DIET: New Developments and Recent Results

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LPC / PCSV (CNRS / IN2P3 UBP Clermont-Ferrand)

29 August 2006
CoreGrid Workshop

Outline

1. Introduction
2. Distributed Interactive Engineering Toolbox
3. DIET Applications
4. Discussion

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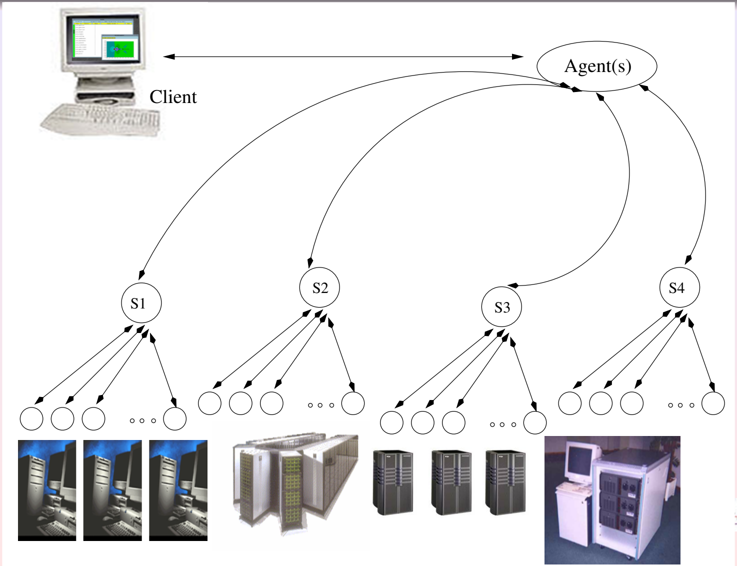
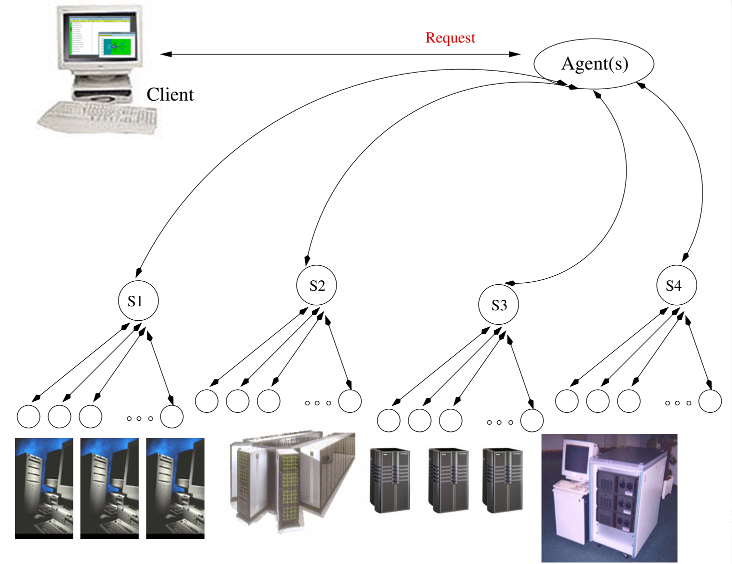
Why we need tools like DIET?

- To access large computational power and/or storage capacity through the Internet.
- Large scale computing over heterogeneous platforms was coined by Ian Foster in the mid-90's - Grid.
- Implementation of RPC programming model over the Grid - GridRPC.
- Existing implementations: NetSolve, Ninf, DIET, XtremWeb, OmniRPC, · · ·

GridRPC Paradigm



GridRPC Paradigm



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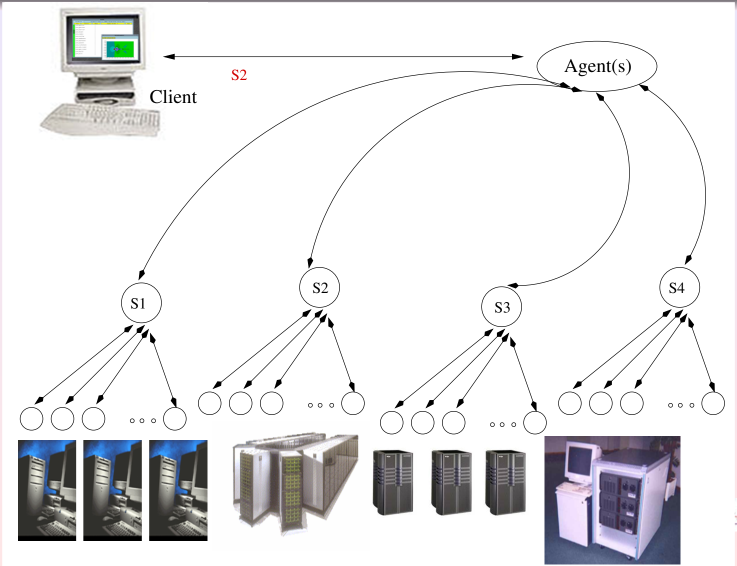

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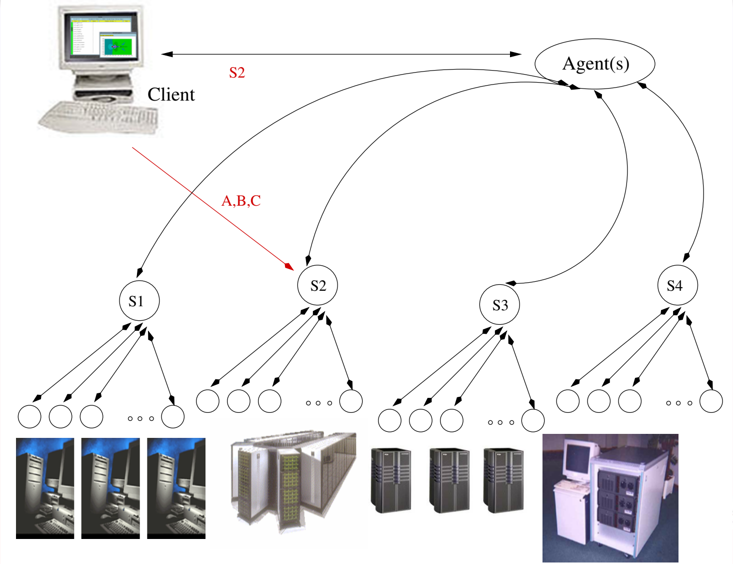

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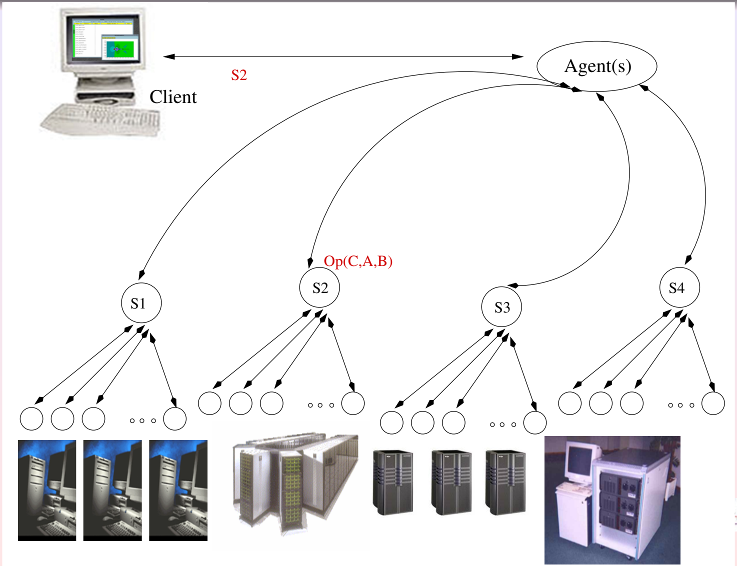

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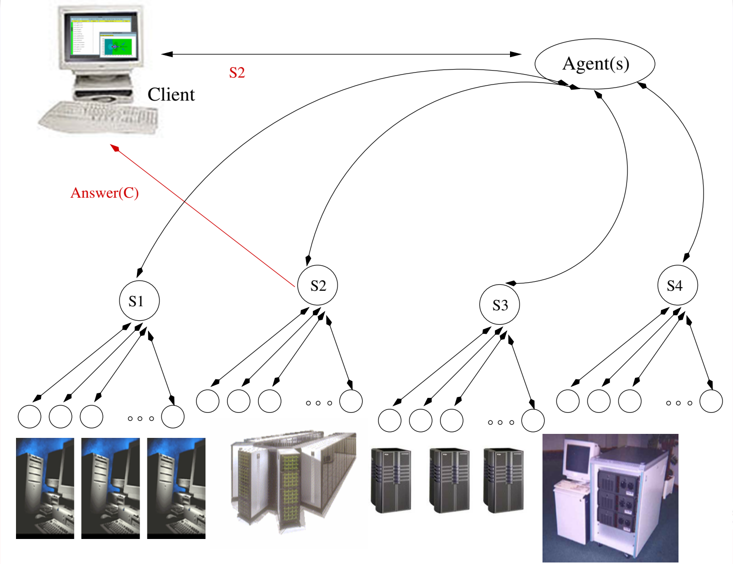

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Hierarchical architecture for an improved scalability.

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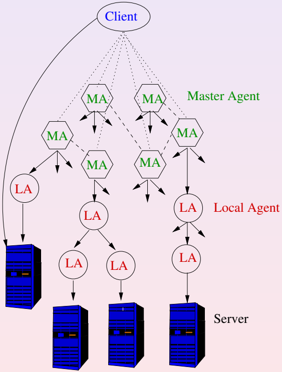

Outline

1 Introduction

2 Distributed Interactive Engineering Toolbox
- DIET Scheduling
- DIET Deployment
- Fault Tolerance in DIET
- DIET Visualization

3 DIET Applications

4 Discussion

DIET Components

- Client : An application that uses DIET to solve problems
- Master Agent (MA) :
  - Receives requests from clients
  - Collects computational abilities from servers and selects
  - Returns the reference of the chosen server to the client
- Local Agents (LA) :
  - Act as transmitter
  - Share the workload of scheduling
- Servers (SeD) : Perform actual computation for client

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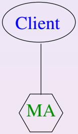

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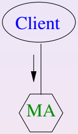

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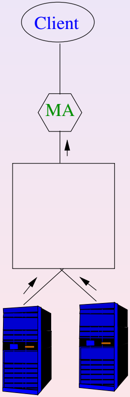

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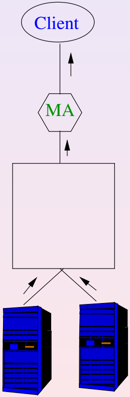

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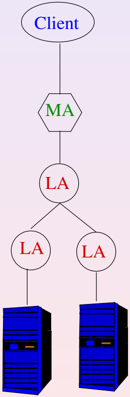

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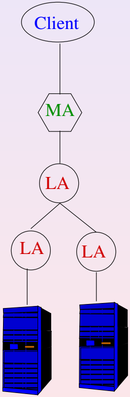

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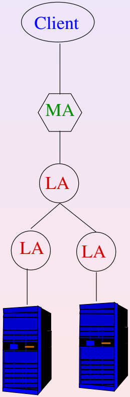

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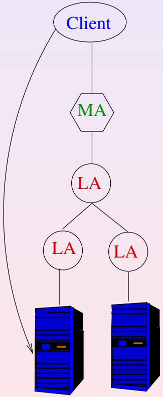

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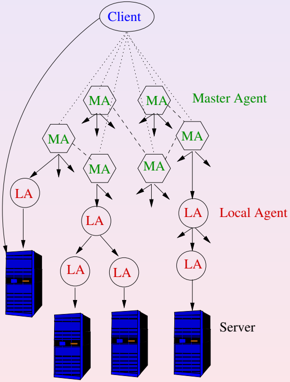
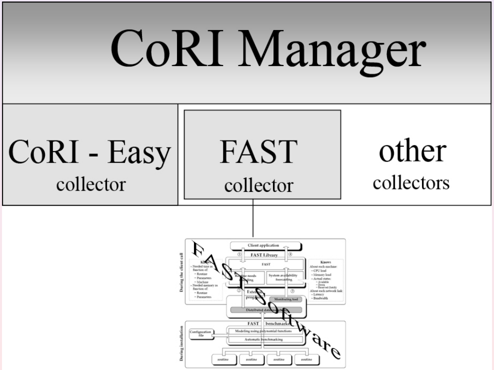


Collector of Resource Information (CoRI)

CoRI-Easy: provides basic measurements of the environment
CoRI Manager: manages the use of different collectors



Plug-in schedulers

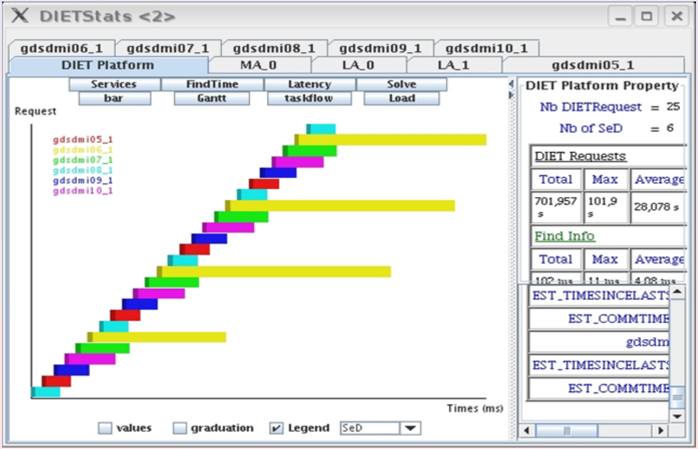
- Applications vary in terms of performance demands
- Performance Estimation Vector (PEV) is used for scheduling
- SeDs sends PEV to MA as a response to a request

`Information tag starts with EST_`	`Explanation`
TCOMP	the predicted time to solve a problem
LOADAVG	CPU load average
FREEMEM	amount of free memory (Mb)
NBCPU	number of available processors
⋮	⋮

Verification of plug-in schedulers

- Six heterogeneous servers
- Sequential and independent requests
- Inter-arrival time for the request is 1 minute
- Compare two scheduler
  - Round Robin scheduler
  - CPU scheduler

Round Robin Scheduler



DIET Platform Property

Nb DIETRequest = 25

Nb of SeD = 6

DIET Requests		
Total	Max	Average
701,957 s	101,9 s	28,078 s

Find Info		
Total	Max	Average
102 ms	11 ms	4,08 ms

EST_TIMESINCELASTS

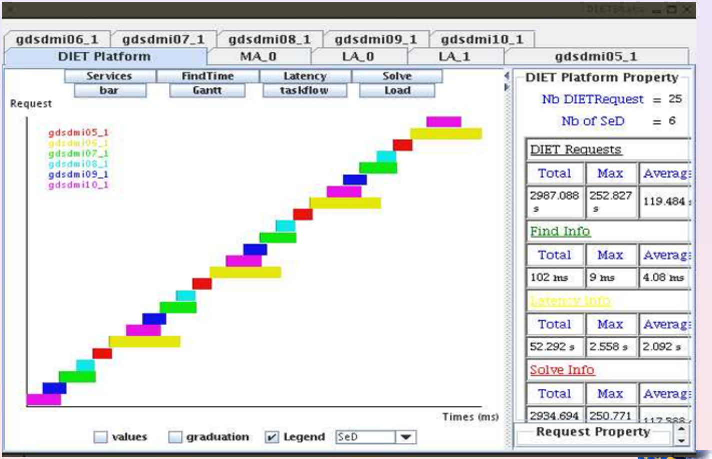
EST_COMMTIME

gdsdm

EST_TIMESINCELASTS

EST_COMMTIME

CPU Scheduler



DIET Platform Property

Nb DIETRequest = 25

Nb of SeD = 6

DIET Requests

Total	Max	Averag
2987.088 s	252.827 s	119.484 s

Find Info

Total	Max	Averag
102 ms	9 ms	4.08 ms

Latency Info

Total	Max	Averag
52.292 s	2.558 s	2.092 s

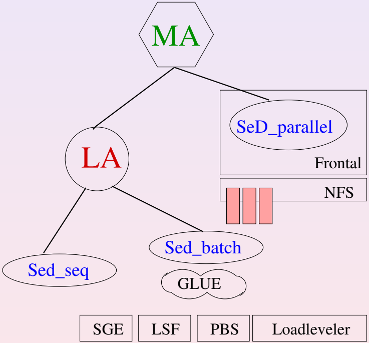
Solve Info

Total	Max	Averag
2934.694	250.771	117.388

Request Property

Batch Scheduler Management

- System dependent
  - NFS: copy the code?
  - MPI: LAM, MPICH?
- Batch system dependent
  - No homogeneity
  - Scheduler behaviour
  - Information about the internal scheduling process
- Monitoring and performance prediction

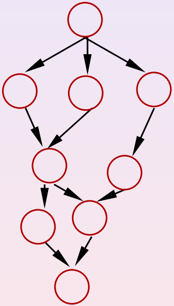


Parallel and batch submissions

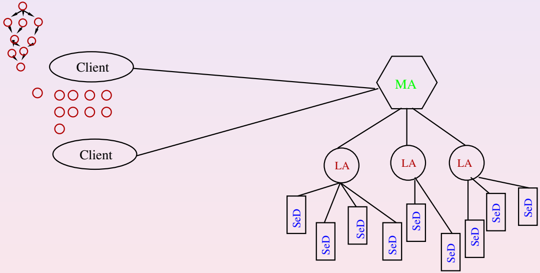
- Performance prediction: SIMBATCH
  - Batch, cluster, parallel tasks simulator plugin for SimGrid
  - Goal: test new grid schedulers more realistically and performance prediction
  - Implement FIFO, Conservative BackFilling, $\cdots$
- More problems
  - Asynchronous, long term production jobs
  - Performance prediction
    - How to decide number of processors for application?
    - If reservation available, how to compute deadline?
  - Co-scheduling?
  - Data and job migration?

Workflow Management

- Workflow is represented as DAG
- Use different heuristic methods to solve scheduling problems
- Extensibility to address multi-workflows submission and large grid platform
- Manage heterogeneity and variability of environment



DIET workflow engine



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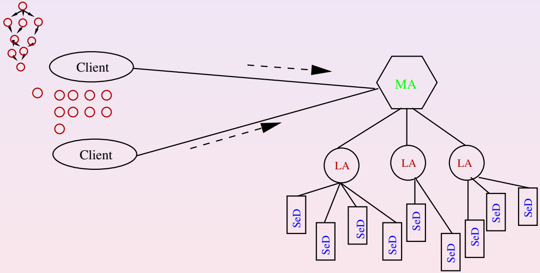

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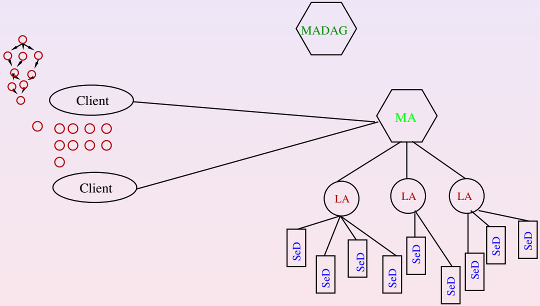

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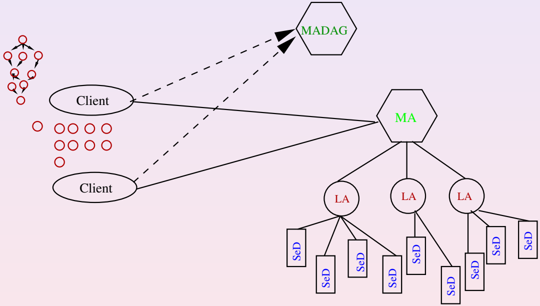

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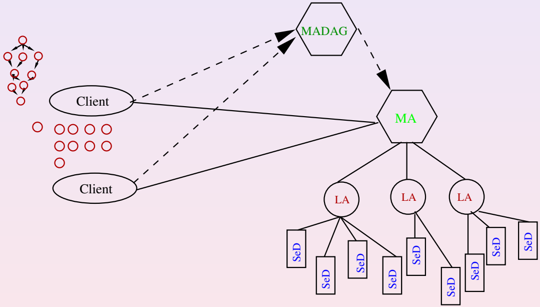

DIET Deployment

Mapping of DIET's components on available resources.

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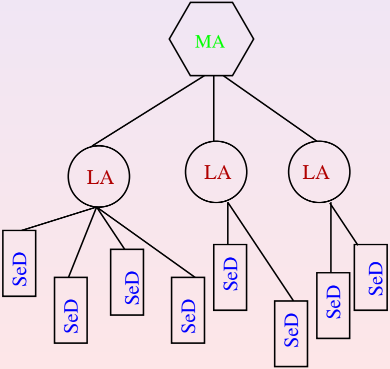
- Homogeneous resources



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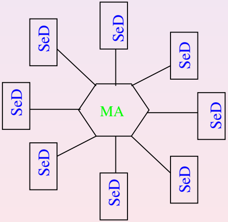

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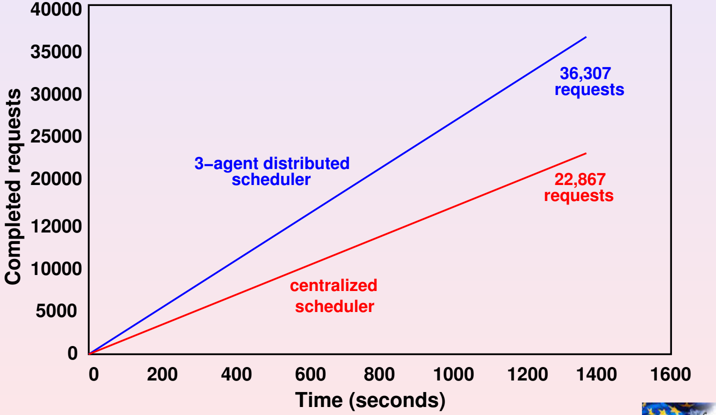

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Complete d-ary Spanning tree

E.Caron, P.K.Chouhan,H.Dail and F.Vivien. Automatic Middleware Deployment Planning for Clusters. RR-2000-50 LIP,October 2005.

DIET Deployment

Mapping of DIET's components on available resources.

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Find the best broadcast tree on a general graph, which is known to be NP-complete.

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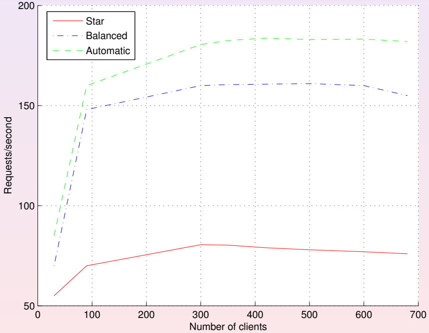

Thesis Automatic Deployment for Application Service Provider Environments by P. K. Chouhan

GoDIET: DIET deployment tool

- XML file as Input
- Generate configuration files
- Launches services (name service, logging services)
- Launches DIET elements
- Destroy deployed platform
- Remote cleanup of launched processes

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E.Caron, P.K.Chouhan and H.Dail GoDIET: A Deployment Tool for Distributed Middleware on Grid'5000. In IEEE, editor, EXPGRID workshop, in conjunction with HPDC-15. pages 1-8.

Failure Detection in DIET

Failure detection

- Detection time: time between failure and definitive suspicion
- Accuracy: probability of the observer to be true at random time

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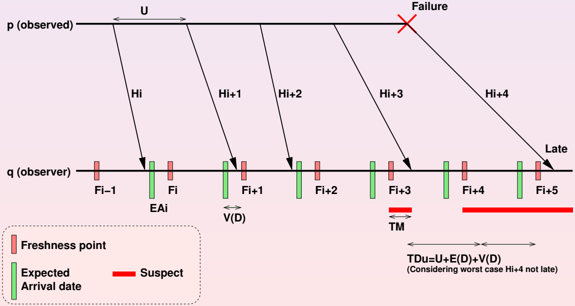
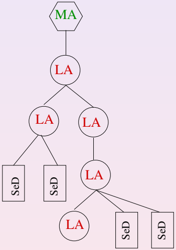


Architecture Recovery

- Problem: Keep architecture connected
- Solution: Keep ancestors list
- tolerates up to f-1 simultaneous failures



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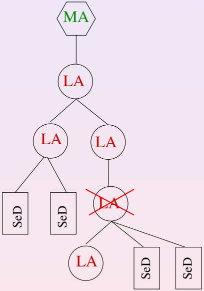

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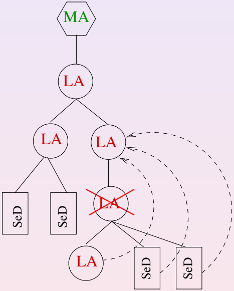

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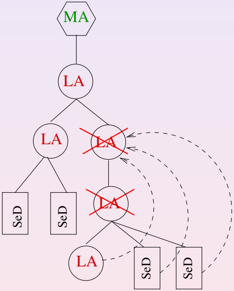

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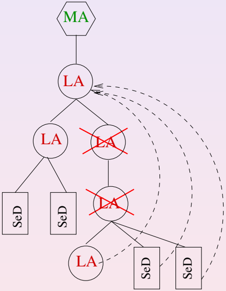

Application Recovery

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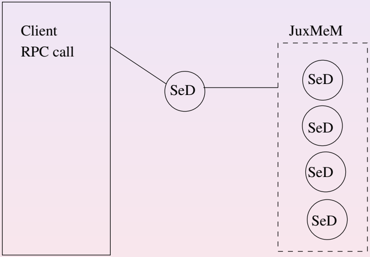
- Replication divides the available computing by f
- Checkpointing takes periodic snapshot of process state, saving it to another place
- JuxMem manages data persistence across failures by replicating it on nodes



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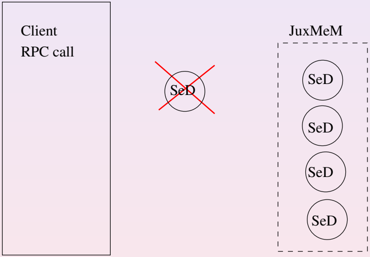

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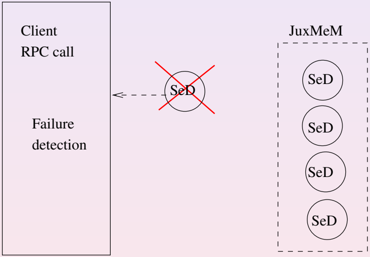

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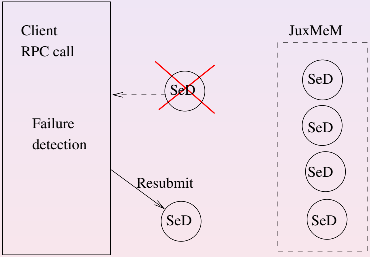

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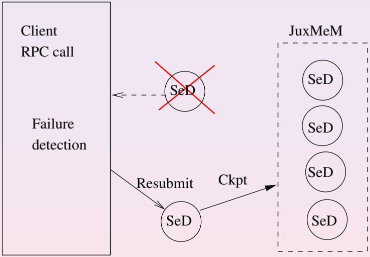

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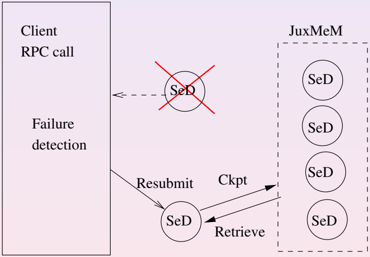
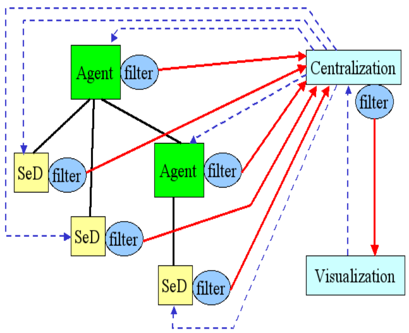


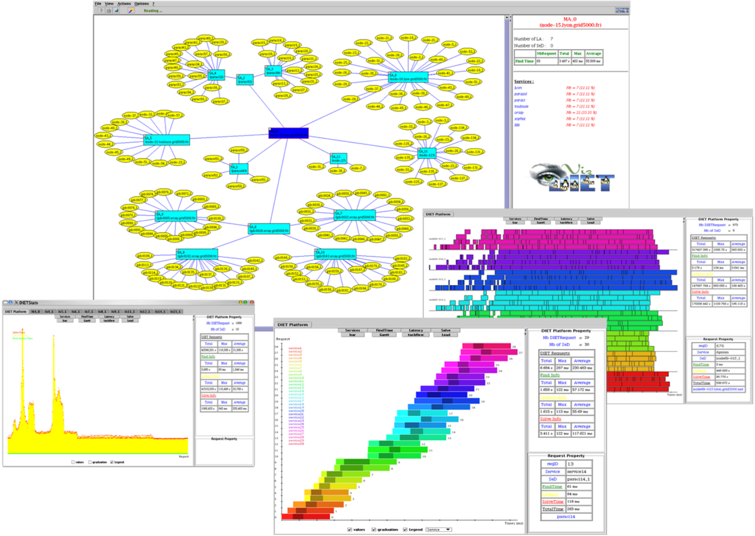
VizDIET: DIET Visualization Tool

- Current view of the DIET platform
- Communication between agents
- State of SeDs
- Scalability
- Available services
- Data persistency
- Name information
- CPU, memory and network load



R.Bolze, E.Caron, F.Desprez, G.Hoesch, and C.Pontvieux. A Monitoring and Visualization Tool and Its Applications. Computational Science and Its Applications-ICCSA 2006, volume 3984 of LNCS, pages 202-213.

Screen-shot of VizDIET



MA_0
(node-15.lyon.grid5000.fr)

Number of LA : 7
Number of SeD : 0

	NbRequest	Total	Max	Average
Find Time	63	3.497 s	452 ms	55.508 ms

Services :

lyon	Nb = 7 (11.11 %)
parasol	Nb = 7 (11.11 %)
paraci	Nb = 7 (11.11 %)
toulouse	Nb = 7 (11.11 %)
orsay	Nb = 21 (33.33 %)
sophia	Nb = 7 (11.11 %)
lille	Nb = 7 (11.11 %)

DIET Platform Property
Nb DIETRequest = 1999
Nb of SeD = 10

DIET Requests		
Total	Max	Average
42500,301 s	116,035 s	21,305 s
Find Info		
Total	Max	Average
3,695 s	80 ms	1,848 ms
Latency Info		
Total	Max	Average
41510,203 s	115,406 s	20,769 s
Solve Info		
Total	Max	Average
1066,420 s	843 ms	533,403 ms

Request Property

DIET Platform Property
Nb DIETRequest = 29
Nb of SeD = 30

DIET Requests		
Total	Max	Average
6.684 s	287 ms	230.483 ms
Find Info		
Total	Max	Average
1.658 s	122 ms	57.172 ms
Latency Info		
Total	Max	Average
1.615 s	113 ms	55.69 ms
Solve Info		
Total	Max	Average
3.411 s	122 ms	117.621 ms

Request Property

reqID	13
Service	service14
SeD	paraci14_1
FindTime	61 ms
Latency	84 ms
SolveTime	118 ms
TotalTime	263 ms
paraci14	

DIET Platform Property
Nb DIETRequest = 679
Nb of SeD = 8

DIET Requests		
Total	Max	Average
317407.385 s	1585.75 s	363.582 s
Find Info		
Total	Max	Average
3.179 s	134 ms	3.641 ms
Latency Info		
Total	Max	Average
147067.764 s	863.055 s	168.463 s
Solve Info		
Total	Max	Average
170336.442 s	1103.756 s	195.116 s

Request Property

reqID	676
Service	dgemm
SeD	node69-015_1
FindTime	3 ms
Latency	448.093 s
SolveTime	90.776 s
TotalTime	538.872 s
node69-015.lyon.grid5000.net	

Outline

1. Introduction
2. Distributed Interactive Engineering Toolbox
3. DIET Applications
4. Discussion

Applications

- BLAST application using DIET
    - Basic Local Alignment Search Tool.
    - Compare biological sequences such as nucleotides sequences
    - N-sequences versus one database
    - Multi-request files are partitioned intro several smaller requests
- DIET to analyse Cosmological Results
    - Study large scale structure and galaxy formation
    - RAMSES collects raw data
    - Galices analysis the data

Outline

1. Introduction
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   - Conclusion
   - Future Work

Conclusion

- Scalable, open-source, and multi-application platform
- Concentration on several issues
  - performance evaluation (CoRI, FAST)
  - scheduling (plugin schedulers, workflow management)
  - deployment (planning and tool GoDIET)
  - data management and replication (JuxMem)
  - fault toleration (architecture and application)
  - monitoring (LogService and VizDIET)
- Large scale validation on the Grid'5000 platform

http://graal.ens-lyon.fr/DIET http://www.grid5000.org

Future work

- Need of implementation and validation of algorithms from the scheduling literature in real-life middleware infrastructures?
- Still room for fundamental research on algorithms
- Some problems waiting for solution
  - Finding accurate models
  - Large scale validation of algorithms (simulators, real grids?)
- Take a look at other applications
- . . .