HDR in Valve's Source Engine

SIGGRAPH 2006

Gary McTaggart
Valve

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Overview

- Intro to HDR
- Reflection/Refraction
- Tone Mapping and Auto-exposure
- Road to a shippable HDR implementation

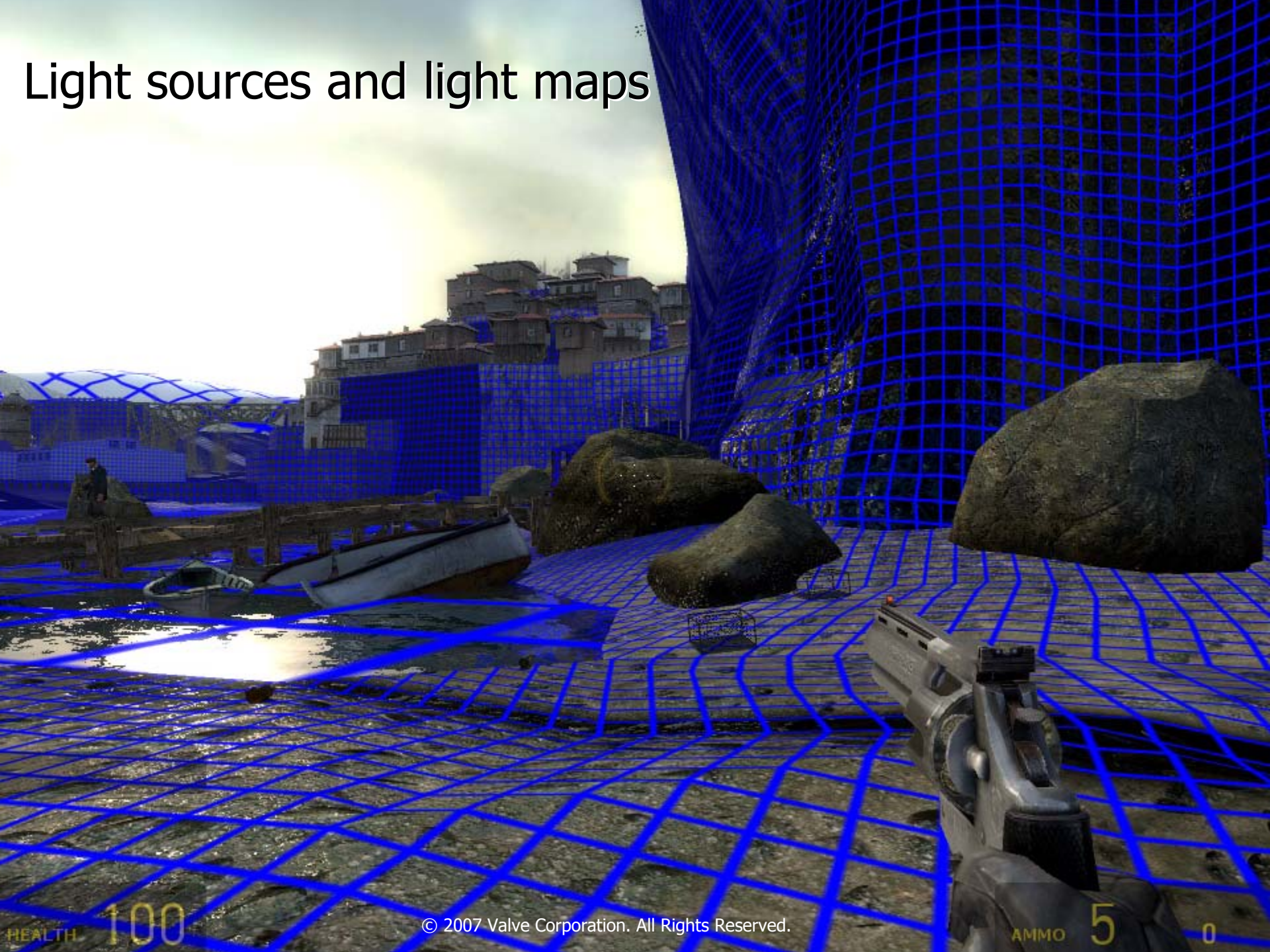
Why HDR?

Paul Debevec's *Rendering with Natural Light*

What is *Lost Coast*?

Source HDR Radiosity Lighting from the Sun

Light sources and light maps



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Real-World Sky at Multiple Exposures

f22 @ 1/1600th second

f22 @ 1/250th second

f22 @ 1/40th second

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Scene from Source Engine/*Lost Coast*

Tonemap scale = 0.05

Tonemap scale = 1

Tonemap scale = 4

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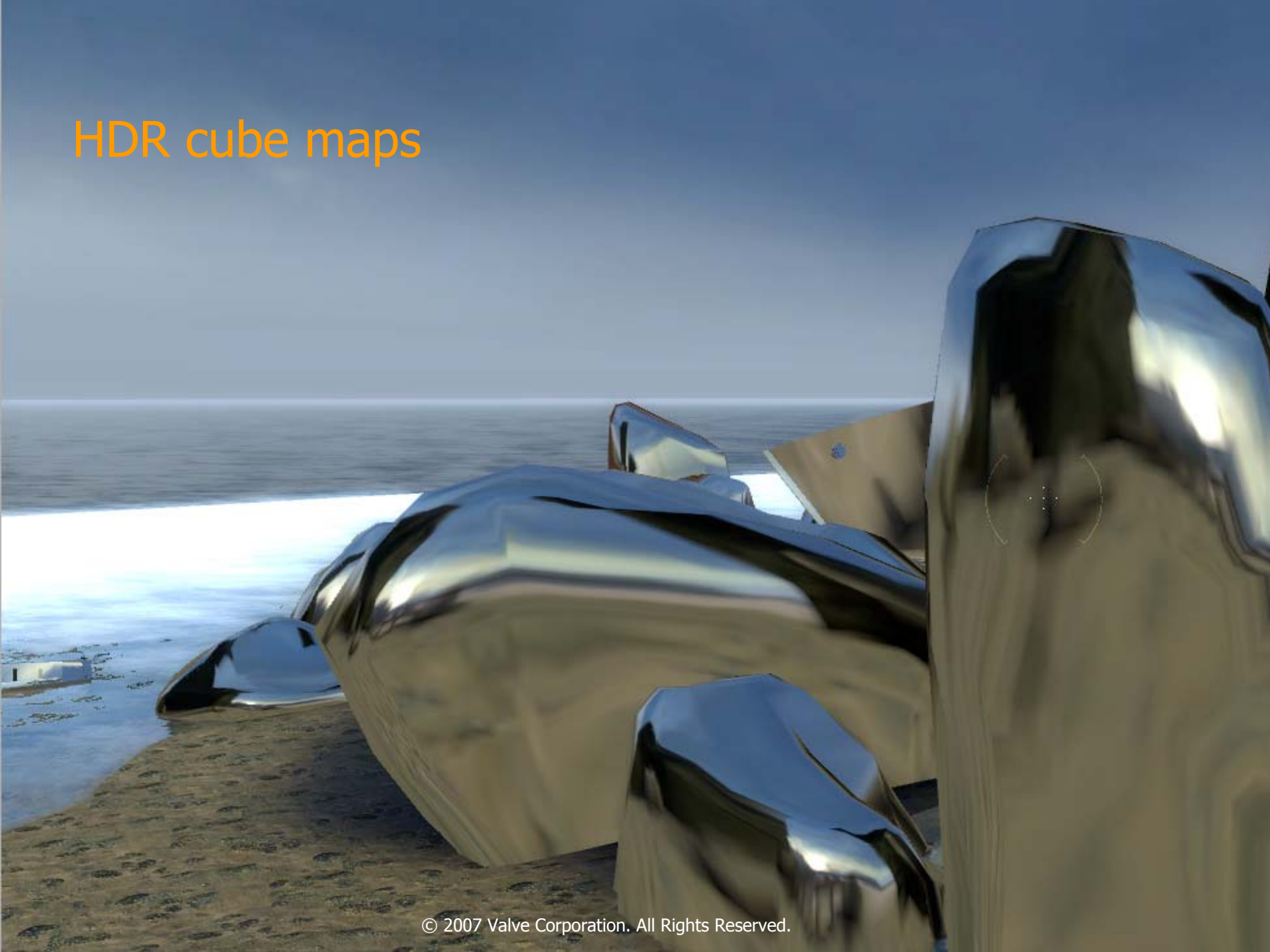
Authored HDR Skybox

HDR cube maps



HDR cube map reflection

LDR

HDR

HDR water reflection and refraction

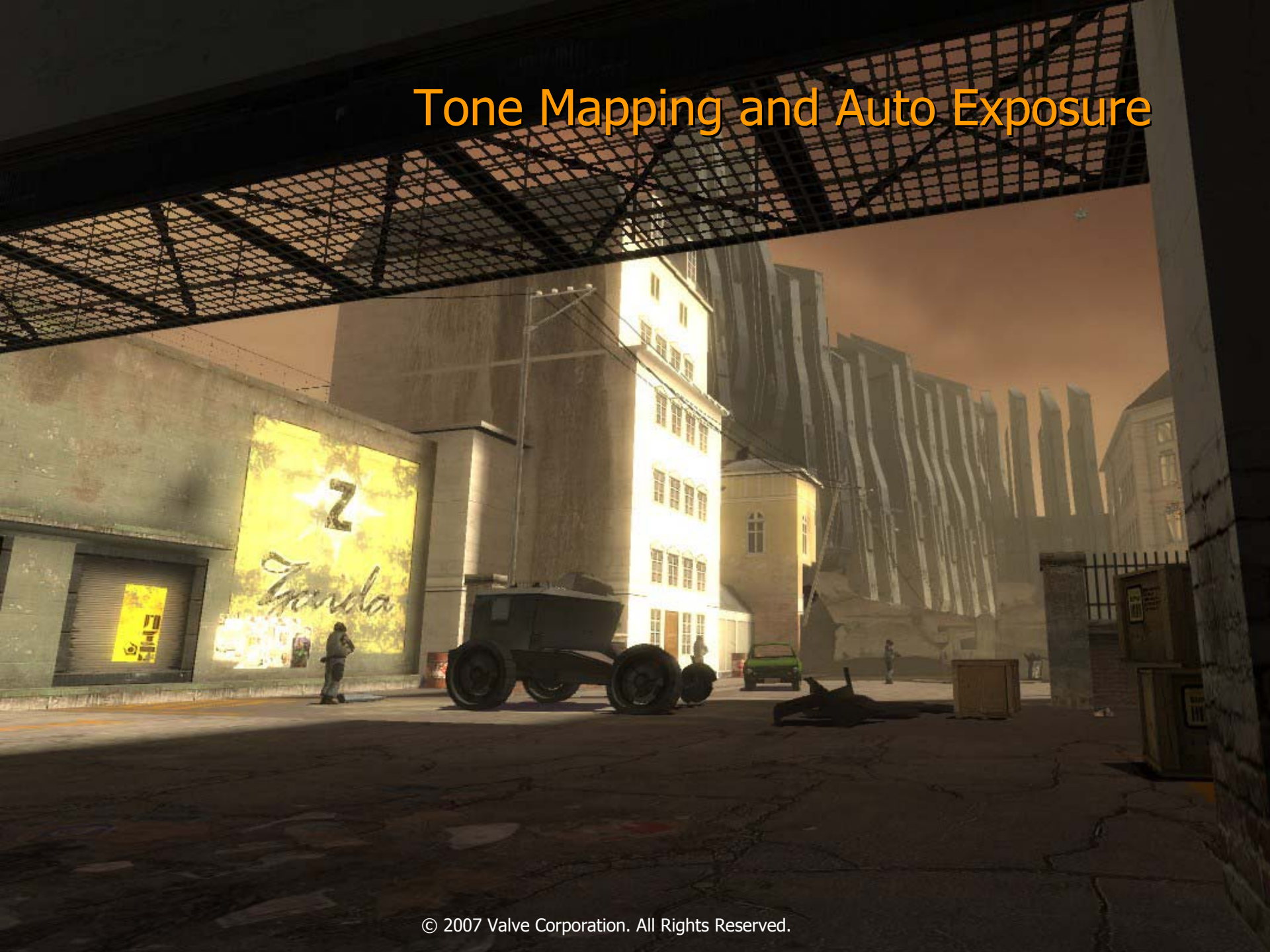
Water: Exposure 1

Water: Exposure 2

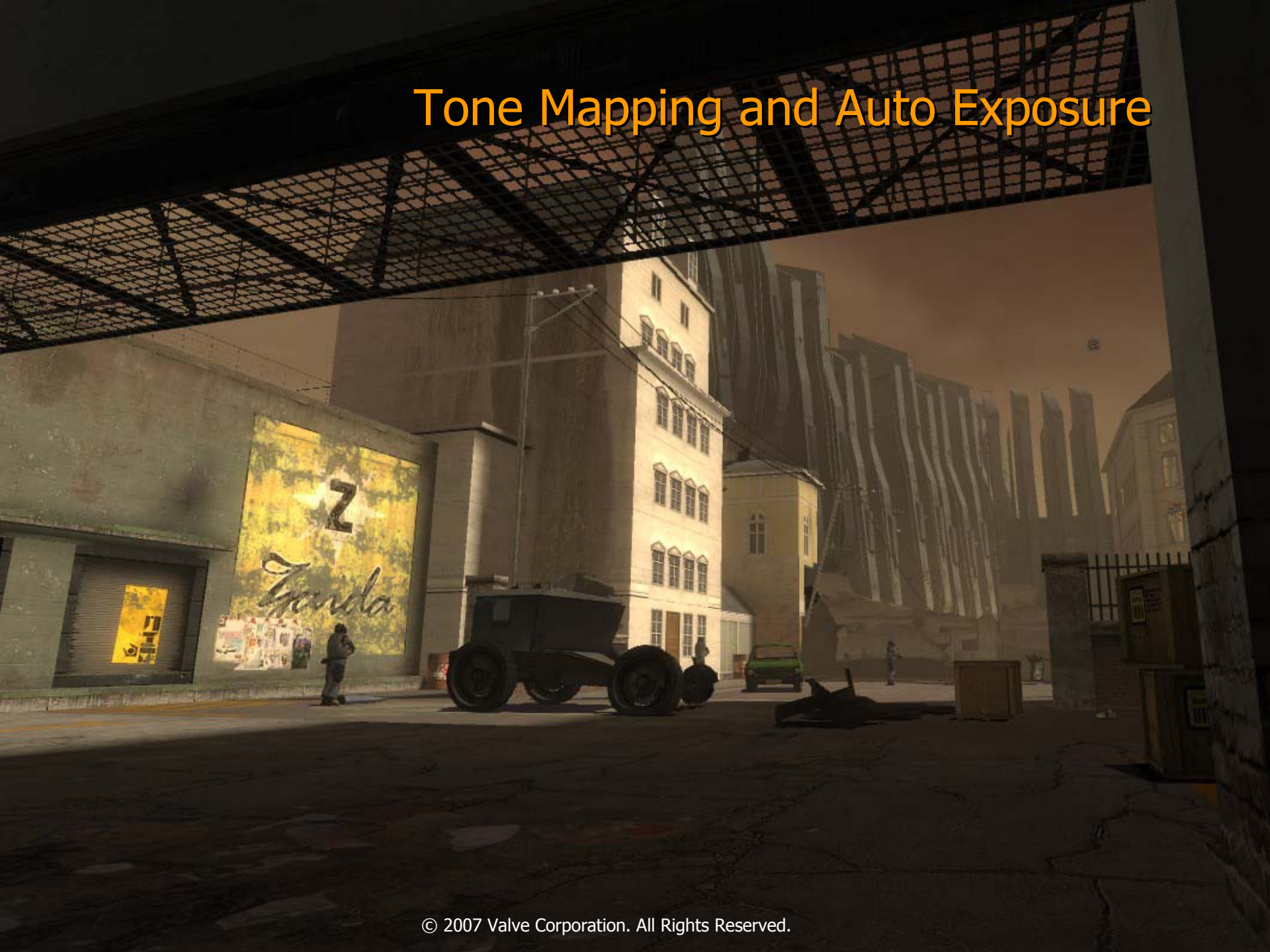
Water: Exposure 3

General Refraction

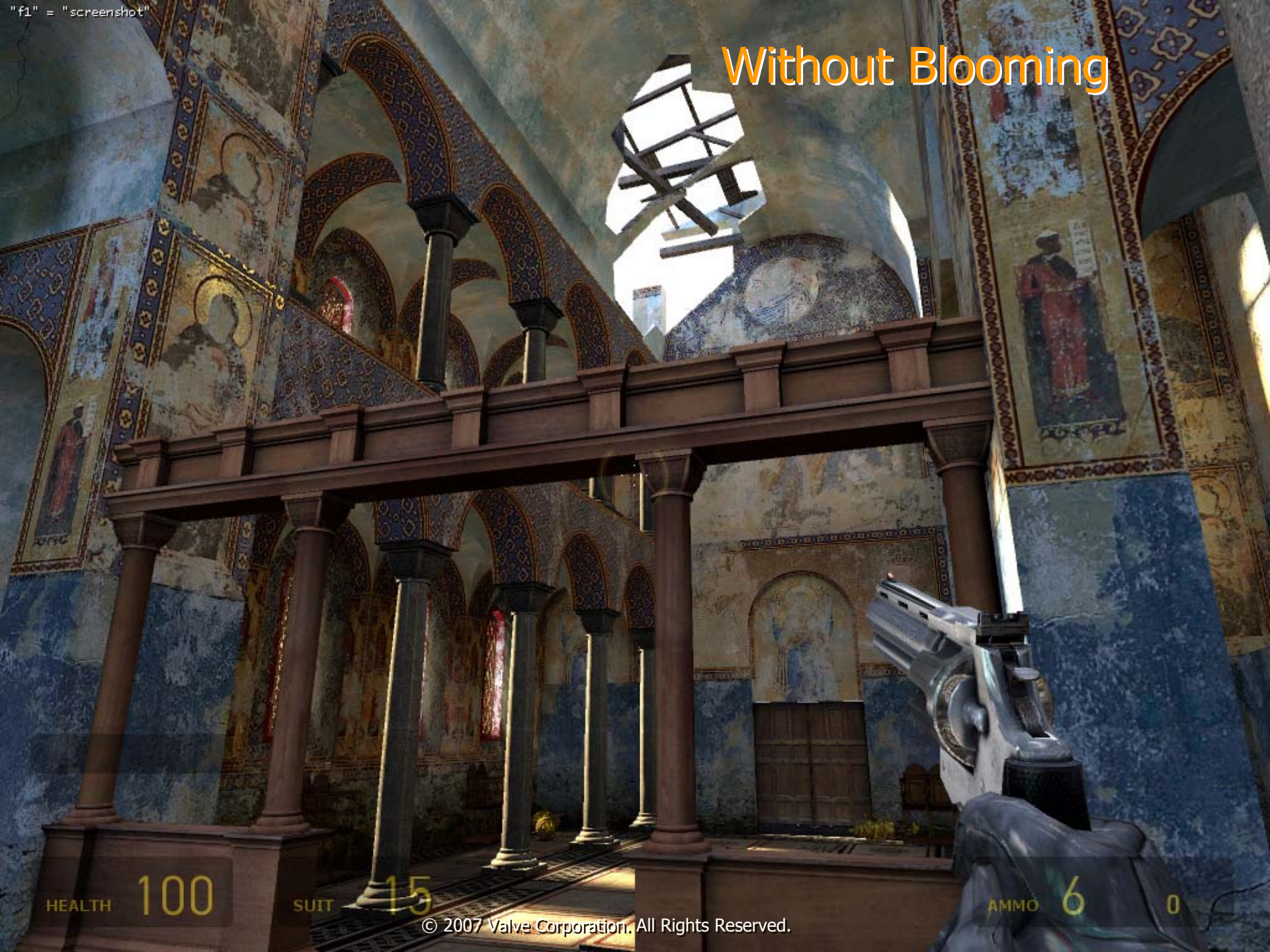
Tone Mapping and Auto Exposure



Tone Mapping and Auto Exposure



Tone Mapping and Auto Exposure


"f1" = "screenshot"
Without Blooming
HEALTH 100
SUIT 15
AMMO 6 0
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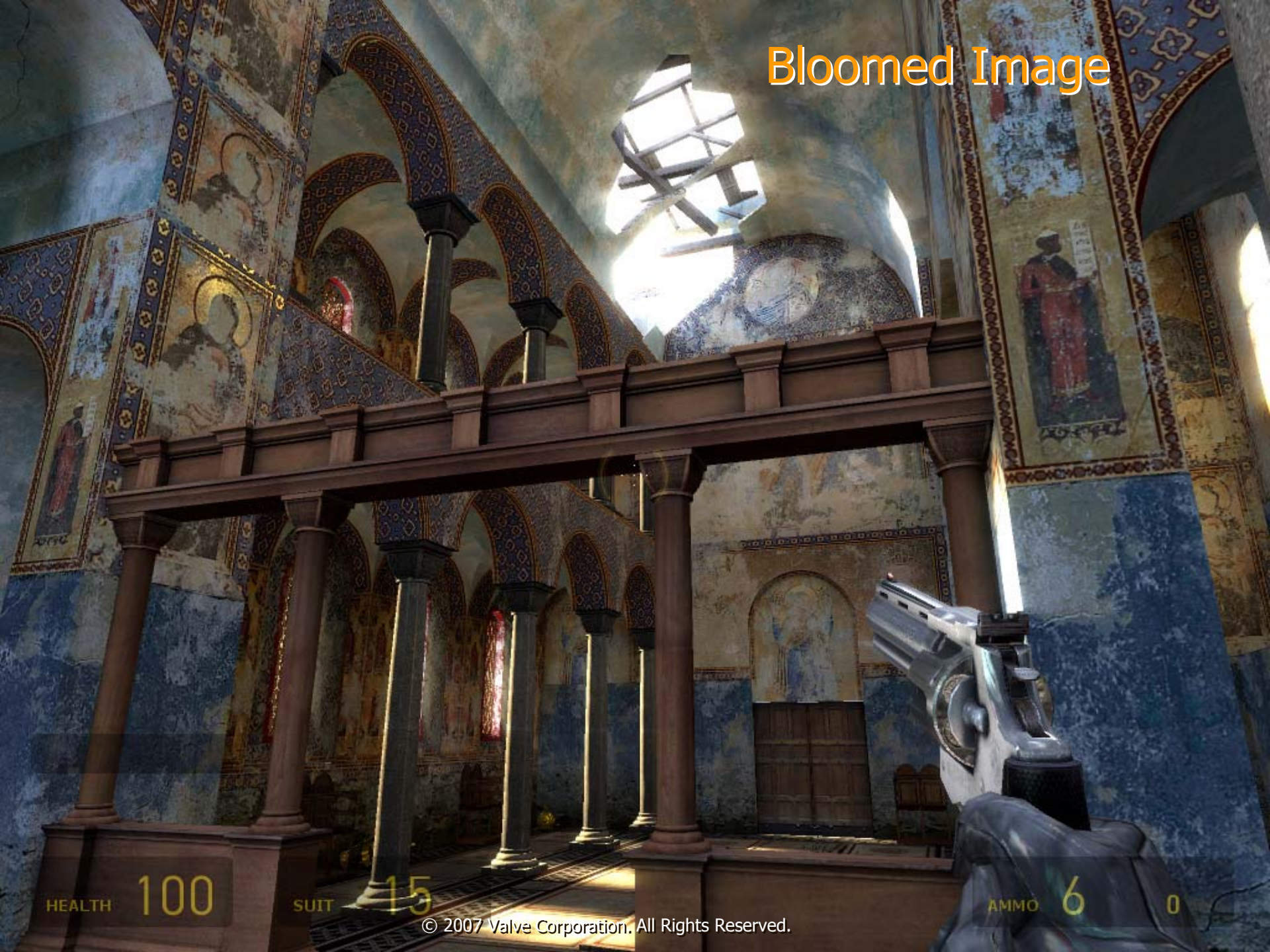
Bloomed Image
HEALTH 100
SUIT 15
AMMO 6 0
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Criteria for evaluating HDR methods

- MSAA Compatibility
- Alpha-blending Compatibility
- HDR blooming
- HDR reflection/refraction
- Bilinear filtering
- Customer hardware support
- Memory requirements
- Performance

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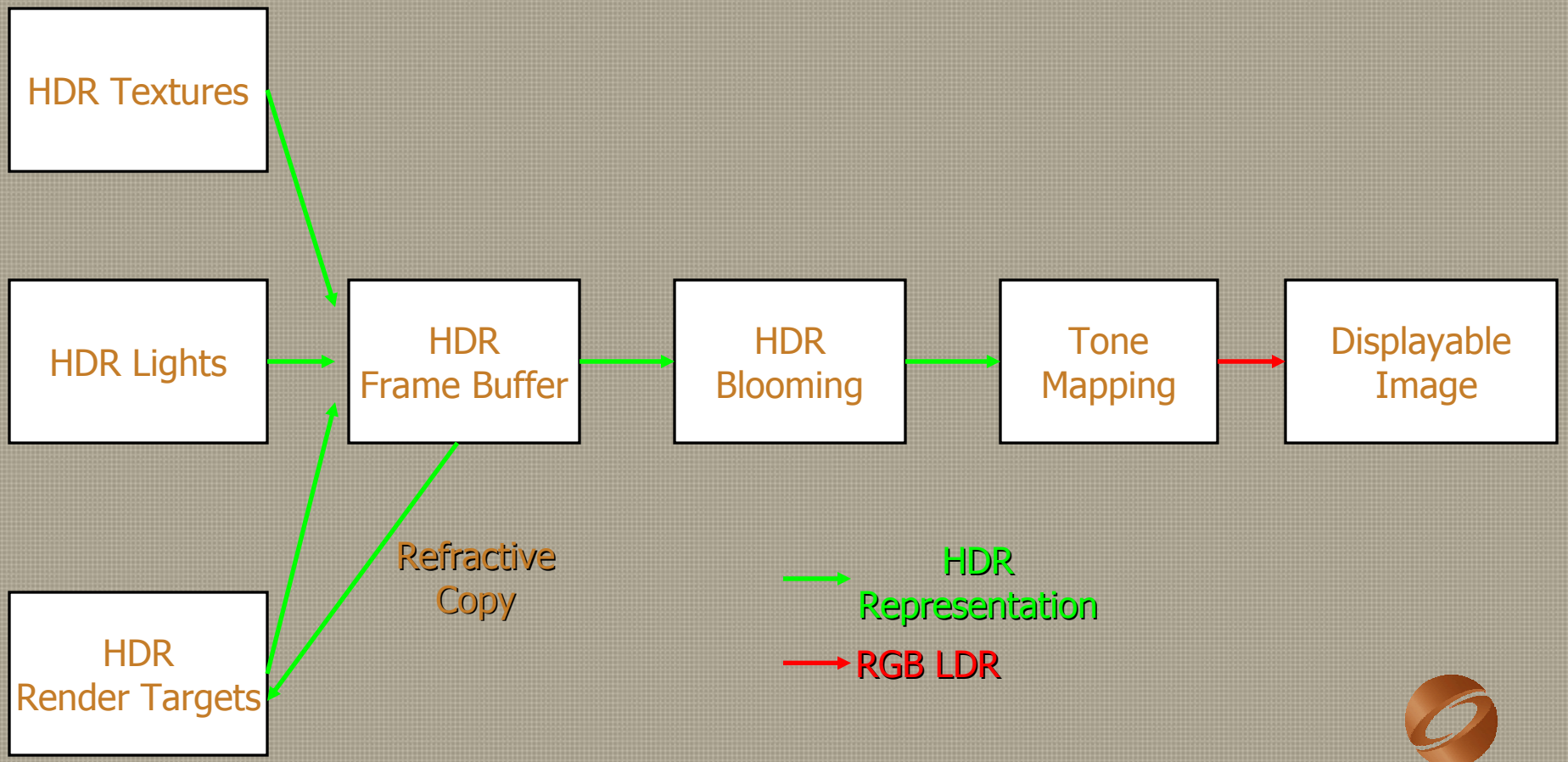
Ideal Implementation



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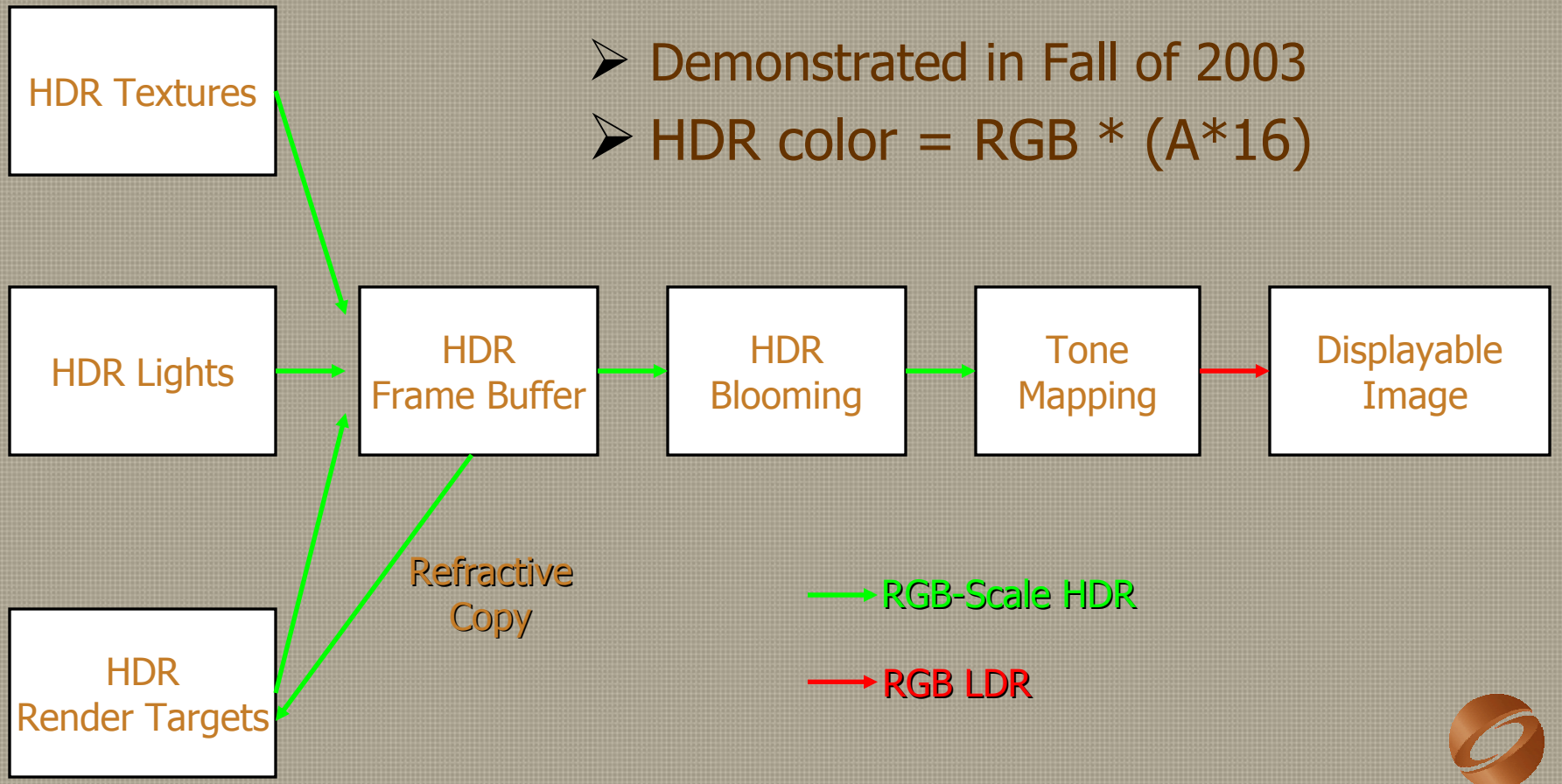
RGB-Scale HDR Implementation

- Demonstrated in Fall of 2003
- HDR color = RGB * (A*16)



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RGB-Scale HDR Tradeoffs

- Pros:
  - MSAA works
  - works on all DirectX 9 hardware
  - HDR Blooming
- Cons:
  - alpha blending very difficult
  - bilinear filtering doesn't work
  - extra conversion of frame buffer

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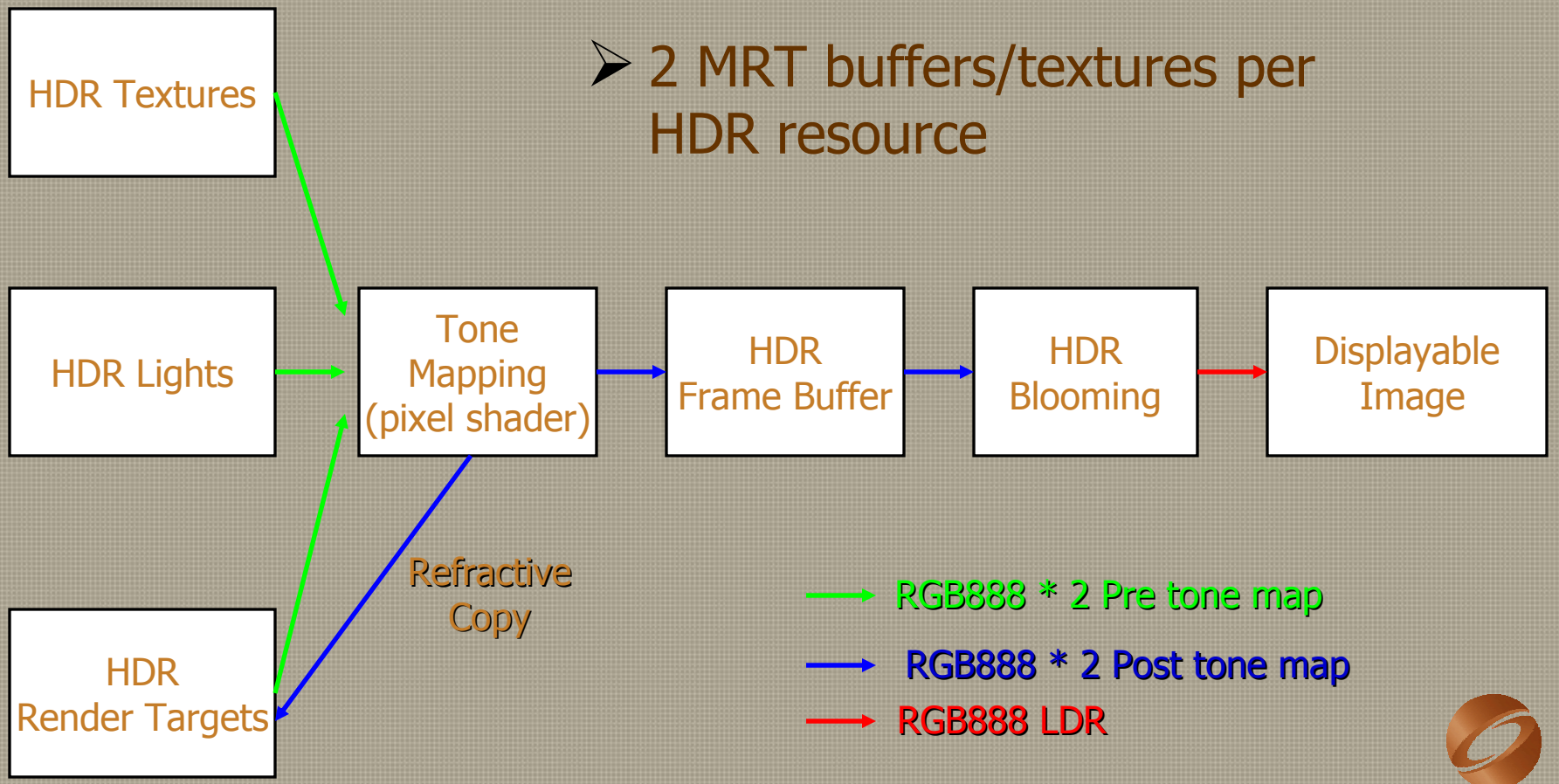
MRT HDR Implementation

- 2 MRT buffers/textures per HDR resource



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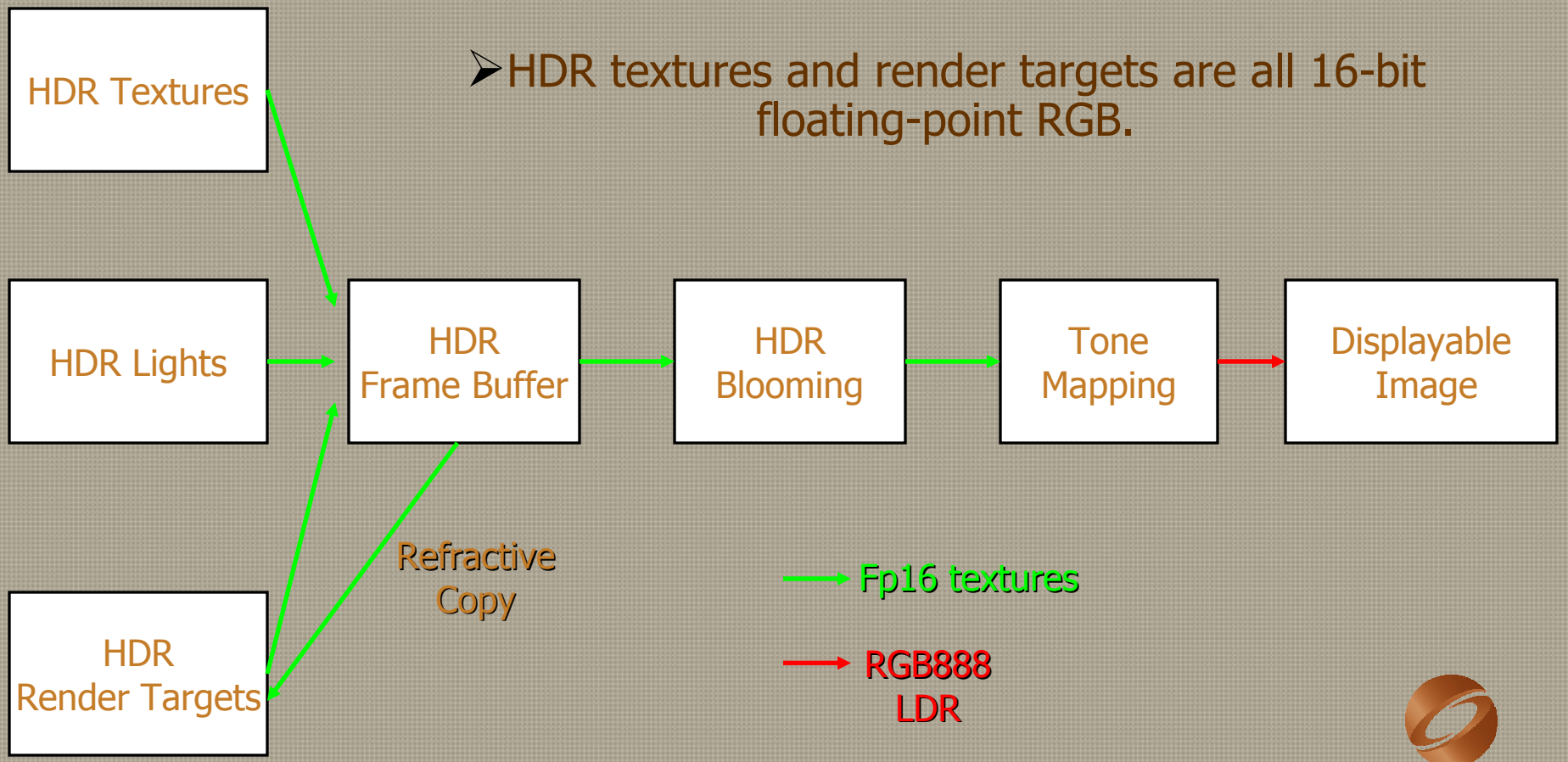
MRT HDR Tradeoffs

- Pros:
  - Main motivation: alpha blending works.
  - bilinear interpolation works
  - works on all DirectX 9 hardware
- Cons:
  - MSAA doesn't work
  - HDR textures, render targets, etc take twice as much space.

Floating Point HDR

- HDR textures and render targets are all 16-bit floating-point RGB.



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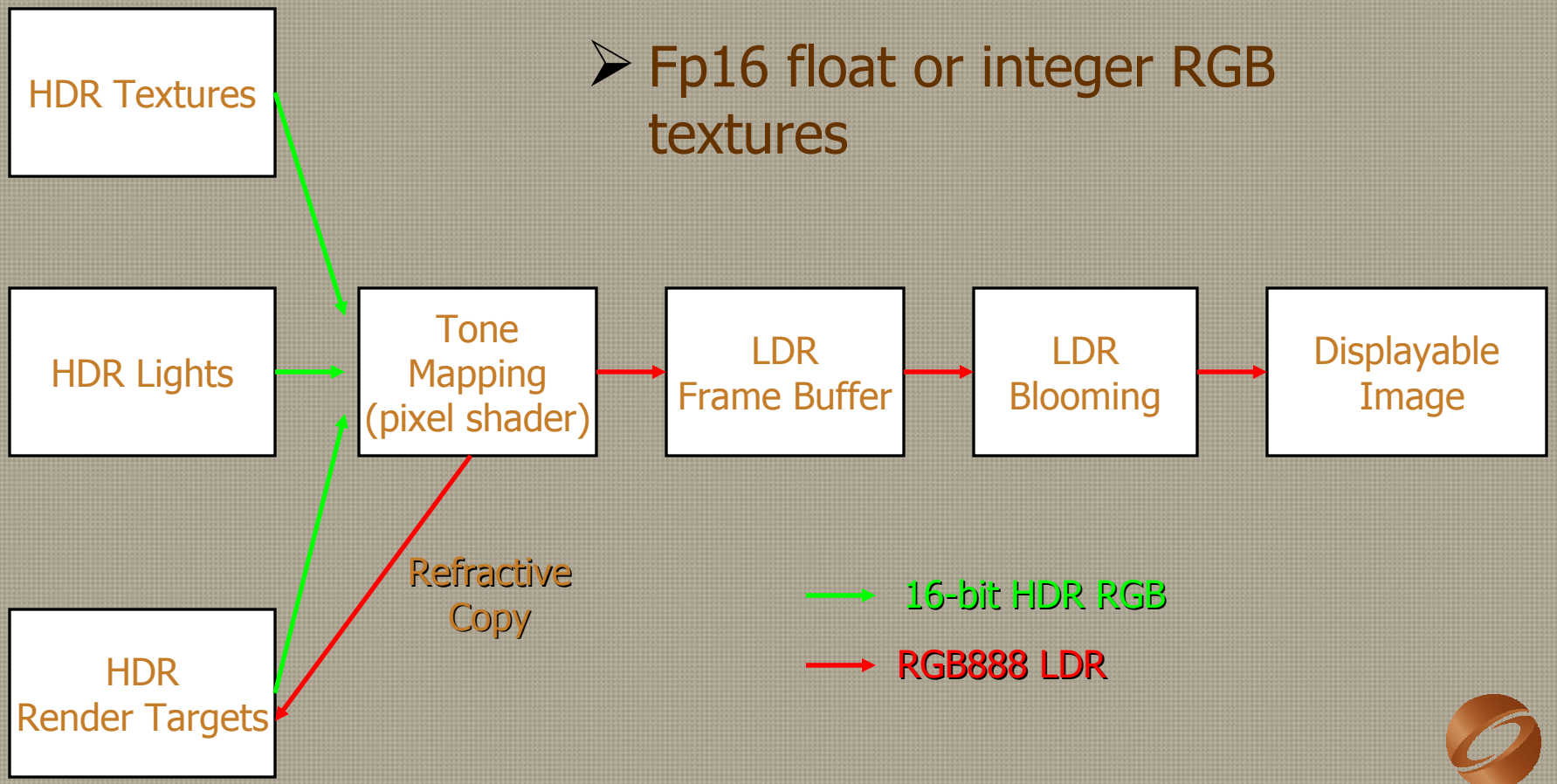
Floating Point HDR Tradeoffs

- Pros:
  - HDR Blooming
  - HDR refraction
  - Improved tone mapping
- Cons:
  - Requires fp16 alpha blending
  - Bad performance
  - Tons of memory
  - MSAA doesn't work
  - **GOTCHA! Floating point SPECIALS!!!**

Valve Integer HDR Implementation

- Fp16 float or integer RGB textures



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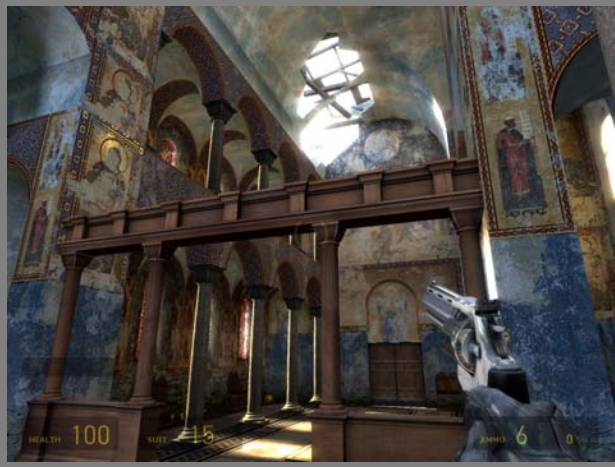
Valve Integer HDR Tradeoffs

- Pros
  - Works on all DX9 hardware
  - Lower memory requirements
  - Very fast!
  - Supports MSAA on all hardware
  - No specials to deal with!
- Cons
  - LDR Blooming
  - LDR Refraction

Valve Integer HDR blooming

+

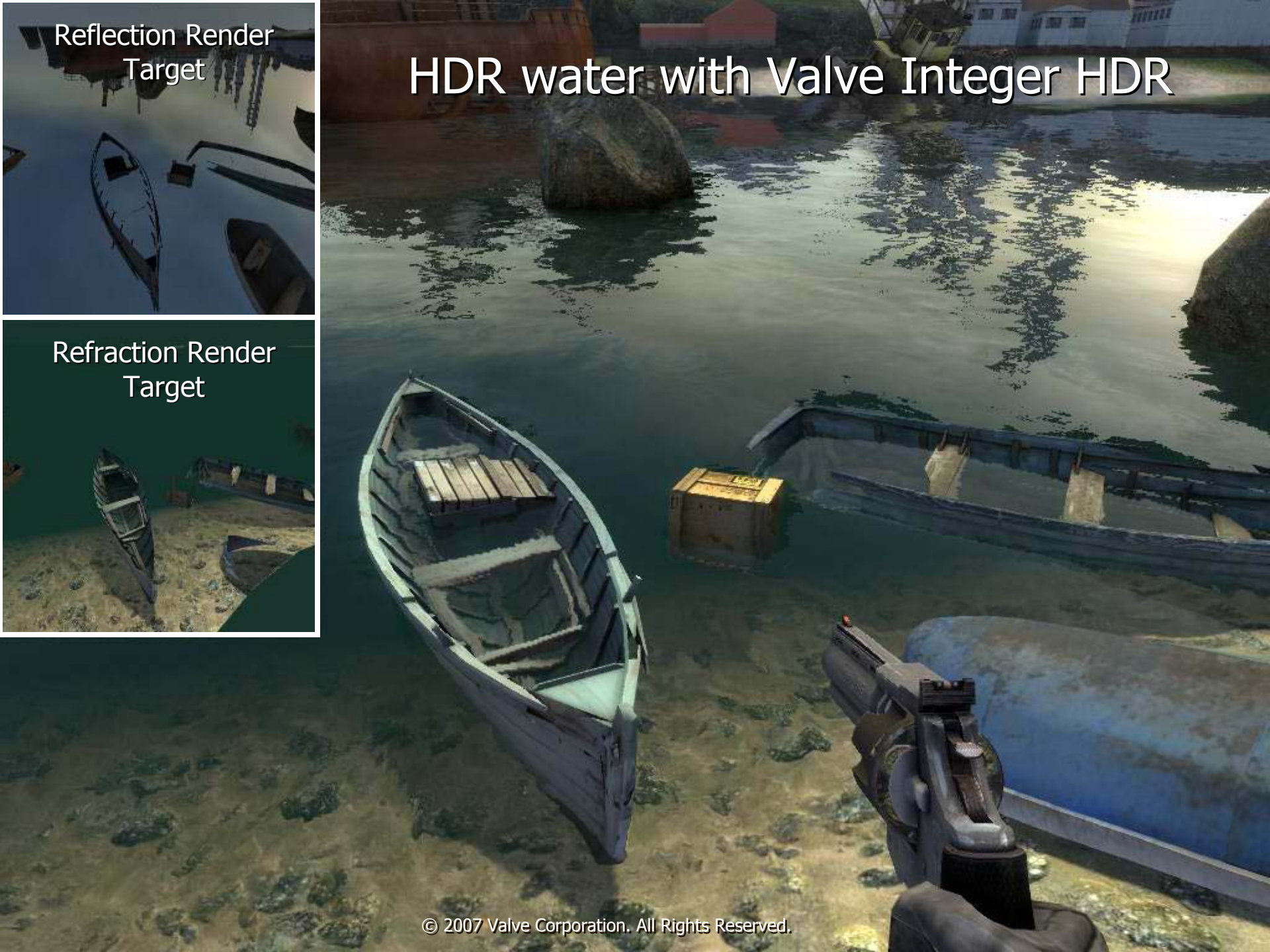
=



color

Luminance(color) * color

Valve Integer HDR blooming



General Refraction/Valve Integer HDR


Auto Exposure
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Auto Exposure

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Tone Mapping with Valve Integer HDR

Tonemap scale = 0.5

Tonemap scale = 1

Tonemap scale = 8

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Beyond Linear Scale Tone Mapping

- Dark scenes with high exposure: desaturate
- Use Color Correction
- For more info, check out Jason Mitchell's talk in the "**Advanced Real-Time Rendering in 3D Graphics and Games**" course on Tuesday in room 156.

Desaturation via Color Correction

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HDR and Authoring

- Bloom amount and exposure range
- Asymmetric autoexposure

Team Fortress 2: NPR + HDR!

Team Fortress 2: NPR + HDR!

Team Fortress 2: NPR + HDR!

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Conclusion

- Intro to HDR
- Reflection/Refraction
- Tone Mapping and Auto-exposure
- Road to a shippable HDR implementation

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SDK & Academic Licensing

- Publicly available SDK
- Academic licenses provide
  - Access to Valve games
  - Source code
    - HLSL shaders, Radiosity and visibility calculations
    - AI system, path finding
    - Animation system, acting system, inverse kinematics
  - Production quality art and sound assets
  - Useful level and modeling tools
    - Hammer level editor, Faceposer, Model viewing utilities

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