Nimbus: A Runtime System For Graphical Simulations In The Cloud
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Introduction
Graphics simulations are a cornerstone of modern movies. These simulations are limited to running on a single host or a small, high performance cluster. Nimbus is a distributed system for running graphics simulations in the computing cloud.

Why is this Interesting
- Cloud nodes have non-uniform resources.
- Graphics simulations have non-uniform load over space and time.
- Graphics simulations combine both grid and particle simulation methods, which has very different data access patterns.

Application
- PhysBAM: PhysBAM is a multi-physics simulation library, capable of simulating compressible & incompressible fluids, coupled solids & fluids, fire, smoke, as well as many other natural phenomena.

Approach
An application is split into jobs. The application provides a small amount of explicit information.
- A data object is a variable over a geometric region.
- Which data objects each job reads and writes.
- Which jobs must complete before this one can safely run (before set).

Application Abstraction
Application is a combination of Job and Data objects

Class Data
Fields: name, region
Methods: Serialize, Deserialize

Class Job
Fields: name, read set, write set, before set, parameter
Methods: Define Partition, Define Data, Spawn Job

Application Example:
\[ V_t(x, y) = f(V_{t-1}(neighbors(x, y))) \]

Application life time:
- Nimbus initiates an application by launching job main.
- A job may spawn new jobs and define data objects.
- Nimbus dynamically places the data over the workers and assigns jobs to workers for execution.

Structure And Features
- Central Scheduler
  - Version management.
  - Data copy and exchange.
  - Avoid race conditions.
  - Dynamic data placement.
  - Dynamic load balancing.
  - Fault recovery.
  - Memory management
  - Data caching.
  - Multi thread job execution.

Implementation
We have implemented Nimbus library in about 8k lines of C++ code. In addition we have ported water simulation from PhysBAM library to Nimbus.

We are actively working on this project and currently working and performance optimization and evaluation of the system.