Agenda

- PhysX Overview
- PhysX SDK Architecture
- PhysX SDK Features
- GPU PhysX
- Q & A
PhysX Overview

- WHAT is PhysX
- WHAT PhysX can do
- WHO uses PhysX
- SDK Roadmap
PhysX Overview

WHAT is PhysX

To be simple, it’s a physics engine

But, it’s a powerful physics engine

– Real-time physics simulation

– Multiple features: rigid bodies, soft bodies, fluids, cloths, force fields, etc

– Unique hardware accelerated physics: GPU & PPU

– Cross-platform support: PC (Windows + Linux), XBOX, PS3, Wii
PhysX Overview

WHAT PhysX Can Do

- Provides you with various features to create your own fantastic world
- Simulates your world forward for you with a simple function call
- Saves you CPU cycles for other important tasks
- Gives you more time to concentrate on other important things: AI, game logic, etc
PhysX Overview

WHO uses PhysX
- 25,000+ registered & active developers
- 150+ games cross all platforms
- Leading game engines
  - UE3, Gamebryo… and many in-house engines
- Leading Middlewares
  - Natural Motion…

SDK Roadmap
- SDK 3.0 in progress
  - Features improvements
  - Performance and management improvements
  - Beta scheduled in March 2009
- GPU porting
PhysX SDK Architecture

- PhysX SDK Architecture Diagram
- PhysX SDK Workflow
PhysX SDK Architecture

PhysX SDK Architecture Diagram

- PhysX SDK
  - NxScene
    - NxActor
    - NxFluid
    - NxCloth
    - NxSoftBody
    - NxForceField
    - NxJoint
    - NxShape
      - Various kinds of meshes
        (convex, triangle mesh, heightfield, cloth, softbody)
      - Creates / Owns
      - References

Various kinds of meshes:
- convex
- triangle mesh
- heightfield
- cloth
- softbody
PhysX SDK Architecture

PhysX SDK Workflow

- Simulation can work in asynchronous mode
- PhysX SDK itself is multi-threaded
- Unified Creation Process: fill in a descriptor and owner to create
- Unified Release Process: owner to release
PhysX SDK Architecture

**PhysX SDK Workflow**
- scene->simulation function call
  - Must be paired with scene->fetchResults call
  - elapsedTime: how long time to go forward?

**Timing setting of the simulation**
- maxIter: how many substeps you want the simulation to divide the elapsedTime?
- maxTimestep: the longest time you want a substep to go
- TimeStepMethod: fixed or variable?
PhysX SDK Features

- Rigid Body
- Fluid
- Cloth
- Soft Body
- Force Field
- Other SDK Functionalities
PhysX SDK Features

**Rigid Body**

- **Fundamental elements of games**
  - NxActor
- **Basic types**
  - Static: fixed in world
  - Dynamic: can move
    - Kinematic
- **Consists of shapes**
  - Primary shapes: box, capsule, sphere
  - Mesh Shapes: convex mesh, triangle mesh, height field mesh
- **Creation of mesh shapes needs cooking**
  - NxCookingLib

**RB pipeline**

- Broad phase: collision detection with AABB Test
- Narrow phase: more accurate collision detection
- Solver
PhysX SDK Features

Rigid Body

Collision Control
- Collision flag per actor and shape
- Collision Filtering: collision group, group masks
- Continuous Collision Detection

Rigid body in games
- Terrain, building, vehicle, game props...
- Rag-doll, NPC,...

Limitations
- Scene: no more than 64k shapes
- Convex mesh shape: no more than 256 polygons
- Avoid using actors with many shapes for better performance
PhysX SDK Features

Fluid
- NxFluid
- A set of particles

Particle
- Basic collision elements
- Particles interaction
  - SPH (Smoothed Particle Hydrodynamics)

Emitter
- Source of particles
- Can be attached to a shape and move with it

Creation
- Specify initial particle state, or
- Particles created later with an Emitter
PhysX SDK Features

**Fluid**

- **Fluid Drains**
- **Fluid Events**
  - NxFluidUserNotify::onEmitterEvent
  - NxFluidUserNotify::onEvent

**Fluid in games**
- Weapon effects, e.g., Massive explosion effects
- Particle system, e.g., Environment particles (leaves…)

**Limitations**
- Maximum of 64k particles per fluid
- No fluid vs. fluid interaction
PhysX SDK Features

**Cloth**
- **NxCloth**
- A mesh defined by a set of particles
- SDK constructs constraints between particles to mimic bending and stretching

**Creation**
- Model your cloth mesh
- Cook it with the cooking lib

**Special cloths**
- Tearable cloth
- Metal cloth
- Pressure cloth
PhysX SDK Features

**Cloth**
- Attachment to shapes
- Cloth valid bound and drains
- Cloth in games
  - Flags, tents, and alike
  - Hair and cloth of a person
- **Limitations**
  - No cloth vs. cloth collision
  - No cloth vs. softbody collision
  - Squeezing cloth between rigid bodies may results in jittering
  - Interaction with rigid bodies with much lesser density may be unstable
PhysX SDK Features

Soft Body

- Softbody
  - NxSoftBody
  - volumetric deformable objects
  - Similar to Cloth

Softbody Tetrahedra Mesh
- specifying the 4 vertex indices of the tetrahedron's corner vertices
- PhysXViewer tool to create this mesh

Softbody in games
- Curvy girls
- Monsters, trees
PhysX SDK Features

**Force Field**
- NxForceField
- Apply force to objects in its activity volume

**Creation**
- Activity volume: Forcefield shapes
- Force field kernel function
  - Default kernels
  - Custom kernels

Force Field pipeline:
1. Calculate force samples to SDK objects inside activity volume
2. Apply force
3. Solver
PhysX SDK API

**Force Field**

**Force Field in Games**
- Tornados, gusts of wind…
- Enhanced weapon effects
- Character’s moving effects
PhysX SDK Features

Other SDK Functionalities

- Ray cast
- Sweep test
- Various kinds of Joint
- Various kinds of user reports
  - Contact report
  - Trigger report
  - Modification report
- Character controller
- Vehicle controller
GPU PhysX

From PPU to GPU
- Wider user base
- More powerful computation capability
- Transparent to developers

CUDA Support
- CUDA makes GPU PhysX possible
- Support features: fluid, cloth, soft body
- Rigid body porting in progress
Misc – PhysX License Fee

Sony SDK Free for PS3 Registered Devs
- Current licensing through Sony is free
- NVIDIA will take over licensing & support soon

Individual Game License for each Platform
- Multi-title flexibility on terms

SDK – Unified PhysX API for both PC and Console Platforms

PC Binary SDK Free for both Non-Commercial AND Commercial use
- No License Fee Required
- Over 20,000 Downloads

Source Code SDK includes HL source code to facilitate debugging process

### Per Game License Fee

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1. Playstation Network, Xbox LIVE Arcade and Wii-Ware binaries are free
2. The PS3 PhysX SDK has been maintained and supported by Sony. If you are a PS3 registered developer, you can find the PhysX SDK on Sony’s online download site. NVIDIA will soon take direct ownership of licensing.
3. Wii SDK in limited release now
4. Linux Driver Support Available
Misc – PhysX Developers’ Websites

- NVIDIA PhysX developers’ homepage

- Where to get latest PhysX SDK

- Where to discuss PhysX problems with developers all over the world
Questions & Answers
Thanks!