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## **InteGrade: Object-Oriented Grid Middleware Leveraging Idle Computing Power of Desktop Machines**

<http://gsd.ime.usp.br/integrade>

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## **InteGrade: Description**

- **Middleware to build a grid of commodity machines**
- **Desktop users (Resource Providers) export their resources into the grid**
- **Grid applications use only idle resources**
- **Advantages over traditional dedicated clusters of commodity hardware**



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## InteGrade: Key Features

- **Based on Distributed Object Oriented Technology (CORBA)**
- **Preserves Resource Provider's QoS at all costs**
- **Supports a wide Range of Parallel Applications**
- **Usage Pattern Collection and Analysis**

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## Feature: Preserves Resource Provider's QoS

- **User Level Scheduler (DSRT)**
- **Lightweight ORB**
- **Configurable Resource Sharing (Optional)**

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## Feature: Usage Pattern Collection and Analysis

- Enhances scheduling by offering an idea of resource usage
- Usage Data regarding short intervals (e.g. 5 min.) is collected
- Data is grouped in larger intervals called Periods
- Clustering Algorithms Applied to data will derive Behavioral Categories (e.g. night, lunch-break, week-days, etc)
- Each machine will have a schedule representing its resources availability throughout the week

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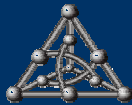
## Feature: Support for a Wide Range of Parallel Applications

- Often unsupported by other grid initiatives, especially ones that make opportunistic use of shared resources
  - Normally parallel applications must have little or even no communication between the application nodes
- InteGrade's architecture addresses those needs
- Network information about lines interconnecting nodes must be available

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# Feature: Ensures Application Progress

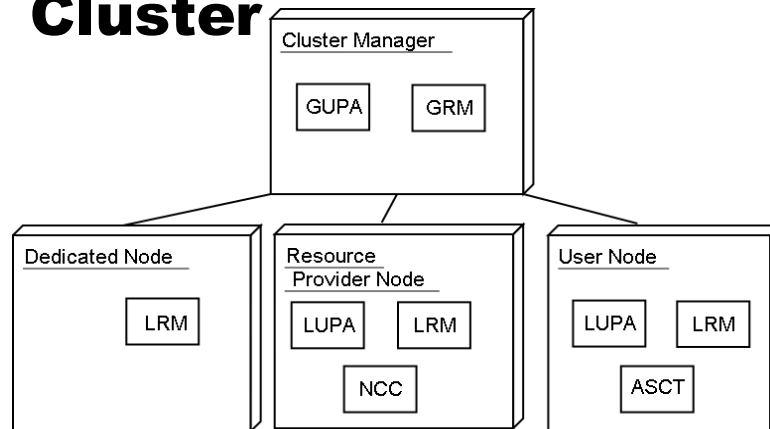
- **Usage Pattern Collection and Analysis provides hints, minimizing checkpointing situations**
- **Checkpointing for sequential applications**
  - **Must be machine and OS independent**
- **Progress of parallel applications is more difficult to ensure**
- **Possible solution: Use BSP as parallel application model**



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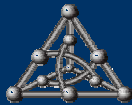
# Architecture: Intra-Cluster



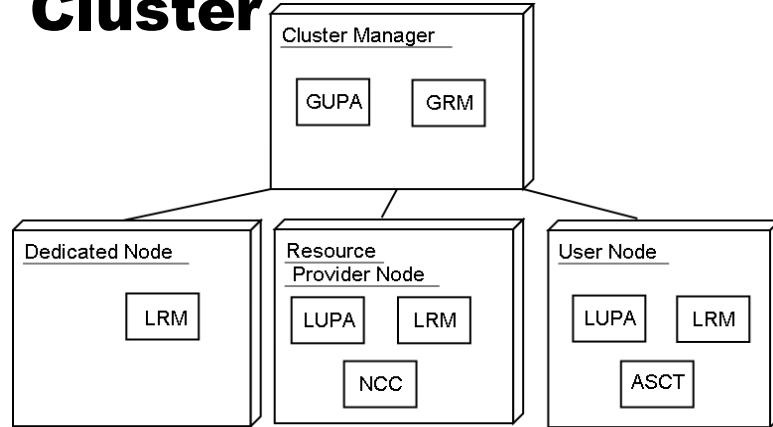
**LRM - Local Resource Manager**  
**GRM - Global Resource Manager**



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# Architecture: Intra-Cluster



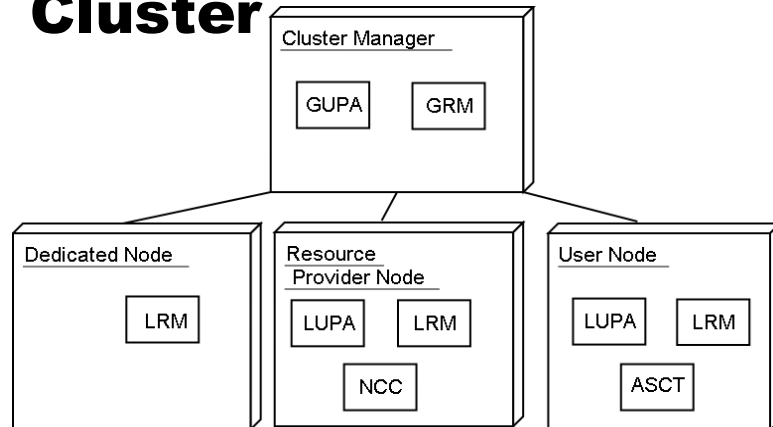
**LUPA - Local Usage Pattern Analyser**  
**GUPA - Global Usage Pattern Analyser**



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# Architecture: Intra-Cluster



**NCC - Node Control Center**  
**ASCT - Application Submission and Control Tool**



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## Related Work

- **Globus (Argonne National Labs / U. of Chicago / USC)**
  - Does not focus on QoS-preserving utilization of desktop machines
  - InteGrade uses CORBA and OO design
- **Legion (U. of Virginia)**
  - Proprietary distributed object model
  - InteGrade has deeper focus on idle resource management and desktop machines

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## Related Work (continued)

- **Condor (U. of Wisconsin-Madison)**
  - Limitations regarding support for parallel applications
- **SETI@Home (U. of California Berkeley)**
  - Hard-coded application
  - No communication between application nodes
- **BOINC (U. of California Berkeley)**
  - Limited support for parallel applications

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# Implementation Status

- **Already Implemented:**
  - **Intra-Cluster Information Update Protocol**
  - **Intra-Cluster Execution Protocol (non-parallel applications only)**
- **Software used:**
  - **GRM: JacORB**
  - **LRM: C++ using Orbil**



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# Implementation Status: ClusterView

The screenshot shows the ClusterView application interface. It features a 'Nodes' list on the left with 'SpitFire', 'Tricolor', and 'BlackBird'. The main area displays detailed metrics for 'BlackBird' and 'SpitFire' nodes. A 'Refreshing Period (seconds): 2' field and a 'Refresh Now' button are at the top right. A 'Tricolor' checkbox is at the bottom left of the main area.

Node	CPU Use	Memory Use	Swap Use	Disk Use	Files Use
BlackBird	30%	13%	0%	64%	71%
SpitFire	13%	4%	0%	69%	66%

Node	Host Name	OS Name	OS Version	Processor Name	Processor Clock	Total RAM	Total Swap	Total Disk	Total Files
BlackBird	BlackBird	Linux	2.4.10	Intel Pentium 4	1820	256	256	20875	10000
SpitFire	SpitFire	Linux	2.4.10	Intel Pentium 4	2440	512	256	3440	2984

Node	Free RAM	Free Swap	Free FS	Free Files	CPU Usage
BlackBird	120	256	10266	2089	30.4
SpitFire	208	256	1080	1010	12.5



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## Project Information

- **Website: <http://www.ime.usp.br/integrate>**
- **Source code available (anonymous CVS checkout & web front end)**
- **Increasing number of students working on the project**
- **Initial working version expected for the end of 2003**