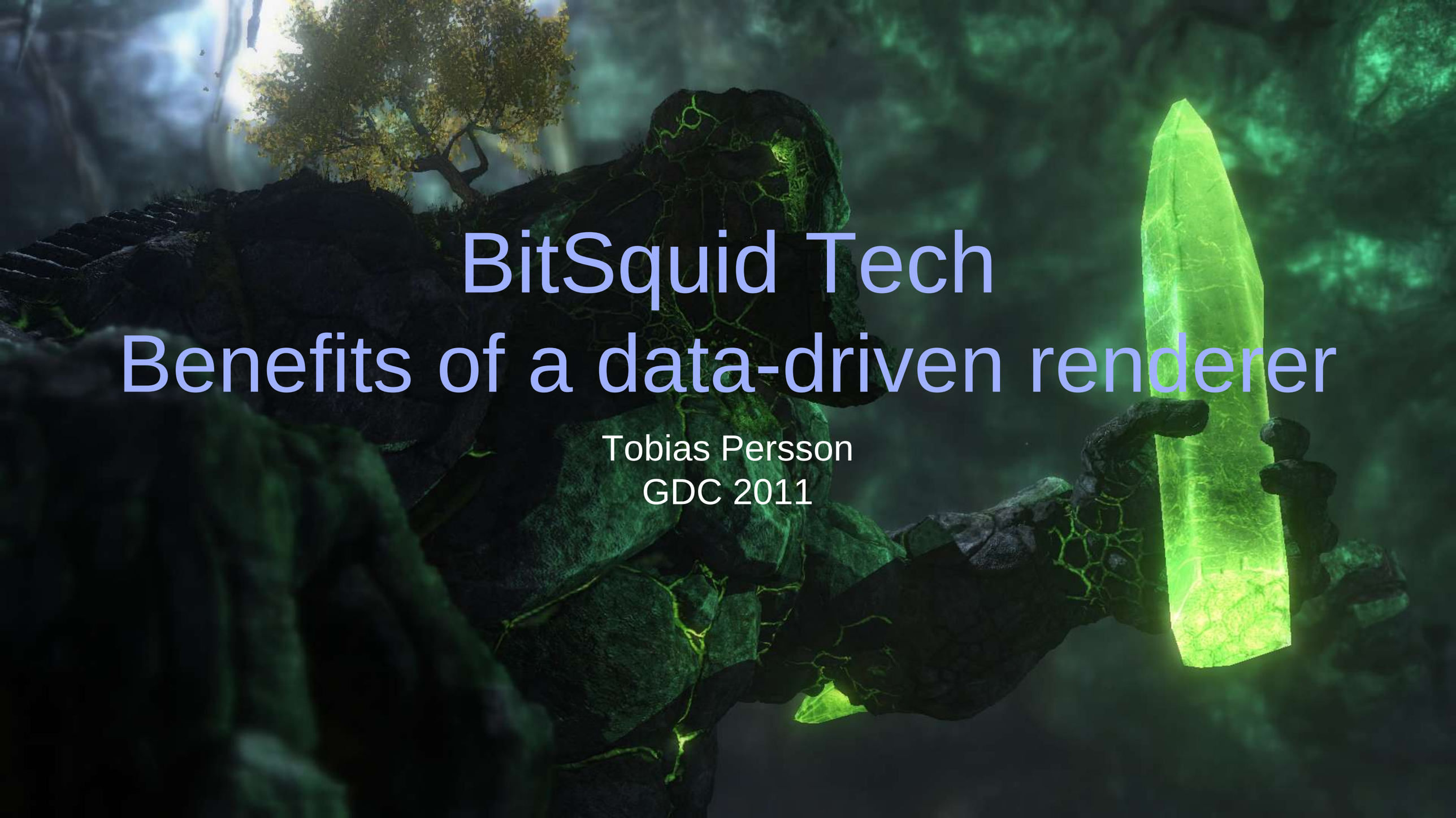


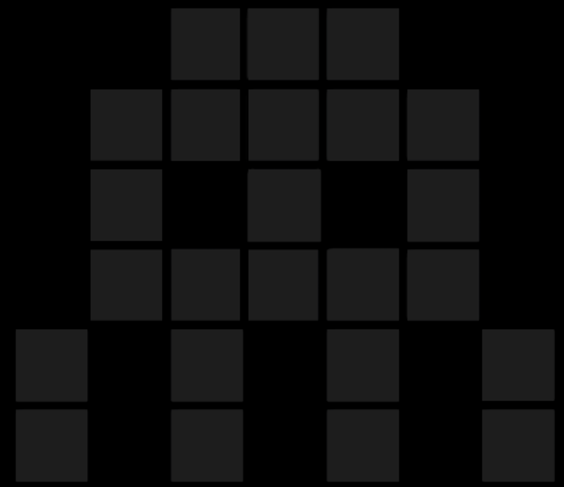
BitSquid Tech
Benefits of a data-driven renderer

Tobias Persson

GDC 2011

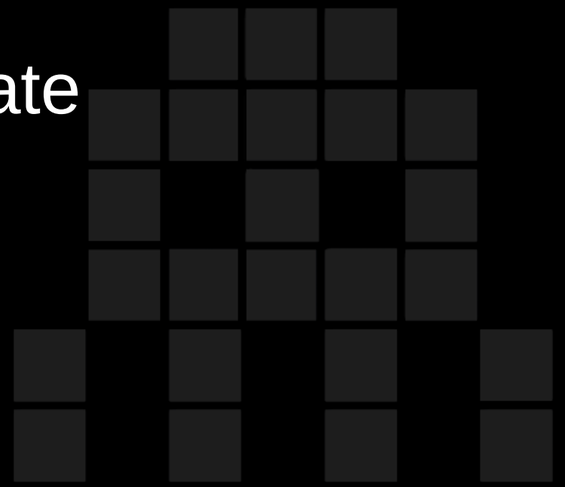
Agenda

- An introduction to BitSquid
- Key design principles of BitSquid Tech
- Benefits of having a data-driven rendering pipe



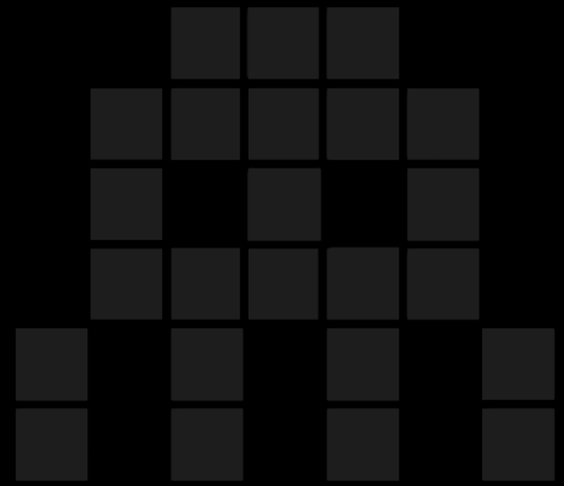
BitSquid

- Core team consists of me (rendering) and Niklas Frykholm (system)
- Based in Stockholm, Sweden
- Founded in September 2009 after GRINs unfortunate bankruptcy



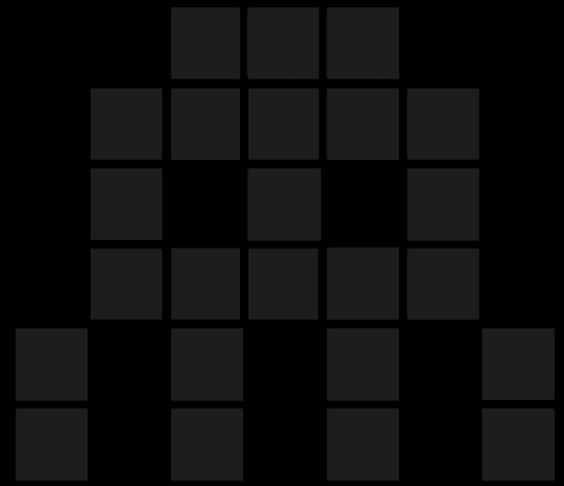
Ambitious Goal

- To develop a new high-end game engine for licensing
- Cross-platform: PS3, X360, PC/DX11 (+ future *“console”* HW)
- We call it *BitSquid Tech*



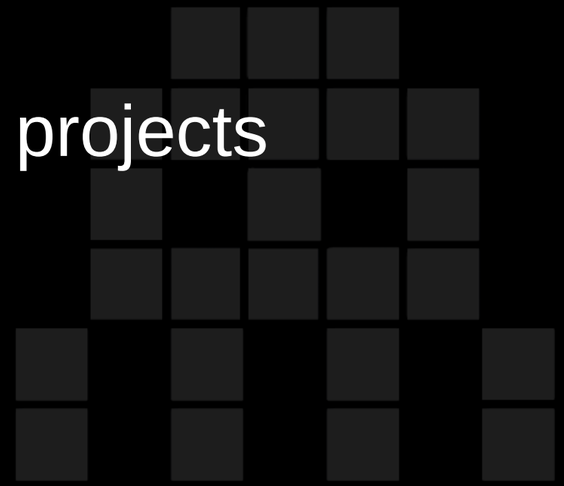
Fatshark collaboration

- Impossible to build game technology without close collaboration with end-users (i.e. game developers)
- Fatshark is an independent mid-sized game developer [Lead and Gold, BCR2, Hamilton]
- BitSquid and Fatshark shares office space
- Fatshark are our crash test dummies

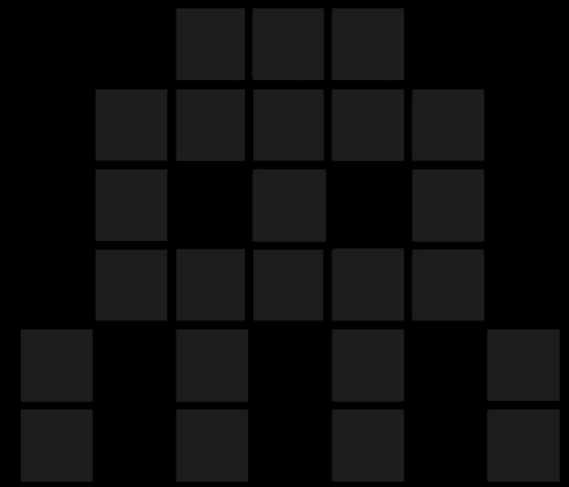


Products running BSTech

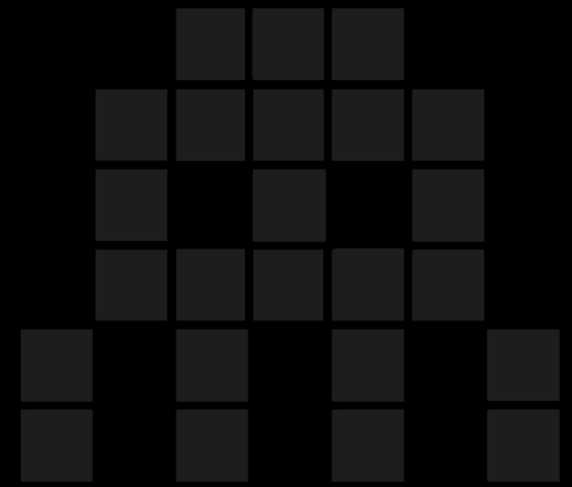
- *Stone Giant* [BitSquid / Fatshark] - DX11/tessellation tech-demo
- *Hamilton's Great Adventure* [Fatshark] - 3rd person puzzle game to be released on PSN and Steam
- Two external developers working on unannounced projects



Stone Giant Demo

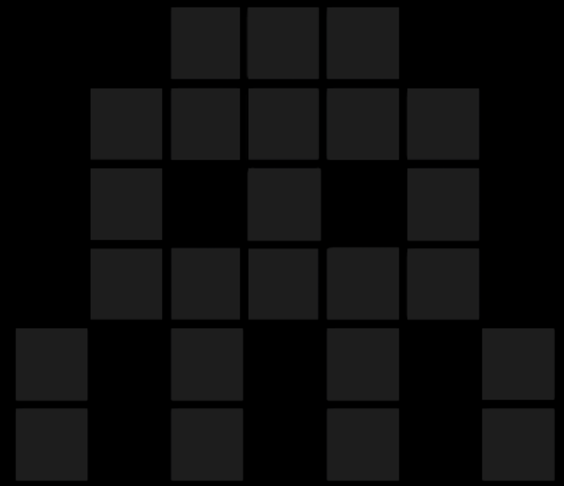


Key design principles of BitSquid Tech



Fast Content Iterations

- Being able to iterate fast over content is key to create great games
- In BSTech content is everything from low-level engine configuration files to high-level art assets
- Support hot-reloading of all content

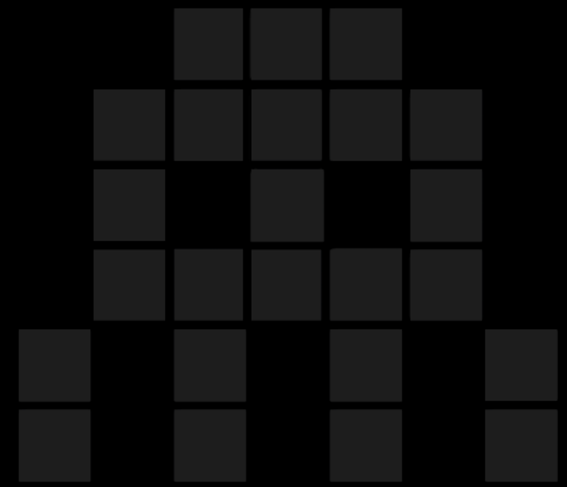


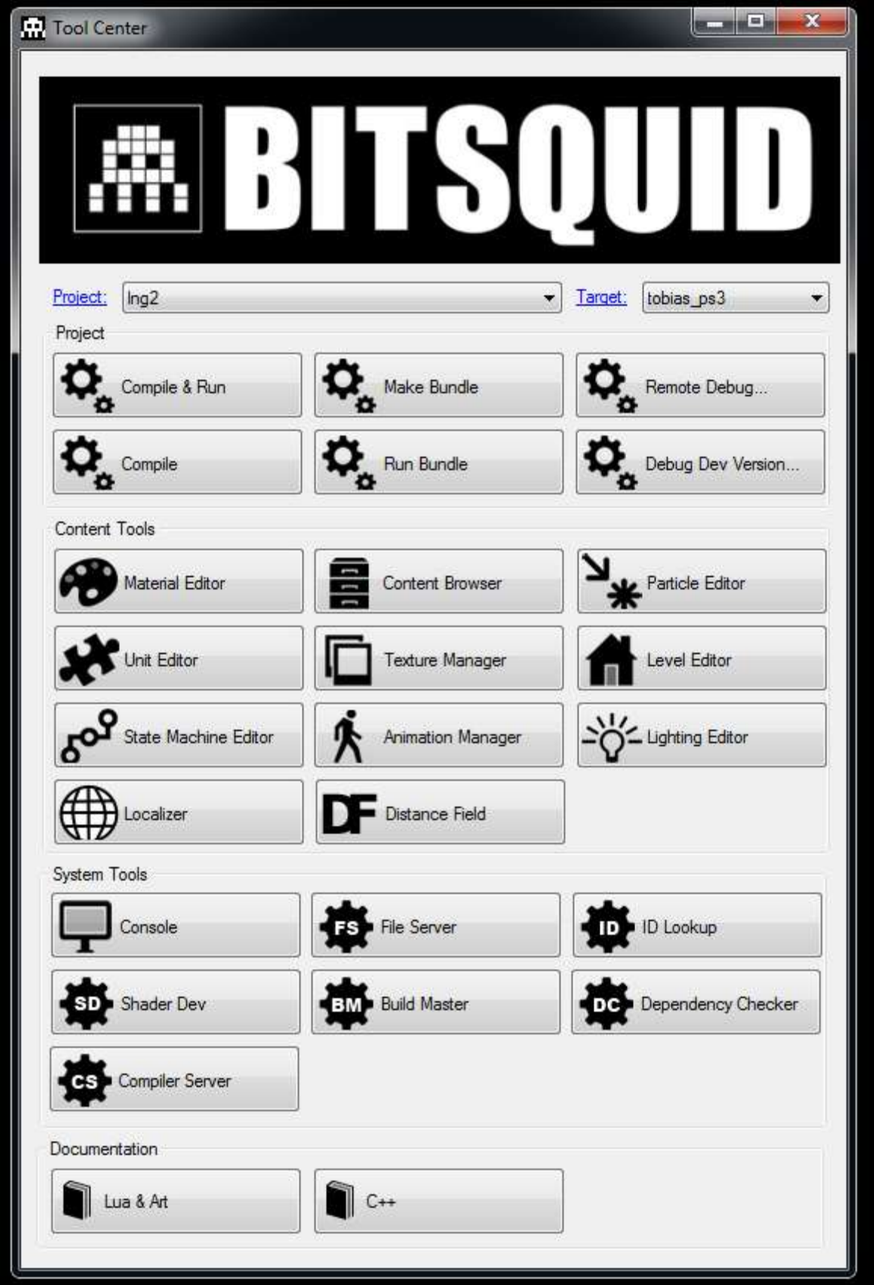
Multi-core

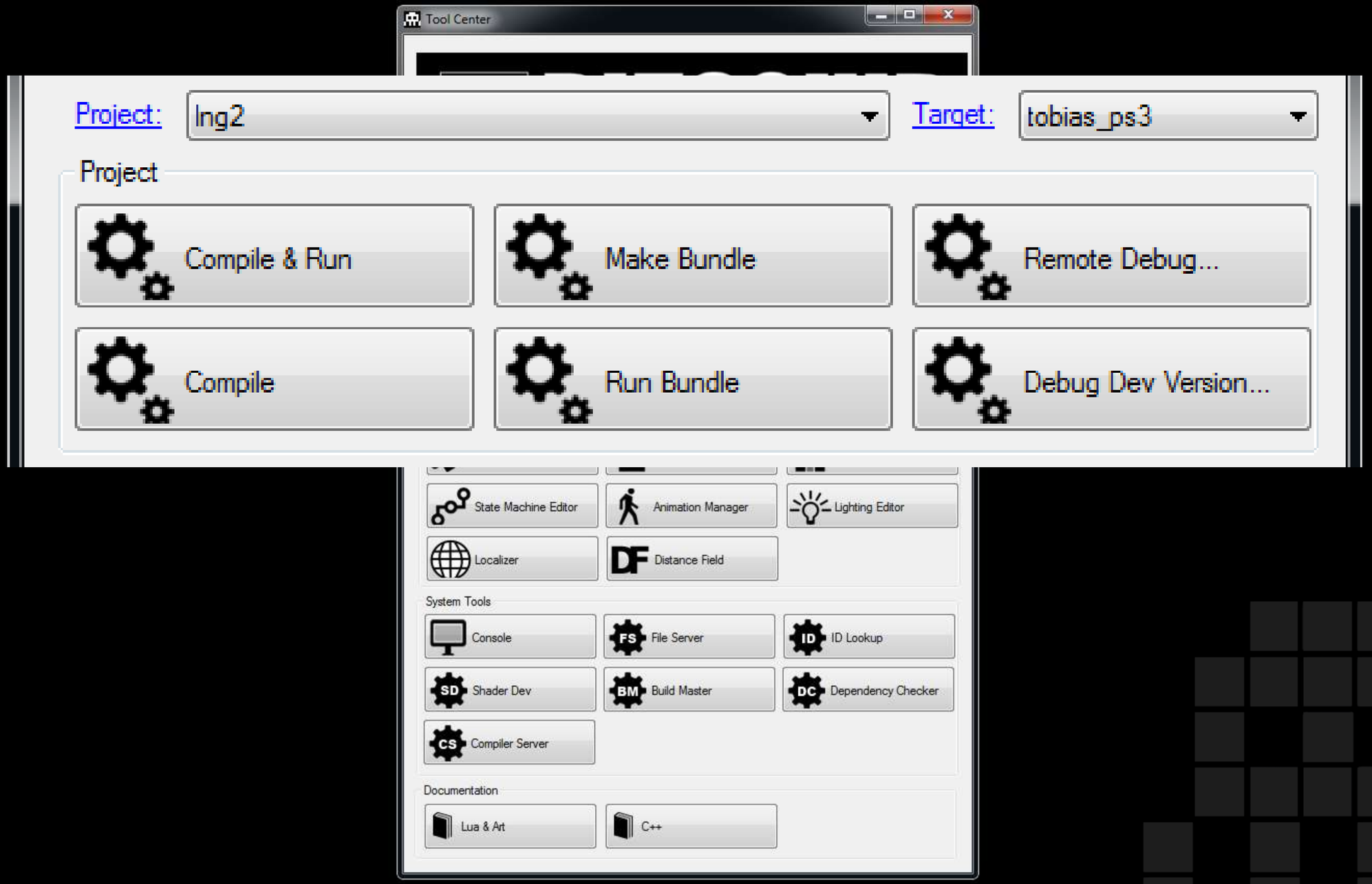
- All bulk workload run through our job-system
  - Mixture of task & data-parallel jobs
- Data oriented design
  - Heavy focus on memory-layout of input/output data
  - Easy DMA to coprocessors (SPU/GPGPU)

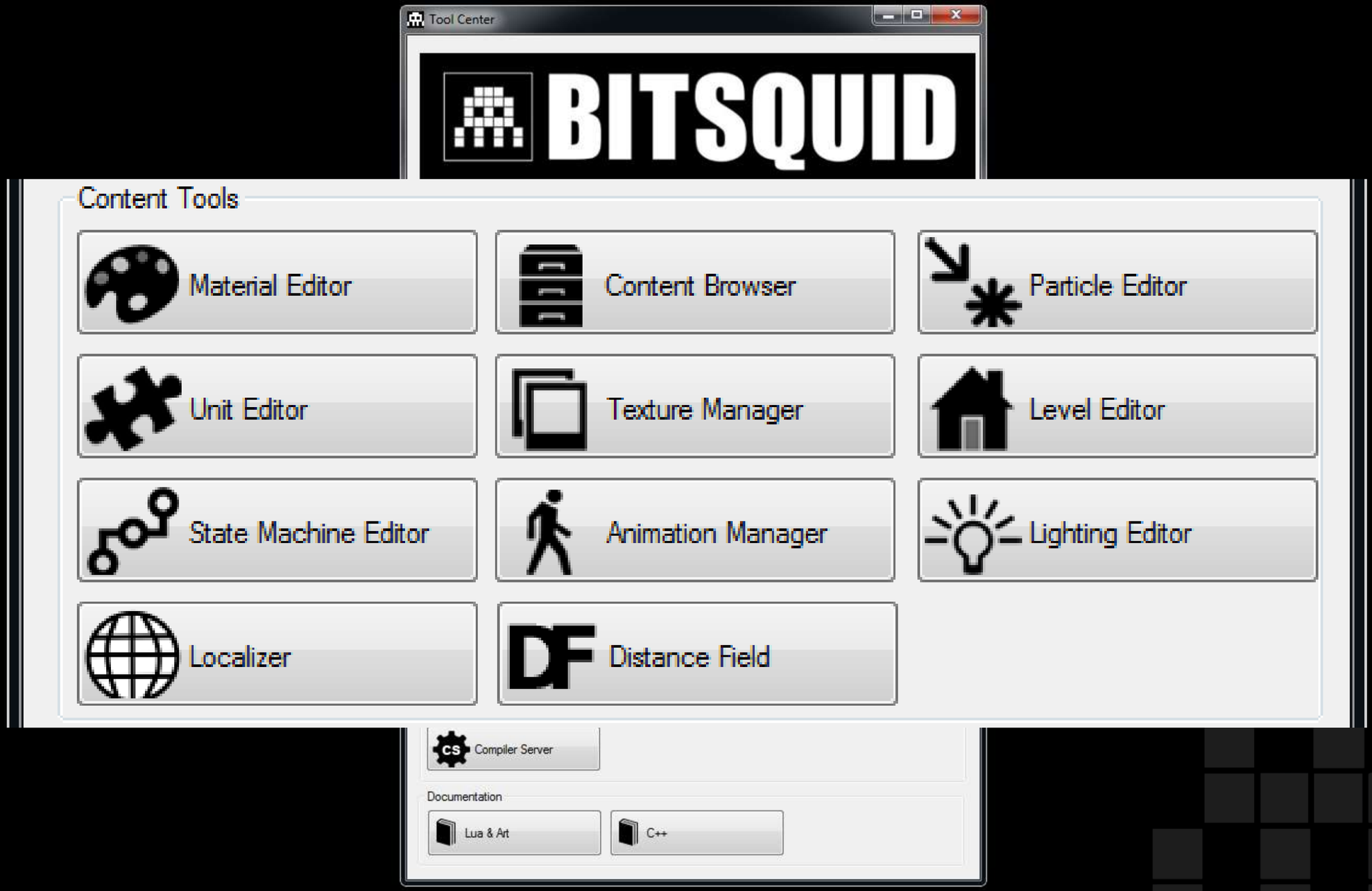
Tools

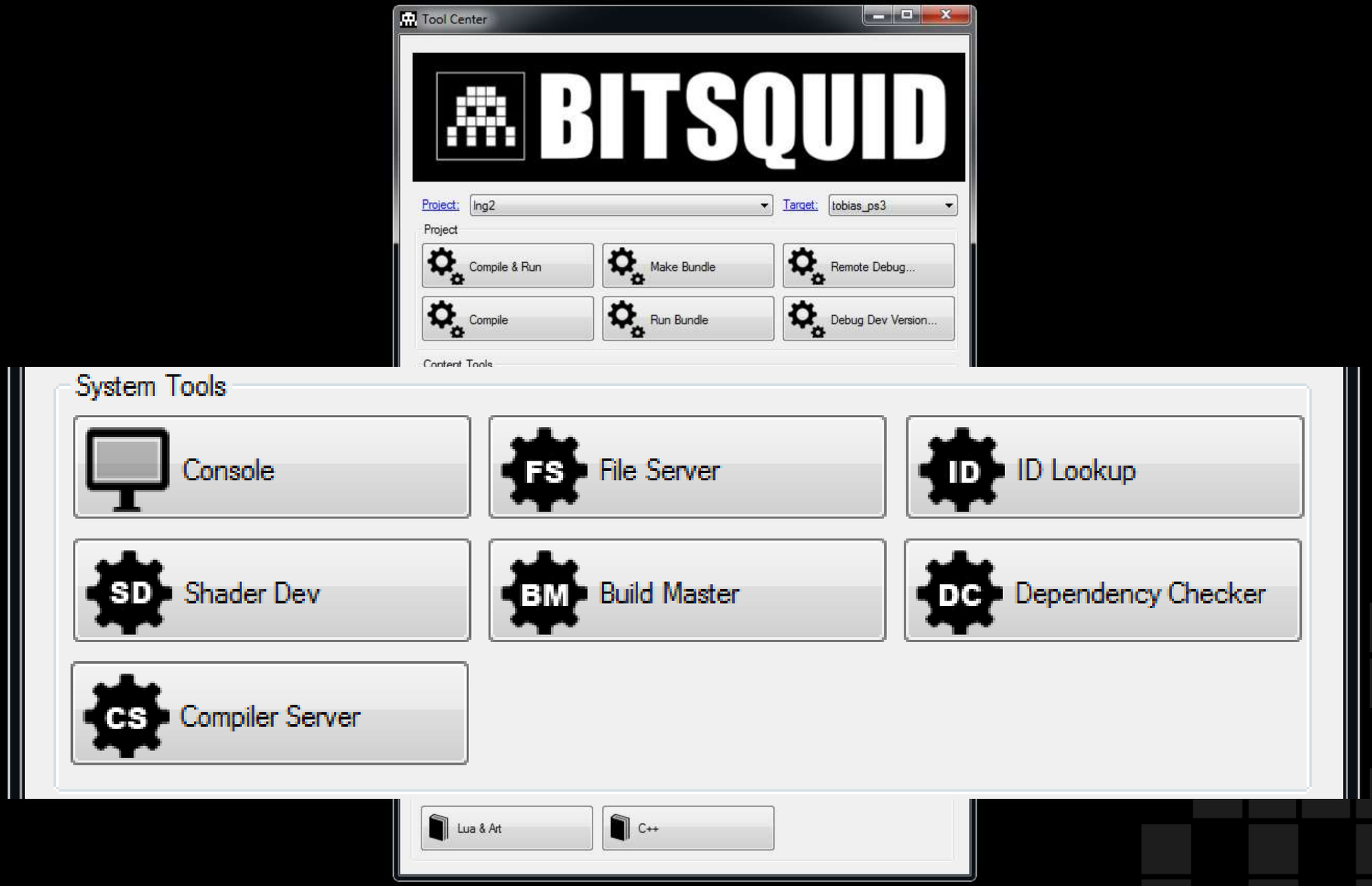
- No mega-editor™
- Instead: multiple tools designed for specific purposes
- Much easier to extend and add new tools
- Gathered in a central launcher called “*tool center*”

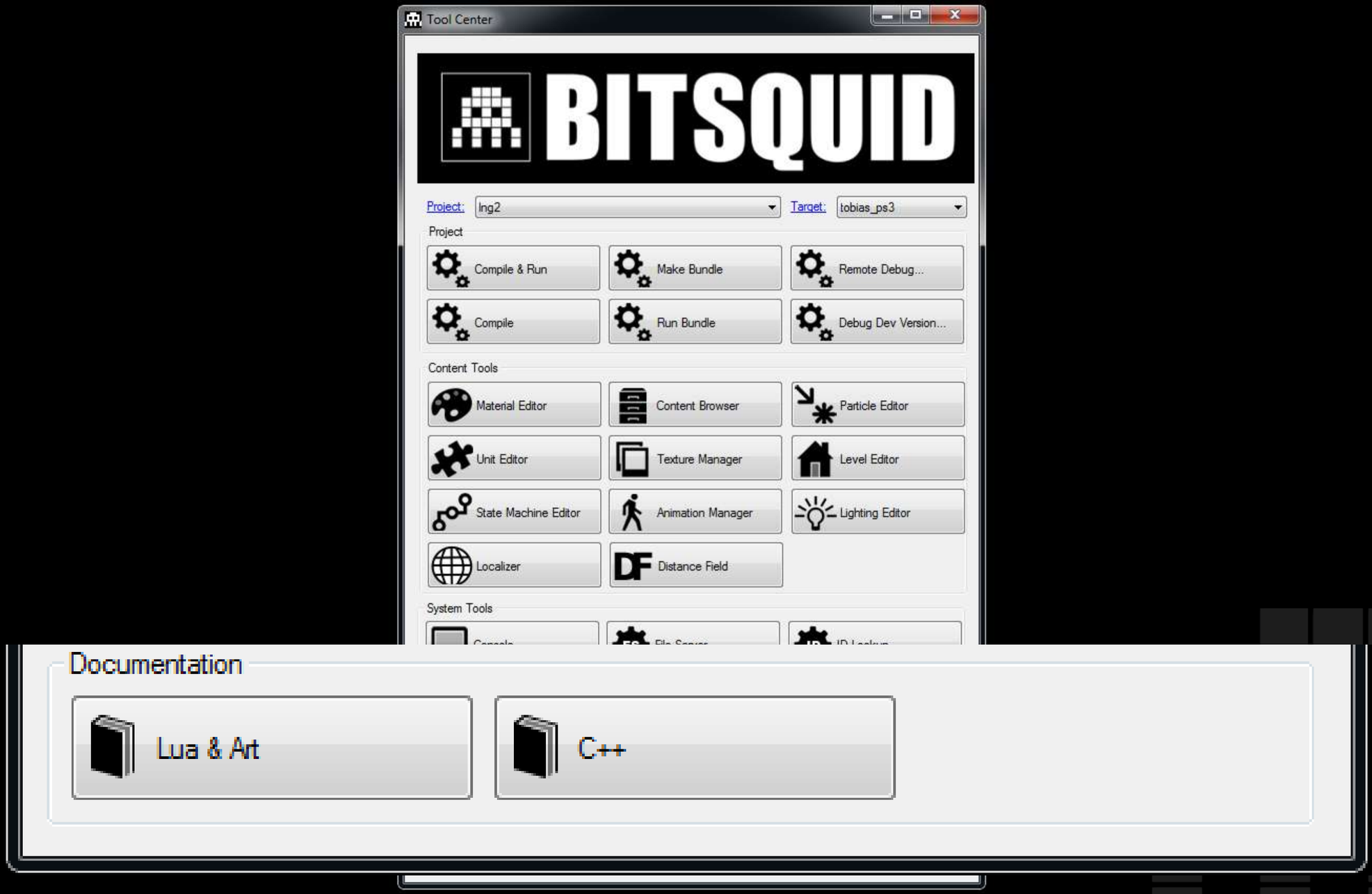



Tool Center
BITSQUID
Project:
lng2
Target:
tobias_ps3
Project
Compile & Run
Make Bundle
Remote Debug...
Compile
Run Bundle
Debug Dev Version...
Content Tools
Material Editor
Content Browser
Particle Editor
Unit Editor
Texture Manager
Level Editor
State Machine Editor
Animation Manager
Lighting Editor
Localizer
Distance Field
System Tools
Console
File Server
ID Lookup
Shader Dev
Build Master
Dependency Checker
Compiler Server
Documentation
Lua & Art
C++


Tool Center
Project:
lng2
Target:
tobias_ps3
Project
Compile & Run
Make Bundle
Remote Debug...
Compile
Run Bundle
Debug Dev Version...
State Machine Editor
Animation Manager
Lighting Editor
Localizer
Distance Field
System Tools
Console
File Server
ID Lookup
Shader Dev
Build Master
Dependency Checker
Compiler Server
Documentation
Lua & Art
C++

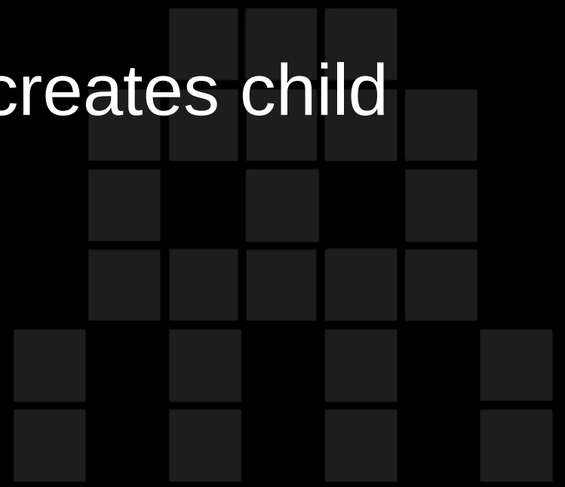

Tool Center
BITSQUID
Content Tools
Material Editor
Content Browser
Particle Editor
Unit Editor
Texture Manager
Level Editor
State Machine Editor
Animation Manager
Lighting Editor
Localizer
Distance Field
Compiler Server
Documentation
Lua & Art
C++


Tool Center
BITSQUID
Project:
lng2
Target:
tobias_ps3
Project
Compile & Run
Make Bundle
Remote Debug...
Compile
Run Bundle
Debug Dev Version...
Content Tools
System Tools
Console
File Server
ID Lookup
Shader Dev
Build Master
Dependency Checker
Compiler Server
Lua & Art
C++

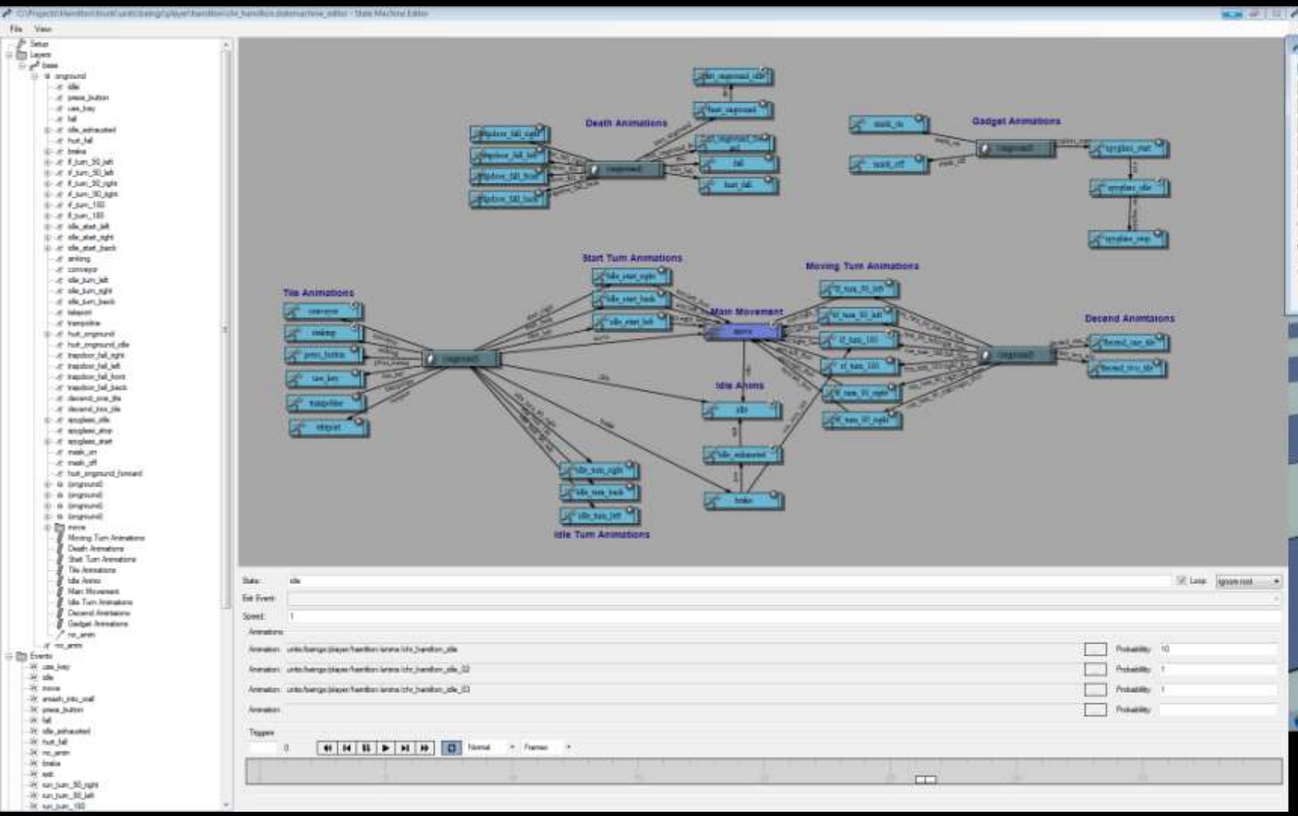

Tool Center
BITSQUID
Project:
lng2
Target:
tobias_ps3
Project
Compile & Run
Make Bundle
Remote Debug...
Compile
Run Bundle
Debug Dev Version...
Content Tools
Material Editor
Content Browser
Particle Editor
Unit Editor
Texture Manager
Level Editor
State Machine Editor
Animation Manager
Lighting Editor
Localizer
Distance Field
System Tools
Documentation
Lua & Art
C++

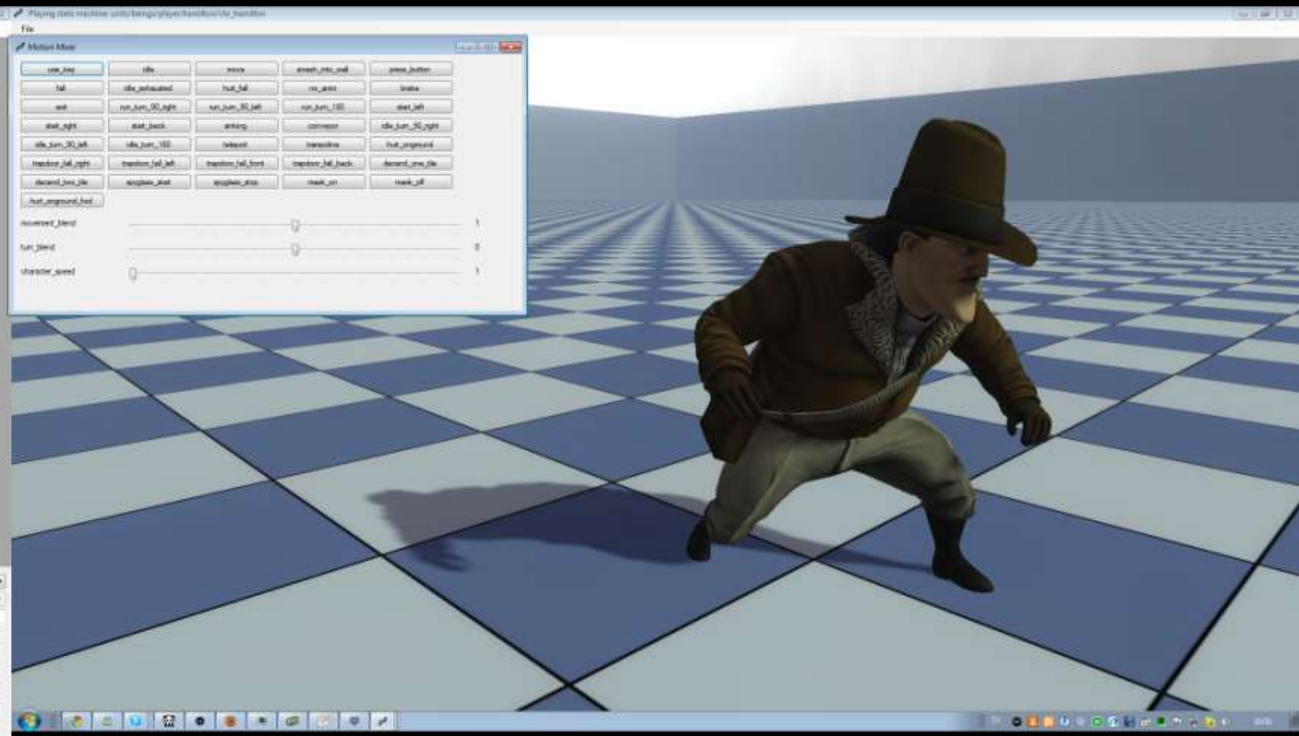
Tools cont.

- All visualization using “real” engine
- Avoids strong coupling to engine by forcing all communication over TCP/IP
  - Boot engine with tool slave script
  - Tool sends windows handle to engine, engine creates child window with swap-chain
  - Write tools in the language you prefer

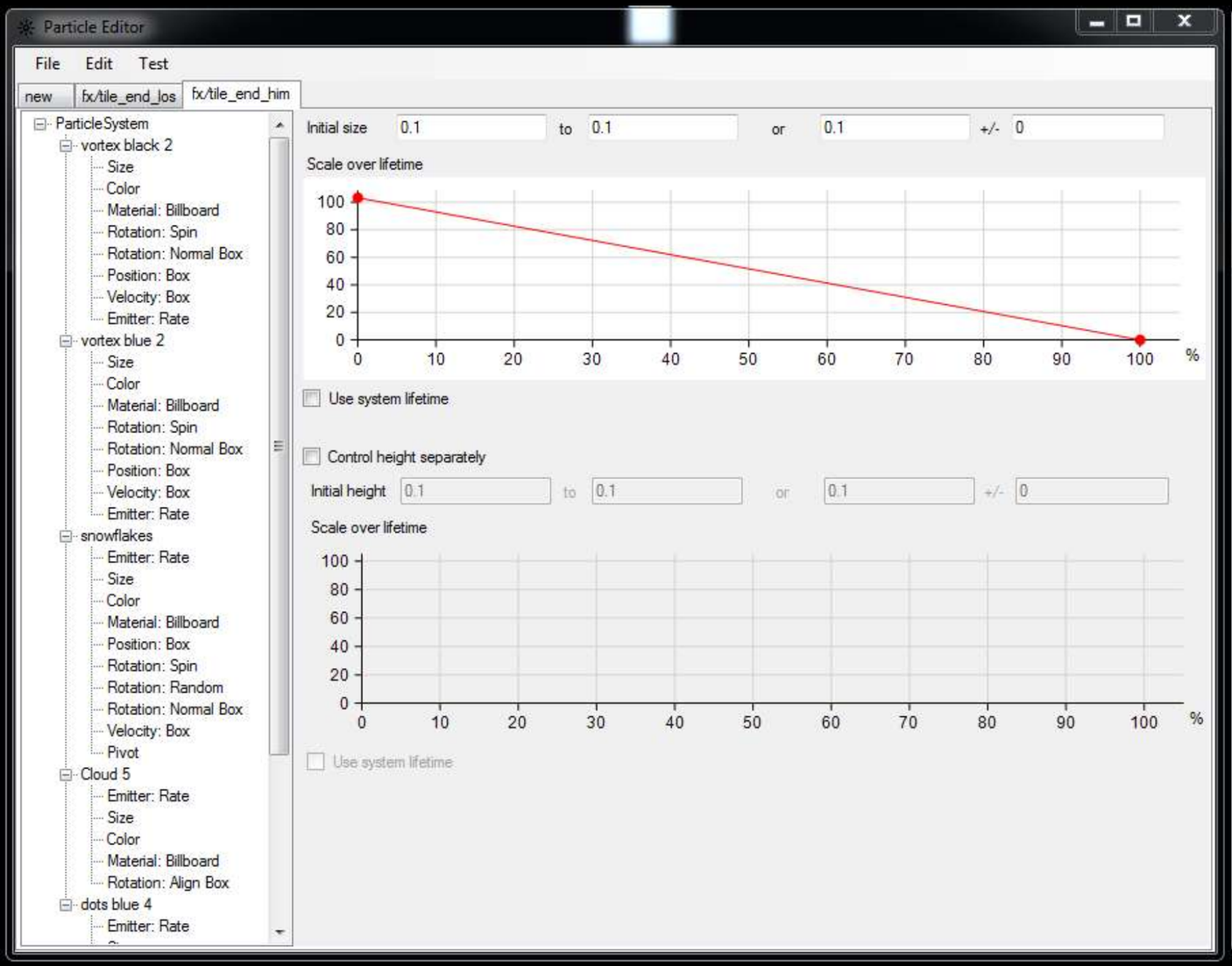


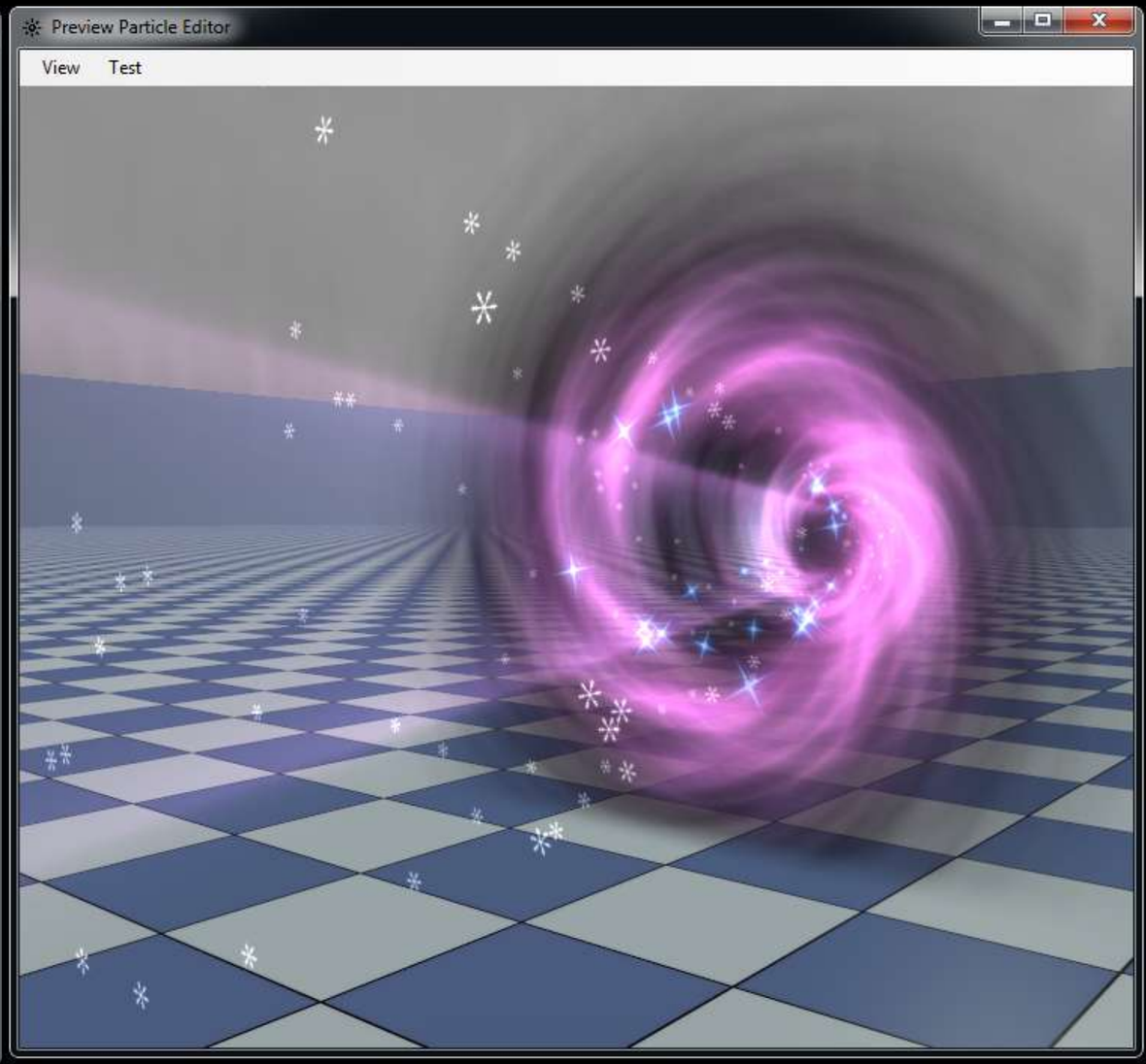
Animation State Machine Editor





Particle Editor

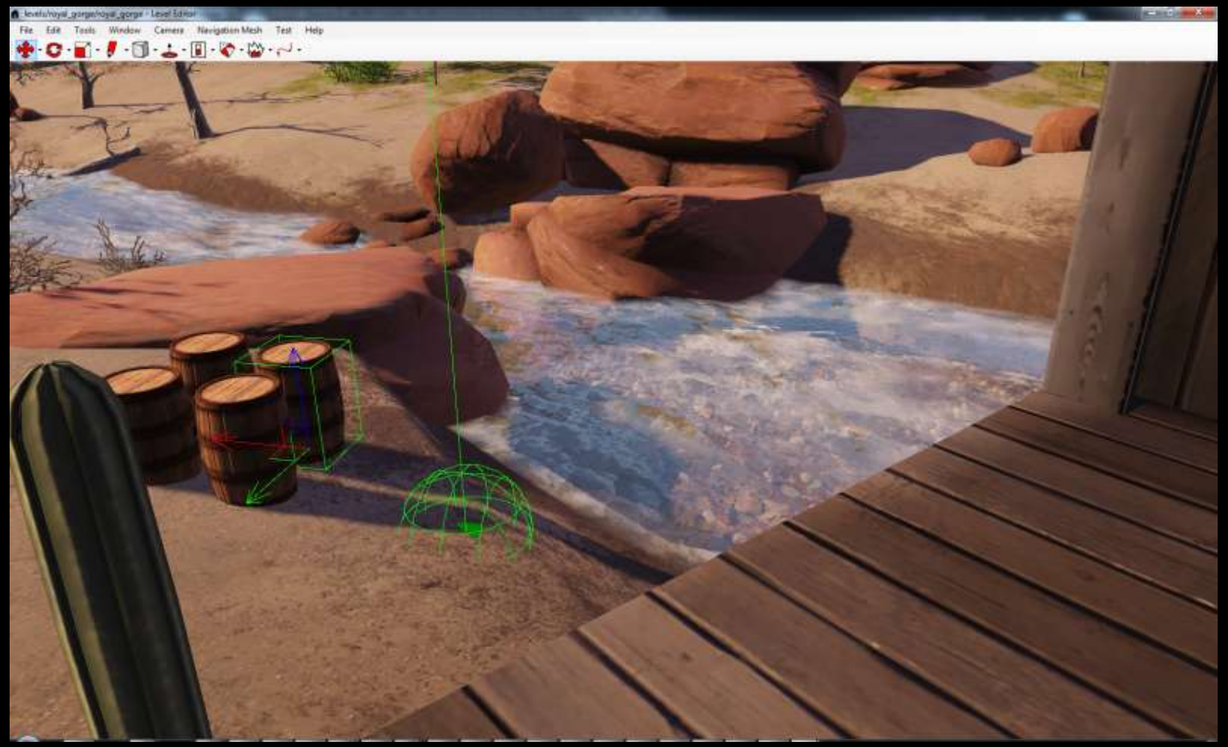




Console Focus

- Hard to get all departments to test their content on console HW
  - Two options: 1.Make PC runtime suck or 2.Make console testing easy
- All tools run on console, examples:
  - Mirroring of level editor
  - Simultaneous tweaking of lighting / material properties

Level Editor mirroring

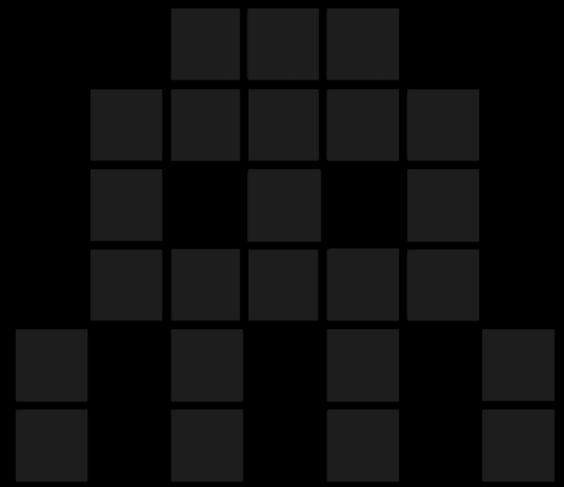


PC

PS3

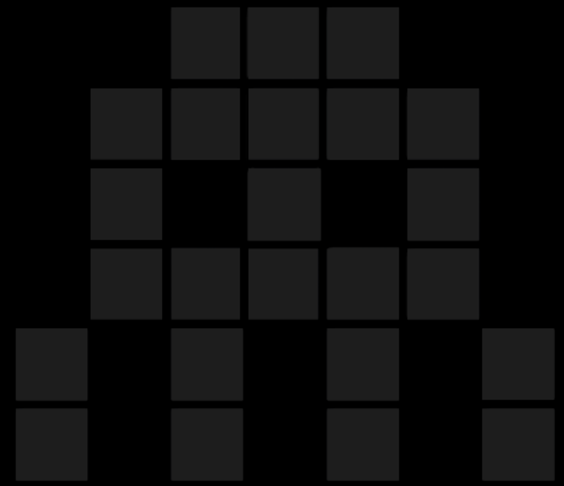
Content from unannounced project
Courtesy of Fatshark

Benefits of a data-driven renderer



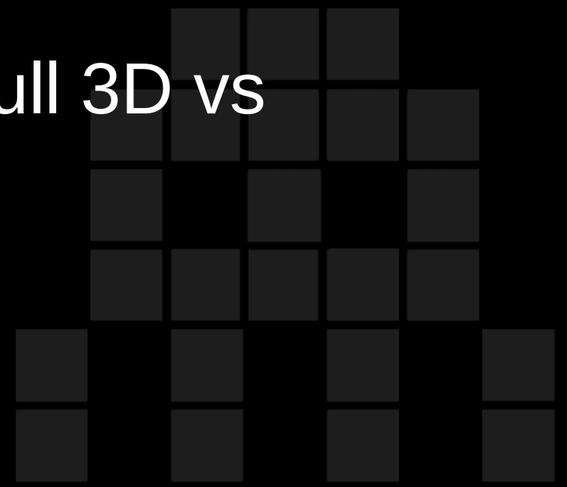
Definition

- *What is a data-driven renderer?*
  - Shaders, resource creation/manipulation and flow of the rendering pipe is defined entirely in data
  - Hot-reloadable - for minimal iteration times



Motivation

- Multiple projects with different needs
  - Projects targeting 60Hz will have a completely different rendering pipe than those targeting 30Hz
  - Artistic style: Photorealism vs Toon-shading, Full 3D vs 2.5D, etc.



Early prototype of a
60Hz rendering pipe
(Running on PS3)

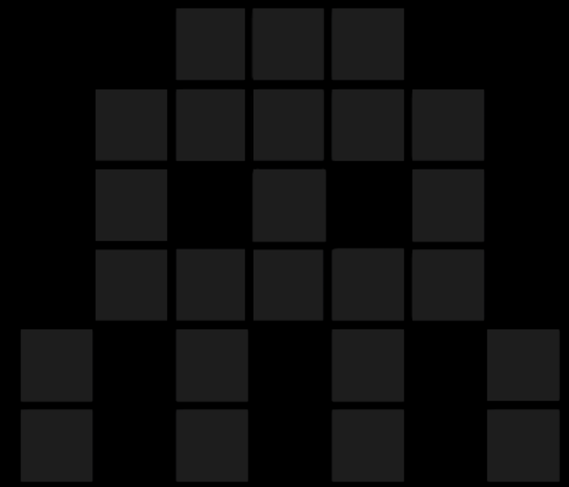
- Baked AO
- HDR but no light-adaption
- Simplified post processing

Content from ”The Fight: Lights Out”
Courtesy of Coldwood Interactive and SCEE

Motivation cont.

- Flexibility: Easy debugging and experimentation
- Scalability: Targeting a wide range of HW requires a rendering pipe that scales
- Game context aware rendering pipe – e.g. stop rendering sun shadows when indoors, simplify rendering in split-screen, etc.
- High-level render pipe code not performance critical

.. is very different from ..



Hamilton’s Great Adventure (PS3)
Courtesy of Fatshark

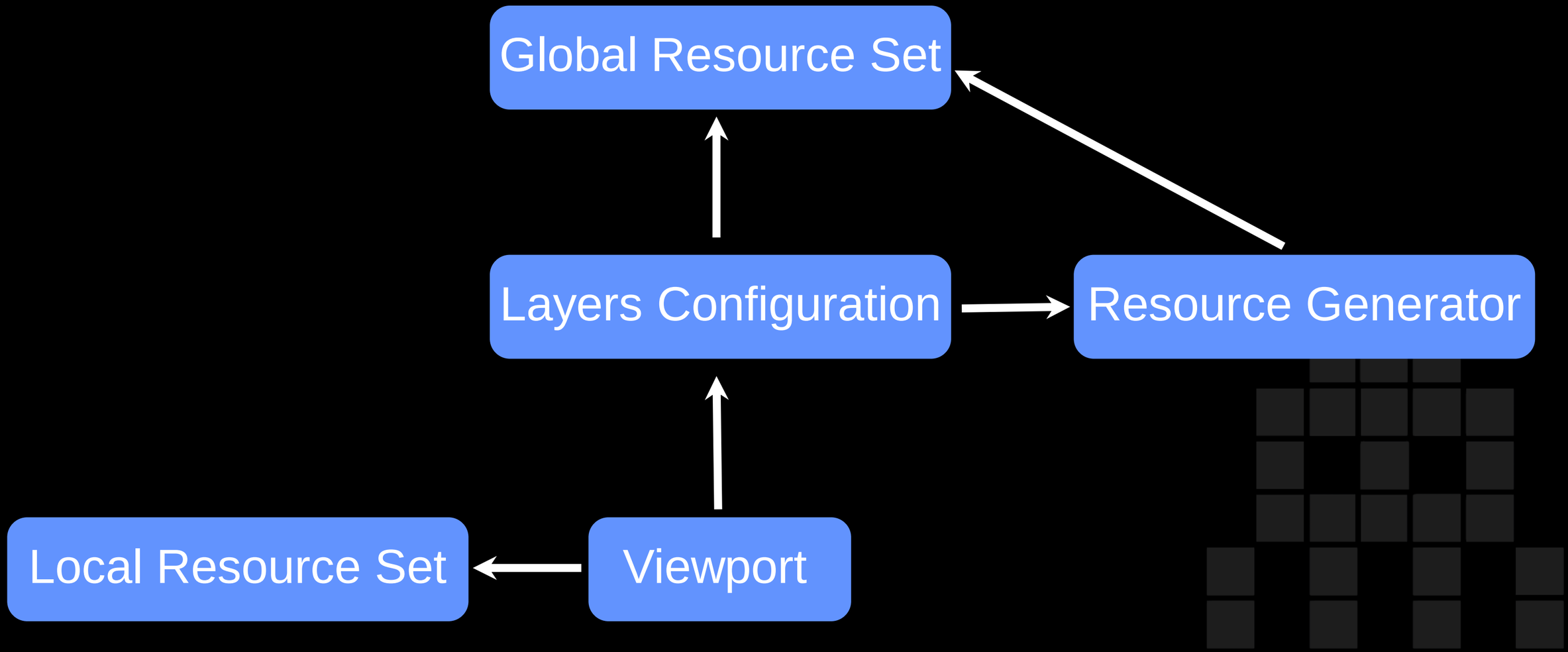
Hamilton’s Great Adventure (PS3)
Courtesy of Fatshark

Implementation

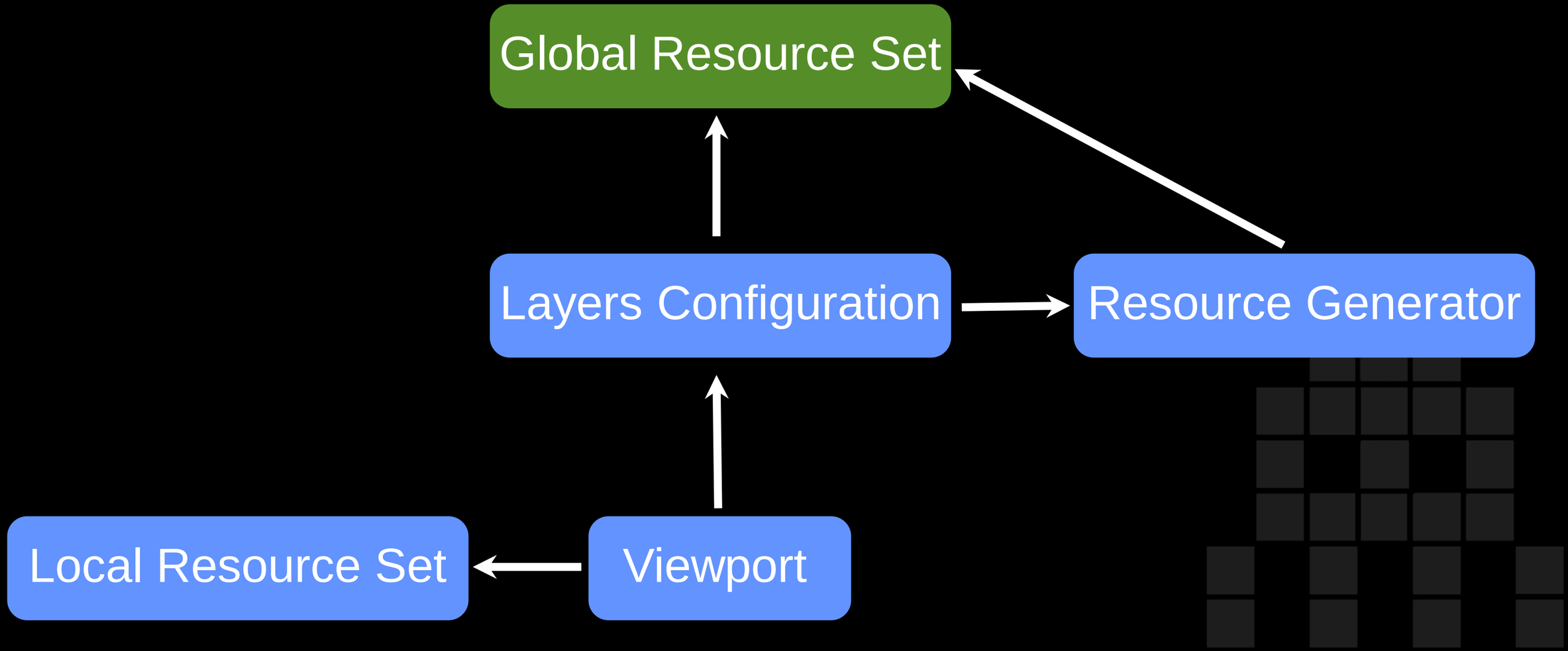
- The *render_config* file:
  - JSON* configuration file describing the entire rendering pipe
  - Supports hot-reloading

* Well, not really JSON. We call it SJSON:
http://bitsquid.blogspot.com/2009/10/simplified-json-notation.html

Overview of render_config



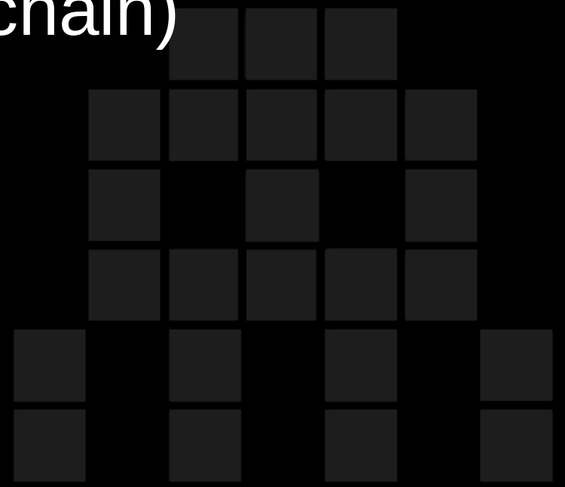
Global Resource Set



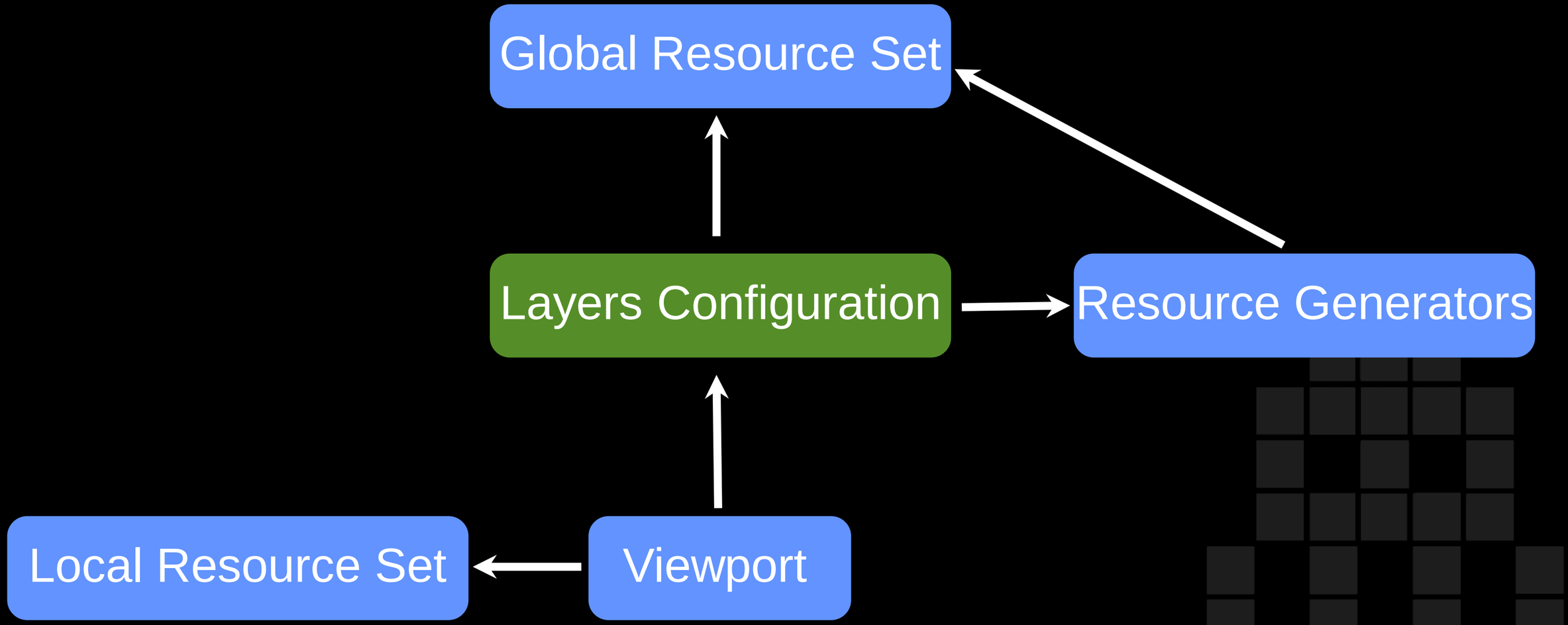
Global Resource Set

```
global_resources = [
    { name = "depth_stencil_buffer" type="render_target" depends_on = "back_buffer" w_scale=1 h_scale=1 format="D24S8" hint_needs_clearing = true }
    { name = "albedo" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R8G8B8A8" hint_needs_clearing = false}
    { name = "normal" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R8G8B8A8" hint_needs_clearing = false}
    { name = "depth" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R32F" hint_needs_clearing = false}
    { name = "mask" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R8G8B8A8" hint_needs_clearing = false}
    { name = "light_accumulation" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R16G16B16A16" hint_needs_clearing = true}
    { name = "self_illumination" type="render_target" depends_on = "back_buffer" w_scale = 1 h_scale = 1 format = "R8G8B8A8" hint_needs_clearing = true}
```

- Specifies GPU resources to be allocated at start-up
- Mainly render targets (all global RTs except swap-chain)
- Resources identified by name

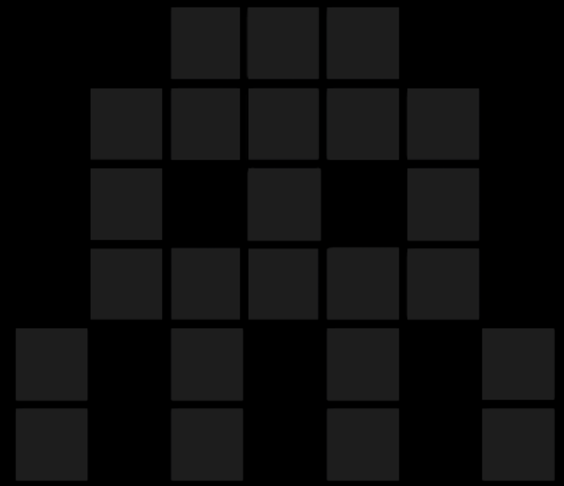


Layers Configuration



Layers Configuration

- Defines the draw order of the visible batches in a game world
- Layers are processed in the order they are declared
- Shader system points out which layer to render in



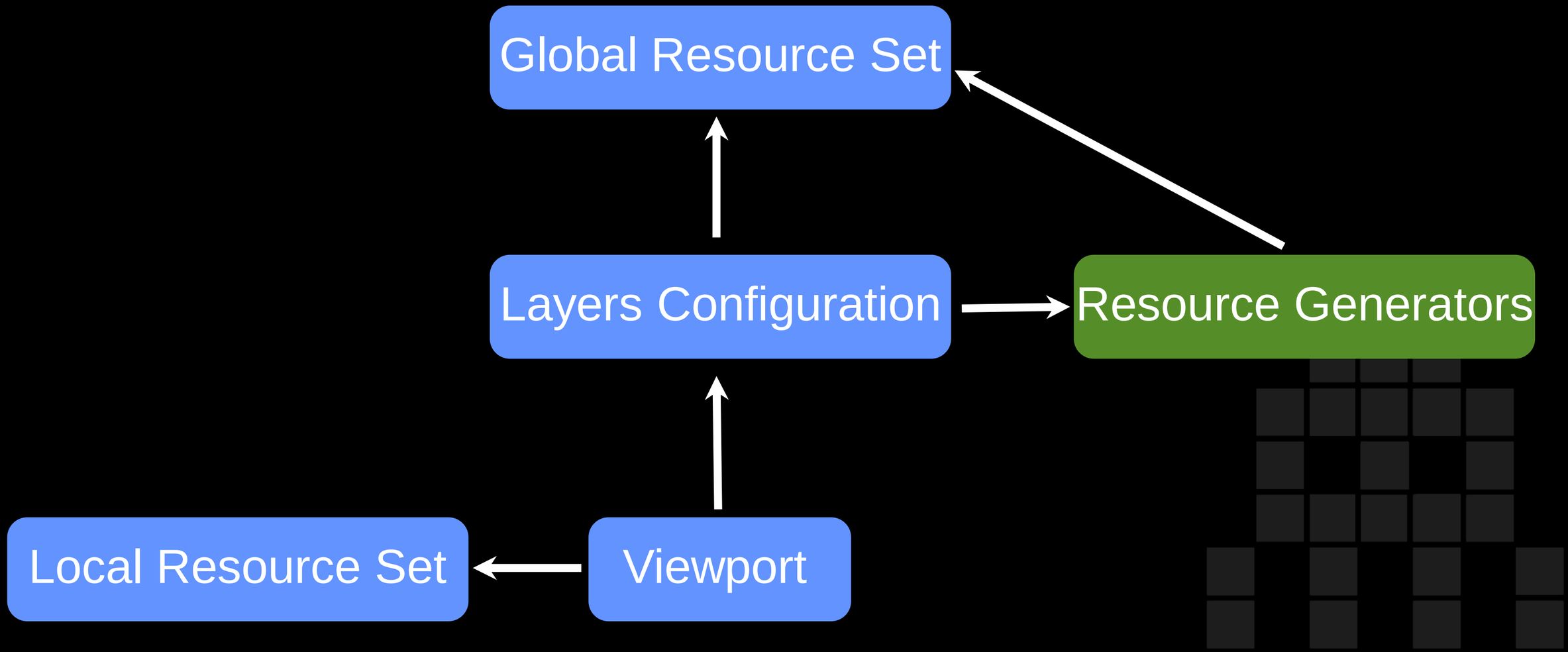
Layer Breakdown

```
default = [
    { name = "depth_prepass" depth_stencil_target="depth_stencil_buffer" sort="FRONT_BACK" }
    { name = "gbuffer" render_targets="albedo normal" depth_stencil_target="depth_stencil_buffer" sort="FRONT_BACK" profiling_scope="gbuffer"}
    { name = "deferred_shading" resource_generator = "deferred_shading" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" profiling_scope="lighting&shadows" }
    { name = "skydome" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" sort="BACK_FRONT" profiling_scope="skydome" }
    { name = "reflections" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" sort="FRONT_BACK" profiling_scope="reflections" }
    { name = "fog_apply" resource_generator = "fog_apply" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" profiling_scope="fog" }
    { name = "semi_transparency" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" sort="BACK_FRONT" profiling_scope="semi_transparency" }
    { name = "transparent" render_targets="light_accumulation" depth_stencil_target="depth_stencil_buffer" sort="BACK_FRONT" profiling_scope="transparent" }
    { name = "tone_mapping" resource_generator = "tone_mapping" render_targets="back_buffer" depth_stencil_target="depth_stencil_buffer" profiling_scope="tone_mapping" }
    { name = "post_processing" resource_generator = "post_processing" render_targets="back_buffer" depth_stencil_target="depth_stencil_buffer" profiling_scope="post_processing" }
```

- Name used for referencing from shader system
- Destination render targets (& DST) for the layer batches
- Depth sorting: front-to-back / back-to-front
- Optional Resource Generator* to run

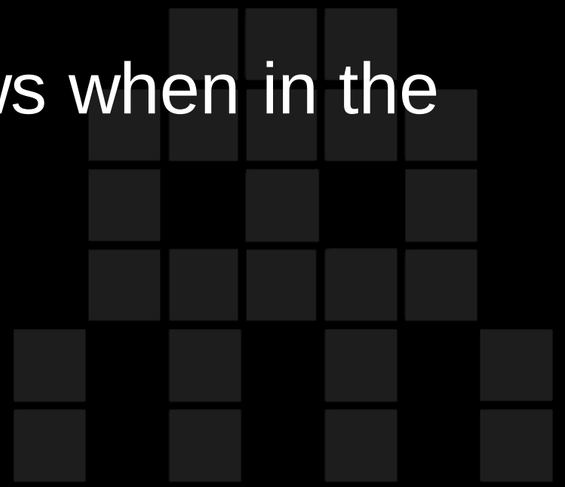
* More on Resource Generators in the coming slides

Resource Generators



Resource Generators

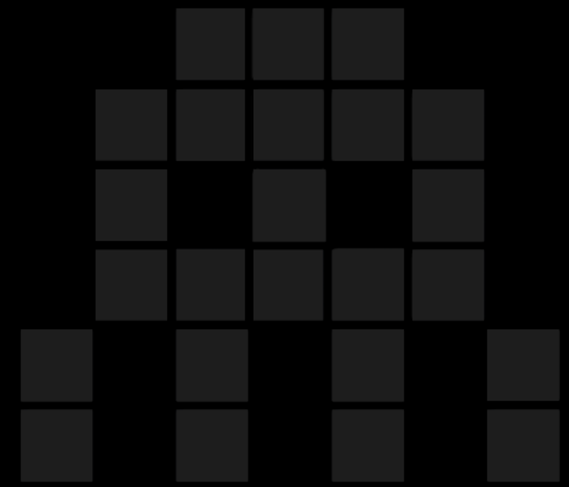
- Minimalistic framework for manipulating GPU resources
- Used for post processing, deferred shading, shadow maps, procedural texture effects, debug rendering, and much more..
- Simple design - just a queue of *Modifiers* that knows when in the frame to run



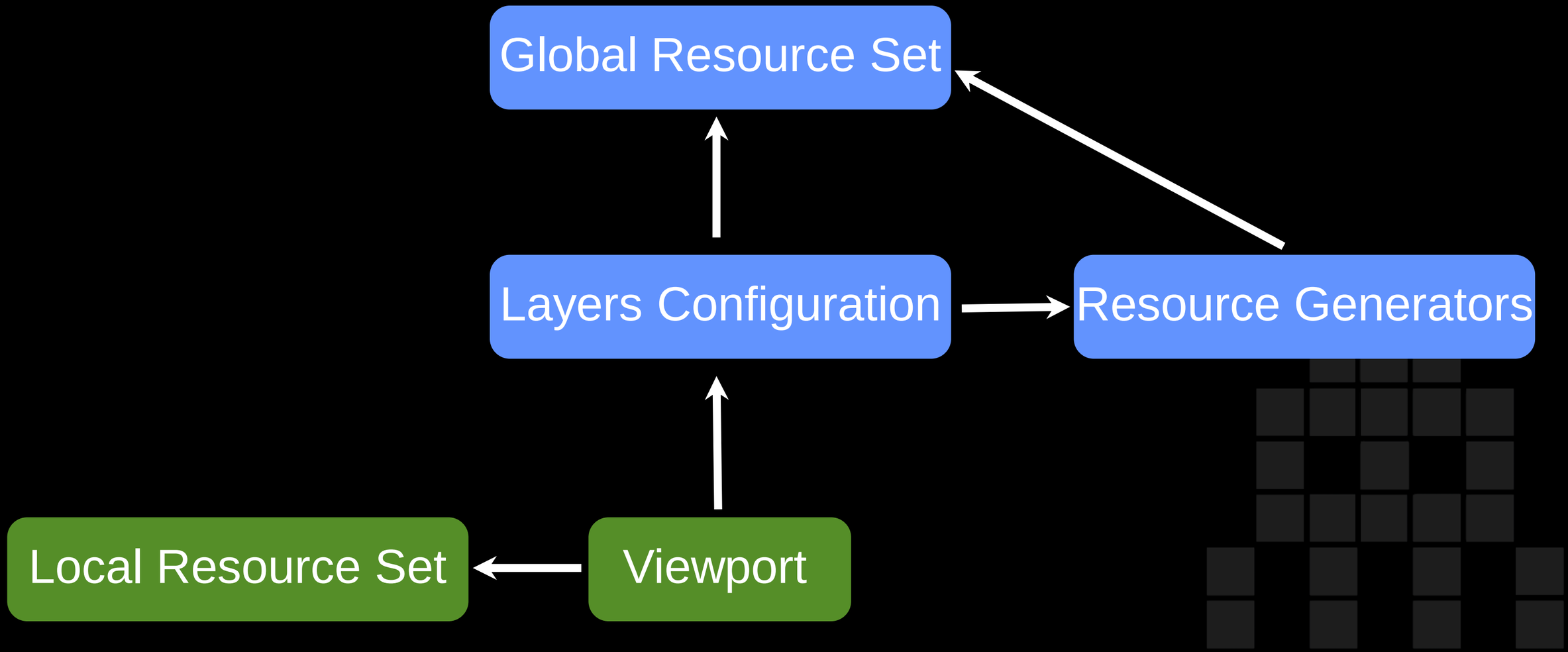
Resource Generators

Example of a few *Modifiers*

- Fullscreen Pass
- Deferred Shading
- Shadow Mapping
- Compute Shader [DX11]
- SPU Job [PS3]
- Branch

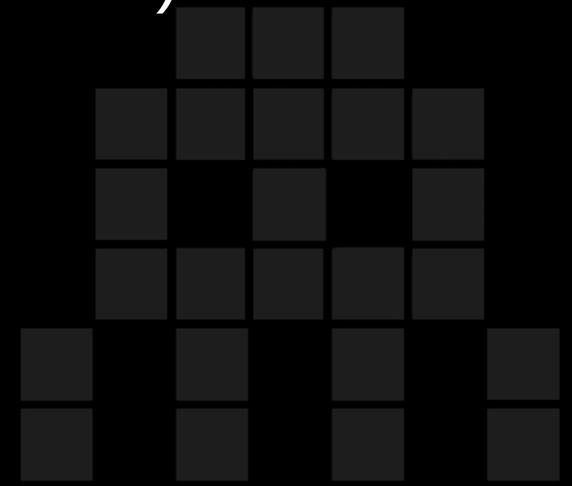


Viewport


Global Resource Set
Layers Configuration
Resource Generators
Local Resource Set
Viewport

Viewport

- Ties everything together
- Specifies which layer configuration to use
- Local resource set - resources unique for each instance of a viewport (useful for stuff like current adapted luminance)
- GP programmer renders a game world by calling
  - render_world(world, camera, viewport)



Questions?

tobias.persson@bitsquid.se

http://www.bitsquid.se

http://bitsquid.blogspot.com