

# 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

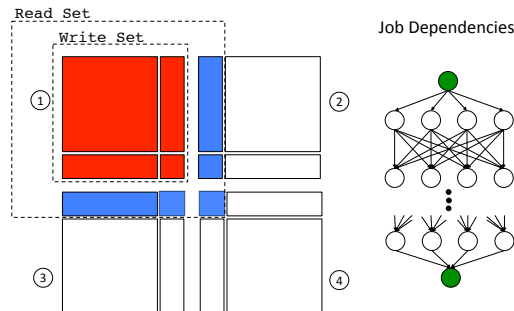
| Class Data     |  |
|----------------|--|
| <b>Fields</b>  | name, region   |
| <b>Methods</b> | Clone, Create, Destroy, Copy, Serialize, Deserialize |

| Class Job      |  |
|----------------|--|
| <b>Fields</b>  | name, read set, write set, before set, parameter |
| <b>Methods</b> | Define Partition, Define Data, Spawn Job         |

### Application Example:

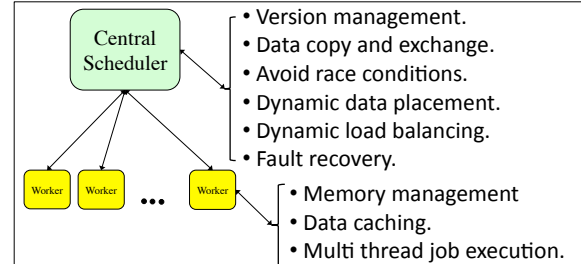
$$V_i(x, y) = f(V_{i-1}(\text{neighbors}(x, y)))$$



### 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



## 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.