Computer Science & Engineering Department

A Simulation Model for Large Scale Distributed Systems

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Outline

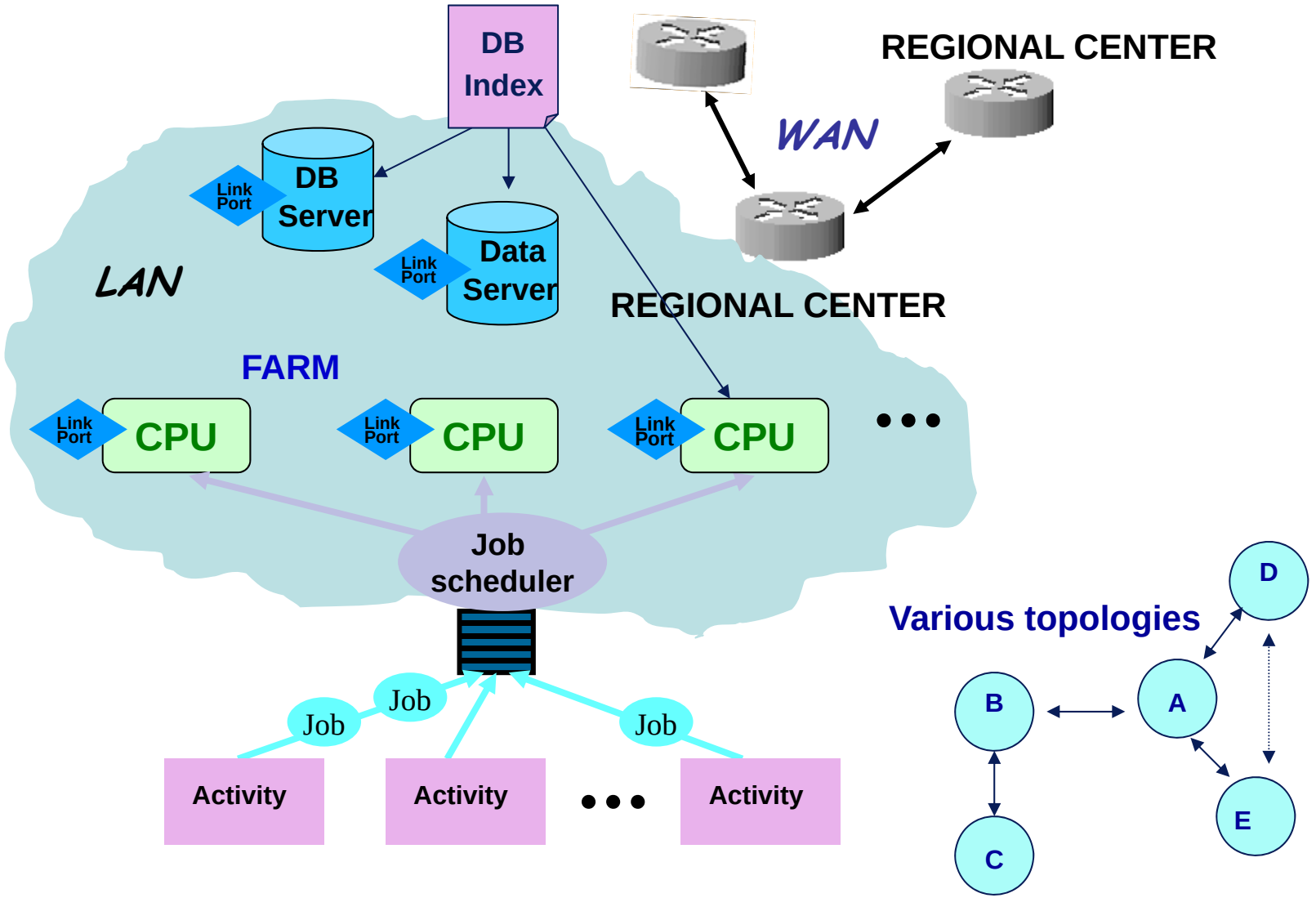
- MONARC 2, a simulation framework for large scale distributed systems
- The Grid influences on the design of the simulation framework
- Simulation experiments
- Conclusions

The Grid influences on the design of the simulation framework

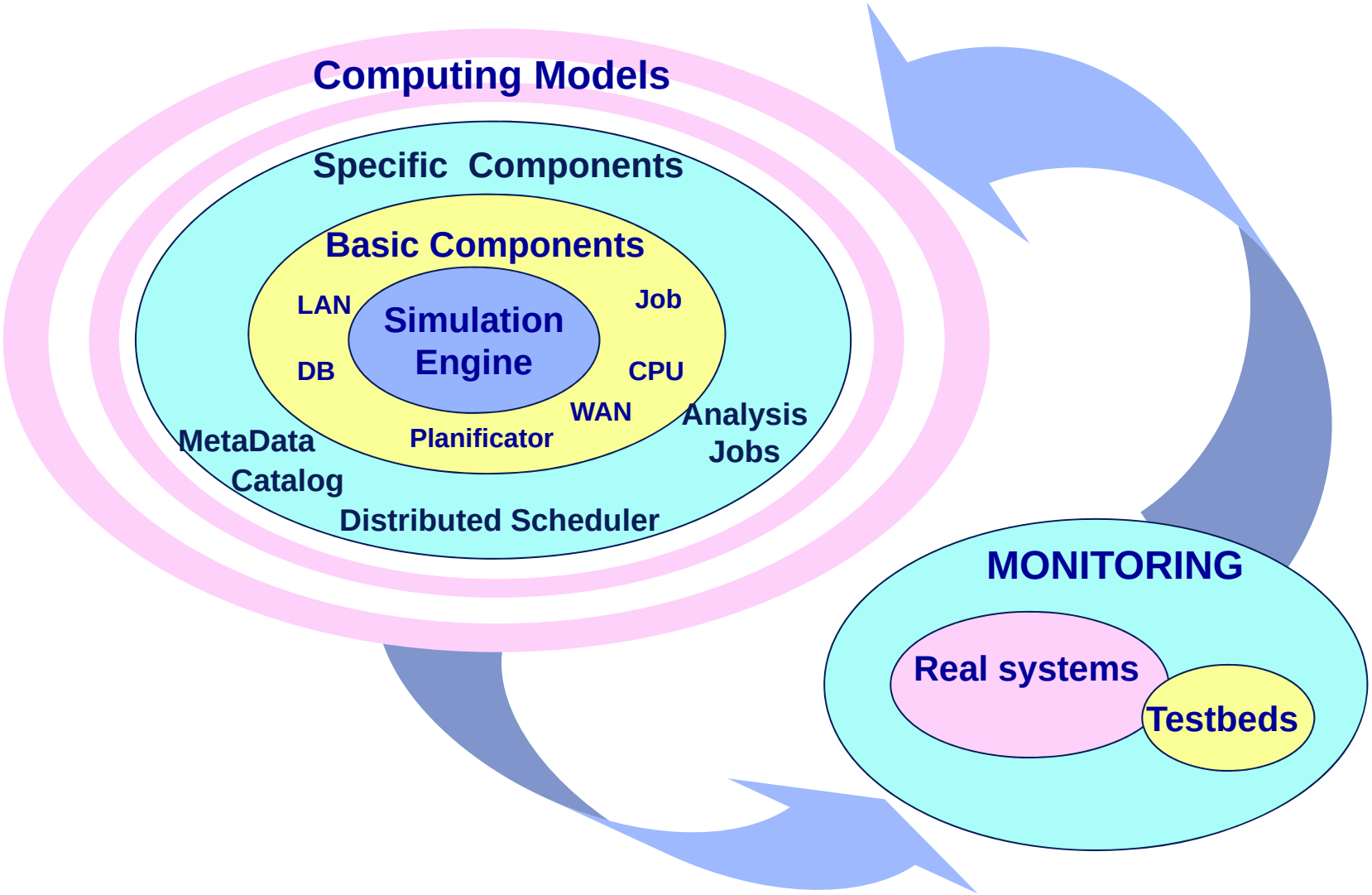
- The simulation model proposed by MONARC 2 includes the necessary components for simulating various distributed systems technologies, with respect to their specific components and characteristics
- The model includes the necessary components to describe various actual distributed system technologies, and provides the mechanisms to describe concurrent network traffic, evaluate different strategies in data replication, and analyze job scheduling procedures
- One important characteristic of the proposed simulation model is its generality

- **http://monarc.cacr.caltech.edu**

Components of the Simulation Framework

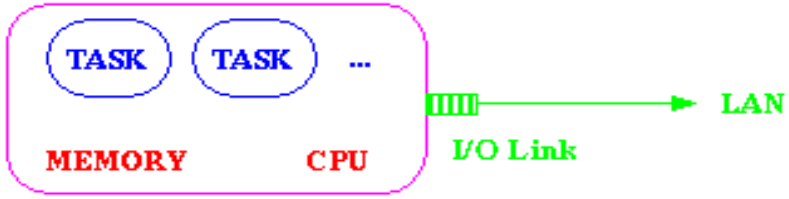


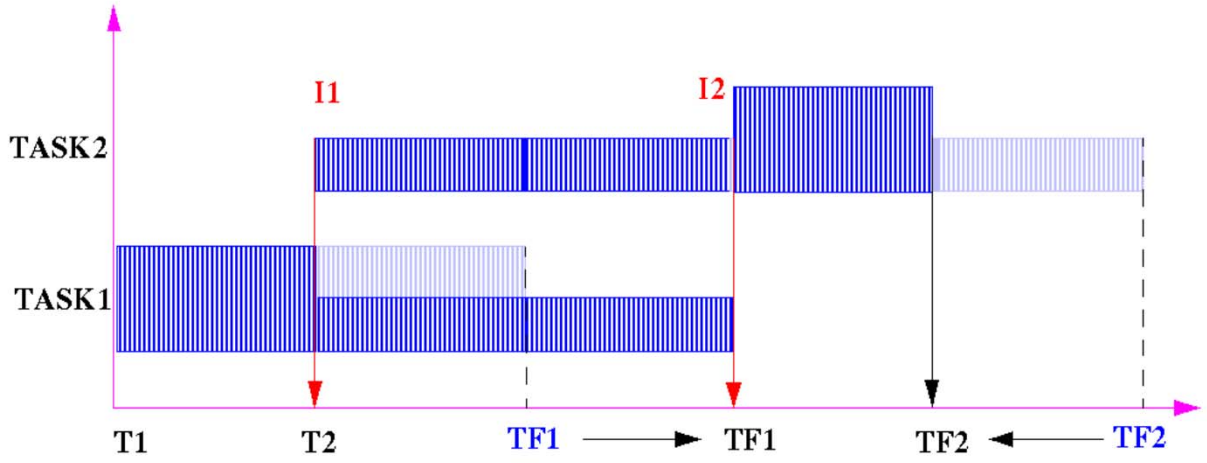
The architecture of the simulation framework



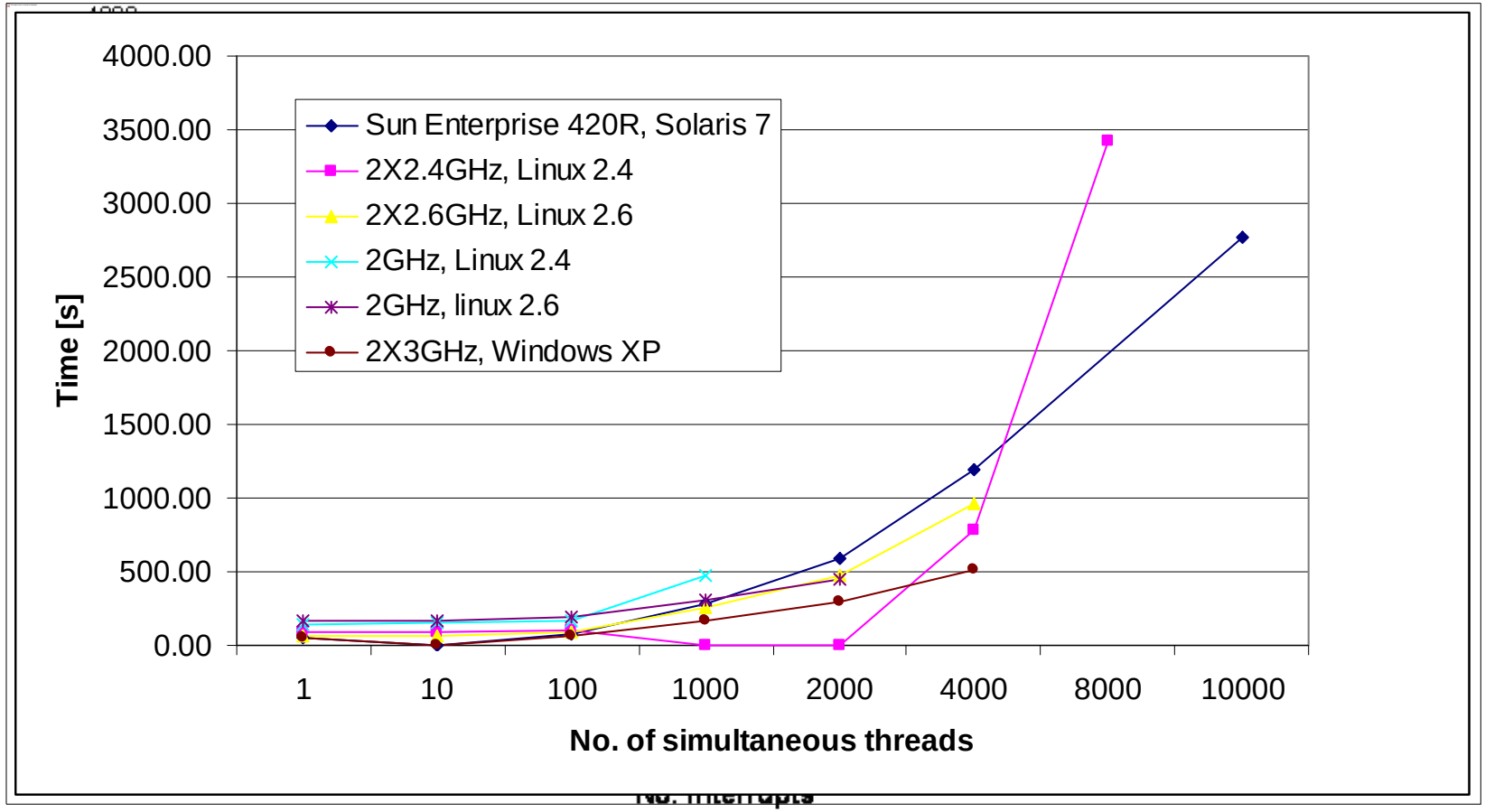
Multitasking Processing Model

- The interrupt mechanism is useful for describing concurrent running tasks sharing resources, memories, I/O operations
- It is based on the simulation events





The running performance



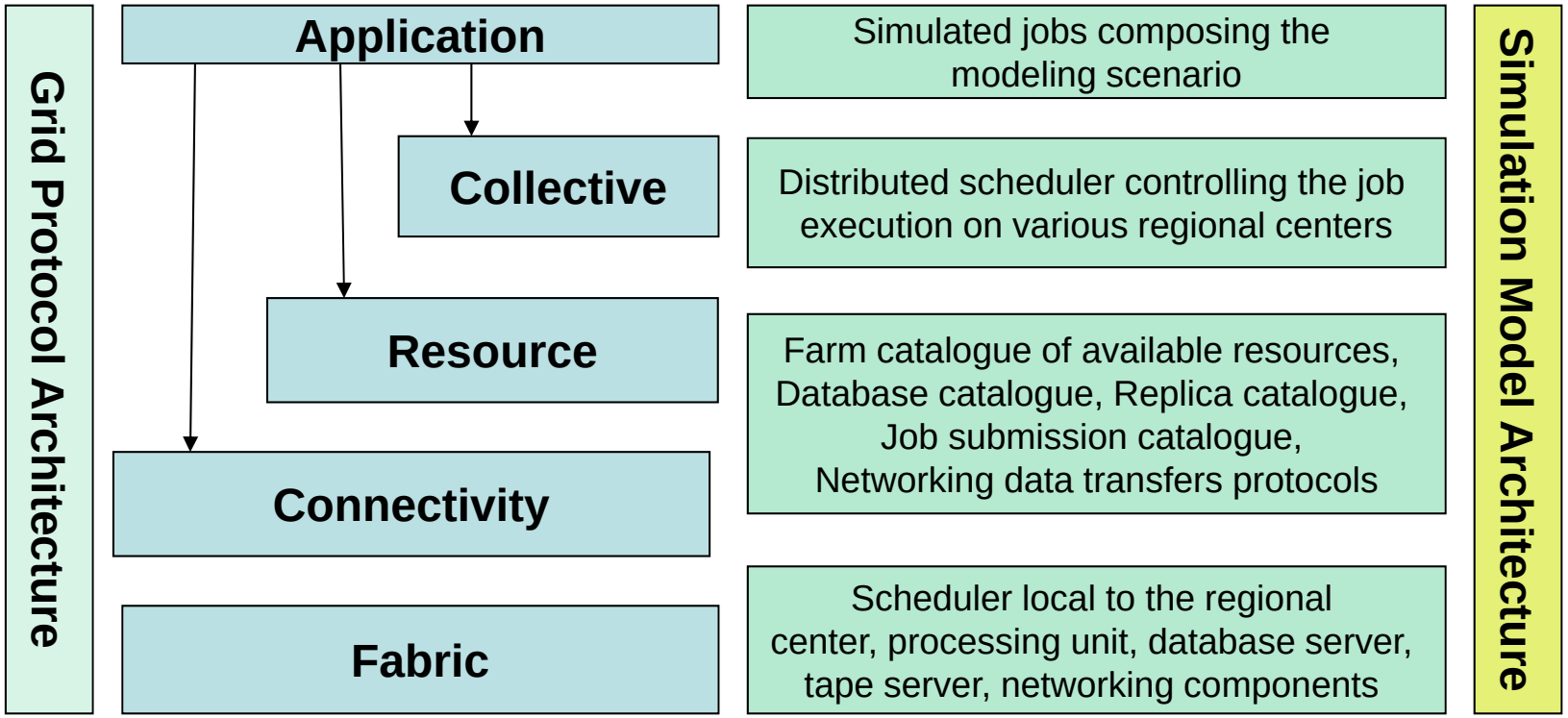
Characteristics of the distributed systems

- The original distributed system characteristics are well mapped on the simulation model

Characteristic	Influence on the simulation model
Resource sharing	Use of networking components and data sharing entities.
Openness	Inclusion of easily extendable object-oriented modelling infrastructure and standard interfaces that allow access to the fabric components inside a running simulation experiment.
Concurrency	Use of an interrupt mechanism that allows the simulation of concurrent processes and networking data transfers.
Scalability	The adoption of an object-oriented simulation model and the use of advanced internal structure.
Fault-tolerance	The scheduler takes into account this property to ensure successful job completion.
Transparency	Use of advanced routing algorithms, data replication algorithms, and scheduling algorithms to consider failure-transparency.

Grid architecture and its influence on the simulation model

- The simulation model incorporate the components and characteristics specific to the Grid layered architecture



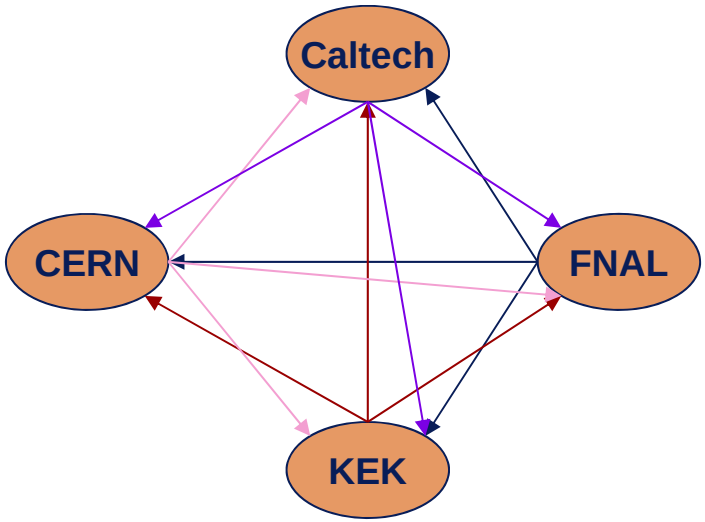
Grid systems characteristics

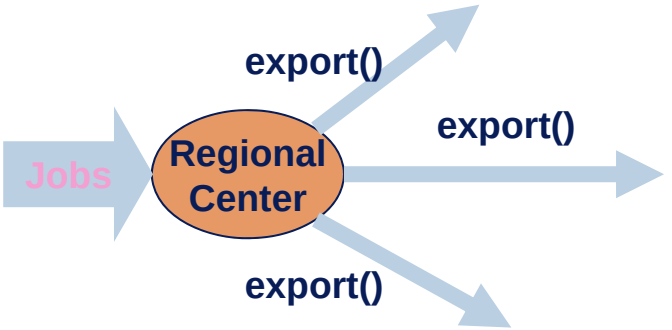
- The characteristics of the Grid systems are well preserved by the simulation model proposed in MONARC 2

Grid characteristic	Influence on the simulation model
Large scale	Use of advanced internal structure allows the modelling of experiments with many incorporated resources.
Geographical distribution	The regional center architecture of the simulation model.
Heterogeneity	Use of various models for hardware components; software architectures captured in different probability distributions.
Resource sharing	Represented in the network model.
Multiple administration	Inclusion of a distributed scheduler.
Resource coordination	Resource coordination mechanisms.
Dependable access	Implementation of DAG scheduling algorithms based on QoS politics.
Consistent access	Use of standard methods to access the resources.
Pervasive access	The scheduling framework detecting faults and taking appropriate actions.

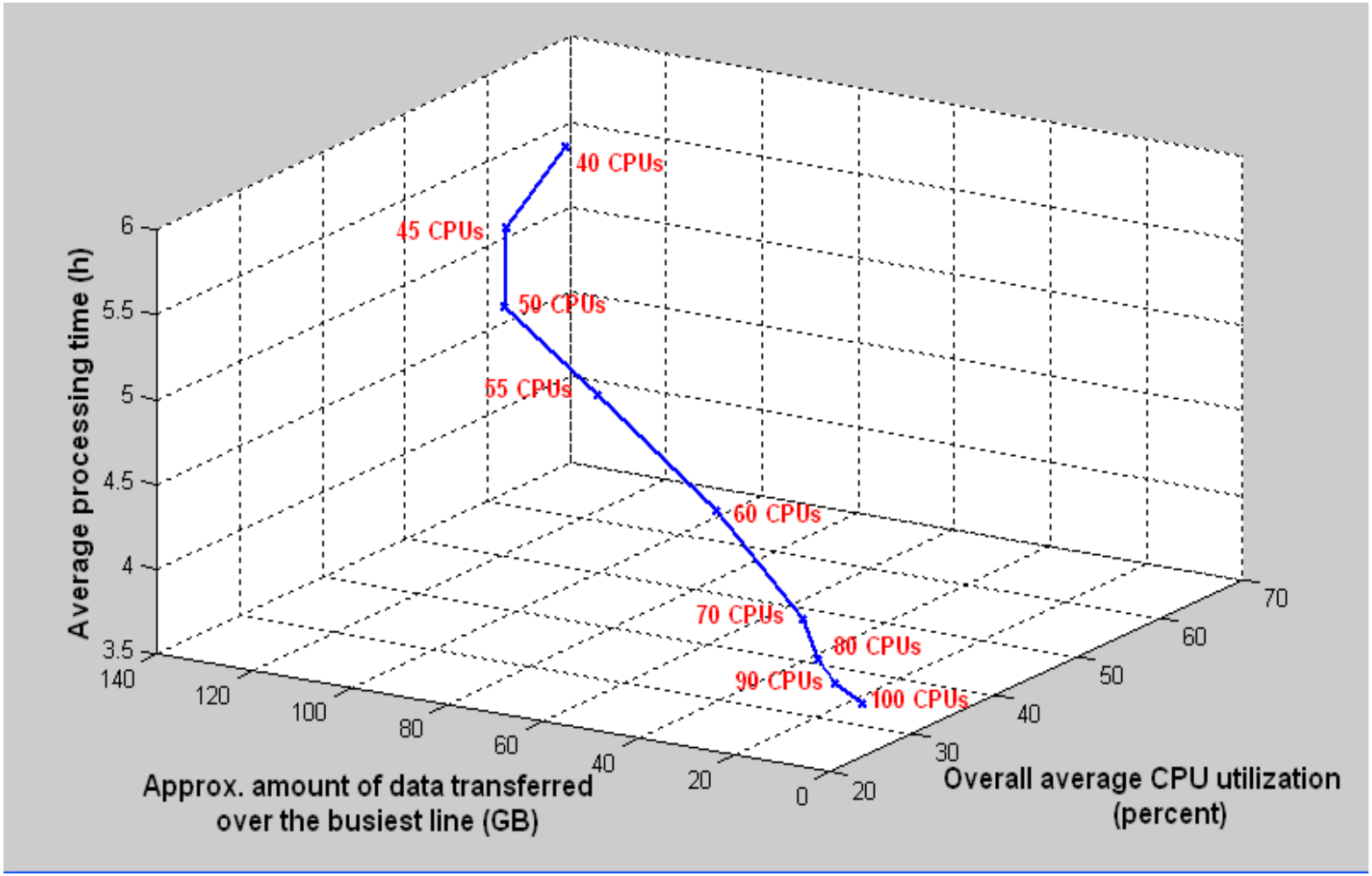
Simulation Experiments

- The simulation model adopted in MONARC 2 allowed the testing of various scheduling algorithms, data transport algorithms and infrastructures, data transfer protocols, replication algorithms, all with interesting results that were used in real-world
- Example: distributed scheduling



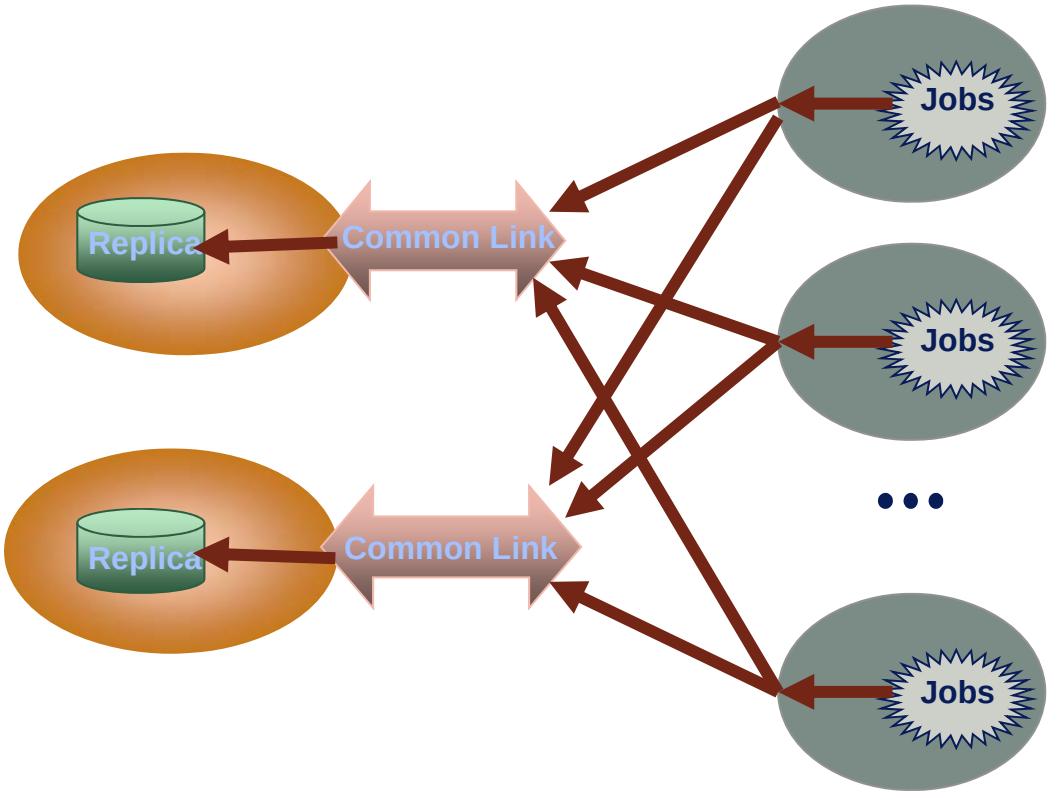


Distributed scheduling



Data replication

- Experiments designed to analyze the capability of the simulation framework to handle the modelling of various replication technologies



Data replication

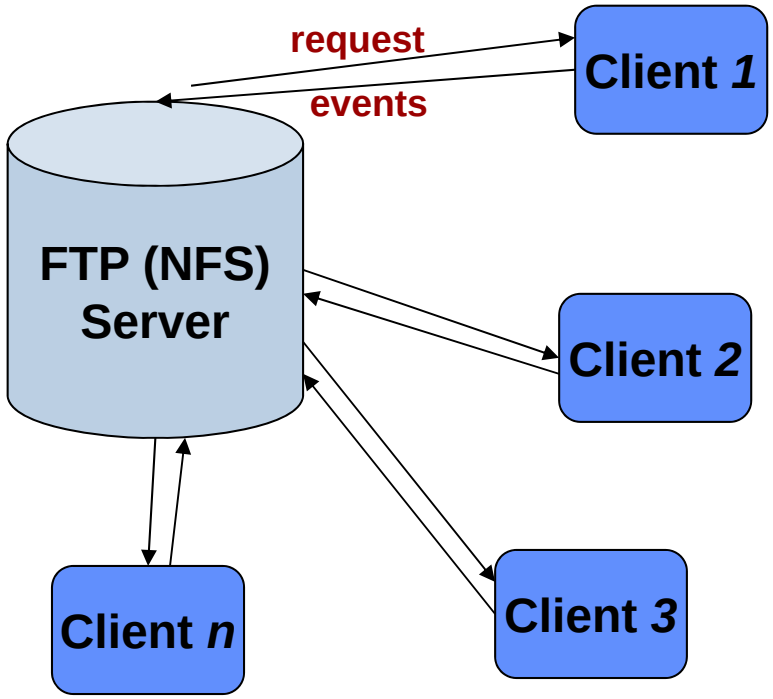
Both servers have the same bandwidth and support the same maximum load

Better average response time, total execution time is smaller when taking decisions based on load balancing

One server has half of the other's bandwidth and supports half of its maximum load

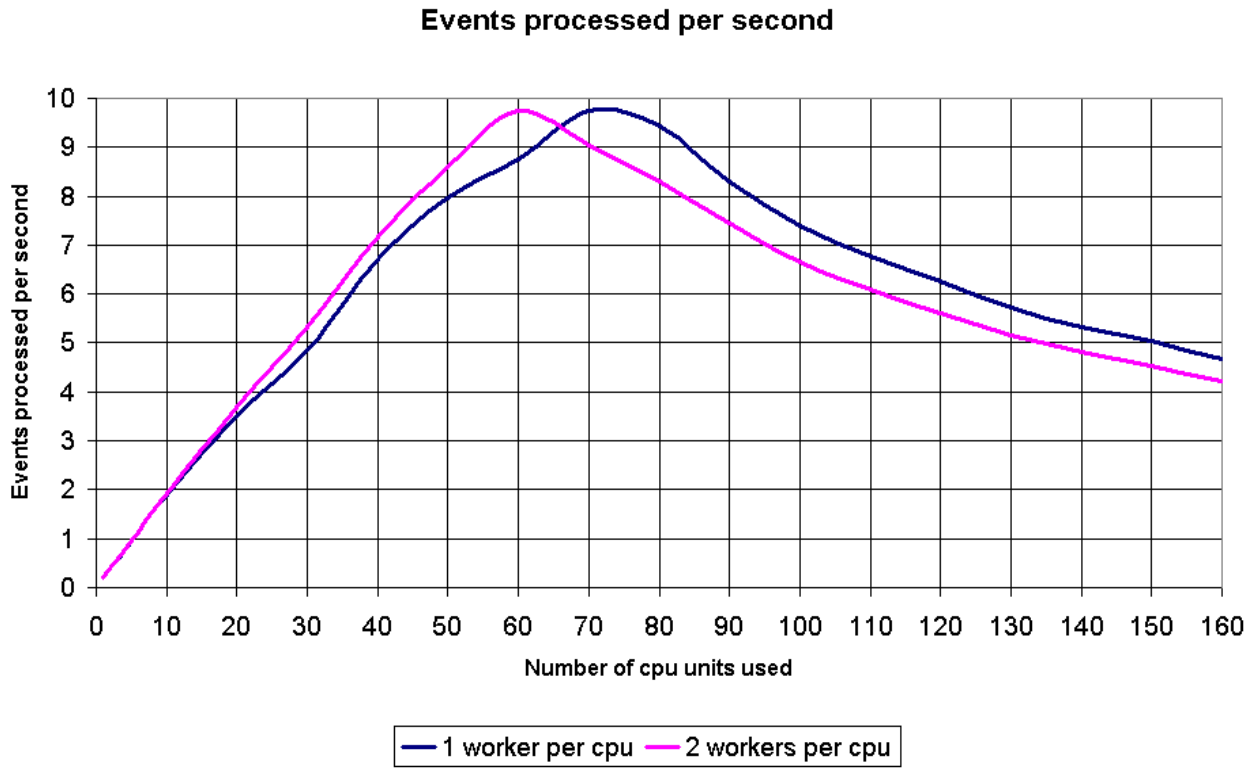
Data Transferring Simulation Experiments

- The experiments demonstrate the capability of the simulation framework to model various data transferring technologies
- The scenario assumes the use of a FTP-like network protocol for transferring the processing data

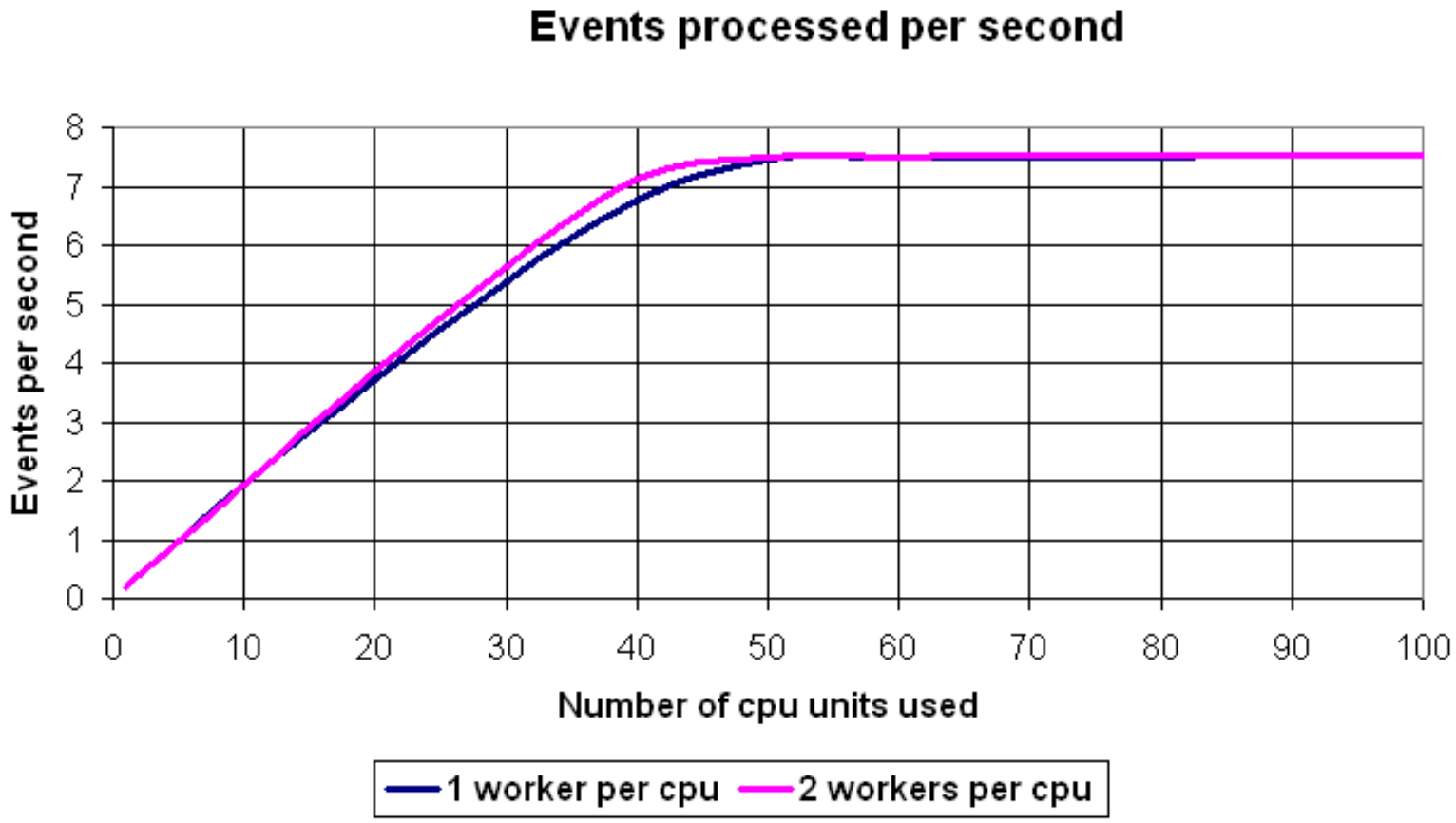


FTP Data Transferring Experiment

- Assumptions:
  - A processing job processes 100 data events
  - An event has 1 MB
  - The server sends data at a maximum 60 Mbps



NFS Data Transferring Experiment



Conclusions

- The model allows the realistic simulation of a wide-range of distributed systems technologies, with respect to their specific components and characteristics
- We presented the design characteristics of the simulation model being proposed by MONARC 2, as it incorporates the necessary components to model various modern-day distributed systems technologies, providing the mechanisms to describe concurrent network traffic and to evaluate different strategies in data replication or in the job scheduling procedures
- The maturity of the simulation model is demonstrated by the number of simulation scenarios that were successfully conducted

Questions?

Thank you!

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