Technical Report

Parallel Real-time Support for Distributed Adaptive Embedded Applications

Ricardo Garibay-Martinez
Luis Lino Ferreira
Luis Miguel Pinho

HURRAY-TR-120101
Version:
Date: 1/24/2012
Parallel Real-time Support for Distributed Adaptive Embedded Applications

Ricardo Garibay-Martinez, Luis Lino Ferreira, Luis Miguel Pinho

IPP-HURRAY!
Polytechnic Institute of Porto (ISEP-IPP)
Rua Dr. António Bernardino de Almeida, 431
4200-072 Porto
Portugal
Tel.: +351.22.8340509, Fax: +351.22.8340509
E-mail: rgmz@isep.ipp.pt, llf@isep.ipp.pt, lmp@isep.ipp.pt
http://www.hurray.isep.ipp.pt

Abstract

Real-time embedded applications require to process large amounts of data within small time windows. Parallelize and distribute workloads adaptively is suitable solution for computational demanding applications. The purpose of the Parallel Real-Time Framework for distributed adaptive embedded systems is to guarantee local and distributed processing of real-time applications. This work identifies some promising research directions for parallel/distributed real-time embedded applications.
Parallel Real-time Support for Distributed Adaptive Embedded Applications

Ricardo Garibay-Martinez, Luis Lino Ferreira and Luís Miguel Pinho

Motivation and Objectives

• Target applications characteristics:
  • Embedded real-time applications which require processing large amounts of data within a deadline,
  • Parallelizable,
  • Resource constrained nodes.

• Objectives:
  • Parallelize and distribute the workload adaptively to more powerful nodes in the network,
  • Guarantee application timeliness.

Objectives:

Target applications characteristics:

Resource constrained nodes.

Parallelizable,

Embedded real-time applications

Guarantee application timeliness.

OpenMP: Distributed Real-Time Scheduler

```
#pragma omp parallel for schedule(dist-rt)
deadline(200)
for (i=0; i<n; i++)
{
    printf("Parallel Distributed Execution");
    ...
}/*-- End of parallel for using distributed real-time scheduler--*/
```

Schedule kind ‘dist-rt’ (distributed real-time) in OpenMP

Acknowledgements

This work was supported by National Funds through FCT (Portuguese Foundation for Science and Technology) and by ERDF (European Regional Development Fund) through COMPETE (Operational Programme ‘Thematic Factors of Competitiveness’), within projects ref. FCOMP-01-0124-FEDER-015006 (VIPCORE) and ref. FCOMP-01-0124-FEDER-022701 (CISTER Research Unit); also by FCT and the EU ARTEMIS JU funding, within ENFORCE project, ref. ARTEMIS/0002/2010, JU grant nr. 269354.

Parallel Adaptive Real-Time Distributed Framework Architecture

- Parallel Distributed RT Interface: represents the interface between the application and the framework
- Distributed RT Libraries and Run-time: provides the libraries and adaptive run-time support for parallel and distributed execution.
- Local RT Scheduler: schedules workloads and applies admission control real-time tests
- Local Resource Manager: monitors local resources usage and grants resources when available
- Allocation Optimizer: applies adaptive policies for enhancement of performance during distributed processing
- Allocation Manager: plans and executes the distribution of the workload through the system
- Global Resource Manager: monitors global resources by updating the system's state

Local and Distributed RT Scheduling

- Local RT Scheduler:
  • Applications and their deadlines are considered and locally scheduled
  • The local scheduler triggers distributed execution whenever deadlines cannot be guaranteed locally
- Allocation Manager:
  • Takes care of distributed real-time scheduling
  • Distributes data and aggregate the results

Research Challenges

- Propose Library/run-time extensions on existing programming models (e.g. OpenMP, MPI, etc.) for supporting real-time.
- Develop adequate models and architectures for resource reservations handling in distributed real-time systems.
- Design and analyze distributed algorithms that guarantee real-time properties in heterogeneous embedded systems.