JavaGAT and Ibis Demo

SP 3.1

high-performance distributed computing

Mid-term progress report page 24

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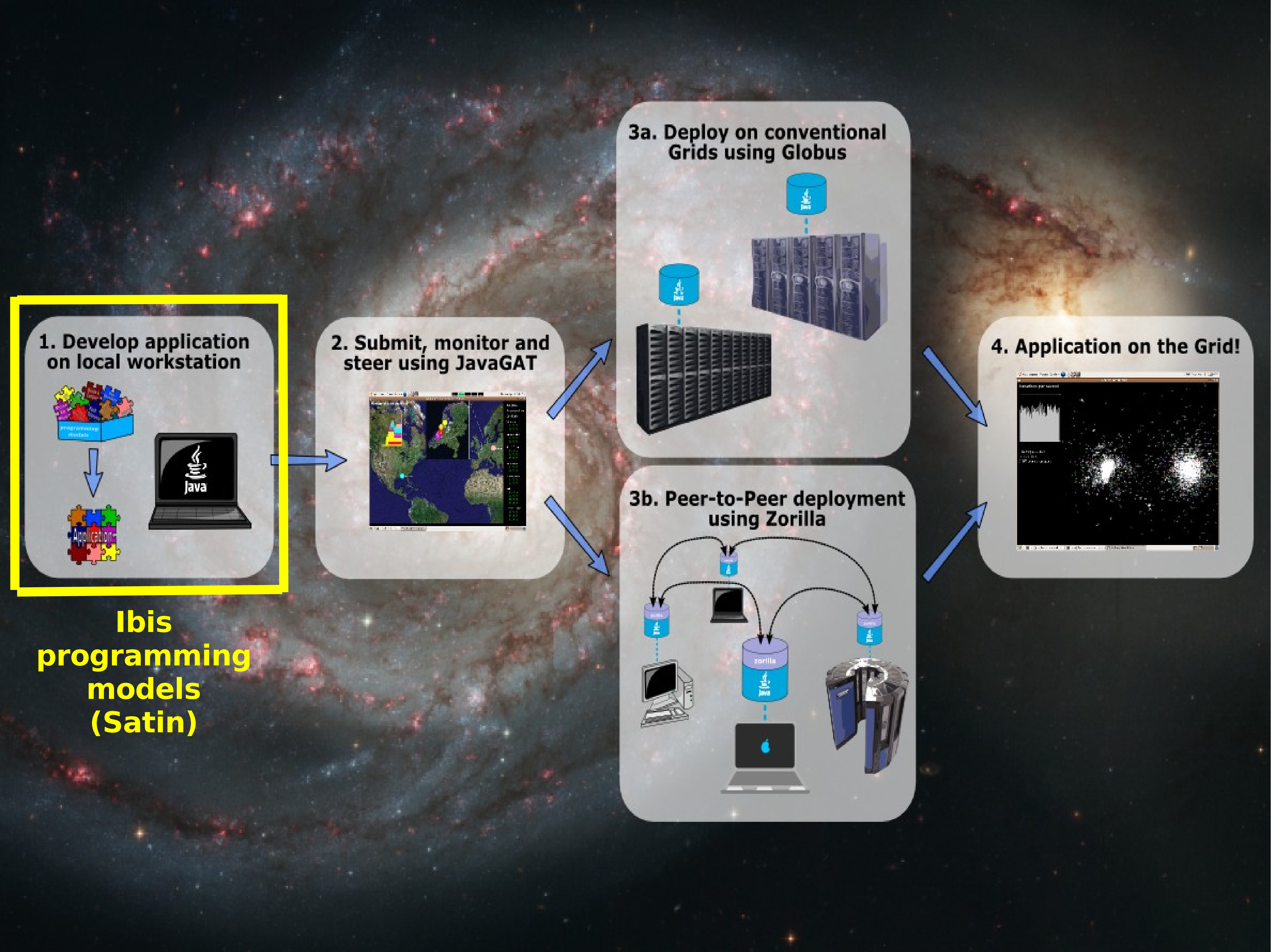
1. Develop application on local workstation
2. Submit, monitor and steer using JavaGAT
3a. Deploy on conventional Grids using Globus
3b. Peer-to-Peer deployment using Zorilla
4. Application on the Grid!
Java
Application
zorilla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zorilla
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Ibis programming models (Satin)

Satin

- One of the high-level programming models for the Ibis communication library
- Provide a powerful programming model
  - master/worker, divide-and-conquer, shared objects
- Extremely easy to use
- Satin allows applications to transparently deal with grid issues
  - load balancing, malleability, migration, fault-tolerance, adaptivity, firewalls, heterogeneity


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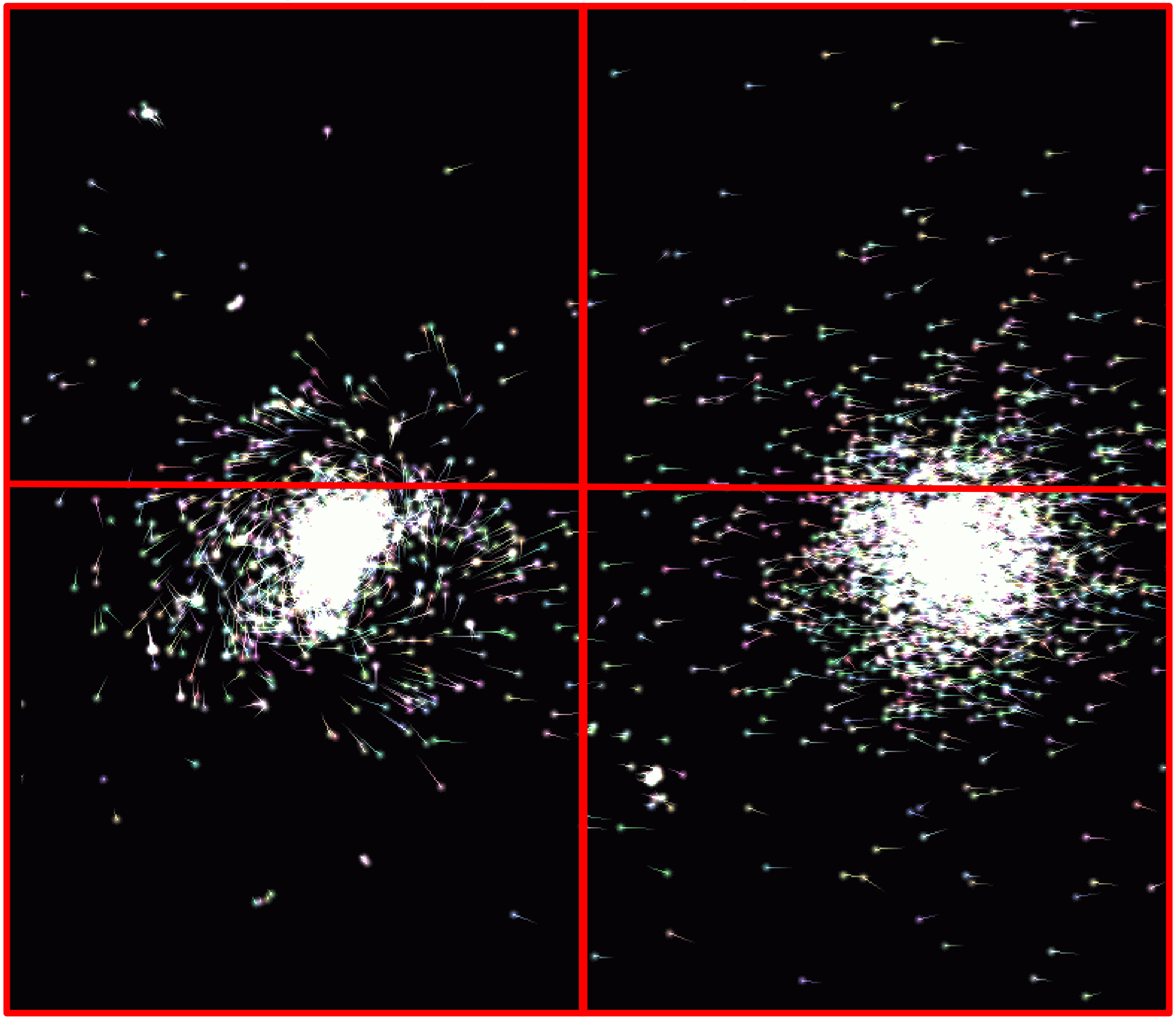
Barnes-Hut Nbody simulation

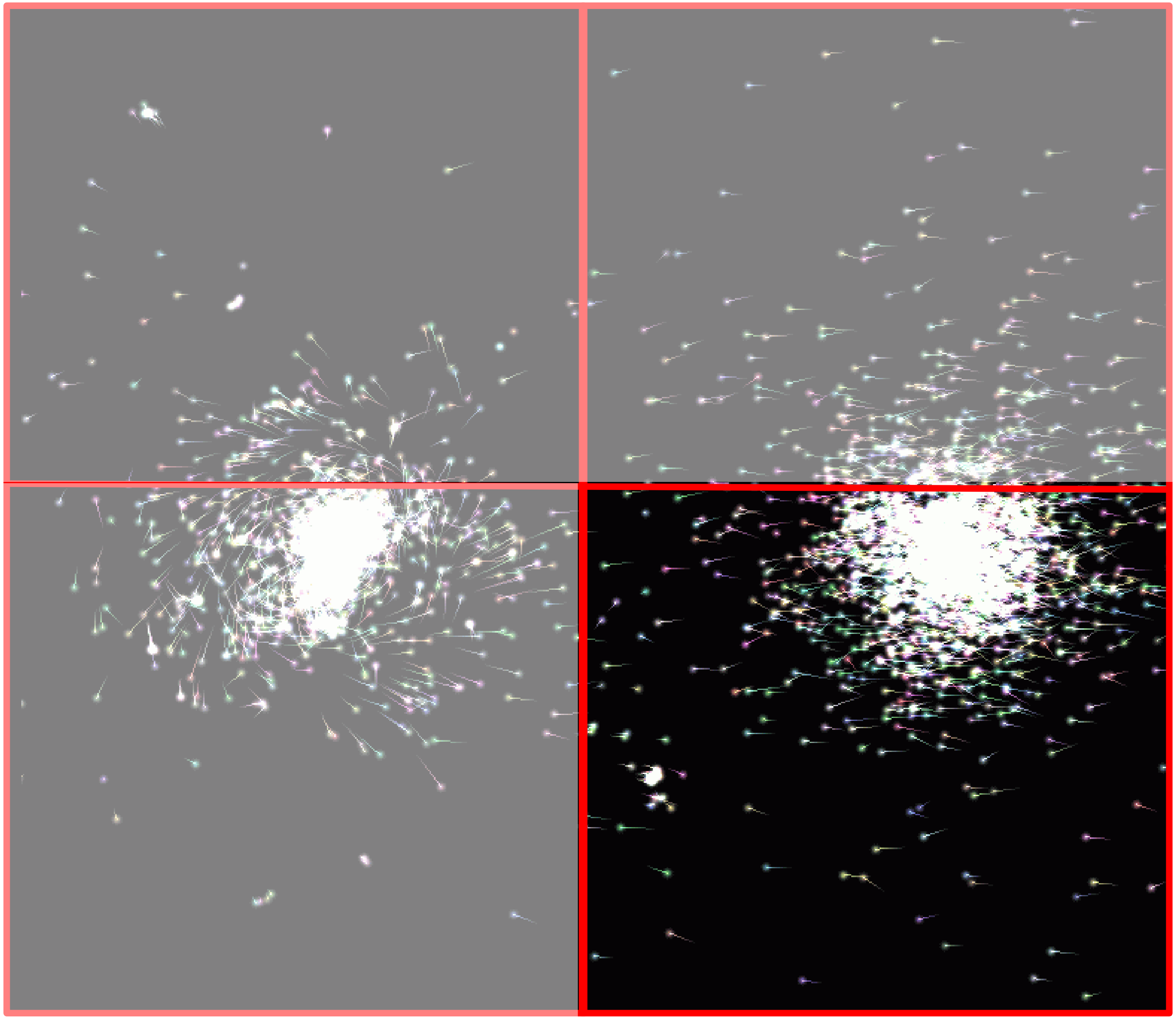
Barnes-Hut N-body simulation

Bodies (stars) are organized in a tree
complexity is not N^2 but $N \log N$

Barnes-Hut N-body simulation



Barnes-Hut N-body simulation



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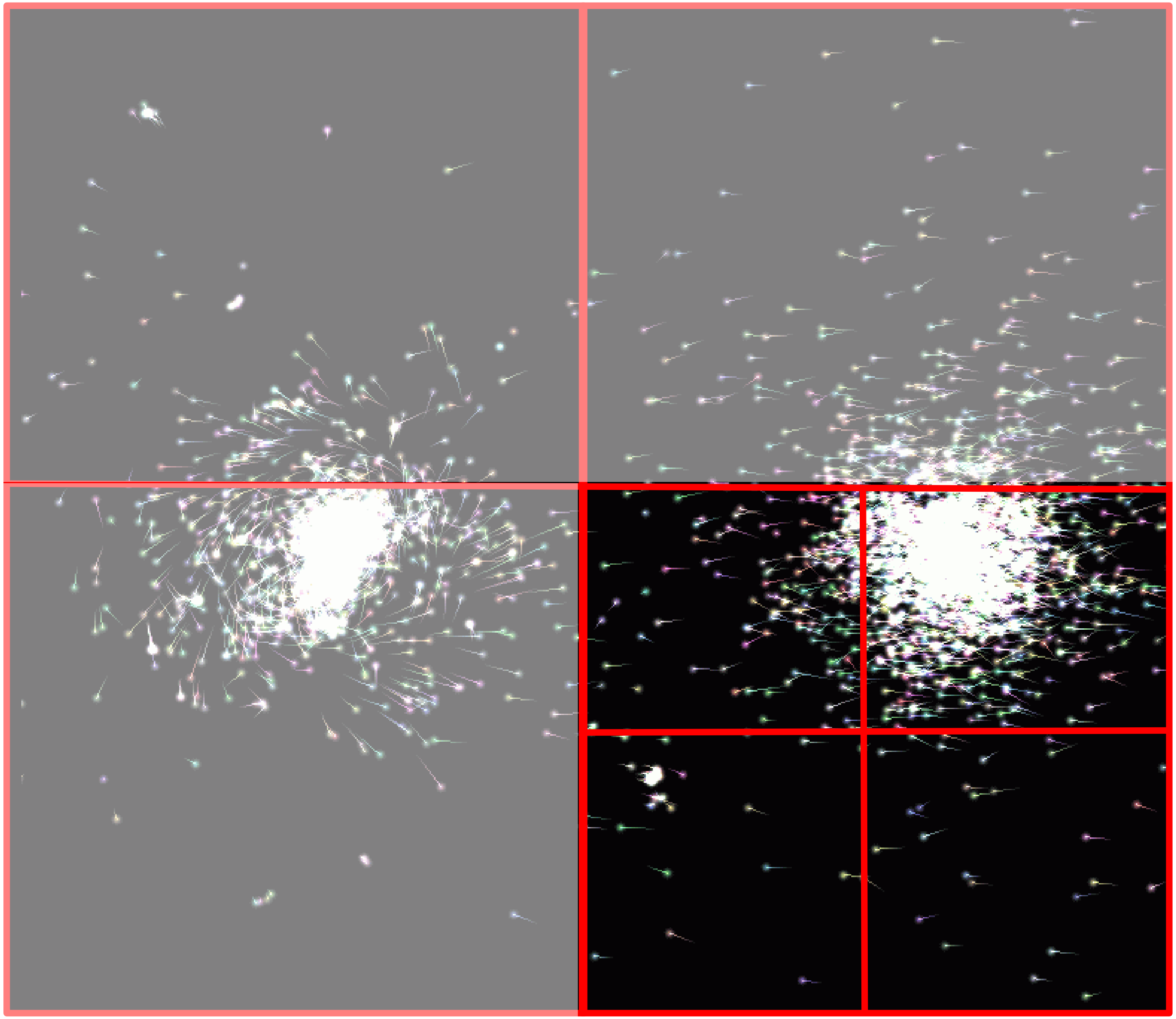

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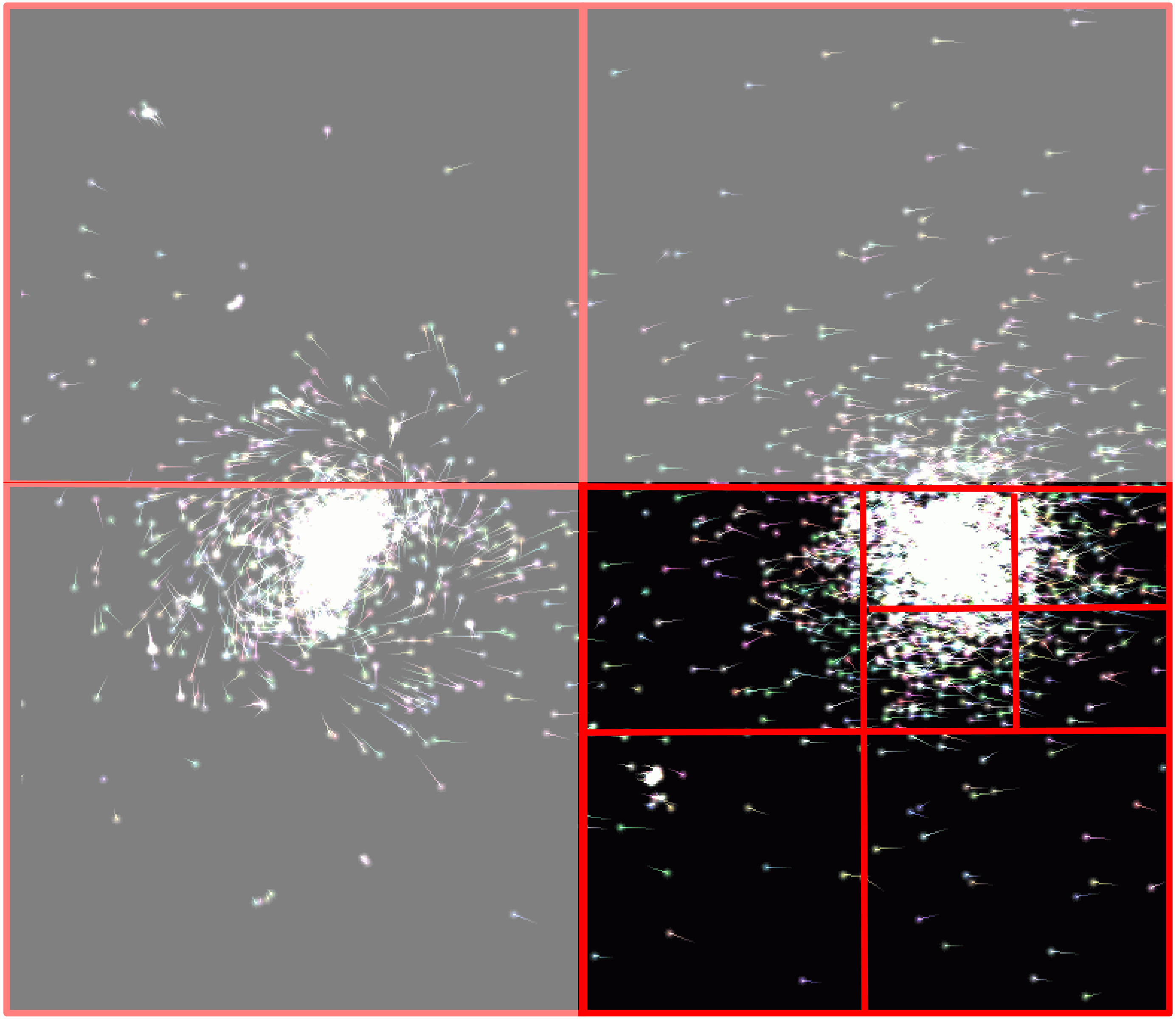

Satin Applications

- Vl-e
  - Grammar induction, SP 2.2
    - Pieter Adriaans, Ceriel Jacobs
  - N-body simulations (DEMO)
- Grammar-based text analysis
- VLSI routing
- Satisfiability solver
- Gene sequencing
- Game-tree search
- Raytracing
- Numerical functions
- ...


1. Develop application on local workstation
Java
2. Submit, monitor and steer using JavaGAT
Java Grid Application Toolkit (JavaGAT)
3a. Deploy on conventional Grids using Globus
3b. Peer-to-Peer deployment using Zorilla
zorilla
4. Application on the Grid!

The Java Grid Application Toolkit

- API for developing and running portable grid applications independently of the underlying grid infrastructure and available services
- Simple API
- GAT Adaptors (“plugins”) connect GAT to grid services (Globus, Unicore, SSH, ProActive, ...)

Java GAT users

- The Virtual Labs for E-science project (Vl-e)
  - AMOLF, Institute for Atomic and Molecular Physics, SP 1.6
  - Vrije Universiteit Amsterdam, SP 3.1
  - VU Medical Center Amsterdam, SP 1.3
  - Vbrowser, SP 2.5 / SP 1.3
- The Multimedian project
- Max Planck Institute for Astrophysics in Garching
- D-Grid, Astrogrid
- Louisiane State University
- University of Texas
- The workflow system Triana (University of Cardiff)
- Georgia State University
- Zuse Institute Berlin, Germany
- Download is anonymous, so we don't know

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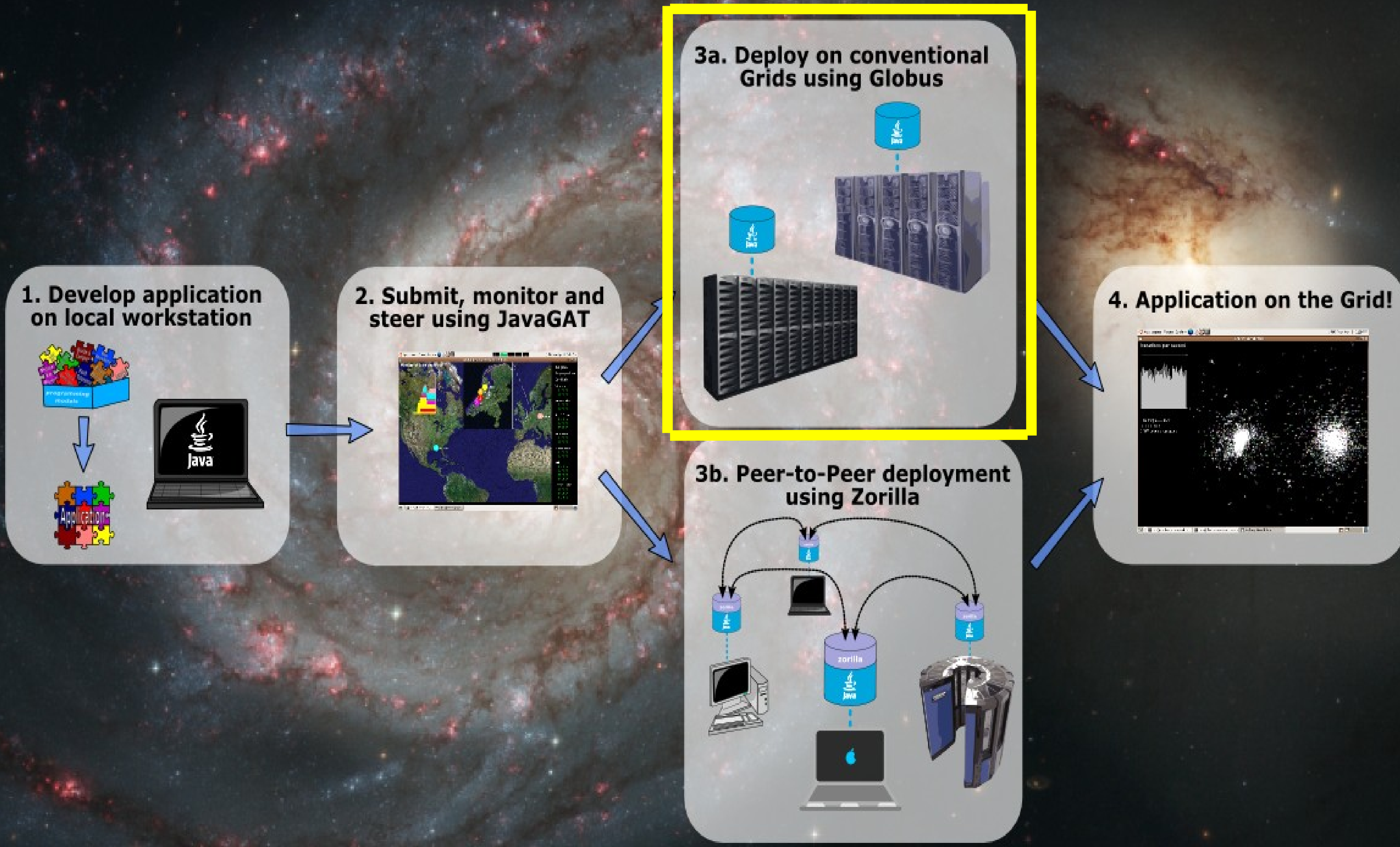
rapid prototyping environment: DAS-3
(also works on proof of concept environment)



Demo …

Distributed supercomputing

- Parallel processing on geographically distributed computing systems (grids)
- Our goals:
  - Don’t use individual supercomputers / clusters, but combine multiple systems
  - Provide high-level programming support

Optimizing for the grid

- Grids usually are hierarchical
  - Collections of clusters, supercomputers
  - Fast local links, slow wide-area links
- Optimize algorithms to exploit hierarchy
  - Message combining + latency hiding on wide-area links
  - Collective operations for wide-area systems
  - Successful for many applications

Satin master-worker

- Master-worker parallelism
  - Divide work into parts
  - Spawn job for each part
  - Solve parts in parallel
  - Combine results

Satin divide-and-conquer

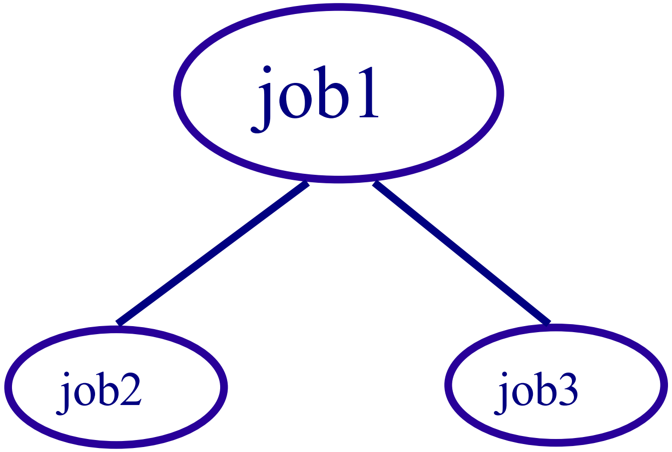
- Parallel Divide-and-conquer
  - Divide work into parts
  - Spawn job for each part
  - Solve parts in parallel
  - Combine results
  - But now recursively!
  - sub-problems split the work up further and spawn their own sub-jobs

Satin

- Divide-and-conquer

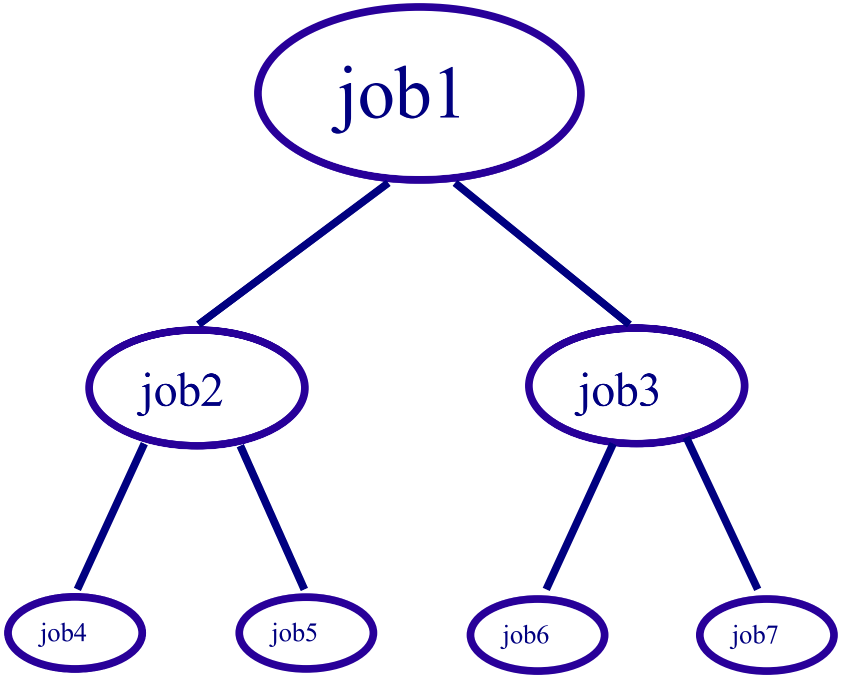
Satin

- Divide-and-conquer



Satin

- Divide-and-conquer



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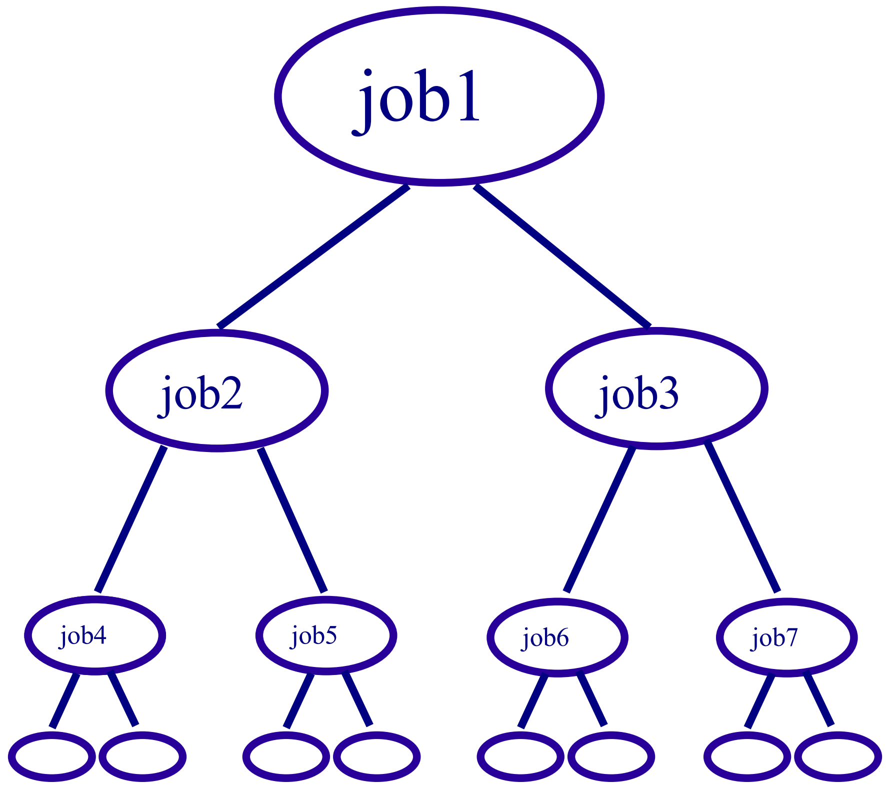
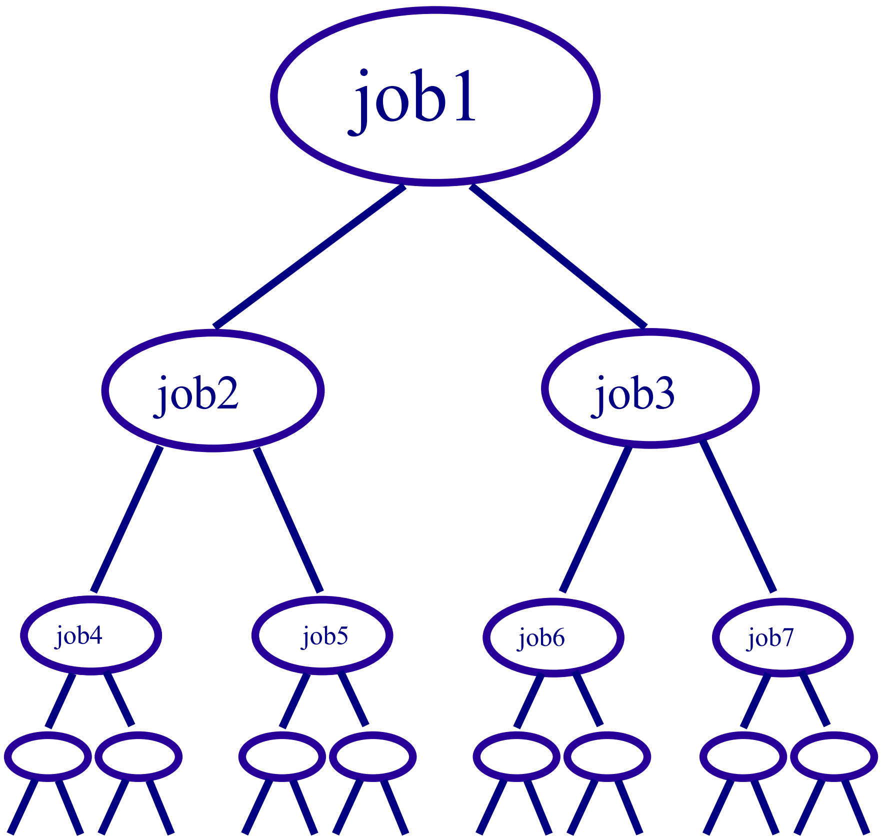
Satin

- Divide-and-conquer



Satin

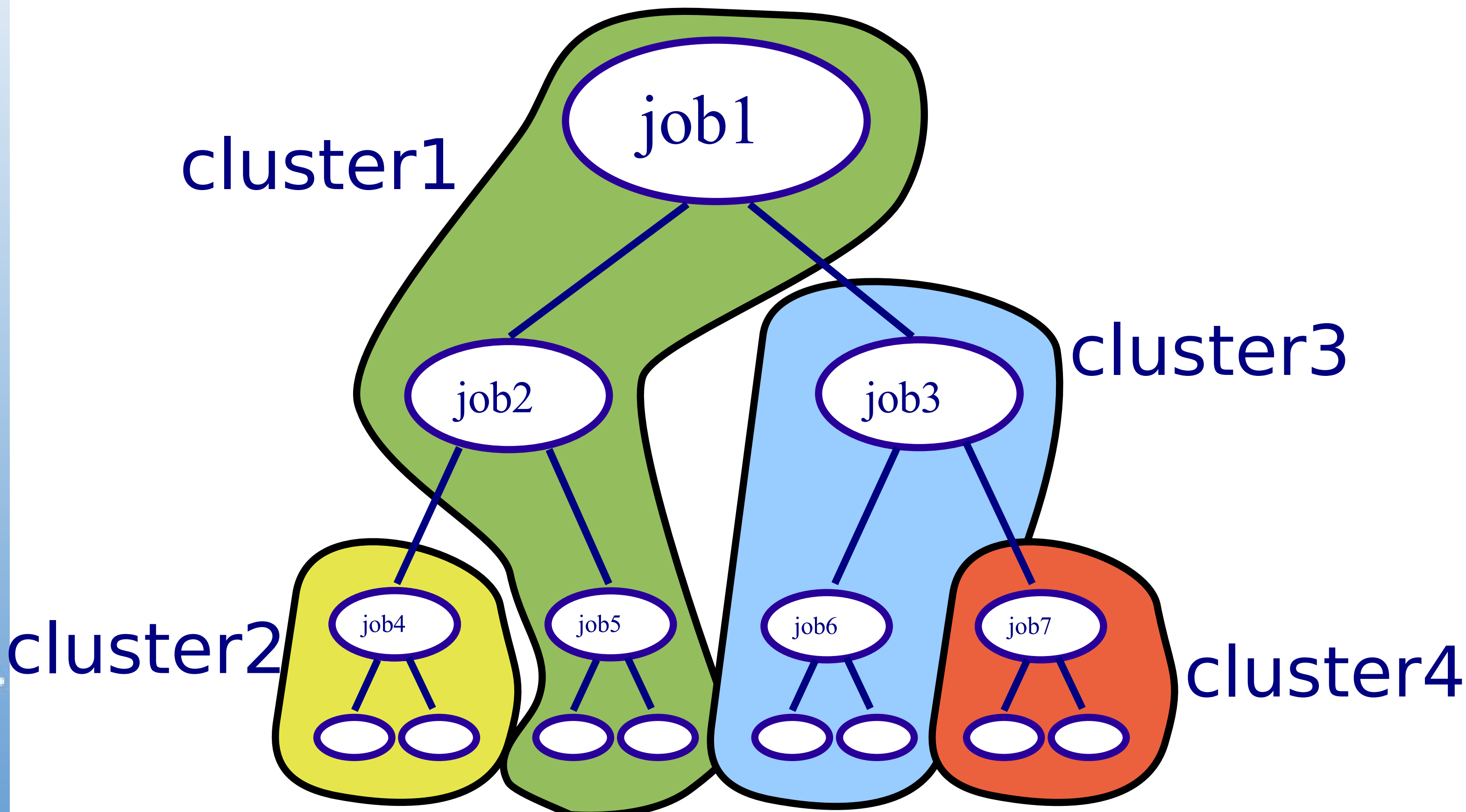
- Divide-and-conquer



... millions of jobs ...

Satin

- Fits hierarchical structure of Grids



The Grid

- Satin explicitely targets the grid
- Different architectures
- Firewalls
- Slow networks (latency)
- Distributed memory
- Machines come and go
- Machines crash
- Machines have different speeds

Barnes-Hut Nbody code

```
// Marker interface that defines updateBodies as a global method.
interface BodiesInterface extends satin.GlobalMethods {
  void updateBodies(BodyUpdates b, int iter);
}

// A shared object containing the tree of bodies.
class Bodies extends satin.SharedObject implements BodiesInterface {
  BodyTreeNode root;

  void updateBodies(BodyUpdates b, int iter) { // Global method.
    root.applyUpdates(b, iter); // Update bodies in our tree.
  }

  BodyTreeNode getRoot() { // Local method.
    return root;
  }
}

// Mark the computeForces method as a spawn operation.
interface BHSpawns extends satin.Spawnable {
  BodyUpdates computeForces(Subtree s, int iter, Bodies bodies);
}

class BarnesHut extends satin.SatinObject implements BHSpawns {
  boolean guard_computeForces(Subtree s, int iter, Bodies bodies) {
    return bodies.iter + 1 == iter;
  }

  // Spawnable method. The "bodies" parameter is a shared object.
  BodyUpdates computeForces(Subtree s, int iter, Bodies bodies) {
    if(s.hasNoChildren) {
      computeSequentially(s, iter, bodies.getRoot());
    } else { // Divide the work and spawn tasks (recursion step).
      for(int i=0; i<s.nrChildren; i++) {
        res[i] = computeForces(s.child[i], iter, bodies); // Spawn.
      }
      sync(); // Wait for the spawn operation to finish.

      return mergeSubresults(res); // Merge results and return.
    }
  }

  public static void main(String[] args) {
    BarnesHut bh = new BarnesHut();
    Bodies bodies = new Bodies(); // Create shared object.
    for (int iter = 0; iter < N; iter++) {
      results = bh.computeForces(root, iter, bodies); // Spawn.
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      bodies.update(results, iter); // Shared method invocation.
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```
boolean guard_computeForces(Subtree s, int iter, Bodies bodies) {
  return iter == bodies.iter + 1;
}
```

```
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```

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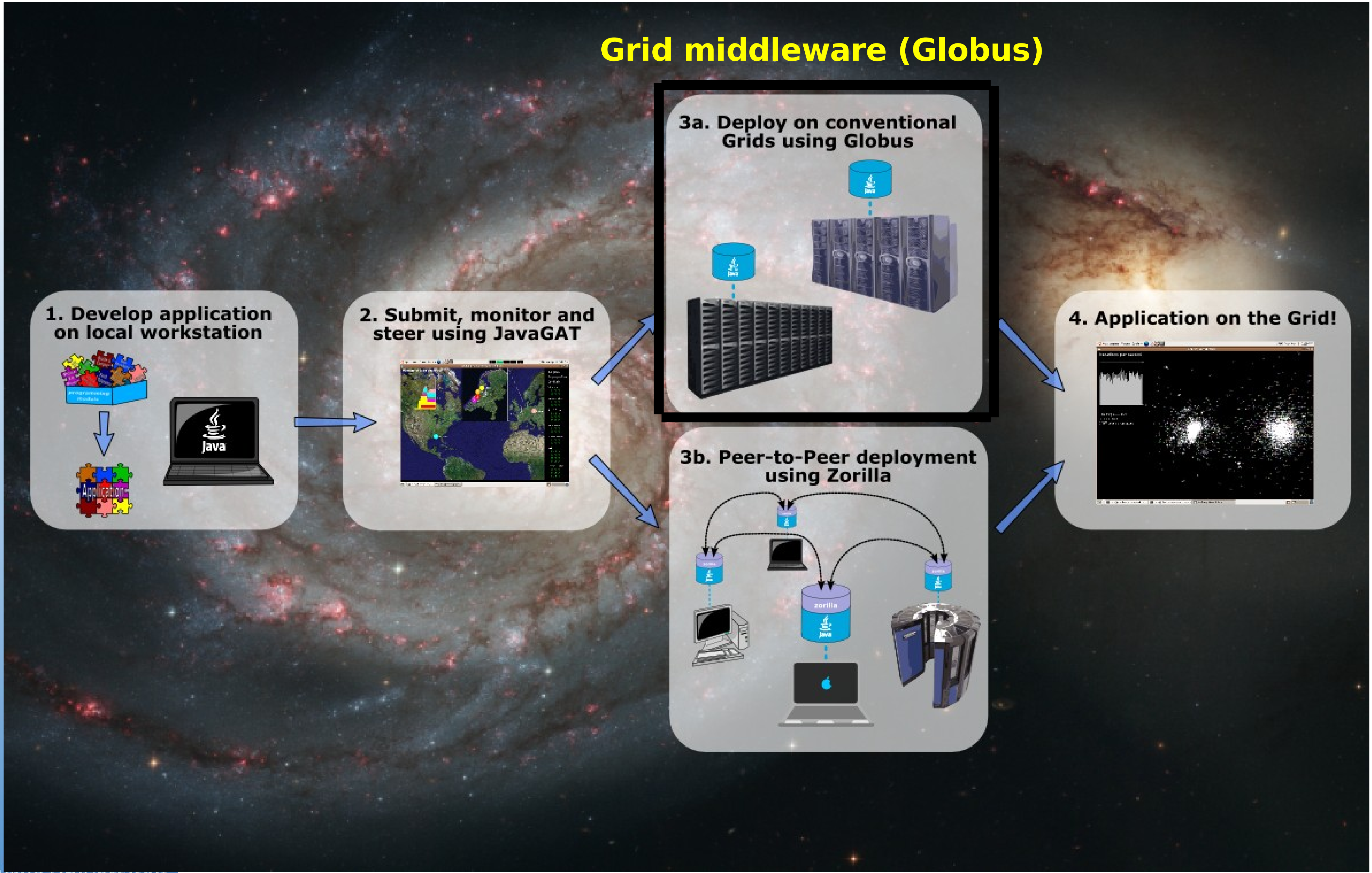
Application Example



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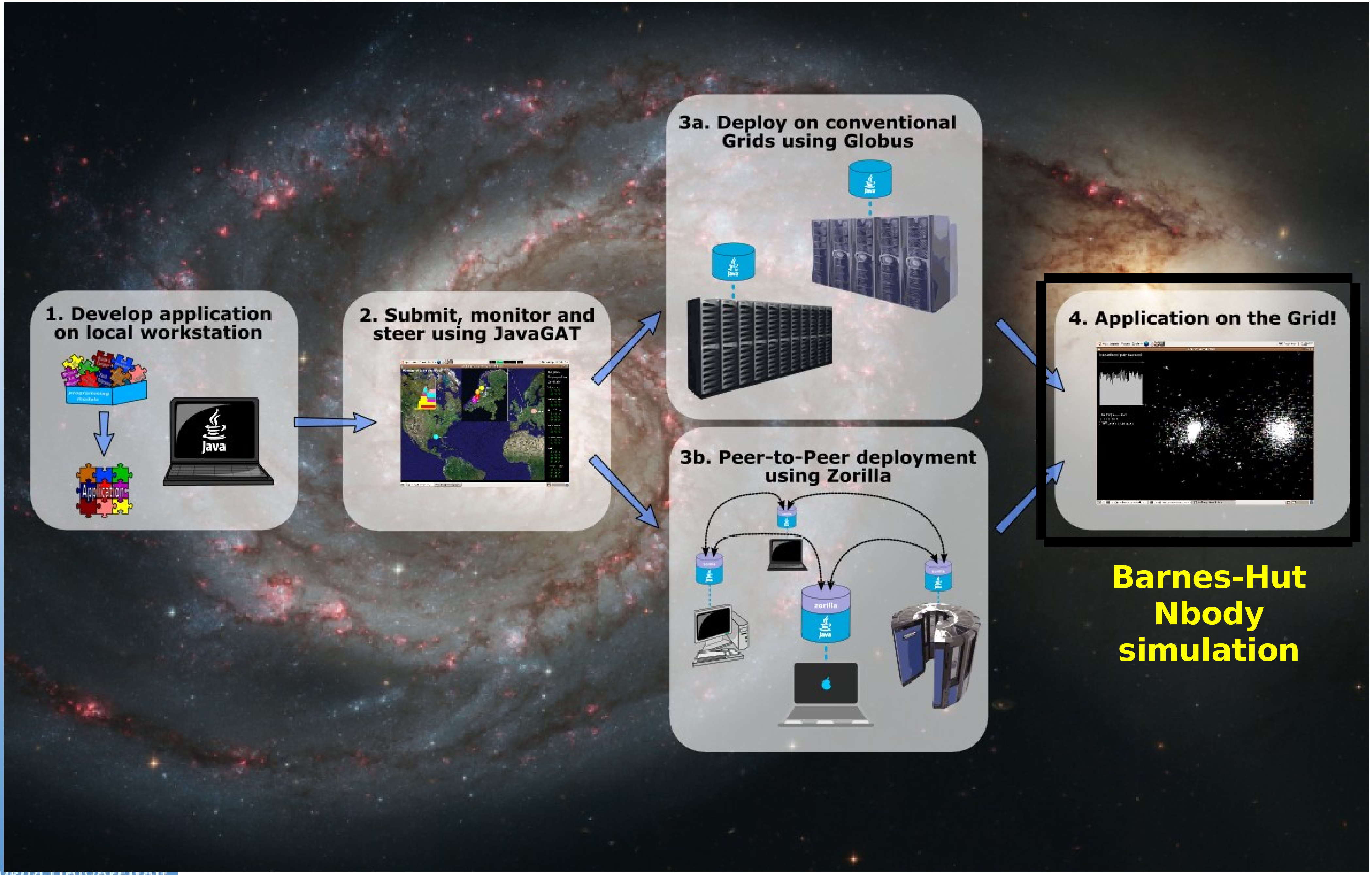

Barnes-Hut Nbody simulation

Sequential Fibonacci

```
public long fib(int n) {
        if (n < 2) return n;

        long x = fib(n - 1);
        long y = fib(n – 2);

        return x + y;
}
```

Parallel Fibonacci

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interface FibInterface extends ibis.satin.Spawnable {
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Mark methods as

Spawnable.

They can run in parallel.

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```
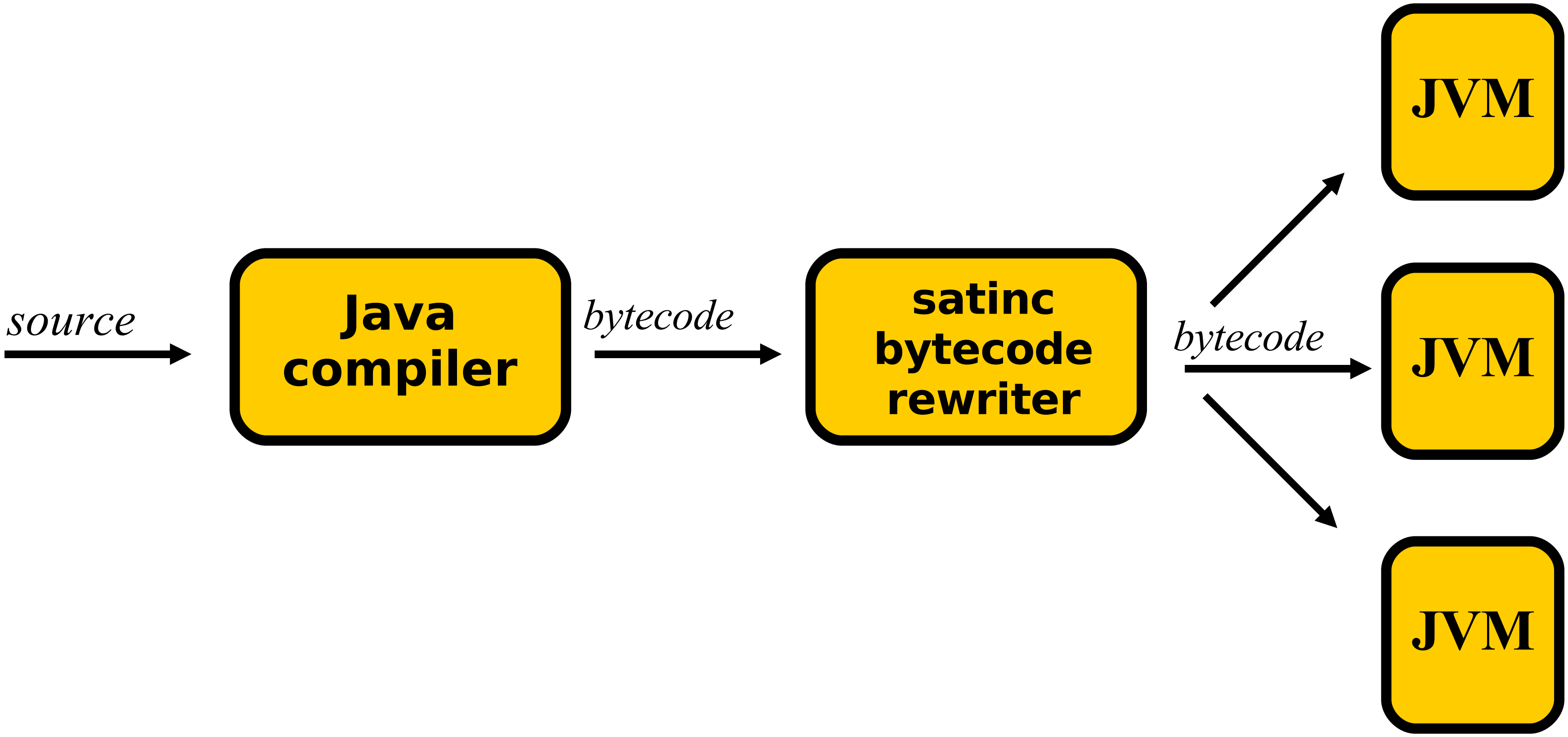

Mark methods as
Spawnable.
They can run in parallel.

Wait until spawned methods are done.

Compiling Satin Programs



Java GAT API features

- Security (deal with passwords, credentials, etc)
- Grid I/O
  - File operations, remote file access, file replication
  - Inter-process communication
- Resource Management
  - Resource brokering
  - Forking grid applications, job management
- Application Information Management
  - Global repository for application specific information
  - Query this information repository
- Monitoring
  - Grid monitoring
  - Application monitoring and steering

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Java GAT File example

```
public class RemoteCopy {
    public static void main(String[] args) {
        GATContext context = new GATContext();

        URI src = new URI(args[0]);
        URI dest = new URI(args[1]);
        File file = GAT.createFile(context, src);
        file.copy(dest);
        GAT.end();
    }
}
```