Performance evaluation of chromium through task modeling and critical path analysis

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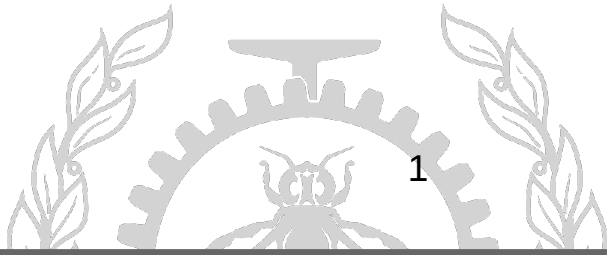
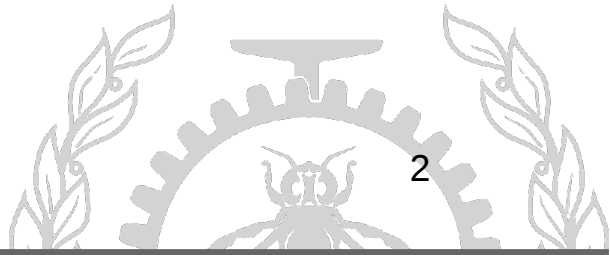
Agenda

- Motivation
- An overview of task scheduling in Chromium
- Chromium tracer
- Multi-level analysis
- Detection of root cause in more details
- Finding performance bugs and problems
- Trace Compass views
- Conclusion
- Future work



Motivation

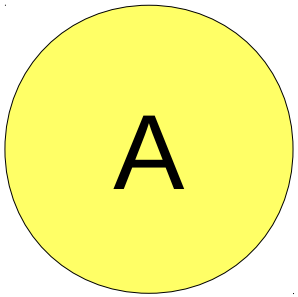
- Identifying performance degradation and bottlenecks of chromium as a complex multi-threaded program
- Extracting all the important tracing data from a complex shared memory application
- Multi-level analysis of chromium in order to obtain a comprehensive insight into performance problems and issues
- Critical path analysis as an efficient approach to understand the Chromium behavior and enhance its responsiveness



An overview of task scheduling in Chromium

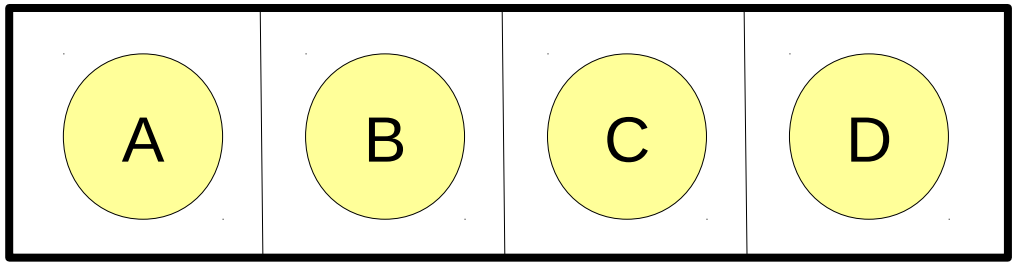
Task

- A task is a unit of work to be executed
- Each task as an object inside the task scheduler has:
  - a closure
  - traits
  - post timestamp

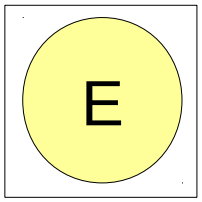


Sequence

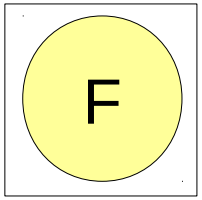
- The tasks in a sequence are executed in the order they were added to the sequence.



‘A’ is the next task to execute in this sequence

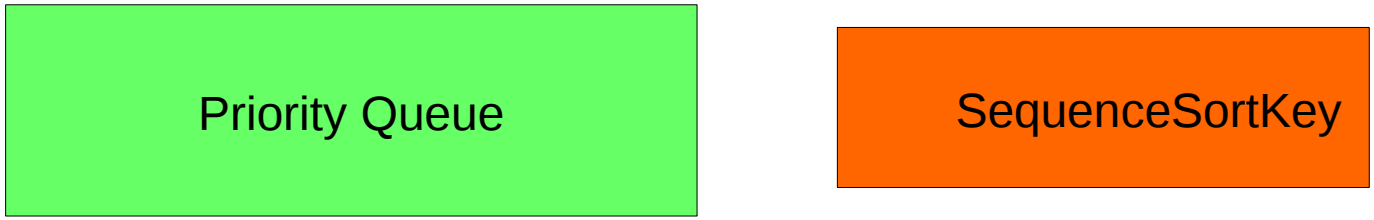


Parallel tasks



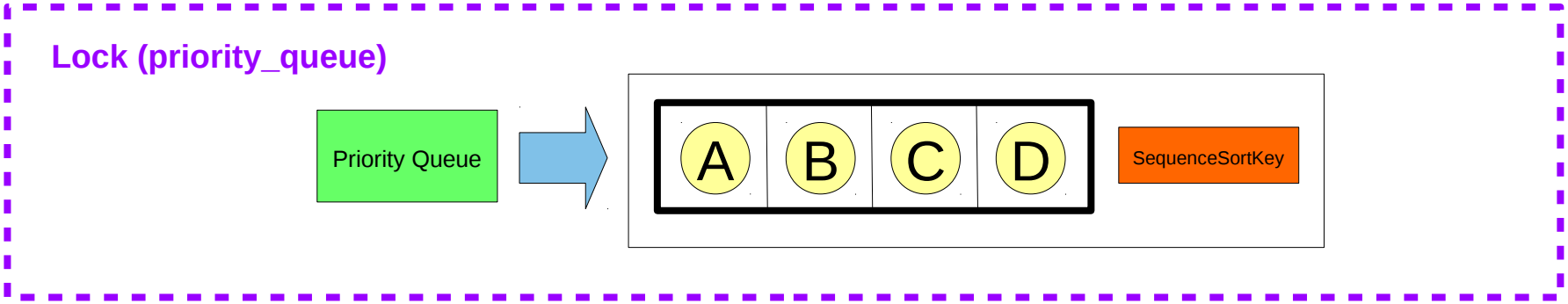
Priority Queue (and SequenceSortKey)

- Sequences which are waiting to be run live in a priority queue
- The SequenceSortKey is used to change the priority of the sequence after being posted

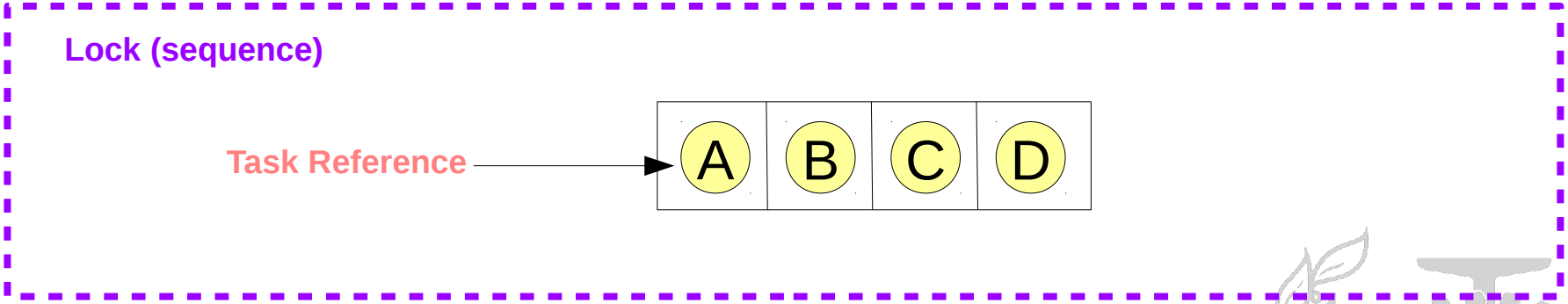


Scheduling Algorithm

- Lock the Priority Queue to pop its top sequence

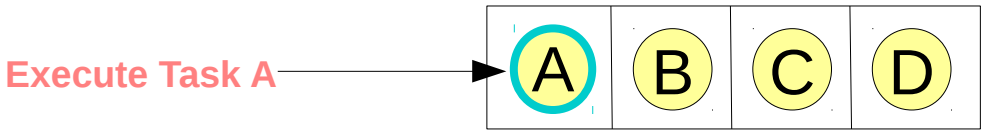


- Lock the sequence to peek the next Task to execute

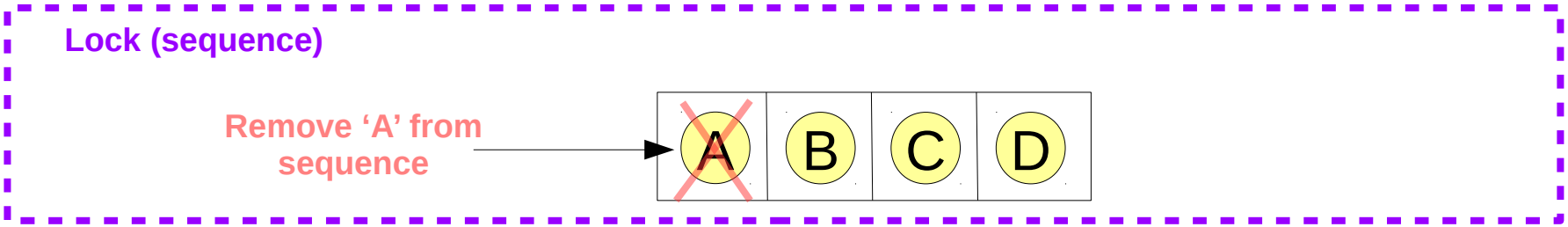


Scheduling Algorithm

- Release the sequence lock and execute the task

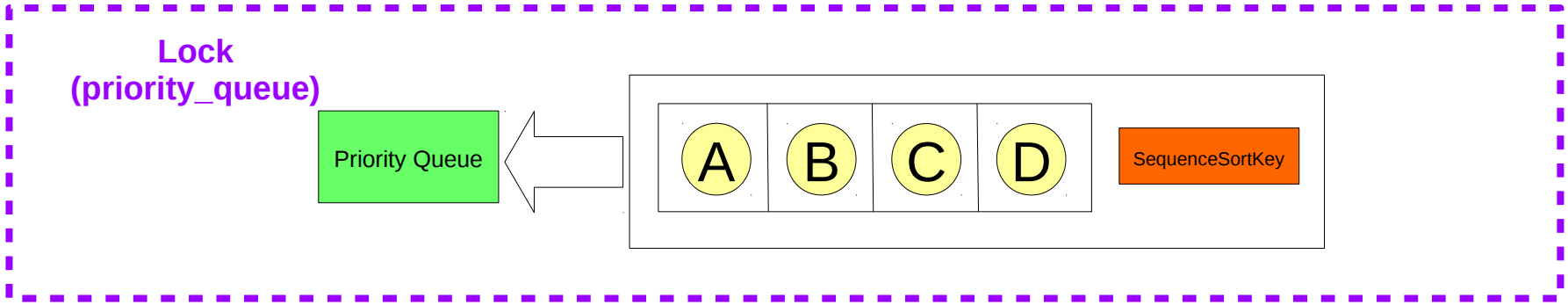


- Lock the sequence and remove the task that was just executed



Scheduling Algorithm

- If (SequenceLength != 0), lock the PriorityQueue and insert the sequence into it

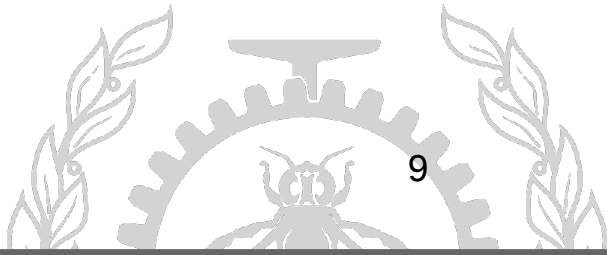


Chromium processes

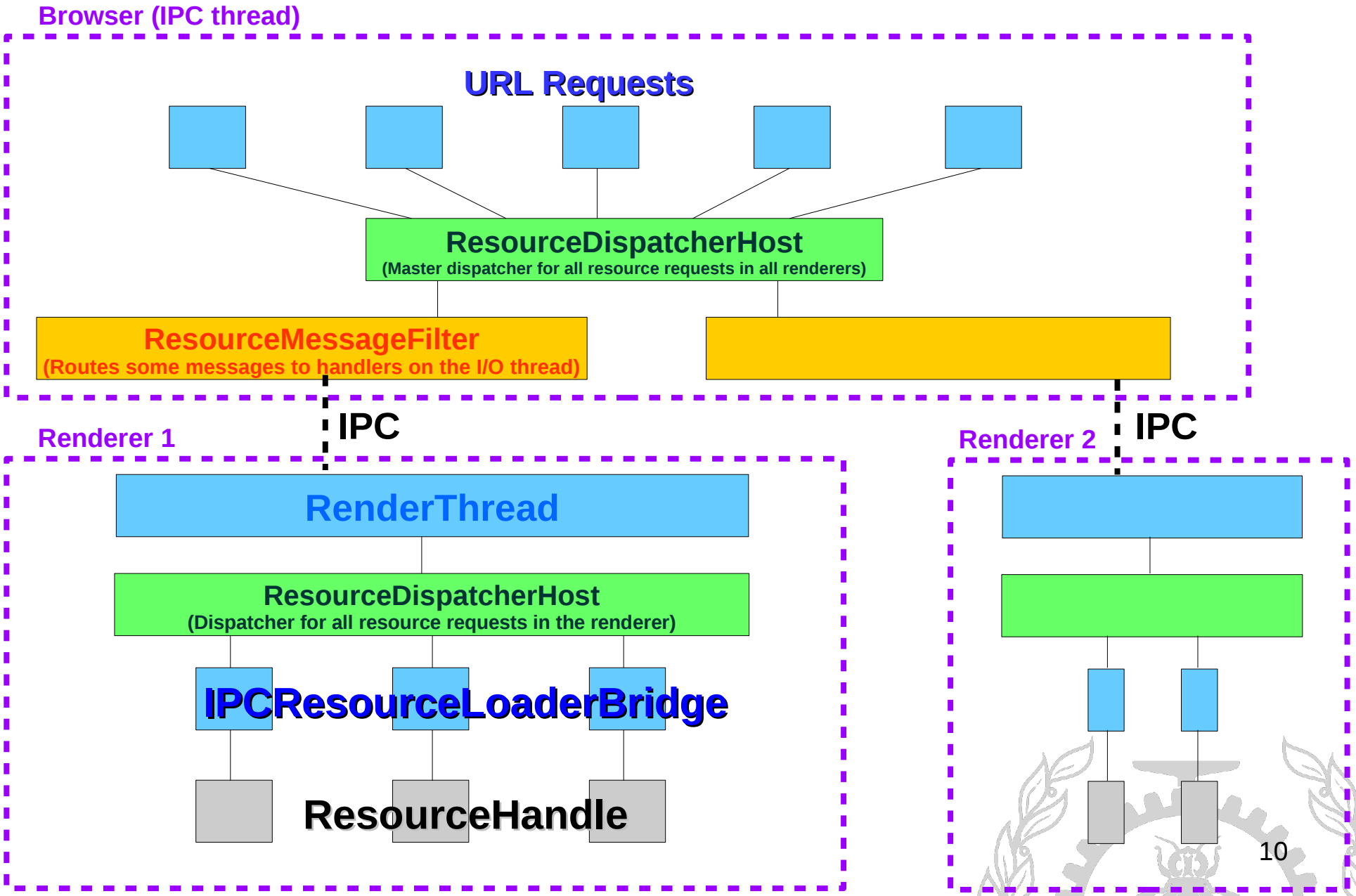
- The Browser Process **(CrBrowserMain)**
  - Receiving input from the OS, controls the browser UI (e.g. omnibox, back buttons, the tabstrip, menus, etc)

- Renderer Processes **(CrRendererMain)**
  - Putting each tab in its own render process

- The GPU Process **(CrGpuMain)**
  - GPU accelerated operations are issued to the graphics driver



How pages and images are loaded from the network into the renderer?



Chromium tracer

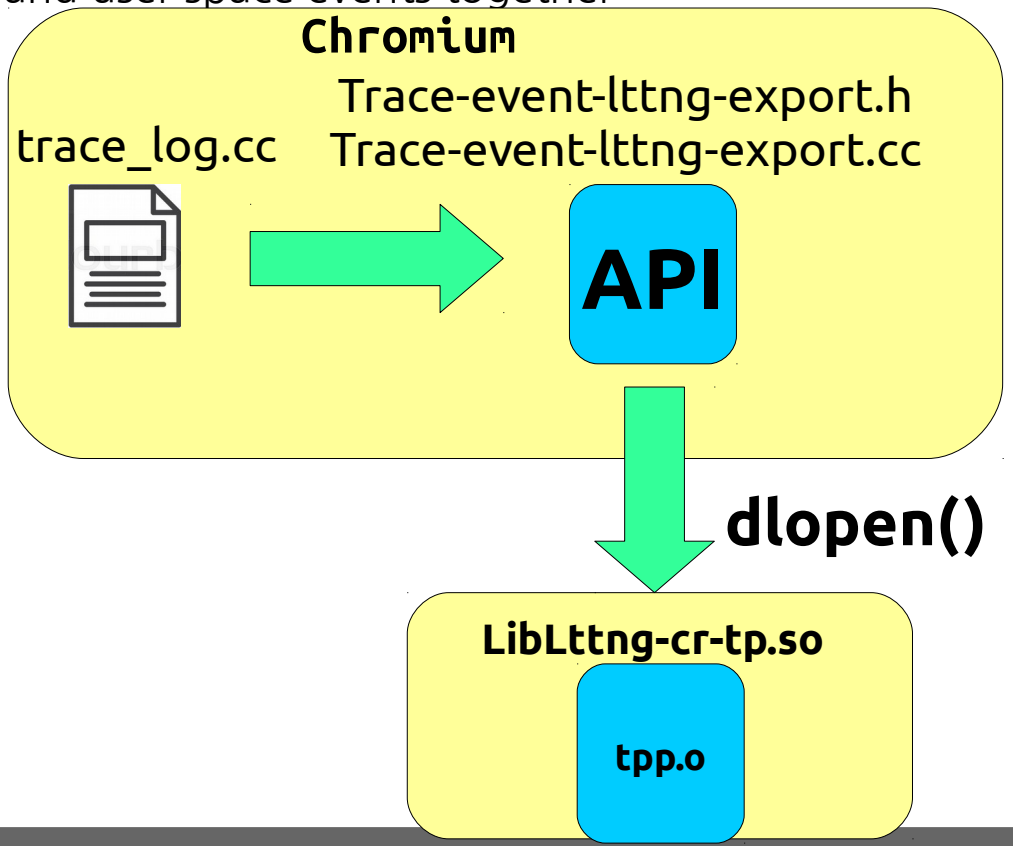
Features and specifications

- Tracing the system at user level to provide a call stack view
- Low overhead tracer with configurable parameters
- Ease of use
- Lack of information about kernel level

Multi-level analysis of chromium

Export Chromium events to Lttng

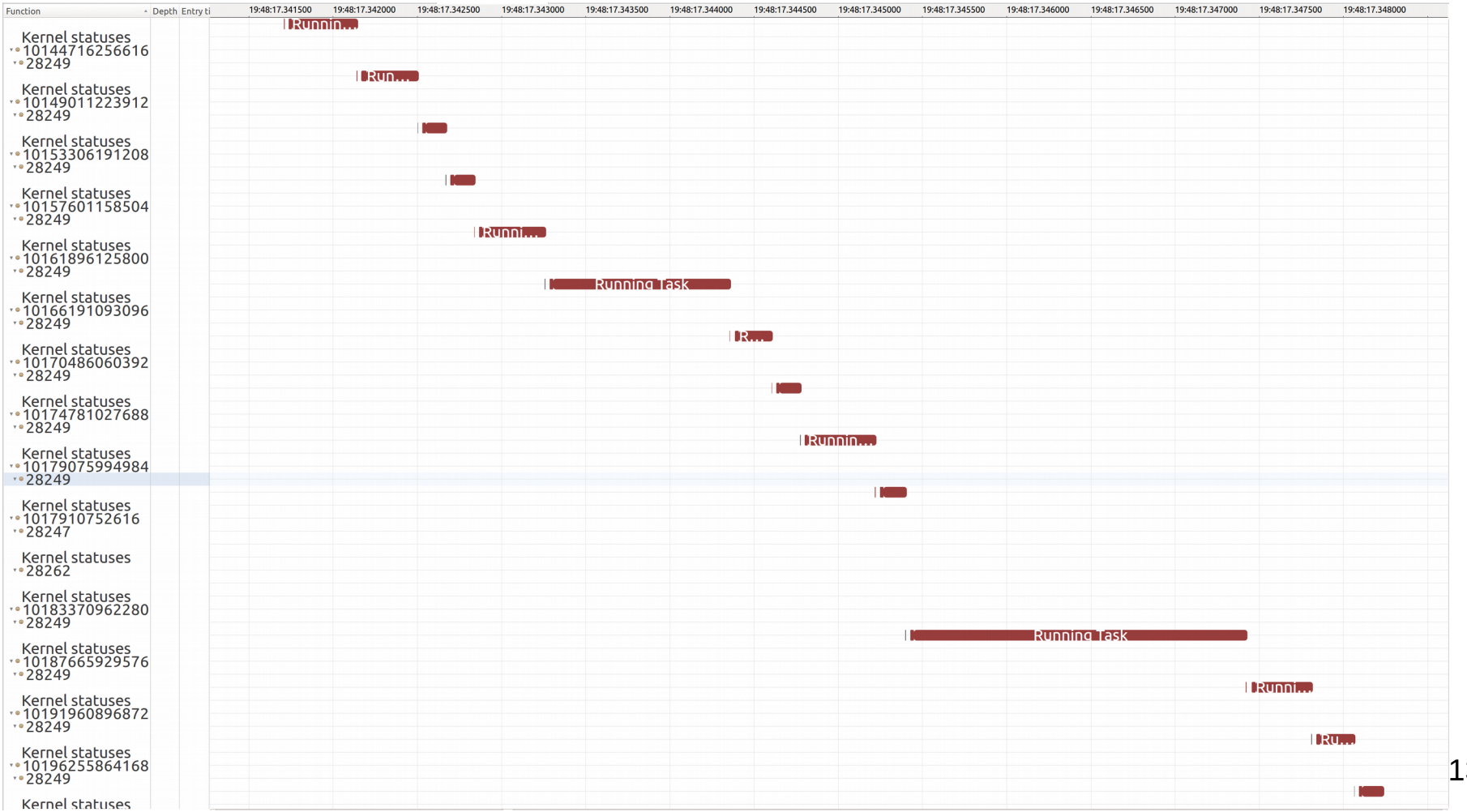
- Lttng tracepoints built into a shared library
- Developed API for exporting Chromium events to Lttng via the shared library
  - dlopen("lib.so", RTLD_NOW)
  - dlsym(var, "[symbol]")
- Getting kernel and user space events together



Trace Compass views

ChromeTaskTrackerPerTask.xml

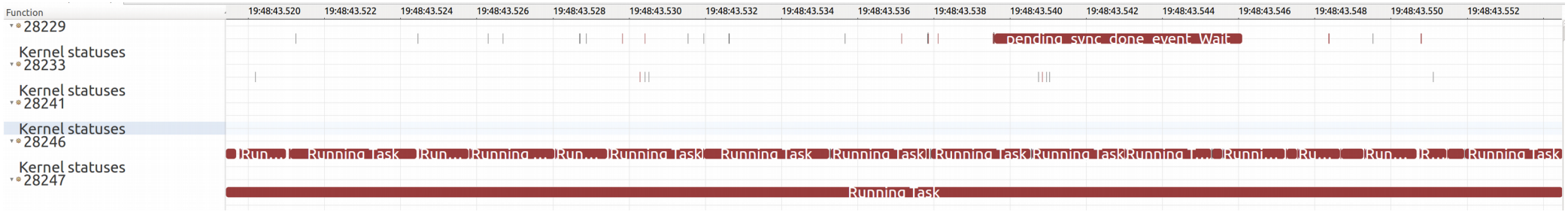
- Tracking the tasks by a unique ID from the start up to the end



Trace Compass views

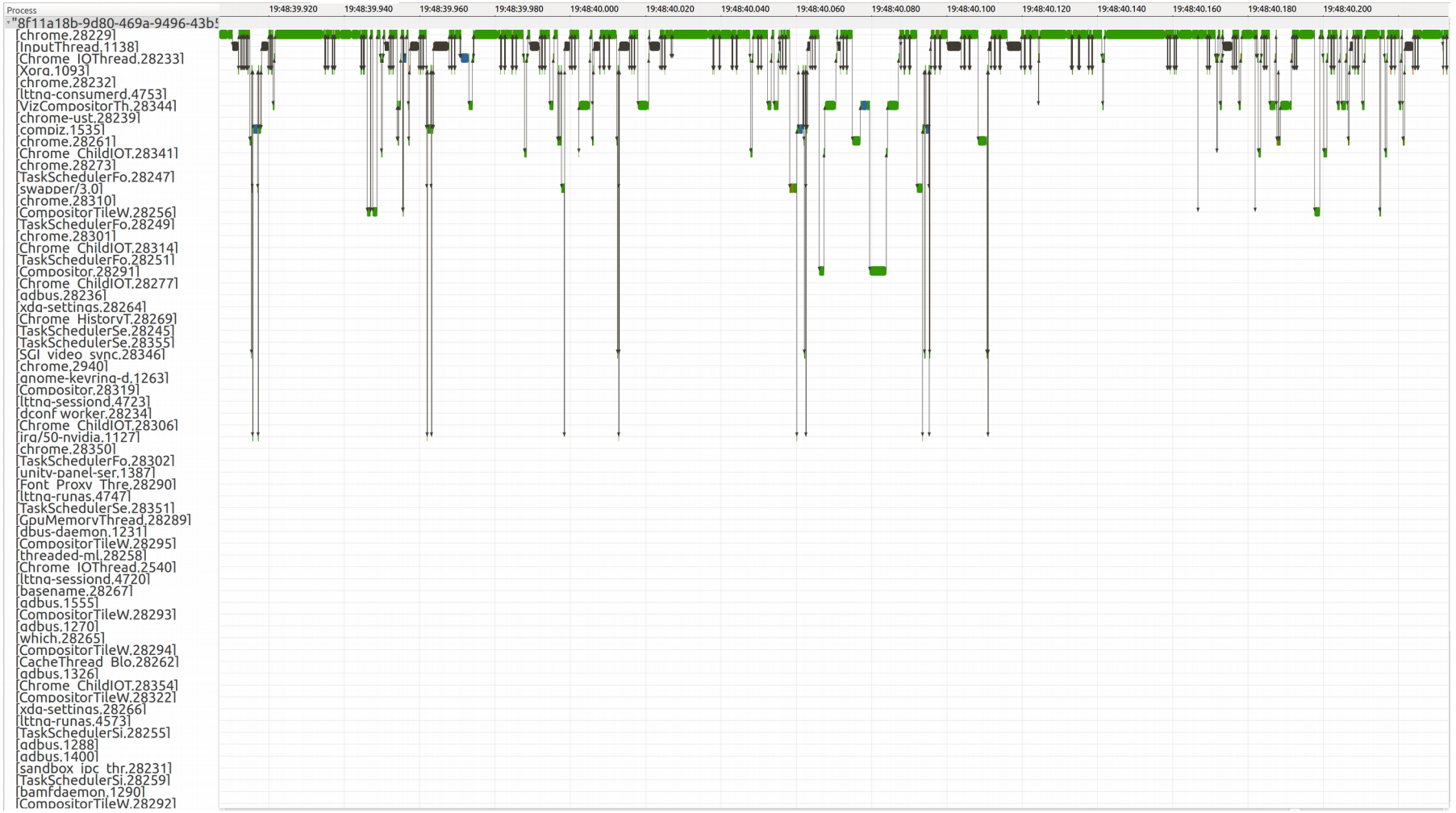
ChromeTaskTrackerByThread.xml

- Tracking the different states of tasks on different threads



Trace Compass views

Critical path view to show the execution bottleneck

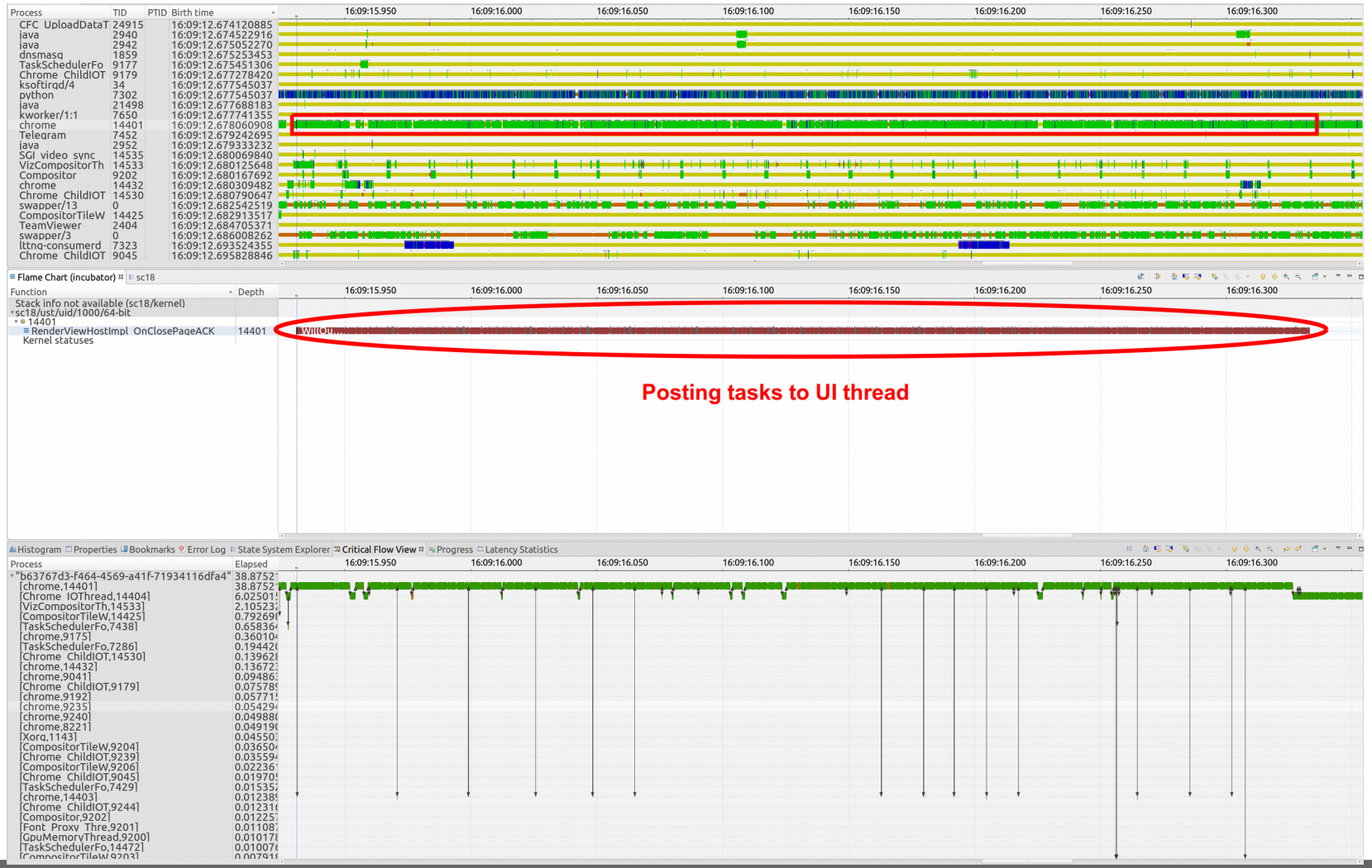


Chromium performance analysis

GpuChannelHost::Send blocks UI thread to send IPC messages using IPC::SyncChannel (**Issue 125264**)

Chromium performance analysis

Processing the IPC message ViewHostMsg_ClosePage_ACK on the main thread can be too slow (**Issue 892747**)



Conclusion

- Overview of task modeling
- Introducing the multi-process architecture of Chromium
- Proposing an approach to extract more information using LTTng, in order to analyze Chromium in more details
- Critical path analysis to detect performance bugs and latencies

Future work

- Analyzing the navigation to detect the root cause of some performance issues
- Building a tool to understand the interaction of tasks for a specific user action
- Making a more flexible and automated tool which is able to analyze Chromium

References

[1] Browser I/O Scheduler, URL:
https://docs.google.com/document/d/1S2AAeoo1xa_vsLbDYBsDHCqhrkfiMgoIPlyRi6kxa5k/edit#
[2] TaskTracker in SequenceManager,
URL:https://docs.google.com/document/d/1sb5PdWz5q2pSZEU1mtR8lei9K-fjtpzkLmjRGGDfAPo/edit?ts=5ba16d8c#
[3] https://bugs.chromium.org/p/chromium/issues/detail?id=125264
[4] https://bugs.chromium.org/p/chromium/issues/detail?id=892747
[5] https://www.chromium.org/developers/design-documents/multi-process-resource-loading
[6] https://www.chromium.org/developers/how-tos/trace-event-profiling-tool

Questions?

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