Instrumentation of the CERN Accelerator Logging Service

Ensuring Performance, Scalability, Maintenance & Diagnostics

Chris Roderick, Ronny Billen, Daniel Teixeira

Everybody lies

Be wary of the users!

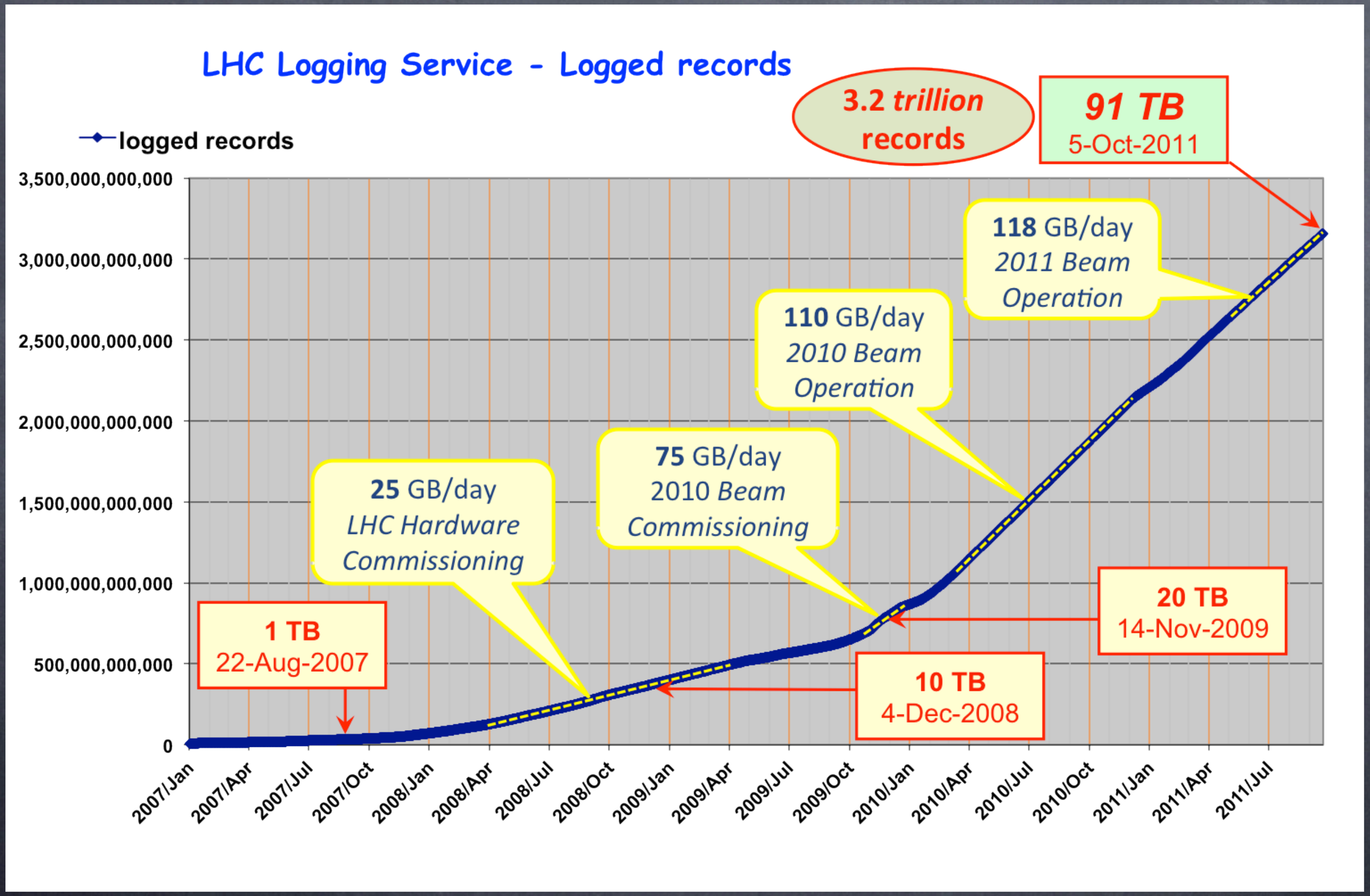
Big difference between how:

You think users will read/write data

Users tell you they intend to read/write data

Users actually read/write data

Lots of Data !


LHC Logging Service - Logged records
logged records
3,500,000,000,000
3,000,000,000,000
2,500,000,000,000
2,000,000,000,000
1,500,000,000,000
1,000,000,000,000
500,000,000,000
0
2007/Jan
2007/Apr
2007/Jul
2007/Oct
2008/Jan
2008/Apr
2008/Jul
2008/Oct
2009/Jan
2009/Apr
2009/Jul
2009/Oct
2010/Jan
2010/Apr
2010/Jul
2010/Oct
2011/Jan
2011/Apr
2011/Jul
3.2 trillion records
91 TB
5-Oct-2011
118 GB/day
2011 Beam Operation
110 GB/day
2010 Beam Operation
75 GB/day
2010 Beam Commissioning
25 GB/day
LHC Hardware Commissioning
1 TB
22-Aug-2007
20 TB
14-Nov-2009
10 TB
4-Dec-2008

System misuse

can have severe

negative impact on stability

Instrument everything!

What is Instrumentation?

Capturing information about
system activity in real time
(& over time)

Who?
What?
Where?
How?
How Long?

We **know** what the system is doing

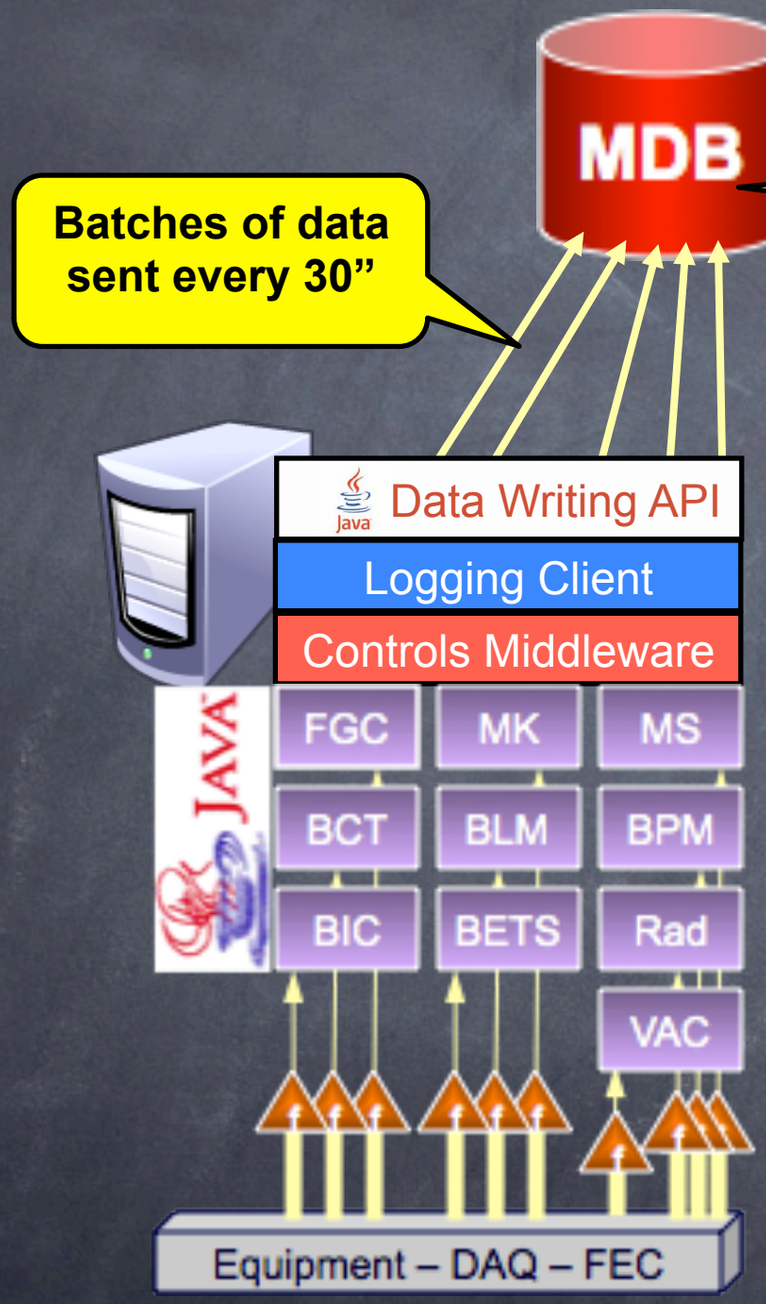
We **know** how the system is performing

Throughput & Response times

Instrumentation is everywhere
within logging service

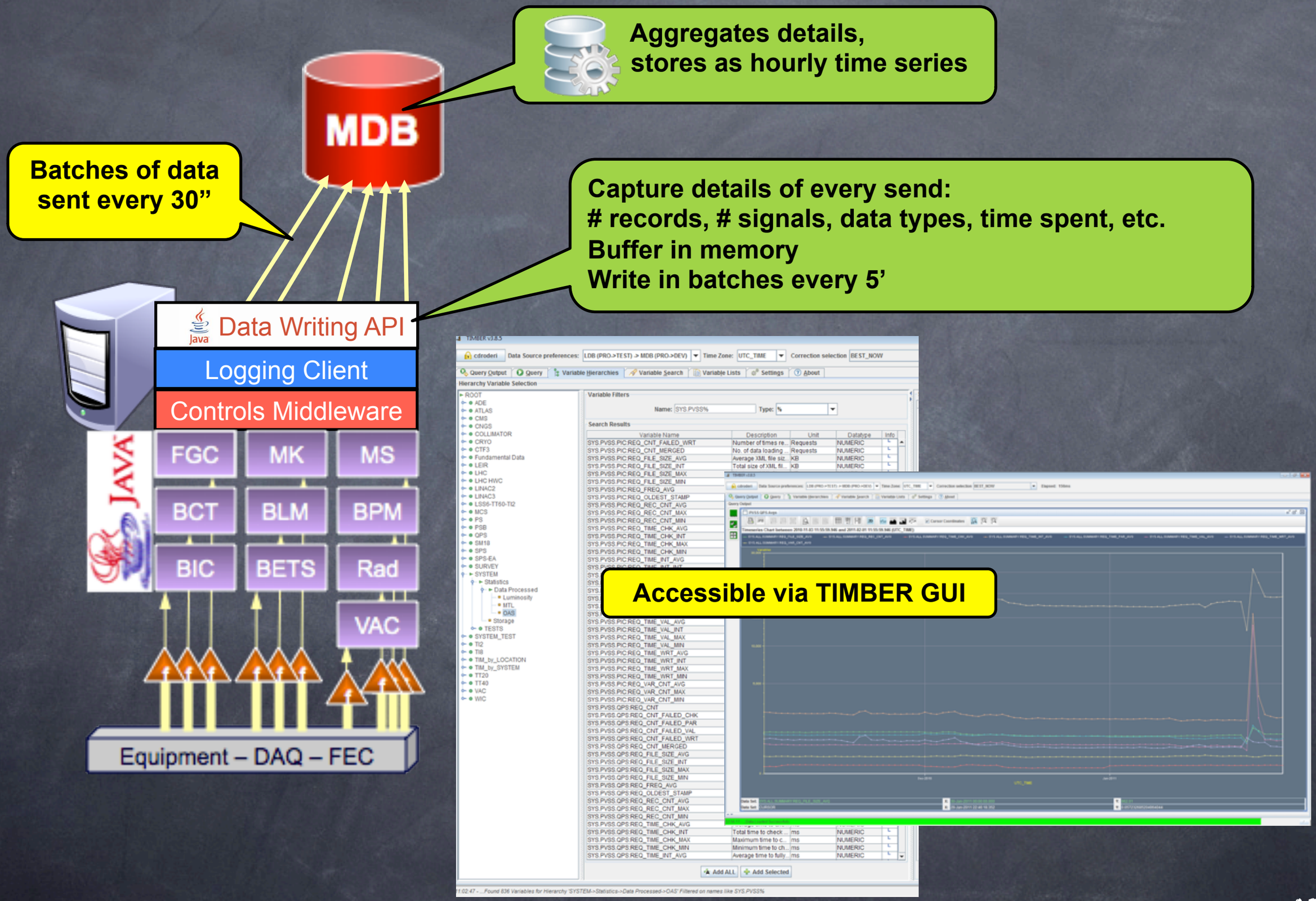
Logging Service - Architecture Overview

MDB Data Loading

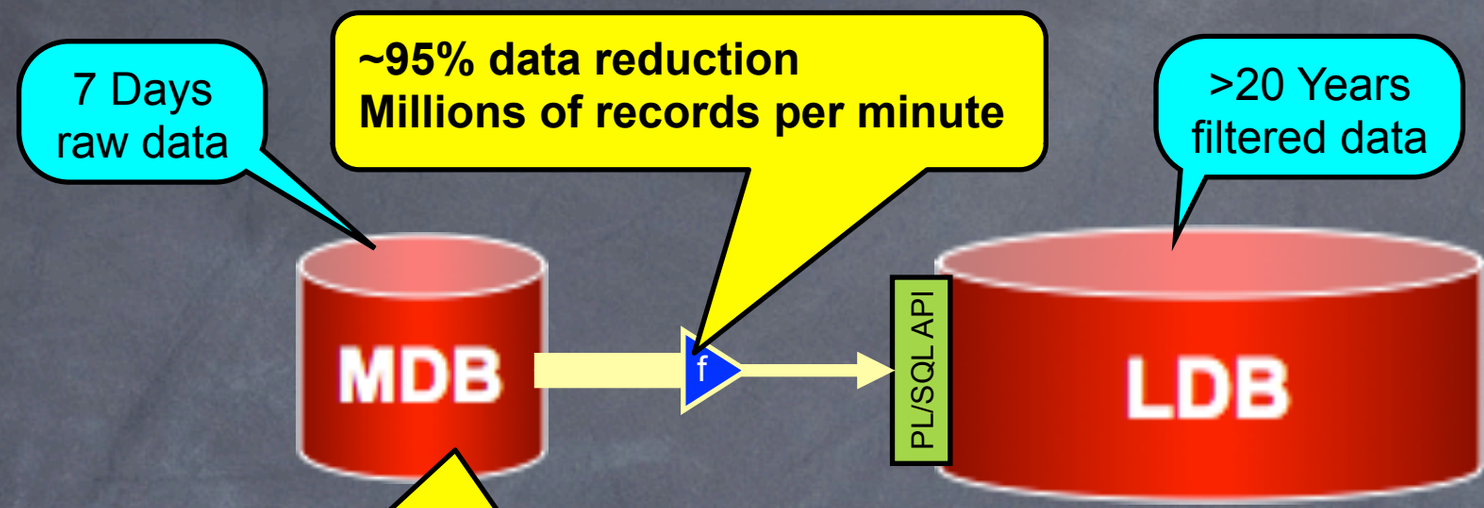


~ 250’000 signals
16 multi-threaded data loading processes
~ 5.4 billion records per day
~ 275 GB per day
~ 100 TB per year *throughput*

MDB Data Loading Instrumentation

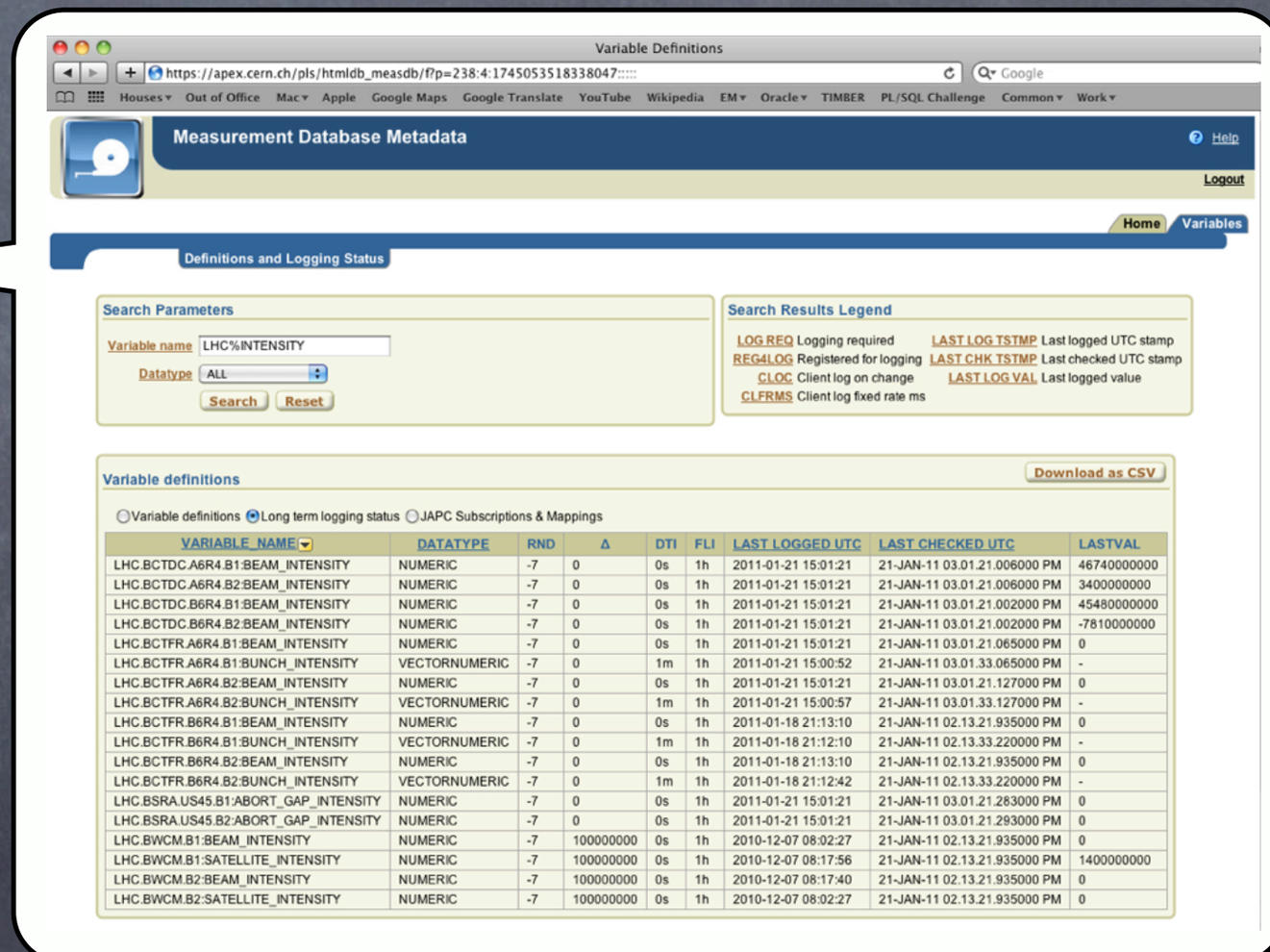


Measurements to Logging Transfer



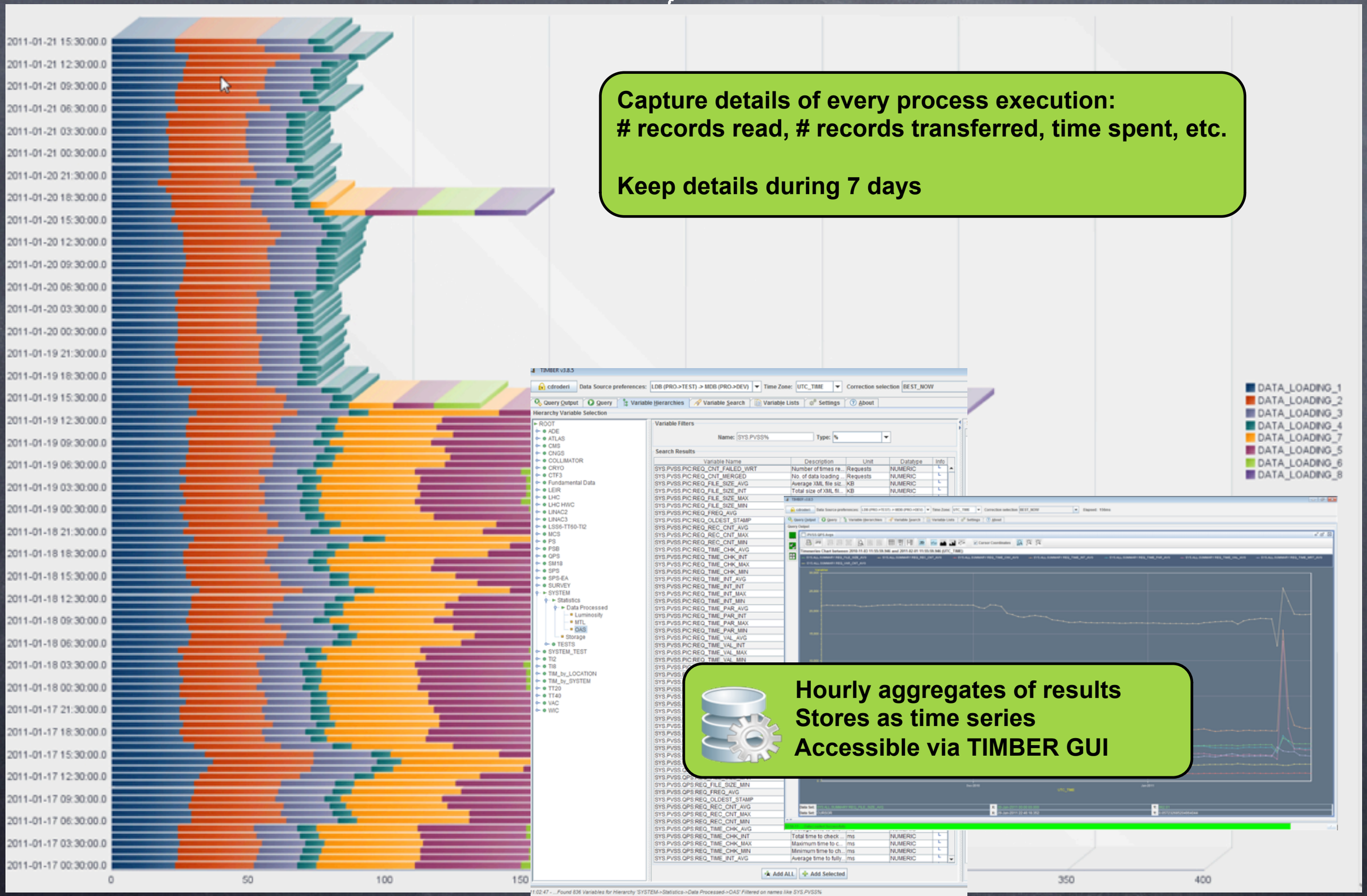
8x jobs
running every 5'

PL/SQL
- bulk read data by category
- apply custom filters
- bulk transfer



VARIABLE_NAME	DATATYPE	RND	Δ	DTI	FLI	LAST LOGGED UTC	LAST CHECKED UTC	LASTVAL
LHC.BCTDC.A6R4.B1:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.006000 PM	46740000000
LHC.BCTDC.A6R4.B2:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.006000 PM	3400000000
LHC.BCTDC.B6R4.B1:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.002000 PM	45480000000
LHC.BCTDC.B6R4.B2:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.002000 PM	-7810000000
LHC.BCTFR.A6R4.B1:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.065000 PM	0
LHC.BCTFR.A6R4.B1:BUNCH_INTENSITY	VECTORNUMERIC	-7	0	1m	1h	2011-01-21 15:00:52	21-JAN-11 03.01.33.065000 PM	-
LHC.BCTFR.A6R4.B2:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.127000 PM	0
LHC.BCTFR.A6R4.B2:BUNCH_INTENSITY	VECTORNUMERIC	-7	0	1m	1h	2011-01-21 15:00:57	21-JAN-11 03.01.33.127000 PM	-
LHC.BCTFR.B6R4.B1:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-18 21:13:10	21-JAN-11 02.13.21.935000 PM	0
LHC.BCTFR.B6R4.B1:BUNCH_INTENSITY	VECTORNUMERIC	-7	0	1m	1h	2011-01-18 21:12:10	21-JAN-11 02.13.33.220000 PM	-
LHC.BCTFR.B6R4.B2:BEAM_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-18 21:13:10	21-JAN-11 02.13.21.935000 PM	0
LHC.BCTFR.B6R4.B2:BUNCH_INTENSITY	VECTORNUMERIC	-7	0	1m	1h	2011-01-18 21:12:42	21-JAN-11 02.13.33.220000 PM	-
LHC.BSRA.US45.B1:ABORT_GAP_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.283000 PM	0
LHC.BSRA.US45.B2:ABORT_GAP_INTENSITY	NUMERIC	-7	0	0s	1h	2011-01-21 15:01:21	21-JAN-11 03.01.21.293000 PM	0
LHC.BWCM.B1:BEAM_INTENSITY	NUMERIC	-7	100000000	0s	1h	2010-12-07 08:02:27	21-JAN-11 02.13.21.935000 PM	0
LHC.BWCM.B1:SATELLITE_INTENSITY	NUMERIC	-7	100000000	0s	1h	2010-12-07 08:17:56	21-JAN-11 02.13.21.935000 PM	1400000000
LHC.BWCM.B2:BEAM_INTENSITY	NUMERIC	-7	100000000	0s	1h	2010-12-07 08:17:40	21-JAN-11 02.13.21.935000 PM	0
LHC.BWCM.B2:SATELLITE_INTENSITY	NUMERIC	-7	100000000	0s	1h	2010-12-07 08:02:27	21-JAN-11 02.13.21.935000 PM	0

MDB to LDB Transfer Instrumentation

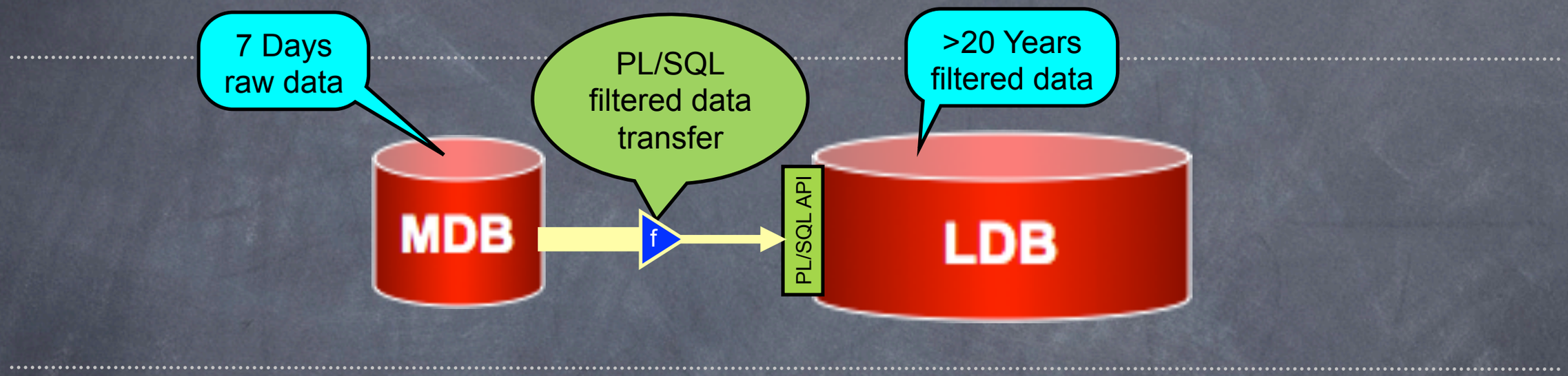


Capture details of every process execution:
 # records read, # records transferred, time spent, etc.

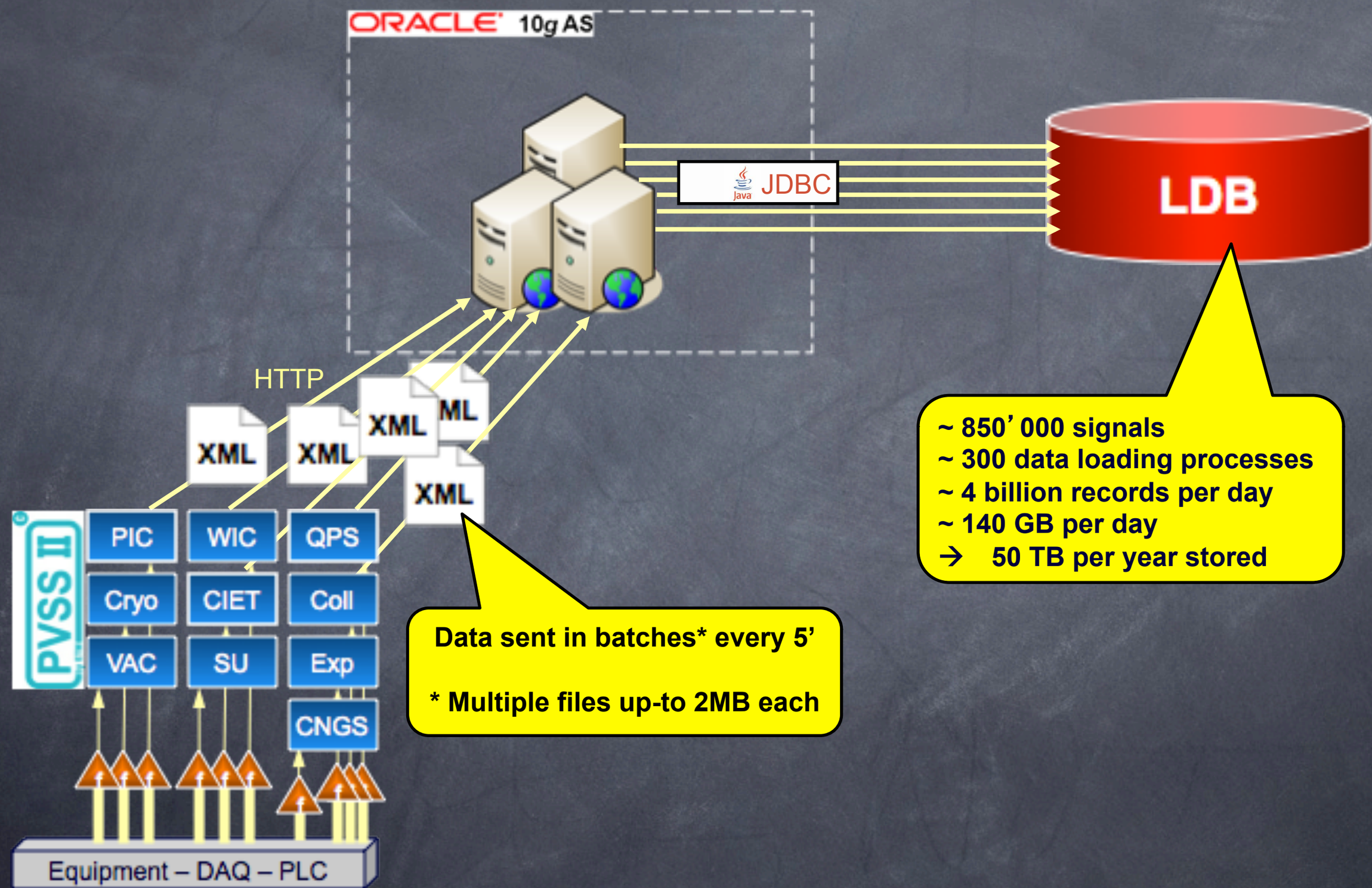
Keep details during 7 days

Hourly aggregates of results
Stores as time series
Accessible via TIMBER GUI

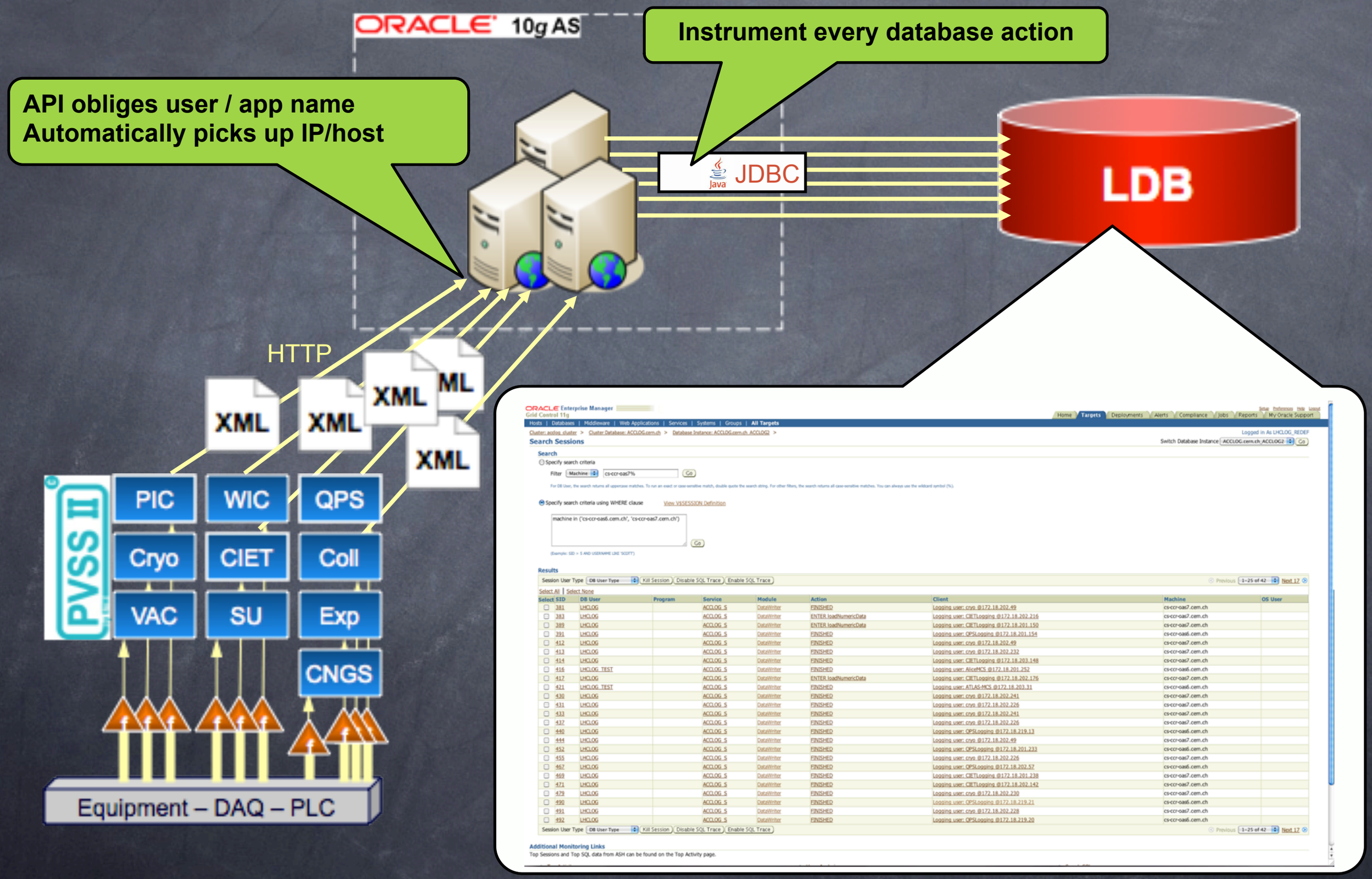
Logging Service - Architecture Overview



PVSS Data Loading



PVSS Data Loading Instrumentation



PVSS Data Loading Instrumentation

ORACLE Enterprise Manager
Grid Control 11g

Home | Targets | Deployments | Alerts | Compliance | Jobs | Reports | My Oracle Support

Hosts | Databases | Middleware | Web Applications | Services | Systems | Groups | All Targets

Cluster: acclog_cluster > Cluster Database: ACCLOG.cern.ch > Database Instance: ACCLOG.cern.ch: ACCLOG2 >

Logged in As LHCLOG_REDEF

Search Sessions

Switch Database Instance ACCLOG.cern.ch:ACCLOG2 Go

Search

Specify search criteria

Filter Machine cs-ccr-oas7% Go

For DB User, the search returns all uppercase matches. To run an exact or case-sensitive match, double quote the search string. For other filters, the search returns all case-sensitive matches. You can always use the wildcard symbol (%).

Specify search criteria using WHERE clause View V$SESSION Definition

```
machine in ('cs-ccr-oas6.cern.ch', 'cs-ccr-oas7.cern.ch')
```

Go

(Example: SID > 5 AND USERNAME LIKE 'SCOTT')

Results

Session User Type DB User Type | Kill Session | Disable SQL Trace | Enabl

Previous 1-25 of 42 Next 17

Select All | Select None

Select	SID	DB User	Program	Service	Module	Action	Client	Machine	OS User
	381	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.49	cs-ccr-oas7.cern.ch	
	383	LHCLOG		ACCLOG_S	DataWriter	ENTER loadNumericData	Logging user: CIETLogging @172.18.202.216	cs-ccr-oas7.cern.ch	
	389	LHCLOG		ACCLOG_S	DataWriter	ENTER loadNumericData	Logging user: CIETLogging @172.18.201.150	cs-ccr-oas7.cern.ch	
	391	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.201.154	cs-ccr-oas6.cern.ch	
	412	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.49	cs-ccr-oas7.cern.ch	
	413	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.232	cs-ccr-oas7.cern.ch	
	414	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: CIETLogging @172.18.203.148	cs-ccr-oas7.cern.ch	
	416	LHCLOG_TEST		ACCLOG_S	DataWriter	FINISHED	Logging user: AliceMCS @172.18.201.252	cs-ccr-oas6.cern.ch	
	417	LHCLOG		ACCLOG_S	DataWriter	ENTER loadNumericData	Logging user: CIETLogging @172.18.202.176	cs-ccr-oas7.cern.ch	
	421	LHCLOG_TEST		ACCLOG_S	DataWriter	FINISHED	Logging user: ATLAS-MCS @172.18.203.31	cs-ccr-oas6.cern.ch	
	430	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.241	cs-ccr-oas7.cern.ch	
	431	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.226	cs-ccr-oas7.cern.ch	
	433	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.241	cs-ccr-oas7.cern.ch	
	437	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.226	cs-ccr-oas7.cern.ch	
	440	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.219.13	cs-ccr-oas6.cern.ch	
	444	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.49	cs-ccr-oas7.cern.ch	
	452	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.201.233	cs-ccr-oas6.cern.ch	
	455	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.226	cs-ccr-oas7.cern.ch	
	467	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.202.57	cs-ccr-oas6.cern.ch	
	469	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: CIETLogging @172.18.201.238	cs-ccr-oas7.cern.ch	
	471	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: CIETLogging @172.18.202.142	cs-ccr-oas7.cern.ch	
	479	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.230	cs-ccr-oas7.cern.ch	
	490	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.219.21	cs-ccr-oas6.cern.ch	
	491	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: cryo @172.18.202.228	cs-ccr-oas7.cern.ch	
	492	LHCLOG		ACCLOG_S	DataWriter	FINISHED	Logging user: OPSLogging @172.18.219.20	cs-ccr-oas6.cern.ch	

Session User Type DB User Type | Kill Session | Disable SQL Trace | Enabl SQL Trace

Previous 1-25 of 42 Next 17

Additional Monitoring Links

Top Sessions and Top SQL data from ASH can

Who, is doing What, from Where?

What: Module & Action

Who / Where: *Real* end-user in a 3-tier environment

PVSS Data Loading Instrumentation

ORACLE Enterprise Manager
Grid Control 11g

Hosts | Databases | Middleware | Web Applications | Services | Systems | Groups | **All Targets**

ACCLOG2 >

How is time being spent within a Module?

Module: DataWriter

Actions | Activity | Statistics

Top Actions

Active Actions

View Active Actions

Action	Activity (% for the last 5 minutes)	Aggregation Enabled	SQL Trace Enabled	D
ENTER loadNumericData	84.2	FALSE	FALSE	
ENTER checkVariables	9.9	FALSE	FALSE	
EXIT loadNumericData	5.4	FALSE	FALSE	
FINISHED	.5	FALSE	FALSE	

Actions | Activity | Statistics

Home | **Targets** | Deplo

About Oracle Enterprise Manager

PVSS Data Loading Instrumentation

ORACLE Enterprise Manager
Grid Control 11g

Home | Targets | Deployments | Alerts | Compliance | Jobs | Reports | My Oracle Sup

Hosts | Databases | Middleware | Web Applications | Services | Systems | Groups | All Targets

Cluster: acclog_cluster > Cluster Database: ACCLOG.cern.ch > Top Sessions > Database Instance: ACCLOG.cern.ch: ACCLOG2 > Top Activity >

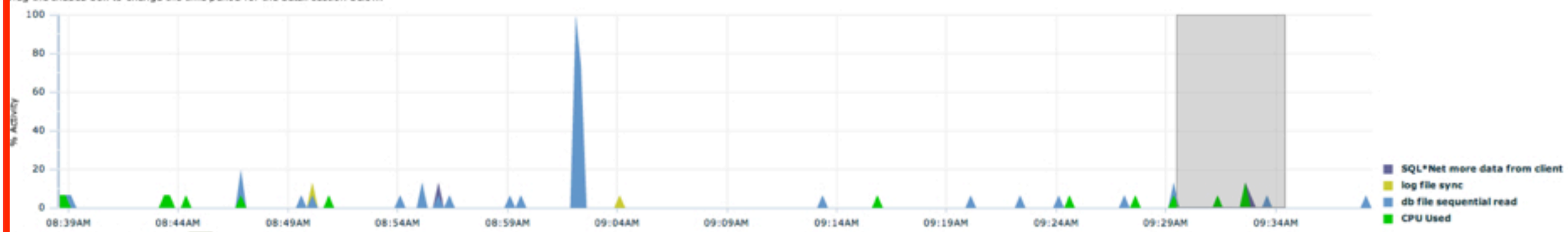
Logged in As LHCLOG_RED

Session Details: 383 (LHCLOG)

What is really happening over time?

General | Activity | Statistics | Open Cursors | Blocking Tree | Wait Event History | Parallel SQL

Drag the shaded box to change the time period for the detail section below.



Anchor shaded box to latest time Go

Detail for Selected 5 Minute Interval

Start Time **Feb 1, 2011 9:29:28 AM** View Show Aggregated Data Run ASH Report

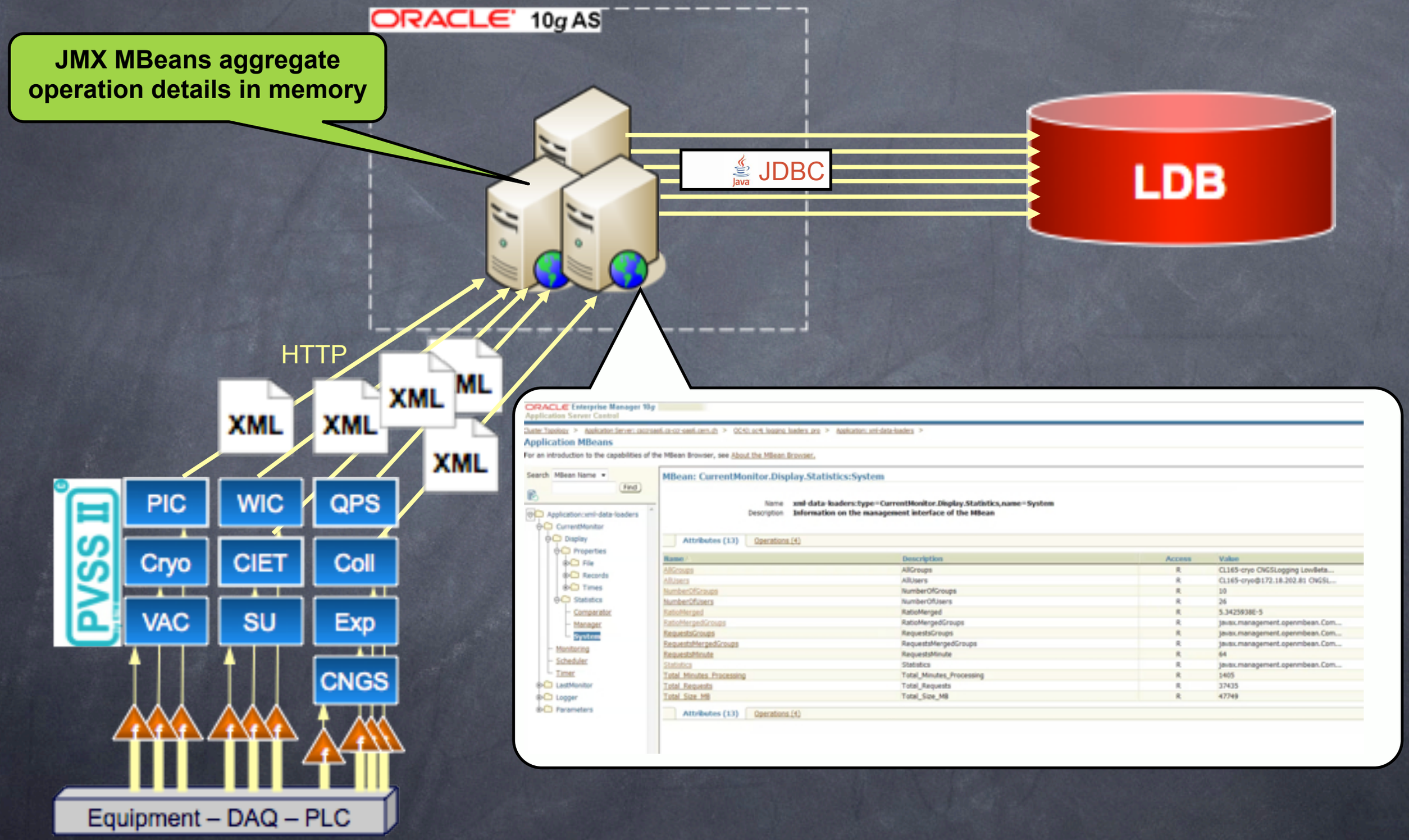
Sample Time	SQL ID	SQL Type	Plan Hash Value	Wait Event	P1 Value	P2 Value	P3 Value	Time Waited (mhu s)	Object	File	Block Number	Program	Module	Action	Client ID	QC Session ID	QC Instance ID
2/1/11 9:34:26 AM		UNKNOWN	0	log file sync	12404	301243609	0	18167	LHCLOG.DN_PK	/ORA/dbs...ta_6n3kxs3d_.dbf	265835		DataWriter	EXIT loadNumericData		0	0
2/1/11 9:33:16 AM	3pkrm4ccbknta	INSERT	0	db file sequential read	2169	71285	1	72556	LHCLOG.DN_PK	/ORA/dbs...ta_6n3kxs3d_.dbf	71285		DataWriter	ENTER loadNumericData		0	0
2/1/11 9:32:27 AM	3pkrm4ccbknta	INSERT	0	SQL*Net more data from client	1413697536	2	0	167140	LHCLOG.DN_PK	/ORA/dbs...ta_6n3kxs3d_.dbf	283997		DataWriter	ENTER loadNumericData		0	0
2/1/11 9:32:17 AM	3pkrm4ccbknta	INSERT	1575093030	CPU									DataWriter	ENTER loadNumericData		0	0
2/1/11 9:32:16 AM	1f4h83gj20032	SELECT	4091179982	CPU									DataWriter	ENTER checkVariables		0	0
2/1/11 9:31:01 AM	4hw28r7x7ub55	SELECT	4091179982	CPU									DataWriter	ENTER checkVariables		0	0

General | Activity | Statistics | Open Cursors | Blocking Tree | Wait Event History | Parallel SQL

Kill Session | Enable SQL Trace

Augment internal DB instrumentation data with Contextual Information

PVSS Data Loading Instrumentation



PVSS Data Loading Instrumentation

ORACLE Enterprise Manager 10g
Application Server Control

Setup Logs Help Lo

Cluster Topology > Application Server: csccroas6.cs-ccr-oas6.cern.ch > OC4J: oc4j_logging_loaders_pro > Application: xml-data-loaders >

Application MBeans

For an introduction to the capabilities of the MBean Browser, see About the MBean Browser.

Search MBean Name Find

- Application:xml-data-loaders
  - CurrentMonitor
    - Display
      - Properties
        - File
        - Records
        - Times
      - Statistics
        - Comparator
        - Manager
        - System
    - Monitoring
    - Scheduler
    - Timer
  - LastMonitor
  - Logger
  - Parameters

MBean: CurrentMonitor.Display.Statistics:System

Page Refreshed **Feb 2, 2011 5:19:56 PM C**

Name **xml-data-loaders:type=CurrentMonitor.Display.Statistics,name=System**
Description **Information on the management interface of the MBean**

Related Link: Cluster MBean Brow

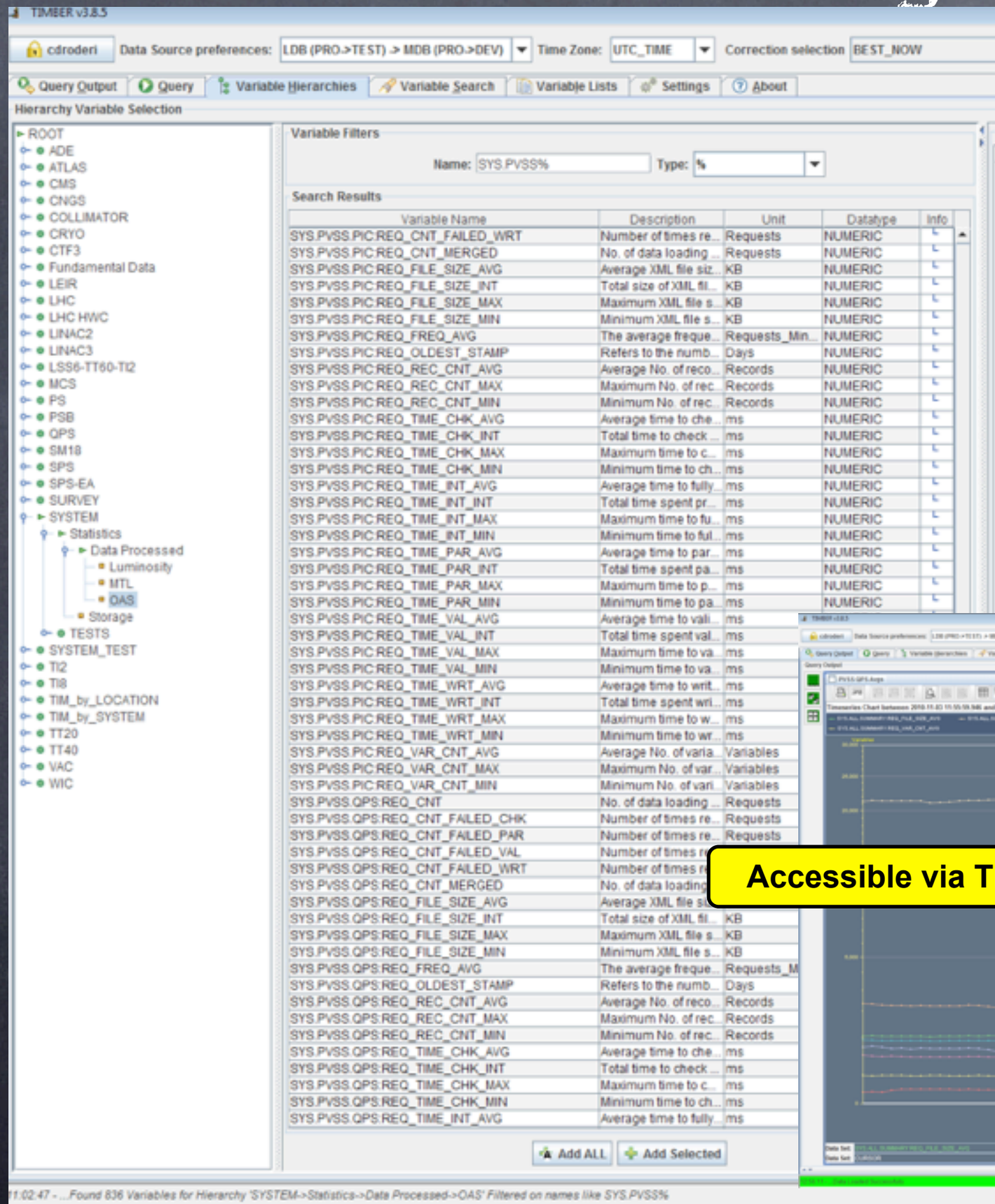
Attributes (13) Operations (4)

Name	Description	Access	Value
AllGroups	AllGroups	R	AtlasCryoLog CL165-cryo CMSLog...
AllUsers	AllUsers	R	AtlasCryoLog@172.18.202.222 At...
NumberOfGroups	NumberOfGroups	R	13
NumberOfUsers	NumberOfUsers	R	30
RatioMerged	RatioMerged	R	0.0
RatioMergedGroups	RatioMergedGroups	R	javax.management.openmbean.Com...
RequestsGroups	RequestsGroups	R	javax.management.openmbean.Com...
RequestsMergedGroups	RequestsMergedGroups	R	javax.management.openmbean.Com...
RequestsMinute	RequestsMinute	R	68
Statistics	Statistics	R	javax.management.openmbean.Com...
Total_Minutes_Processing	Total_Minutes_Processing	R	3144
Total_Requests	Total_Requests	R	67288
Total_Size_MB	Total_Size_MB	R	80435

Attributes (13) Operations (4)

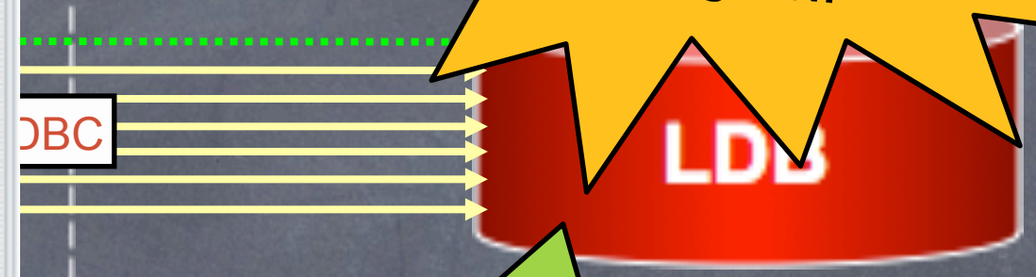
Done. Local intranet | Protected Mode: On 125%

PVSS Data Loading Instrumentation



ns write daily
s to the DB

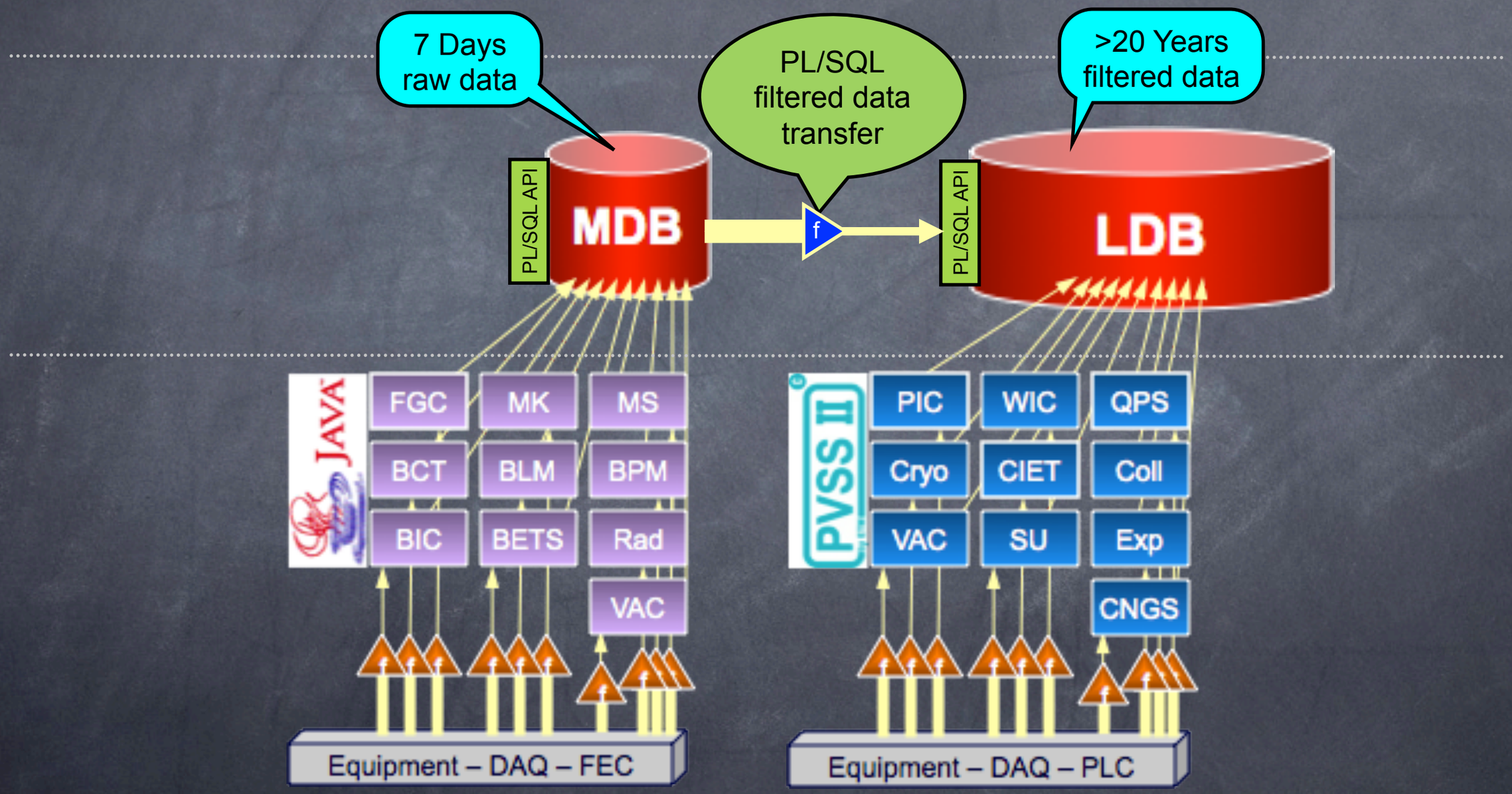
Massive Improvement WRT Database Aggregation



Aggregates details, stores as hourly time series

Accessible via TIMBER GUI

Logging Service - Architecture Overview



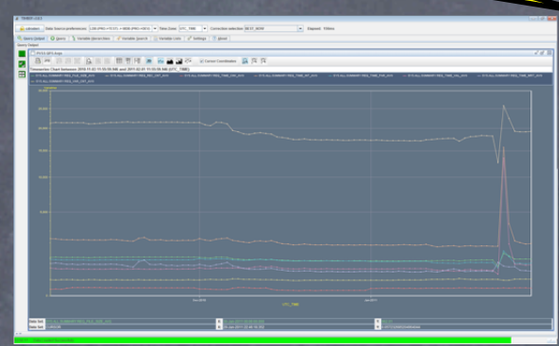
Data Providers

Data Persistence

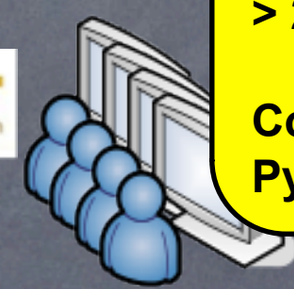
NOT a
write-only system!

Logging Service - Data Extraction

> 500 registered active users



timber
The LHC Logging System



DB access via API only!

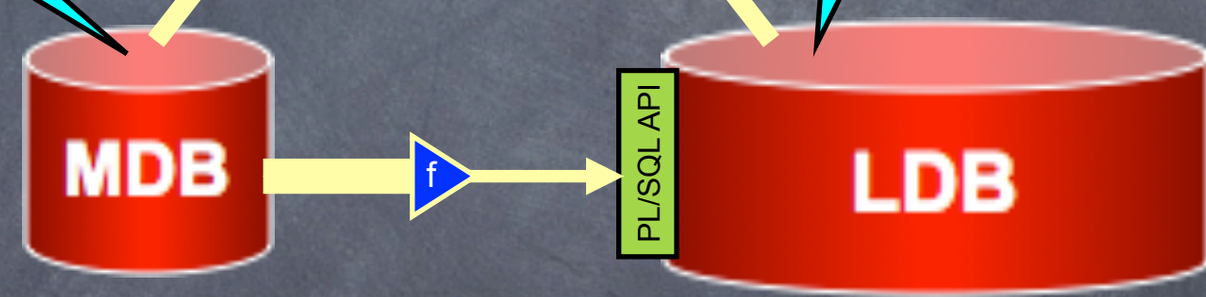
> 100 custom applications
> 2 million extraction requests per day

Command line interface used from Python, PHP, C++, Mathematica…

Extraction API

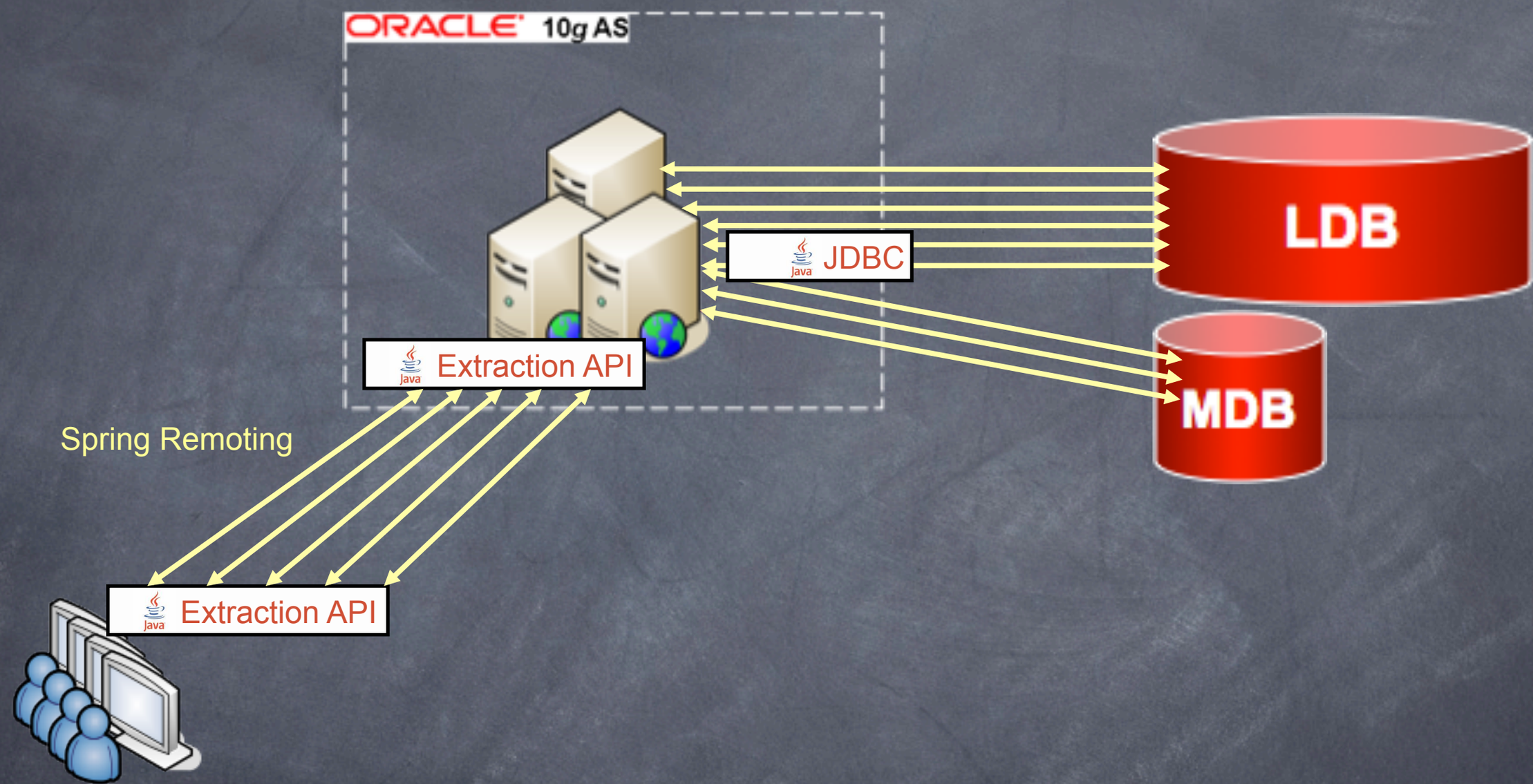
7 Days
raw data

>20 Years
filtered data

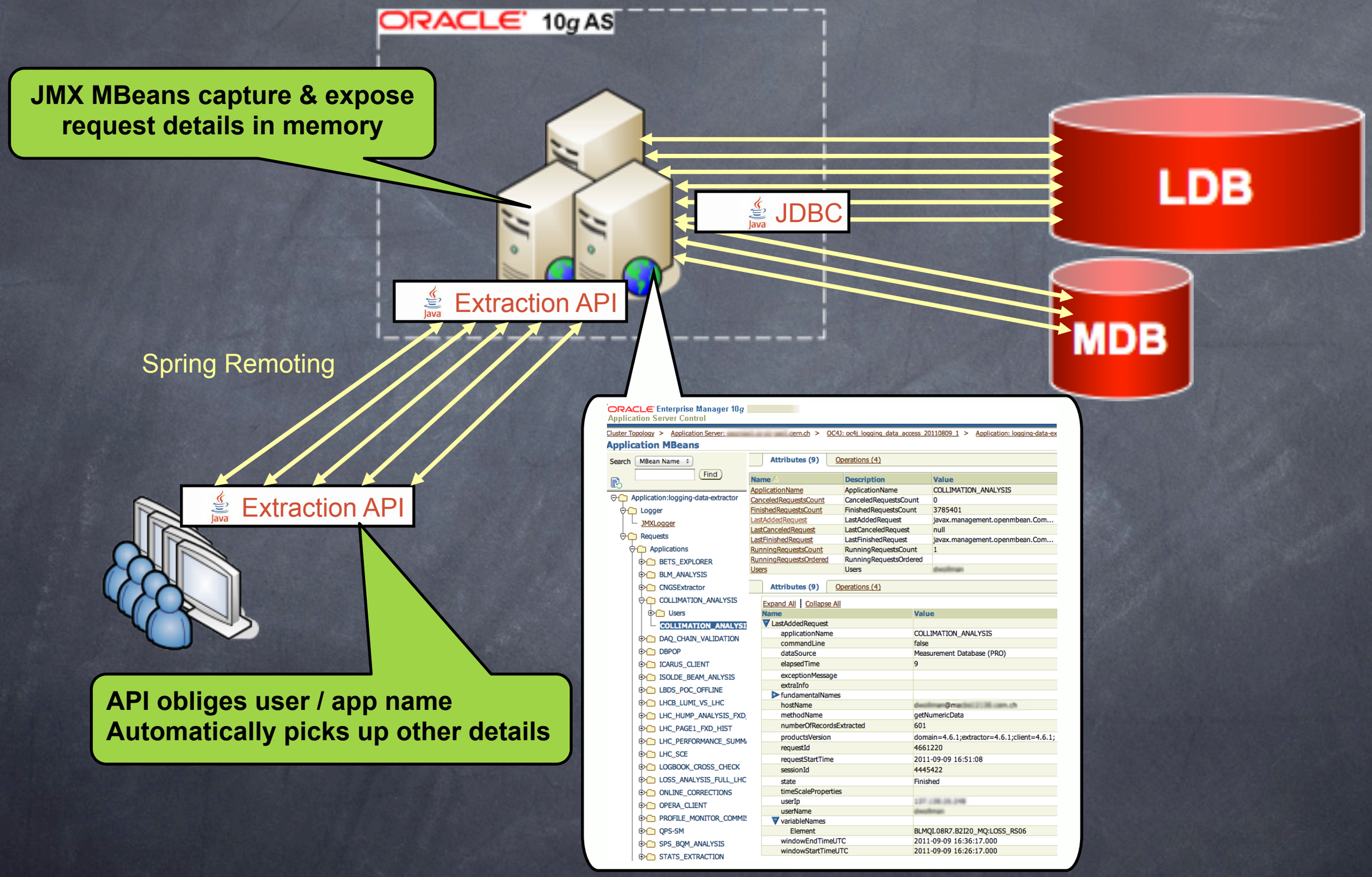


Data Persistence Data Consu

Data Extraction



Data Extraction Instrumentation



ORACLE Enterprise Manager 10g
Application Server Control

Cluster Topology > Application Server: [redacted]cern.ch > OC4J: oc4j_logging_data_access_20110809_1 > Application: logging-data-ex

Application MBeans

Search MBean Name Find

- Application:logging-data-extractor
  - Logger
    - JMXLogger
  - Requests
    - Applications
      - BETS_EXPLORER
      - BLM_ANALYSIS
      - CNGSExtractor
      - COLLIMATION_ANALYSIS
        - Users
        - COLLIMATION_ANALYSI
      - DAQ_CHAIN_VALIDATION
      - DBPOP
      - ICARUS_CLIENT
      - ISOLDE_BEAM_ANLYSIS
      - LBDS_POC_OFFLINE
      - LHCB_LUMI_VS_LHC
      - LHC_HUMP_ANALYSIS_FXD
      - LHC_PAGE1_FXD_HIST
      - LHC_PERFORMANCE_SUMM
      - LHC_SCE
      - LOGBOOK_CROSS_CHECK
      - LOSS_ANALYSIS_FULL_LHC
      - ONLINE_CORRECTIONS
      - OPERA_CLIENT
      - PROFILE_MONITOR_COMMI
      - QPS-SM
      - SPS_BQM_ANALYSIS
      - STATS_EXTRACTION

Attributes (9) | Operations (4)

Name	Description	Value
ApplicationName	ApplicationName	COLLIMATION_ANALYSIS
CanceledRequestsCount	CanceledRequestsCount	0
FinishedRequestsCount	FinishedRequestsCount	3785401
LastAddedRequest	LastAddedRequest	javax.management.openmbean.Com...
LastCanceledRequest	LastCanceledRequest	null
LastFinishedRequest	LastFinishedRequest	javax.management.openmbean.Com...
RunningRequestsCount	RunningRequestsCount	1
RunningRequestsOrdered	RunningRequestsOrdered	
Users	Users	[redacted]

Attributes (9) | Operations (4)

Expand All | Collapse All

Name	Value
LastAddedRequest	
applicationName	COLLIMATION_ANALYSIS
commandLine	false
dataSource	Measurement Database (PRO)
elapsedTime	9
exceptionMessage	
extraInfo	
fundamentalNames	
hostName	[redacted]
methodName	getNumericData
numberOfRecordsExtracted	601
productsVersion	domain=4.6.1;extractor=4.6.1;client=4.6.1;
requestId	4661220
requestStartTime	2011-09-09 16:51:08
sessionId	4445422
state	Finished
timeScaleProperties	
userIp	[redacted]
userName	[redacted]
variableNames	
Element	BLMQI.08R7.B2I20_MQ:LOSS_RS06
windowEndTimeUTC	2011-09-09 16:36:17.000
windowStartTimeUTC	2011-09-09 16:26:17.000

How Long

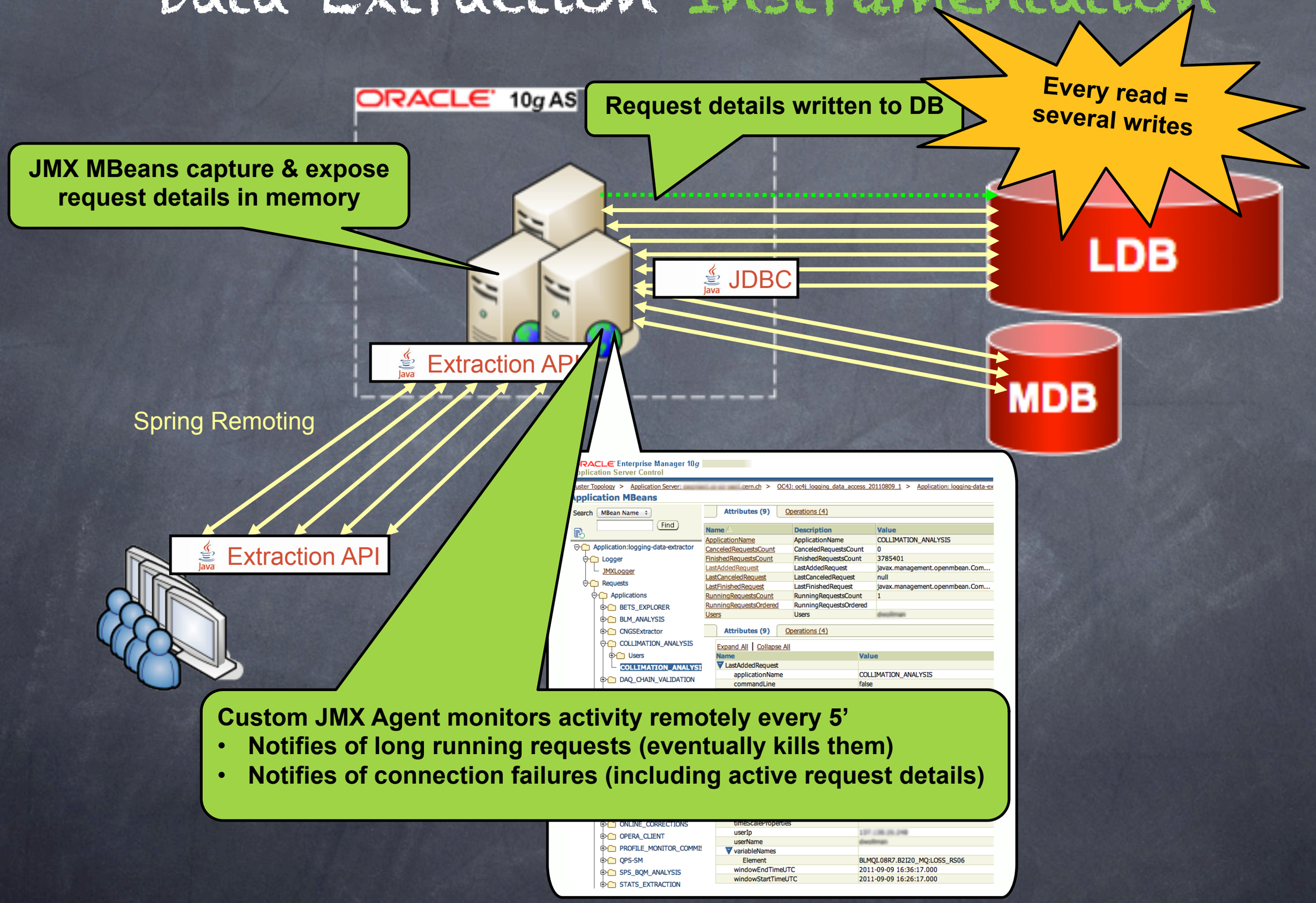
How

What

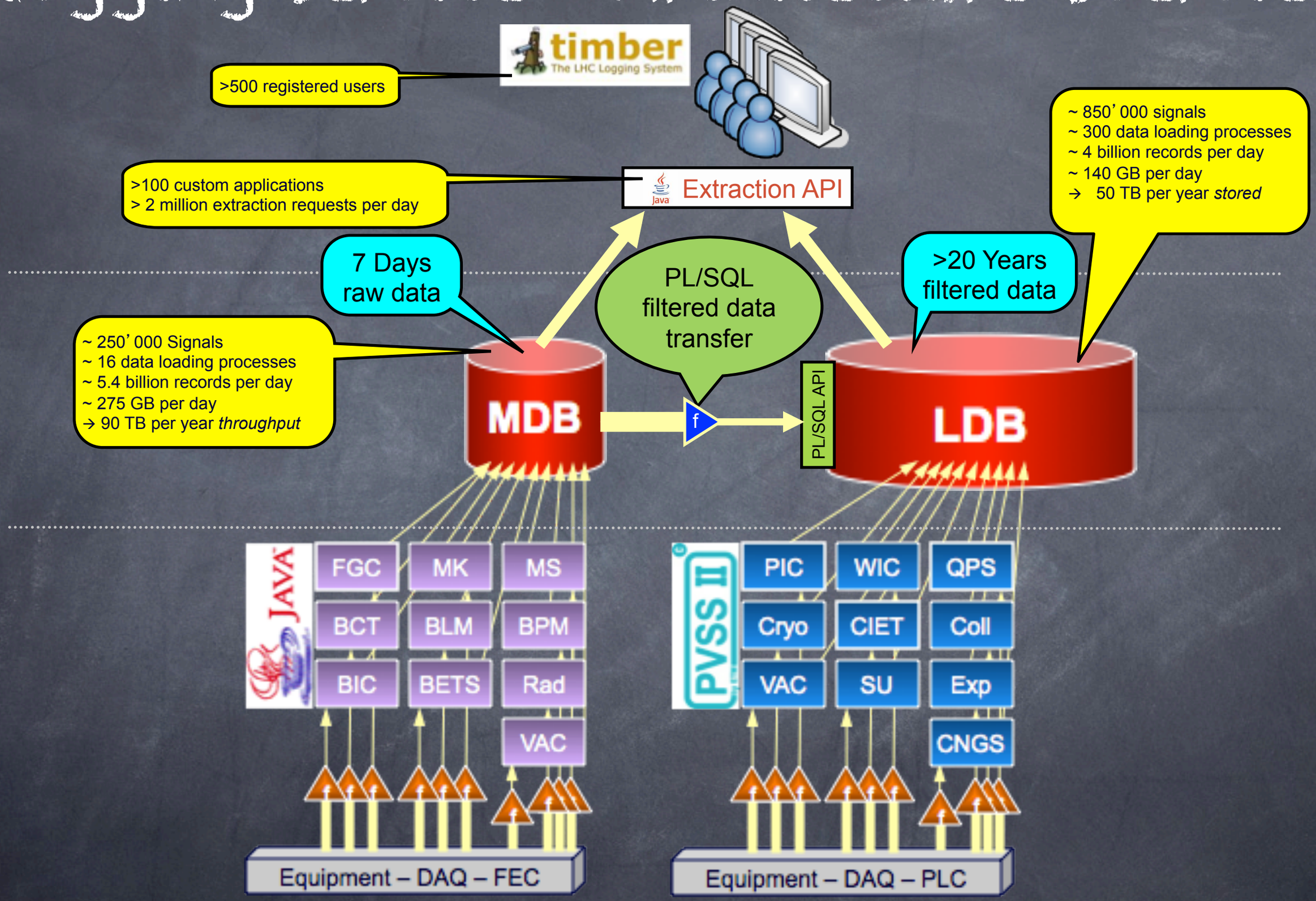
Where

Who

Data Extraction Instrumentation



Logging Service – Architecture Overview



Summary

Instrumentation is a key factor in the success of the Logging Service

NOT an Overhead!

Instrumentation...

Facilitates Performance Tuning, Scalability planning & Diagnostics

Enhances system stability

Enables rapid reactive & proactive user support

Questions?