

From Grid to Clouds: GCM TC Grid Standards and Genomic Sequencing

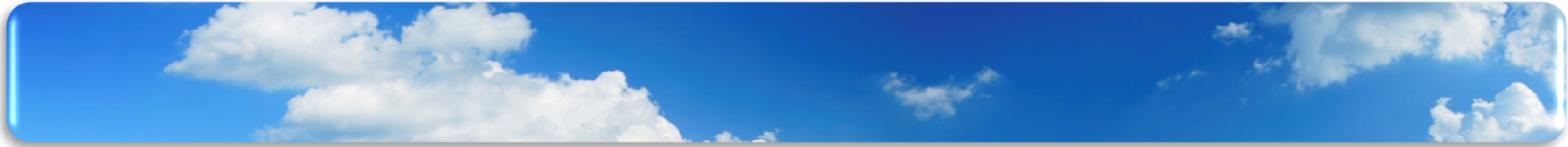
D. Caromel, et al.



1. Background
2. Cloud Computing
GCM & Grid Plustests

3. ProActive Parallel Suite:
Programming, Scheduling, Resourcing
4. Genomic, Cloud Seeding

Non Intrusive Cloud Computing



1. Background

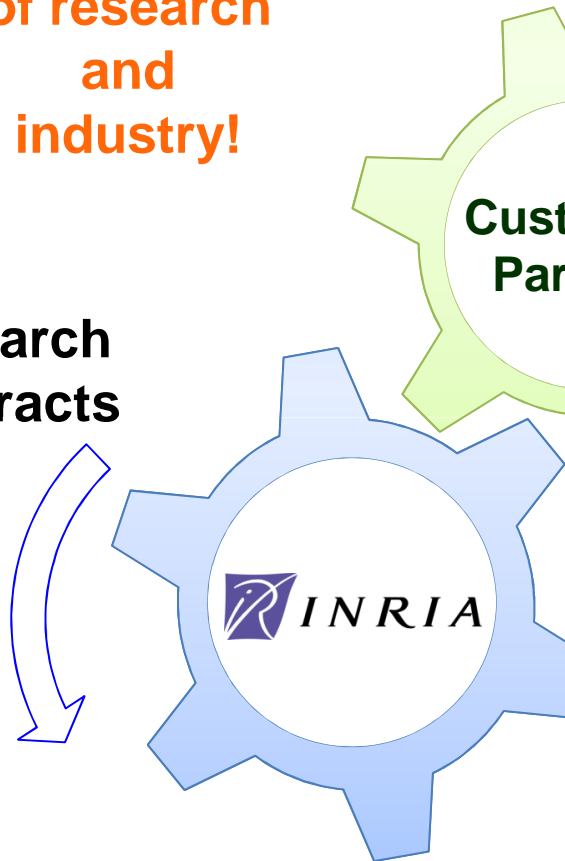
- A Research team, about 35 persons
- 2004: First ProActive User Group
- 2009, April: ProActive 4.1, Distributed & Parallel:
From Multi-cores to Enterprise GRIDs & Clouds



ActiveEon and INRIA synergy

The best
of research
and
industry!

Research
Contracts



ProA
Paralle



Located in Sophia Antipolis, between
Nice and Cannes,
Visitors Welcome!

ActiveEon Company Overview (1)



ACTIVEeon
SCALE BEYOND LIMITS

- ❑ Co-developing, Support for [ProActive Parallel Suite](#)
- ❑ Worldwide Customers:
Fr, UK, USA

Selected Partners:

Microsoft **ORACLE**



ProACTIVE
Parallel Suite





2. Cloud Computing and Plugtests

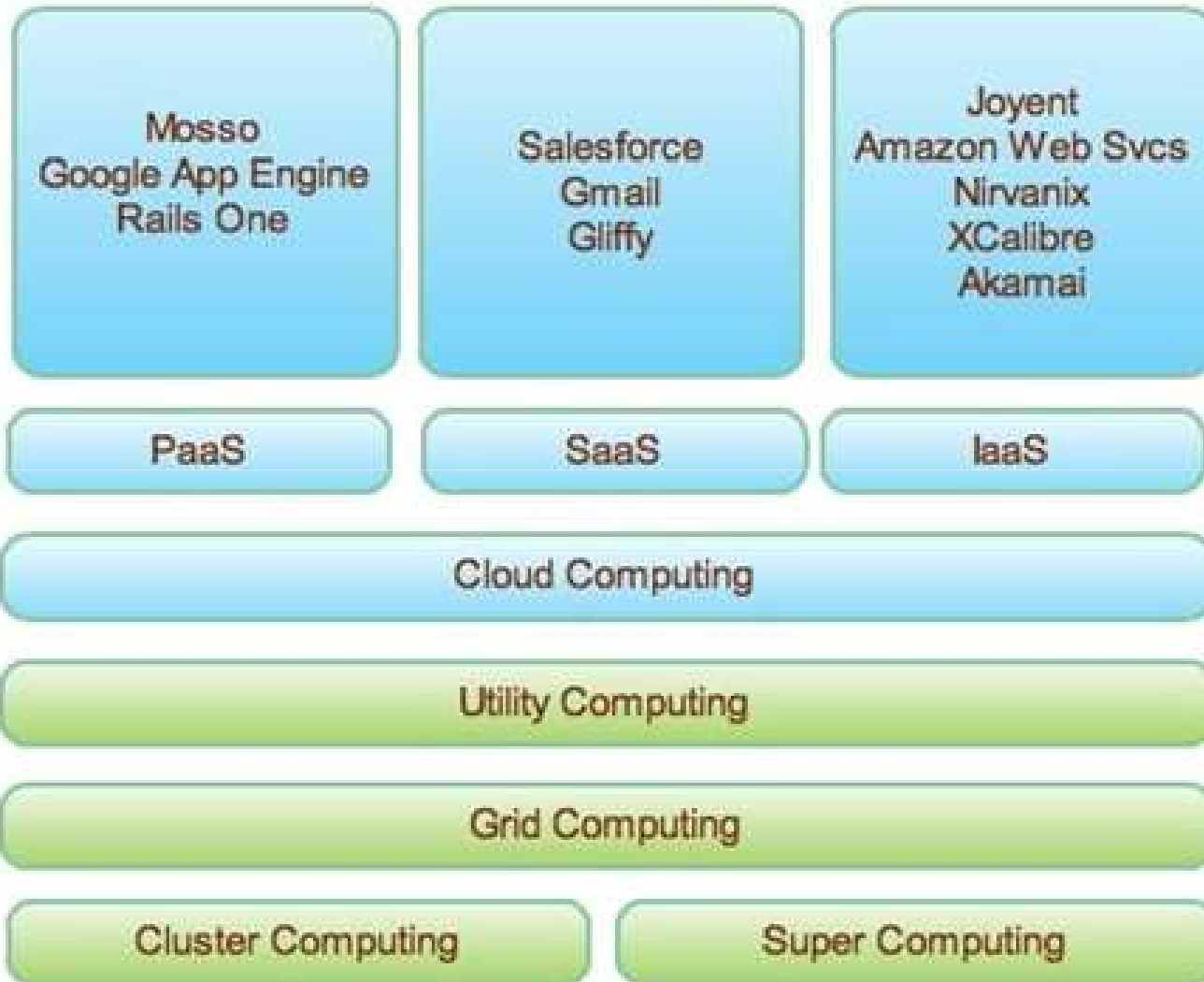
Clouds: Basic Definition

- ❑ Dynamically scalable, often virtualized resources
- ❑ Provided as a service over the Internet
- ❑ Users need not have knowledge of, expertise in, or control over the technology infrastructure

- ❑ Software as a service (SaaS), CRM, ERP
- ❑ Platform as a service (PaaS), Google App Engine
- ❑ Infrastructure as a service (IaaS), Amazon EC2

XaaS
You-Name-It as a Service

Clouds in Picture



From Grids to Clouds

□ Grid Computing

- Several administrative Domains
- Virtual Organizations
- Trading not based on Currency

→ (Too) Hard

□ Still a strong need for Sharing, On-Demand: Cloud

- “*Cloud Federation*”: please no VO
- Standard APIs is the minimum, but Hard (WS)!
- Maybe more on std Archi + Semantics

Distributed, //, & Grid Technologies for Clouds



Grid Plugtests: 2004 to 2008

Open Source

PLUGTESTS™
INTEROP EVENTS

GRIDS for Finance
& Telecommunications

V GRIDS@WORK

20-24 October 2008
INRIA – Sophia Antipolis - FRANCE

INTEROP

2004
French Riviera
SOPHIA ANTIPOLIS
ETSI • 18-20

▶ A LARGER EVENT INVOLVING
& SOLUTION PROVIDERS IS

REGULAR SPONSORS:

ACADEMIC SPONSORS:

Information & Registration: www.etsi.org/plugtests/GRID2008/GRID.htm

▶ With the support of



▶ European partners



▶ Sponsors



▶ Co-Organizers



From 2004 to 2008:

□ 2004 Grid Plugtests:

Winner: Univ CHILE

Deployed 560 Workers all over the world
on a very heterogeneous infrastructure (no VO)

□ 2008 Grid Plugtests:

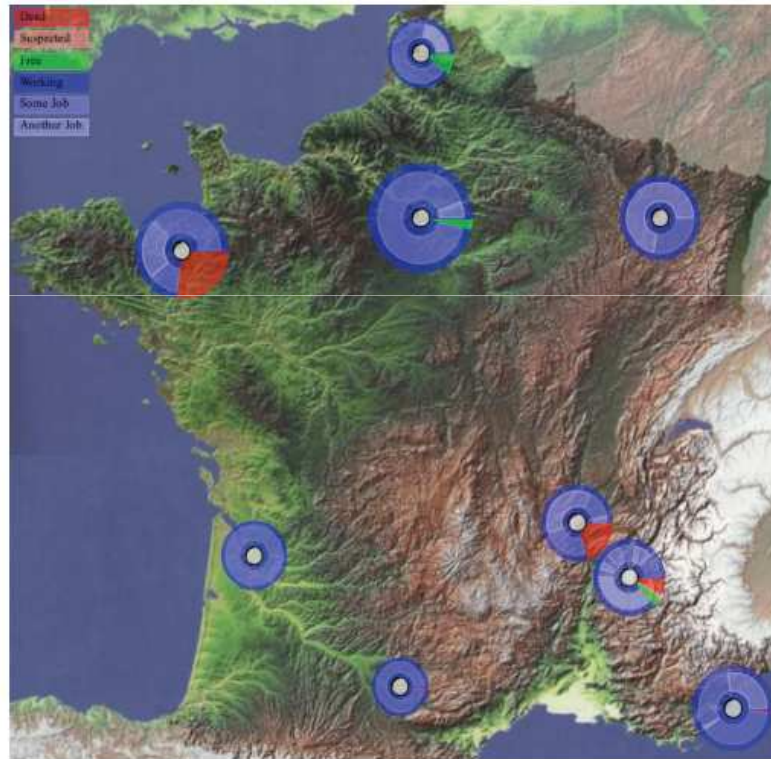
KAAPI, MOAIS Grenoble: 3609 Nodes

ACT, China: Beihang University, Beijing, China:
4329 Nodes

Grid 5000 - ALADDIN



Grid'5000*



Lille:

500 (198)

Orsay

1000 (684)

Nancy:

500 (334)

Lyon

500 (252)

Grenoble

500 (270)

Rennes

522 (522)

Toulouse

500 (116)

Bordeaux

500 (198)

Sophia Antipoli

500 (434)



27/0



INRIA

Renater



CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

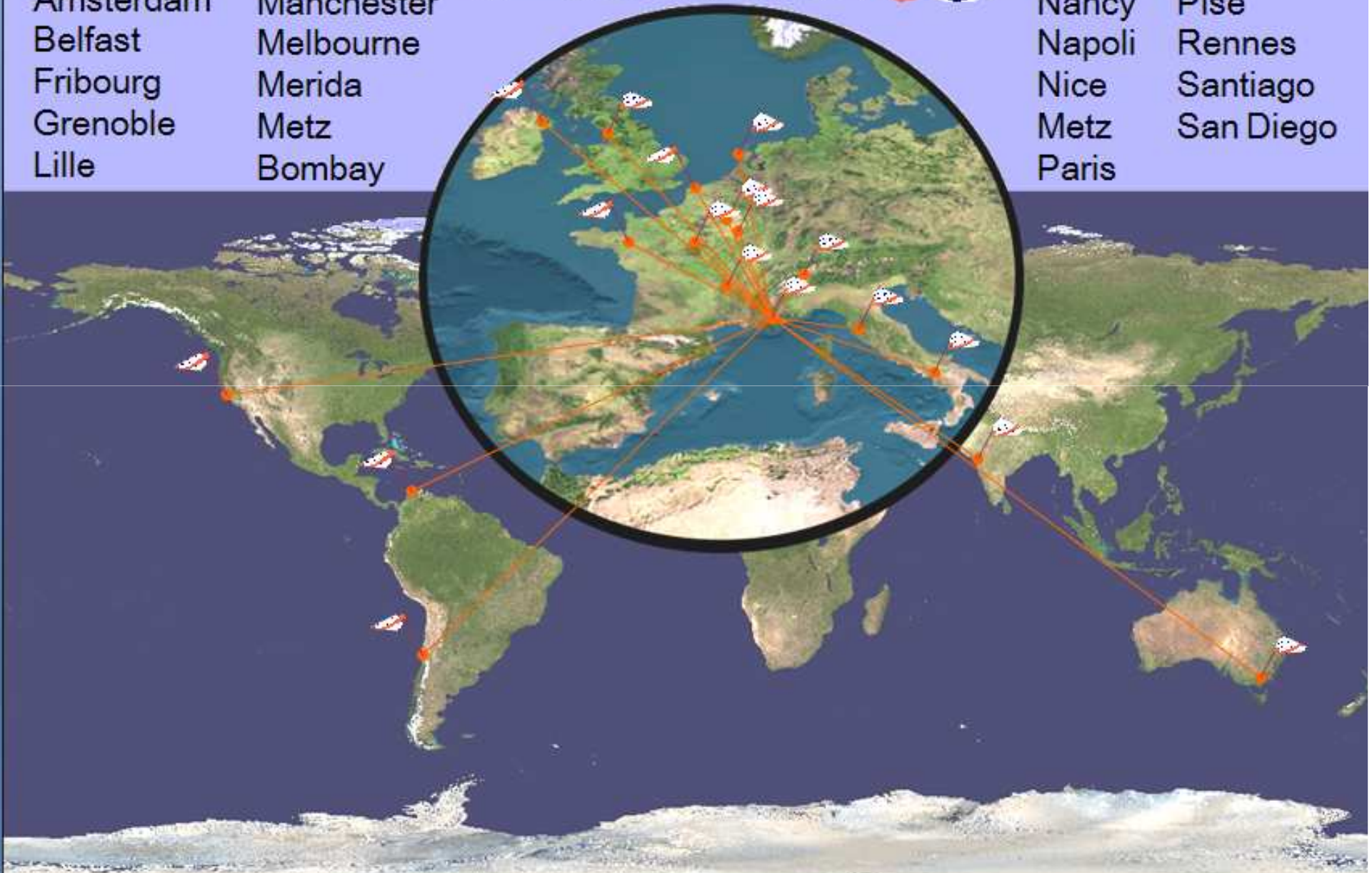


Amsterdam
Belfast
Fribourg
Grenoble
Lille

Manchester
Melbourne
Merida
Metz
Bombay

Nancy
Napoli
Nice
Metz
Paris

Pise
Rennes
Santiago
San Diego



Infrastructure tested in Plugtests and in GCM Deployment Standard

□ Protocols:

- Rsh, ssh
- Oarsh, Gsissh

□ Scheduler, and Grids:

- GroupSSH, GroupRSH, GroupOARSH
- ARC (NordGrid), CGSP China Grid, EEGE gLITE,
- Fura/InnerGrid (GridSystem Inc.)
- GLOBUS, GridBus
- IBM Load Leveler, LSF, Microsoft CCS (Windows HPC Server 2008)
- Sun Grid Engine, OAR, PBS / Torque, PRUN

□ Clouds:

- Amazon EC2

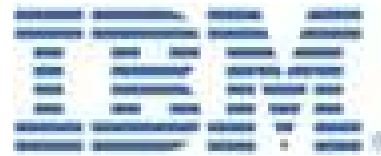
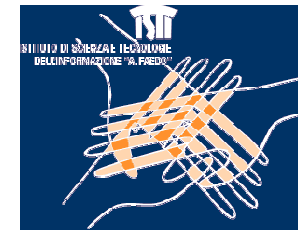
GCM Standardization: TC Grid



4 Standards:

1. GCM Interoperability Deployment
2. GCM Application Description
3. GCM Fractal ADL
4. GCM Management API (pending)

EU Project: GridCOMP Partners

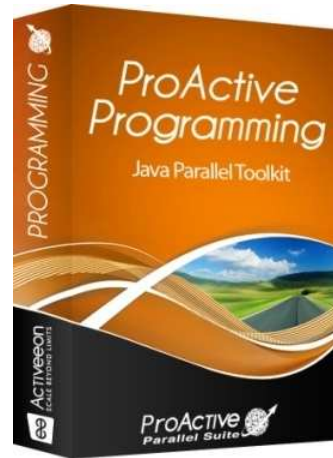




3. ProActive Parallel Suite

ProActive Parallel Suite

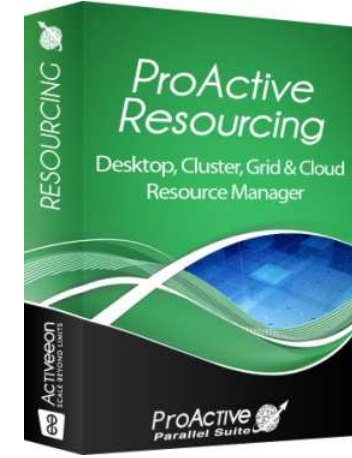
ProActive
Parallel Suite



**Java Parallel
Toolkit**



**Multi-Platform
Job Scheduler**



**Resource
Manager**

amaDEUS
Your technology partner

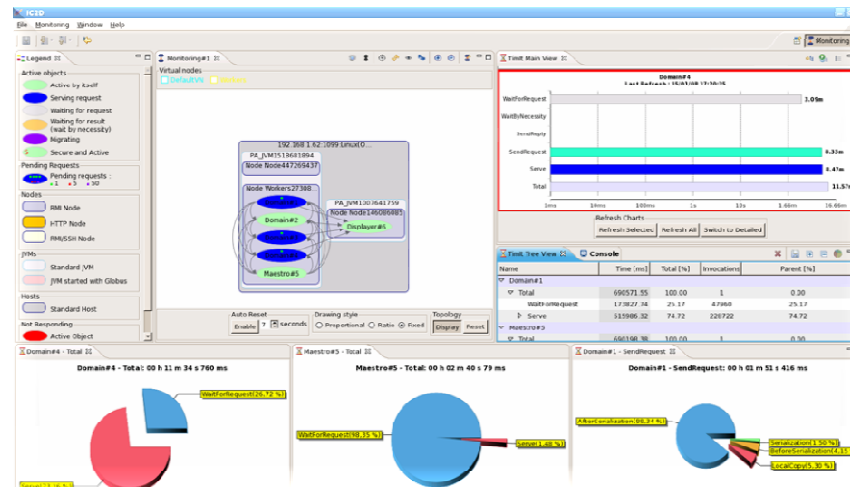
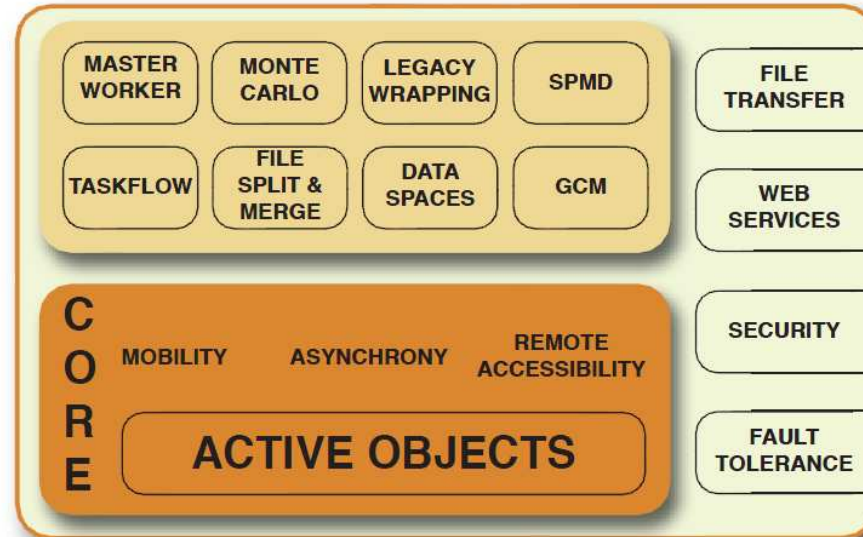
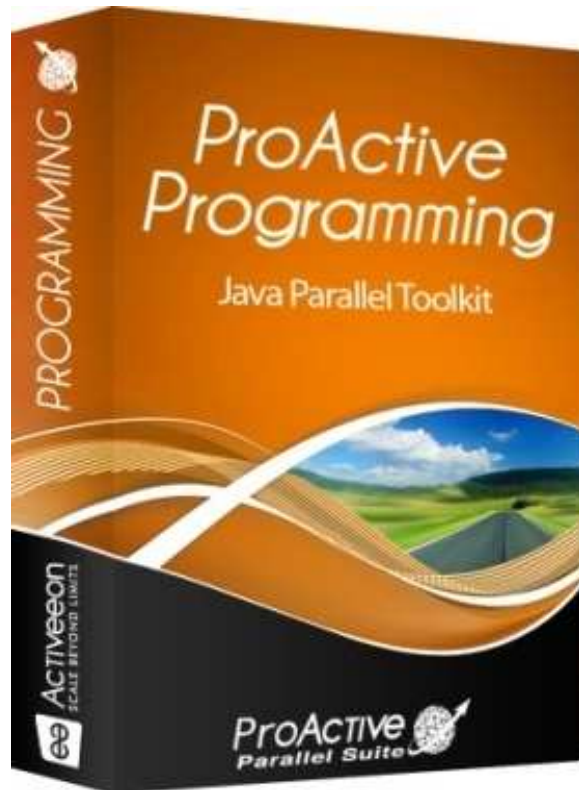
Used in Production everyday:
50 Cores → 300 Cores early 2010

Strong Features:

- ❑ Java Parallel Programming + Legacy + Integration +
- ❑ Portability: Windows, Linux, Mac +
- ❑ Versatility: Desktops, Cluster, Grid, Clouds = Perfect Flexibility

ProActive
Parallel Suite

ProActive Programming



Optimizing GUI: IC2D

Monitoring View

Job Monitoring View

The screenshot displays the Eclipse IDE's Monitoring View, which is used for visualizing the execution of a Java application. The main window is titled "Monitoring - Eclipse SDK" and contains a menu bar (File, Edit, Navigate, Search, Project, Run, Control, Monitoring, Window, Help) and a toolbar. The central area is divided into two main panes:

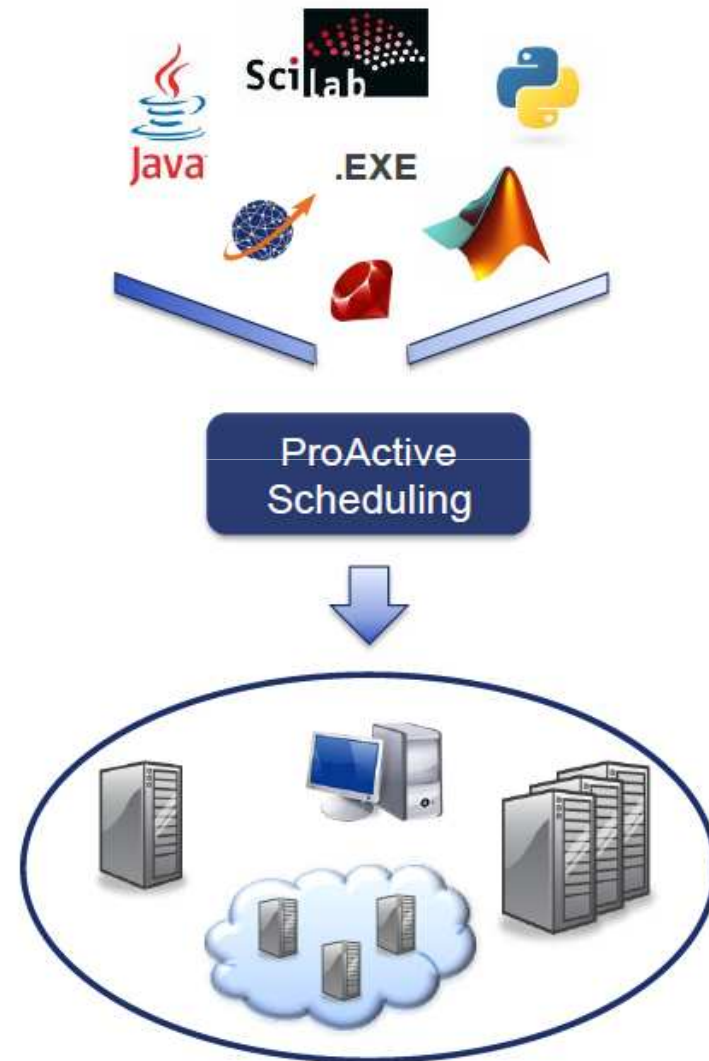
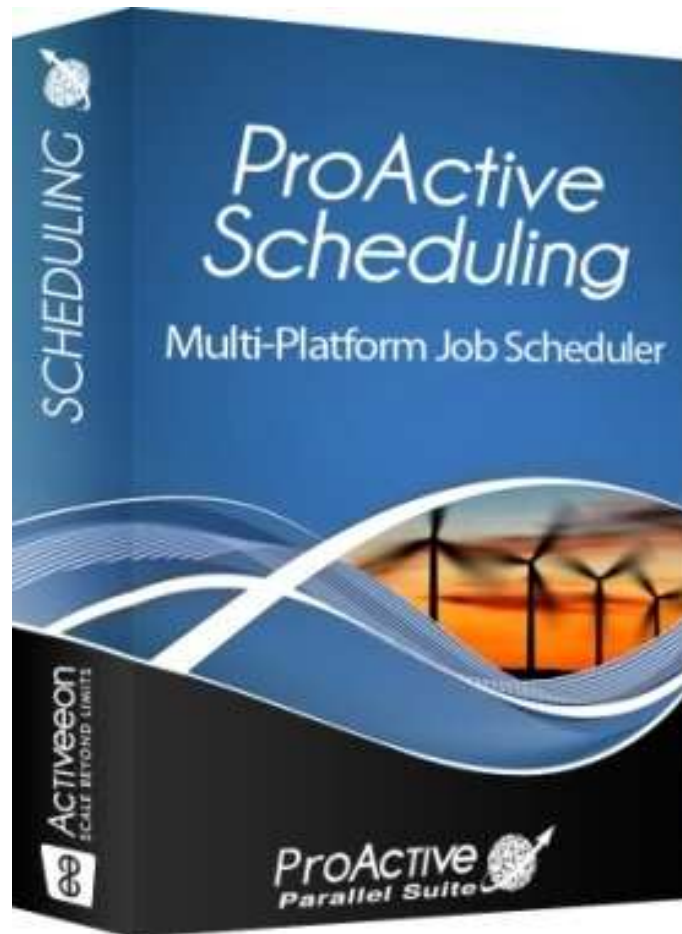
- Monitoring View (Left):** This pane shows a hierarchical tree of virtual nodes. The root node is "Virtual nodes" with sub-nodes for "Renderer", "DefaultVN", "Dispatcher", and "User". Below this, a large diagram shows a network of nodes connected by lines. The nodes include "DinnerLayout#2", "Table#3", "Philosopher#4" through "Philosopher#8", "Node Renderer#427...", "Node Dispatcher#5...", "Node User#1602646...", and "Node Renderer#1307...". Each node is associated with a specific job ID (e.g., PA_JVM-436155261_be...). The diagram is titled "bebita.inria.fr:1099:OS u...".
- Legend (Right):** This pane provides a visual key for the nodes in the Monitoring View. It lists the nodes and their corresponding colors and shapes: "DinnerLayout#2" (red circle), "Table#3(JOB-13" (red circle), "Philosopher#4(J" (red circle), "Philosopher#5(J" (red circle), "Philosopher#6(J" (red circle), "Philosopher#7(J" (red circle), "Philosopher#8(J" (red circle), "Dispatcher (JOB--16720764" (blue square), "User (JOB--294719007)" (blue square), "Node User#160264" (blue square), and "C3DUser#13(JC" (red circle).

At the bottom of the Monitoring View, there are several checkboxes and buttons: "Display topology" (checked), "Proportional" (unchecked), "Ratio" (unchecked), "Filaire" (checked), "Reset Topology", and "Monitoring enable" (checked).

The Console window at the bottom shows the following log message:

```
15:09:15 => NodeObject id=Node-455186381 already monitored, ckeck for new active objects
```

ProActive Scheduling



ProActive Scheduling Big Picture

The screenshot displays the ProActive Scheduler interface with three main panels: Pending jobs, Running jobs, and Finished jobs. A 'RESUMED' banner is visible across the bottom of the job lists. Below the job lists, the 'Console' panel shows details for job 2008, including a table of tasks and their states. The 'Job Info' panel provides summary statistics for the selected job.

Pending (674)

Id	State	User	Priority	Name
1996	Pending	jl	Normal	job_with_cep
1997	Pending	jl	Normal	job_with_cep
1998	Pending	jl	Normal	job_with_cep
1999	Pending	jl	Normal	job_with_cep
2000	Pending	jl	Normal	job_with_cep
2001	Pending	jl	Normal	job_with_cep
2002	Pending	jl	Normal	job_with_cep
2003	Pending	jl	Normal	job_with_cep
2004	Pending	jl	Normal	job_with_cep
2005	Pending	jl	Normal	job_with_cep
2006	Pending	jl	Normal	job_with_cep
2007	Pending	jl	Normal	job_with_cep
2008	Pending	jl	Normal	job_with_cep
2009	Pending	jl	Normal	job_with_cep
2010	Pending	jl	Normal	job_with_cep

Running (60)

Id	State	Progress	# Finished	User	Priority
1313	Running	4/8	4/8	user1	Normal
1314	Running	4/8	4/8	user1	Normal
1315	Running	7/8	7/8	admin	Normal
1316	Running	4/8	4/8	user1	Normal
1317	Running	7/8	7/8	admin	Normal
1318	Running	4/8	4/8	user1	Normal
1319	Running	7/8	7/8	admin	Normal
1320	Running	3/8	3/8	user1	Normal
1321	Running	7/8	7/8	admin	Normal
1322	Running	3/8	3/8	user1	Normal
1323	Running	7/8	7/8	admin	Normal
1324	Running	2/8	2/8	user1	Normal
1325	Running	2/8	2/8	user1	Normal
1326	Running	2/8	2/8	user1	Normal
1327	Running	2/8	2/8	user1	Normal

Finished (31)

Id	State	User	Priority	Name
010	Finished	jl	Low	job_proActive
008	Finished	jl	Low	job_proActive
005	Finished	jl	Low	job_proActive
001	Finished	jl	Low	job_proActive
006	Finished	jl	Low	job_proActive
004	Finished	jl	Low	job_proActive
003	Finished	jl	Low	job_proActive
009	Finished	jl	Low	job_proActive
007	Finished	jl	Low	job_proActive
002	Finished	jl	Low	job_proActive
245	Finished	user1	Normal	job_wth_dep
246	Finished	user1	Normal	job_wth_dep
247	Finished	user1	Normal	job_wth_dep
252	Finished	admin	Normal	job_wth_dep
253	Finished	admin	Normal	job_wth_dep

Console

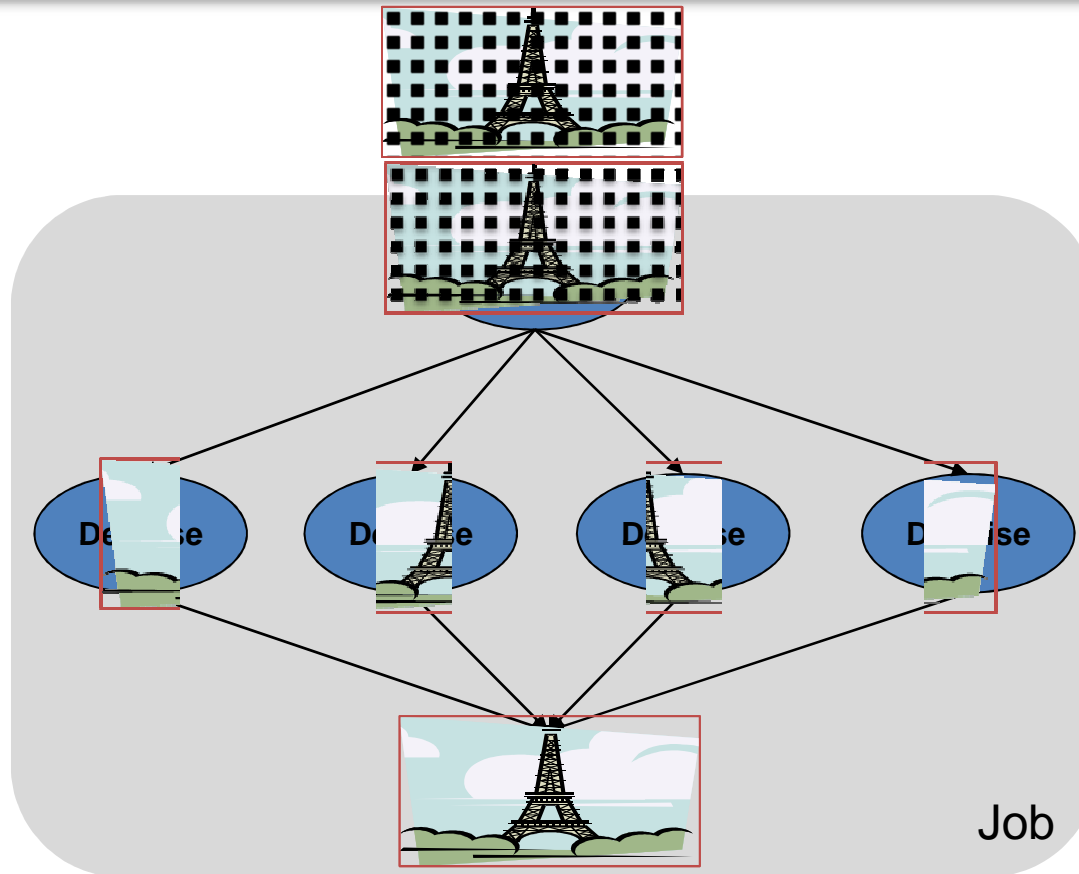
job 2008 has 8 tasks

Id	State	Name	Host name	Start time	Finished time	Re-run	Description
200800	Submitted	task4	n/a	Not yet	Not yet	0/2	This task will sleep 5s
200800	Submitted	task2	n/a	Not yet	Not yet	0/1	This task will sleep 10s
200800	Submitted	task6	n/a	Not yet	Not yet	0/1	This task will sleep 8s
200800	Submitted	task1	n/a	Not yet	Not yet	0/2	This task will sleep 6s
200800	Submitted	task5	n/a	Not yet	Not yet	0/1	This task will sleep 2s
200800	Submitted	task7	n/a	Not yet	Not yet	0/2	This task will sleep 6s
200800	Submitted	task3	n/a	Not yet	Not yet	0/1	This task will sleep 4s
200800	Submitted	task8	n/a	Not yet	Not yet	0/1	This task will sleep 6s

Job Info

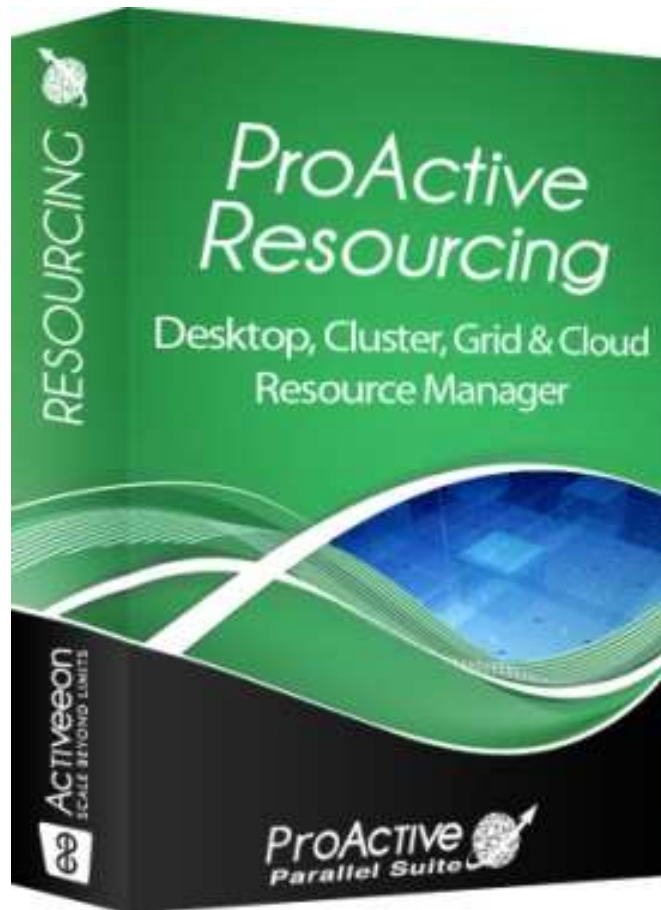
Property	Value
Id	2008
State	Pending
Name	job_with_dep
Priority	Normal
Pending tasks number	0
Running tasks number	0
Finished tasks number	0
Total tasks number	8
Submitted time	09:40:06 03/12/08
Started time	Not yet
Finished time	Not yet

TaskFlow Example : Picture Denoising

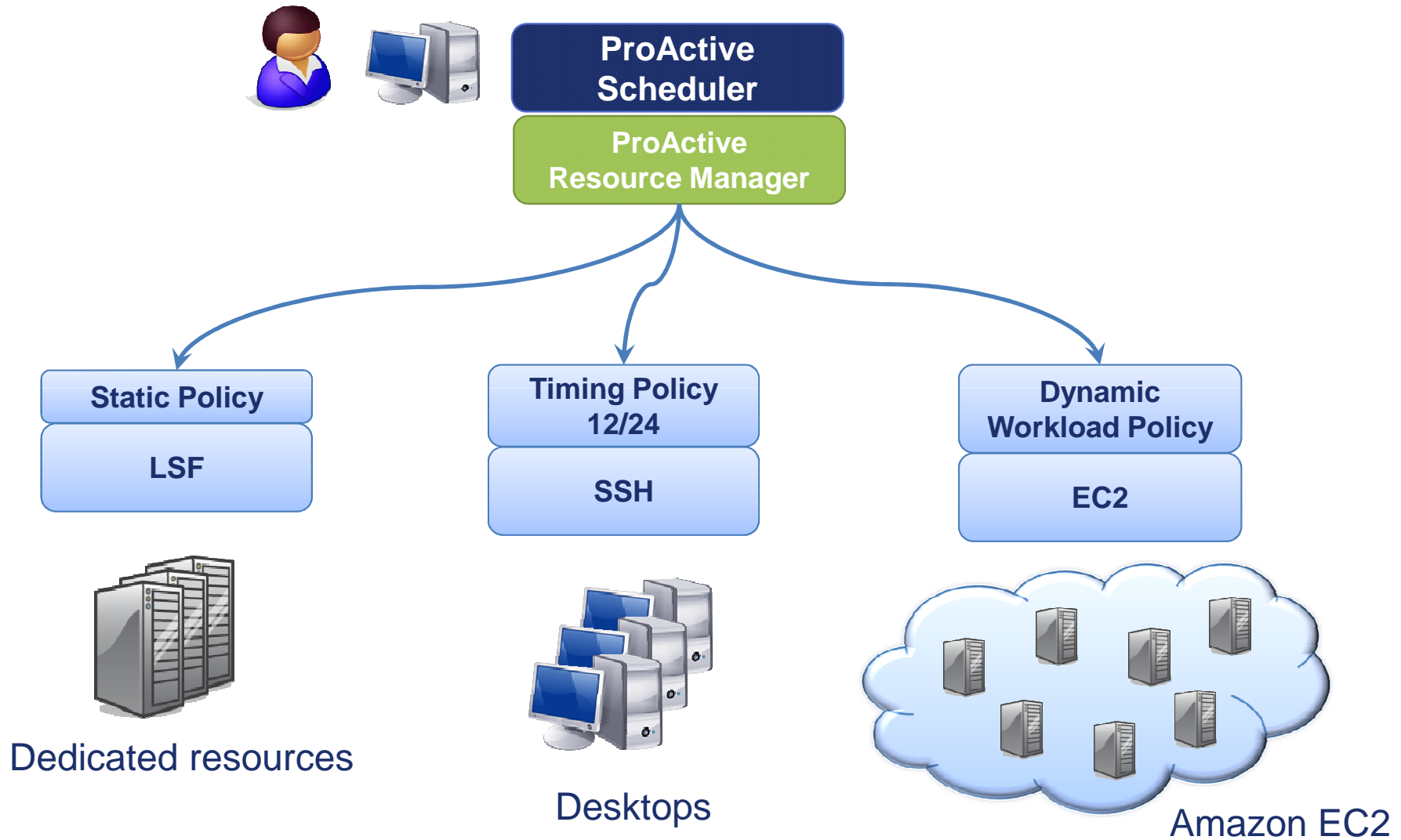


- with selection on native executable availability (ImageMagik, GREYstoration)
 - Multi-platform selection and command generation
- with file transfer

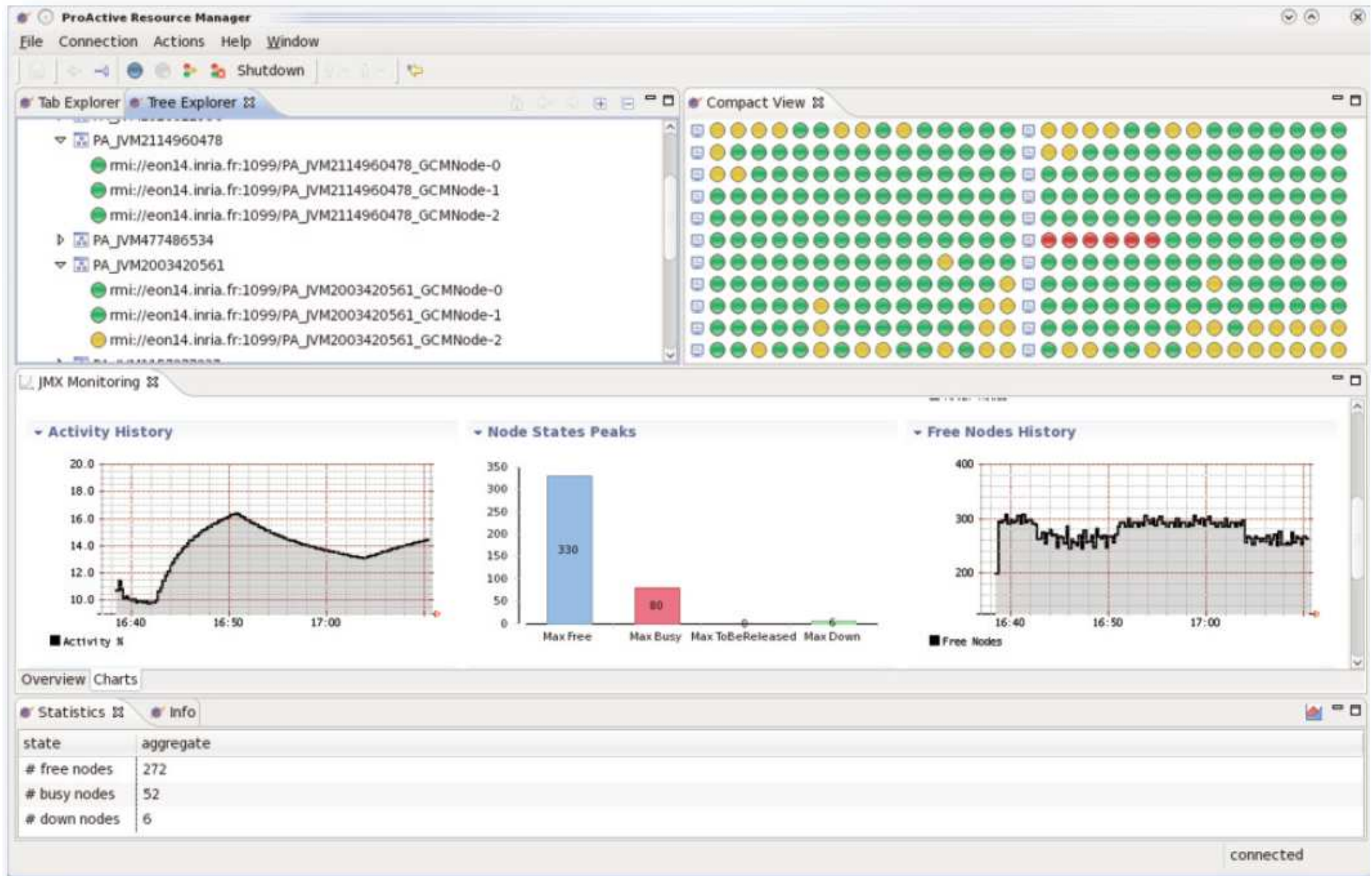
ProActive Resourcing



Versatility: Desktops, Grids, Clouds (EC2), Multi-Core, VMs (Hyper-V, Xen, VMware, Kvm)



RESOURCING User Interface





4. Use Case: Genomics

SOLiD and ProActive

- ❑ SOLiD Transcriptom Pipeline:
 - Genomic Sequencing Solution
 - Including Multi-language tools, partially ported on Windows
 - Pipelined with Java wrappers

- ❑ SOLiD Platform:
Hardware provided with preconfigured Linux solution
(based on Torque)

- ❑ Up to 20 days Long Computation !
 - ➔ *Need for extra computational power to reduce computation time*

- ❑ Many Windows Desktops are Available
 - ➔ *Need for a dynamic and multi-OS solution*

Resources set up

SOLID
machine from
AB Applied Biosystems



ProACTIVE
Parallel Suite

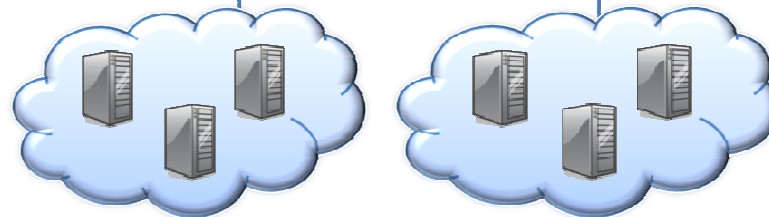


Cluster



Desktops

**Nodes
can be
dynamically
added!**

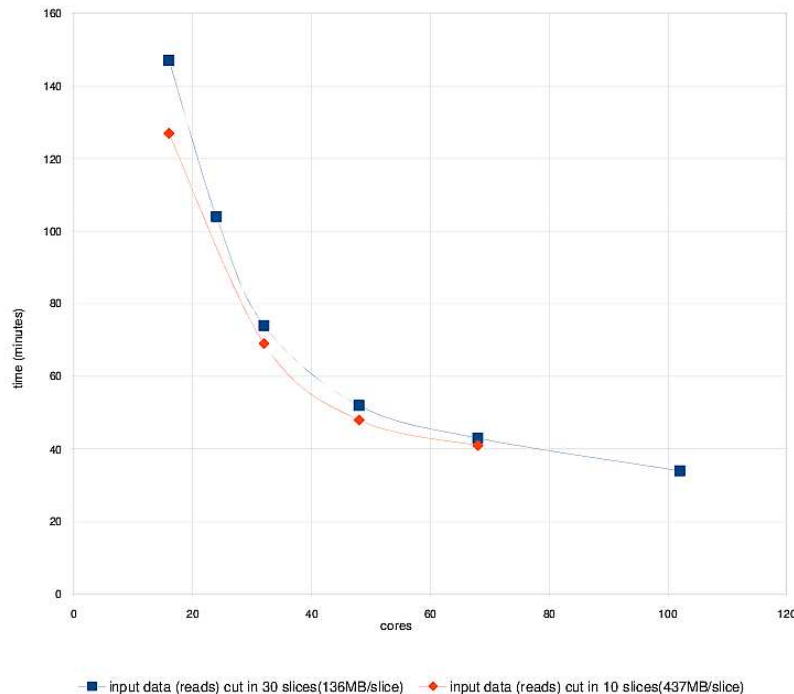


amazon
web services™
EC2

Clouds

First Benchmarks

- ❑ The distributed version with ProActive of Mapreads has been tested on the INRIA cluster with two settings: the Reads file is split in either 30 or 10 slices
- ❑ Use Case: Matching 31 millions Sequences with the Human Genome (M=2, L=25)



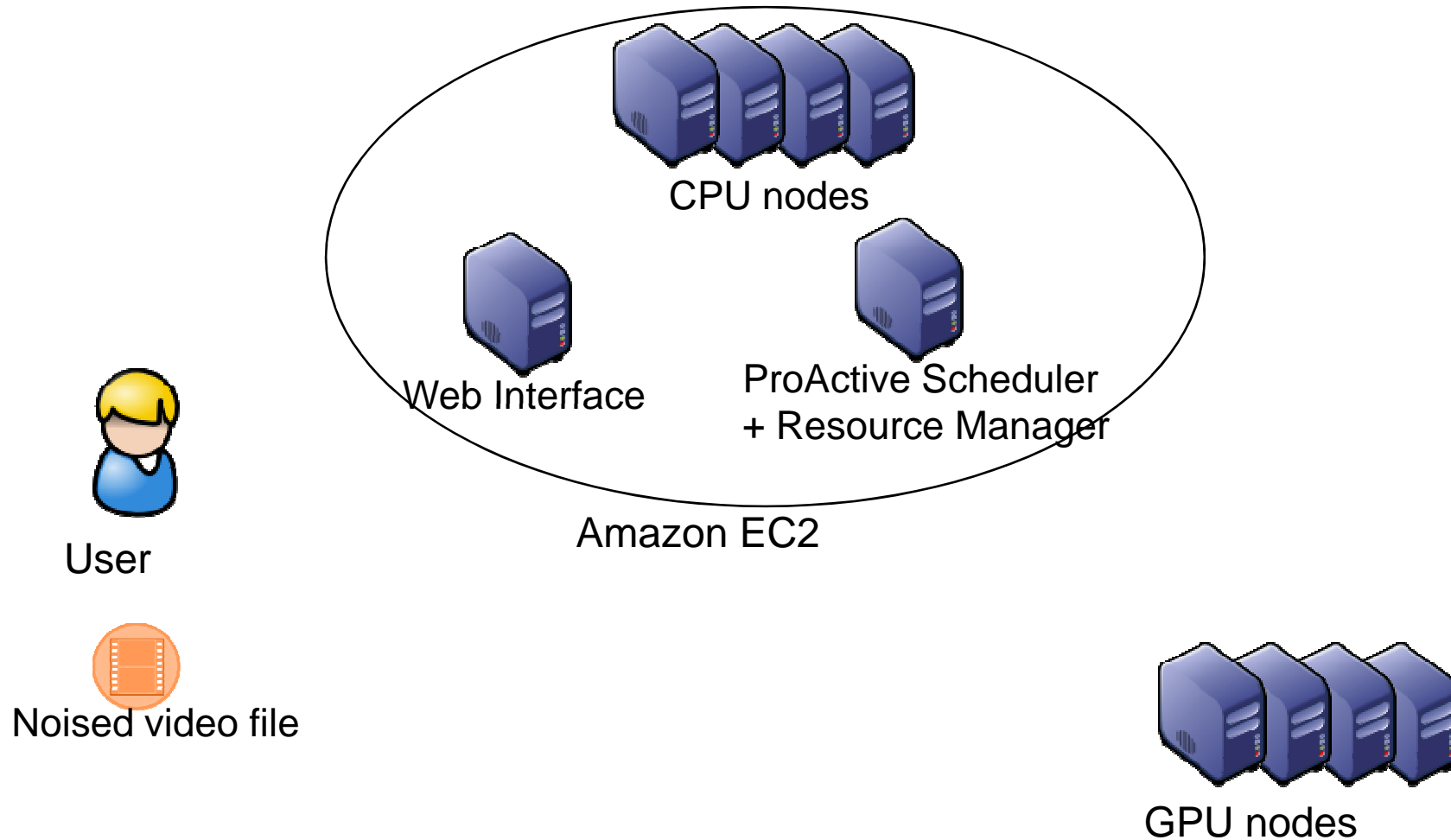
4 Time FASTER from 20 to 100
Speed Up of 80 / Th.
Sequential : 50 h → 35 mn

EC2 only test: nearly the
same performances as the
local SOLiD cluster (+10%)

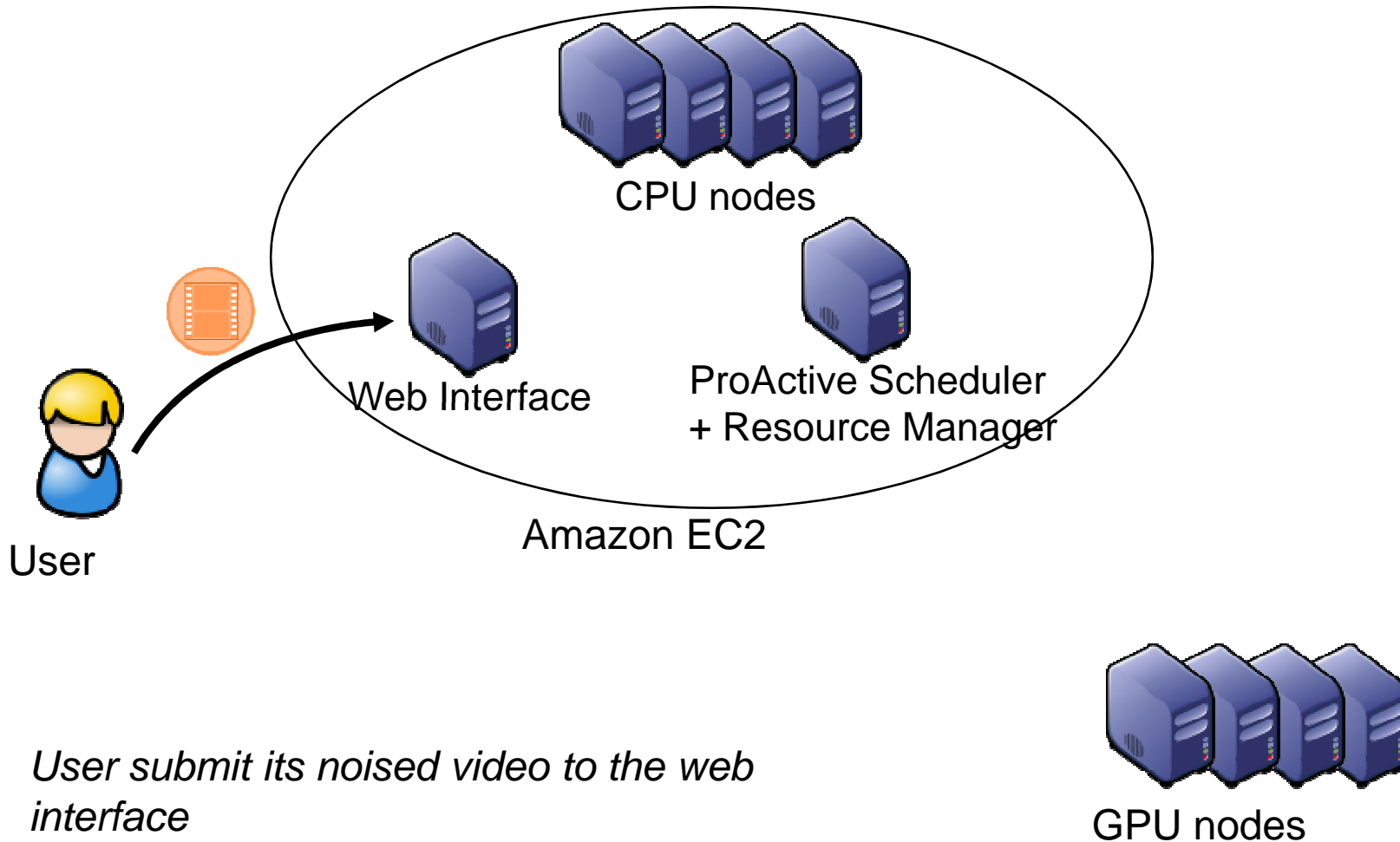
Cloud Seeding with ProActive

- ❑ Amazon EC2 Execution
- ❑ *Cloud Seeding* strategy to mix heterogeneous computing resources :
 - External GPU resources

Cloud Seeding with ProActive

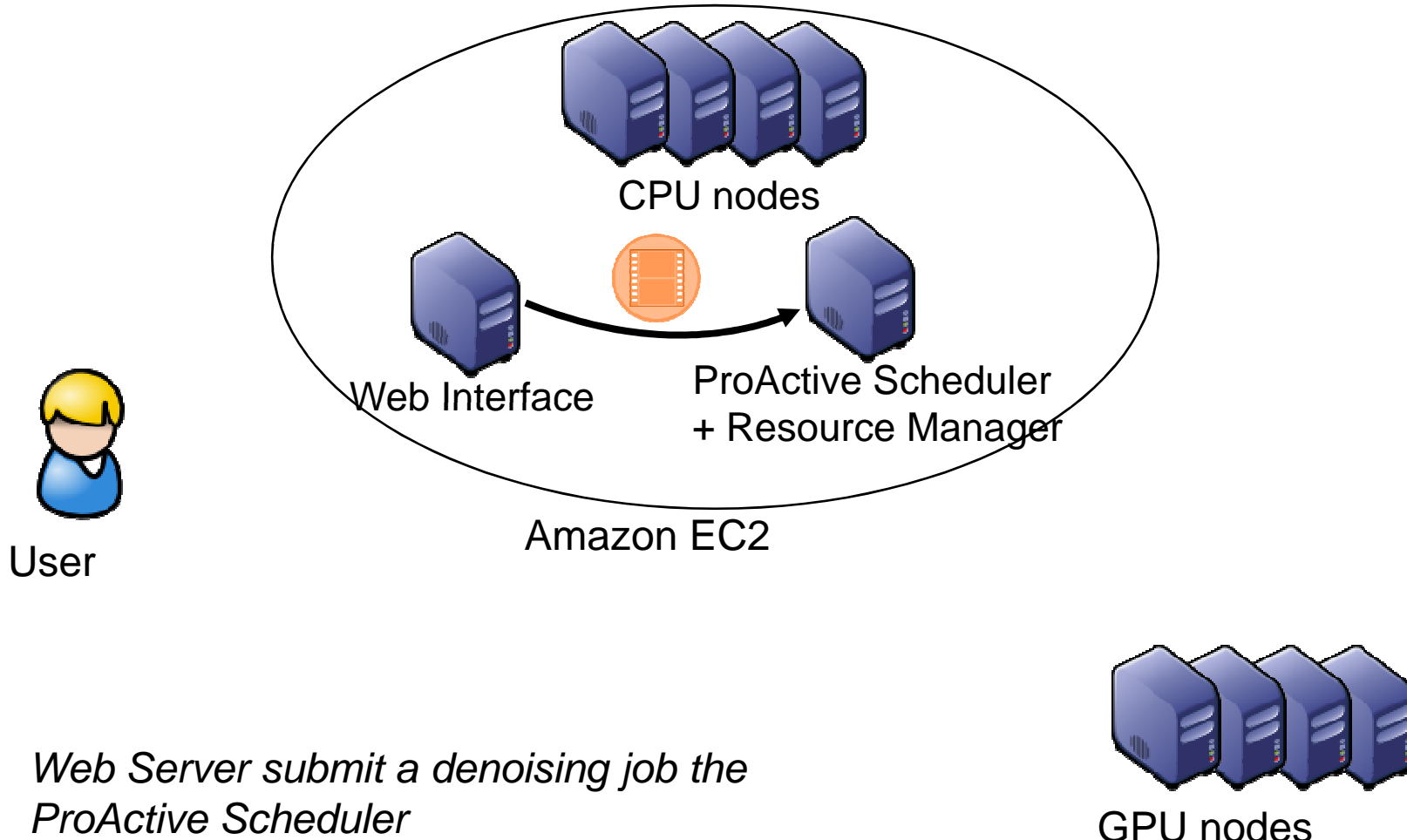


Cloud Seeding with ProActive



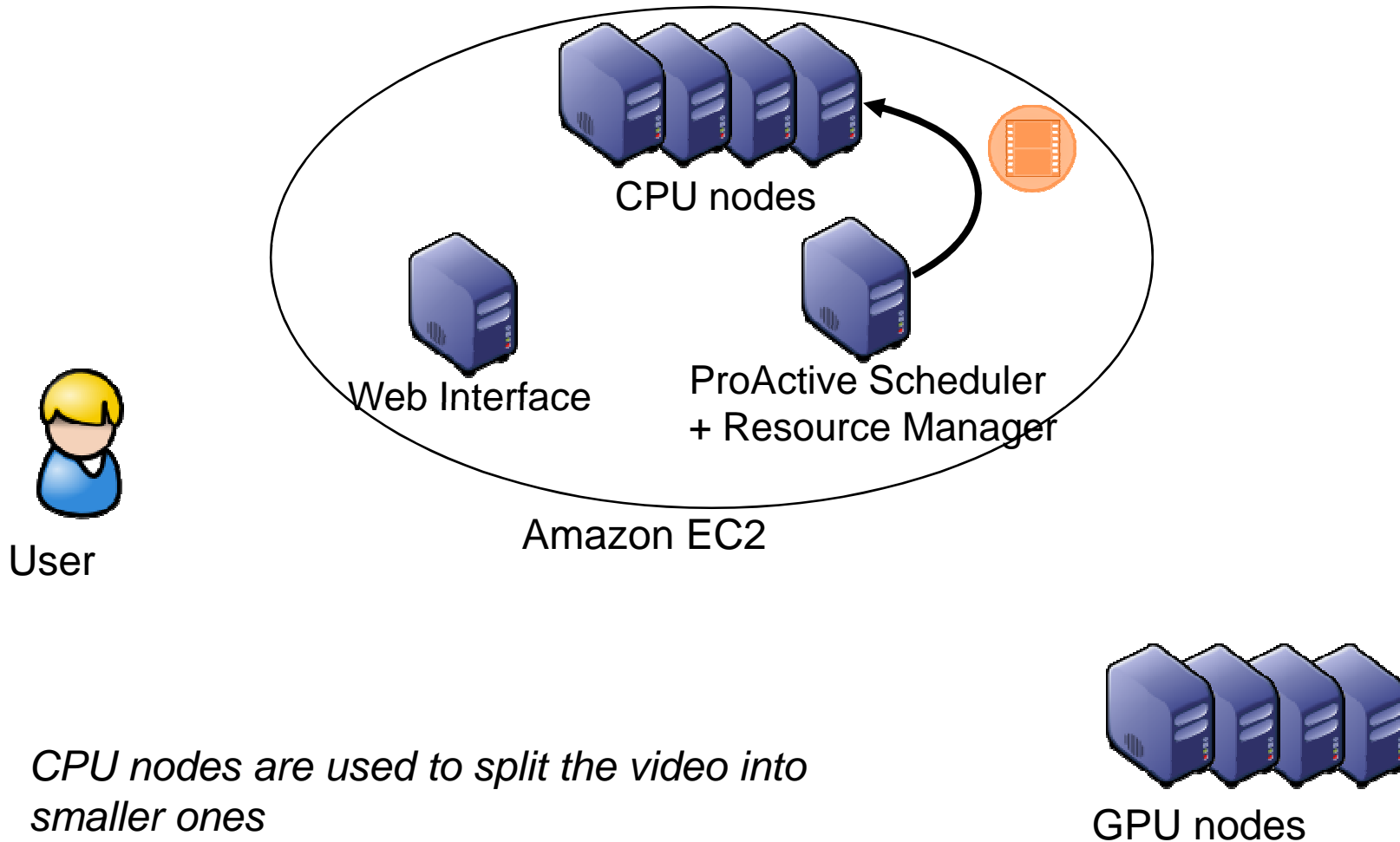
User submit its noised video to the web interface

Cloud Seeding with ProActive

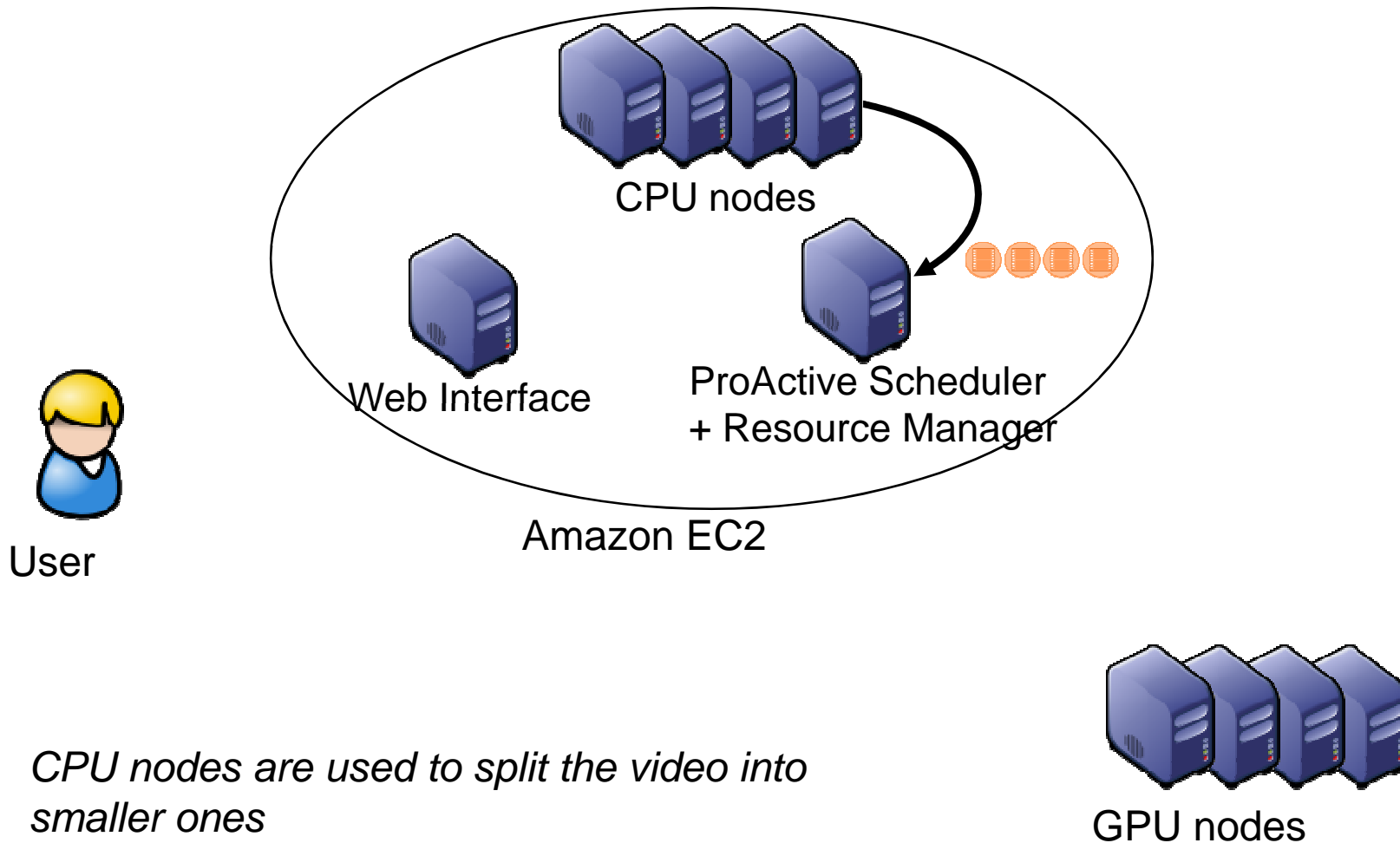


Web Server submit a denoising job the ProActive Scheduler

Cloud Seeding with ProActive

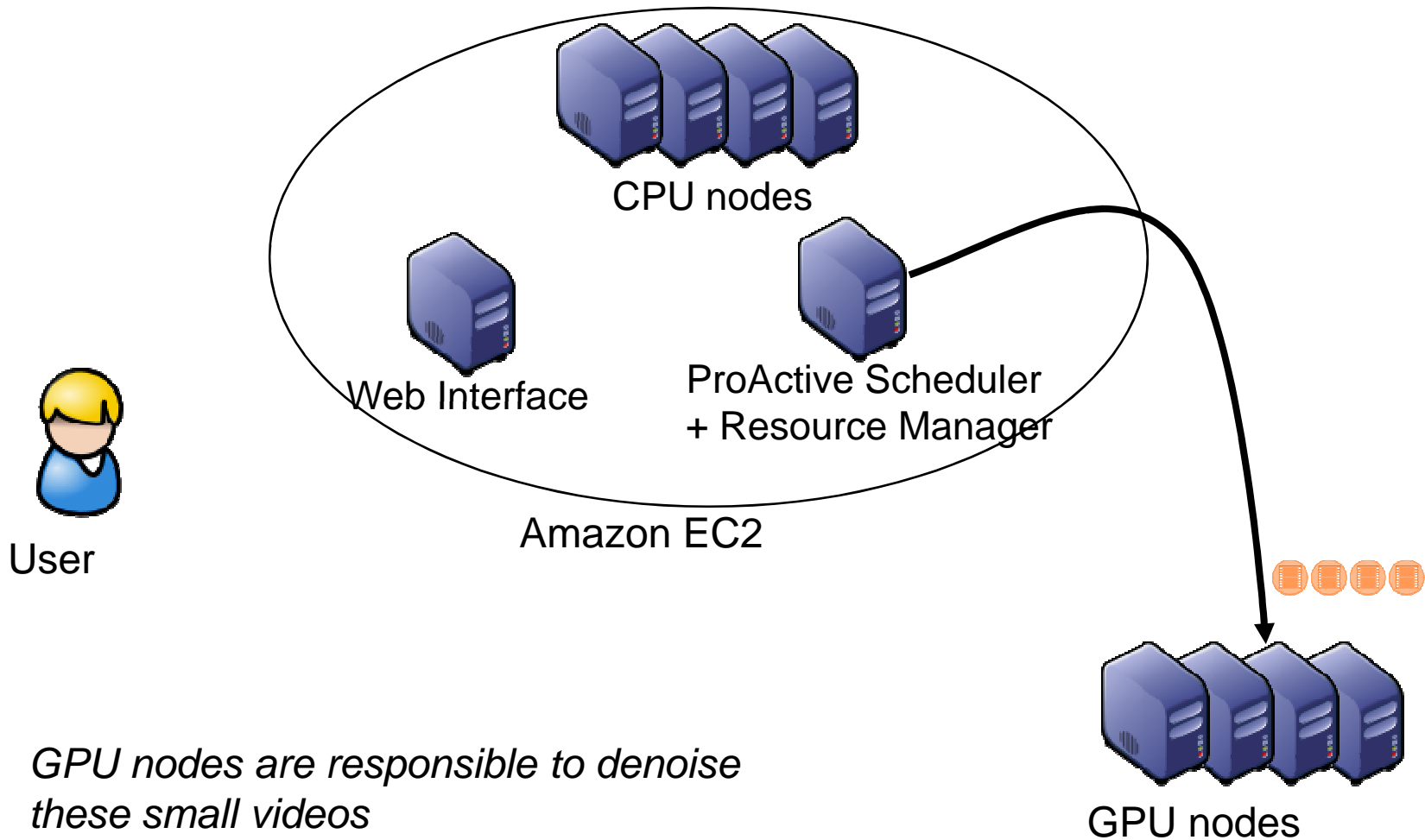


Cloud Seeding with ProActive

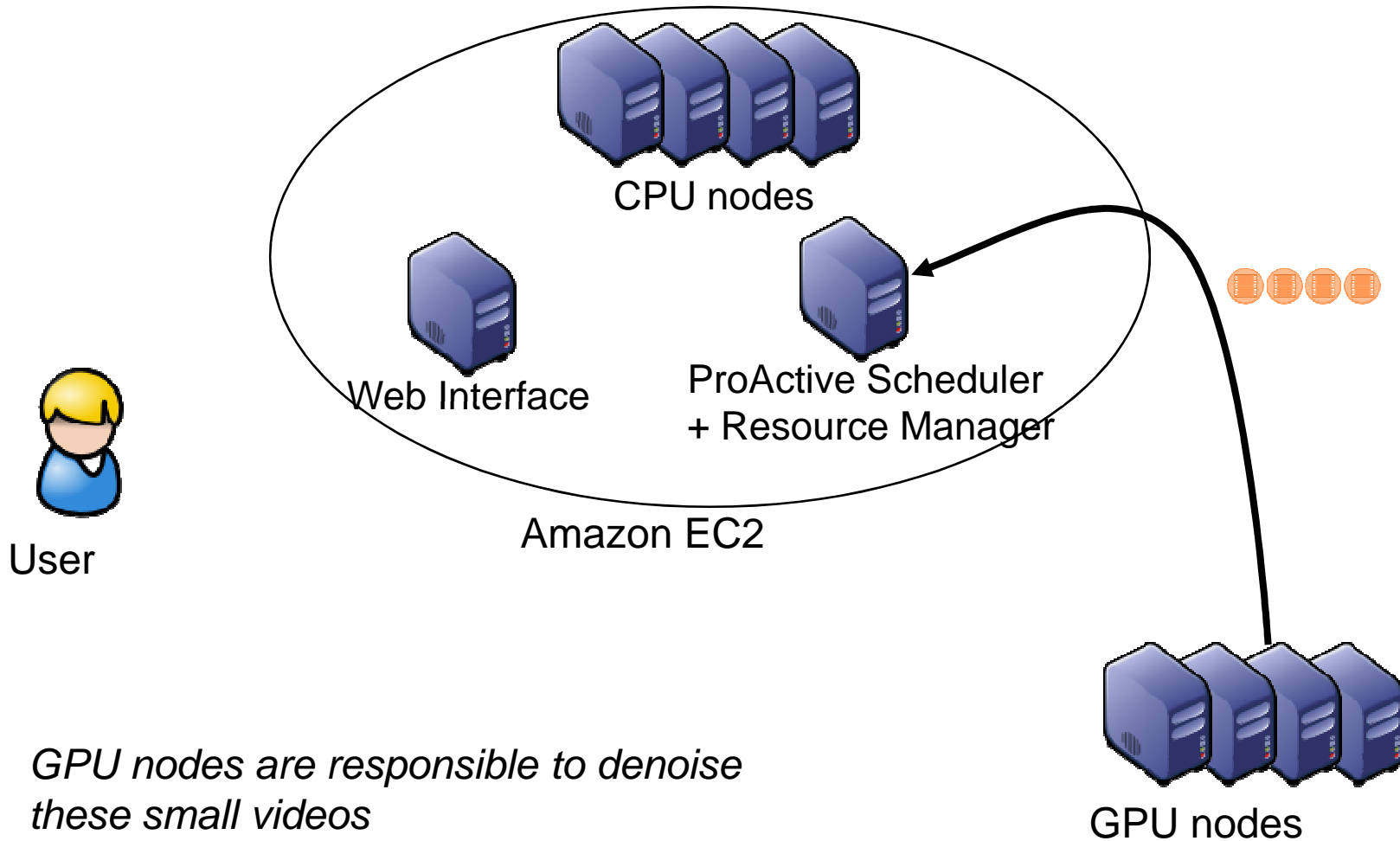


CPU nodes are used to split the video into smaller ones

Cloud Seeding with ProActive

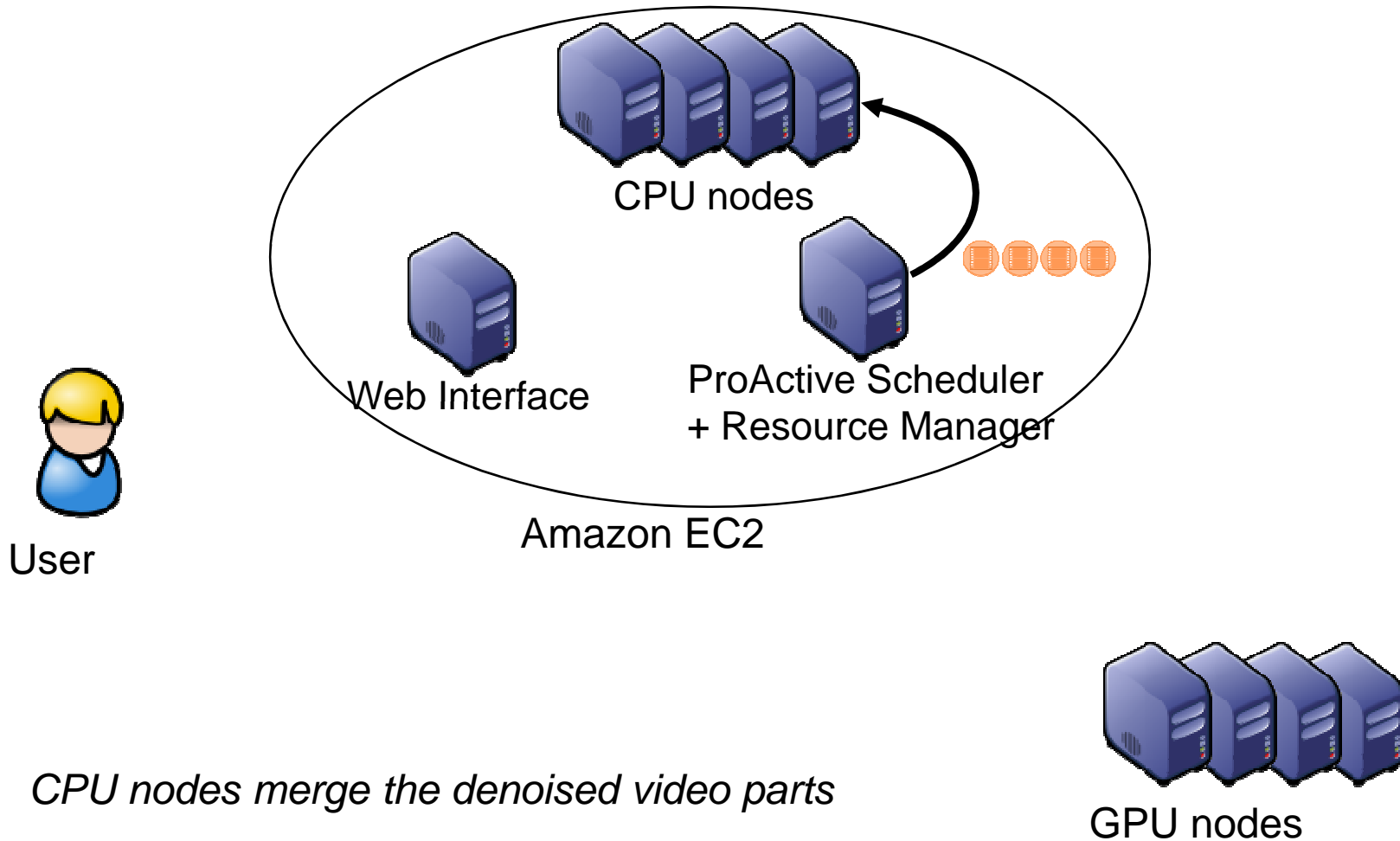


Cloud Seeding with ProActive

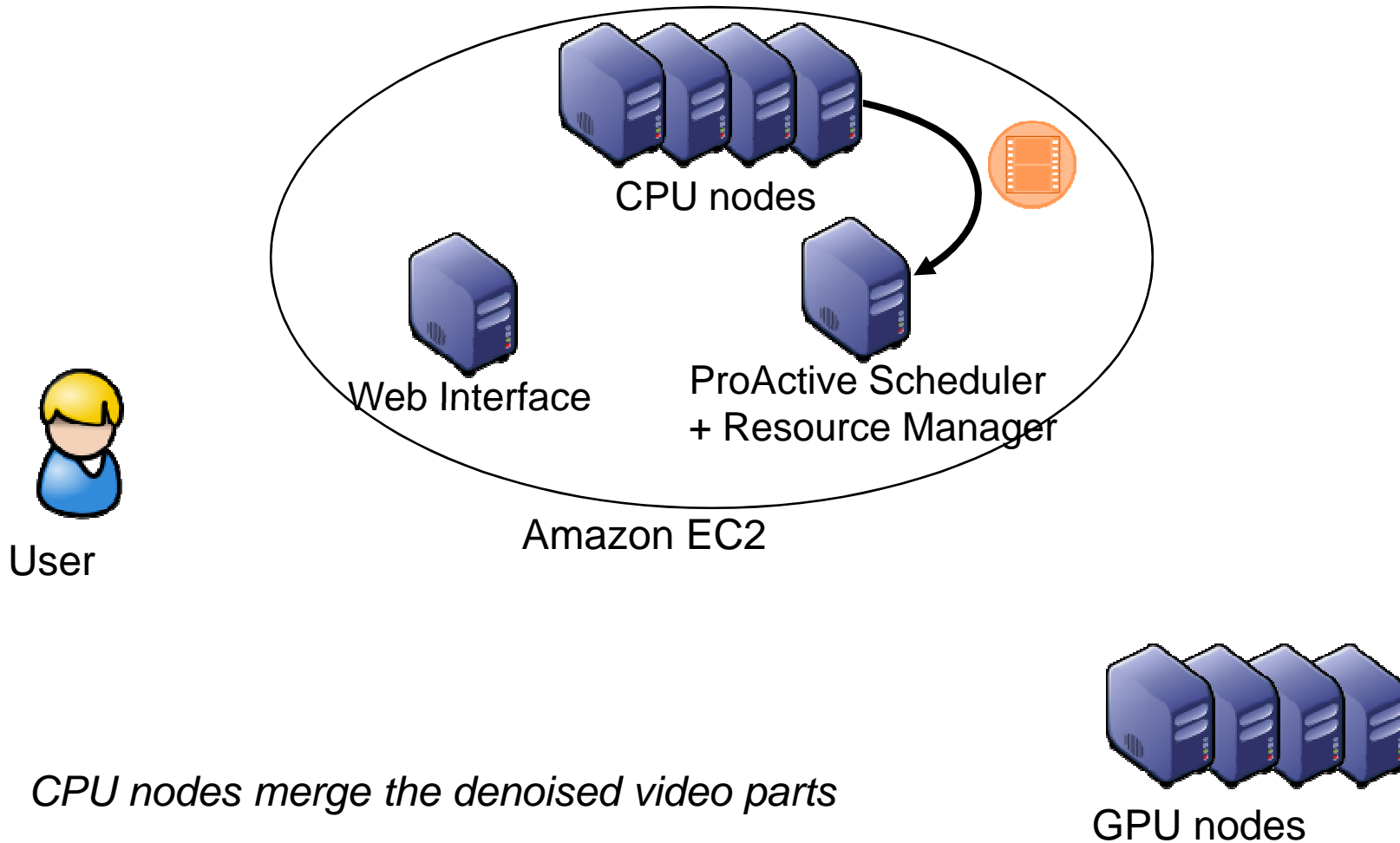


GPU nodes are responsible to denoise these small videos

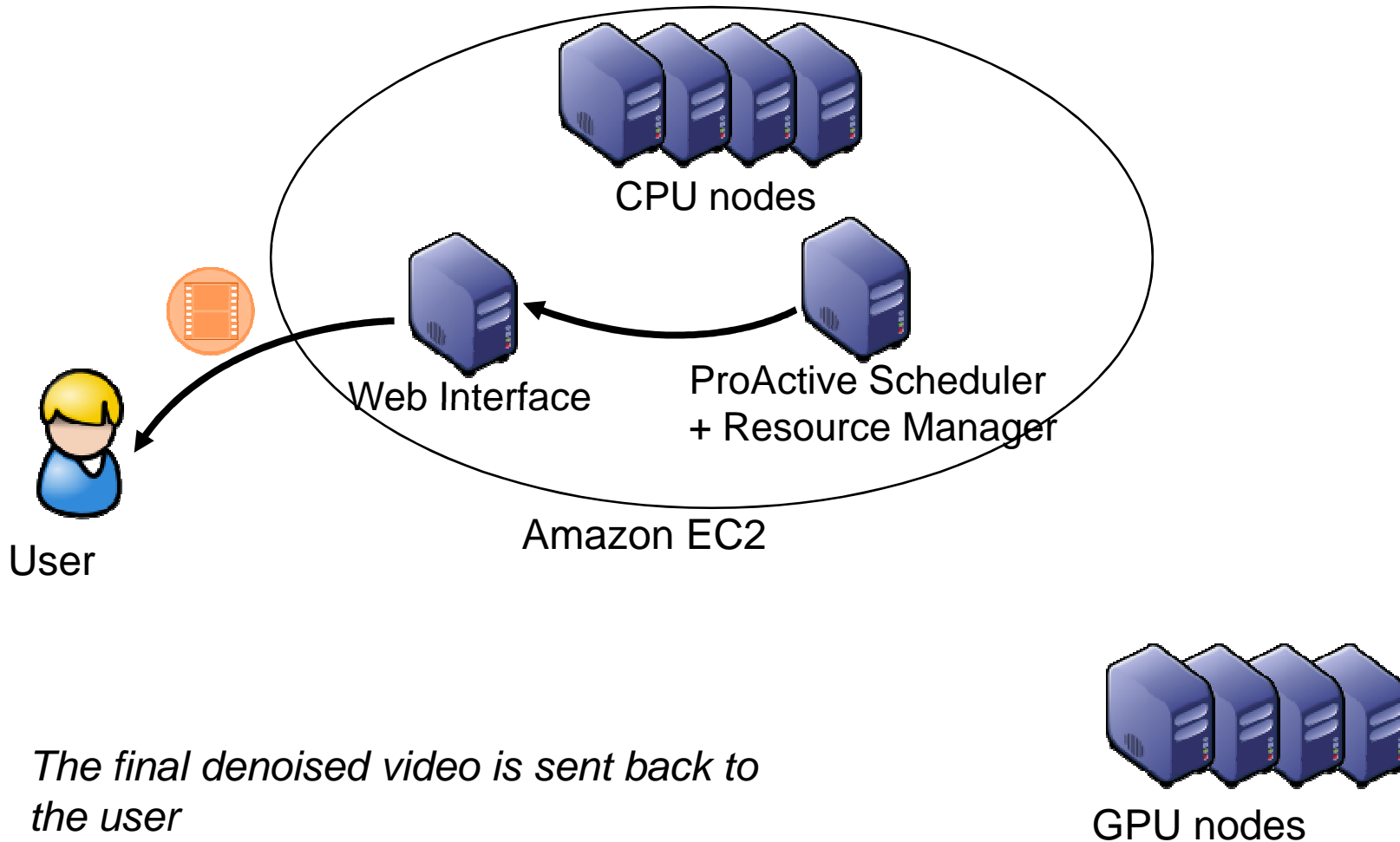
Cloud Seeding with ProActive



Cloud Seeding with ProActive



Cloud Seeding with ProActive



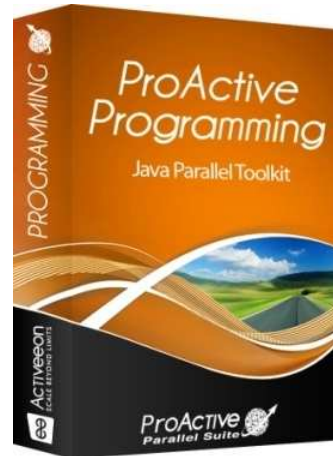


Conclusion

Versatile Cloud: ProActive Parallel Suite



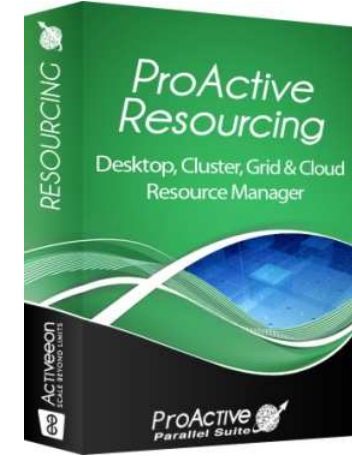
- ☐ Flexibility
Clutch Power
- ☐ Portability:
Windows, Linux, Mac
- ☐ Versatility:
Desktops, Grids, Clouds



Java Parallel Toolkit



Multi-Platform Job Scheduler



Resource Manager

Demo Upstaire: interop on LSF Platform, Sun SGE, Microsoft HPC, Amazon EC2

Smooth transition is needed within the Data center
We removed VO, but we Hype the same dreams!!
Danger: same KO than experienced with Grid
Lets be pragmatic and effective in Standardization!



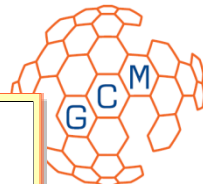
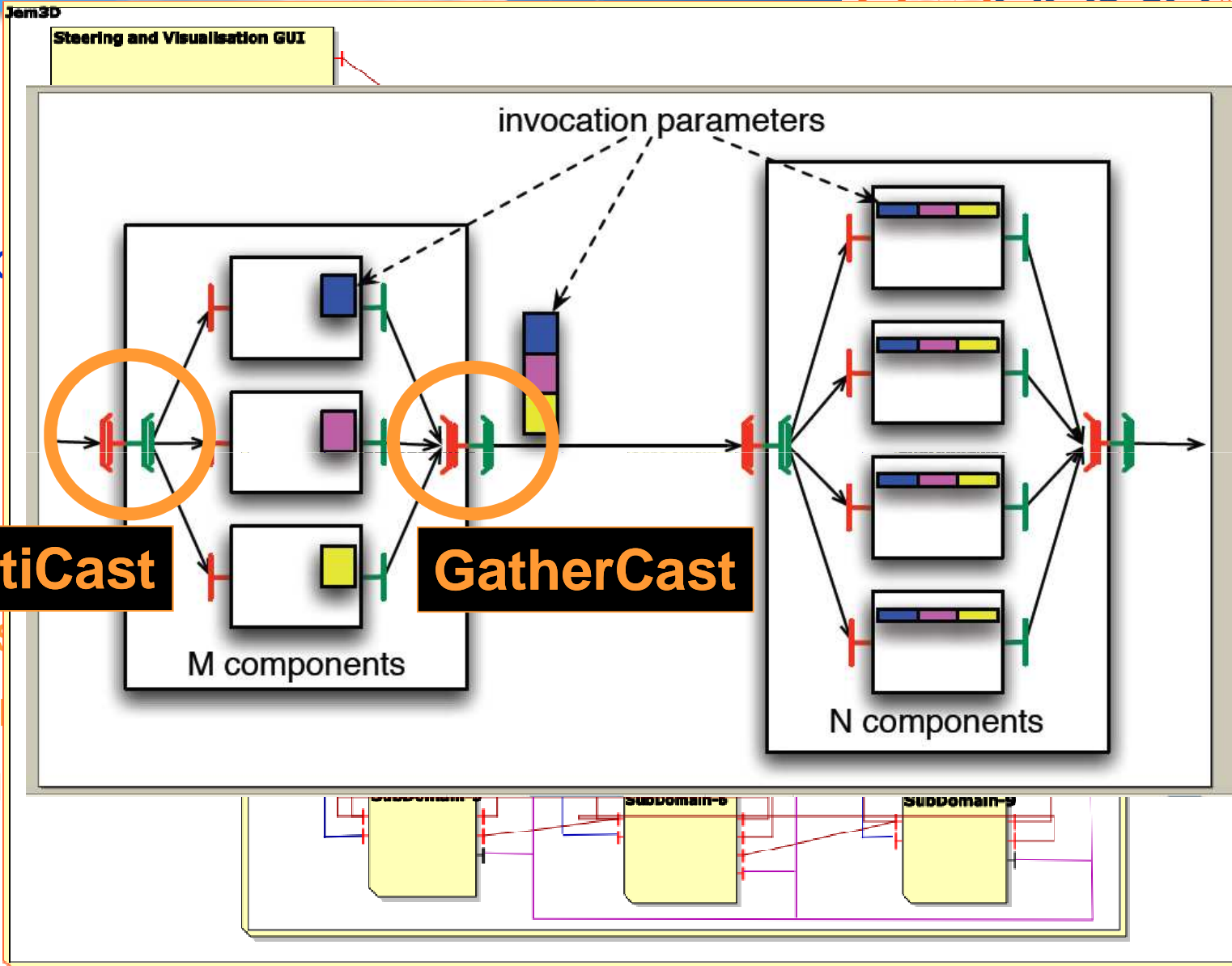


ActiveEon Company Overview (2)

- ❑ **Open Source Software Editor**
Born of INRIA in 2007
- ❑ Core mission: **Scale Beyond Limits**
- ❑ Co-develops
ProActive Parallel Suite[®]
- ❑ Provides **high level services** for ProActive
- ❑ **Ten years experience** in development of parallel computing



A



MultiCast

GatherCast

Sci
Gri
No
Abs
Co
Mu

ProActive PACA Grid in Cloud Context



The screenshot displays the ProActive Scheduler interface with the following components:

- Jobs Table:**

Pending (8)				Running (13)				Finished (11)								
Id	State	User	Priority	Name	Id	State	Progress	#/finche	User	Priority	Name	Id	State	User	Priority	Name
172	Pending	user1	Low	job_2_tasks	54	Running	0/2	1/2	user1	Low	job_2_t	152	Finished	user1	Low	job_2_tasks
173	Pending	user1	Low	job_2_tasks	55	Running	0/2	0/2	user1	Low	job_2_t	167	Finished	user1	Normal	job_2_tasks
174	Pending	user1	Low	job_2_tasks	56	Running	0/2	1/2	user1	Low	job_2_t	171	Finished	user1	Normal	job_2_tasks
176	Pending	user1	Low	job_2_tasks	160	Running	0/2	1/2	user1	Low	job_2_t	153	Finished	user1	Low	job_2_tasks
177	Pending	user1	Low	job_2_tasks	161	Running	0/2	1/2	user1	Low	job_2_t	175	Finished	user1	Normal	job_2_tasks
178	Pending	user1	Low	job_2_tasks	162	Running	0/2	1/2	user1	Low	job_2_t	154	Finished	user1	Low	job_2_tasks
179	Pending	user1	Low	job_2_tasks	163	Running	0/2	1/2	user1	Low	job_2_t	150	Finished	user1	Low	job_2_tasks
180	Pending	user1	Low	job_2_tasks	164	Running	0/2	1/2	user1	Low	job_2_t	156	Finished	user1	Low	job_2_tasks
					165	Running	0/2	1/2	user1	Low	job_2_t	157	Finished	user1	Low	job_2_tasks
					166	Running	0/2	1/2	user1	Low	job_2_t	158	Finished	user1	Low	job_2_tasks
					168	Running	0/2	0/2	user1	Low	job_2_t	159	Finished	user1	Low	job_2_tasks
					169	Running	0/2	0/2	user1	Low	job_2_t					
					170	Running	0/2	0/2	user1	Low	job_2_t					
- Console:**

Id	State	Name	Host name	Start time	Finished time	Re-ru	Description
15000	Running	task1	eon3.inria.fr	16:09:28 08/27/08	Not yet	0/3	task WaitAndPrint - will sleep for 3s
15000	Running	task2	eon8.inria.fr	16:09:28 08/27/08	Not yet	0/2	task WaitAndPrint - will sleep for 20s
- Job Info:**

Property	Value
id	35
State	Running
Name	job_2_tasks
Priority	Low
Pending tasks number	0
Running tasks number	7
Finished tasks number	0
Total tasks number	2
Submitted time	16:09:28 08/27/08
- Compact View:** A grid of 48 nodes (8x6) with status indicators (green for connected, red for disconnected).





ProActive PACA Grid

an INRIA, UNSA, CNRS-I3S, PACA Computing Cloud

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Main

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- » [Monitor](#)
- » [Nodes configuration](#)
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Welcome

Welcome to ProActive PACA Grid web site

ProActive PACA Grid is a set of machines accessible via Graphical Interactive interfaces based on ProActive Parallel Suite (<http://proactive.inria.fr>). The machines are currently deployed within INRIA Sophia Antipolis networks. The Cloud aggregates dedicated machines, both Linux and Windows, and spare desktop machines, dynamically added during nights and week-ends. This Grid is available for INRIA and UNSA members that need to accelerate their scientific applications. Upon request, other PACA labs and SMEs can also access the ProActive PACA Grid.

In production today : Download Graphical client in [download](#) page and schedule your jobs !

On going : Direct Web Access to CPER Cloud cluster by Java Web Start :



[Web Access to the ProActive Scheduler :](#)

[Web Access to the ProActive Resource Manager :](#)

ID	Name	Location	OS	Processor	Memory	Storage	State	OS	Name	Location	OS	Processor	Memory	Storage	State
101	ProActive	nic01	linux	40,000,000	16,000,000	100,000,000	idle	linux	nic01	linux	40,000,000	16,000,000	100,000,000	idle	
102	ProActive	nic02	linux	40,000,000	16,000,000	100,000,000	idle	linux	nic02	linux	40,000,000	16,000,000	100,000,000	idle	
103	ProActive	nic03	linux	40,000,000	16,000,000	100,000,000	idle	linux	nic03	linux	40,000,000	16,000,000	100,000,000	idle	

Node Name	Host	Status	URL
Default	nic01.nice.fr	idle	http://nic01.nice.fr:25000
Default	nic02.nice.fr	idle	http://nic02.nice.fr:25000
Default	nic03.nice.fr	idle	http://nic03.nice.fr:25000
Default	nic04.nice.fr	idle	http://nic04.nice.fr:25000
Default	nic05.nice.fr	idle	http://nic05.nice.fr:25000
Default	nic06.nice.fr	idle	http://nic06.nice.fr:25000
Default	nic07.nice.fr	idle	http://nic07.nice.fr:25000
Default	nic08.nice.fr	idle	http://nic08.nice.fr:25000
Default	nic09.nice.fr	idle	http://nic09.nice.fr:25000
Default	nic10.nice.fr	idle	http://nic10.nice.fr:25000

The screenshot displays the Eclipse IDE's Monitoring View, which is divided into two main sections: 'Monitoring' and 'Job Monitoring View'.

Monitoring View: This section shows a hierarchical tree of virtual nodes. The root node is 'DefaultVN (JOB-135745762)'. Underneath it, there are several nodes representing different components, including 'bebita.inria.fr:1099:OS un...', 'sidonie.inria.fr:1099:OS u...', and 'User (JOB-294719007)'. The 'User' node is expanded to show a 'Node User1602644' which contains a 'C3DUser#13'.

Job Monitoring View: This section provides a detailed view of a specific node, 'Node Node605624'. It shows a complex internal structure with various components and their relationships. The components include 'DinnerLayout#2', 'Table#3', 'Philosopher#4', 'Philosopher#5', 'Philosopher#6', 'Philosopher#7', and 'Philosopher#8'. These components are connected to a central 'Node Dispatcher-5...' and 'Node Renderer-1307...'. The 'Node Dispatcher-5...' is further connected to 'C3D Dispatcher...' and 'C3D User#13'. The 'Node Renderer-1307...' is connected to 'C3D Rendering...'. The 'Node Dispatcher-5...' is also connected to 'C3D Dispatcher...' and 'C3D User#13'. The 'Node Dispatcher-5...' is also connected to 'C3D Dispatcher...' and 'C3D User#13'. The 'Node Dispatcher-5...' is also connected to 'C3D Dispatcher...' and 'C3D User#13'.

Console: The console at the bottom shows the following message: '15:09:15 => NodeObject id=Node-455186381 already monitored, ckeck for new active objects'.

IC2D

The screenshot displays the IC2D monitoring application interface, which is divided into several main sections:

- Monitoring#1:** Shows a network topology diagram with nodes like PA_JVM1820960857, PA_JVM1370729570, PA_JVM1949849146, and various Domains (Domain#3 to Domain#6) and Maestro nodes (Maestro#7, BioMaestro#8).
- Legend:** Defines active objects (Active by itself, Serving request, etc.), pending requests, nodes (RMI, HTTP, RMI/SSH), and JVMs (Standard JVM, JVM started with Globus).
- Timer Tree View:** A table showing performance metrics for Domain#5 and Domain#4.

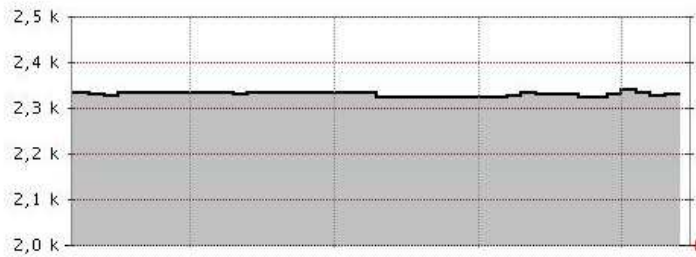
Name	Time [ms]	Total [%]	Invocations	Parent [%]
Domain#5				
Total	142212.28	100.00	1	0.00
WaitForRequest	21627.76	15.21	2056	15.21
Serve	120543.91	84.76	5352	84.76
SendReply	0.00	0.00	0	0.00
WaitByNecessity	17050.55	11.99	5340	14.14
SendRequest	101773.58	71.56	16054	84.43
Domain#4				
Total	142228.27	100.00	1	0.00
WaitForRequest	21249.88	14.94	2114	14.94
Serve	120936.36	85.03	5353	85.03
SendReply	0.00	0.00	0	0.00
GroupOneWayCall	0.00	0.00	0	0.00
GroupAsyncCall	0.00	0.00	0	0.00
WaitByNecessity	16765.29	11.79	5348	13.86
SendRequest	102320.24	71.94	16057	84.61
Serialization	1101.89	0.77	5352	1.08
LocalCopy	2471.16	1.74	10705	2.42
BeforeSerializati	20631.26	14.51	5352	20.16
- Timt View:** A horizontal bar chart for Domain#4 showing performance metrics like GroupAsyncCall (1.28m), BeforeSerialization (20.63s), and Total (2.37m).
- Time Line View:** A console view showing a timeline for BigMaestro#8, Maestro#7, Domain#6, Domain#5, Domain#4, Domain#3, and OctTree#2, with a time scale from 0ms to 746.4ms.

ChartIt

PA_JVM251111462

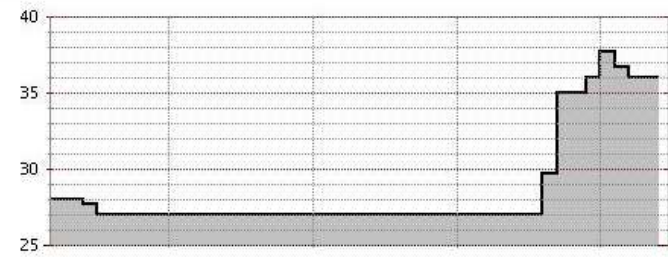
Charts

Chart#1 [LoadedClassCount]



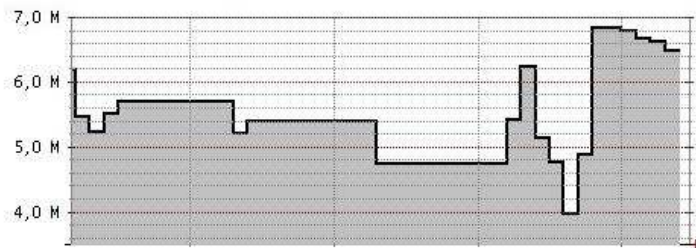
LoadedClassCount

Chart#3 [ThreadCount]



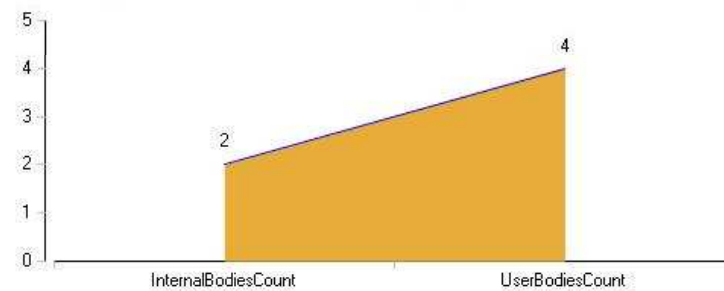
ThreadCount

Chart#2 [UsedHeapMemory]

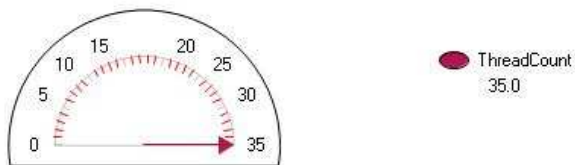


UsedHeapMemory

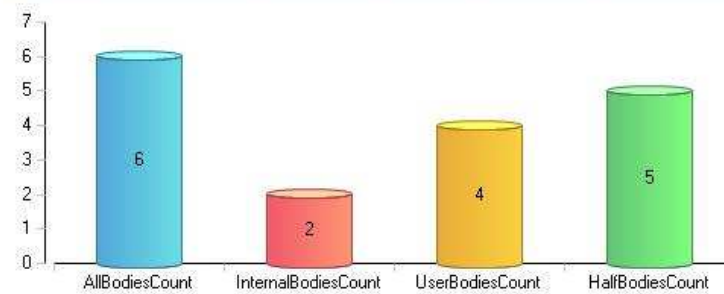
Chart#4 [InternalBodiesCount, UserBodiesCount]



Chart#5 [ThreadCount] Meter



Chart#6 [AllBodiesCount, InternalBodiesCount, UserBodiesCount, HalfBodiesCount]



Pies for Analysis and Optimization

