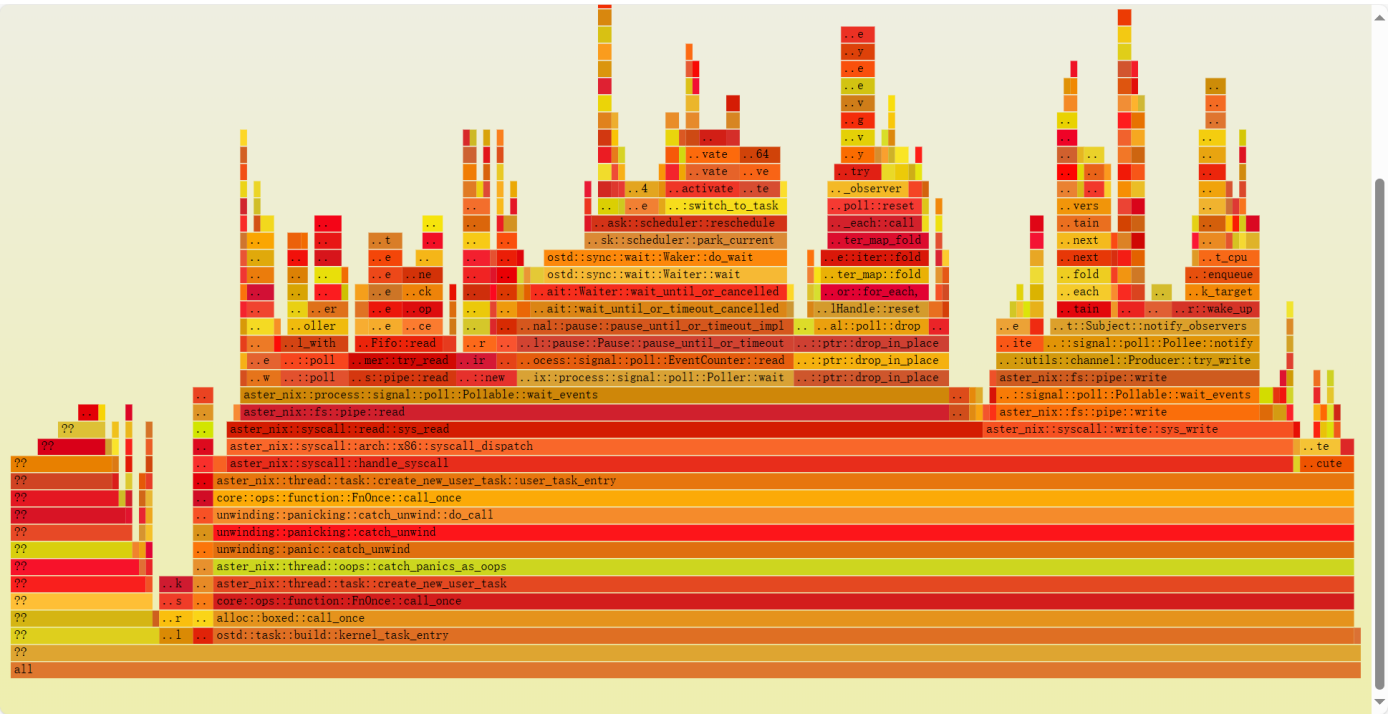
Assignment6

Please complete the report and submit `report.pdf` through Blackboard

Performance is an important factor to consider in operating systems. In this assignment, you will experience **the process of performance optimization**.

Flame graph

From Brendan Gregg: "Flame graphs are a visualization of hierarchical data, created to visualize stack traces of profiled software so that the most frequent code-paths to be identified quickly and accurately." Below is a screenshot of a flame graph analyzing the performance bottleneck of the `lat_pipe` benchmark in Asterinas:



What to do

Code base: lab13-io

In this assignment, you need to do the following things:

(1) Run benchmark

Run `make run` and execute the `fork_time` program in the kernel. Record the output (e.g., `279000 microseconds`).

(2) Generate flamegraph

1. Run `make profile_server` and execute the `fork_time_loop` program in the kernel; this will cause the kernel to hang.
2. After starting `fork_time_loop`, open another shell on the host and run `./profile_client.sh`.
3. Finally, you will get the flamegraph: `kernel.svg`.

(3) Optimize performance

1. Identify performance gaps. You may refer to the following approaches:
    1. Remove unnecessary function calls shown in the flame graph. For instance, a function occupies a high percentage but does not perform **system-essential** work and does not affect normal operation. Note: This approach must consider the system's support for other functionalities.
    2. Optimize top-level functions in the flame graph. The top-level functions represent the code being executed at the sampling points, so consider optimizing these functions. Moreover, a higher percentage of a top-level function indicates greater potential performance gain from optimizing it.
2. Based on the identified performance gaps, proceed with optimization.
3. Rerun step (1) "Run benchmark" and step (2) "Generate flame graph" to demonstrate that your optimizations have improved performance.

Report

Your report should cover:

1. **[10pts]** Screenshot of the `fork_time` result before optimization.
2. **[10pts]** Flame graph generated before optimization.
3. **[30pts]** Performance gaps you identified based on the flame graph.
4. **[20pts]** Description of the optimizations you implemented.
5. **[10pts]** Screenshot of the `fork_time` result after optimization.
6. **[20pts]** Flame graph generated after optimization, along with a brief explanation of how the optimizations affected the flame graph.