“If You Graph It, They Will See It”

Identifying Root Issues From Product Testing to Production Crisis.

Splunk@Murex

For Test and Development

Robert Lynch | Global Splunk Manager & Performance Manager

September 2017 | Washington, DC

Forward-Looking Statements

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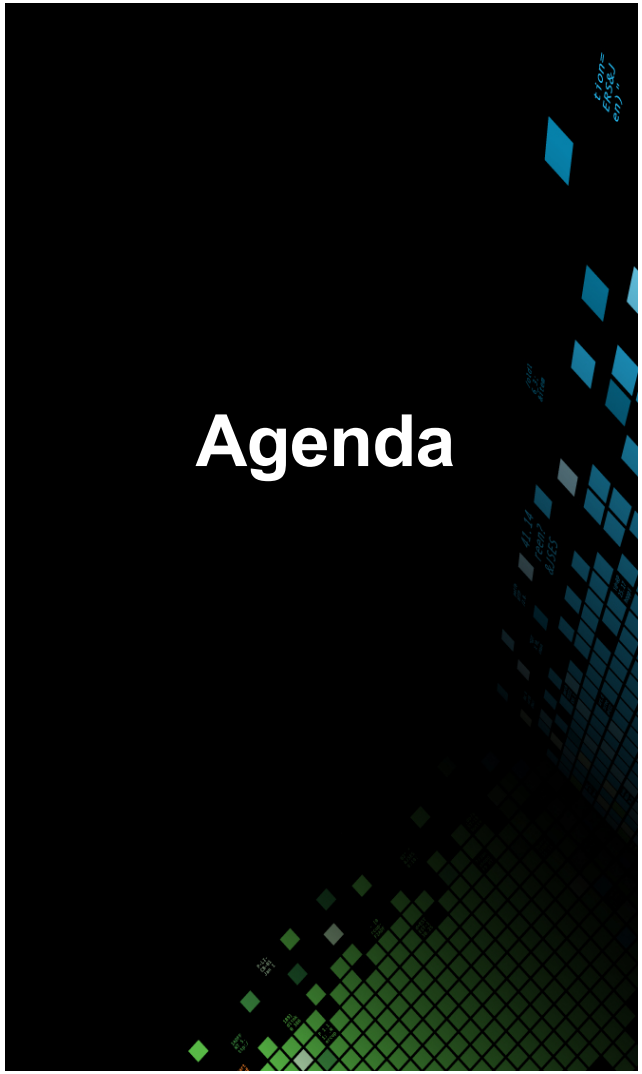

1. Who is Robert Lynch?
2. A little about Murex
3. Murex in-house solution had limitations!
4. How Murex uses **Splunk** for test and development
5. Some Use Cases:
   - The trillion dollar problem
   - Millisecond analysis
   - So, where is my test?

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Who Am I ?

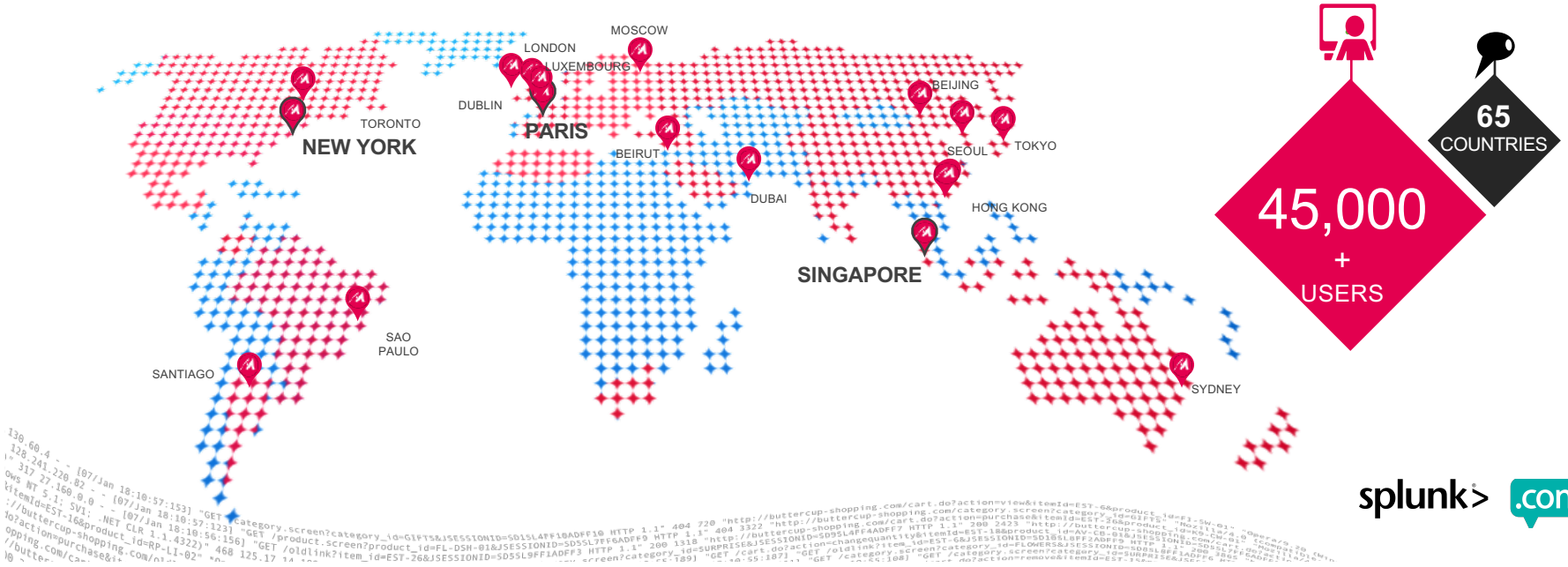
- Name:
  - Robert Lynch
- Current Position:
  - Global Splunk Manager @ Murex
  - Non-Functional Test Manager @ Murex
- History:
  - 13 years working at Murex in Non-Functional Testing
  - Masters “High Performance Computing”
  - Introduced Splunk to Murex 3 Years ago

Murex: Leading Vendor in Financial Software

- Murex is a leading vendor in the provision of integrated solutions for front office, back office and risk management for the capital markets industry
  - 30 years dedicated to our domain and clients
  - Around 45,000 users and 250+ clients in 65 countries
  - 3 Regional Hubs , 17 offices covering all time zones
  - Staff of 2,000, over 60 nationalities
  - Revenue of USD 0.5bn in 2016
  - Over USD 1 billion invested in R&D over the last 10 years
  - #1 Overall Vendor: Risk Magazine Technology Awards 2016
  - #7 in Chartis RiskTech100 for 2017 (highest ranked non-US headquartered company)

A Worldwide Presence

3 REGIONAL HUBS, 17 OFFICES COVERING ALL TIME ZONES



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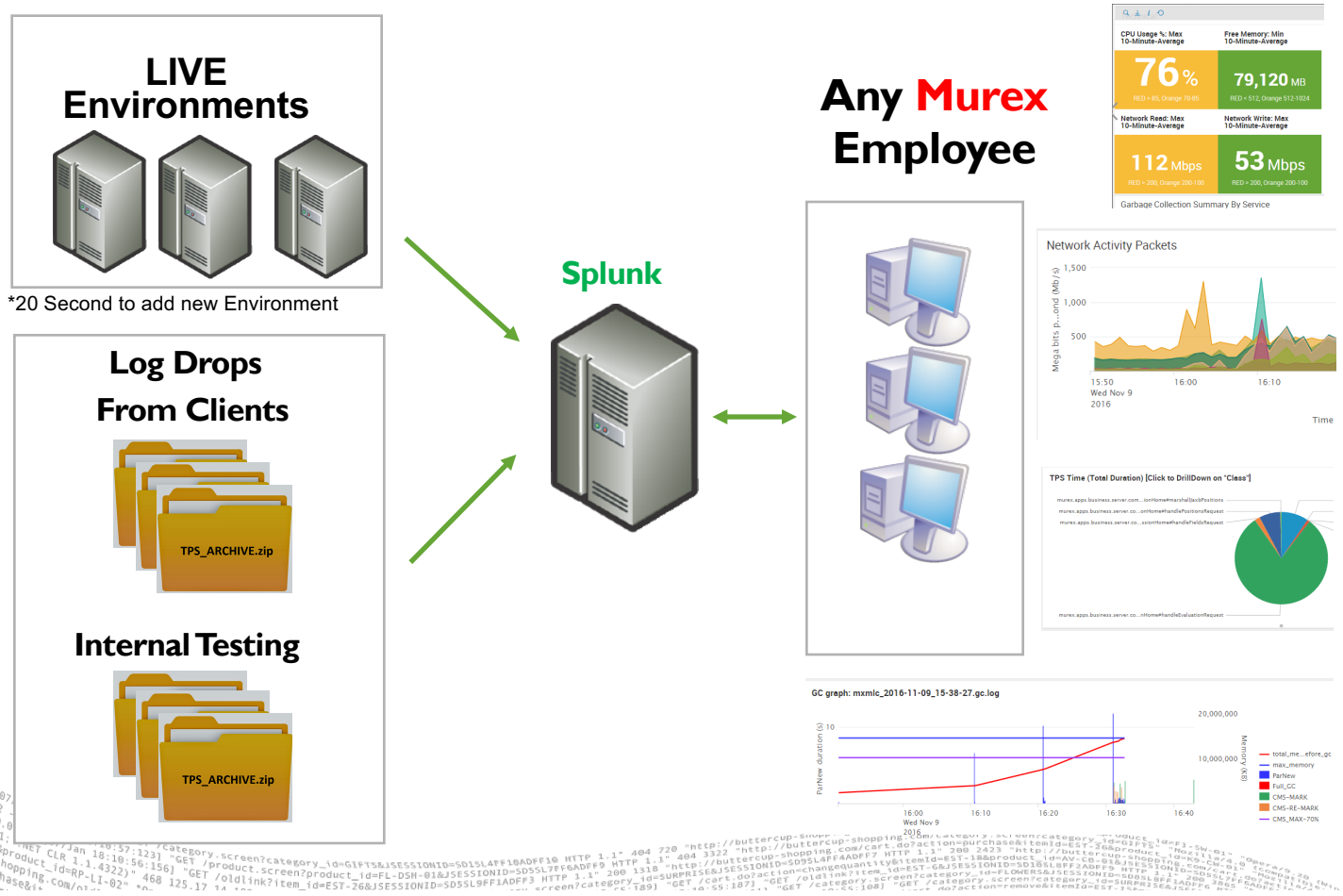
Splunk Deployment At Murex



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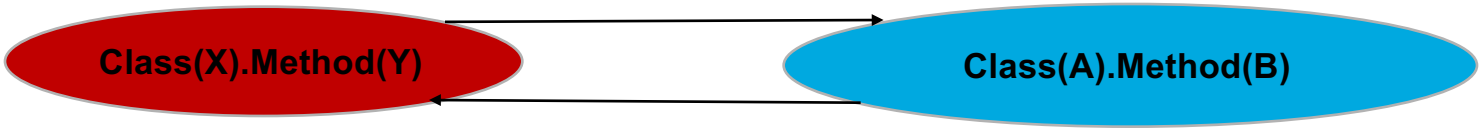
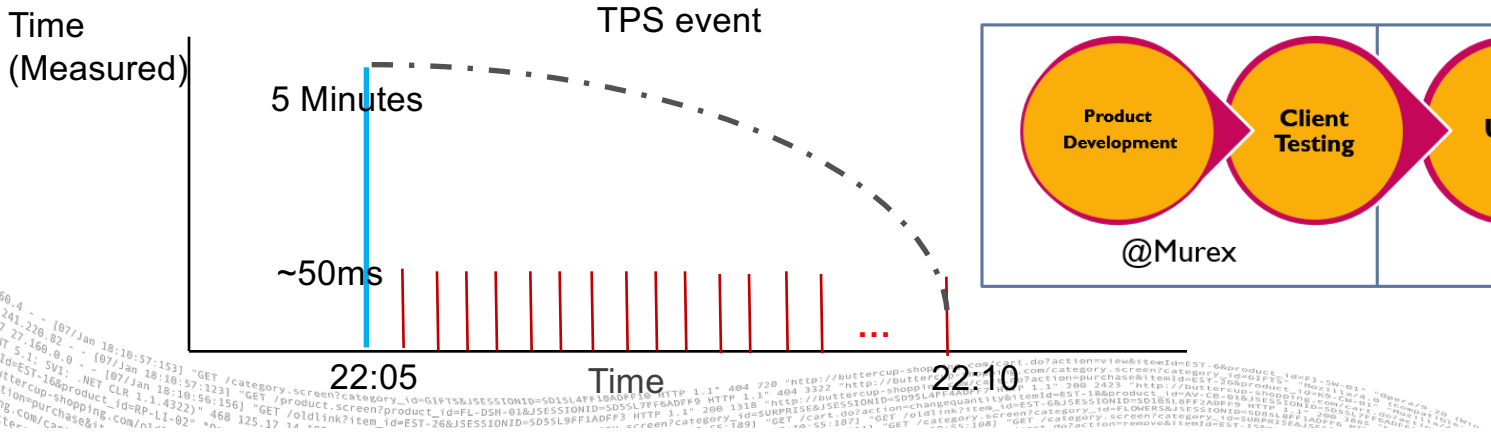
What is TPS tracing?

- TPS is light performance tracing across any JAVA service
- Code level timing on the Class.Method
  - Class(X).Method(Y) does action
  - It calls Class(A).Method(B) 6000 times

	Count	Average	Total
Class(X). Method(Y)	1	5 Minutes	5 Minutes
Class(A). Method(B)	6000	50 ms	5 Minutes





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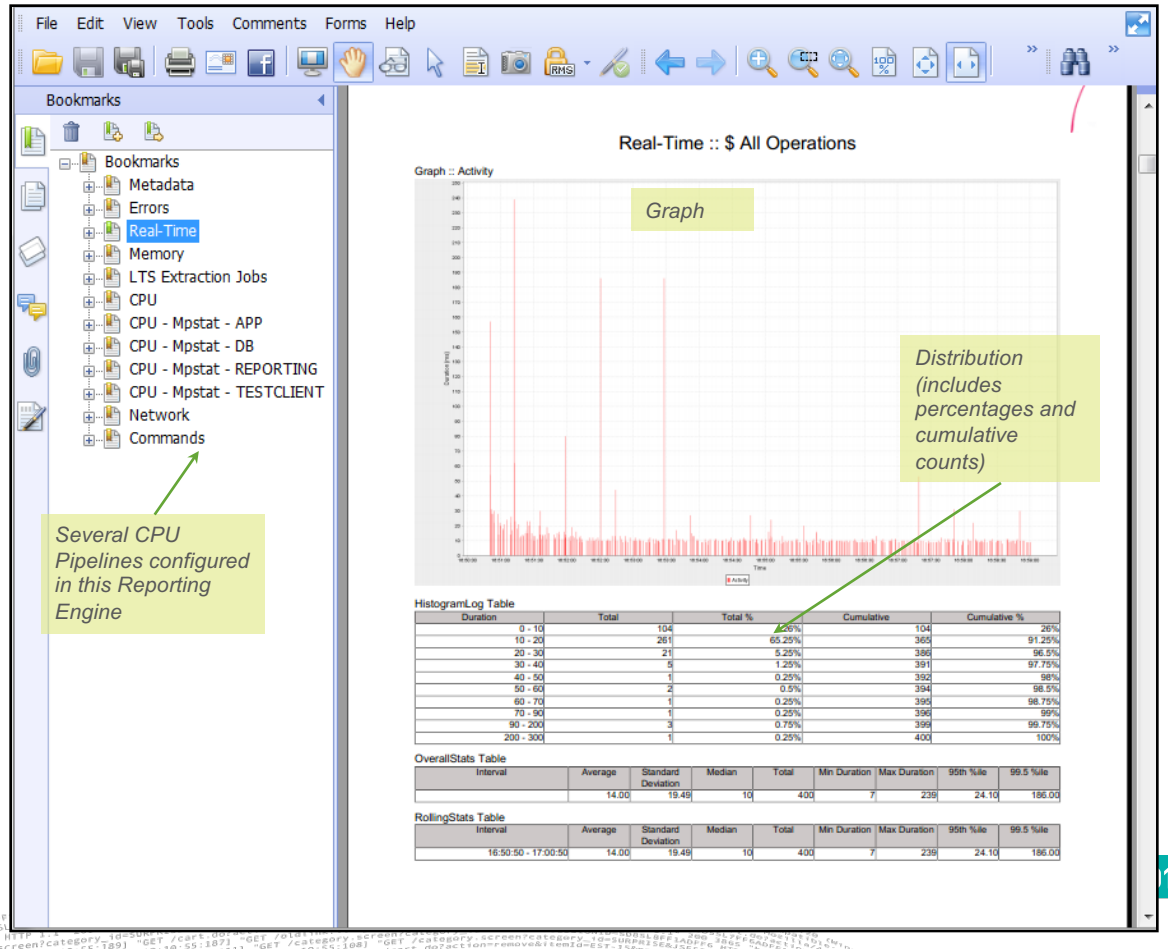
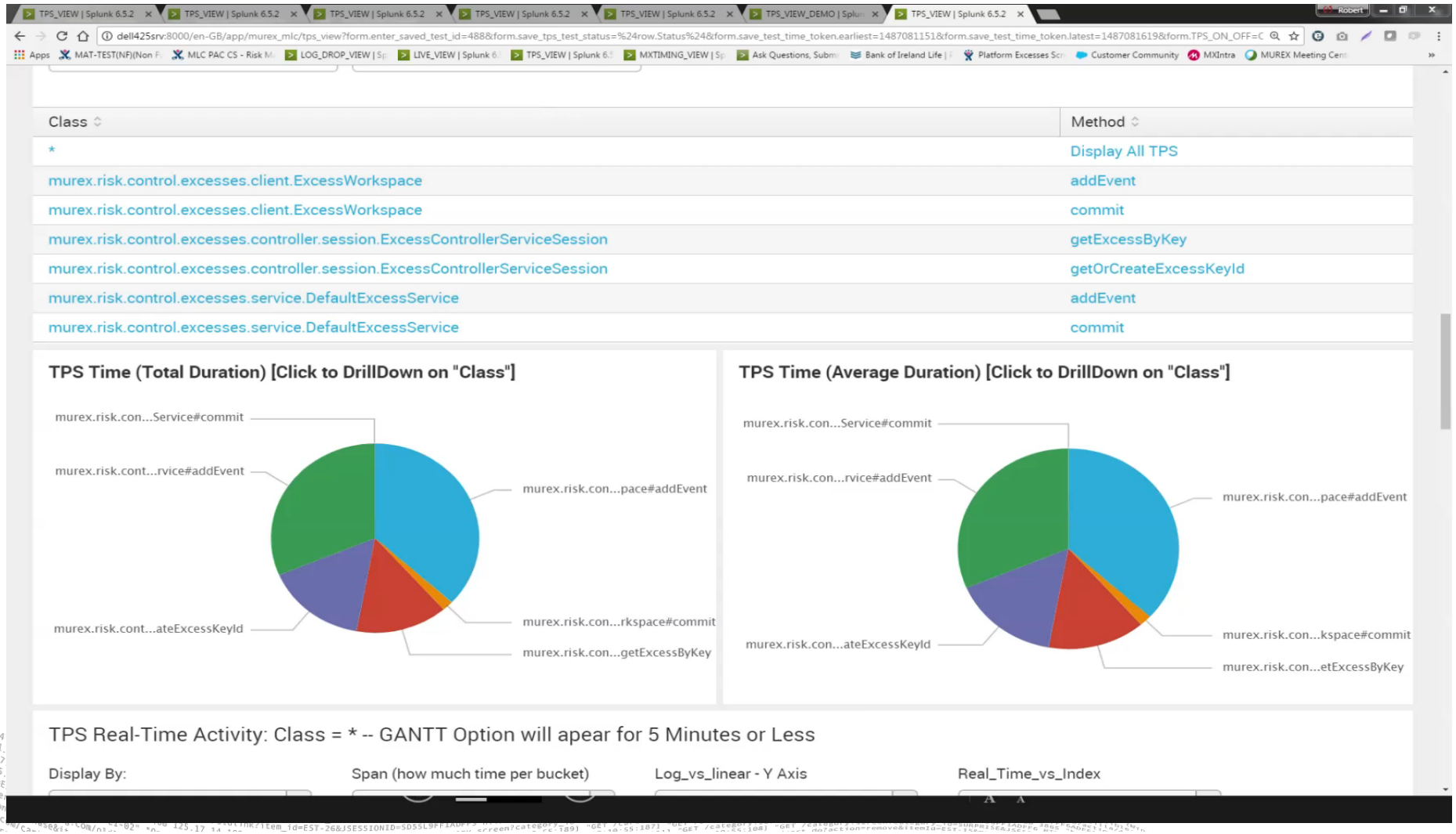
Murex in-house solution had limitations!

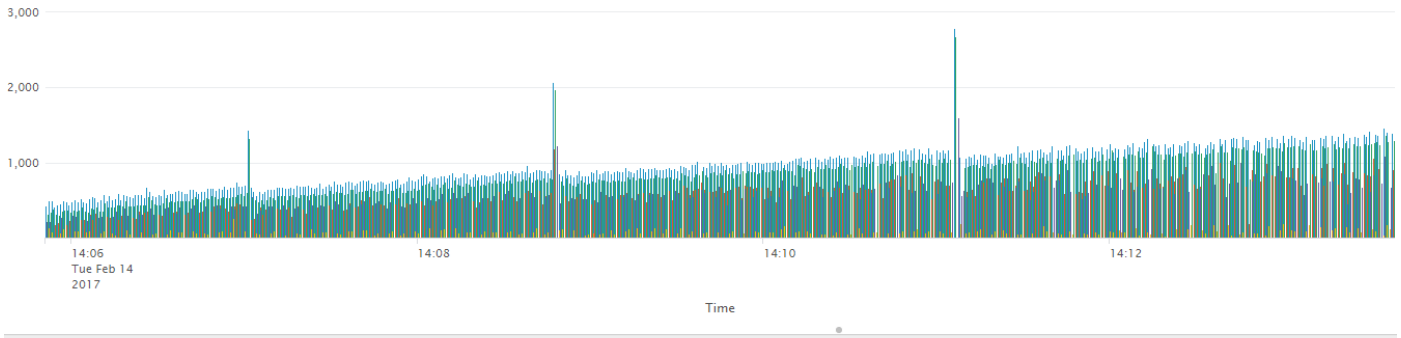
- TPS Report was a PDF = static report
- The existing PDF report was slow to graph millions of lines
- We could not zoom into areas of investigation
- Experts were always needed for analysis
- Introducing the new TPS_VIEW in Splunk




TPS_VIEW | Splunk 6.5.2
TPS_VIEW_DEMO | Splu
dell425srv:8000/en-GB/app/murex_mlc/tps_view?form.enter_saved_test_id=488&form.save_tps_test_status=%24row.Status%24&form.save_test_time_token.earliest=1487081151&form.save_test_time_token.latest=1487081619&form.TPS_ON_OFF=C
Apps
MAT-TEST(NF)(Non F
MLC PAC CS - Risk M
LOG_DROP_VIEW | Sp
LIVE_VIEW | Splunk 6.
TPS_VIEW | Splunk 6.5
MXTIMING_VIEW | Sp
Ask Questions, Subm
Bank of Ireland Life |
Platform Excesses Scr
Customer Community
MXIntra
MUREX Meeting Cent
Class
Method
*
Display All TPS
murex.risk.control.excesses.client.ExcessWorkspace
addEvent
murex.risk.control.excesses.client.ExcessWorkspace
commit
murex.risk.control.excesses.controller.session.ExcessControllerServiceSession
getExcessByKey
murex.risk.control.excesses.controller.session.ExcessControllerServiceSession
getOrCreateExcessKeyId
murex.risk.control.excesses.service.DefaultExcessService
addEvent
murex.risk.control.excesses.service.DefaultExcessService
commit
TPS Time (Total Duration) [Click to DrillDown on "Class"]
murex.risk.con...Service#commit
murex.risk.cont...rvice#addEvent
murex.risk.con...pace#addEvent
murex.risk.cont...ateExcessKeyId
murex.risk.con...rkspace#commit
murex.risk.con...getExcessByKey
TPS Time (Average Duration) [Click to DrillDown on "Class"]
murex.risk.con...Service#commit
murex.risk.con...rvice#addEvent
murex.risk.con...pace#addEvent
murex.risk.con...ateExcessKeyId
murex.risk.con...kspace#commit
murex.risk.con...etExcessByKey
TPS Real-Time Activity: Class = * -- GANTT Option will apear for 5 Minutes or Less
Display By:
Span (how much time per bucket)
Log_vs_linear - Y Axis
Real_Time_vs_Index

“If You Graph It, They Will See It”

- When you graph an issue, it becomes more obvious
- Sometimes “Average” and “Mediums” and “Maximums” are not enough to see issues…
- In the below graph an obvious increase in the “class.method” over time can be seen
- This might not have been obvious without a visualization



TPS Real-Time Stats TPS_Class = * [For the time-period selected in the chart above]

fullyQualifiedMethod	average	count	stdev	median	perc95	perc99.5	min
murex.risk.control.excesses.client.ExcessWorkspace#addEvent	810.30	15330	268.3	789	1230	1422	223
murex.risk.control.excesses.client.ExcessWorkspace#commit	38.80	15301	21.1	34	80	128	14
murex.risk.control.excesses.controller.session.ExcessControllerServiceSession#getExcessByKey	314.60	15330	181.9	288	630	878	34
murex.risk.control.excesses.controller.session.ExcessControllerServiceSession#getOrCreateExcessKeyId	346.10	15325	152.4	325	613	886	62
murex.risk.control.excesses.service.DefaultExcessService#addEvent	689.60	15330	268.5	670	1111	1297	162
murex.risk.control.excesses.service.DefaultExcessService#commit	0.10	15301	0.6	0	1	1	0

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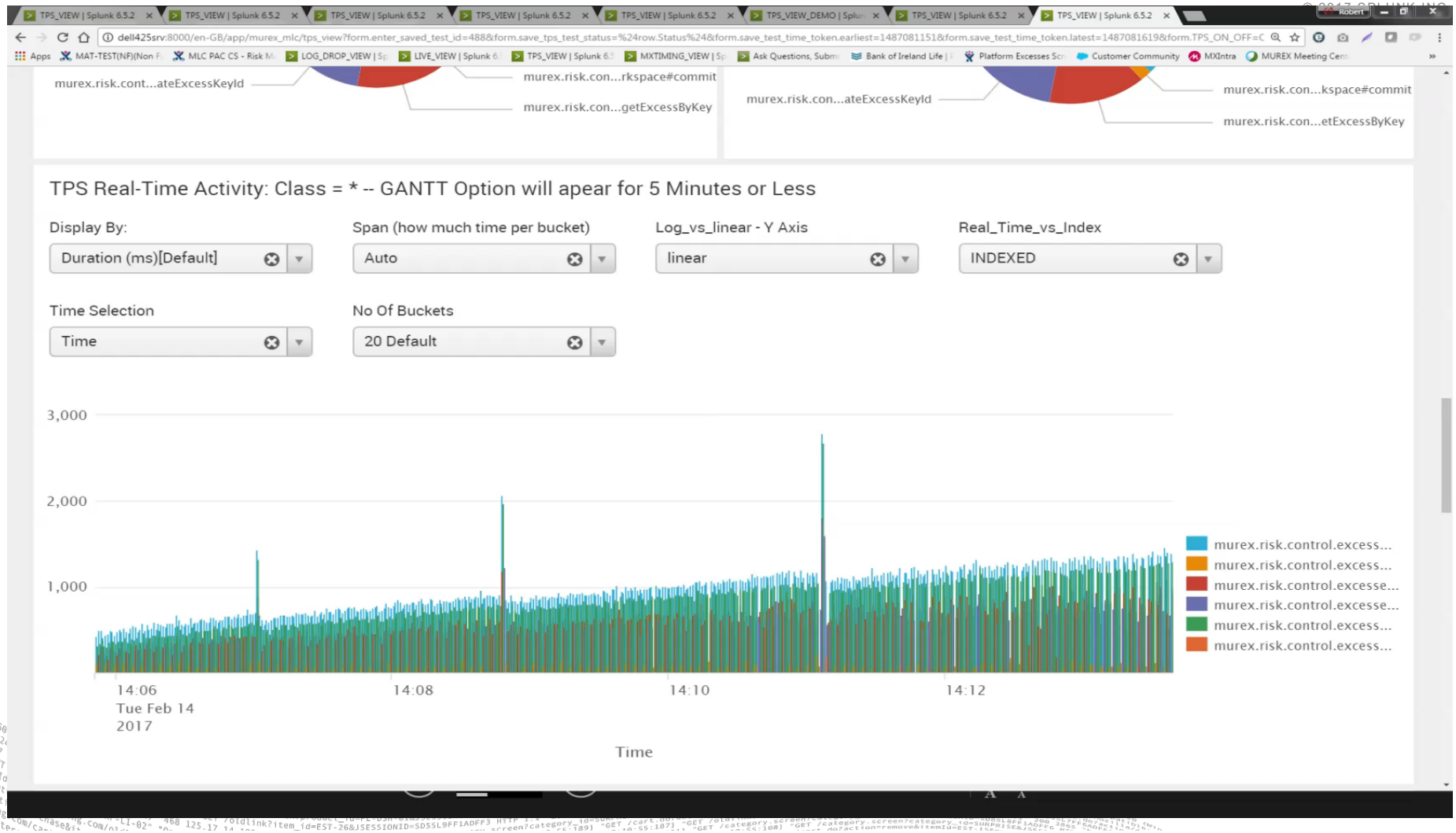
TPS_VIEW | Splunk 6.5.2
dell425srv:8000/en-GB/app/murex_mlc/tps_view?form.enter_saved_test_id=488&form.save_tps_test_status=%24row.Status%24&form.save_test_time_token.earliest=1487081151&form.save_test_time_token.latest=1487081619&form.TPS_ON_OFF=C
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murex.risk.cont...ateExcessKeyId
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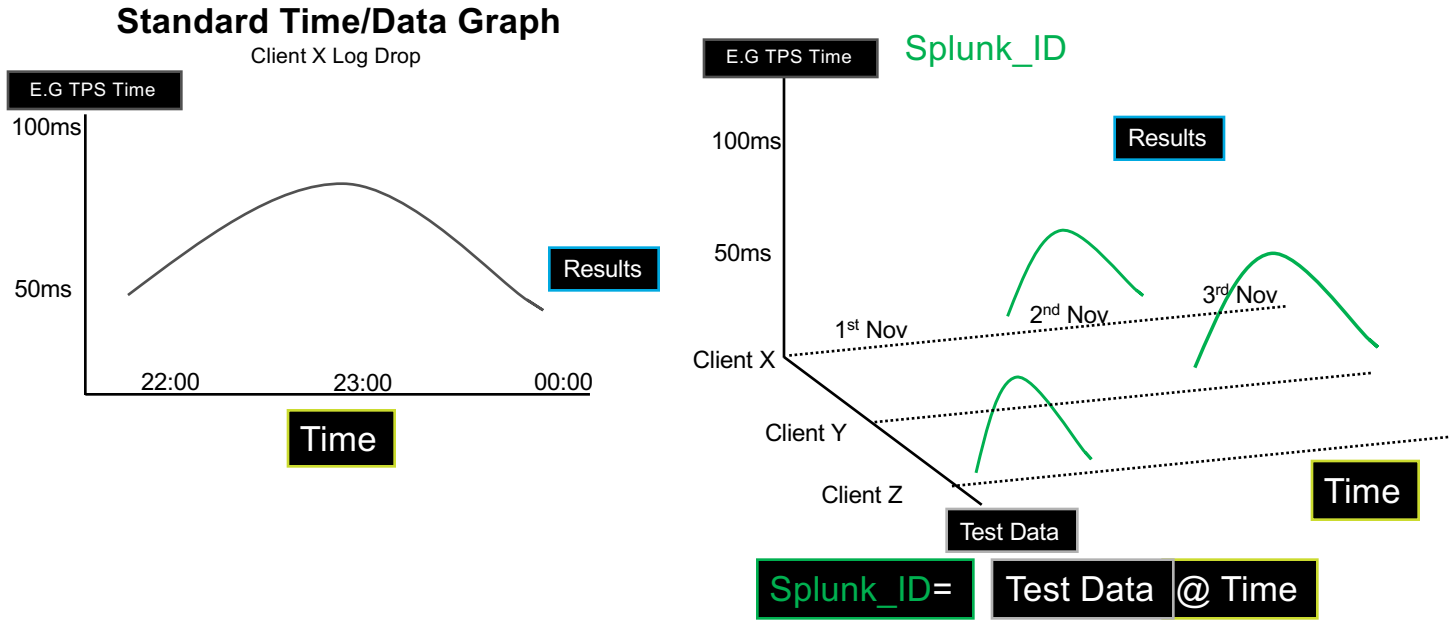
murex.risk.con...ateExcessKeyId
murex.risk.con...kspace#commit
murex.risk.con...etExcessByKey
TPS Real-Time Activity: Class = * -- GANTT Option will apear for 5 Minutes or Less
Display By:
Duration (ms)[Default]
Span (how much time per bucket)
Auto
Log_vs_linear - Y Axis
linear
Real_Time_vs_Index
INDEXED
Time Selection
Time
No Of Buckets
20 Default
3,000
2,000
1,000
14:06
Tue Feb 14
2017
14:08
14:10
14:12
Time
murex.risk.control.excess...
murex.risk.control.excess...
murex.risk.control.excesse...
murex.risk.control.excesse...
murex.risk.control.excess...
murex.risk.control.excess...

What is a Splunk_ID?

- Splunk_ID is a reference to your data in Splunk
- A numeric code that will reference your “Test Data” @ “Time” = Splunk_ID



- This means we can create URL’s to a specific “Time” in a set of “Test Data”
- This is used by developers/testers to quickly share data with one another

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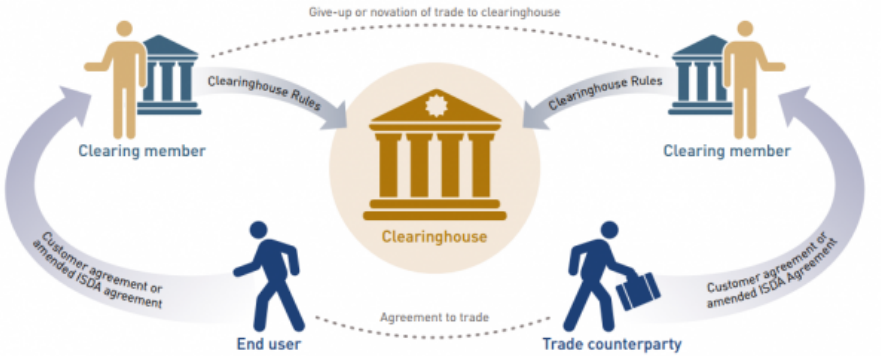
Use Case 1: “The One Trillion Dollar Problem ”

- What is a “Central Counterparty Clearing House” (CCP)?
  - “An organisation that becomes the counterparty to the buyer and the seller of a trade and guarantees the terms of that trade even if one party defaults on the agreement”
  - After 2007-2009 Financial Crash clearing became a regulatory priority
- Murex has a large CCP client in Europe were it needed to perform 60 position updates per second as part of its clearing and risk process
  - 17 Milliseconds per update (1000 Milliseconds = 1 Second)
- This client can clear up to One Trillion Dollars Notional Daily!



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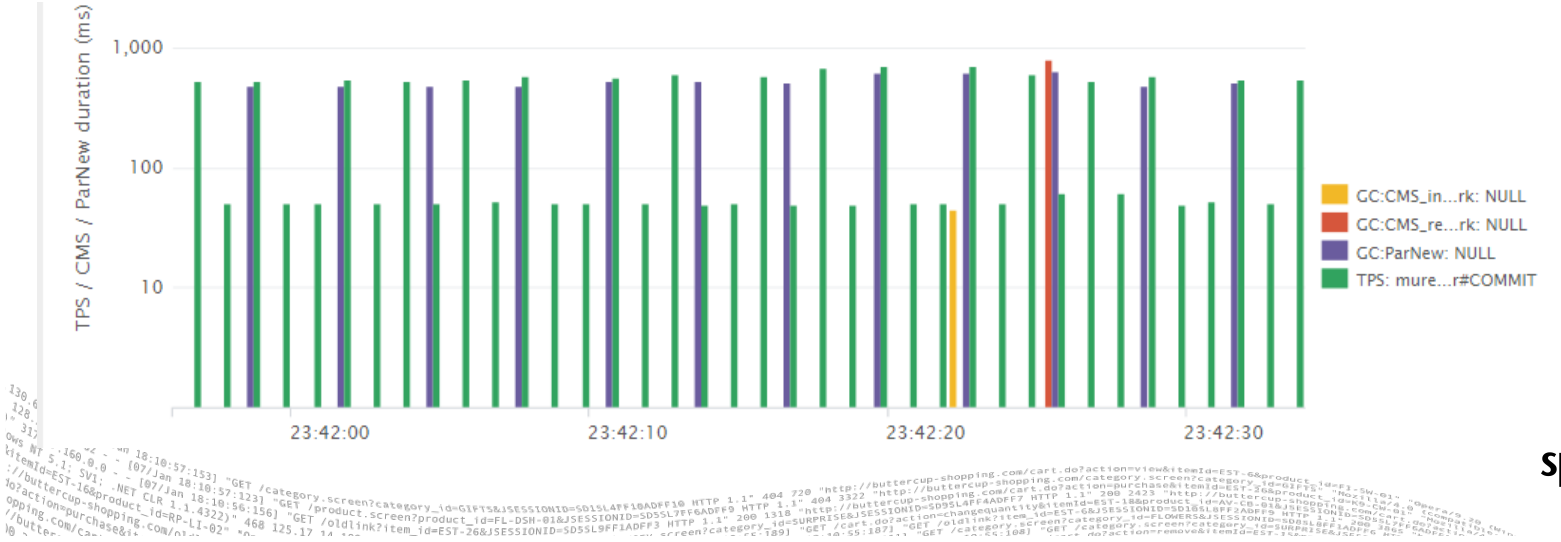
Use Case 1: Overlapping Different Data Sets

- By using Splunk we were able to overlap different data sets
  - TPS Tracing with Garbage Collection(GC) [GC is native to Java to clean memory, however if not handled correctly it can slow down performance]
- Below we can see the GC Overlapped with TPS
  - The green line is updates Insertion (COMMIT), a lot of times in parallel we can see purple, yellow or red lines, this is “Java GC” slowing down the COMMIT!



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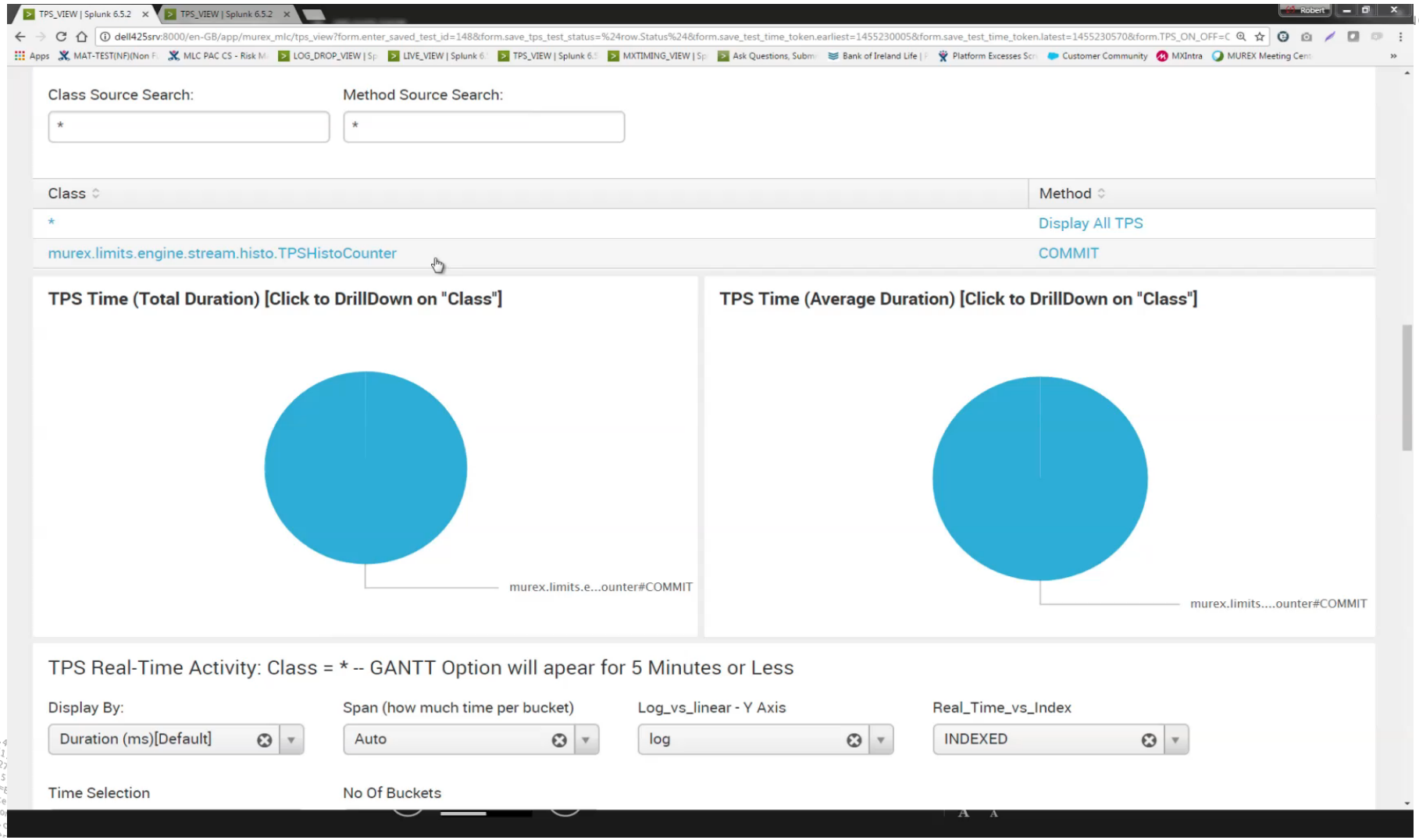

TPS_VIEW | Splunk 6.5.2
TPS_VIEW | Splunk 6.5.2
dell425srv:8000/en-GB/app/murex_mlc/tps_view?form.enter_saved_test_id=148&form.save_tps_test_status=%24row.Status%24&form.save_test_time_token.earliest=1455230005&form.save_test_time_token.latest=1455230570&form.TPS_ON_OFF=C
Class Source Search:
*
Method Source Search:
*
Class
Method
*
Display All TPS
murex.limits.engine.stream.histo.TPSHistoCounter
COMMIT
TPS Time (Total Duration) [Click to DrillDown on "Class"]
murex.limits.e...ounter#COMMIT
TPS Time (Average Duration) [Click to DrillDown on "Class"]
murex.limits....ounter#COMMIT
TPS Real-Time Activity: Class = * -- GANTT Option will apear for 5 Minutes or Less
Display By:
Duration (ms)[Default]
Span (how much time per bucket)
Auto
Log_vs_linear - Y Axis
log
Real_Time_vs_Index
INDEXED
Time Selection
No Of Buckets

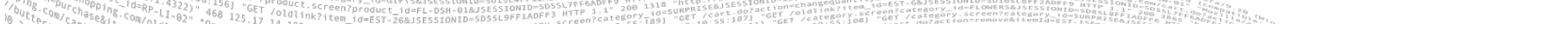
Use Case 1: Before optimizations

- In Splunk we could add up all the GC time divided by the TPS
  - **Par_new_%_of_TPS** = ∑ParNew(GC) / ∑TPS
  - **Par_new_%_of_total_time** = ∑ParNew(GC) / Duration
- Test 1: Before any optimizations
  - The average was 96 milliseconds [That is 10 updates per second, we needed 60!]
  - **Par_new_%_of_TPS = 37% [Major bottle neck identified]**
  - **Par_new_%_of_total_time = 20% [Major bottle neck identified]**

TPS Real-Time Stats TPS_Class = * [For the time-period selected in the chart above]

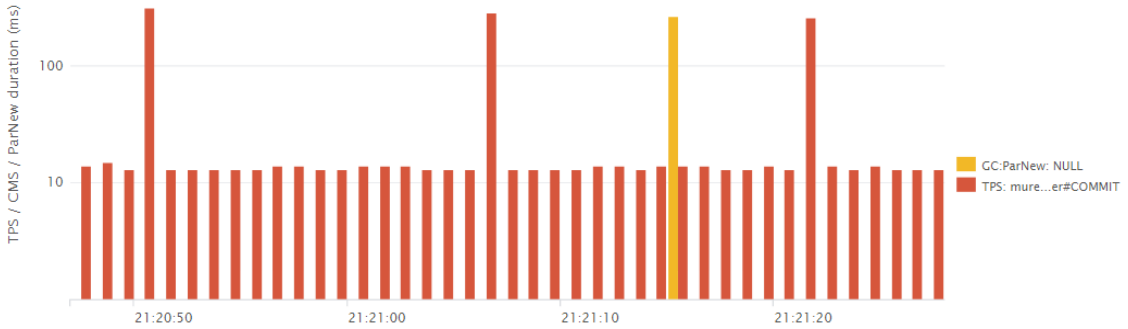
fullyQualifiedMethod	average
murex.limits.engine.stream.histo.TPSHistoCounter#COMMIT	96.30

par_new_%_of_tps	par_new_%_of_total_time
37.75	20.82



Use Case 1: After optimizations

- After multiple binary fixes and garbage collection tuning we hit the 17ms mark
- Some GC peaks we still present, however massive improvement was seen
  - We can see from the graph below that the GC peaks in yellow have reduced and we have also reduced the COMMIT peaks
  - **Par_new_%_of_TPS = 37% Before, 7.8% After**
  - **Par_new_%_of_total_time = 20% Before, 0.89% After**



TPS Real-Time Stats TPS_Class = murex.limits.engine.stream.histo.TPSHistoCounter [For the time-period sel

fullyQualifiedMethod	average
murex.limits.engine.stream.histo.TPSHistoCounter#COMMIT	16.50

par_new_%_of_tps	par_new_%_of_total_time
7.88	0.89

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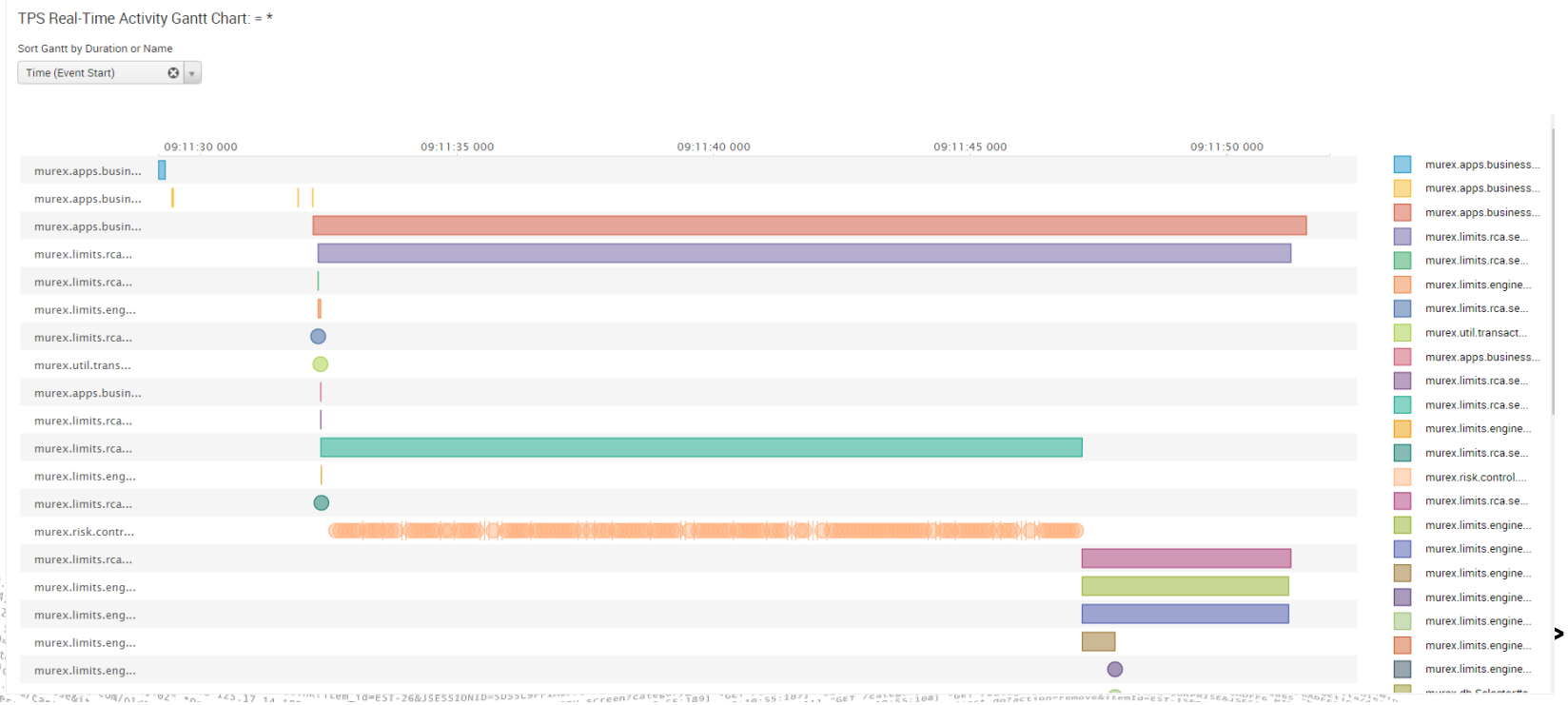
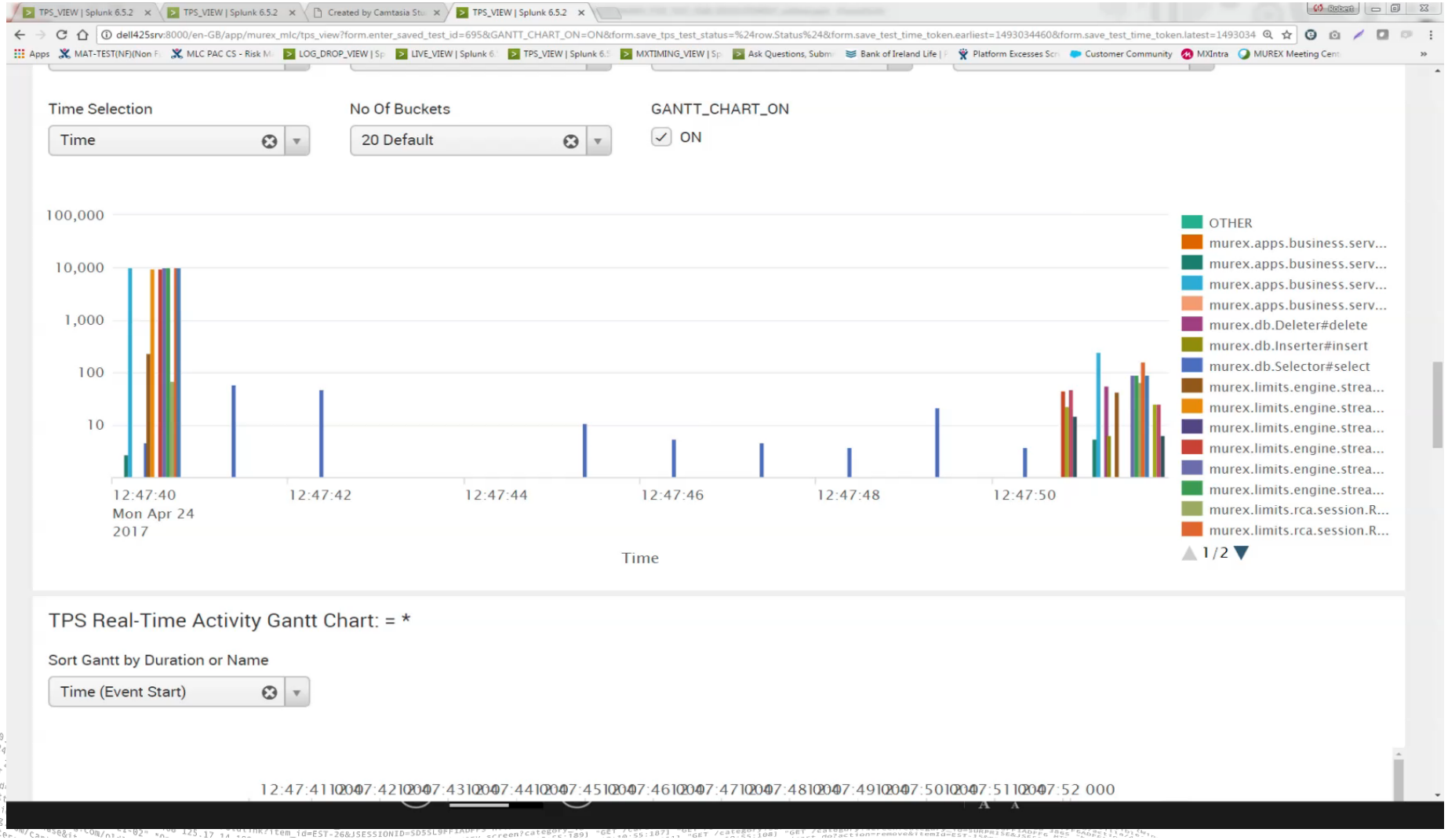
Use Case 2 – Millisecond analysis

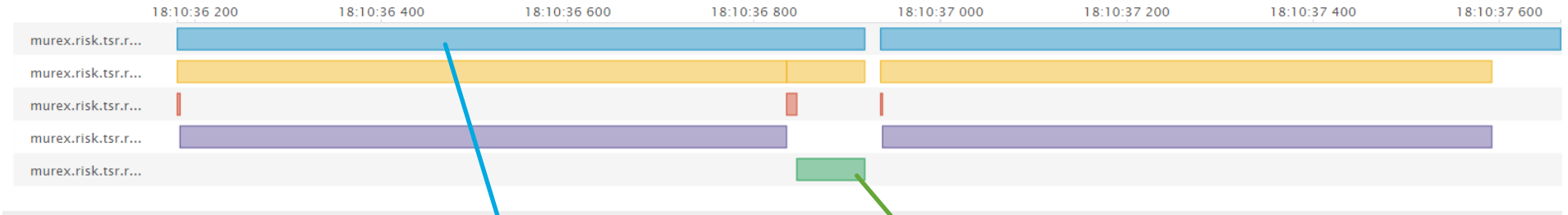
- Viewing the code line in chronological order, helped to improve visualizations
- We can zoom into the Millisecond to see the sequence of method calls




TPS_VIEW | Splunk 6.5.2
Time Selection
Time
No Of Buckets
20 Default
GANTT_CHART_ON
ON
100,000
10,000
1,000
100
10
12:47:40
Mon Apr 24
2017
12:47:42
12:47:44
12:47:46
12:47:48
12:47:50
Time
OTHER
murex.apps.business.serv...
murex.apps.business.serv...
murex.apps.business.serv...
murex.apps.business.serv...
murex.db.Deleter#delete
murex.db.Inserter#insert
murex.db.Selector#select
murex.limits.engine.strea...
murex.limits.engine.strea...
murex.limits.engine.strea...
murex.limits.engine.strea...
murex.limits.engine.strea...
murex.limits.engine.strea...
murex.limits.rca.session.R...
murex.limits.rca.session.R...
1/2
TPS Real-Time Activity Gantt Chart: = *
Sort Gantt by Duration or Name
Time (Event Start)

Use Case 2: Sequential vs. parallel testing

- During product development we have to stress code to make sure it can take Parallel load
- Sequential Import:
  - #addpoint 734ms
  - #storeExisting 73ms

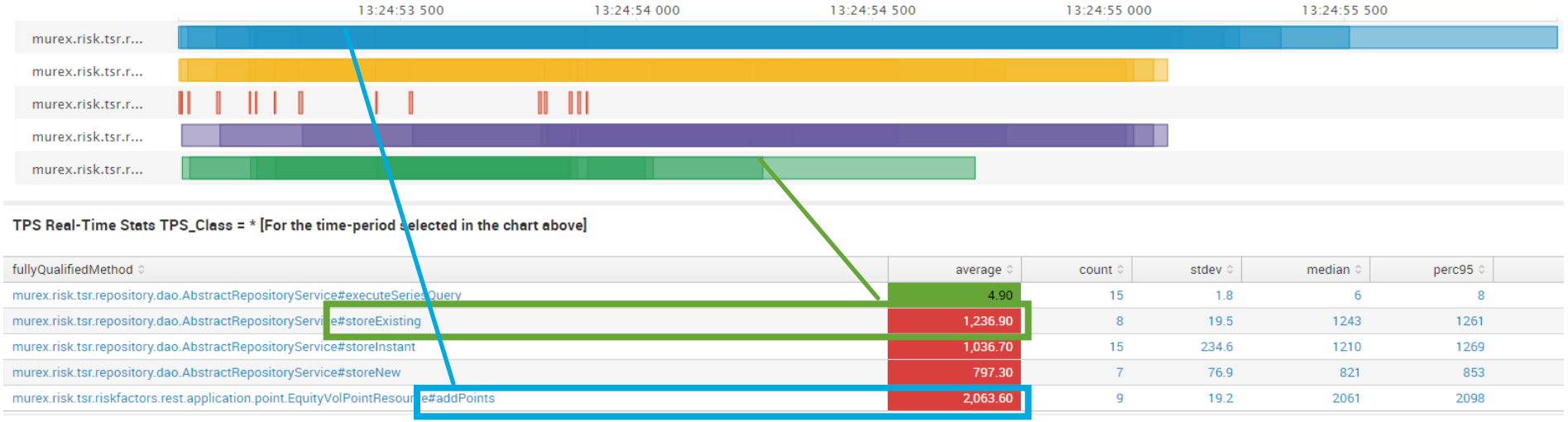


TPS Real-Time Stats TPS_Class = * [For the time-period selected in the chart above]

fullyQualifiedMethod	average	count	stdev	median	perc95
murex.risk.tsr.repository.dao.AbstractRepositoryService#executeSeriesQuery	5.30	3	4.9	3	11
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeExisting	73.00	1	0.0	73	73
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeInstant	464.70	3	329.7	654	656
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeNew	652.50	2	2.1	654	654
murex.risk.tsr.riskfactors.rest.application.point.EquityVolPointResourc#addPoints	734.00	2	5.7	738	738

Use Case 2: Sequential vs. Parallel Testing

- Parallel Import: 15 Imports in Parallel
  - #addpoint Increased from 734ms to 2,063ms => 3 time slower – Not Bad!
  - #storeExisting Increased from 73ms to 1,236ms => 17 Times slower – Possible Issue Found!



TPS Real-Time Stats TPS_Class = * [For the time-period selected in the chart above]

fullyQualifiedMethod	average	count	stdev	median	perc95
murex.risk.tsr.repository.dao.AbstractRepositoryService#executeSeriesQuery	4.90	15	1.8	6	8
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeExisting	1,236.90	8	19.5	1243	1261
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeInstant	1,036.70	15	234.6	1210	1269
murex.risk.tsr.repository.dao.AbstractRepositoryService#storeNew	797.30	7	76.9	821	853
murex.risk.tsr.riskfactors.rest.application.point.EquityVolPointResource#addPoints	2,063.60	9	19.2	2061	2098

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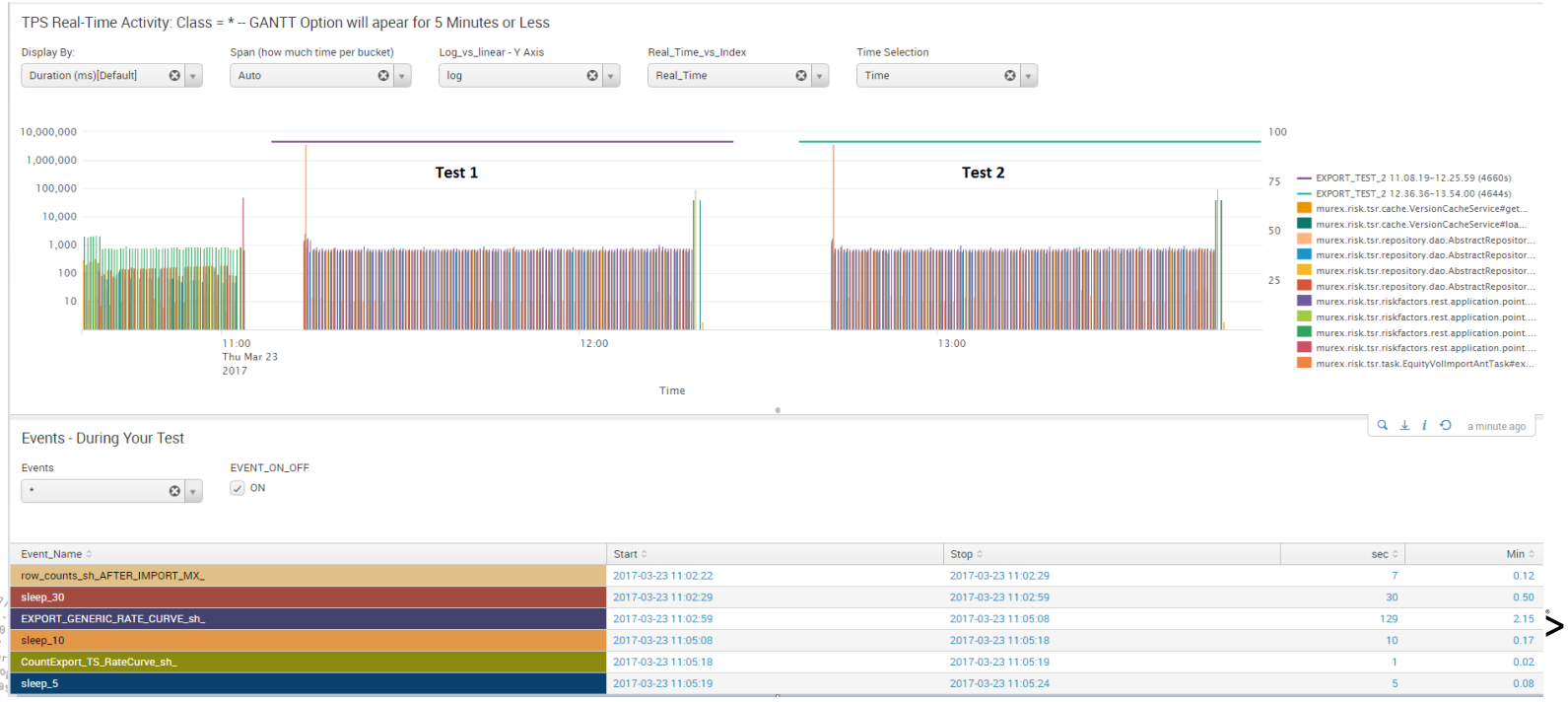
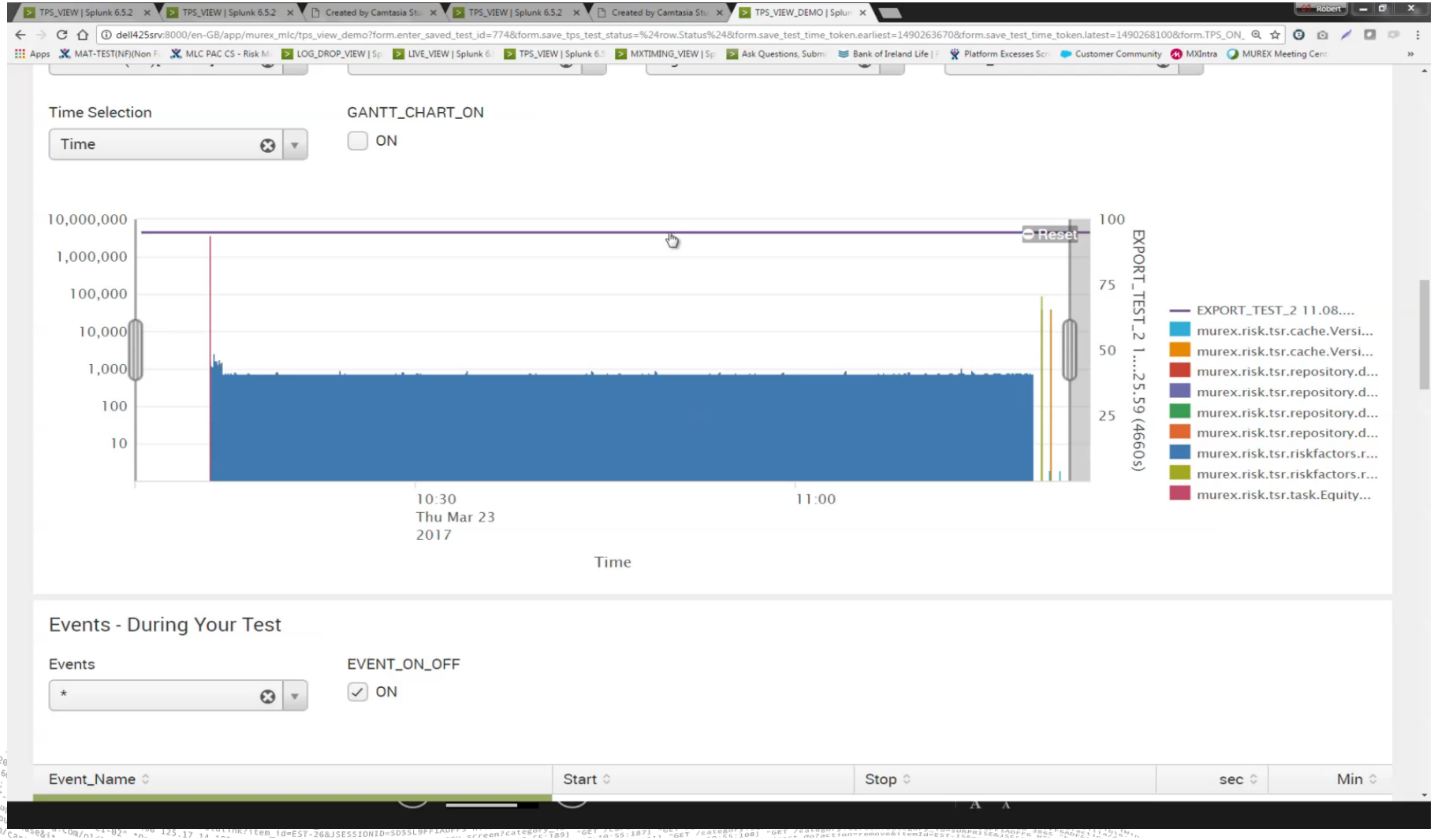
Use Case 3: So Where Is My Test?

- Over a large timeline we need to be able to identify different tests quickly
- Overnight a user might run 10 different tests
- By developing an overlap it becomes obvious where each test is (Test 1 or Test 2)




TPS_VIEW | Splunk 6.5.2
TPS_VIEW | Splunk 6.5.2
Created by Camtasia Stu
TPS_VIEW | Splunk 6.5.2
Created by Camtasia Stu
TPS_VIEW_DEMO | Splun
Robert
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Apps
MAT-TEST(NF)(Non F
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LOG_DROP_VIEW | Sp
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Ask Questions, Subm
Bank of Ireland Life |
Platform Excesses Scr
Customer Community
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MUREX Meeting Cent
Time Selection
Time
GANTT_CHART_ON
ON
10,000,000
1,000,000
100,000
10,000
1,000
100
10
Reset
100
75
50
25
EXPORT_TEST_2 1....25.59 (4660s)
EXPORT_TEST_2 11.08....
murex.risk.tsr.cache.Versi...
murex.risk.tsr.cache.Versi...
murex.risk.tsr.repository.d...
murex.risk.tsr.repository.d...
murex.risk.tsr.repository.d...
murex.risk.tsr.repository.d...
murex.risk.tsr.riskfactors.r...
murex.risk.tsr.riskfactors.r...
murex.risk.tsr.task.Equity...
10:30
Thu Mar 23
2017
11:00
Time
Events - During Your Test
Events
*
EVENT_ON_OFF
ON
Event_Name
Start
Stop
sec
Min

Conclusion: The Splunk "TPS View"

- **Problem**:
  - We needed to view millions upon millions of TPS tracing quickly
- **Problem**:
  - We needed to be able to get data into Splunk quickly
- **Problem**
  - We needed to overlap different data sets to find bottle necks
- **Problem**:
  - How can I show my colleagues quickly what I am looking at?

- **Solution:**
  - How about….100 million lines of data (sliced and diced) in 10 seconds!!
  - New TPS VIEW is hyper accelerated to handle heavy volumes
- **Solution**:
  - LIVE Monitoring: 20 seconds to attach any environment to Splunk (one line command)
  - Log DROP: Upload logs from anywhere (one line command)
- **Solution**:
  - By overlapping TPS tracing with GC, CPU etc.. new bottle necks became obvious:
- **Solution:**
  - Splunk ID: Unique ID to allow you to save a point of investigation and pass it on to you colleagues

splunk> .conf2017


Thanks
MUREX™
Don't forget to rate this session in the .conf2017 mobile app
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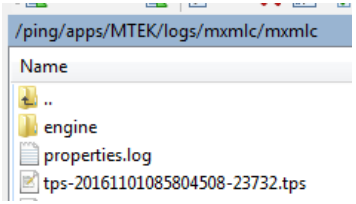
Appendix - Simple TPS Example

- Annotation for basic classes and methods for TPS tracing to produce traces into a file.

```
class Example{
   @Traced
   public void exampleMethod() {
      doWork();
   }
}
```

Output: in “json”

```
{
  "endTime":1473177098093,                    (milliseconds)
  "startTime":1473177098031,
  "operationIdentity":“exampleMethod",
  "name":"Murex.Exmaple“
}
```



_time	FULL_TPS_TRACE
2017-07-18 08:50:11.375	{"endTime":1500360611376,"startTime":1500360611375,"operationIdentity":"publishCacheStatistics","name":"murex.limits.utilities.cache.statistics.CacheStatisticsTimerTask","context":{"parentContext":{"id":-1,"parentContext":null},"data":[{"value":"RTLIM-12472@2015-06-09--Sanity_MaxMaturity_PCE-47--PillarNettingUTable-177891","key":"name"},{"value":"0","key":"hits"},{"value":"0","key":"misses"},{"value":"0","key":"count"},{"value":"4096","key":"maxElements"},{"value":"0","key":"evictions"},{"value":"Default","key":"policy"}],"id":8590023}}
2017-07-18 08:50:11.382	{"endTime":1500360611382,"startTime":1500360611382,"operationIdentity":"publishCacheStatistics","name":"murex.limits.utilities.cache.statistics.CacheStatisticsTimerTask","context":{"parentContext":{"id":-1,"parentContext":null},"data":[{"value":"GlobalRuleCache:Sanity_MaxTenor_ISSp:ValidationRuleRepository","key":"name"},{"value":"0","key":"hits"},{"value":"0","key":"misses"},{"value":"0","key":"count"},{"value":"0","key":"maxElements"},{"value":"0","key":"evictions"},{"value":"Default","key":"policy"}],"id":8590168}}

Appendix – SPLUNK ID

- A SPLUNK ID is stored in a Lookup Table, there are 4 main parts
  1. ID = Unique ID numeric value
  2. Host = What data set are you looking at
  3. Start_Time = Start time of the time slice
  4. Stop_Time = Stop time of the time slice
- Additional Information can be stored and displayed if needed

New Search

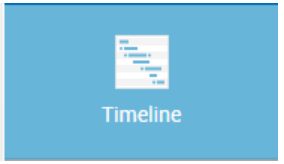
```
| inputlookup Saved_Tests.csv | where Host="EW_COMP" | where 1=1 | search Dev_Optimization="*" | search Functional_Optimization="*" | eval
   Start_epoc=Start | eval Stop_epoc=Stop | convert ctime(Start) | convert ctime(Stop) | table ID, Comment, Dev_Optimization,
   Functional_Optimization, Status, Start, Stop, Version, MX_Build_ID , Start_epoc , Stop_epoc | head 1001 | sort - by ID
```

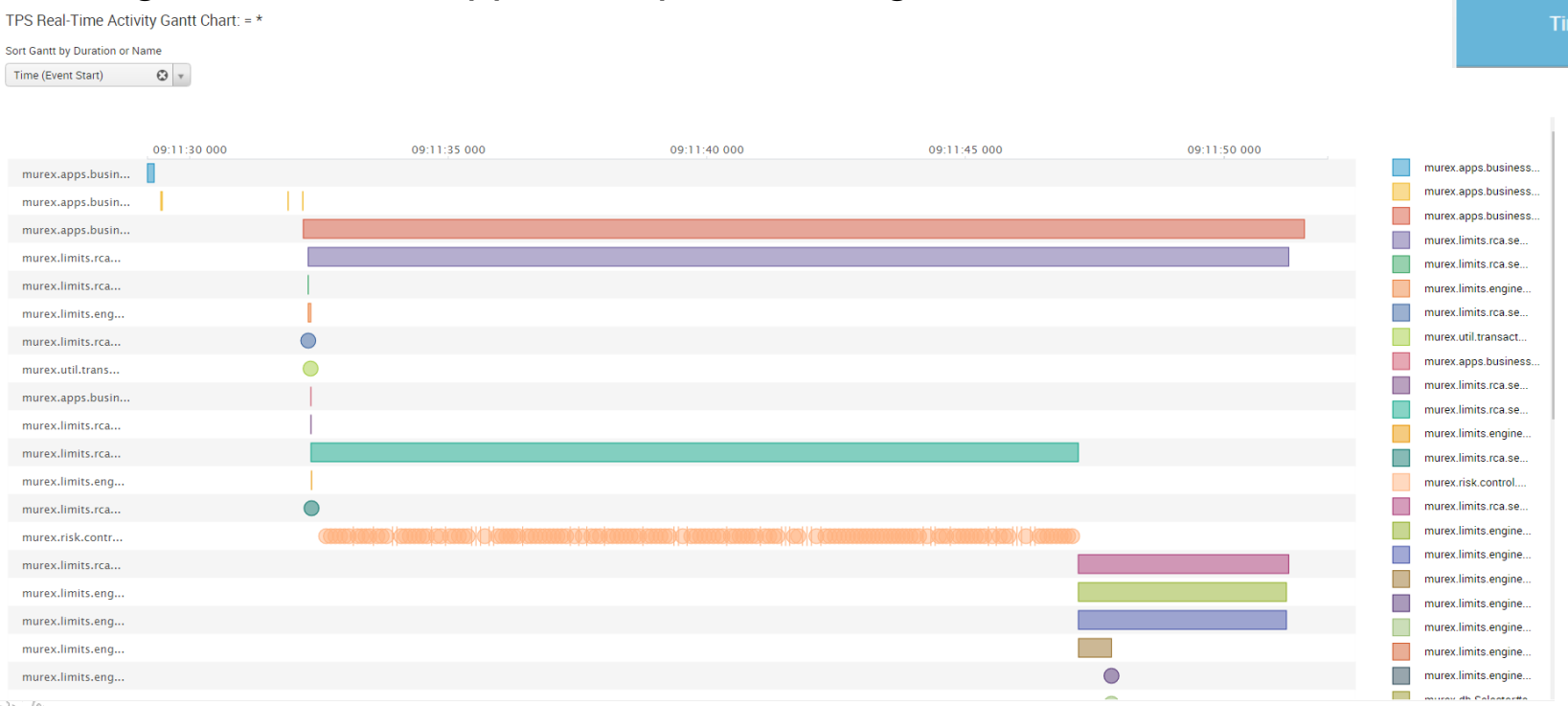
Currently viewing : SPLUNK ID = " 488 " : LINK to Test = http://dell425srv:8000/en-GB/app/murex_mlc/tps_view?&form.enter_saved_test_id=488

ID	Comment	Dev_Optimization	Functional_Optimization	Status	Start	Stop
777	SOFT_TEST_V5	-	-	GOLD	02/14/2017 15:11:01	02/14/2017 15:11:14
776	SOFT_TEST4	-	INDEX_REMOVED	GOLD	02/14/2017 15:11:02	02/14/2017 15:11:12
775	SOFT_TEST_3	-	NO_INDEX	$row.Status$	02/14/2017 15:10:58	02/14/2017 15:11:14

Appendix - Charts

- Using the TimeLine app it was possible to get the below visualizations





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