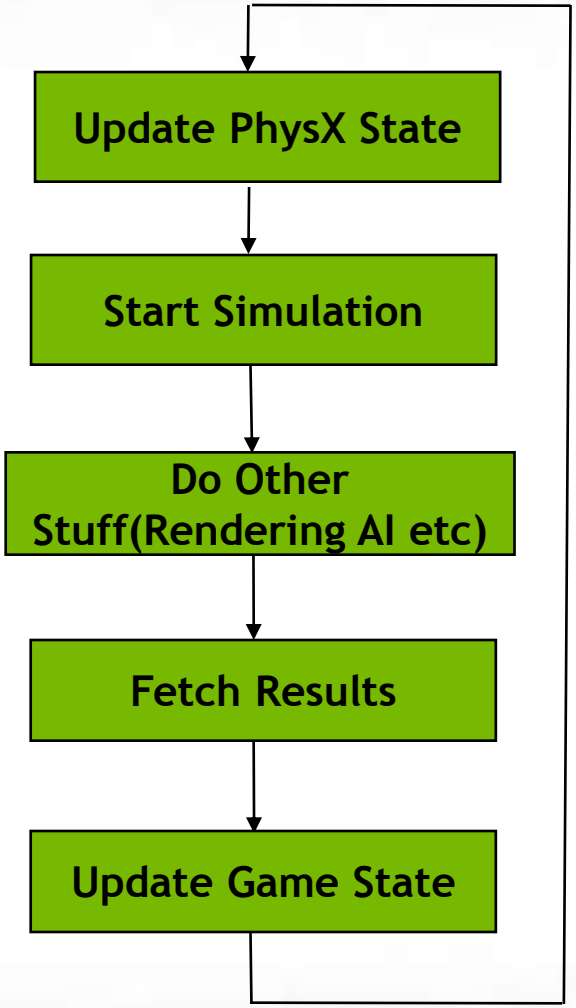
PhysX & APEX Programming and Optimization

Purpose of this Presentation

- Understand the story behind the Scene
- Tips on how to create similar effect in a Game engine
- Tips on Optimization

PhysX SDK Workflow

- PhysX Workflow
  - Asynchronous Simulation
  - PhysX SDK natively is multi-threaded
- PhysX-related Game State
  - Position
  - Velocity
  - Normal
  - ……



PhysX Fluid/Particle

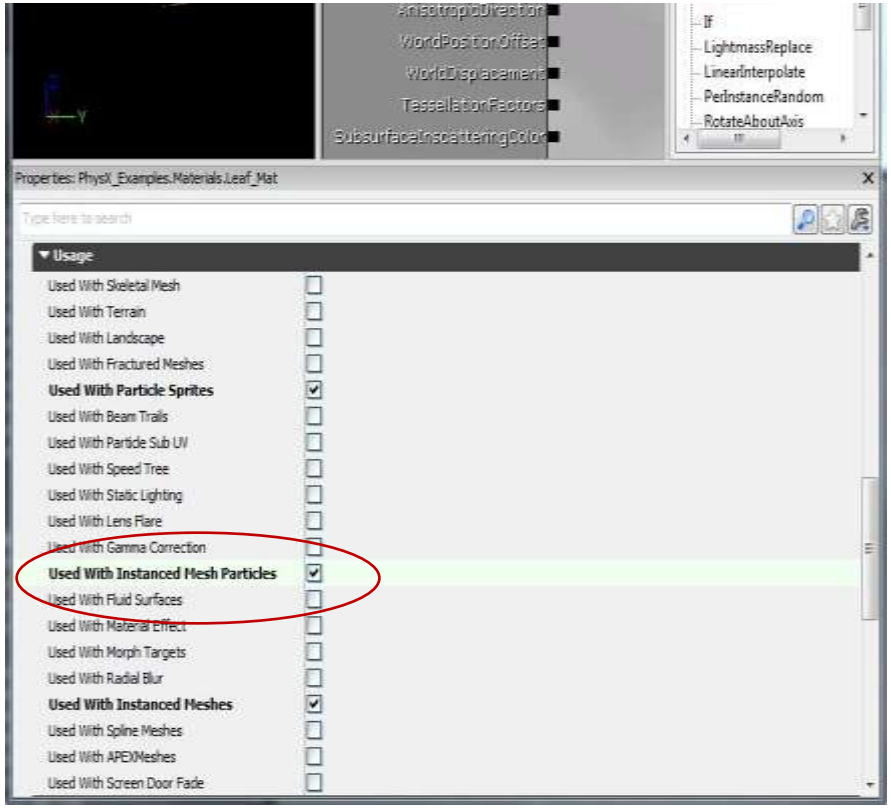
- From 《P.L.A》Benchmark

PhysX Particle Creation

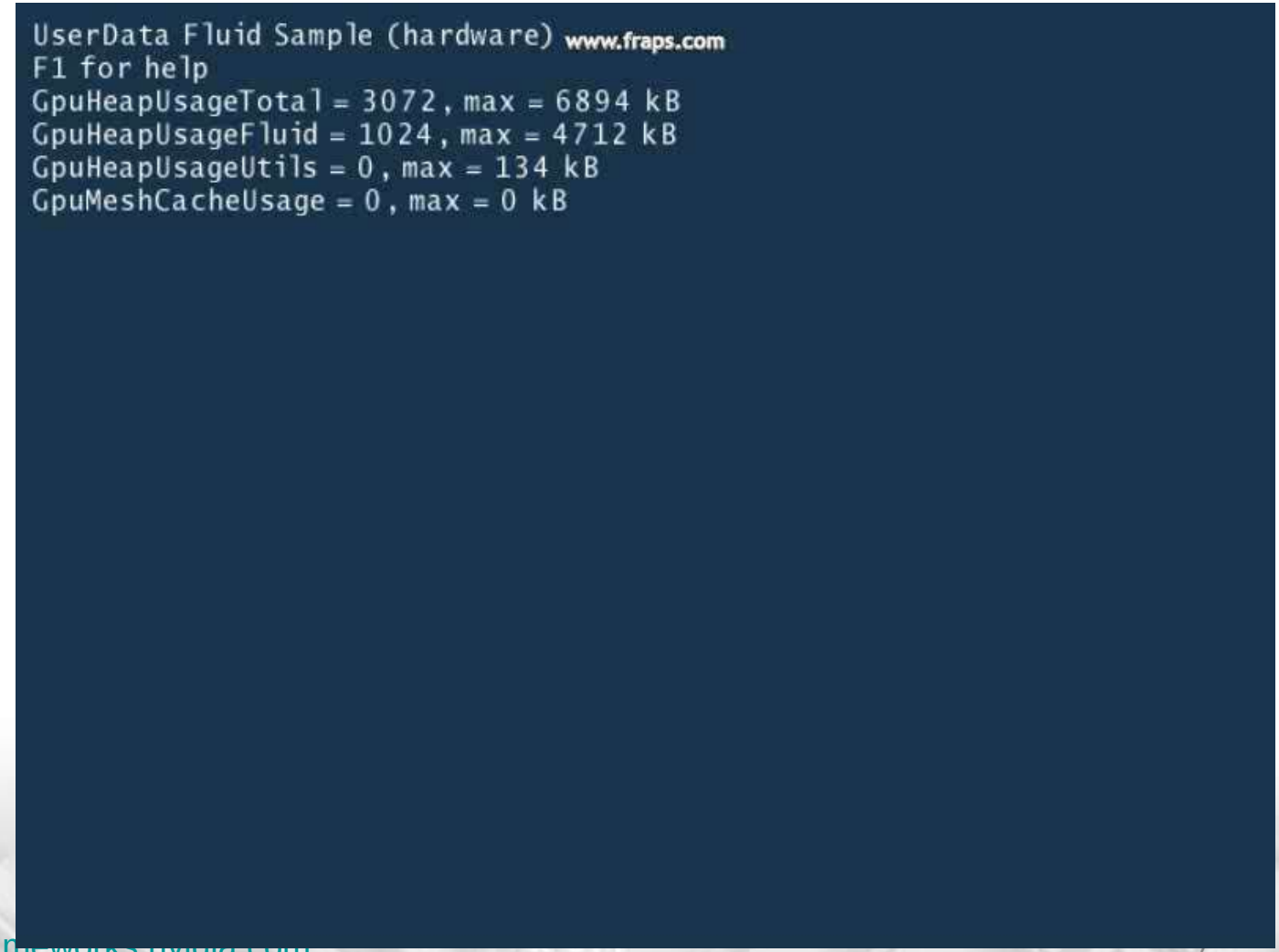
- Creation of Particles
  - Directly calculate states(pos, vel) of particles
    - Create All particles upfront
    - Insert/Delete Particles each frame
  - Use NxFluidEmitter to emit particles automatically
- Main Properties
  - Collision radius and collision response
  - Velocity control of particles
  - SPH(fluids) only properties, e.g., viscosity and surfaceTension

Hardware Acceleration

- To increase the number of Particles
  - GPU PhysX particle (NX_FF_HARDWARE)
  - Adopt Instancing
    - UE3 material setting→



Share PhysX Particle SDK Sample



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Share PhysX Particle

- Max Particles
  - Maximum Number of Particles in a Particles system
- Particle Reserve
  - Old Particles in the FIFO will be deleted
  - Maximum Number of Particles to emit in a frame after the Maximum Particle number is reached

PhysX Cloth

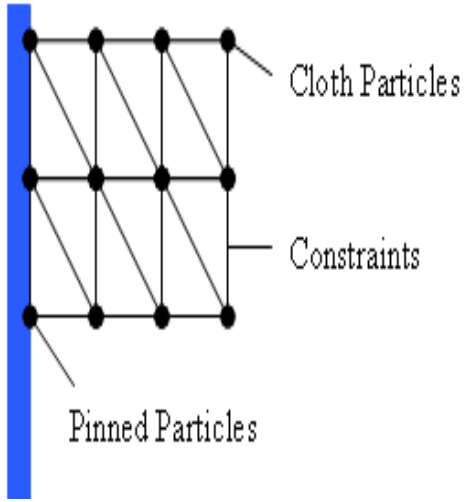
- 《P.L.A》Cloth Sample

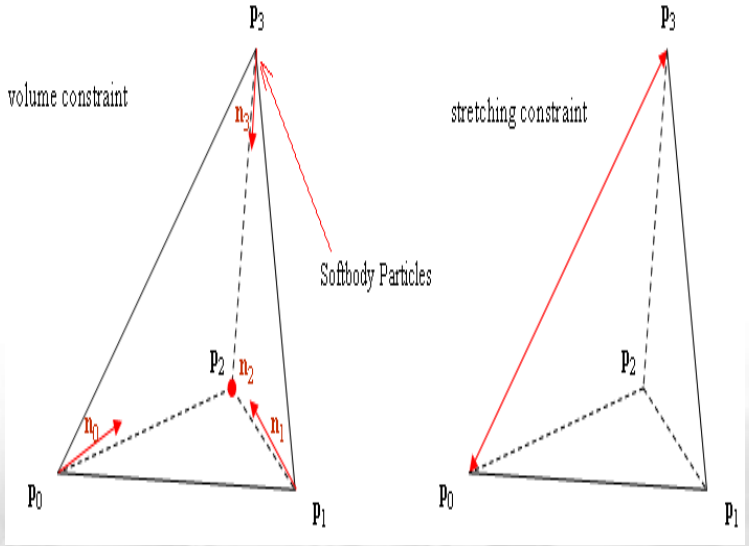
PhysX Cloth

- 《P.L.A》Cloth Sample， Explosion Interaction

Deformables

- Cloth & Softbody
- Particles + Constraints + Meshes
  - Cloth: triangle mesh
  - Softbody: Tetrahedral mesh
- Special features
  - Tearing
  - Self-collision
  - Pressure





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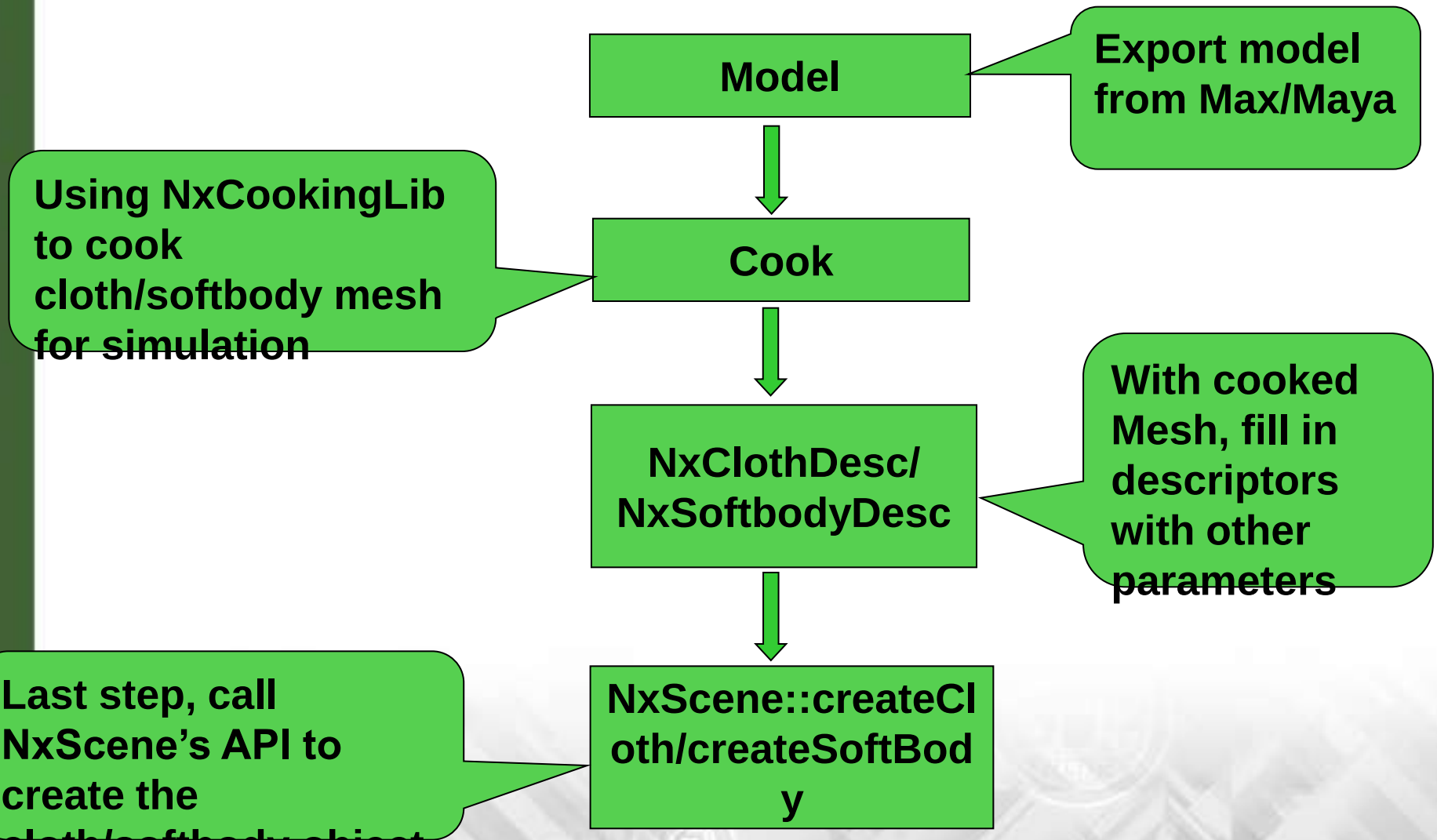
Deformables Creation Process



Cloth Optimization

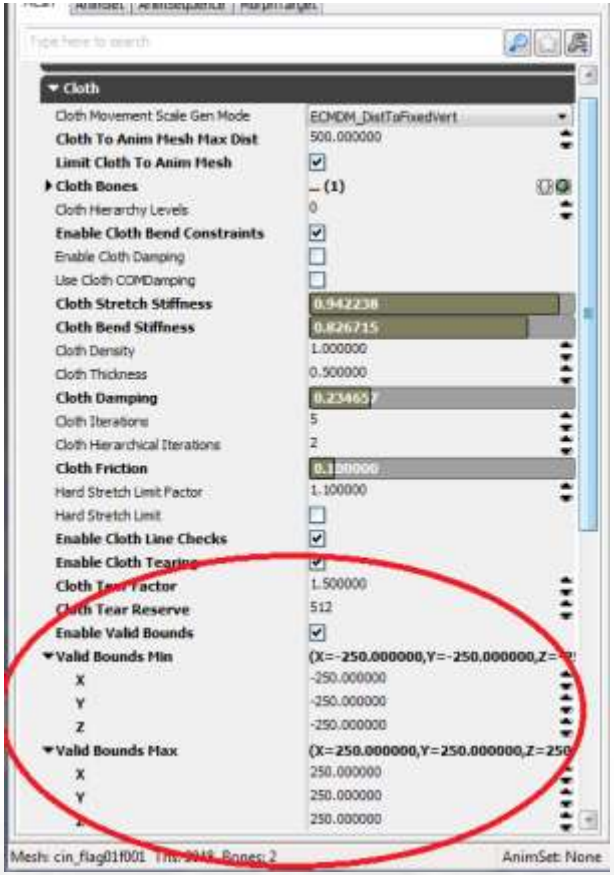
- FreezeWhenNotRendered(pseudo-code)

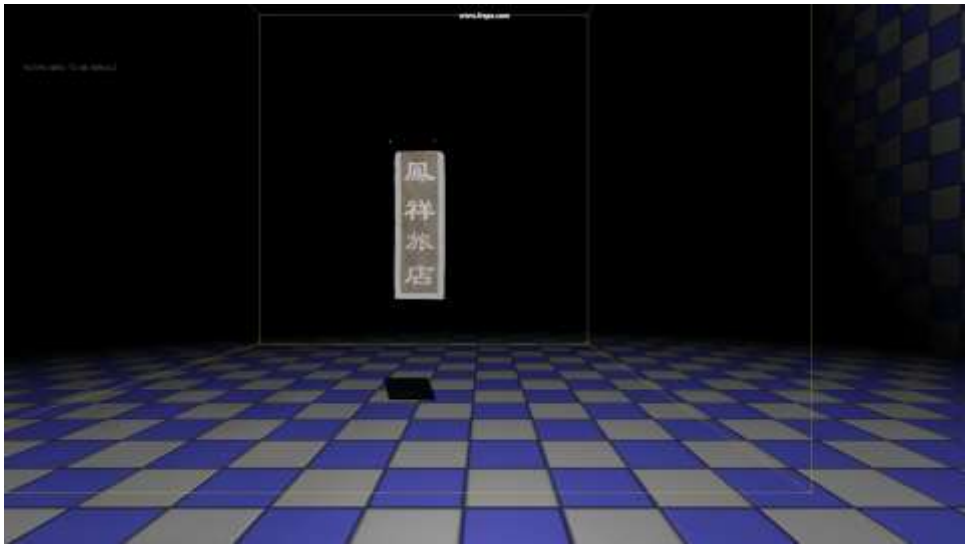
```
if (Cloth out of view frustrum)
{
    Cloth->setFlag(NX_CLF_STATIC)
}
```

- Cloth stops at the last position.
- Simulation stops to increase performance

Optimization for Tearable Cloth

- ValidBound Setting and Sample





ValidBound Opt Setting

- Cloth Flags
  - NX_CLF_TEARABLE
  - NX_CLF_VALIDBOUNDS
- setValidBounds(const NxBounds3& validBounds)
  - A World space cube
  - Cloth verts outside this cube will be deleted
  - Note: to remove the rendering triangles as well

APEX Destructible

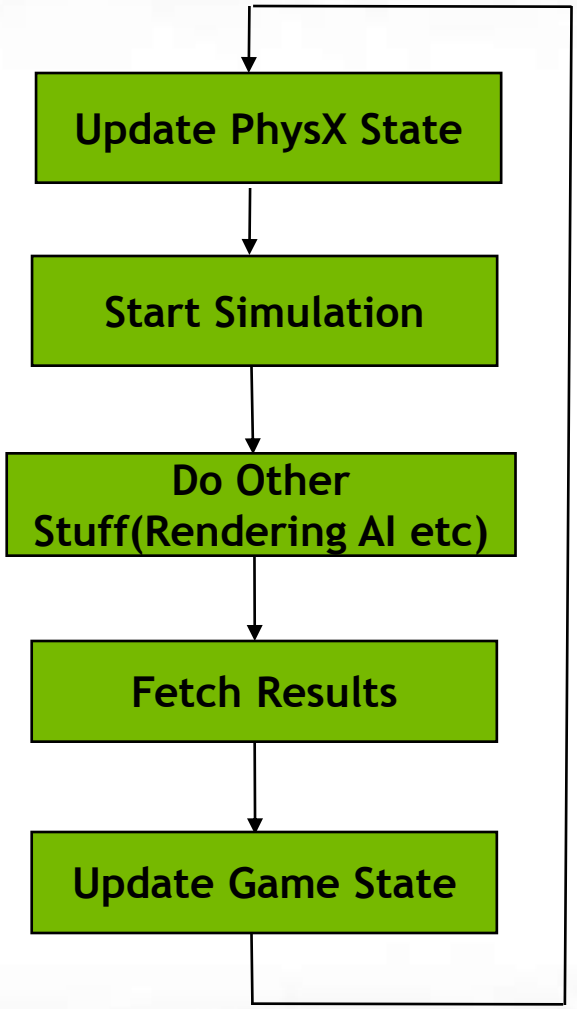
- 《P.L.A》 Destructible Scene

APEX Destructible

- 《P.L.A》 Destructible Scene

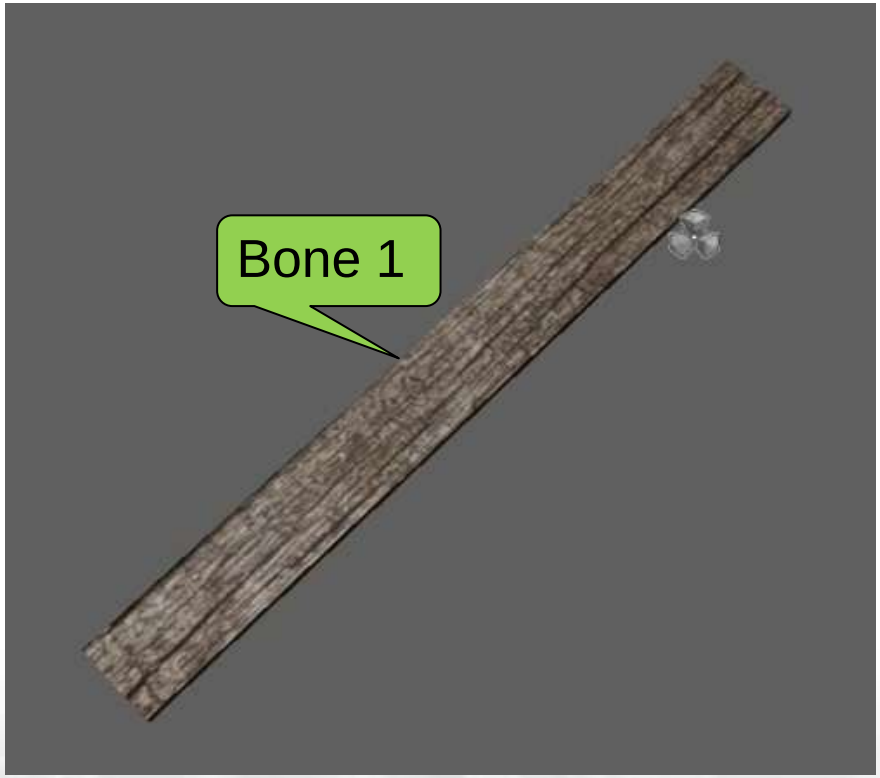
APEX vs PhysX Workflow

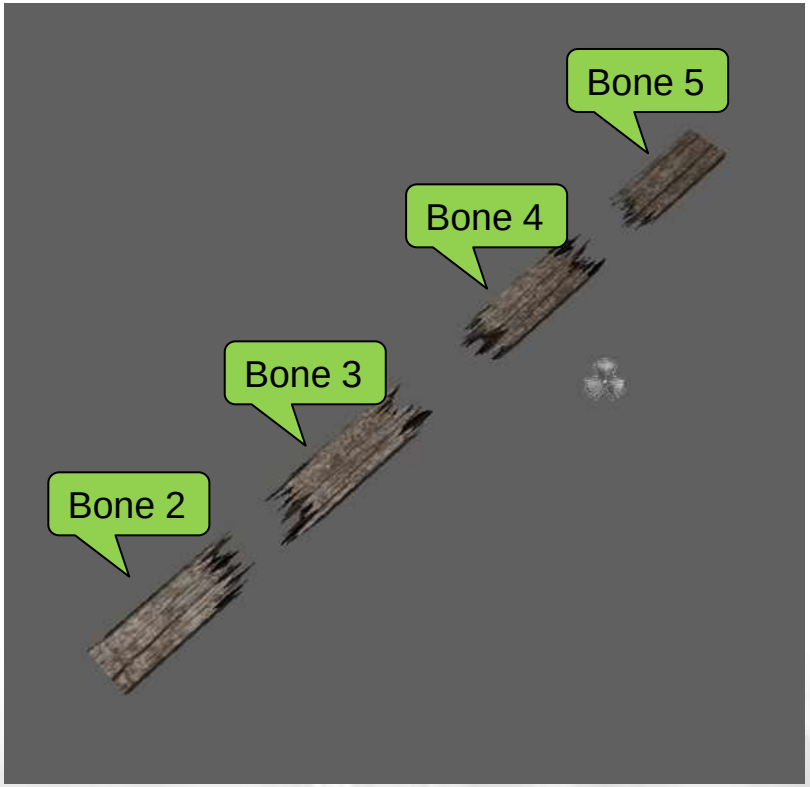
- PhysX
  - Simulate/fetchResults
  - Update Game State
    - Position, Rotation, Velocity, Normal, etc.
- APEX
  - Load Assets
  - Simulate/fetchResults
  - Update Game State
    - Vertex Buffer, Index Buffer, Bone Buffer, etc



Rigid Skinning Rendering

- Single VertexBuffer





Callback on Fracturing

- Callback function
  - Sample:

```
void physx::apex::NxUserChunkReport::onDamageNotify ( const NxApexDamageEventReportData & damageEvent )
{
        for each DamageEvent
        {
          Emit Fracturing Particles at the hit Location;
          Playback Fracturing Sound;
        }
}
```

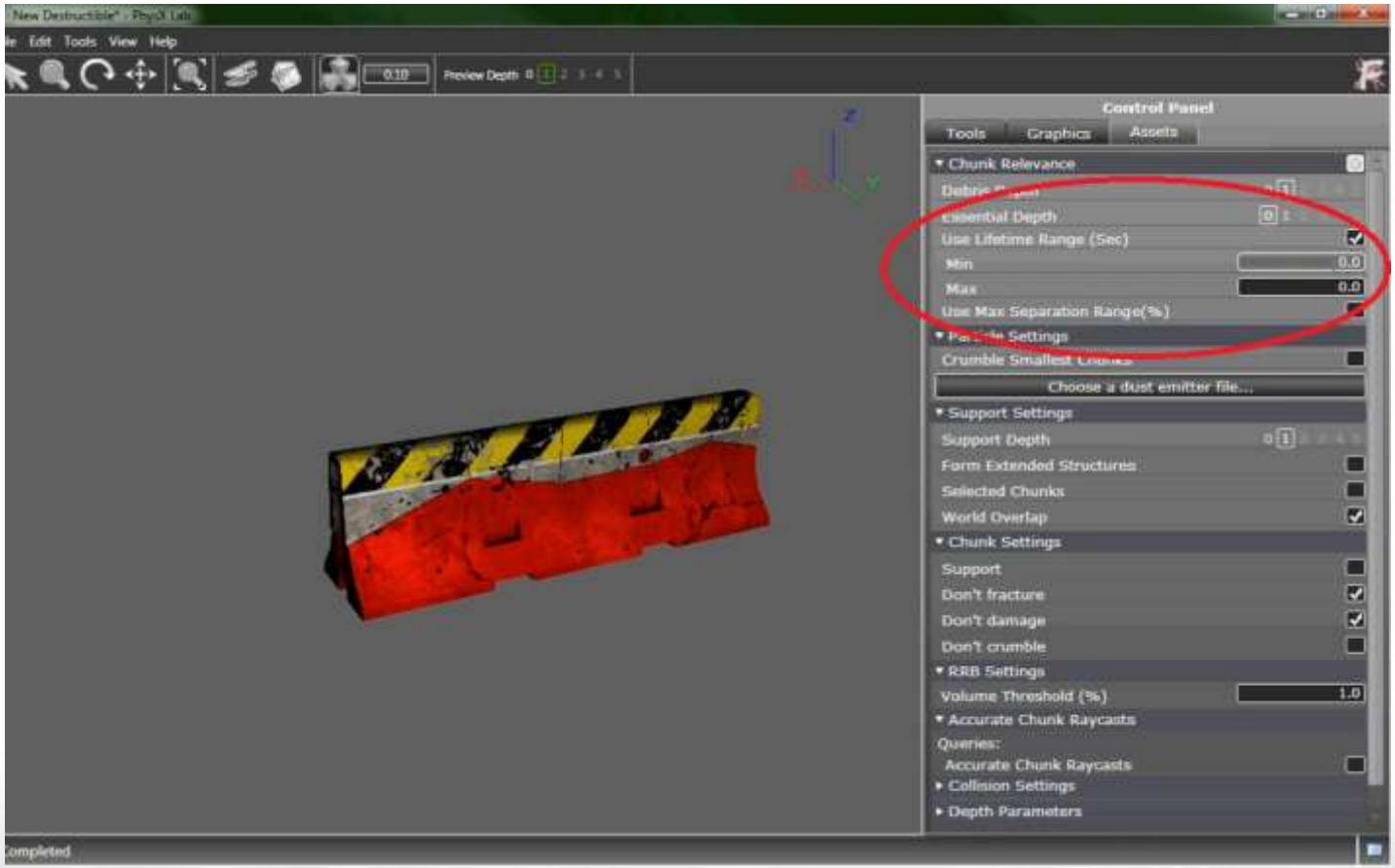
- NxApexDamageEventReportData
  - Destructible Actor
  - HitLocation, HitNormal
  - Fracturing Chunk index
  - …….

Jitter

- Problem:
  - Sometimes a pile of PhysX convexes can bounce around unnaturally for a long time.
- Possible Solution
  - Increase damping
    - Increase angular damping parameter to a value of 10-15
  - Lose energy
    - Increase friction and lower restitution
  - Equalize masses
    - If there is a large mass difference the body with the smaller mass can move quite a lot and keep the whole pile moving.
  - Put them to sleep
    - Increase the sleep energy threshold value will cause destructible chunks to fall asleep more easily.

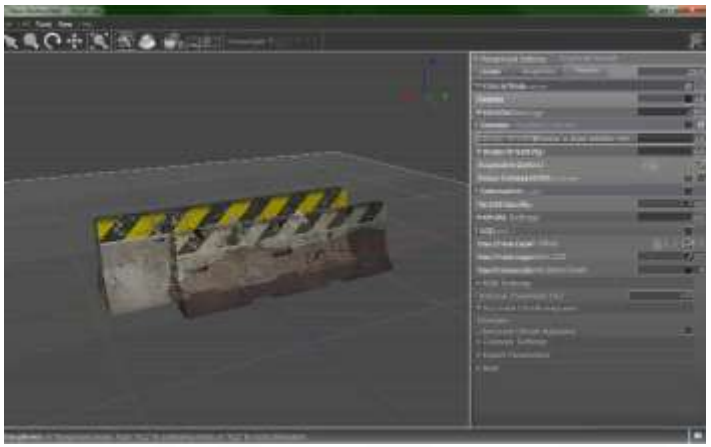
Authoring Optimization

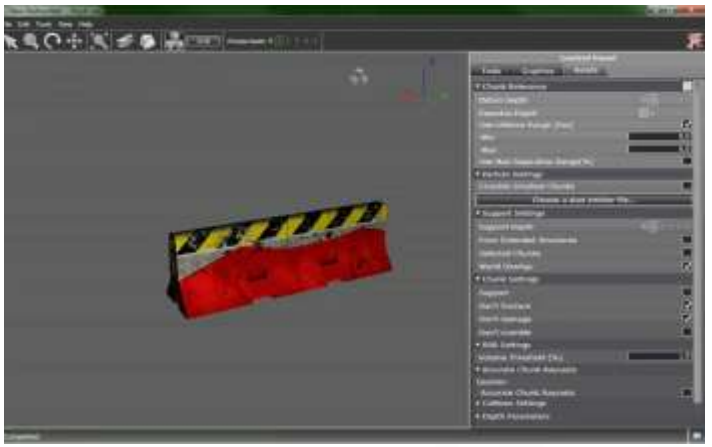
- Debris Timeout



Authoring Optimization

- Debris Setting with Code
  - setParamBool(*params,"destructibleParameters.flags.DEBRIS_TIMEOUT“, true);
  - setParamI32(*params,"destructibleParameters.debrisDepth", 1);
  - setParamF32(*params,"destructibleParameters.debrisLifetimeMin", 0.0f);
  - setParamF32(*params,"destructibleParameters.debrisLifetimeMax”, 0.0f);





- Similar for *Debris Max Separation*

Simulation Optimization

- Avoiding too many chunks on screen
  - setMaxDynamicChunkIslandCount
    - Maximum number of dynamic chunks island in the scene.
  - setMaxChunkCount
    - Maximum number of dynamic chunks in the scene. No less than maxDynamicChunkIslandCount
  - setLODResourceBudget
    - Overall LOD resource setting for an APEX scene(including destructible)
  - setMaxActorCreatesPerFrame
    - Cap the maximum number of Destructible actors in a frame

Hardware Acceleration

- Simulate Rigid body on GPU--GRB

Q & A?