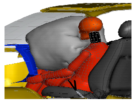
Mathias Dalheimer
PhD-student
PLEASE INTERRUPT, ASK!

Working at the Fraunhofer Institute for Applied mathematics
- Kaiserslautern (close to Frankfurt)
- 150 Employees & PhD students
- several departments with strong focus on math
  -> "Mathematics as a technology"
- We have an energy-efficient building (we don't need cooling during the

Departments



Transport Processes

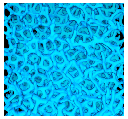
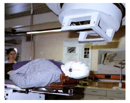
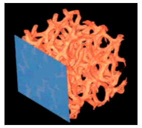


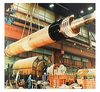
Image Analysis



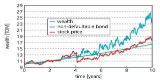
Optimzation



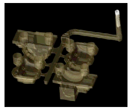
Flow in Complex Structures



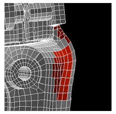
Adaptive Systems



Financial mathematics

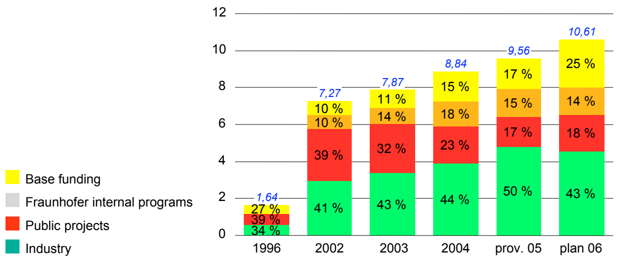


HPC + Visualisation

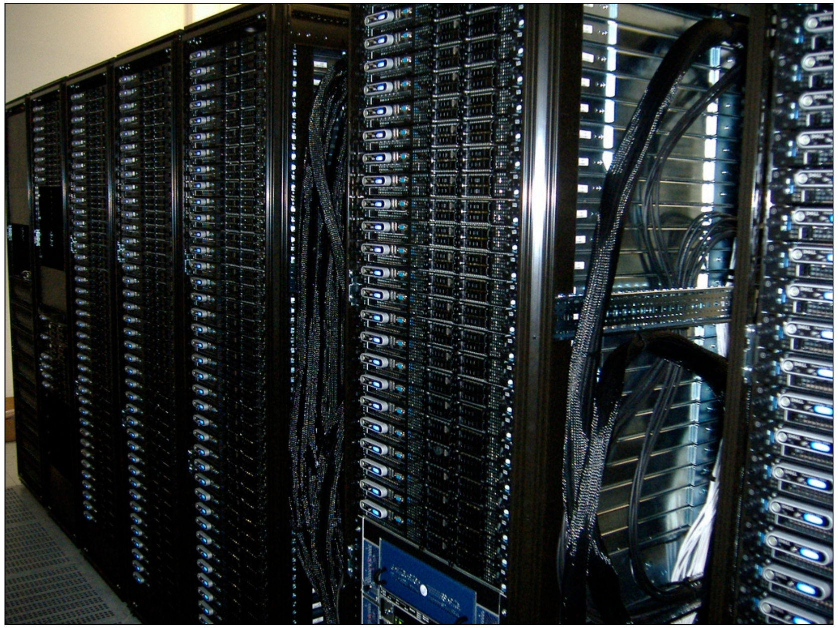


Dynamics + Durability

Budget Development



The CC-HPC is engaged in various industry and research projects
- Oil industry
- Financial business
- ...



Our new cluster system “hercules”
- 1000 core cluster, Intel Woodcrest, >250 nodes
- 8GB RAM per node
- Infiniband DDR interconnect

-> Up until end of the month

Grid Projects:

-EGEE

-Jawari

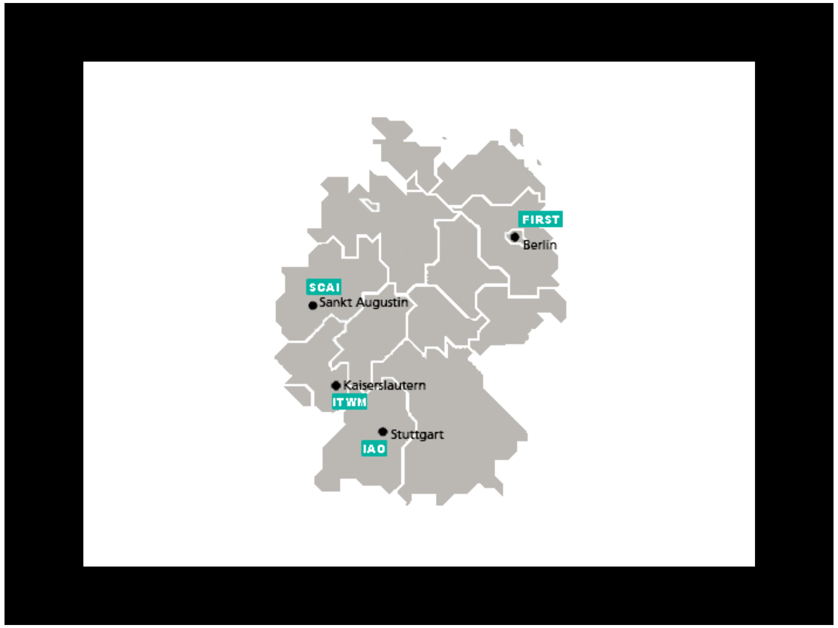
Projects I am not involved:
- EGEE
- Jawari

Enterprise Grids

Kooperationsprojekt WISA

A Fraunhofer-internal project to bring grid technology to industry users
- clear commercial focus

Ziel: Konkrete Wirtschaftserträge!

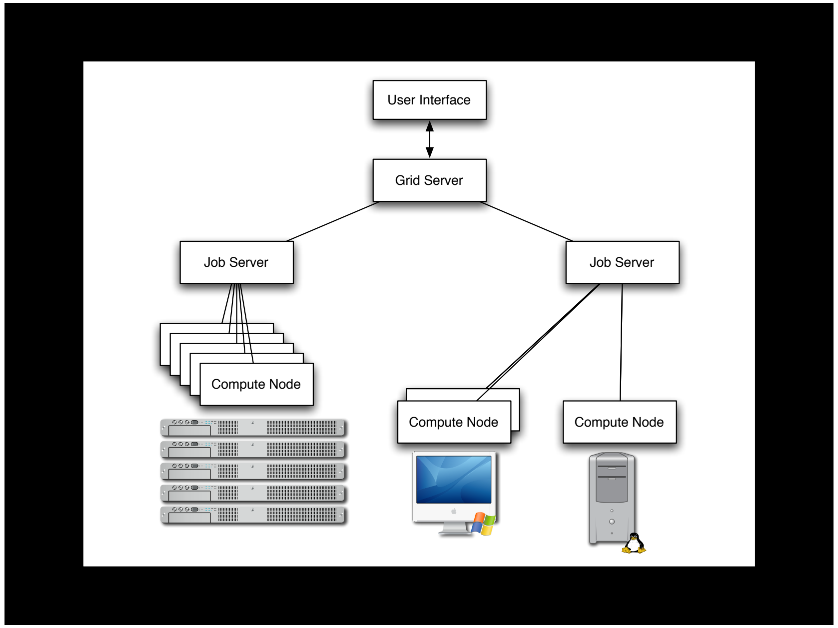


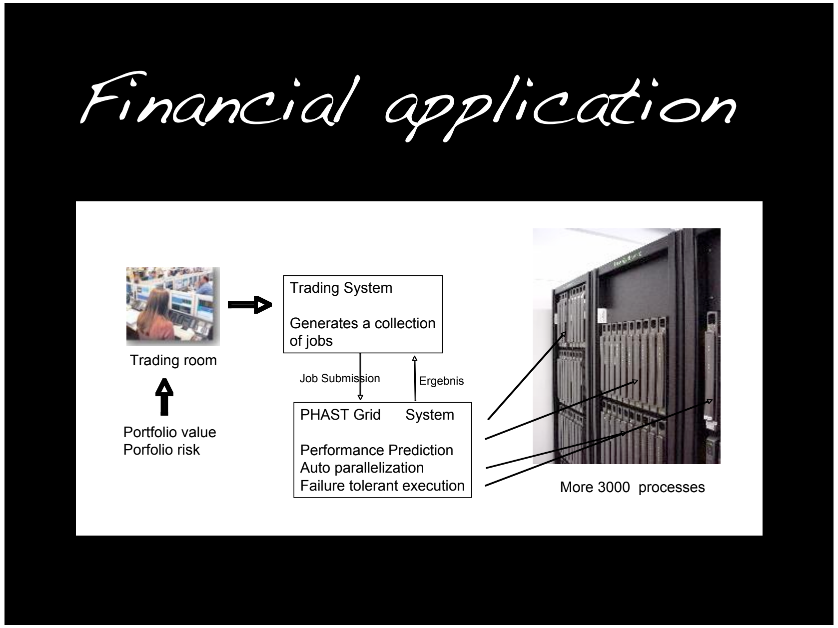
Member Institutes:
- IAO: Portal, Einführungsprozesse
- SCAI: MPCCI
- ITWM: Operating, PHASTGrid
- FIRST: Grid Workflow Management

People at ITWM (beside me)
Tiberiu: PHASTGrid-Development
Kai: Deployment, Test infrastructure, support
Me: Coordination, Standardization our efforts (PHASTGrid, Calana, Xenbee)

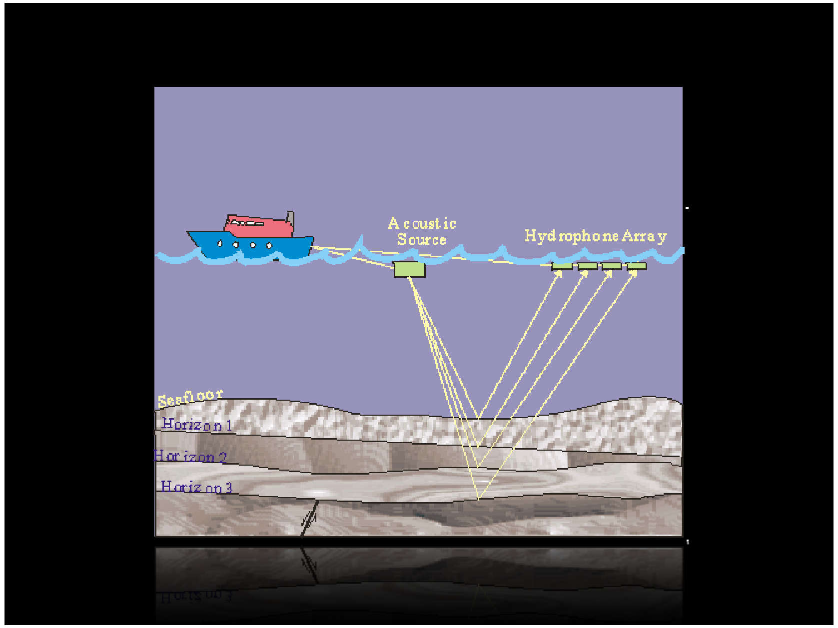
Fraunhofer
PHASTGrid

PHASTGrid as Execution-plane-product
- maybe depict architecture





- high throughput, 50 jobs/sec
- 24/7 on two datacenters for 3 years



Seismic migration processing
- Computations that take 6 Months on 6000 CPUs
- MPI-based parallel application
- Machine crashes unavoidable – checkpointing, ...
-> Integration of the algorithm into PHASTGrid, no MPI neccessary.

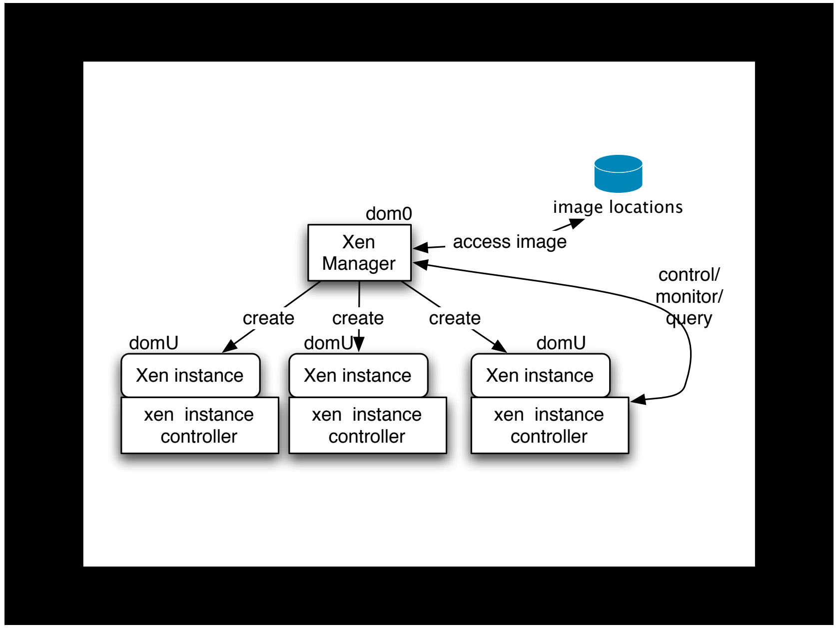
PartnerGrid

German Project (approval pending) within D-Grid
3 Fraunhofer Institutes, DLR (NASA pendant)
2 Industry partners: Magma, GNS (FEM-Simulation INDEED)

- Fraunhofer SCAI, ITWM, IAO
- DLR Simulations- und

Using grid technology in industry settings

e.g. Magma:
Simulation of metal in a mold
- Many SME customers of Magma let process their jobs at Magma
- Magma wants to move those jobs to service providers

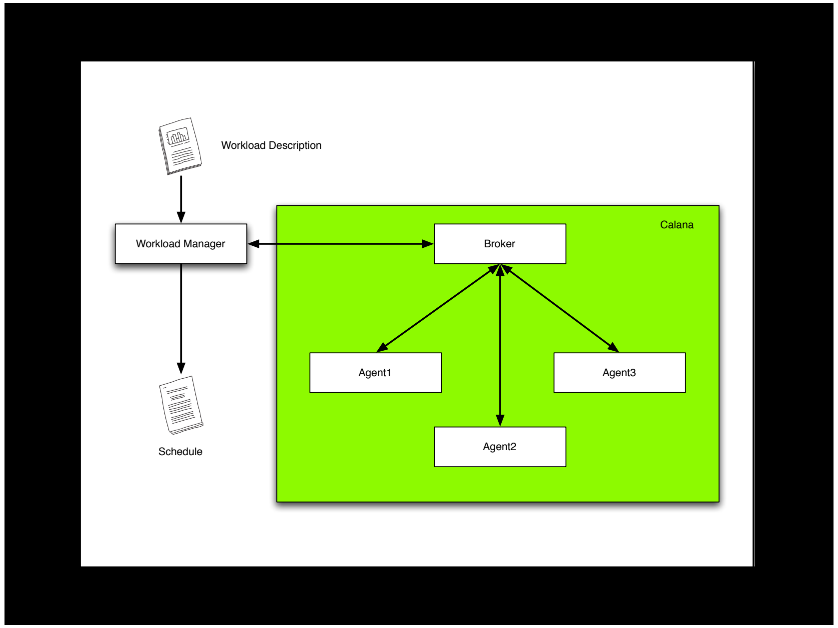


Part of our contribution:
Management of virtual machines based on Xen
- Application-images can be shipped completely with input data and license information to the service provider

- a virtual filesystem acts as a container
- as long as the kernel is suitable, there are no real dependencies on the target system
- easy to maintain: only a master image must be updated/certified

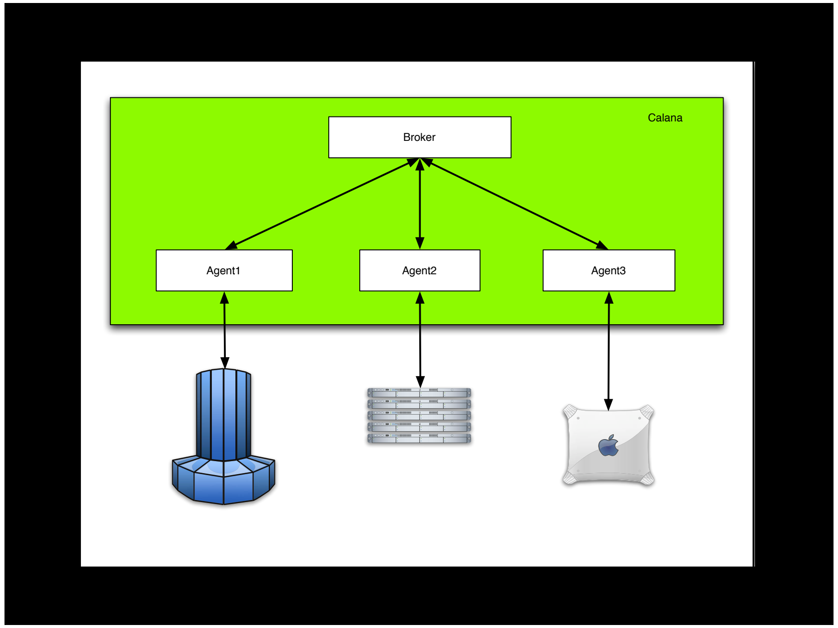
Secured Containers:
It is also possible to protect the containers using encryption.
- customer data is only accessible when the computation runs
- different provider levels: gold, silver, platinum, depending on the security a provider enforces

Architecture of today's scheduling systems:
Mostly hierarchical. Resources propagate their usage in information systems and schedulers work on this information.
Typically no reservations etc in this setup, which makes it difficult to do coallocation.



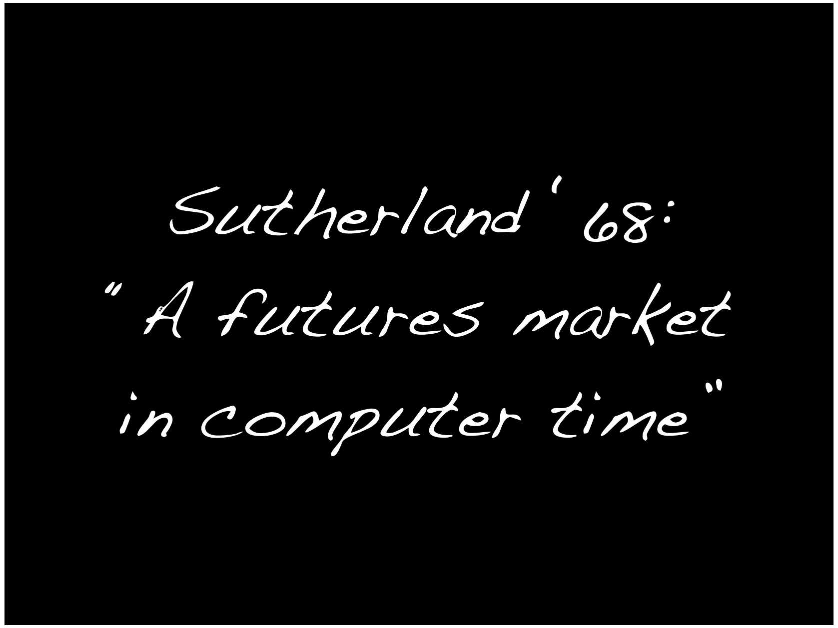
Setup Calana:
(1) A workload manager reads the job description and tries to execute it.
(2) Communication with Calana (rather complex)
(3) A schedule is built and can be used.

Calana:
(1) Ein Workloadmanager übernimmt

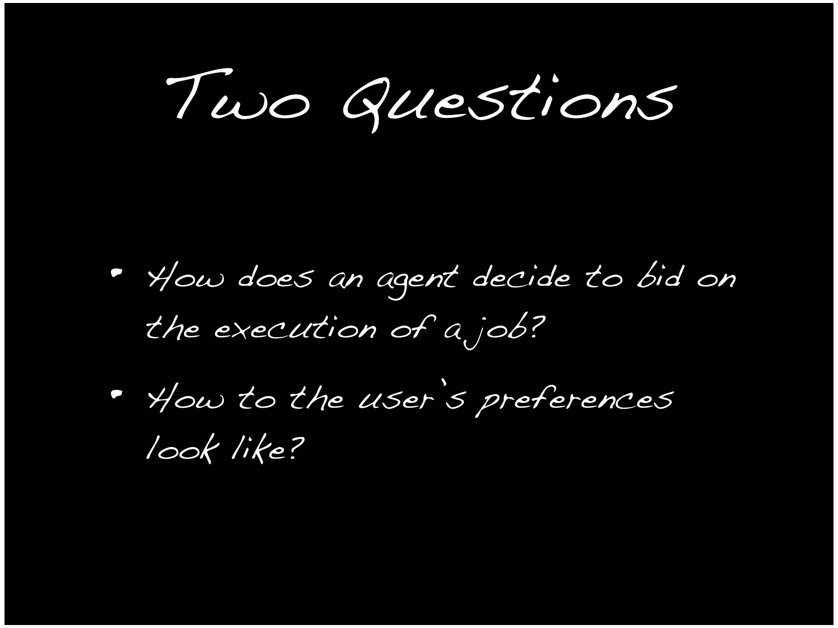


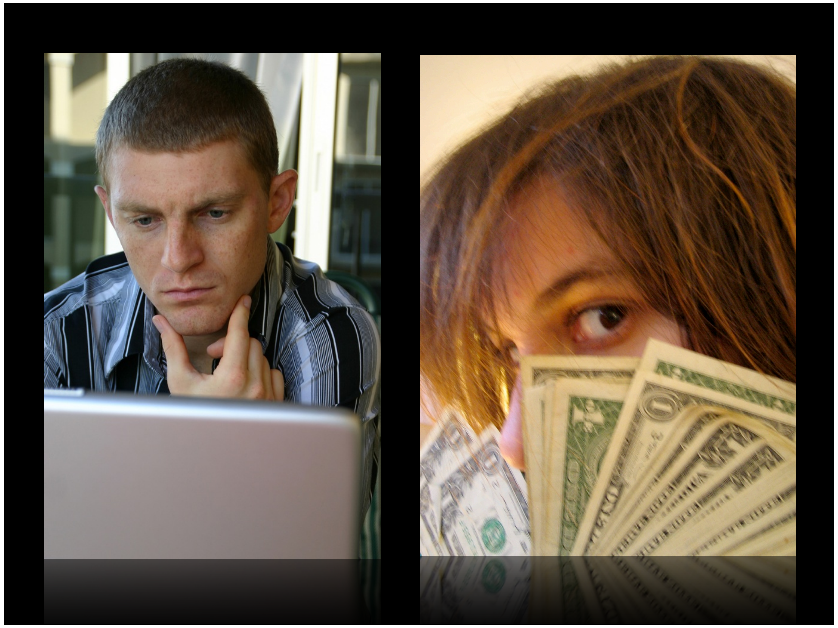
Calana in more detail:
The broker communicates with the agents. The agents are placeholders for individual resources and provide an active abstraction layer.

Request comes in, the broker starts an auction. The agents consider the request and create bids on the



-> Simple daily auction for allocating slots on a PDP-1
- Other systems like Waldspurger et al, "Spawn", or "Popcorn"





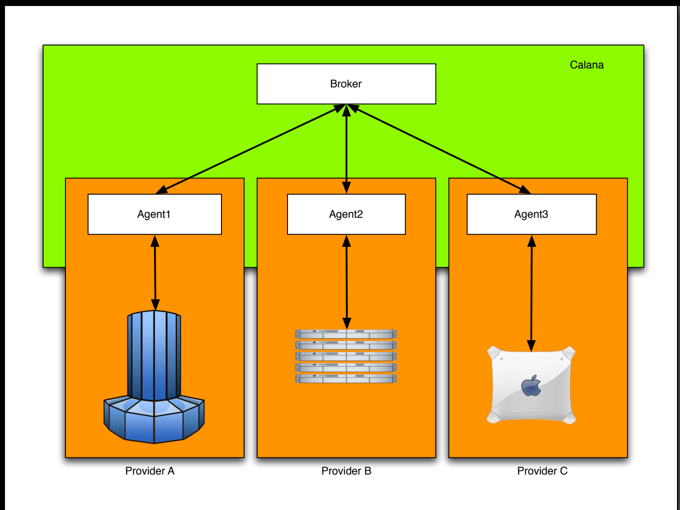
One user might want to have his jobs running *now*, as fast as possible. This might impose high resource usage costs (no optimization by the scheduler possible, “gaps” in the schedule)

The other user might want to run her jobs as cheap as possible – speed is

$$v_i = f(p_i, t_i^{\mathrm{f}}) = g \cdot \frac{p_i}{p_{max}} + (1-g) \cdot \frac{t_i^{\mathrm{f}}}{t_{max}^{\mathrm{f}}}$$

So, a bid consists of a tuple (p, tf). How can the broker judge the bids? Compare the relative values of the bids.

g: The user’s price preference.

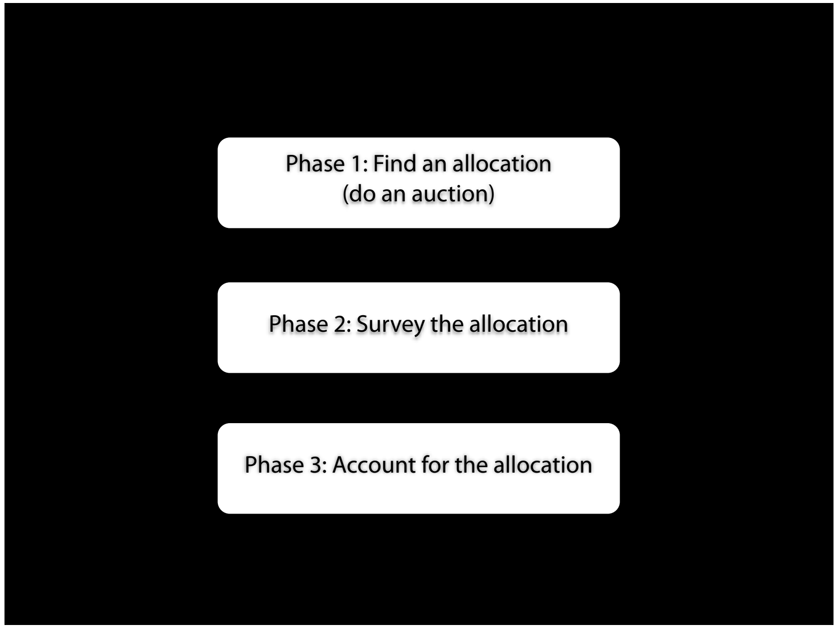


The agents may implement any strategies, depending on their providers. The behaviour of the whole system depends on the behaviour of the agents.

To prevent fraud, the system must make the agents accountable for their actions. They need an incentive to

collusion effects:
- information trade, syndicates
-> Countermeasure: Auction protocol to use (Vickrey-Auction)

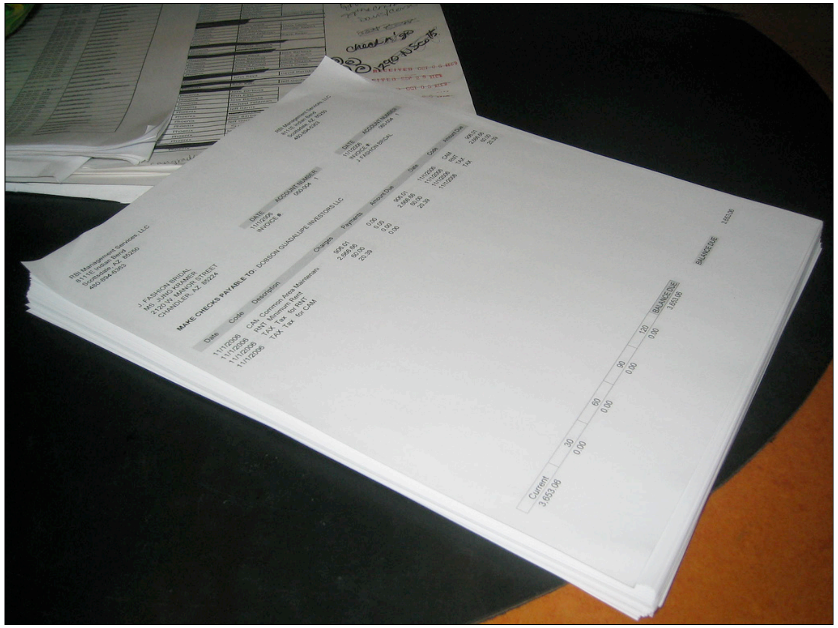
fraud:
-> Allocation needs to be surveilled by the broker.
-> Rather complex communication



What I add to these mechanisms is accountability for actions:

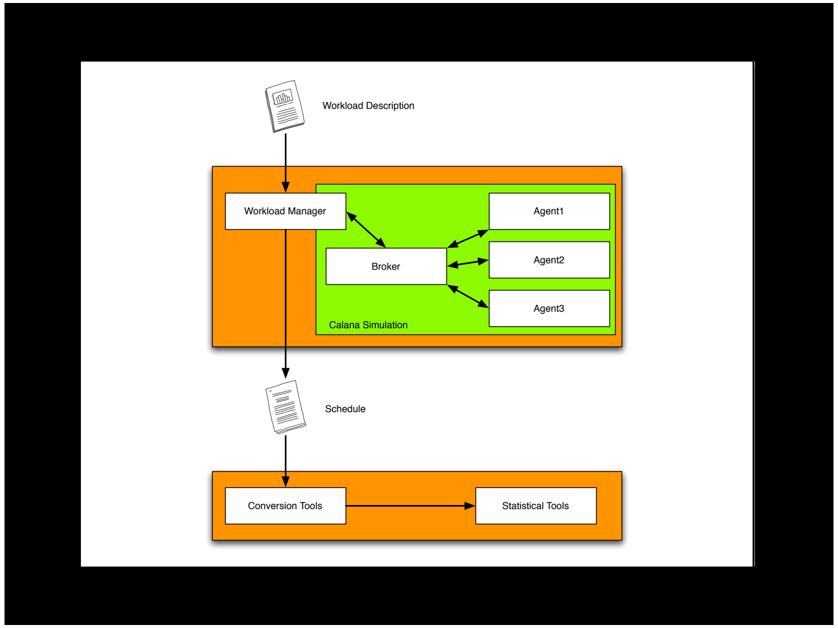
scheduling needs to be more: its more transaction-based!
-> three phases

-> If one fails to fulfill a contract, a penalty payment is due. this is



The broker knows all transactions and their results
- easy to do accounting
- billing easy since pricing is known

For commercial applications, it is important to the user to know who is processing the job
- for each job, there is a contract made
- this way, a user could prevent that sensitive data is processed at a not trustworthy provider

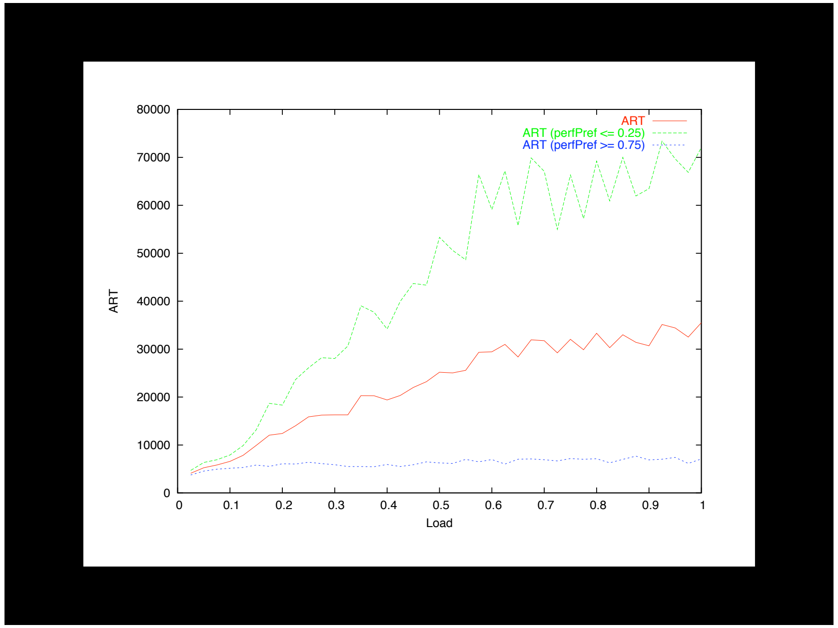


Simulation Toolchain

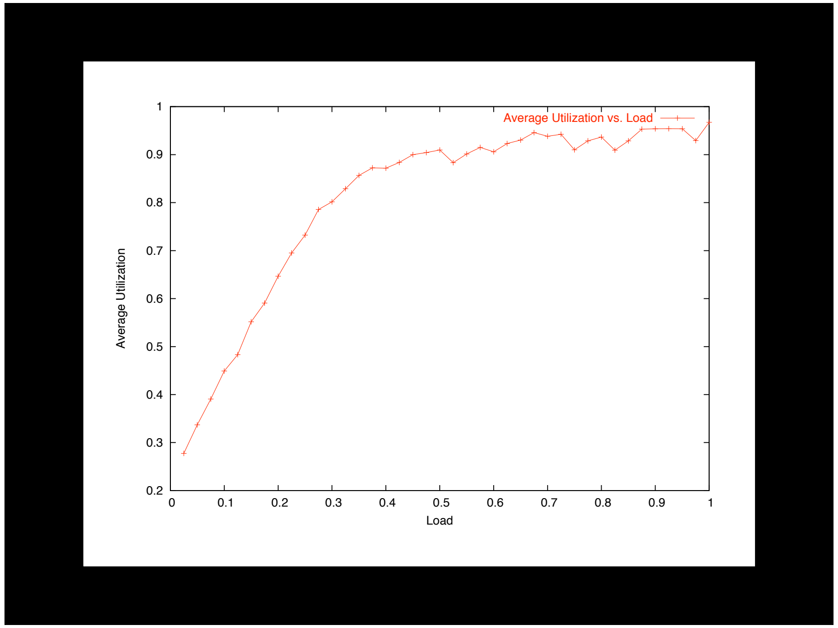
Problem: You need to simulate online (timing has a huge influence on scheduling results)
-> Alex implemented an eventbased simulation

Problem: The workloads need to be

50 agents in charge of one CPU each. 1000 users with random preferences, the input workload consists of 10000 jobs.



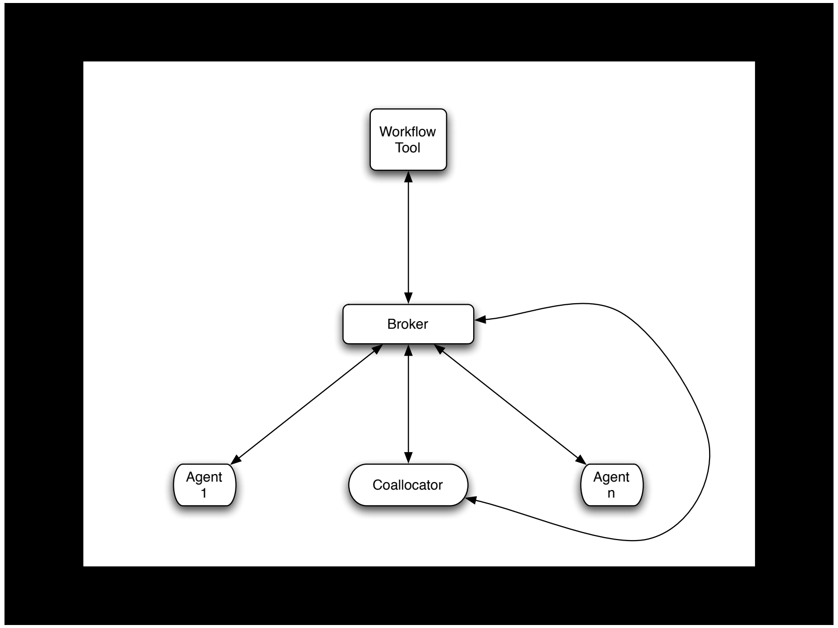
Blue: hich performance preference -> the ART is almost constant
Green: price preference dominates.



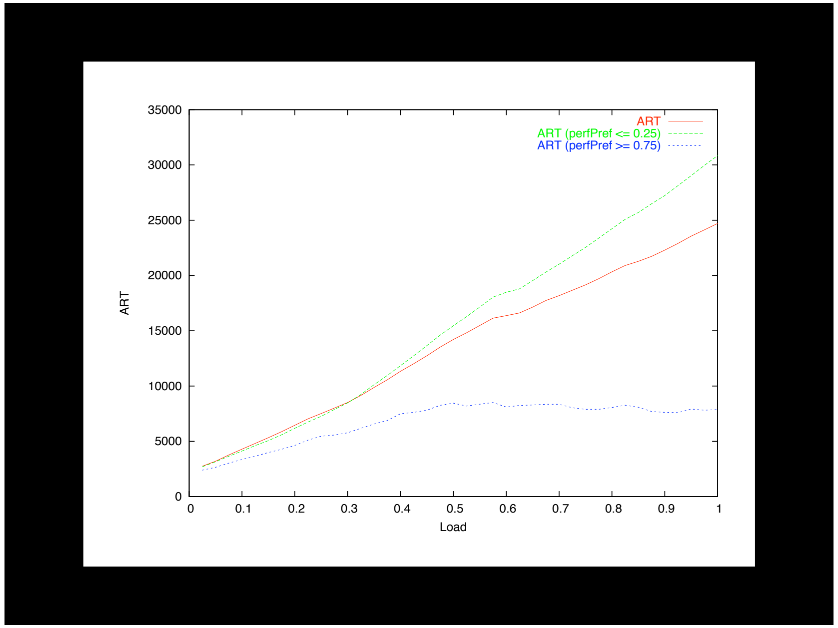
The system is almost saturated – workload contains idle times, so no full utilization possible.

Experiment 2:
Small Grid with
Clusters,
Coallocation

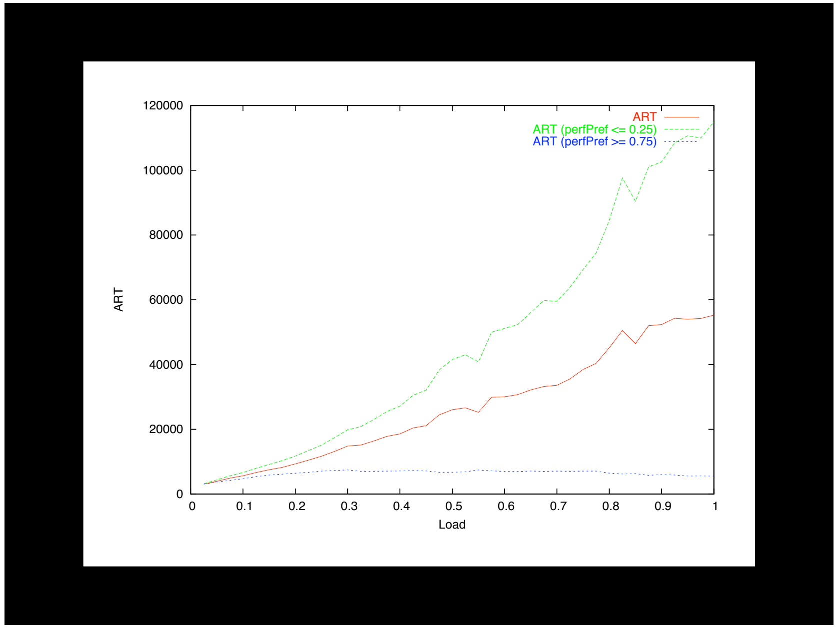
the clusters simulation also contains a simulation of a backfilling cluster scheduler



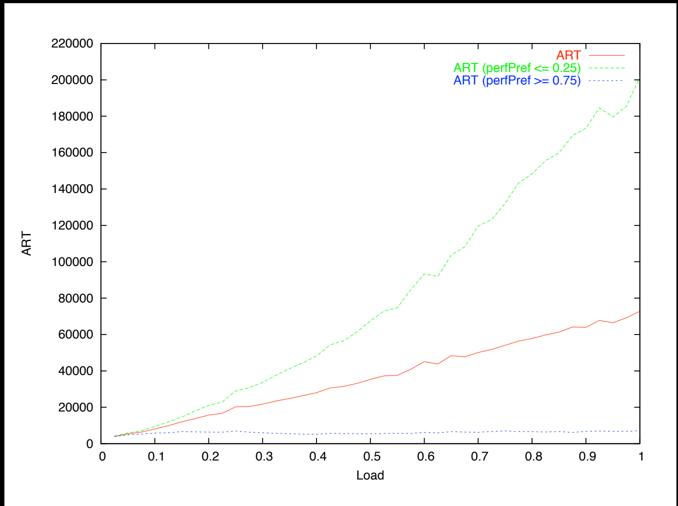
Coallocation can be done by a separate agent which alligns the bids of others.
Auctions can be nested.
-> Very flexible.



reference: no coallocation here.



10% of the jobs ask for coallocation over several clusters



20 % coallocation jobs

Outlook (1)

- Integrate Coallocation in the production code
- Add java messaging service layer
- Create agents for Xen installations

Outlook (II)

- Add a data management layer
- Investigate bidding strategies
- Change auction type

Fraunhofer Institut Techno- und Wirtschaftsmathematik

dalheimer@itwm.fhg.de