PROJECT PROPOSAL

Energy Characterization and Optimization in Heartbeat Monitoring Systems

MO632/MC972 – Energy Efficient Computing - Second Semester, 2021
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1. Description

This project consists in the energy characterization and optimization study for monitoring systems. In the fault tolerance area, a monitoring system is usually employed, there are few different ways to monitor applications in parallel systems. Prior to this project[1], a library of fault tolerance was developed to make applications of OmpCluster[2] (a set of tools developed under LLVM infrastructure to ease the development of parallel applications). This library, among other objectives, is intended to make the application watch every process participating in the application, launching one thread of fault tolerance for each MPI process employed.

The monitoring system consists in a heartbeat ring-based system, where each process monitors another process, exchanging the beat messages. If a process dies, a process will detect the failure and propagate to every other process. This procedure could not only be used for these kinds of parallel applications in clusters, but could be adapted to be employed in other type of systems that would require some self monitoring system, for example, an IoT sensoring model where a set of devices monitors different sensors, and if one of the devices fails, another device can detect, and a procedure would be taken to supply the malfunctioning sensor.

The system was not developed concerning energy consumption, so there is no characterization of how much energy it employs to work, and there are few parameters that would direct affect how much energy would be consumed. The main objective of this project is first to characterize the energy consumption of the monitoring system, and then evaluating possible optimizations

2. Objectives and Expected Results

The monitoring system was not energy characterized yet, so the main objective of this project is to characterize and evaluate if there is space for optimizations via algorithm optimizations or the backend tools employed.

[1] Developed during my masters course [1].
[2] Project site: https://ompcluster.gitlab.io/.

2.1. Objectives

To achieve the main goal of this project, a few specific objectives are made:

- Characterize the energy consumption of the monitoring system under two situations:
  - High resource usage applications (Where the majority of the system energy would be spent by the application and not by the monitoring system. This is the use case of our FT library, running with a parallel application)
  - Low resource usage applications (Where the majority energy would be spent on the monitoring system depending on the monitoring frequency.)
- Evaluate how the heartbeat parameters impact on the energy consumption
- Evaluate different backends (other than MPI) to see the behavior of result/energy relationship.
- Evaluate possible optimizations for the existing algorithm
- Define a relation between the results of the monitoring system (efficiency) and the results concerning the energy consumption.

2.2. Expected Results

As results, it is expected that after this project development, we could have characterized the monitoring system. Having evaluated how the parameters of the system affects and how the type of application used impacts on the energy consumption of entire applications that use these kinds of monitoring systems.

We also expect that the characterization could give insights on how to improve the system where it is used (inside OmpCluster) as well as insights of how it could be used in total different systems, like IoT systems.

3. Methodology

To execute this project, one will first execute the different applications that use the monitoring system to characterize the system. Then, with the characterization in hands, the evaluation of optimizations and different backends of communication can be done. Then a comparison of the initial results with the new results can be done defining how, if possible, the monitoring system can be improved concerning energy. Finally, a relationship between the results in terms of monitoring efficiency and energy efficiency can be defined.

3.1. Project Members

This project will be entirely executed and developed by the proponent Pedro Henrique Di Francia Rosso, supervised by the class professor.

3.2. Materials

This project will be developed in a personal computer and in a small cluster located at Unicamp. To make the characterization, the Eztrace with RAPL will be used, so we can collect the information about the computer running the applications. Further development activities will make use of the other tools, like the OmpCluster and MPI. For evaluating other communication backends, we will still evaluate what to be used, but there are some options, like using another TCP libraries.

Table 1. Schedule of the project activities

Activity	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9
A1										
A2										
A3										
A4										
A5										
A6										
A7										

3.3. Activities and Schedule

We initially divide this work in 10 weeks (2 and a half months), starting from September 13 to November 19. The Table 1 shows how the activities will be driven through the weeks, and then every activity is briefly explained.

- **A1.** *Proposal Definition:* define the final version of this proposal.
- **A2.** *Project Set up:* set up the git repository and every other project requisite.
- **A3.** *Energy Characterization:* characterize the monitoring system in terms of energy, evaluating different type of applications and how the monitoring system affects the energy consumption.
- **A4.** *Modifications proposal:* propose and evaluate changes in the algorithm and communication backend.
- **A5.** *Results Comparison:* compare the results of the initial characterization and the results after modifications.
- **A6.** *Another Cases of Use:* elaborate other uses of this monitoring system and point how the energy characterization would help concerning energy consumption, specially for IoT applications.
- **A7.** *Final Presentation:* evaluate the results of the project and make presentation of them.

References

[1] Pedro HDF Rosso and Emilio Francesquini. "Improved Failure Detection and Propagation Mechanisms for MPI". In: *Anais Estendidos da XII Escola Regional de Alto Desempenho de São Paulo. Aceito para publicação.* SBC. 2021. URL: http://cradsp.sbc.org.br/eradsp/2021/artigos/s1.2.pdf.