



3DServices

Scalable GPU computing service architecture - GTC-S0261



Hinnerup Net
www.hinnerup.net

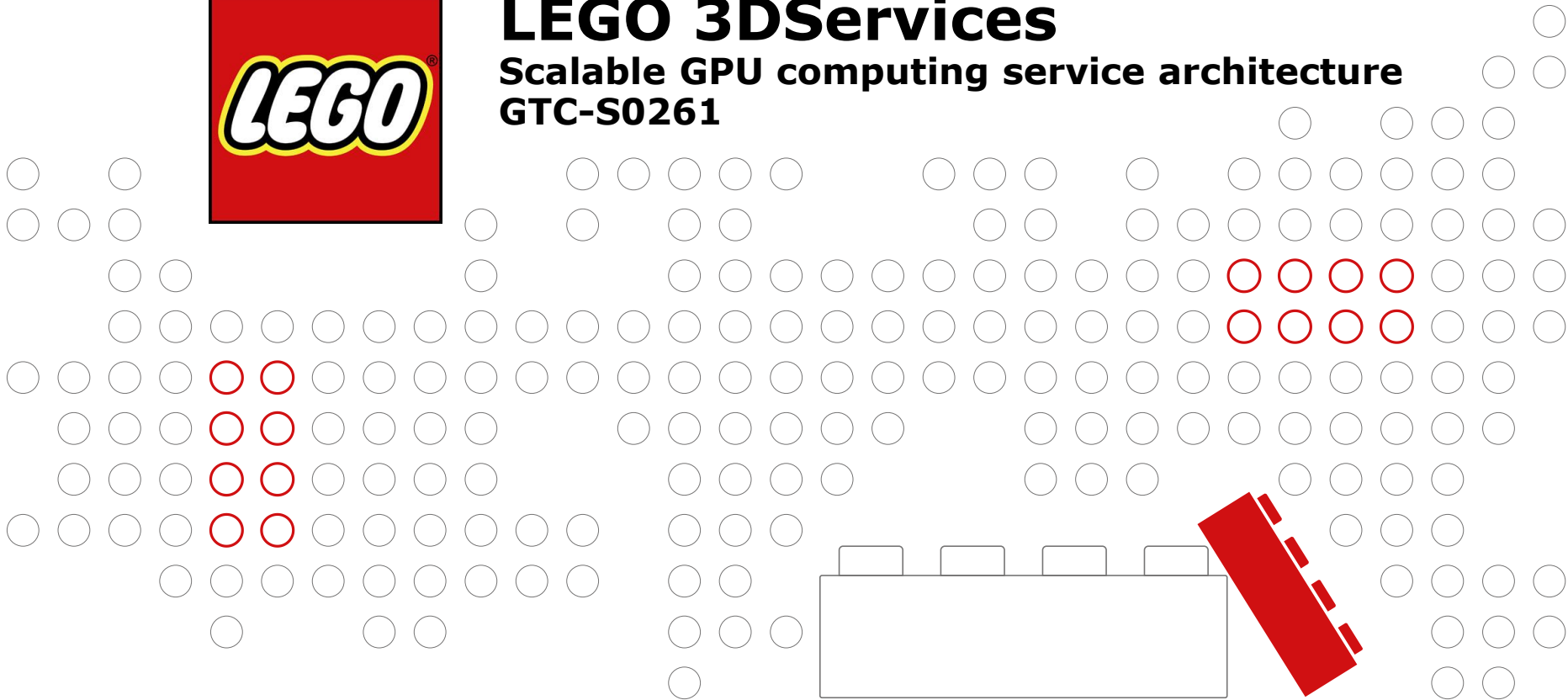




LEGO 3DServices

Scalable GPU computing service architecture

GTC-S0261

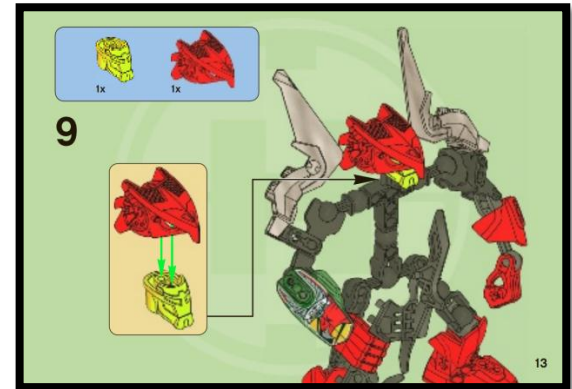




Project Background

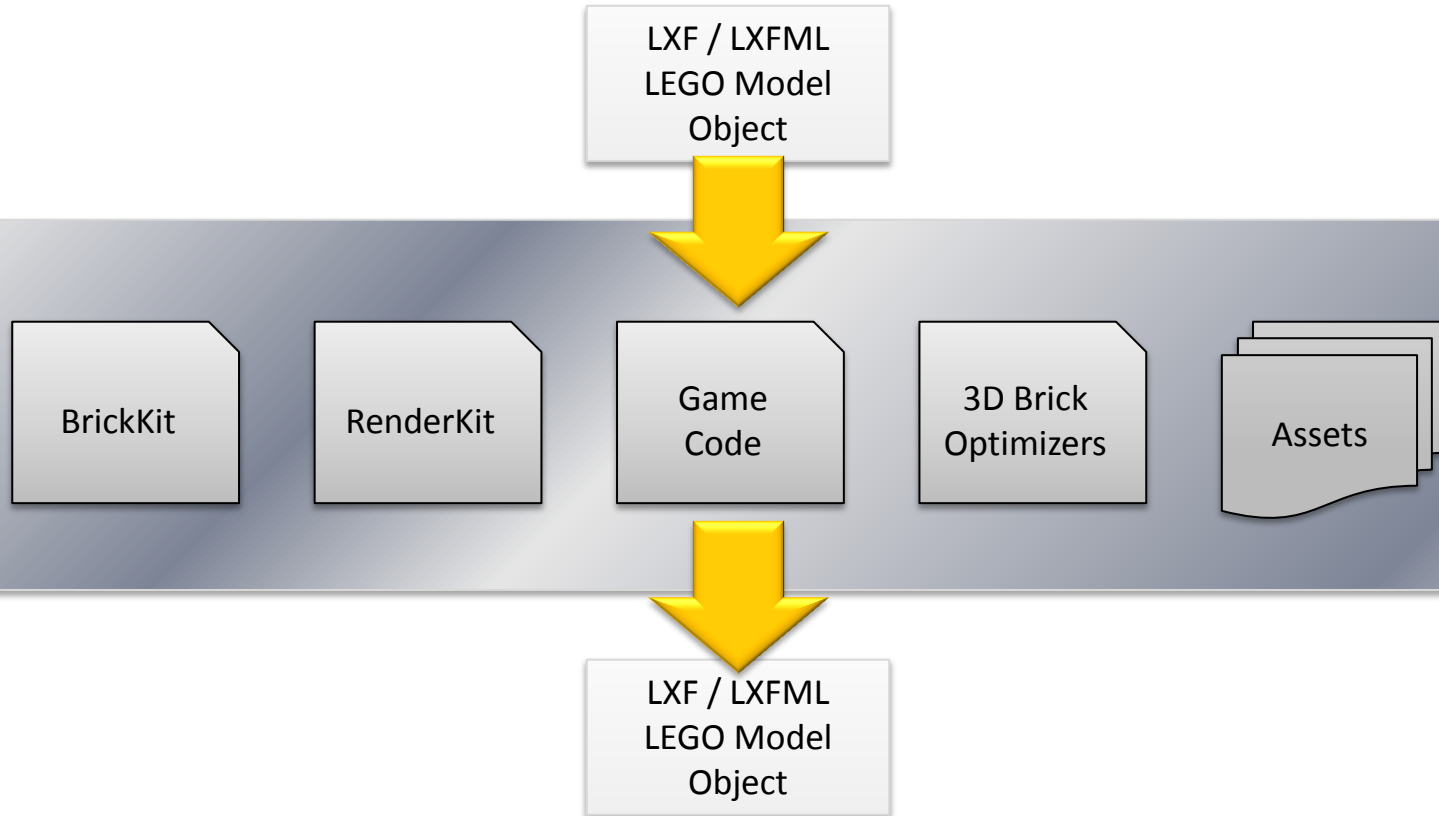


- Customized Content Experiences
- Game Experiences
- Building Experiences
- Improved Online Shopping Experience
- In-House HPC platform (CPU/GPGPU)
- In-House Digital Design Software





Reusing LEGOs 3D technology



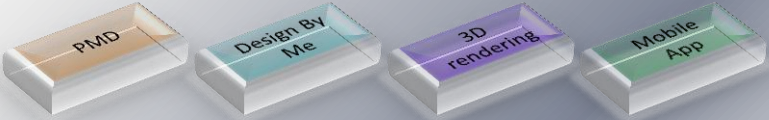


Technology Strategy

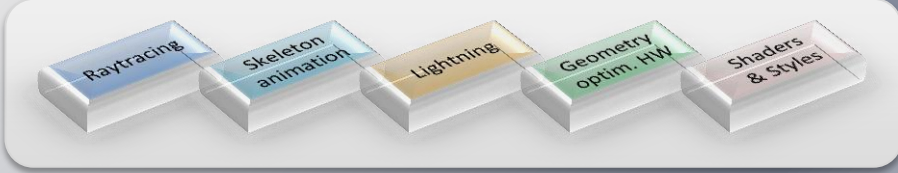
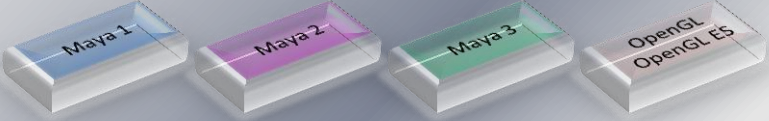
In-house rendering technologies

New digital platform

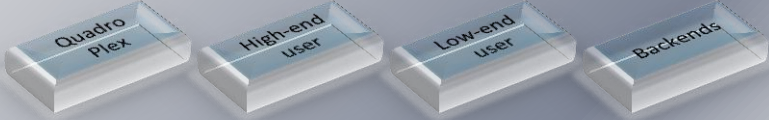
Applications



Technology



Platform



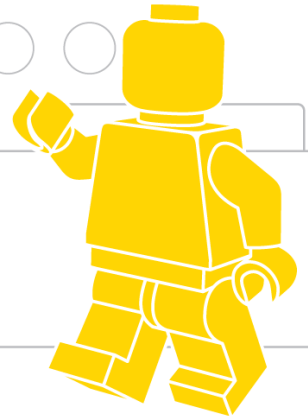
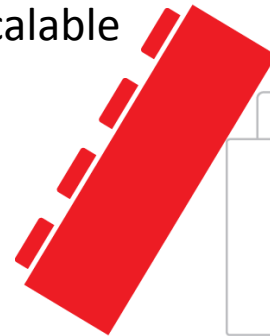
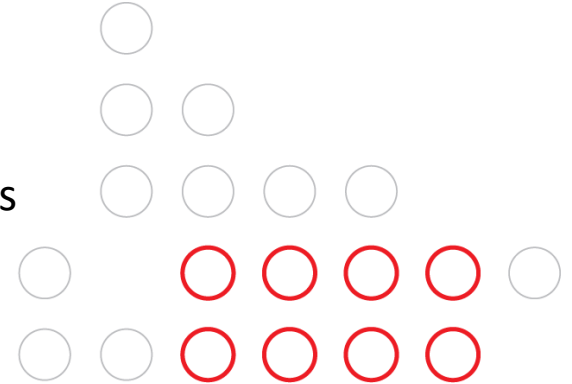
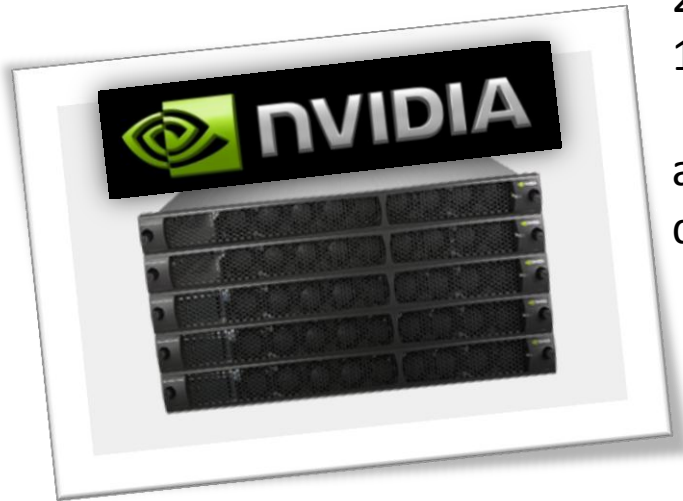


LEGO 3DServices setup consists of 16 x NVIDIA Quadro Plex 2200 S4 servers

Totalling in:

64 x Quadro FX 5800 GPUs
256 Gb GPU memory
15.360 x CUDA cores

as one expandable/scalable
distributed system

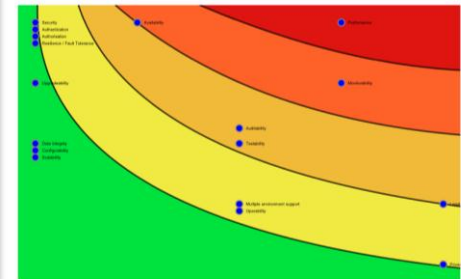


Distributed and Scalable system



DEV: 1 server
QA: 1 server
STAGING: 2 servers
LIVE: 12 servers

4 processes / server
~50.000 CCUs



Web Based UI

Client Application	<input type="text" value="UGCC150"/>
Client Model Id	<input type="text" value="1501152921509921390201"/>
Model Name	<input type="text" value="LEGO Universe Model"/>
Model Version	<input type="text" value="0"/>
Created By LEGO ID	<input type="text" value="efeee793-5fdb-4d6a-9386-92dd7a761c55"/>
Created DateTime	<input type="text" value="11/26/2011 4:54:54 PM"/>
Received DateTime	<input type="text" value="11/26/2011 4:53:36 PM"/>
Superseded	<input type="text" value="False"/>
LXFML	<input type="button" value="Download LXFML"/> <input type="button" value="Download LXF"/> <small>(LXFML size: 764)</small>

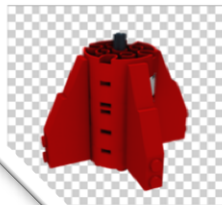
Requested Model Output Types:

Output Type	Requested	Started	Error	Completed	
IMAGE128DDS	11/26/2011 4:53:36 PM	12/6/2011 12:06:46 PM		12/6/2011 12:06:46 PM	<input type="button" value="Reset"/>
LUMODELIMAGE	11/26/2011 4:53:36 PM	12/6/2011 12:06:46 PM		12/6/2011 12:06:47 PM	<input type="button" value="Reset"/>
3DOPTIMIZED	11/26/2011 4:53:36 PM	12/6/2011 12:06:48 PM		12/6/2011 12:06:52 PM	<input type="button" value="Reset"/>

Generated Output Files:

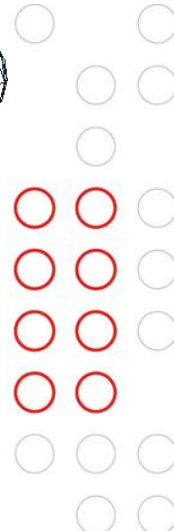
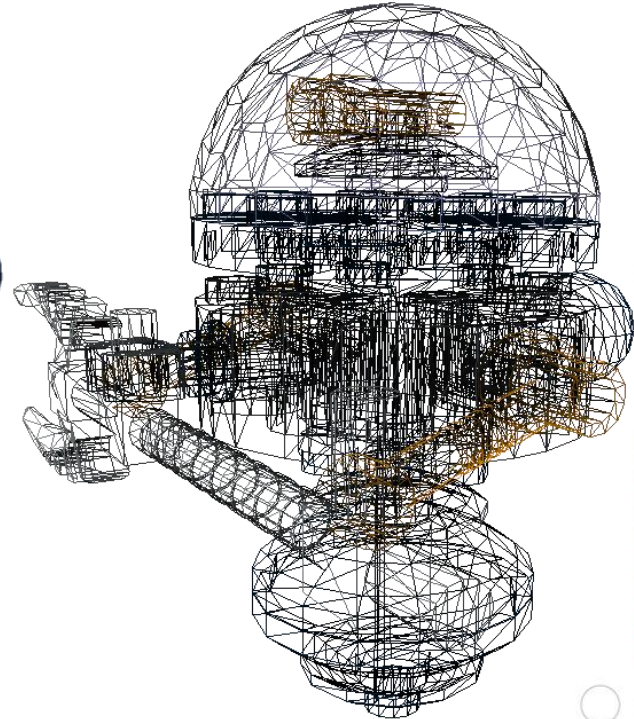
Output Type	File Type	Ordinal	File Size	Compressed File Size	Created
IMAGE128DDS	DDS	1	22000	6180 (15820 saved)	12/6/2011 12:06:46 PM
LUMODELIMAGE	PNG	1	64320	63988 (332 saved)	12/6/2011 12:06:47 PM
3DOPTIMIZED	HGX	1	56736	9414 (47322 saved)	12/6/2011 12:06:52 PM
3DOPTIMIZED	NIF	1	577021	161435 (415586 saved)	12/6/2011 12:06:52 PM

Assets thumbnails and image links:





The Complexity of LEGO Models



Moderation of User Generated Content

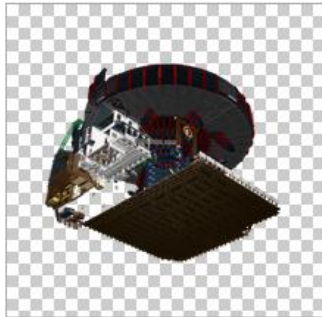
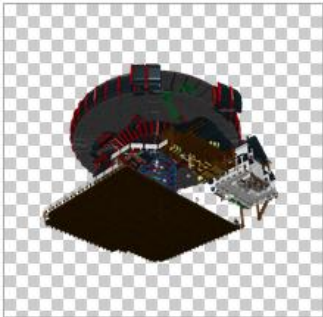


Moderation of User Generated Content





Moderation of User Generated Content

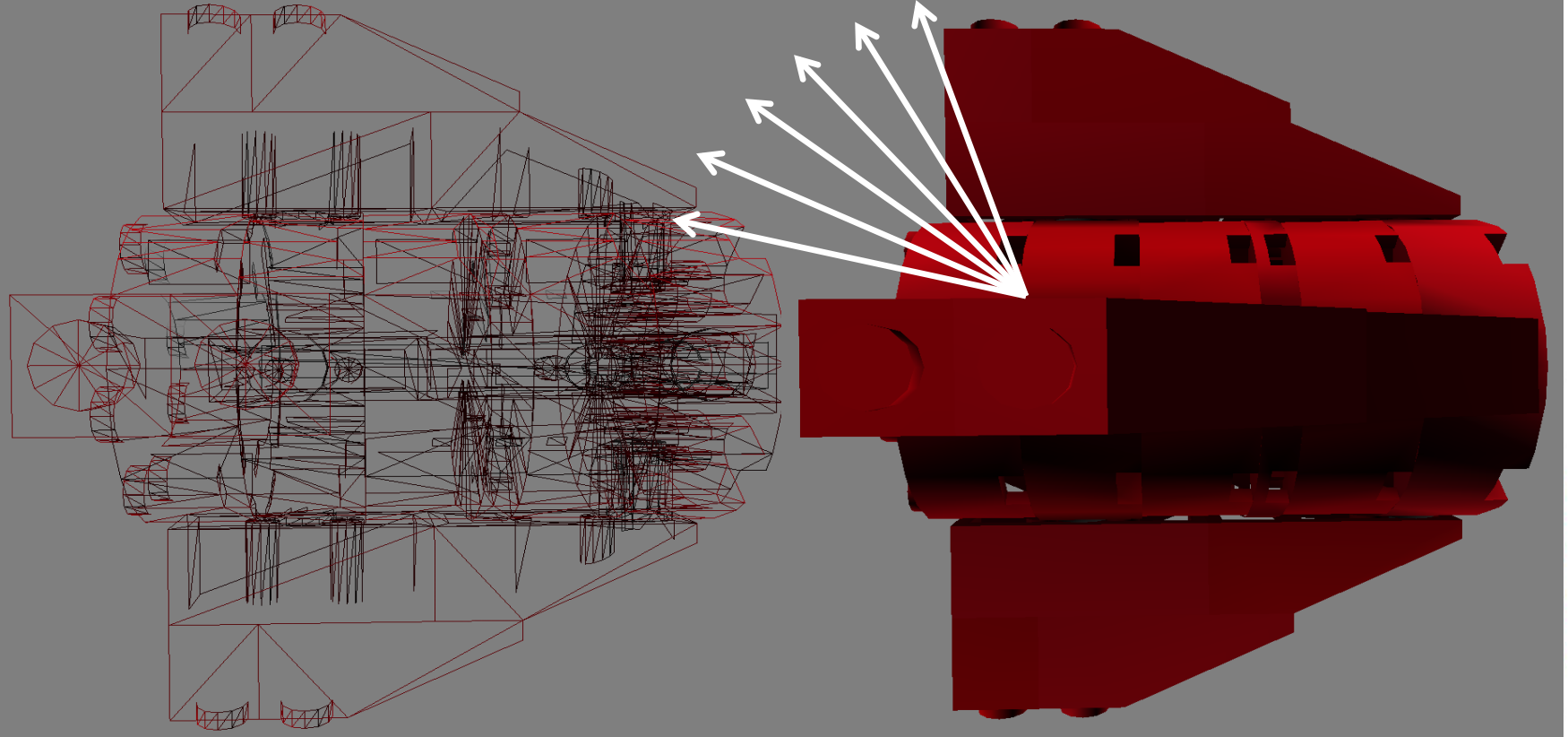


~1.650 revisions

~24.000 bricks 8+ Mb LFXML



Mesh Optimization



Mesh Optimization



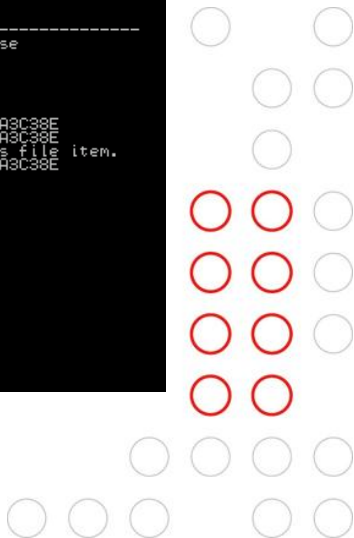
```
-----
INFO: ModelProcessorService will only save LXFML to database
INFO: Getting next queued item - 3D0PTIMIZED
FILEIO: Loading 940k-tower.lxfml
LXFML size: 960512
INFO: Model output id ... : 3F79CD1E-9302-42D5-8B9D-785910A3C38E
INFO: Model id ..... : 3F79CD1E-9302-42D5-8B9D-785910A3C38E
INFO: Test iteration. Stopping worker after processing this file item.
ACTION: Mesh optimizing model 3F79CD1E-9302-42D5-8B9D-785910A3C38E
LXFML size: 960512
Timestamp: 08:30:42:0981 ... Before ConvertModel COP.dll
--- LOD vertices : 312680
--- LOD vertices : 370569
--- LOD vertices : 269763
Done
run optix
Optimizing LOD 0:
Building Acceleration Structure...Done
Selected CUDA device after starting opti
Removing Hidden surfaces...Done
Optimizing LOD 1:
Building Acceleration Structure...Done
Selected CUDA device after starting opti
Removing Hidden surfaces...Done
Optimizing LOD 2:
Building Acceleration Structure...Done
Selected CUDA device after starting optix: 3
Removing Hidden surfaces...Done
Culling hidden triangles...[LOD0:72907] [LOD1:172296] [LOD2:111147] Done for re
Timestamp: 08:31:48:0969 ... After ConvertModel COP.dll
08:31:48
-----
INFO: ConvertModel result: 0
INFO: HKX bytes: 1448512
INFO: runOptimizers(...) returns 0
INFO: Skipping model data hardware optimization (disabled)
DLL: Generated HKX data (size = 1448512 bytes).
INFO:
08:31:49
-----
INFO: Generated NIF data (size = 23529054 bytes).
```



938 Kb LXFML
COP.dll w. OptiX
~ 1min 6sec

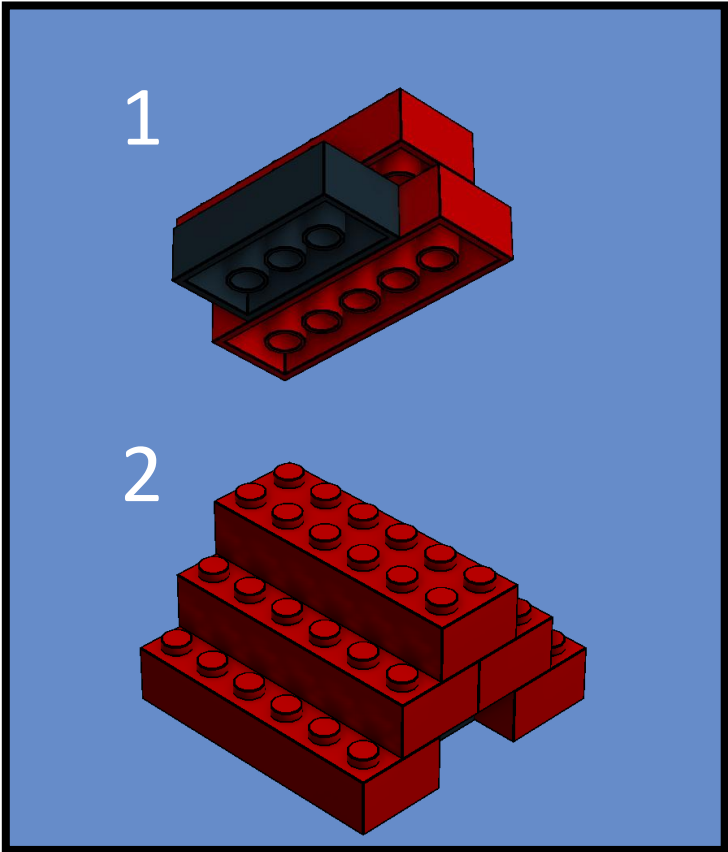
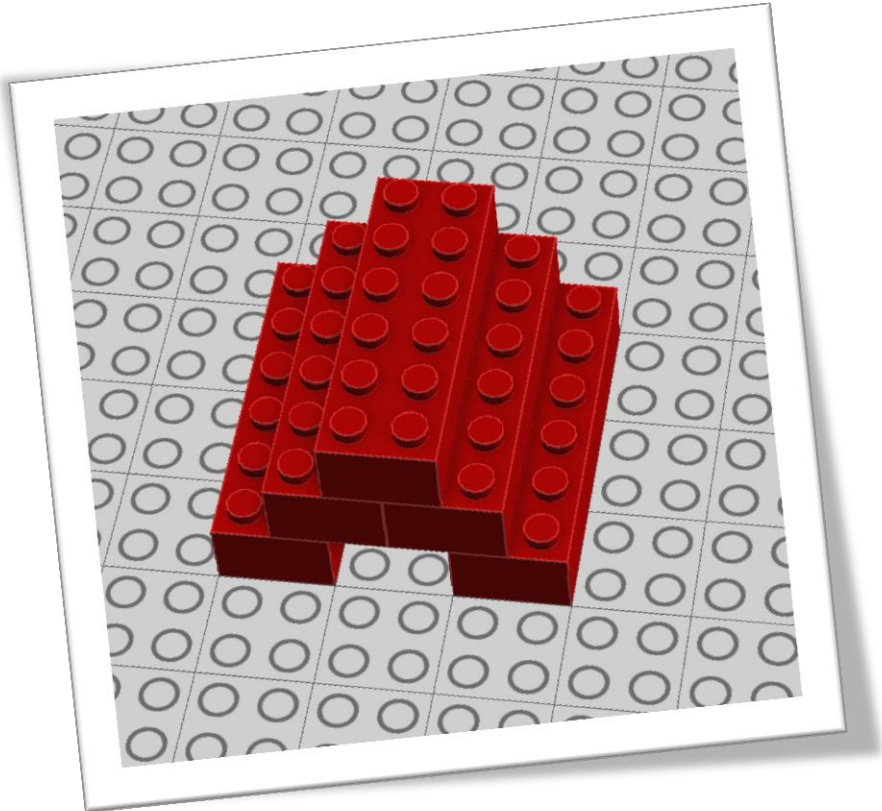
```
E:\TestWorkerNoOptix\worker /standalone /nocuda /nolxf2pics /1 /ignoreloaderrors
/test 940k-tower.lxfml
08:32:01
ACTION: Running service as standalone
-----
INFO: ModelProcessorService initializing.
INFO: Using test LXFML file: '940k-tower.
DLL: CUDA/OptiX nVidia hardware optimiza
DLL: COP-OptiX-Lib.dll functions not loa
INFO: Setting COP DB path to E:\TestWorke
08:32:02
-----
DLL: COP.dll has been initialized
INFO: ModelProcessorService will use COP mesh optimizer
INFO: ModelProcessorService will not use Lxf2Pics renderer
INFO: ModelProcessorService initialized.
-----
INFO: ModelProcessorService will only save LXFML to database
INFO: Getting next queued item - 3D0PTIMIZED
FILEIO: Loading 940k-tower.lxfml
LXFML size: 960512
INFO: Model output id ... : 3F79CD1E-9302-42D5-8B9D-785910A3C38E
INFO: Model id ..... : 3F79CD1E-9302-42D5-8B9D-785910A3C38E
INFO: Test iteration. Stopping worker after processing this file item.
ACTION: Mesh optimizing model 3F79CD1E-9302-42D5-8B9D-785910A3C38E
LXFML size: 960512
Timestamp: 08:32:02:0276 ... Before ConvertModel COP.dll
Timestamp: 09:35:36:0960 ... After ConvertModel COP.dll
09:35:36
-----
INFO: ConvertModel result: 0
INFO: HKX bytes: 1448512
INFO: runOptimizers(...) returns 0
DLL: Skipping model data hardware optimization (disabled)
INFO: Generated HKX data (size = 1448512 bytes).
-----
09:35:37
-----
INFO: Generated NIF data (size = 25025792 bytes).
```

Same LEGO model
COP.dll wo. OptiX
~ 1hr 3min 34sec



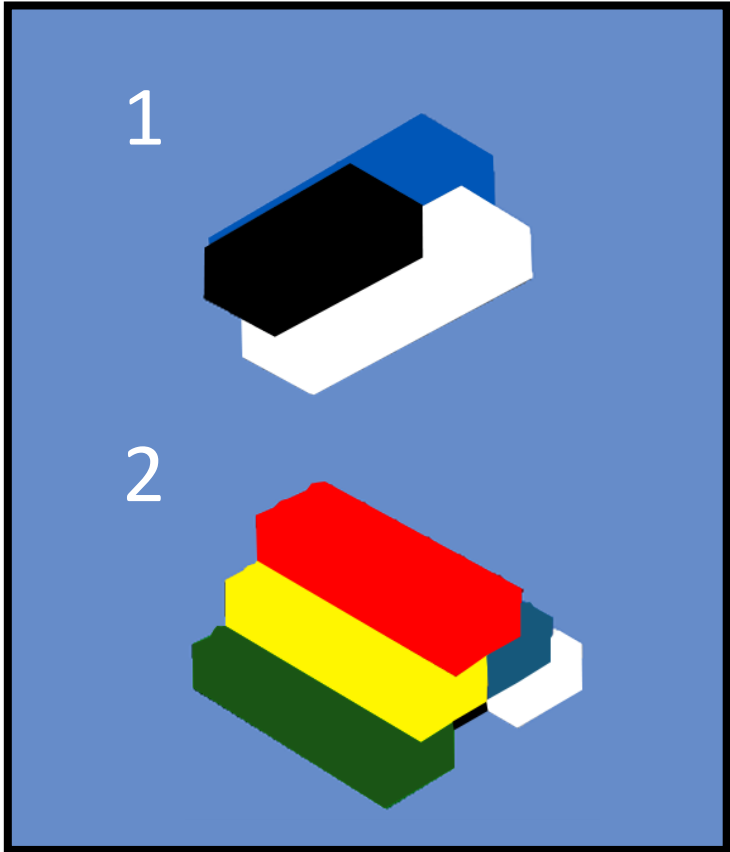
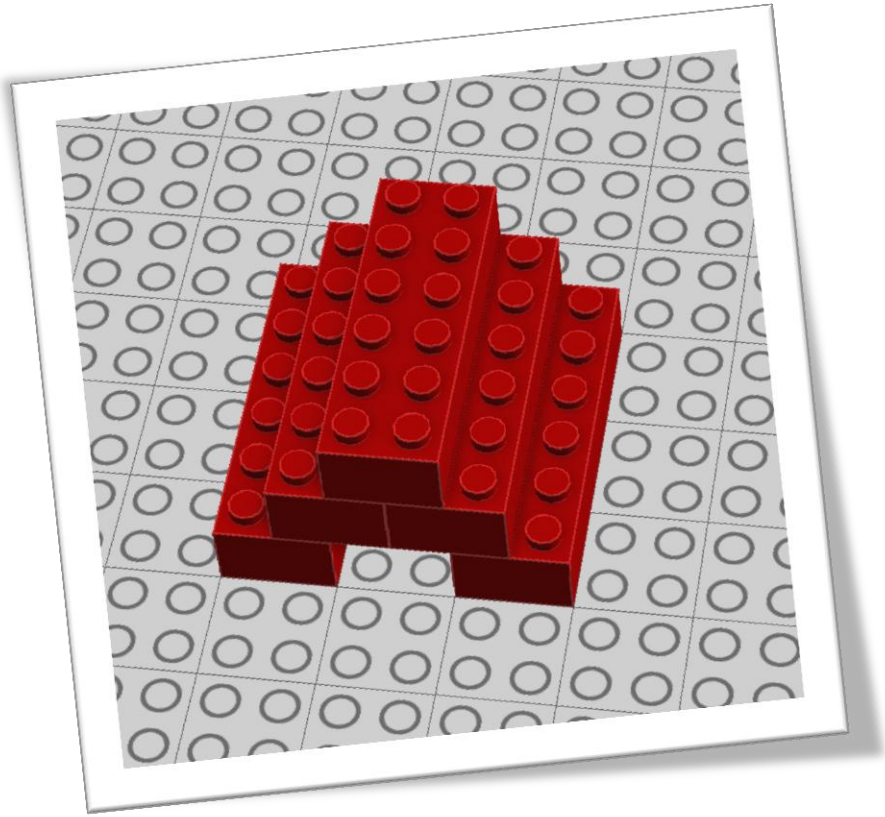


Building Guide Generation





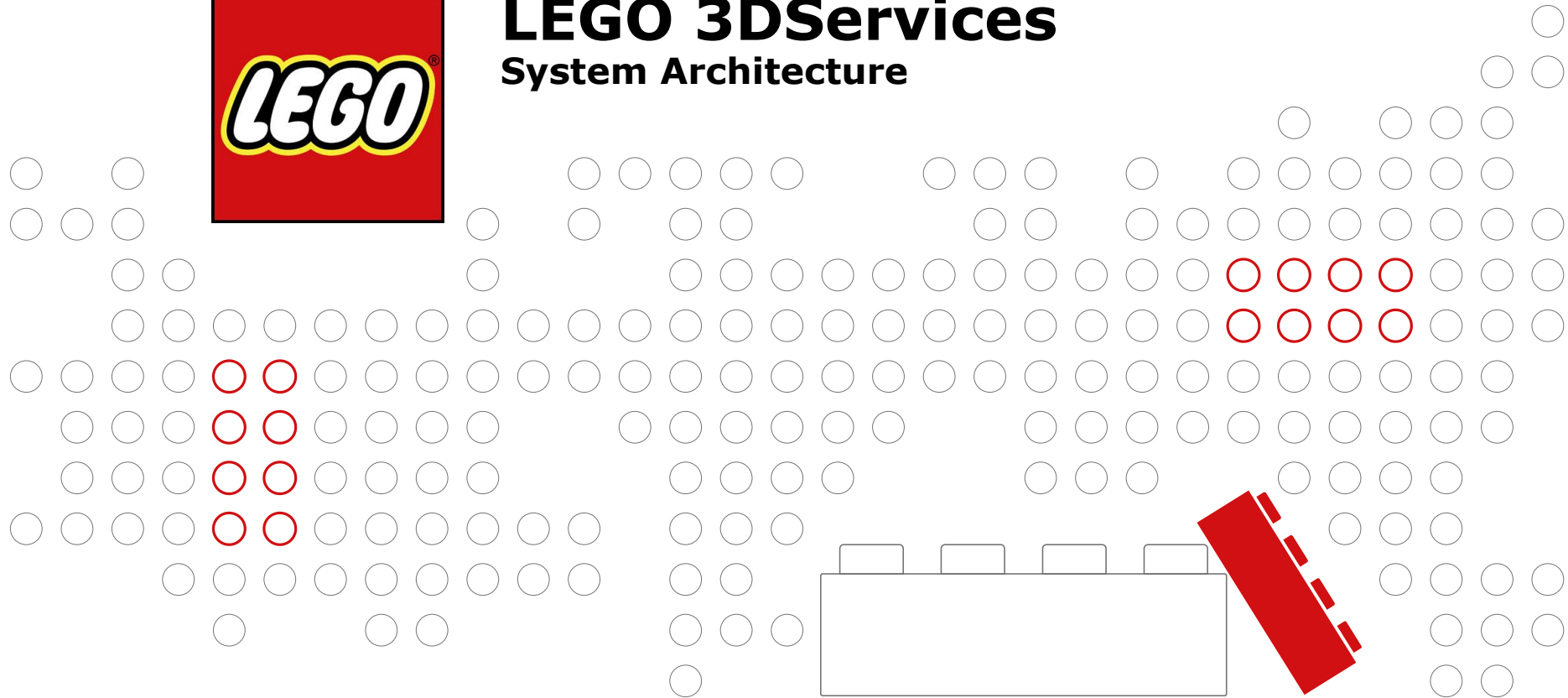
Building Guide Generation





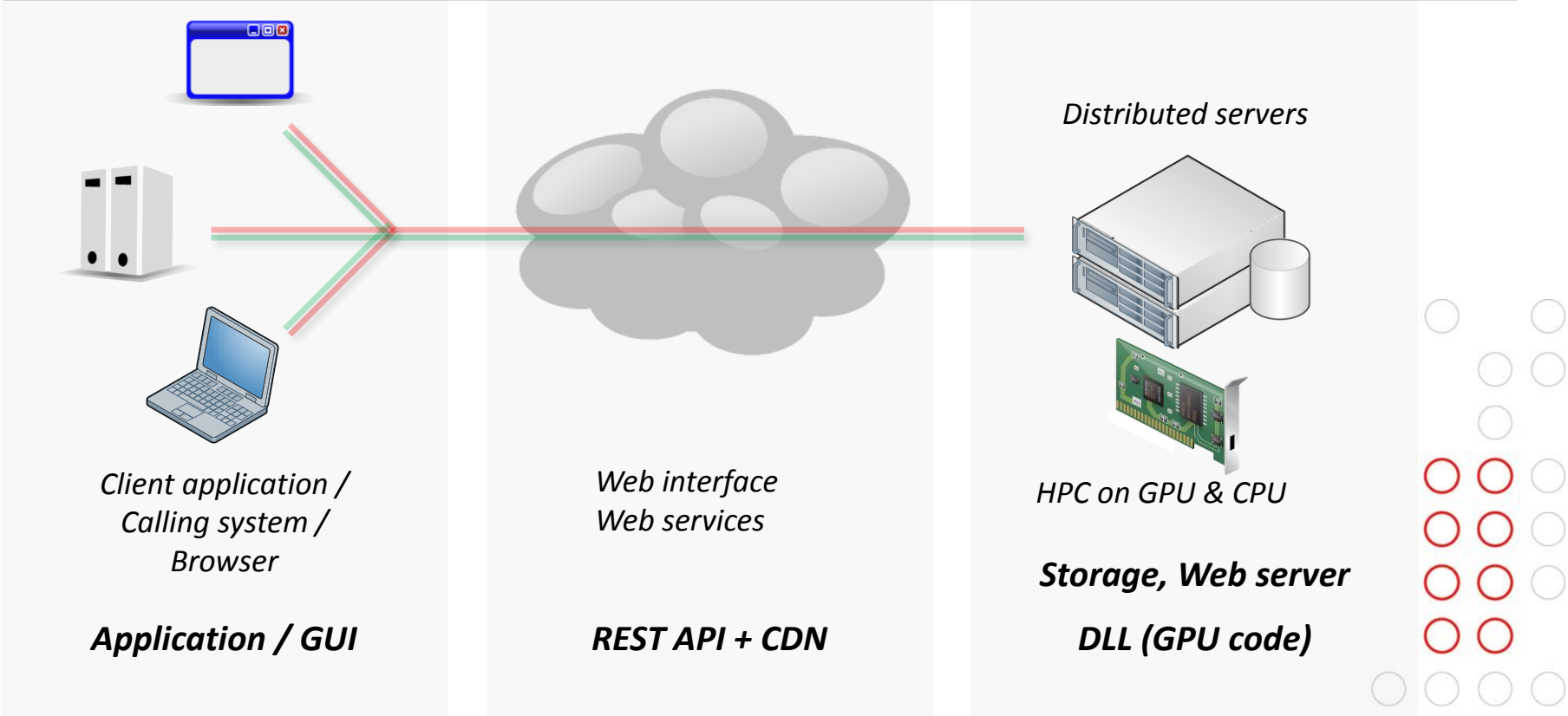
LEGO 3DServices

System Architecture





System Architecture

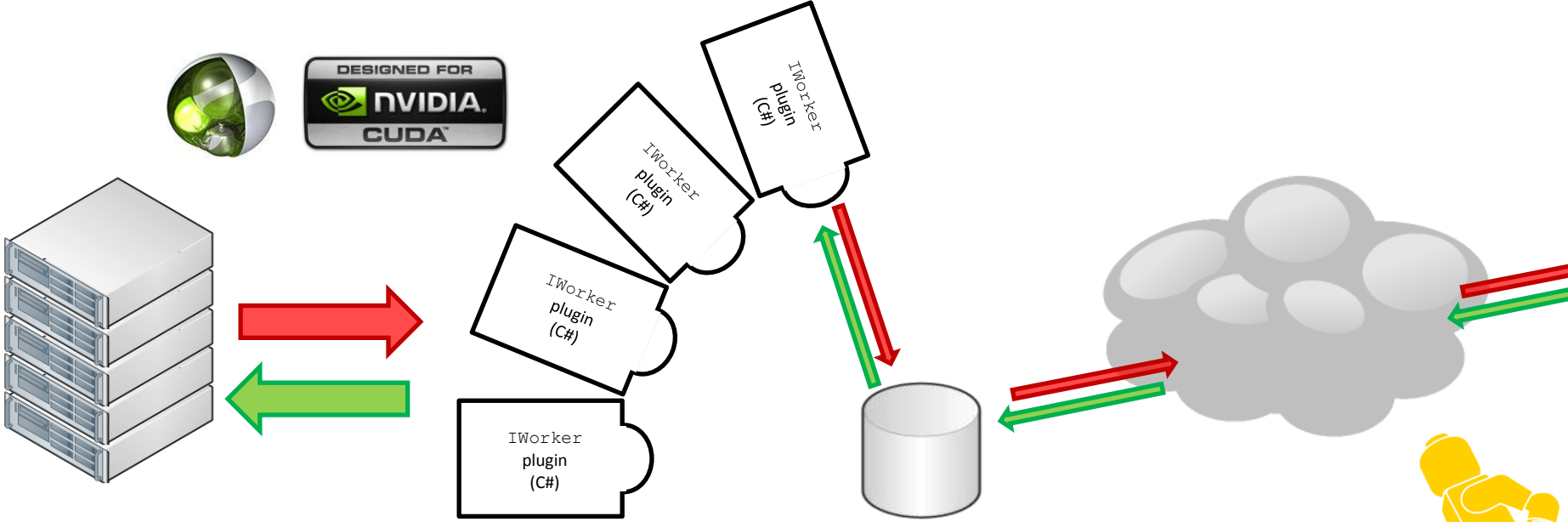


System Architecture





System Architecture



Worker Servers

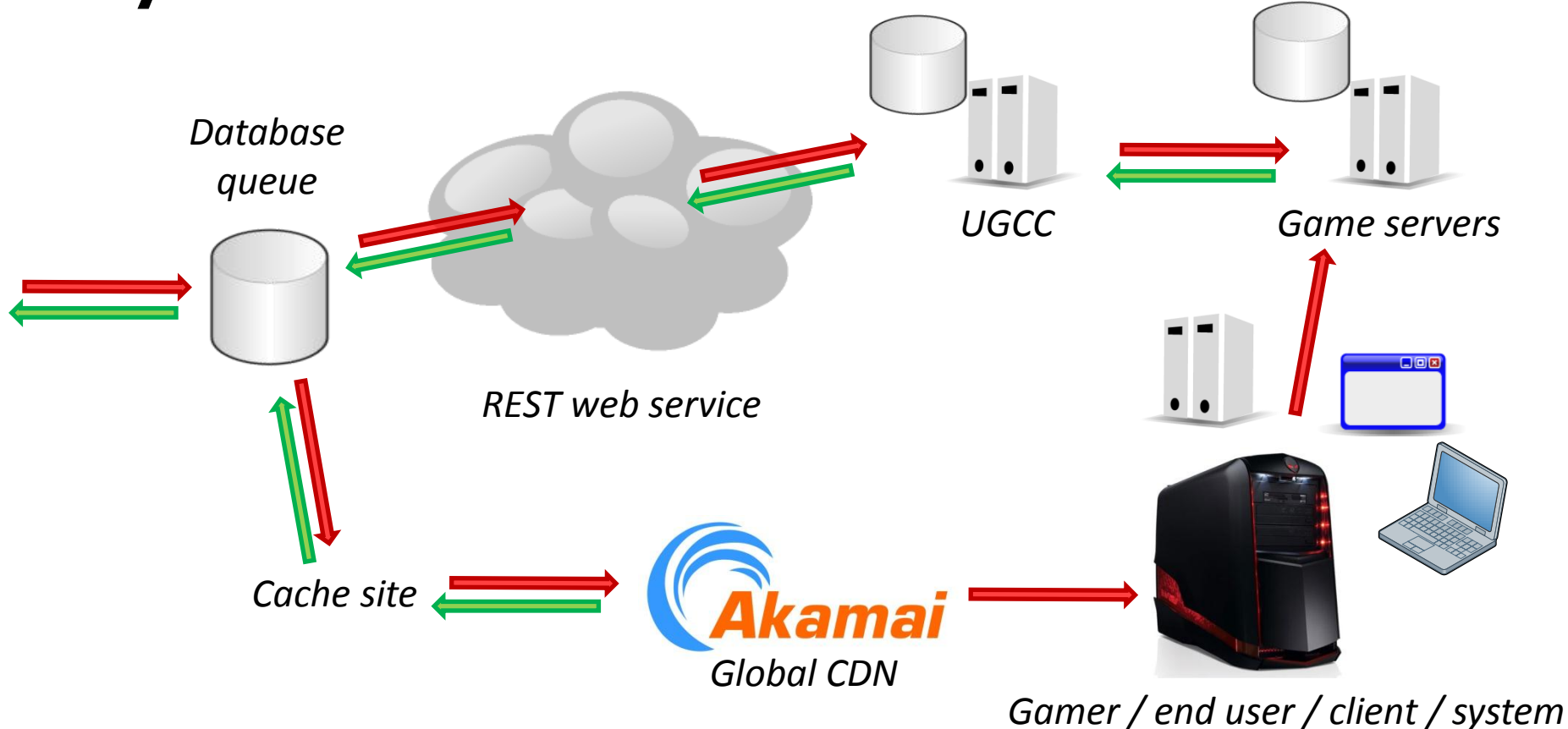
Worker processes

REST web service



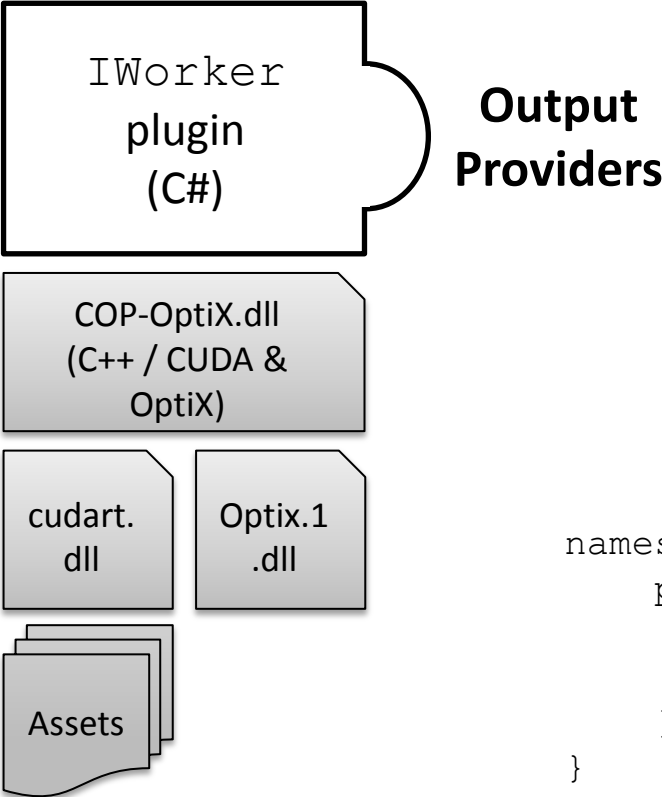


System Architecture

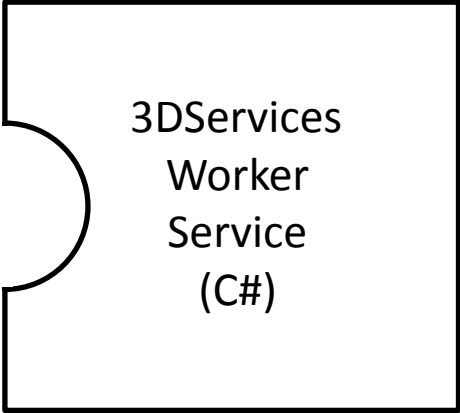




System Architecture



Technology Platform



```
namespace LEGO.DDDServices.Worker.Entities {  
    public interface Iworker {  
        void ProcessModel(Model model);  
        void Close();  
    }  
}
```



System Architecture

```
.. public void ProcessModel (Model model)
.. {
..... if (!_initialized)
..... {
..... throw new WorkerException ("Building Guide Generator has not been initialized.");
..... }

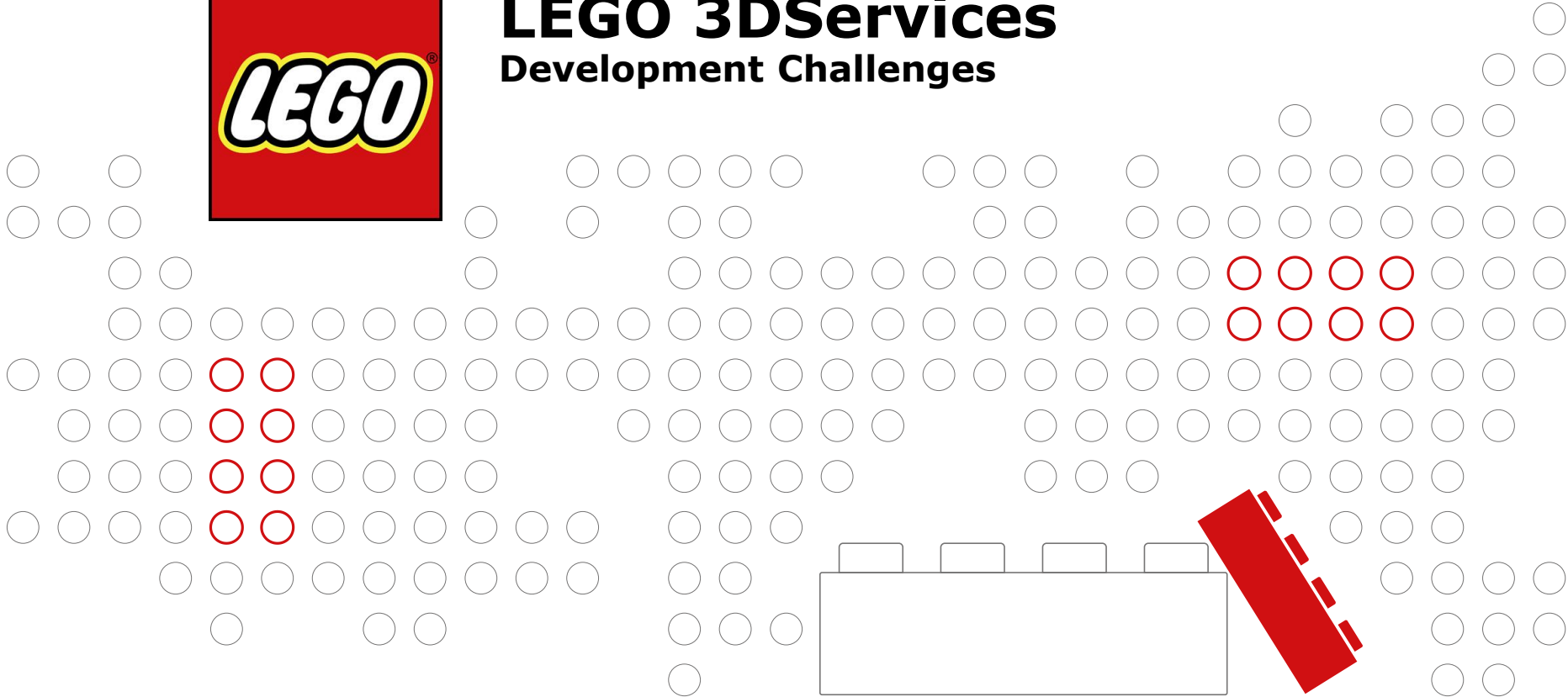
..... var outputLxfml = GetBuildingGuideLxfml (model);
..... var encoding = new ASCIIEncoding ();
..... var bggLxfml = encoding.GetBytes (outputLxfml);

..... model.ModelOutput.AddFileOutput (new FileOutput (bggLxfml)
..... {
..... ErrorDescription = "",
..... Extension = Extension.lxfml,
..... Ordinal = 0
..... });
```



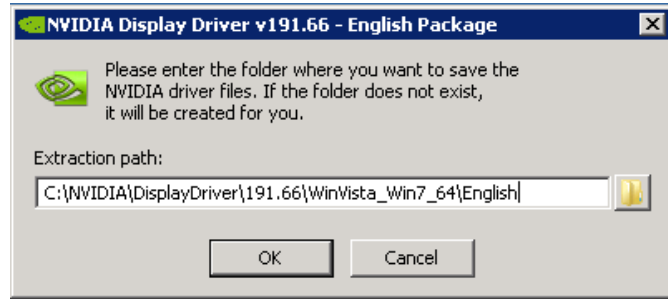
LEGO 3DServices

Development Challenges

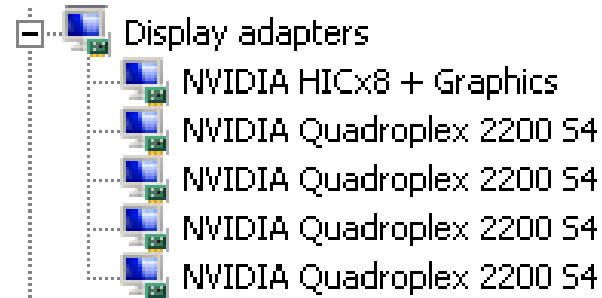




Affinity

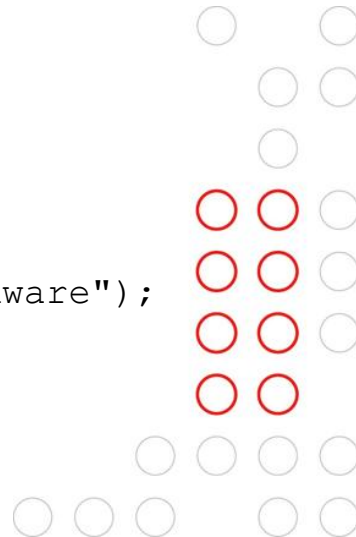


GHIC adapter driver



```
if (!wglEnumGpusNV || !wglCreateAffinityDCNV ||  
    !wglDeleteDCNV || !wglEnumGpuDevicesNV ||  
    !wglEnumGpusFromAffinityDCNV)  
{  
    errorStrings.PushBack("Affinity not supported by graphics hardware");  
    return false;  
}
```

***OpenGL Extension for Affinity selection was
unavailable on the G-HICx8 frontend card***





Virtual Adapter and Session-0 isolation

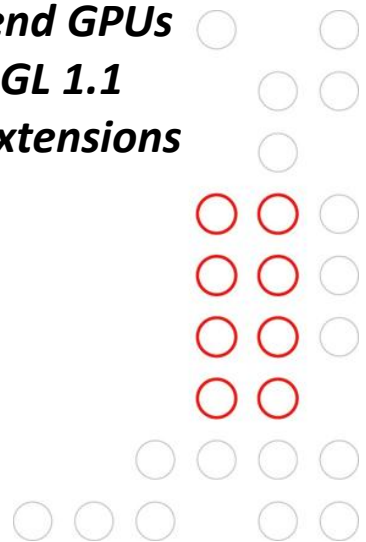


Windows Service



**Remote Desktop
(Hosting / Terremark)**

**4 high-end GPUs
OpenGL 1.1
with 2 extensions**





Automatic Driver Rescue (loop)

Windows Registry Editor Version 5.00

[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\GraphicsDrivers]

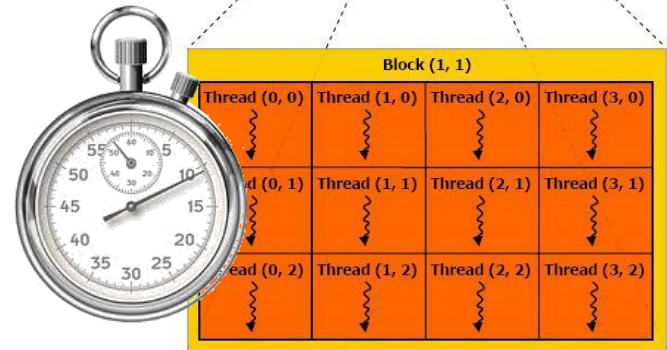
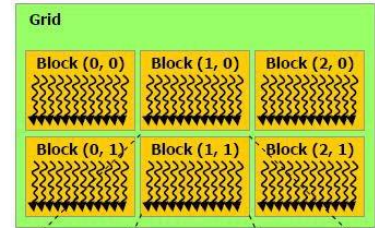
"TdrDelay"=dword:0000000a

"TdrLevel"=dword:00000000

CUDA Kernel Execution Timeout fix



```
INFO: Model output id ... : 3F79CD1E-93D2-42D5-8B9D-785910A3C38E
INFO: Model id ..... : 3F79CD1E-93D2-42D5-8B9D-785910A3C38E
INFO: Test iteration. Stopping worker after processing this file item.
ACTION: Mesh optimizing model 3F79CD1E-93D2-42D5-8B9D-785910A3C38E
--- LOD verticies : 76855
--- LOD verticies : 57059
--- LOD verticies : 34332
Done
run optix
Optimizing LOD 0:
Building Acceleration Structure...Done
Removing Hidden surfaces...OptiX failure: Unknown error (Details: Function "rtContextLaunch1D" caught exception: Encountered a CUDA error: cuEventSynchronize(m_event) returned (702): Launch timeout [6619225])
```



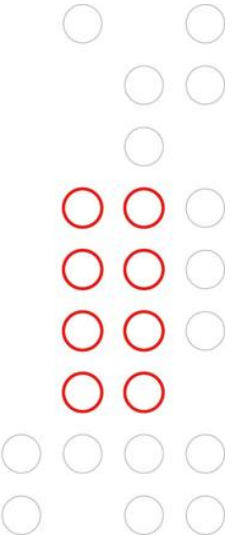
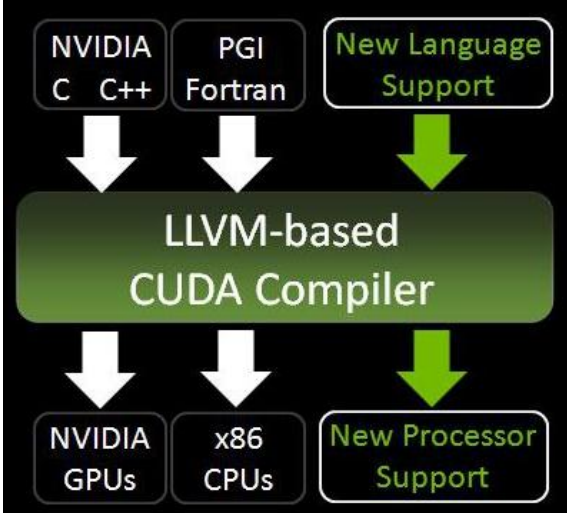


GPGPU C/C++ expertise required

```
#include <stdio.h>
int main(void)
{
    printf("Hello World!\n");
    return 0;
}
```

C/C++

managedCUDA





Demo time!

(if time permits... ~5 mins.)

Credits for the Hero Builder:

Developers :

Vladimir Milenov Gorov (app dev)

Lars Axberg (web dev)

Anders Nygaard (web dev)

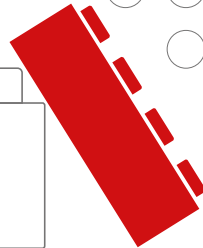
Designers:

Matias Billeschou (interaction designer)

Megan Shellenbarger (GUI designer)

Paw Max Andersen (3D models)

Martin Lykke (3D models)





Thanks!
Questions?



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Michael Schøler

michael@hinnerup.net

