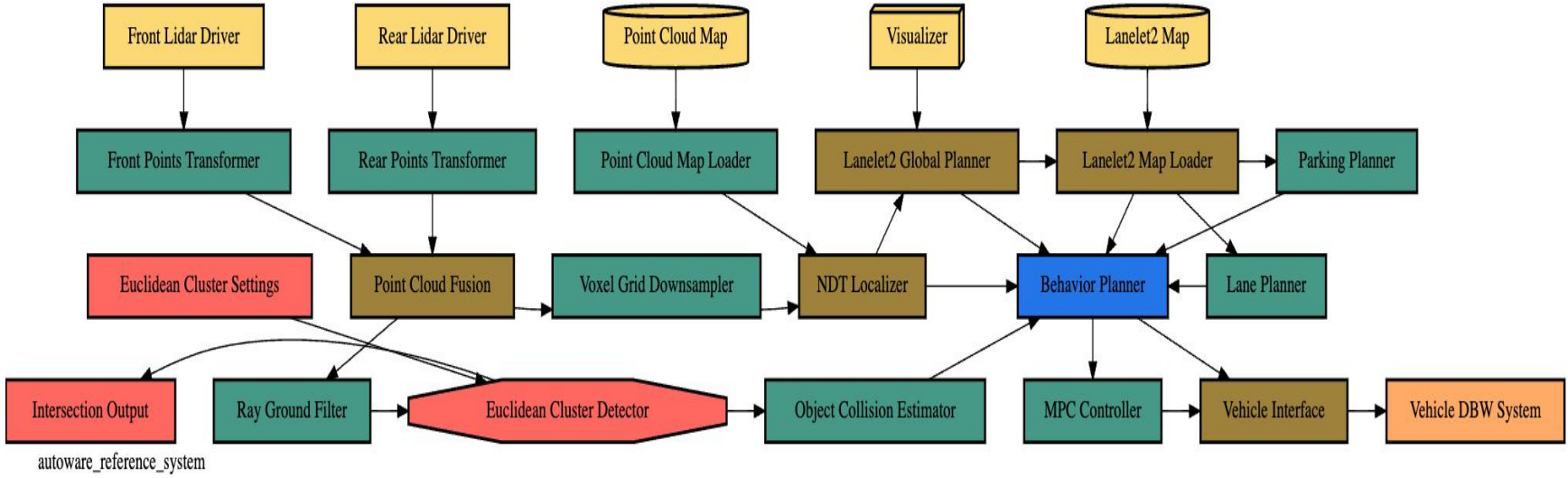
ROS 2

Benchmark & ROS2

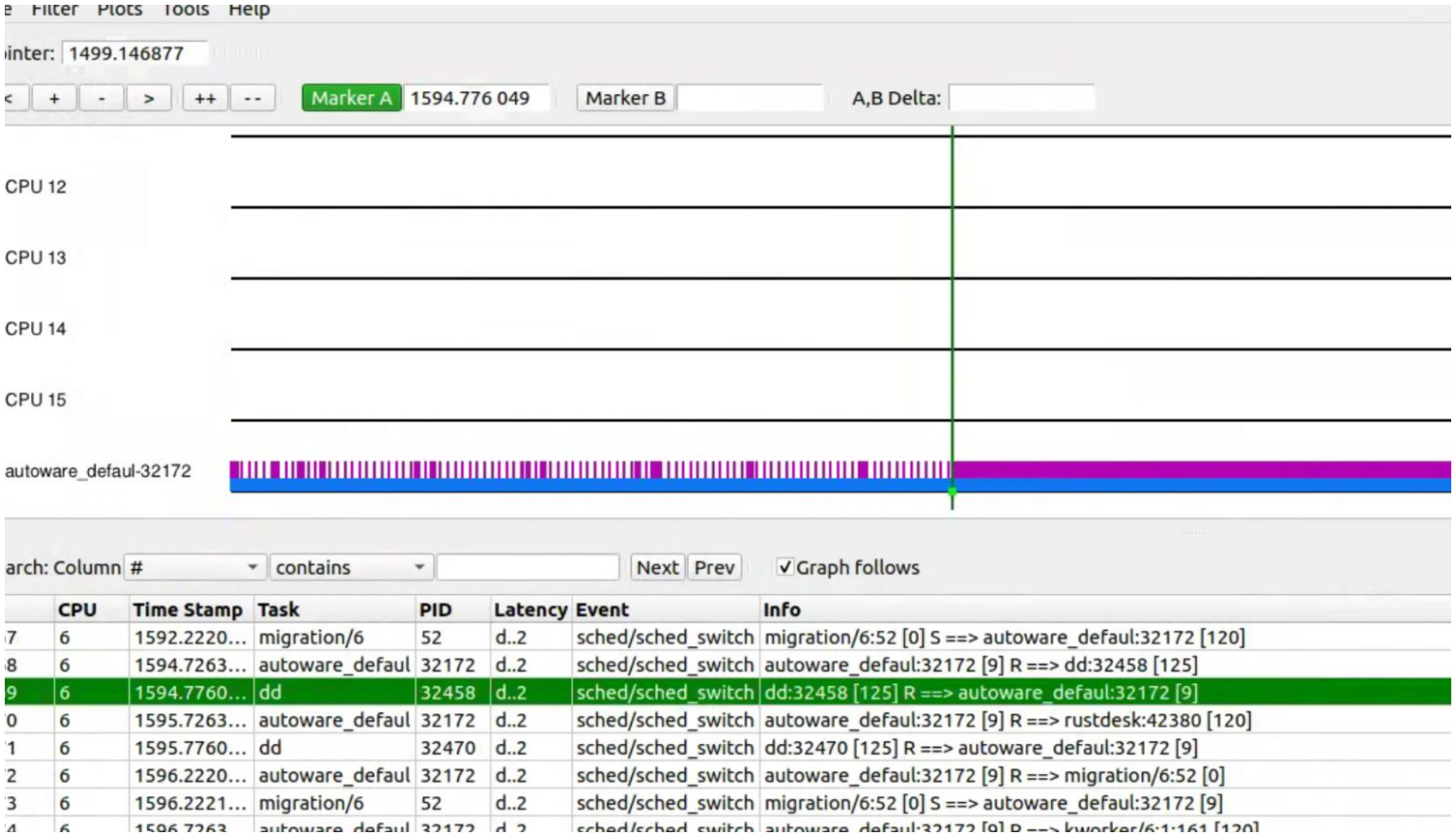
- **performance_test** （https://github.com/ros2/performance_test/）
- Test the performance and latency of various communication methods (such as ROS 2, FastDDSetc.)
- Optional message size (128--8m), number of publish and subscribe, number of threads...
- But in tests, the scheduling policy did not have a significant impact
- **reference-system** （https://github.com/ros-realtime/reference-system/）
- This example simulates a real scenario, with a variety of node types, arranged in a way that conforms to the actual system (as shown in the figure, publish-subscribe order, etc.)
- The message size is fixed at 4kB. The single run time can be configured according to the platform performance (default 4096)
- Used the test package autoware_default_singlethreaded: All nodes are assigned to the same single-threaded ROS executor

```
ros2 run autoware_reference_system number_cruncher_benchmark
maximum_number     run time
    64             0.003533ms
   128             0.010693ms
   256             0.035756ms
   512             0.12813ms
  1024             0.446658ms
  2048             1.68166ms
  4096             5.87434ms
  8192             21.5425ms
 16384             81.0377ms
 32768             297.538ms
 65536             1105.35ms
```



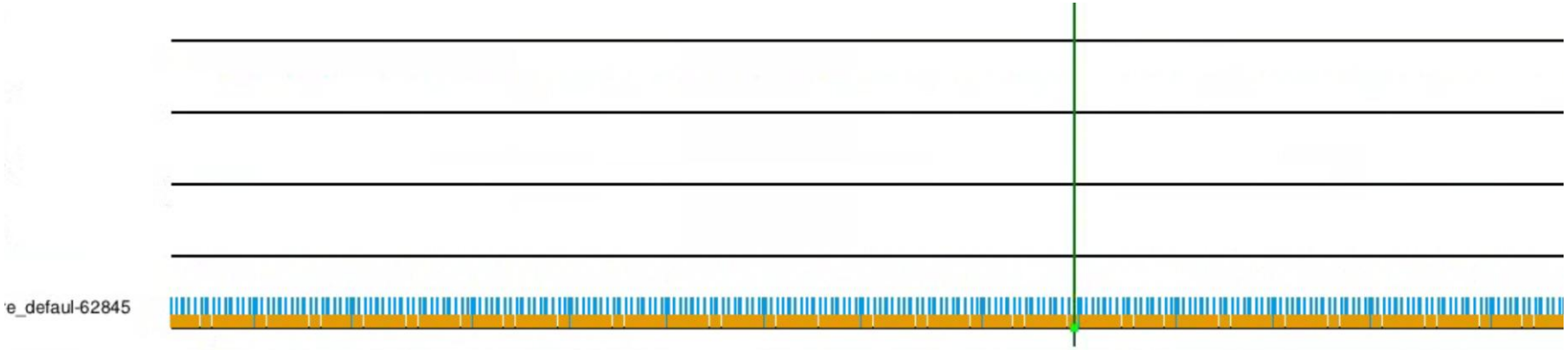
Benchmark & ROS2

- Change the scheduling strategy to FIFO, priority 9
- When the load is always full,
- Default scheduling strategy: ROS2 program will be disturbed, and there will be more delays.
- FIFO scheduling strategy: ROS2 program delay is significantly reduced



Benchmark & ROS2

- Change the scheduling strategy to FIFO, with priorities 9 and 89.
- Under full load conditions, the change in priority has no significant effect on the operation of the ROS2 program (such as latency).



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CPU	Time Stamp	Task	PID	Latency	Event	Info
0	2727.5049...	dd	62982	d..2	sched/sched_switch	dd:62982 [125] R ==> autoware_defaul:62845 [9]
0	2728.2301...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [9] R ==> migration/10:76 [0]
0	2728.2301...	migration/10	76	d..2	sched/sched_switch	migration/10:76 [0] S ==> autoware_defaul:62845 [9]
0	2728.4544...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [9] R ==> kworker/10:2:1185 [120]
0	2728.5049...	dd	62989	d..2	sched/sched_switch	dd:62989 [125] R ==> autoware_defaul:62845 [9]
0	2729.4544...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [9] R ==> kworker/10:2:1185 [120]
0	2729.5049...	dd	62988	d..2	sched/sched_switch	dd:62988 [125] R ==> autoware_defaul:62845 [9]
0	2730.4544...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [9] R ==> rustdesk:66761 [120]
0	2730.5049...	dd	62985	d..2	sched/sched_switch	dd:62985 [125] R ==> autoware_defaul:62845 [9]
0	2731.4584...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [89] R ==> ksoftirqd/10:77 [120]
0	2731.5049...	dd	62981	d..2	sched/sched_switch	dd:62981 [125] R ==> autoware_defaul:62845 [89]
0	2732.2301...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [89] R ==> migration/10:76 [0]
0	2732.2301...	migration/10	76	d..2	sched/sched_switch	migration/10:76 [0] S ==> autoware_defaul:62845 [89]
0	2732.4544...	autoware_defaul	62845	d..2	sched/sched_switch	autoware_defaul:62845 [89] R ==> rustdesk:66808 [120]

Benchmark & ROS2

- Change the scheduling strategy to DDL
- When the load is always full, the ROS2 program will be less disturbed under the DDL scheduling strategy

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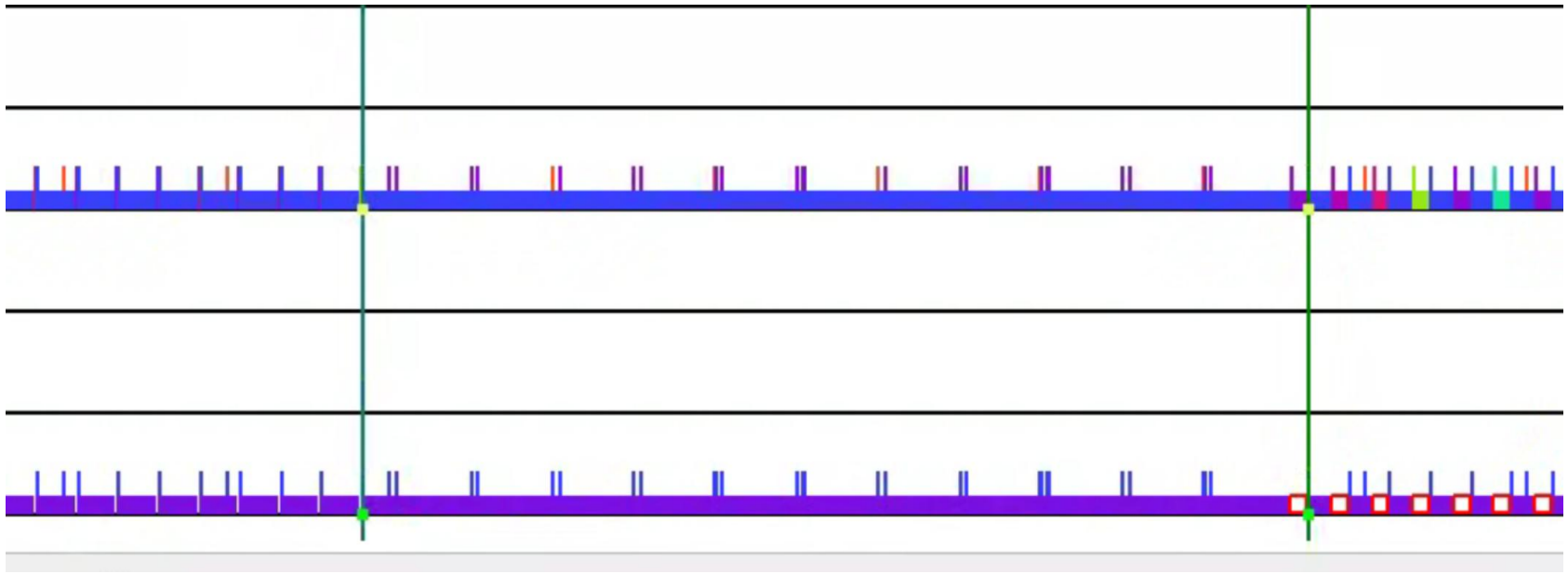
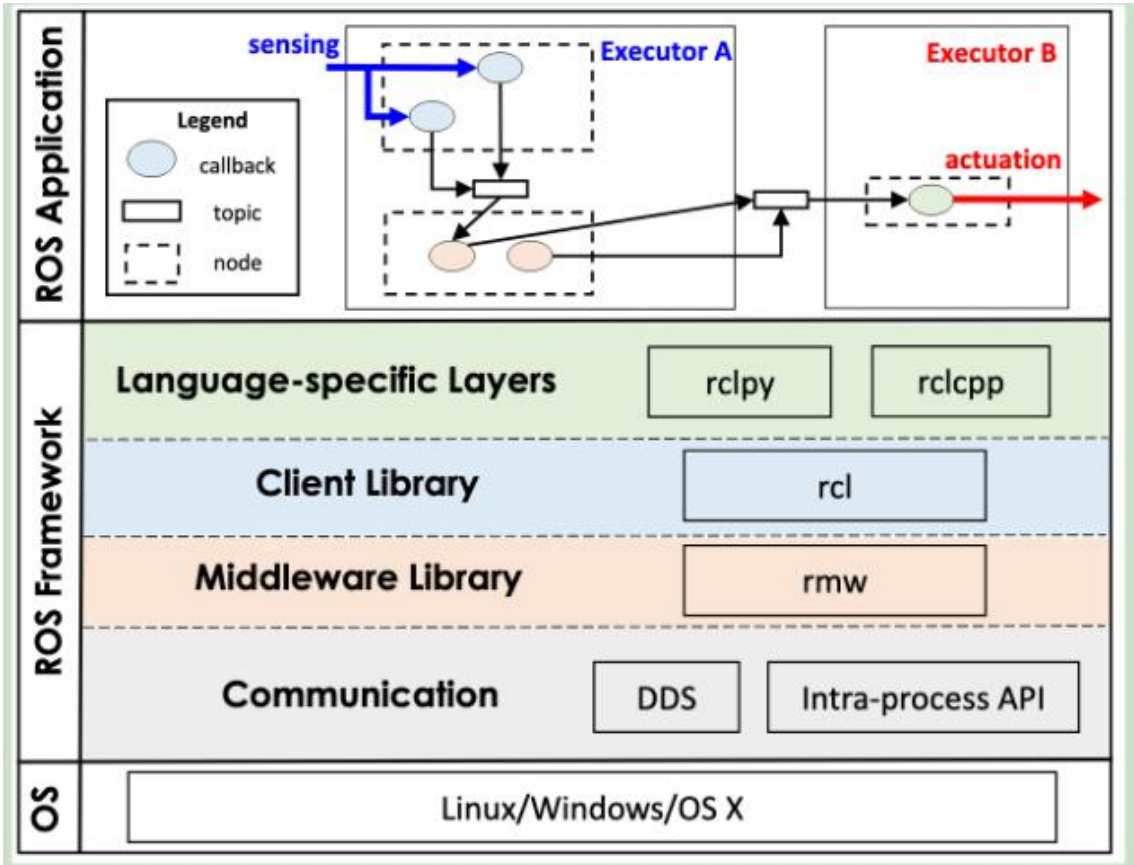
#	CPU	Time Stamp	Task	PID	Latency	Event	Info
252	1	99690.624...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [120] R ==> kworker/1:1:895003 [120]
253	1	99690.624...	kworker/1:1	895003	d..2	sched/sched_switch	kworker/1:1:895003 [120] W ==> autoware_defaul:1137997 [120]
254	1	99691.552...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [120] R ==> kworker/1:1:895003 [120]
255	1	99691.552...	kworker/1:1	895003	d..2	sched/sched_switch	kworker/1:1:895003 [120] W ==> autoware_defaul:1137997 [120]
256	1	99692.000...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [-1] R ==> zsh:1139899 [120]
257	1	99692.038...	dd	1138265	d..2	sched/sched_switch	dd:1138265 [125] R ==> autoware_defaul:1137997 [-1]
258	1	99692.096...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [-1] R ==> kworker/u32:3:1083673 [120]
259	1	99692.138...	dd	1138265	d..2	sched/sched_switch	dd:1138265 [125] R ==> autoware_defaul:1137997 [-1]
260	1	99692.196...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [-1] R ==> kworker/u32:3:1083673 [120]
261	1	99692.238...	dd	1138265	d..2	sched/sched_switch	dd:1138265 [125] R ==> autoware_defaul:1137997 [-1]
262	1	99692.296...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [-1] R ==> dd:1138265 [125]
263	1	99692.338...	dd	1138265	d..2	sched/sched_switch	dd:1138265 [125] R ==> autoware_defaul:1137997 [-1]
264	1	99692.396...	autoware_defaul	1137997	d..2	sched/sched_switch	autoware_defaul:1137997 [-1] R ==> kworker/u32:3:1083673 [120]
265	1	99692.438...	dd	1138261	d..2	sched/sched_switch	dd:1138261 [125] R ==> autoware_defaul:1137997 [-1]

Benchmark & ROS2

- Modify the scheduling strategy to FIFO--OTHER--DDL
- The real-time scheduling strategy will reduce the delay or interference of the ROS2 program, but the impact of the FIFO and DDL scheduling strategies on ROS2 under the non-real-time kernel does not show a significant difference




ROS Application
sensing
Executor A
Executor B
actuation
Legend
callback
topic
node
ROS Framework
Language-specific Layers
rclpy
rclcpp
Client Library
rcl
Middleware Library
rmw
Communication
DDS
Intra-process API
OS
Linux/Windows/OS X