



# ***Galaxy Simulation Using Ibis***

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# ***Outline***

Distributed computing

Ibis

Galaxy simulation

Demo



# ***Distributed Computing***

Distributed computing: run application on a collection of computers instead of on a single processor

Why do it?

The amount of data and processing is increasing all the time

Processors are NOT getting faster; instead, we get more of them → multicore, clusters

Processing that used to take hours, may now take days on a single processor

Solution: use more computers, to make it run as fast as (or faster than) before



# ***Distributed Computing with Ibis***



Start with a laptop  
(in Intertain)



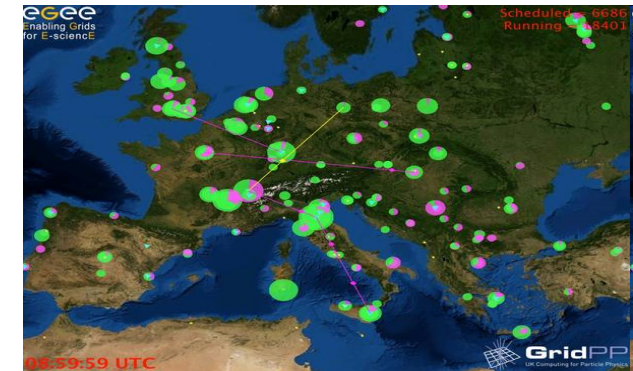
Get access to a cloud  
(Amazon, Google, ...)



Use student or office  
machines



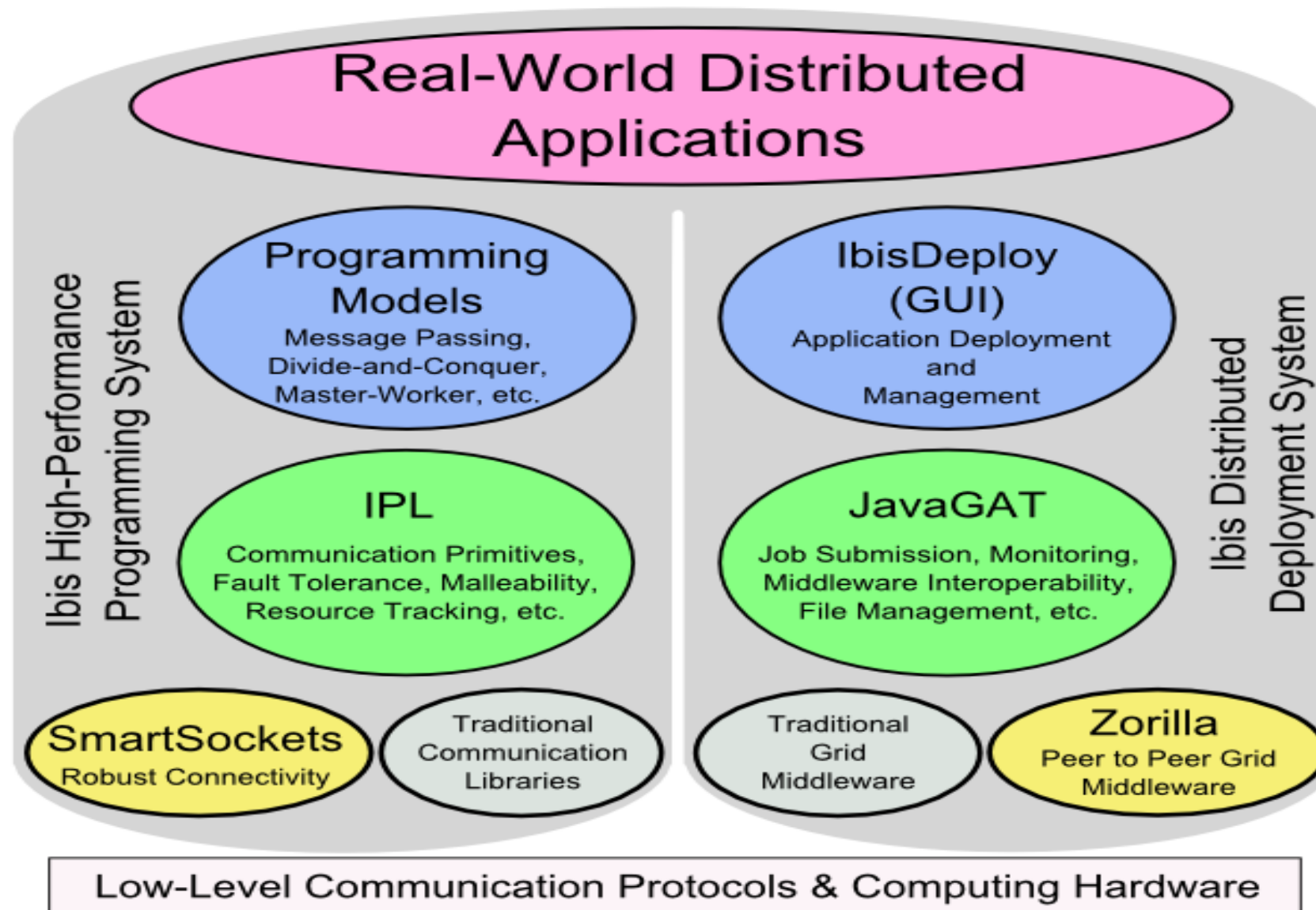
Get access to a cluster  
(VU DAS-3)



Get access to a grid  
(EGEE)



# Ibis System





# ***Galaxy simulation***

A galaxy is a large group of stars, close together

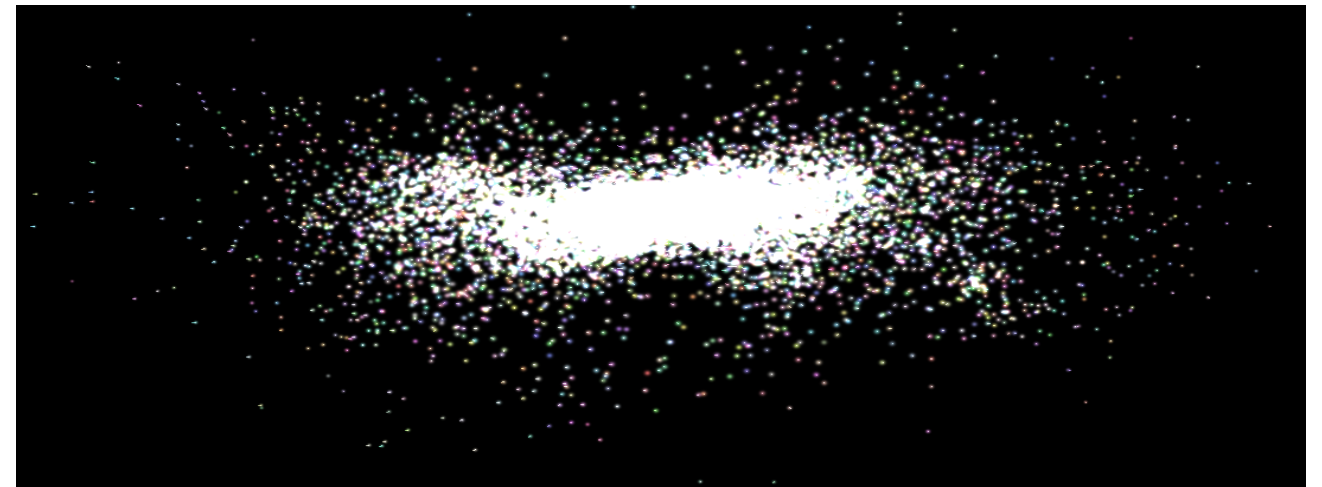
Stars move, have a velocity

Stars have a mass, so have gravitational influence on each other

Velocity is affected over time

What will the galaxy look like in the future?

Simulation → prediction



# ***Basic galaxy algorithm***

Split time into "small enough" timesteps

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for each timestep do
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    Compute forces between all stars
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```
    Compute new positions and velocities
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```
od
```

Very expensive: 100 stars  $\rightarrow$  10000 interactions,  $10^4$  stars  $\rightarrow 10^8$  interactions (per timestep)

Far too expensive for realistic problems (galaxies)

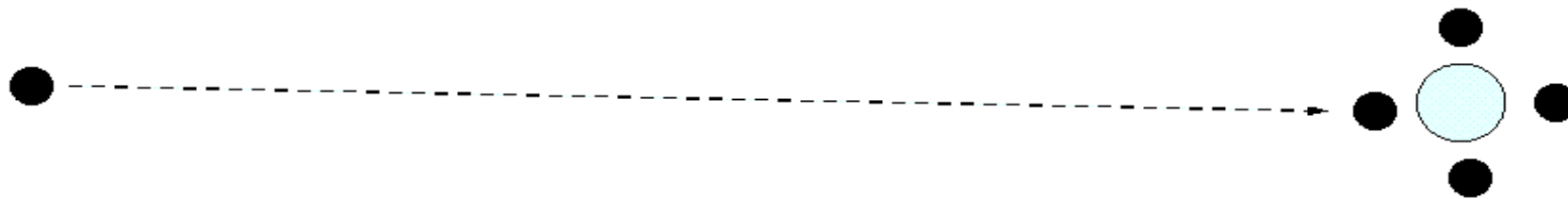


# ***Barnes-Hut algorithm***

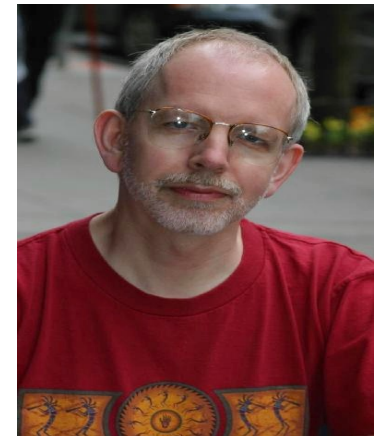
Barnes and Hut designed an algorithm that works hierarchically

Forces decrease rapidly with the distance between the stars

Long-range interactions can be approximated: groups of stars are approximated by a single cell with combined mass and center-of-mass



Joshua Barnes



Piet Hut





# ***Live Demo***

Parallel implementation of the Barnes-Hut algorithm developed using Ibis

Deployment of visualization (locally) and computation (on VU DAS-3 cluster) using ibis-deploy

