Assignment 4
SPM course a.a. 24/25

May 14 2025

Hybrid MPI + FastFlow MergeSort

Design and implement a scalable MergeSort for an N-element array of fixed-size records. Each record has the following layout:

```
struct Record {
    unsigned long key;  // sorting value
    char  rpayload[RPAYLOAD];
};
```

The MPI part handles inter-node distribution and merging, whereas the FastFlow part provides intra-node MergeSort parallelization of local partitions.

Tasks

1. Single-node version (shared-memory)
   Provide a parallel implementation for a single node using FastFlow building blocks (i.e., farm, pipeline, and all-to-all) of the MergeSort algorithm.
2. Multi-node hybrid version
   Provide a hybrid parallel implementation using MPI and FastFlow. The intra-node parallel MergeSort should reuse what was developed in Task 1. The inter-node MPI communications of the merging phase should try to maximize the opportunity of computation-to-communication overlap.
3. Performance study and discussion
   Analyze the performance by varying the problem size N, the record payload, and the number of FastFlow threads. Report speedup and efficiency varying the number of threads on a single node, and strong and weak scalability curves on the spmcluster up to 8 nodes.
   Summarize bottleneck phases, overlap effectiveness, challenges encountered, and optimizations you adopted.

Command line options to consider for both parallel versions:

- -s N: array size (e.g., -s 10M -s 100M)
- -r R: record payload (in bytes, e.g., -r 8, -r 64, -r 256)
- -t T: number of FastFlow threads (e.g., -t 16, -t 32)

All parallel versions developed should aim to minimize the overhead.

Deliverables

Provide all source files, scripts to compile and execute your code on the cluster nodes, and a PDF report (max 5-6 pages) including a brief description of your implementations and the performance analysis conducted. Mention the challenges encountered and the solutions adopted. Submit by email your source code and PDF report in a single zip file named 'sort_parallel_<YourName>.zip' **by June 1 EOB.** Please use the email subject "SPM Assignment 4".