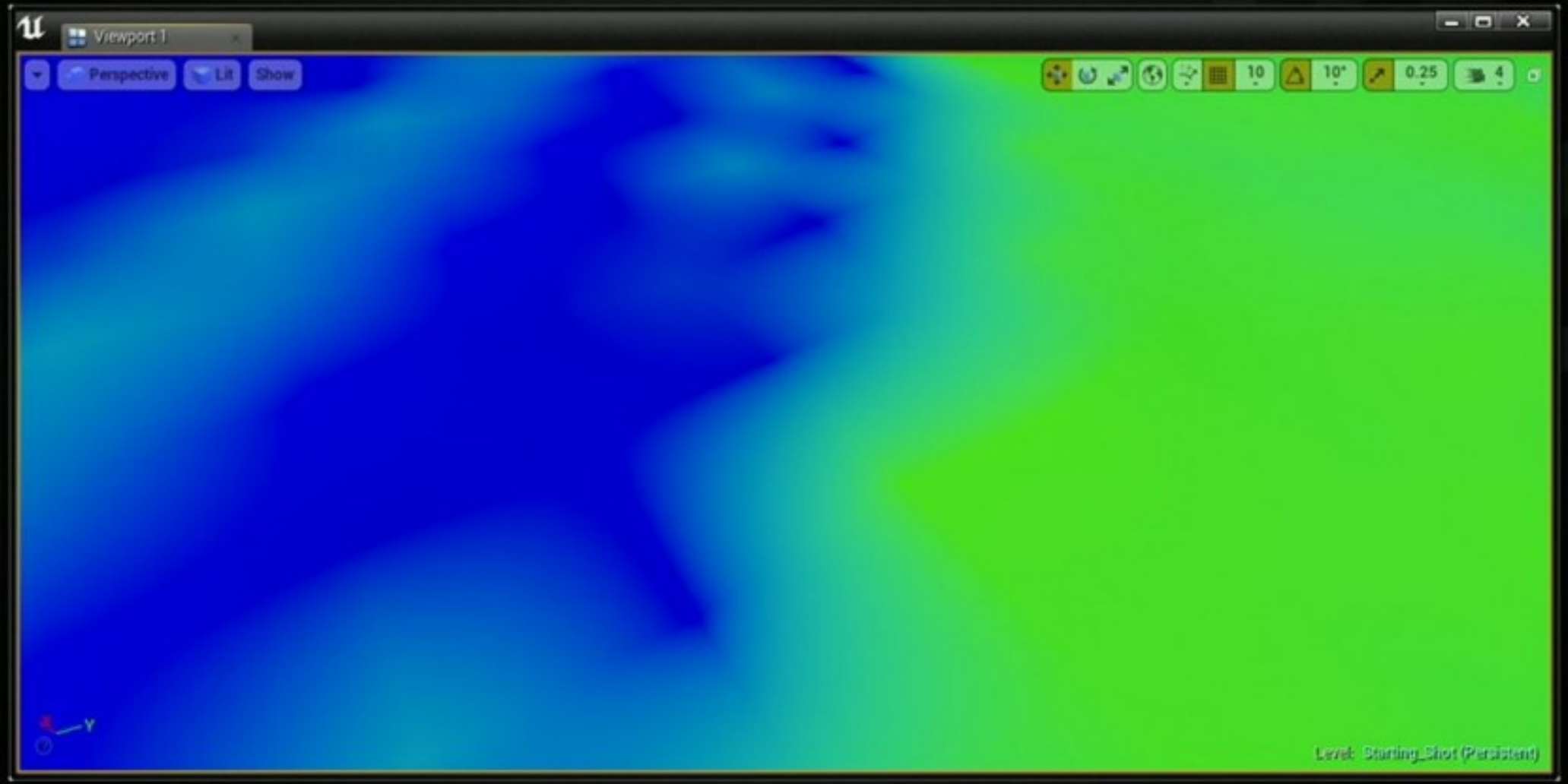
Textured using weight maps

Landscape

Result: textured, lit material view

Landscape



Raw weight map

Landscape

Simple blend

Landscape

Blend using ‘height map’

Foliage

Foliage

- Trees, rocks...
- Collision
- Manual/procedural placement

Grass

- Grass, flowers, pebbles...
- No collision
- Material driven placement

Foliage

- Hierarchical Instanced Static Mesh
  - Render over a million instances
  - Organize meshes into BSP-like tree
  - Per-pixel LOD transitions

Foliage

UNREAL ENGINE

LOD polys: 115,000 13,000 2,500 32

Foliage

- Use pixel depth offset on LODs to improve shadows

Simulation

- Natural looking
  - Clustering
  - Self Thinning
  - Growth Curves
- Fast iteration
- Artist intervention

Simulation

Create a ‘ecosystem’ containing species

Add a few instances of each species, based on density settings

Simulation

Each step we age the plants and spread seeds

Simulation

System can also place rocks, bushes etc.

Simulation

Use species rules to decide overlaps

- Relative Size
- Shade
- Altitude
- Slope

Simulation

Final result!

Tiles

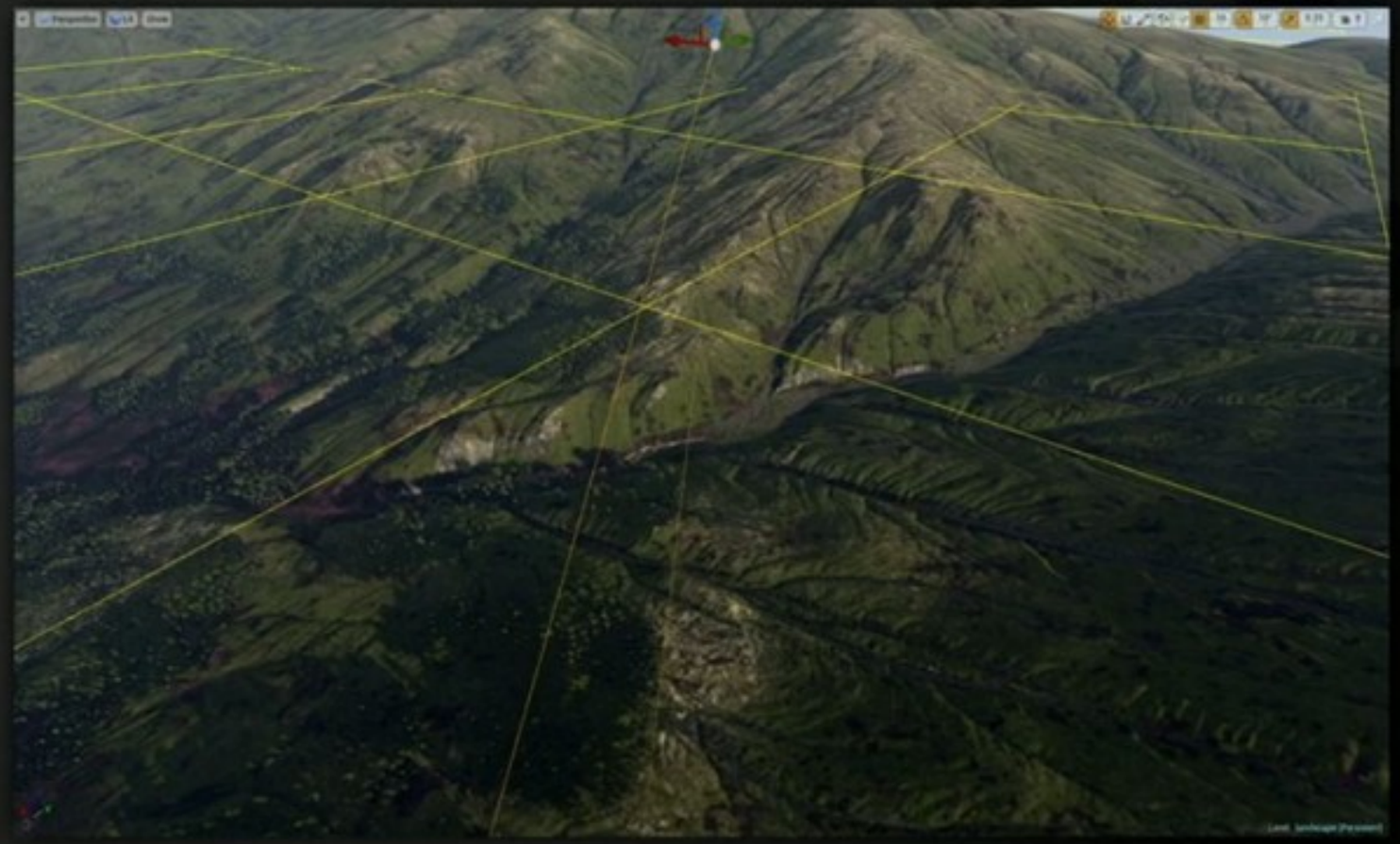
Natural simulation for entire world too expensive

Compute 2D tiles and apply them

Use rules to cull trees

Tiles

Volumes act as masks



Painting

Deterministic simulation, allows for easy touch ups

Artists can edit result like ordinary foliage

Demo Foliage

Demo Foliage

Demo Foliage

Demo Foliage

Rocks 193,000

Trees 226,000

Bushes 1,170,000

Flowers 6,358,000

Grass 7,879,000

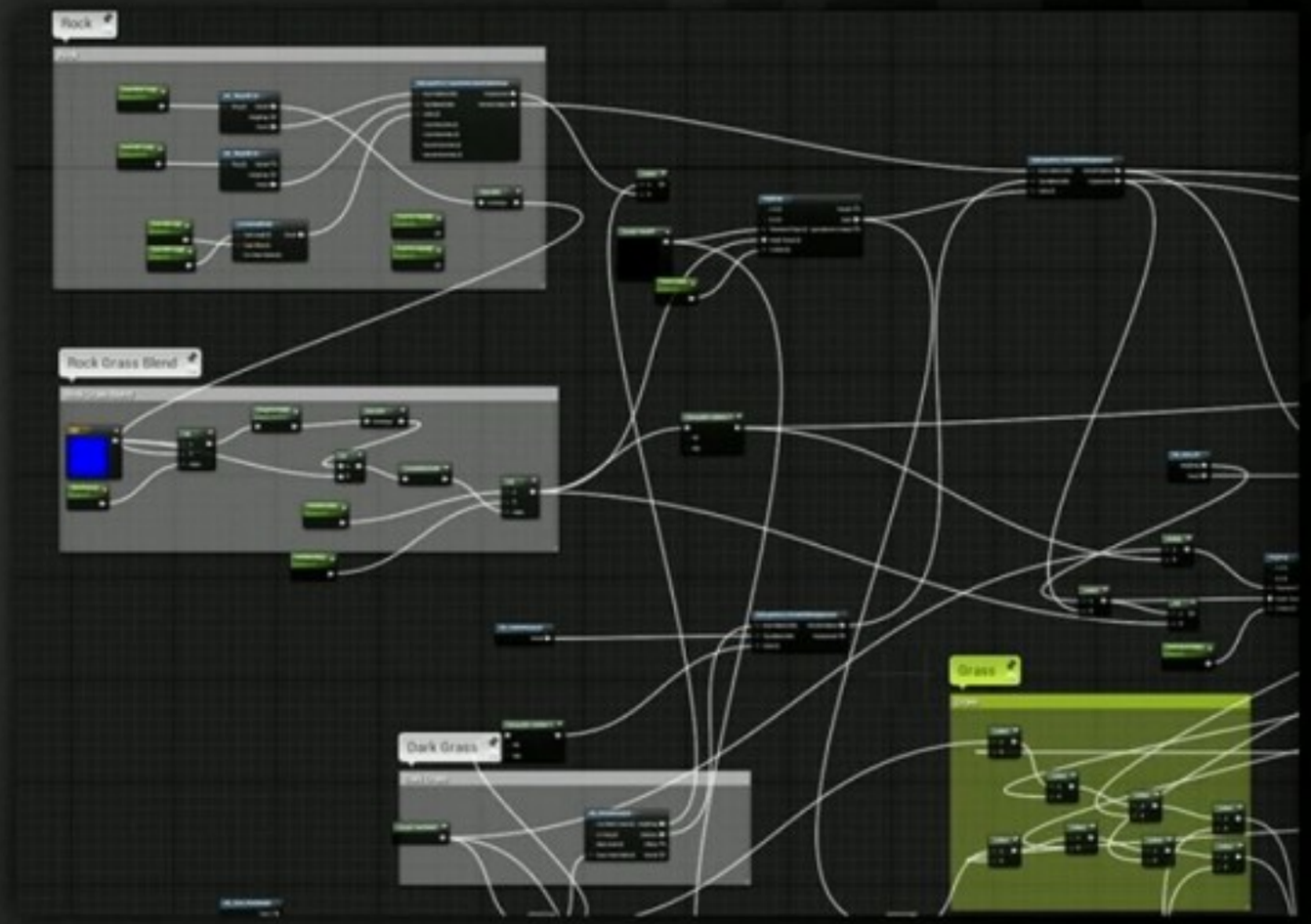
Excluding grass system!

Grass Placement

Using weight maps did not work well

Use the material graph to define grass density!

Rasterize terrain on CPU to find instance locations



FAUNA

Fauna

- Our world is very pretty.. but static

We wanted to add some life!

Fauna

- Test how our dynamic systems scale in large worlds

Fauna

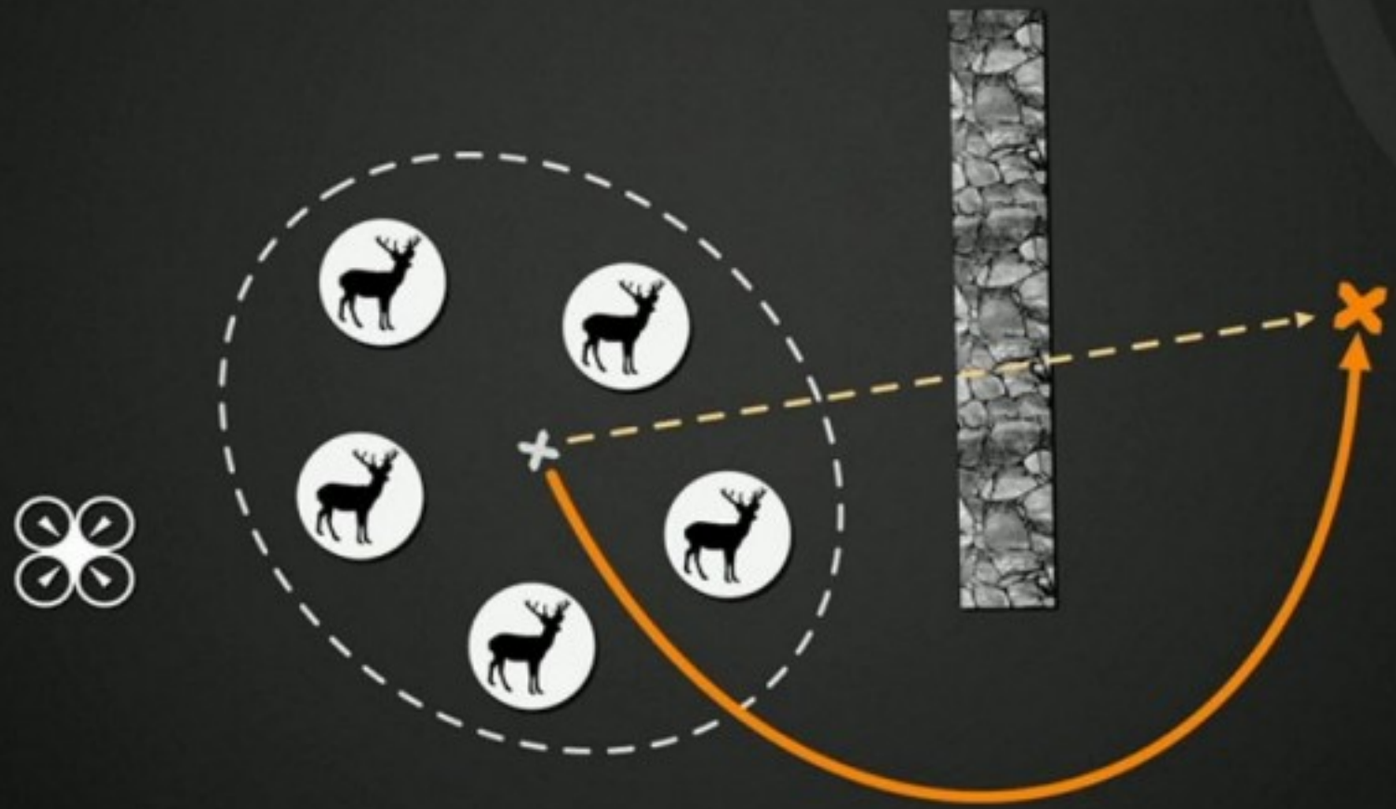
- Test how our dynamic systems scale in large worlds

Fauna

- Test how our dynamic systems scale in large worlds

AI

- Find path from centre of herd away from drone



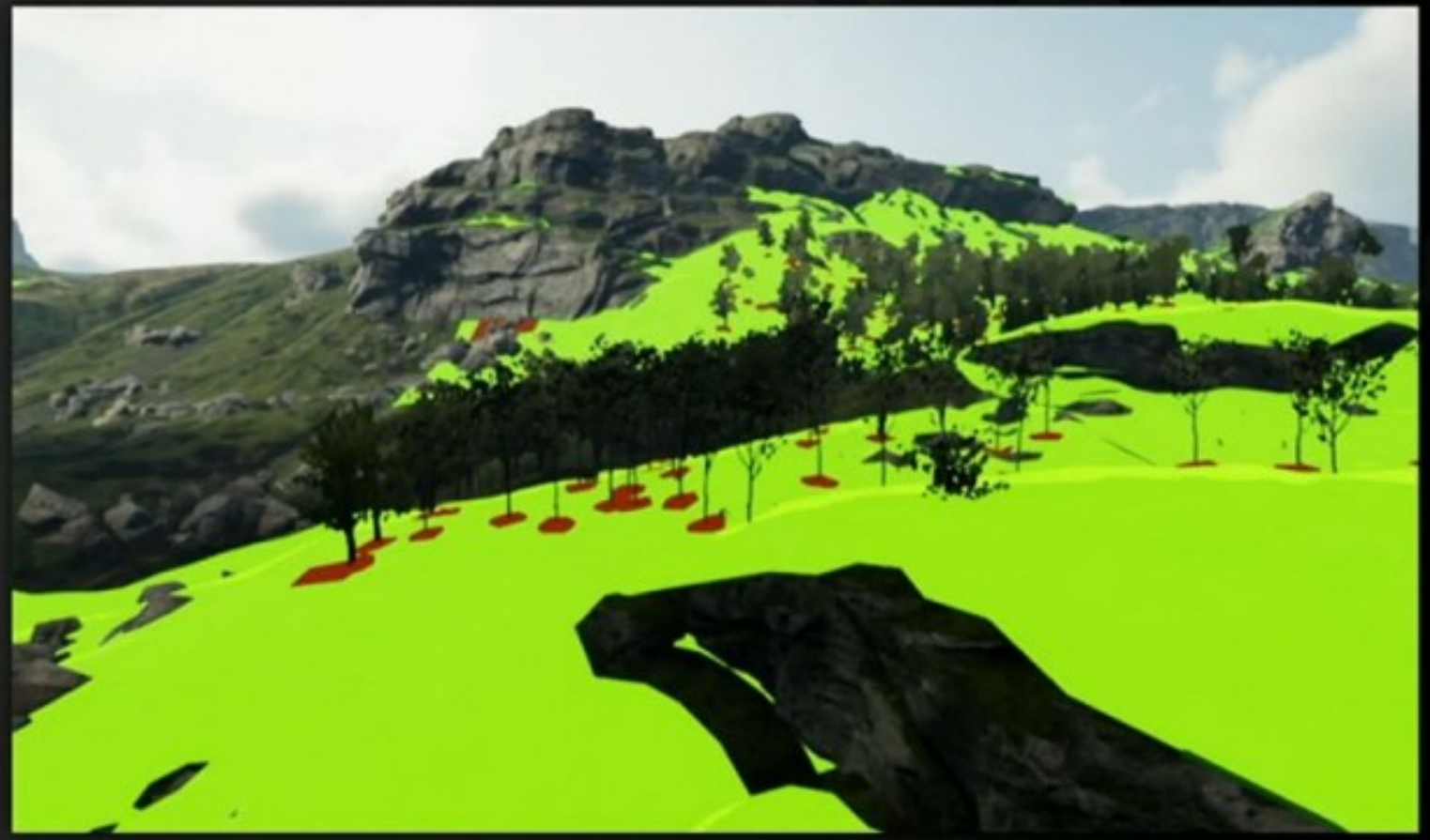
AI

- Crowd simulation used to avoid trees and other deer

- Quadruped challenges
  - Turning on the spot
  - Takes time to accelerate

Navigation Mesh

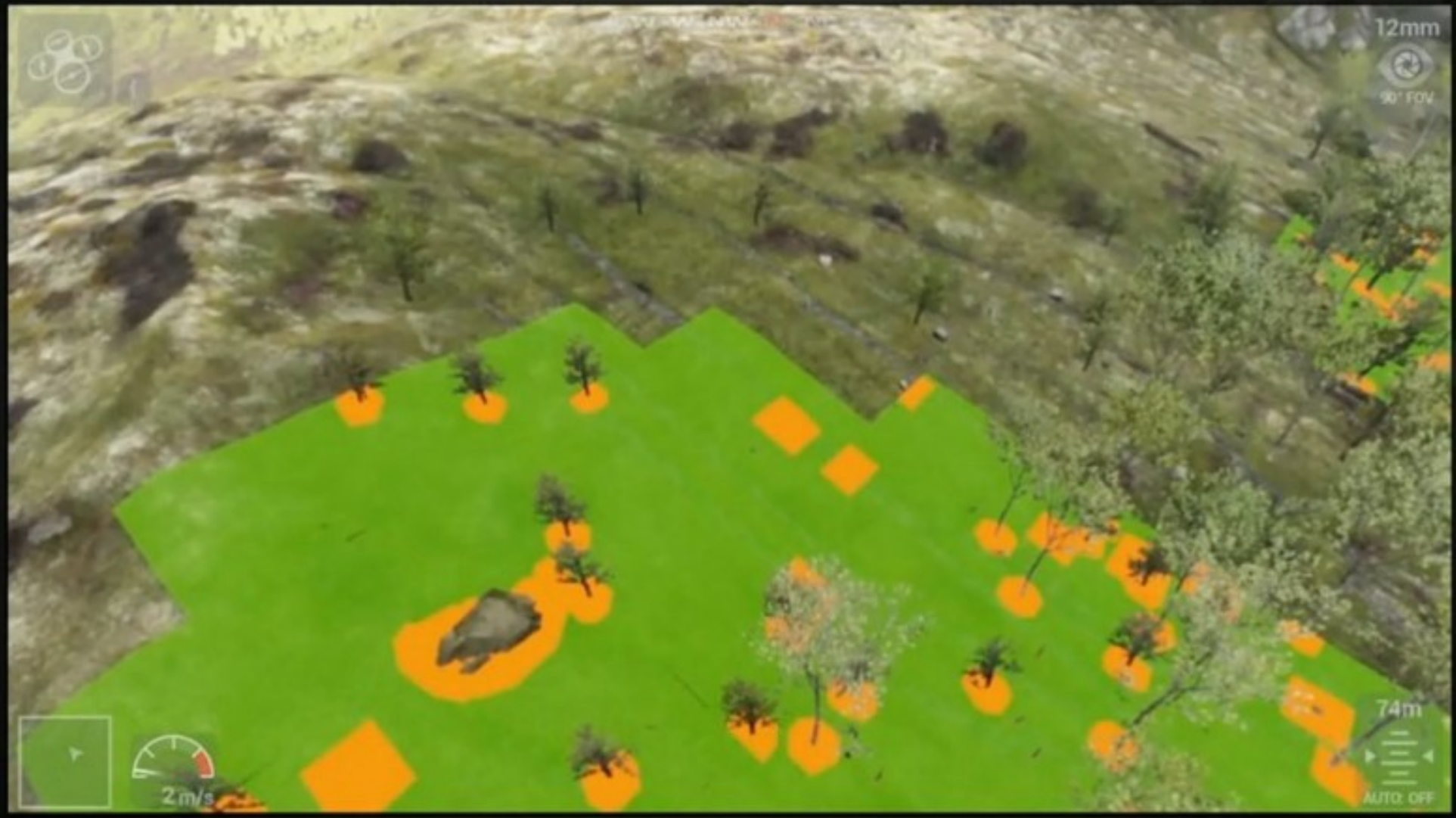
- Need navigation data
  - Avoid trees and cliffs!
  - New efficient movement



Navigation Mesh

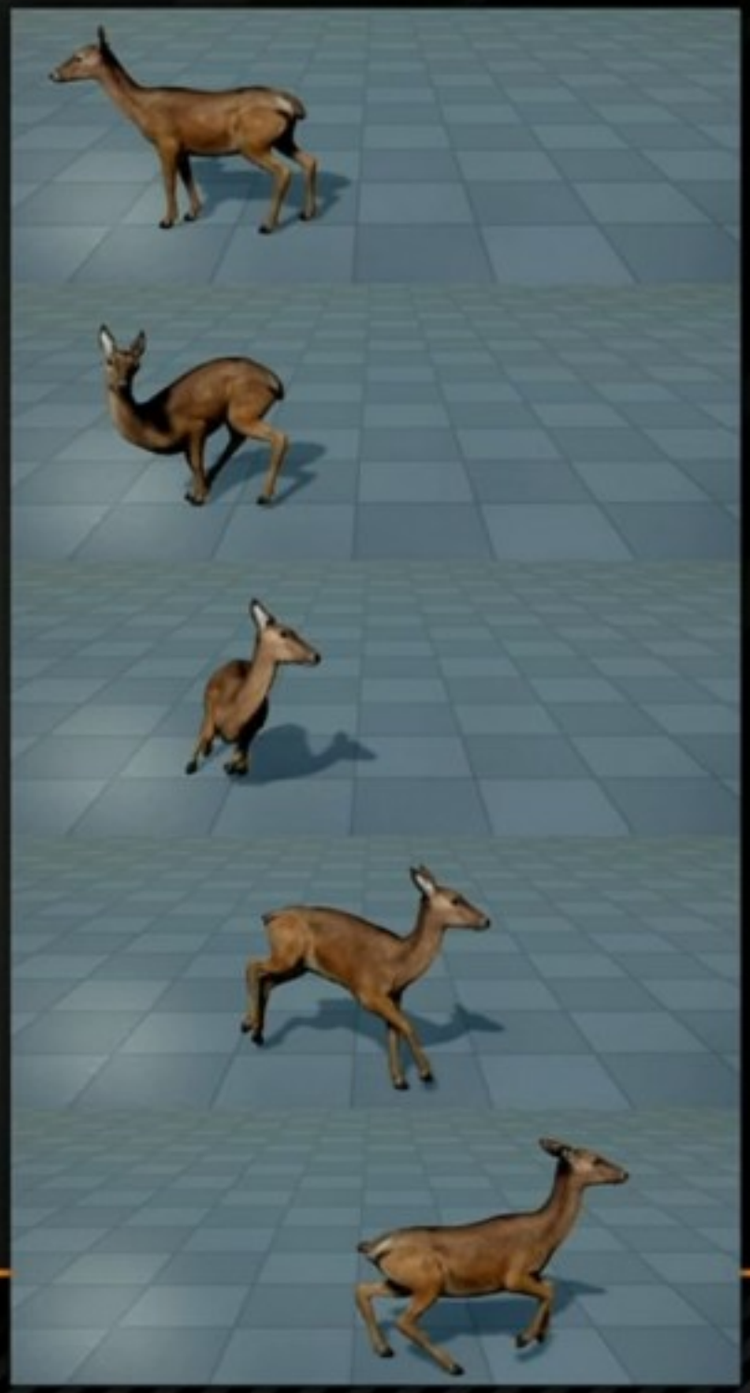
- World too large to pre-calculate
  - Would use >5GB of memory!
- Generate tiles on demand
  - Spread work across multiple cores

Navigation Mesh



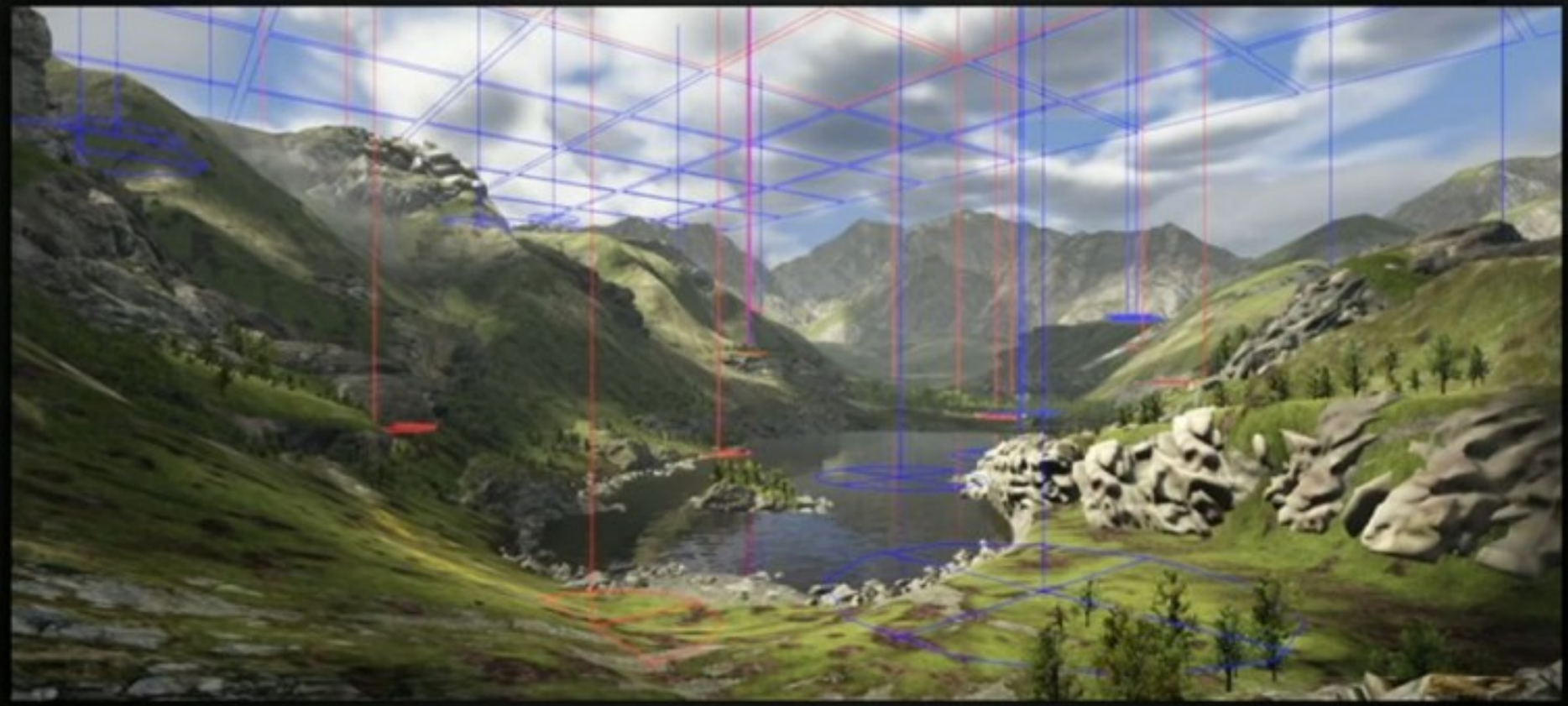
Animation

- Blended root motion
  - AI gives a goal
  - State machine finds best anim



Spawning

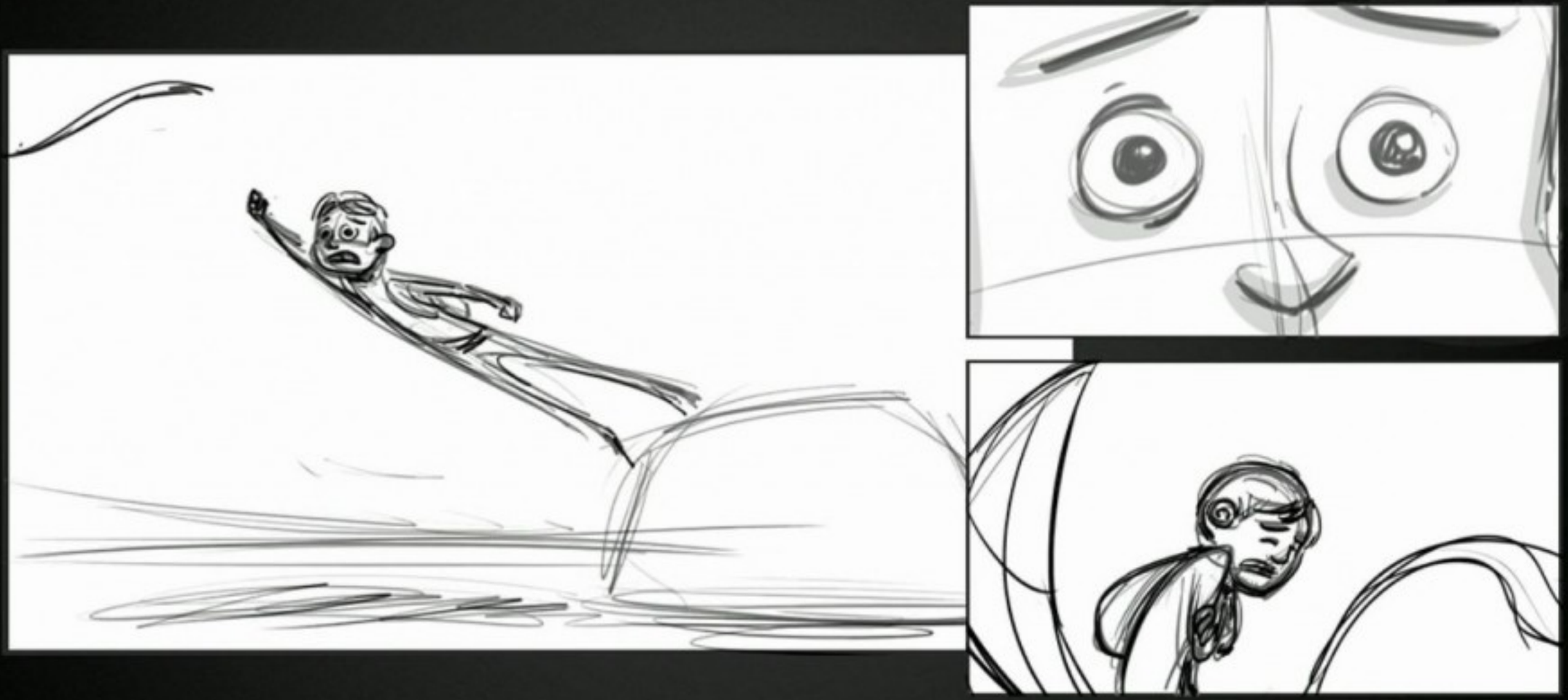
- Divide world into cells
- Rules determine best locations in each cell



INTRODUCTION

- Showcasing technology by telling a story
- Character's journey

BOARDS



CONCEPTS

CONCEPTS

CINEMATIC FIDELITY

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UNREAL ENGINE

CHARACTER TECHNOLOGY

- **Feature film facial rig**
  - FACS rig with >500 blendshapes
- **Corrective shapes on body**
  - Artistically direct how the mesh looks in specific poses
- **Improved Skin Shading**
  - Custom SSS diffusion profiles

CHARACTER TECHNOLOGY

UE4: FOR STORYTELLERS

We want you telling your stories in Unreal Engine!

(Royalty free use for all linear content and storytelling)