Tracing and Modeling High-Level Multi-Threaded Applications

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TRACE
COMPASS

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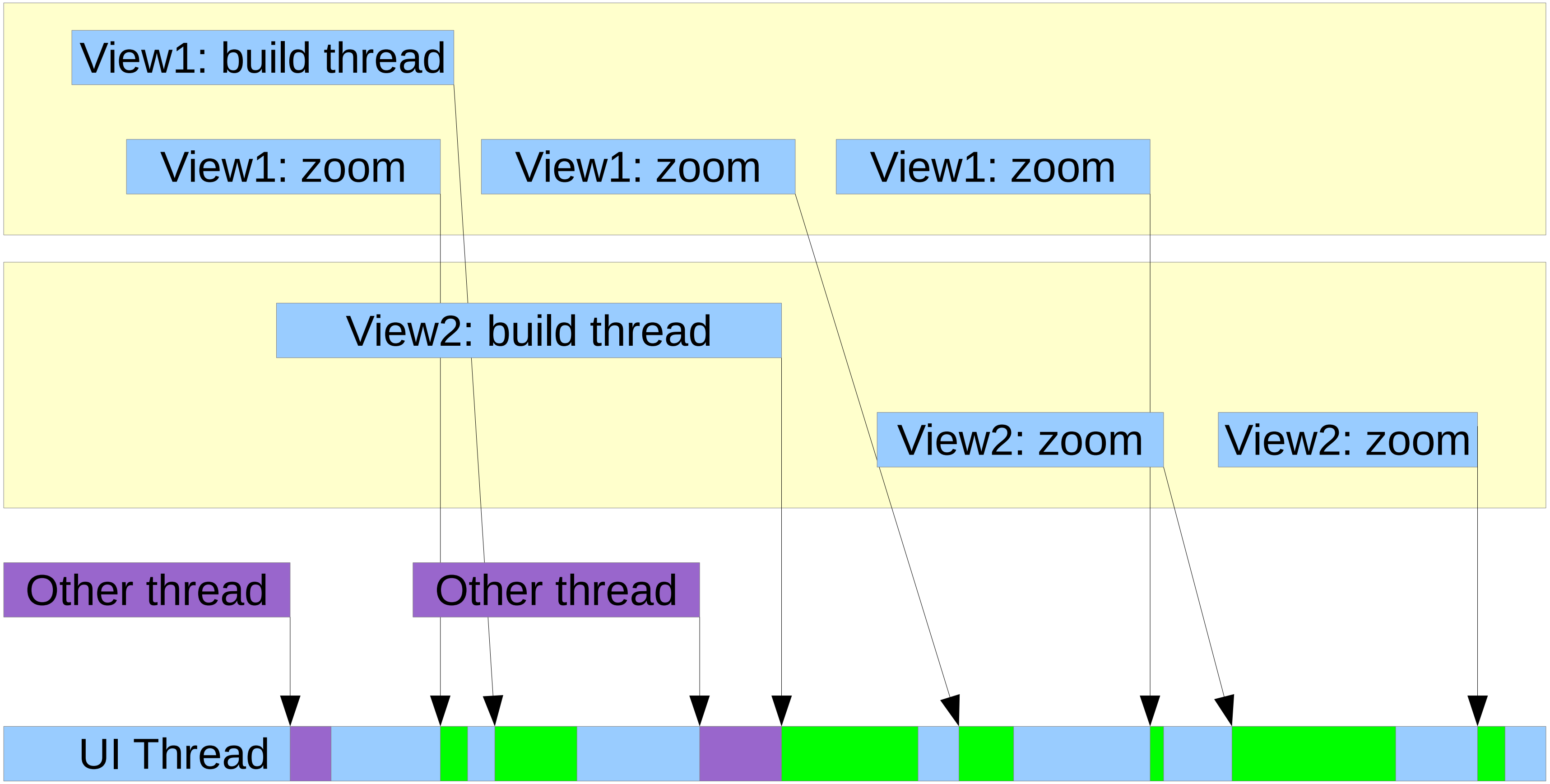
Background

- Performance problems in TraceCompass
- Solution proposed
- Do they impact the user? Will the user see the difference?

How to benchmark the UI

- Many threads sending data to the UI thread



Profiling ?

- Generic sampling data
- No knowledge of the application
- Will tell which functions took more time, which objects more memory
- Won’t tell why it was called, with what parameters
- It helps, but may mislead
- Correlate with kernel trace

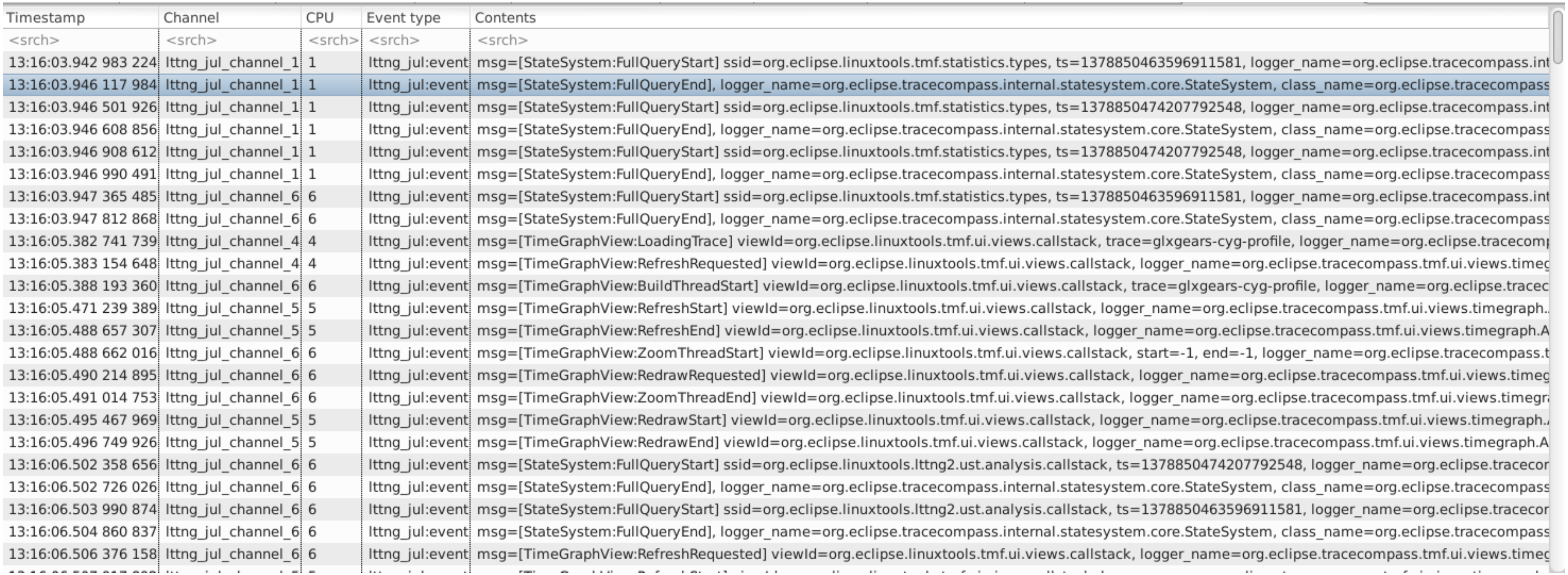
Tracing !

- JUL
- Knowledge of the application
- Start/end of threads and methods for populating views
- Start/end of backend queries
- Other interesting events

Benchmark the tracing

- Cost of tracing:
  - Near 0 when log point disabled
  - Some order of magnitude per tracepoint, overhead depends on tracing level
  - File handler: better for single-threaded applications
  - Lttng handler: better multi-threaded performance

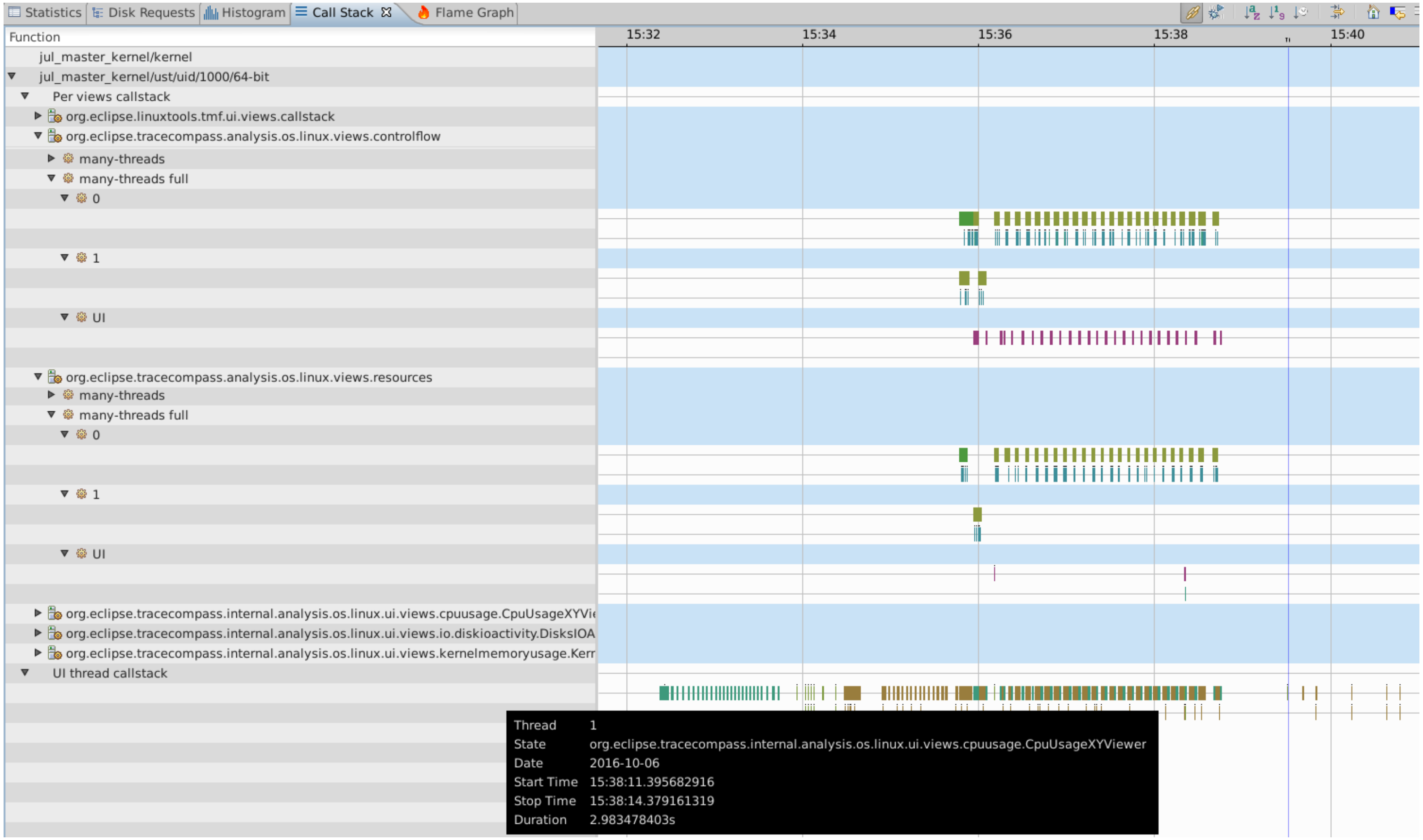
Analyze the trace



Timestamp	Channel	CPU	Event type	Contents
<srch>	<srch>	<srch>	<srch>	<srch>
13:16:03.942 983 224	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.tmf.statistics.types, ts=1378850463596911581, logger_name=org.eclipse.tracecompass.int
13:16:03.946 117 984	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:03.946 501 926	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.tmf.statistics.types, ts=1378850474207792548, logger_name=org.eclipse.tracecompass.int
13:16:03.946 608 856	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:03.946 908 612	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.tmf.statistics.types, ts=1378850474207792548, logger_name=org.eclipse.tracecompass.int
13:16:03.946 990 491	lttng_jul_channel_1	1	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:03.947 365 485	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.tmf.statistics.types, ts=1378850463596911581, logger_name=org.eclipse.tracecompass.int
13:16:03.947 812 868	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:05.382 741 739	lttng_jul_channel_4	4	lttng_jul:event	msg=[TimeGraphView:LoadingTrace] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, trace=glxgears-cyg-profile, logger_name=org.eclipse.tracecom
13:16:05.383 154 648	lttng_jul_channel_4	4	lttng_jul:event	msg=[TimeGraphView:RefreshRequested] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timeg
13:16:05.388 193 360	lttng_jul_channel_6	6	lttng_jul:event	msg=[TimeGraphView:BuildThreadStart] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, trace=glxgears-cyg-profile, logger_name=org.eclipse.tracec
13:16:05.471 239 389	lttng_jul_channel_5	5	lttng_jul:event	msg=[TimeGraphView:RefreshStart] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timegraph..
13:16:05.488 657 307	lttng_jul_channel_5	5	lttng_jul:event	msg=[TimeGraphView:RefreshEnd] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timegraph.A
13:16:05.488 662 016	lttng_jul_channel_6	6	lttng_jul:event	msg=[TimeGraphView:ZoomThreadStart] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, start=-1, end=-1, logger_name=org.eclipse.tracecompass.t
13:16:05.490 214 895	lttng_jul_channel_6	6	lttng_jul:event	msg=[TimeGraphView:RedrawRequested] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timeg
13:16:05.491 014 753	lttng_jul_channel_6	6	lttng_jul:event	msg=[TimeGraphView:ZoomThreadEnd] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timegra
13:16:05.495 467 969	lttng_jul_channel_5	5	lttng_jul:event	msg=[TimeGraphView:RedrawStart] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timegraph.
13:16:05.496 749 926	lttng_jul_channel_5	5	lttng_jul:event	msg=[TimeGraphView:RedrawEnd] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timegraph.A
13:16:06.502 358 656	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.lttng2.ust.analysis.callstack, ts=1378850474207792548, logger_name=org.eclipse.tracecor
13:16:06.502 726 026	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:06.503 990 874	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryStart] ssid=org.eclipse.linuxtools.lttng2.ust.analysis.callstack, ts=1378850463596911581, logger_name=org.eclipse.tracecor
13:16:06.504 860 837	lttng_jul_channel_6	6	lttng_jul:event	msg=[StateSystem:FullQueryEnd], logger_name=org.eclipse.tracecompass.internal.statesystem.core.StateSystem, class_name=org.eclipse.tracecompass
13:16:06.506 376 158	lttng_jul_channel_6	6	lttng_jul:event	msg=[TimeGraphView:RefreshRequested] viewId=org.eclipse.linuxtools.tmf.ui.views.callstack, logger_name=org.eclipse.tracecompass.tmf.ui.views.timeg

Analyze the trace

- New trace type
- Data-driven analysis: callstack, grouped per view/trace



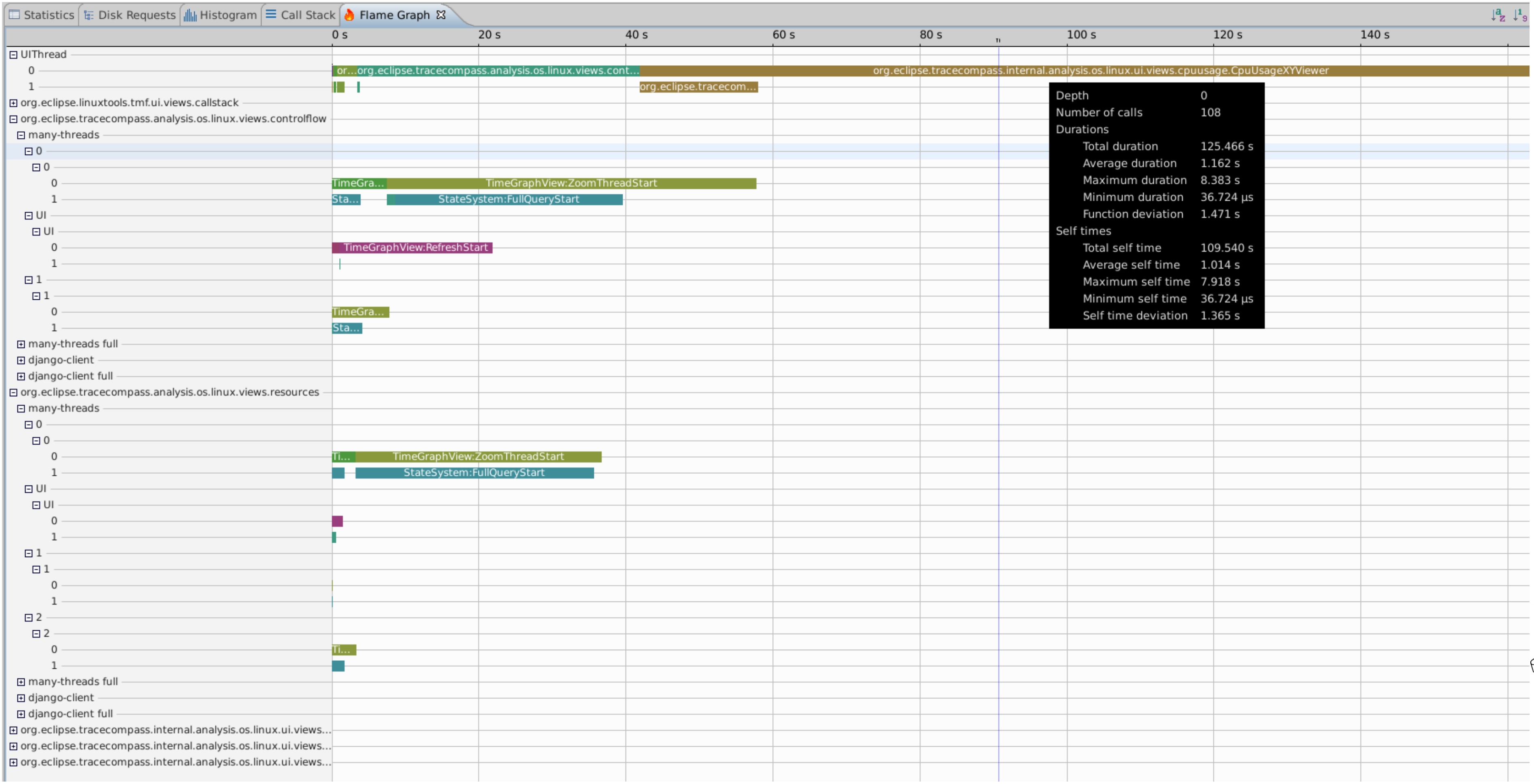
Function

- jul_master_kernel/kernel
- jul_master_kernel/ust/uid/1000/64-bit
  - Per views callstack
    - org.eclipse.linuxtools.tmf.ui.views.callstack
    - org.eclipse.tracecompass.analysis.os.linux.views.controlflow
      - many-threads
      - many-threads full
        - 0
        - 1
        - UI
    - org.eclipse.tracecompass.analysis.os.linux.views.resources
      - many-threads
      - many-threads full
        - 0
        - 1
        - UI
    - org.eclipse.tracecompass.internal.analysis.os.linux.ui.views.cpuusage.CpuUsageXYVi
    - org.eclipse.tracecompass.internal.analysis.os.linux.ui.views.io.diskioactivity.DisksIOA
    - org.eclipse.tracecompass.internal.analysis.os.linux.ui.views.kernelmemoryusage.Kerr
  - UI thread callstack

```
Thread      1
State       org.eclipse.tracecompass.internal.analysis.os.linux.ui.views.cpuusage.CpuUsageXYViewer
Date        2016-10-06
Start Time  15:38:11.395682916
Stop Time   15:38:14.379161319
Duration    2.9834784035
```

Analyze the trace

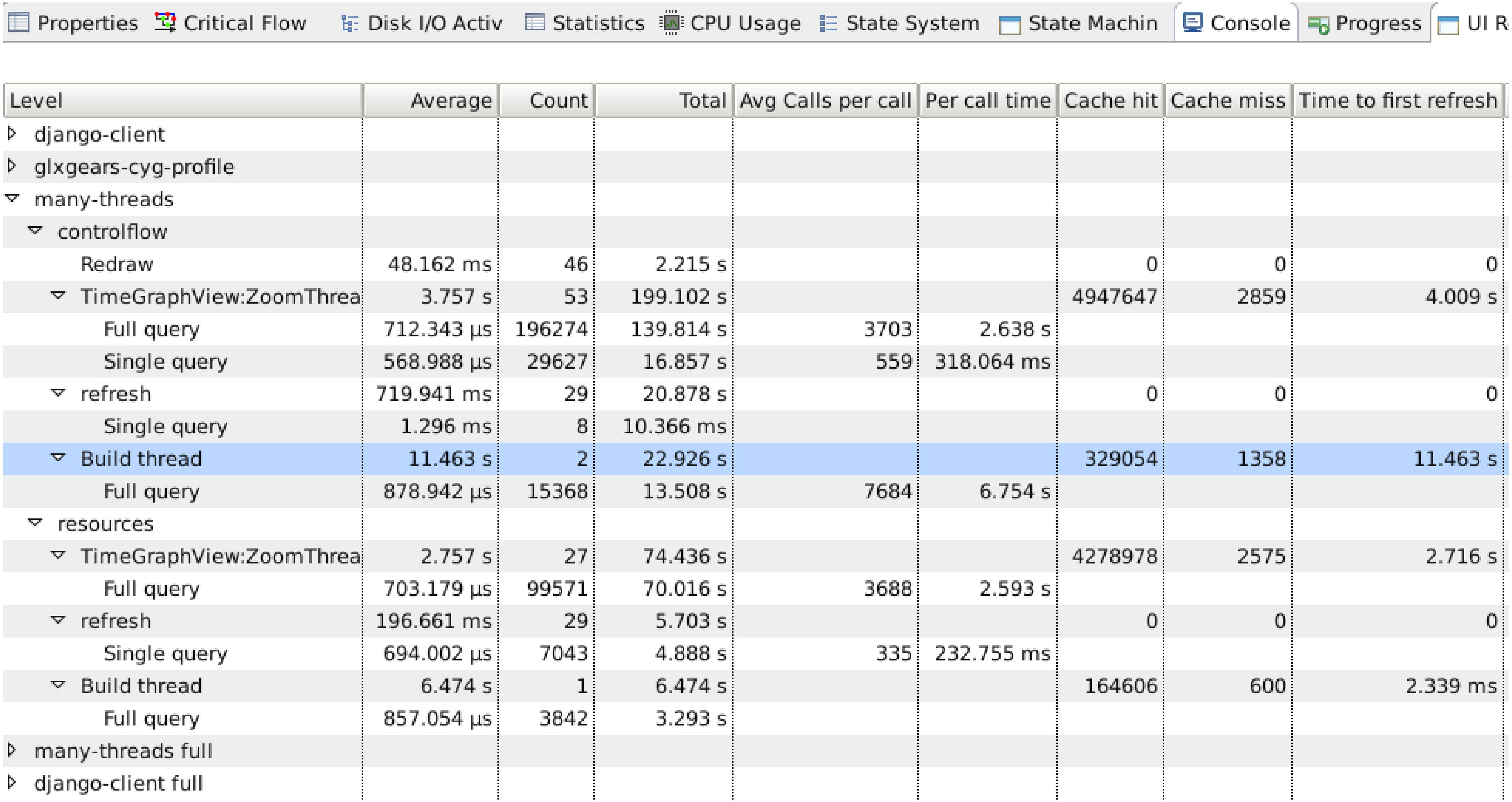
- Gives us flamegraphs


Statistics
Disk Requests
Histogram
Call Stack
Flame Graph
0 s
20 s
40 s
60 s
80 s
100 s
120 s
140 s
UIThread
0
1
org.eclipse.linuxtools.tmf.ui.views.callstack
org.eclipse.tracecompass.analysis.os.linux.views.controlflow
many-threads
0
0
0
1
UI
UI
0
1
1
1
0
1
many-threads full
django-client
django-client full
org.eclipse.tracecompass.analysis.os.linux.views.resources
many-threads
0
0
0
1
UI
UI
0
1
1
1
0
1
2
2
0
1
many-threads full
django-client
django-client full
org.eclipse.tracecompass.internal.analysis.os.linux.ui.views...
org.eclipse.tracecompass.internal.analysis.os.linux.ui.views...
org.eclipse.tracecompass.internal.analysis.os.linux.ui.views...
or...
org.eclipse.tracecompass.analysis.os.linux.views.cont...
org.eclipse.tracecompass.internal.analysis.os.linux.ui.views.cpuusage.CpuUsageXYViewer
org.eclipse.tracecom...
TimeGra...
TimeGraphView:ZoomThreadStart
Sta...
StateSystem:FullQueryStart
TimeGraphView:RefreshStart
TimeGra...
Sta...
Ti...
TimeGraphView:ZoomThreadStart
StateSystem:FullQueryStart
Ti...

```
Depth                       0
Number of calls             108
Durations
    Total duration          125.466 s
    Average duration        1.162 s
    Maximum duration        8.383 s
    Minimum duration        36.724 µs
    Function deviation      1.471 s
Self times
    Total self time         109.540 s
    Average self time       1.014 s
    Maximum self time       7.918 s
    Minimum self time       36.724 µs
    Self time deviation     1.365 s
```

Analyze the trace

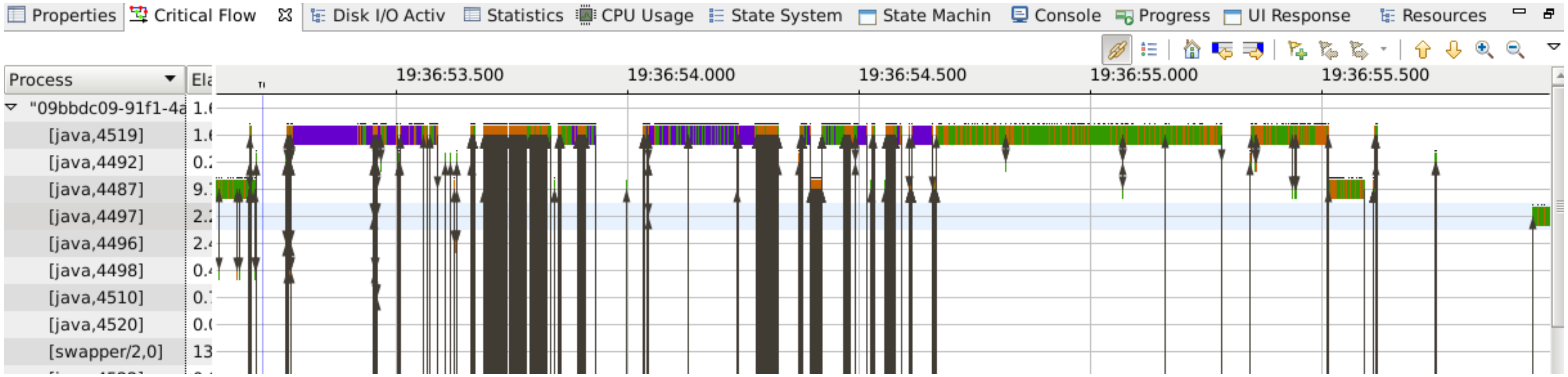
- Other application-specific statistics



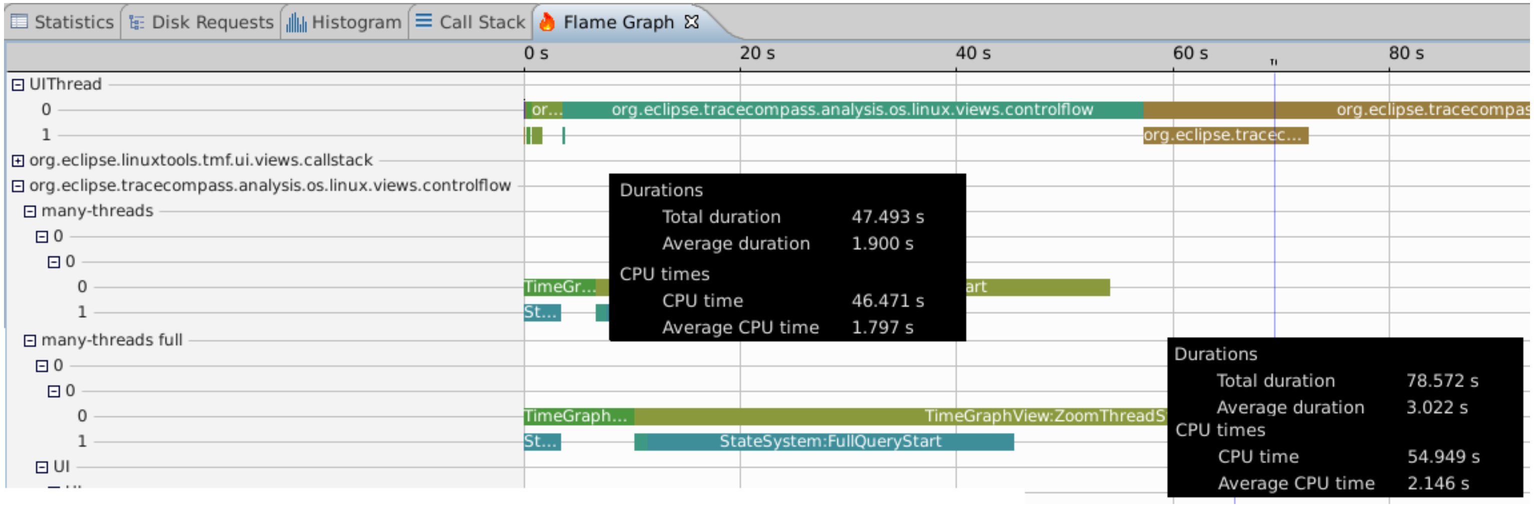
Level	Average	Count	Total	Avg Calls per call	Per call time	Cache hit	Cache miss	Time to first refresh
▷ django-client								
▷ glxgears-cyg-profile								
▽ many-threads								
▽ controlflow								
Redraw	48.162 ms	46	2.215 s			0	0	0
▽ TimeGraphView:ZoomThrea	3.757 s	53	199.102 s			4947647	2859	4.009 s
Full query	712.343 µs	196274	139.814 s	3703	2.638 s			
Single query	568.988 µs	29627	16.857 s	559	318.064 ms			
▽ refresh	719.941 ms	29	20.878 s			0	0	0
Single query	1.296 ms	8	10.366 ms					
▽ Build thread	11.463 s	2	22.926 s			329054	1358	11.463 s
Full query	878.942 µs	15368	13.508 s	7684	6.754 s			
▽ resources								
▽ TimeGraphView:ZoomThrea	2.757 s	27	74.436 s			4278978	2575	2.716 s
Full query	703.179 µs	99571	70.016 s	3688	2.593 s			
▽ refresh	196.661 ms	29	5.703 s			0	0	0
Single query	694.002 µs	7043	4.888 s	335	232.755 ms			
▽ Build thread	6.474 s	1	6.474 s			164606	600	2.339 ms
Full query	857.054 µs	3842	3.293 s					
▷ many-threads full								
▷ django-client full								

Analyze the trace

- Correlate with kernel data



Process	Ela
"09bbdc09-91f1-4a	1.(
[java,4519]	1.(
[java,4492]	0.:
[java,4487]	9.:
[java,4497]	2.:
[java,4496]	2.4
[java,4498]	0.4
[java,4510]	0.:
[java,4520]	0.(
[swapper/2,0]	13



Statistics
Disk Requests
Histogram
Call Stack
Flame Graph
0 s
20 s
40 s
60 s
80 s
UIThread
0
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org.eclipse.linuxtools.tmf.ui.views.callstack
org.eclipse.tracecompass.analysis.os.linux.views.controlflow
many-threads
0
0
0
1
many-threads full
0
0
0
1
UI
or...
org.eclipse.tracecompass.analysis.os.linux.views.controlflow
org.eclipse.tracecompas
org.eclipse.tracec...
TimeGr...
St...
art
TimeGraph...
TimeGraphView:ZoomThreadS
St...
StateSystem:FullQueryStart

```
Durations
    Total duration        47.493 s
    Average duration      1.900 s
CPU times
    CPU time              46.471 s
    Average CPU time      1.797 s
```

```
Durations
    Total duration        78.572 s
    Average duration      3.022 s
CPU times
    CPU time              54.949 s
    Average CPU time      2.146 s
```

Results

- Some steps to improve performance for the user:
    - Xy viewers: Don’t compute the data from the UI thread!
    - Views in general: Update only the visible ones
    - Metrics to compare runs

Analyze the trace

Demo

Questions

Resources

- Trace Compass standalone application used in this presentation:
  http://secretaire.dorsal.polymtl.ca/~gbastien/TracingRCP/DorsalExperimental/
- Update site for JUL feature (first install, then check for updates):
  http://secretaire.dorsal.polymtl.ca/~gbastien/TraceCompassUpdateSite/
- Sources:
  - Experimental: branch dorsal_experimental
    http://git.dorsal.polymtl.ca/~gbastien?p=linuxtools-tmf.git;a=summary
  - JUL: http://git.dorsal.polymtl.ca/~gbastien?p=ca.polymtl.tracecompass.git;a=summary
- Traces used in this demo: http://secretaire.dorsal.polymtl.ca/~gbastien/tracingSummit2016/