Solving Visibility and Streaming in The Witcher 3: Wild Hunt with Umbra 3

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Agenda

INTRODUCTION
UMBRA 3 OVERVIEW
THE WITCHER 3 REQUIREMENTS
MIDDLEWARE AND THE REDEngine 3
UMBRA 3 IN REDEngine 3
Umbra — a force behind many games

“Level artists are there to fill the world with content. Integrating Umbra saved us not only artist time but the time to create and maintain an efficient visibility culling solution. Umbra’s support provides us with the solutions and features that we need.”
Video games powered by Umbra 3
SO WHAT’S

Occlusion Culling

ANYWAY?
UMBRA 3 OVERVIEW

- Polygon Soup
- Occlusion Data
- Visible Objects

Occluder Generation → Visibility Query
WHY LICENSE?

+ SAVE ENGINEERS’ TIME
+ SAVE ARTISTS’ TIME
+ IT’S EASY
+ PORTABLE
+ PROVEN
+ SUPPORT

- ENGINEERS DON’T GET TO ROLL THEIR OWN 😞
HOW TO SATISFY

The Witcher 3 Requirements

IN UMBRA 3?
MAY CONTAIN CONTENT INAPPROPRIATE FOR CHILDREN

Visit www.esrb.org for rating information
THE WITCHER 3 REQUIREMENTS

• LARGE, OPEN WORLD
  → PVS, MANUAL STUFF OUT OF QUESTION
• UMBRA IS AUTOMATIC
• STREAMING
• LODs
STREAMING IN UMBRA 3
STREAMING IN UMBRA 3
STREAMING IN UMBRA 3

VISIBILITY QUERY

COMBINED DATA

VISIBLE OBJECTS
STREAMING CHALLENGES

• INDEPENDENT BLOCKS
• MATCH ON BORDERS
• DO IT QUICKLY!
LODs IN UMBRA 3

• PREVIOUSLY: SCENE CONSISTS OF SINGLE OBJECT INSTANCES

• PROBLEMS:
  – NEED MULTIPLE LOD LEVELS
  – SELF-OCCLUSION BETWEEN LEVELS
  – LOD HIERARCHIES?
LODs SOLVED

DISTANCE RANGE

Z = 0
Z = LIKE, A LOT

LOD 0
(OCCLUDER)

LOD 1

LOD 2

LOD 3
LOD CHALLENGES

• DISTANCE REFERENCE POINT
• OTHER CRITERIA FOR LOD SELECTION
• SMARTER LOD OCCLUDERS
ABOUT CD PROJEKT RED

- Located in Warsaw and Cracow, Poland
- Established in 2002
- Focused on RPGs
ABOUT CD PROJEKT RED

• The Witcher (2007)
  • PC, heavily modified Aurora Engine

• The Witcher 2: Assassins of Kings (2011)
  • PC, heavily modified Aurora Engine

  • PC/X360, REDengine 2
  • metacritics score: 88
ABOUT CD PROJEKT RED

• The Witcher 3: Wild Hunt
  • REDengine 3
  • Releasing in February 2015
  • PC/XBOX / PS4

• Cyberpunk 2077
  • REDengine 3
  • Release date TBD
THE WITCHER 3: WILD HUNT

35x bigger than The Witcher 2
- open world
- complex streaming
- a lot of tools refactoring
- different approaches

Engine team:
- 16 people
AGENDA

• Why middleware?
  • Things we consider
  • Umbra 3 as middleware for REDengine 3

• Integration process
  • Editor features
  • Cooker / data generation
  • Game features

• Summary
WHY MIDDLEWARE?

**Pros**
- Too much time to provide own solutions
- Documentation
- Customer support
- Often access to source code
- Specific solutions for specific game

**Cons**
- Evaluation time
- Pipeline modifications
- Code integrations
- Code not written by us
WHY MIDDLEWARE?

• “Business” aspects
  - Documentation – quality
  - Customer support
  - Changes to our pipeline
  - Source / libs

• Technical aspects
  - Changes to our pipeline
  - Memory management
  - Multithreading
  - Amount of data to provide
  - How it “fits” the engine
WHY MIDDLEWARE?

- Middlewares that we use in the game
  - Umbra 3
  - PhysX
  - APEX
  - SpeedTree
  - Wwise
  - Scaleform
SOLVING VISIBILITY in REDengine 3 with UMBRA 3

UMBRA 3 AS A MIDDLEWARE FOR REDengine 3

- Documentation
  - Description of the classes, methods and concepts behind solutions
  - Basic tutorials

- Access to source code / libraries

- Both

- Customer support
  - Great
UMBRA 3 AS A MIDDLEWARE FOR REDengine 3

- **Memory management**
  - Ability to plug in your own allocator

- **Multithreading**
  - Multithreaded building and queries

- **Amount of data to provide**
  - Triangle soup
  - No additional data created by artists

- **Additional work**
  - Coming up with ID scheme
  - Including occlusion culling in the rendering part
  - Tools for building occlusion data
Editor features

UMBRA 3 IN REDengine 3
OCCLUSION DATA STREAMING
OCCLUSION DATA STREAMING

1. From certain camera position required set of Tiles is determined

2. If the newly determined set differs from the currently used one, asynchronous computation starts

3. Precooked buffers are streamed in (only for Tiles that had no data streamed in yet)

4. Tome objects are created (only for Tiles that haven’t had this object created yet)

5. Once all the Tomes exist, the TomeCollection object is created from them

6. Newly created TomeCollection is sent to renderer to replace the currently used one

7. Tiles that are no longer necessary destroy their Tome object and unstream the precooked data buffers. Previous TomeCollection object is destroyed.
OCCLUSION DATA STREAMING
UMBRA 3 IN REDengine 3

OCCLUSION DATA STREAMING
• Quite a few in-engine tools
  • Detachable camera
  • Streaming visualizations
  • Memory statistics
  • Geometry statistics
  • All visualizations that Umbra library gives us
• 43 Tomes loaded
• 61 MB of Tome data loaded
• Additional 15 MB of inter-Tome data generated on the fly
• Over 62000 static mesh chunks on scene
• Less than 500 visible (~0.76%)
• Query time: ~1.8 ms
• Dynamic objects occlusion:
  • Particles
  • Skinned meshes
  • Simulated meshes
  • Decals
ONE DOES NOT SIMPLY
NOT GIVE STATISTICS IN GDC PRESENTATION
**Skellige**
- Area size: 8km x 8km
- Amount of geometry: 45000-50000 chunks loaded
- Average amount of visible geometry: ~1-5%

**City of Novigrad**
- Area size: 8.5km x 8.5km
- Amount of geometry: over 100k chunks loaded
- Average amount of visible geometry: ~2-5%
- **Size of Umbra data (cooked data + object IDs)**
  - Skellige: ~300 MB
  - Novigrad: ~250 MB

- **Size of data loaded during runtime**
  - Skellige: 40-80 MB
  - Novigrad: 45-80 MB
- Offline process
- Data built more than once per day
- Dedicated machines (server farm)
- Ability to build data in the editor
Chunks – parts of the same mesh
COOKER / DATA GENERATION

• LOD levels
  • Each has drawing distance
    • Set up by artists

Data Generation:
• Gather mesh
  • Gather LOD level
    • Gather chunks
    • Assign LOD distances
    • Assign unique ID
COOKER / DATA GENERATION

Retrieving data during runtime:

- Query Umbra for IDs
  - Find chunk
  - Push chunk for drawing
    - Only visible ones
    - Proper LOD level
WE ARE HIRING!

APPLY NOW: www.cdpred.com

Play your role in CD Projekt RED:
• An international team of talented developers and avid gamers.
• Creating complex, non-linear AAA RPGs.
• Developers of the award-winning Witcher franchise, with over 5 million copies sold.
• Currently working on The Witcher 3: Wild Hunt and Cyberpunk 2077.
Thank you for attending.

WE ARE HIRING!

For more on Umbra 3, go to umbra3.com
Follow us on Twitter @jbushnaief, @czoper, @umbrasoftware