



Technical Report

Parallel Real-time Support for Distributed Adaptive Embedded Applications

Ricardo Garibay-Martinez

Luis Lino Ferreira

Luis Miguel Pinho

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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, lmq@isep.ipp.pt

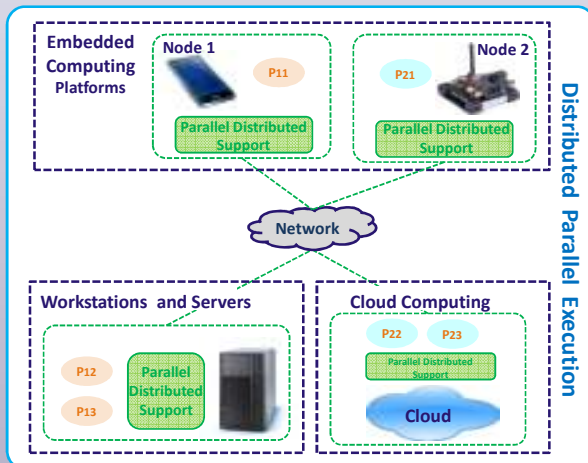
<http://www.hurray.isep.ipp.pt>

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.

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.**



Parallel Distributed Real-time Embedded Applications

OpenMP: Distributed Real-Time Scheduler

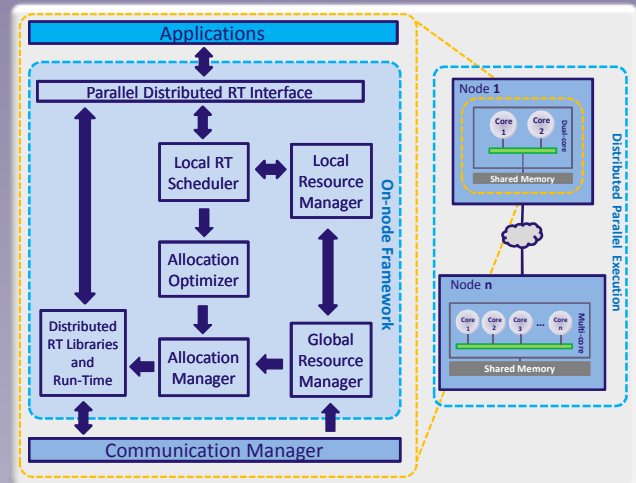
```
#pragma omp parallel for schedule(dist-rt)
deadline(200)
for (i=0; i<n; i++)
{
    printf("Parallel Distributed Execution");
    ...
}
/*-- End of parallel for using distributed
real-time scheduler--*/
```

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

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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**.