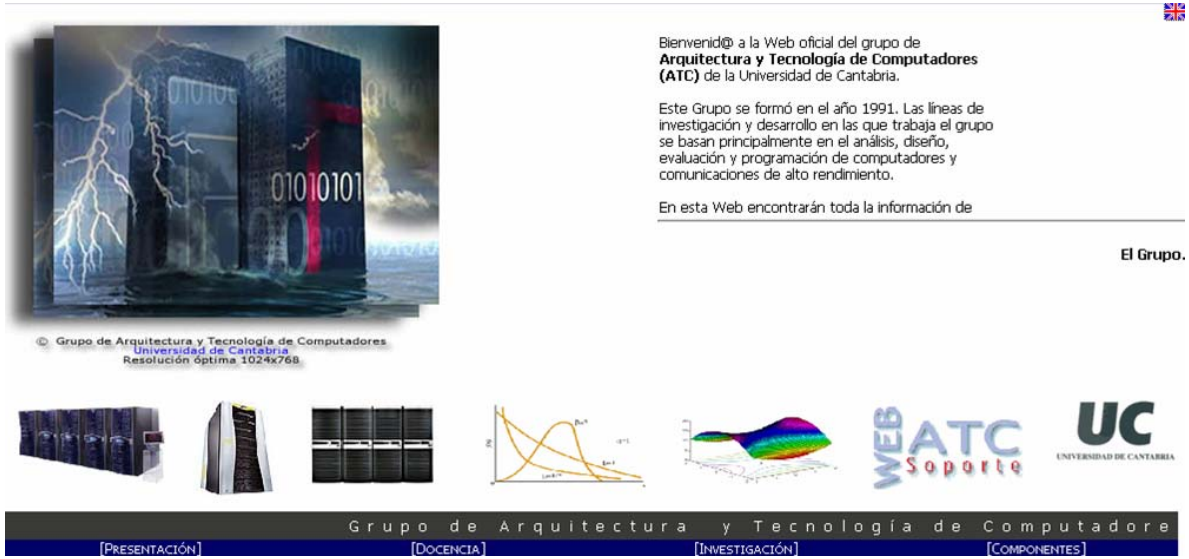
Architecture and Technology Group. University of Cantaria

http://www.atc.unican.es/

- The Computer Architecture Group (ATC) of the University of Cantabria was constituted in 1991.
- The main research areas are analysis, design, and evaluation of parallel computers,
- Actually, the principal research projects can be grouped in three broad categories:
  - Interconnection subsystem of massively parallel machines (MPPs).
  - Design and evaluation of message routers.
  - Parallel Processing.



Heterogeneous Computing

- Theoretical computational models:
  - Scalability
  - Parallel Computational models
  - Performance Evaluation models
- Load balancing algorithms
- Collaborative/Cooperative Information Systems
- Parallel Applications

Scalability Models

- Scalability analysis is one of the most salient attributes of parallel systems
- The scalability analysis of a parallel system gives some very useful information about its behaviour:
  - To compare the performance of different algorithms within the same architecture when the number of processors is increased.
  - It helps to predict how technical changes, can affect the parallel computer's performance for a given algorithm.
  - To improve the parallel implementations detecting bottlenecks and critical points when the number of processors is changed.
- New contributions:
  - *A new definition of efficiency that can be applied both to homogeneous and heterogeneous systems.*
  - *A technique for analyzing scalability within heterogeneous systems, based on heterogeneous isoefficiency concept.*

Parallel Computational Models

- The design and implementation of efficient parallel algorithms is still a problematic issue.
- It is necessary to adopt a model to unify parallel computation, and to play a role much like Von Neumann's model has played for sequential processors.
- A parallel computational model is a mathematical abstraction of parallel computers which hides architecture details to software designers
- New Contributions:
  - *A new heterogeneous parallel computational model based on the LogGP model, HLogGP.*
  - *The model takes into account system heterogeneity both in the computational nodes and in the communication network.*
  - *A set of benchmarks for heterogeneous cluster parameterization.*

Performance Evaluation Models

- All the previous models are based on the number of task on the CPU queue or on the CPU utilization.
- Prediction model capable of predicting the CPU availability for a new task on a system.
- Deep understanding of the CPU time sharing among the processes in its run queue.
- New Contributions:
  - *A new CPU assignment model that takes into account the different processes CPU requirements.*
  - *Static Process Assignment Prediction Model (SPAP), is a static solution which assumes a priori knowledge about some system parameters*
  - *The Dynamic Process Assignment Prediction (DYPAP) model predicts the CPU availability of a system from measurements, without a priori knowledge, and taking into account the CPU requirements of the tasks.*
  - *The DYPAP monitor, a real-time monitoring utility responsible for periodically characterizing a workstation state.*

Load balancing algorithms

- Load balancing is critical for achieving high performance in distributed systems because it enables an effective and efficient utilization of all the available resources.
- Balanced distribution of a set of processes on a heterogeneous system, proportional to each node's computational power.
  - System heterogeneity.
  - Local load of each node.
- New Contributions:
  - *Study of the concrete needs for heterogeneous systems and redefinition of certain traditional concepts.*
  - *Different models and performance metrics:*
    - *To describe heterogeneous system behavior*
    - *To perform an exhaustive analysis of the effects of heterogeneity on load balancing algorithms performance*.
  - *Development of middleware that implements the balance of load bearing in mind these peculiarities.*

Collaborative/Cooperative information systems

- Cooperative Information Systems are characterized by their ability to support and manage large numbers of coordinated heterogeneous resources and services while they cooperate to accomplish a common goal.
- New Contributions:
  - AMBLE (Awareness Model for Balancing the Load in Collaborative Grid Environments), a new extension of the Spatial Model of Interaction, in the context of an asynchronous collaboration in grids
  - WE-AMBLE, a Workflow Engine to manage Awareness in Collaborative Grid Environments through the AMBLE concepts.
  - CAM, Management of resources by means of Collaborative/Cooperative Awareness Management (CAM) model and its implementation (WS-CAM).
  - Managing of resources, information, interaction and awareness.
  - CSCW, agents and grid communities, to create collaborative and cooperative agents-based grid environments.

Parallel and Distributed Applications

- Images processing Applications:
  - CBIR: Content Based Information Retrieval.
  - Parallel Video Segmentation.
- Visualization and virtual reality applications:
  - Ray tracing on a grid environment.
  - Development of several algorithms of virtual reality on parallel (possible heterogeneous) environments.
- Applications of medical Image:
  - Brain activity detection in functional magnetic resonance imaging on heterogeneous clusters.
  - Paralellization of the transformed one wavelet of Haar 3D, as base for the analysis and diagnosis with images of RMN.
  - Development of a Grid environment for the management of medical applications and massive storage of information.