

# Advanced System Monitoring in PTP

September 14, 2013 | Carsten Karbach and Wolfgang Frings

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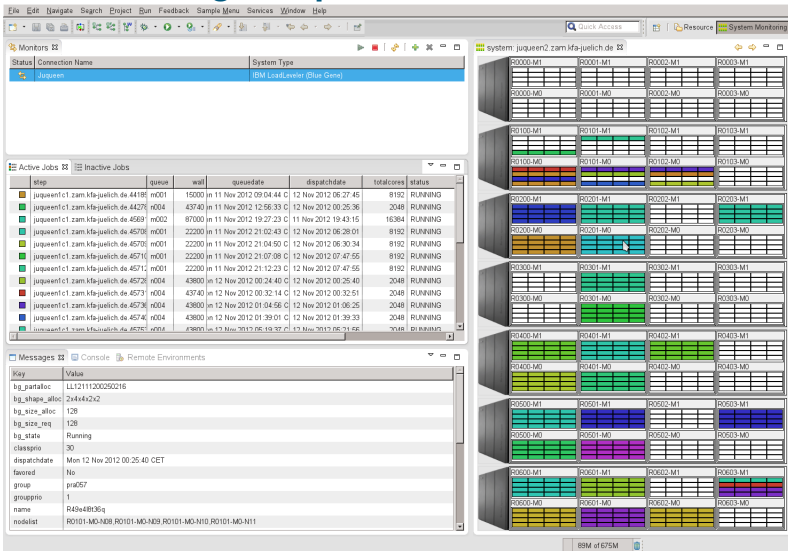
# Part I: System Monitoring – status quo

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## PTP Monitoring Scope

- job and system monitoring of **large-scale** supercomputers
- examples for large-scale systems monitored with PTP:
  - BG/Q system JUQUEEN (JSC), LoadLeveler, 458K cores
  - Cray XT Jaguar (ORNL), TORQUE+ALPS, 299K cores
  - Kraken (NICS), Moab+PBS, 112K cores
  - Yellowstone (NCAR), LSF, 72K cores
- monitoring of **multiple target systems** in one perspective
- support for **many batch systems** (Grid Engine, LoadLeveler, Open MPI, PBS, Slurm, Torque, LSF)
- overview of the system on a **single screen**
- uniform interface to supercomputers
- based on monitoring application **LLview**

# PTP Monitoring Perspective



File Edit View Search Project Run Feedback Sample Menu Services Window Help

Quick Access Resource System Monitoring

system: juqueen2.zam.kfa.juelich.de

**Monitors**

Status	Connection Name	System Type
Running	Juqueen	IBM LoadLeveler (Blue Gene)

**Active Jobs**

step	queue	wait	queue date	dispatch date	total count	status
juqueen1.c1.zam.kfa.juelich.de.44189	m001	15000	in 11 Nov 2012 09:04:44	C 12 Nov 2012 06:27:45	8192	RUNNING
juqueen1.c1.zam.kfa.juelich.de.44279	m004	43740	in 11 Nov 2012 12:56:33	C 12 Nov 2012 00:25:36	2048	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45689	m002	87000	in 11 Nov 2012 19:27:23	C 11 Nov 2012 19:43:15	16384	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45708	m001	22200	in 11 Nov 2012 21:02:43	C 12 Nov 2012 06:28:01	8192	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45709	m001	22200	in 11 Nov 2012 21:04:50	C 12 Nov 2012 06:30:34	8192	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45710	m001	22200	in 11 Nov 2012 21:07:08	C 12 Nov 2012 07:47:55	8192	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45711	m001	22200	in 11 Nov 2012 21:12:23	C 12 Nov 2012 07:47:55	8192	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45726	m004	43800	in 12 Nov 2012 00:24:40	C 12 Nov 2012 00:25:40	2048	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45731	m004	43740	in 12 Nov 2012 00:32:14	C 12 Nov 2012 00:32:51	2048	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45736	m004	43800	in 12 Nov 2012 01:04:56	C 12 Nov 2012 01:06:25	2048	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45741	m004	43800	in 12 Nov 2012 01:39:01	C 12 Nov 2012 01:39:33	2048	RUNNING
juqueen1.c1.zam.kfa.juelich.de.45757	m004	43800	in 13 Nov 2012 05:19:37	C 13 Nov 2012 05:21:55	2048	DISPATCH

**Messages**

Key	Value
bg_pantalloc	LL1211100050216
bg_shape_alloc	2x4x4x2x2
bg_size_alloc	128
bg_size_req	128
bg_state	Running
classprio	30
dispatchdate	Mon 12 Nov 2012 00:25:40 CET
favored	No
group	praf57
groupprio	1
name	R49e48f36q
nodelist	R0101-M0-M09,R0101-M0-M10,R0101-M0-M11

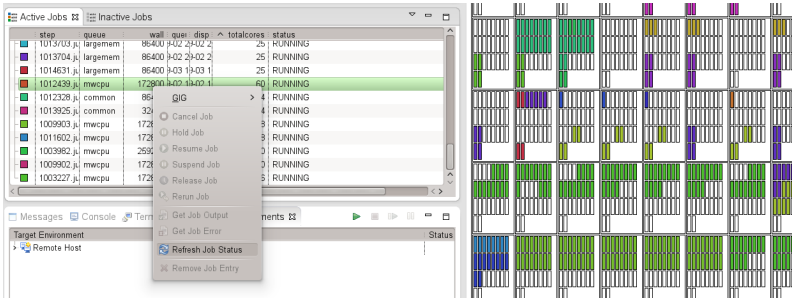
BSM of 675M

## Monitoring Views

- **Nodes View** renders target system architecture, maps jobs to compute resources
- **Active Jobs View** lists running jobs
- **Inactive Jobs View** lists queued jobs
- **Monitoring View** selects active target system, starts/stops monitoring
- **Message View** shows message of the day

## User interaction

- **job management:** cancel, get output/error
- **filtering:** show only user jobs, flexible filtering dialog
- linking information: click on job → highlight its nodes in Nodes View, show detail information in Message View
- change level of detail



The screenshot displays a job management interface with two main panels. The left panel, titled 'Active Jobs', shows a table of jobs with columns for step, queue, wall time, user, group, display name, total cores, and status. A context menu is open over the job '1012439.ji' (queue: mwcpu, wall: 17:28:00, user: jkoo, group: jkoo, display: 1, totalcores: 60, status: RUNNING). The menu options include: GIG, Cancel Job, Hold Job, Resume Job, Suspend Job, Release Job, Rerun Job, Get Job Output, Get Job Error, Refresh Job Status, and Remove Job Entry. The right panel, titled 'Nodes View', shows a grid of nodes represented by colored bars (green, purple, yellow, red) indicating the status of different nodes within the job.

step	queue	wall	user	group	disp	totalcores	status
1013703.ji	largemem	86:40	jkoo	jkoo	2	25	RUNNING
1013704.ji	largemem	86:40	jkoo	jkoo	2	25	RUNNING
1014631.ji	largemem	86:40	jkoo	jkoo	1	25	RUNNING
1012439.ji	mwcpu	17:28:00	jkoo	jkoo	1	60	RUNNING
1012328.ji	common	86:				4	RUNNING
1013925.ji	common	32:				4	RUNNING
1009903.ji	mwcpu	17:28:				3	RUNNING
1011602.ji	mwcpu	17:28:				3	RUNNING
1003982.ji	mwcpu	25:0:				0	RUNNING
1009902.ji	mwcpu	17:28:				0	RUNNING
1003227.ji	mwcpu	17:28:				5	RUNNING

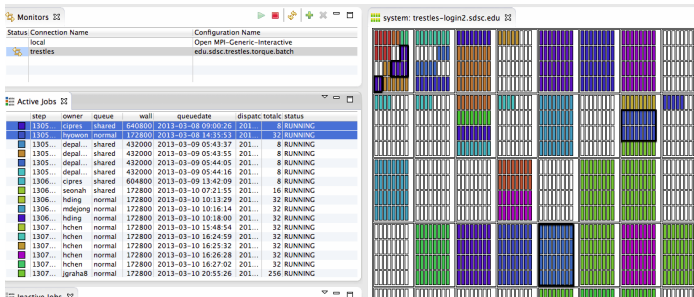
## Part II: Short term enhancements

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## Job selection

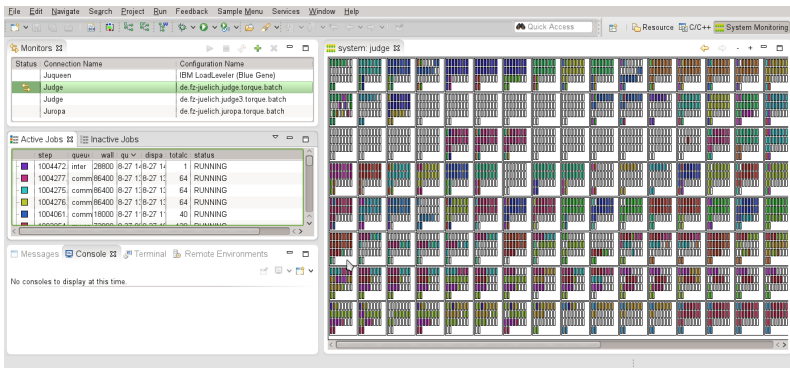
- raised in bug [403060](#)
- allow selection of **multiple** jobs
- keep selected job selected until it is de-selected
- mark entire **connected area** of each job



Source: <https://bugs.eclipse.org/bugs/attachment.cgi?id=228316>

## Improved job localization

- **adjustable** minimum rectangle size
- currently set to 7 px
- ensure, that rectangle width/height are at least 7 px large, if possible take more space



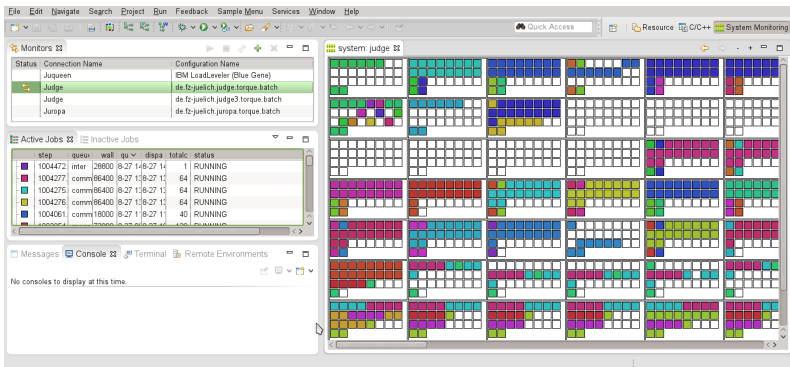
The screenshot displays the Jülich system monitoring interface. On the left, there are panels for 'Monitors' and 'Active Jobs'. The 'Active Jobs' panel shows a table of running jobs with columns for step, queue, wall time, and status.

step	queue	wall	qu	dspa	totalc	status
1004472	inter	26800	0:27 14	0:27 14	1	RUNNING
1004277	comm	86400	0:27 11	0:27 11	64	RUNNING
1004275	comm	86400	0:27 11	0:27 11	64	RUNNING
1004276	comm	86400	0:27 11	0:27 11	64	RUNNING
1004061	comm	18000	0:27 11	0:27 11	40	RUNNING

The main window shows a grid of job rectangles, each representing a job's resource usage and status. The rectangles are color-coded and arranged in a grid pattern, demonstrating the improved job localization.

## Improved job localization

- **adjustable** minimum rectangle size
- currently set to 7 px
- ensure, that rectangle width/height are at least 7 px large, if possible take more space



The screenshot displays a system monitoring application with the following components:

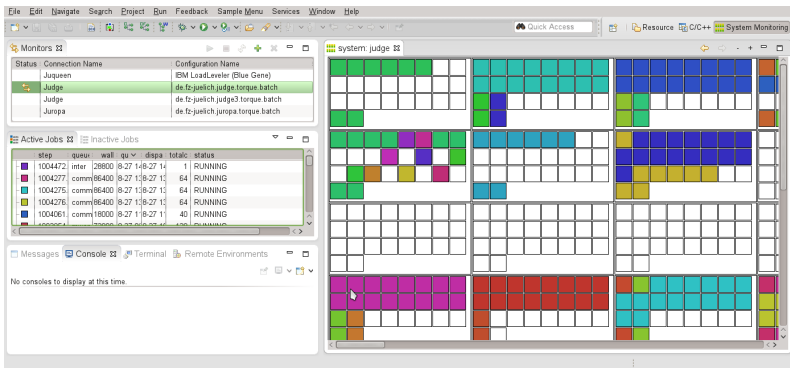
- Monitors:**

Status	Connection Name	Configuration Name
	Juqueen	IBM LoadLeveler (Blue Gene)
	Judge	de-fz-juelich-judge.torque.batch
	Judge	de-fz-juelich-judge3.torque.batch
	Juropa	de-fz-juelich-juropa.torque.batch
- Active Jobs:**

step	queue	wall	qu	dspa	totalc	status
1004472	inter	28800	[8-27 14]	[8-27 14]	1	RUNNING
1004277	comm86400	[8-27 11]	[8-27 11]	64	RUNNING	
1004275	comm86400	[8-27 11]	[8-27 11]	64	RUNNING	
1004276	comm86400	[8-27 11]	[8-27 11]	64	RUNNING	
1004061	comm18000	[8-27 11]	[8-27 11]	40	RUNNING	
- System Monitoring Grid:** A grid of 10x10 resource allocation visualizations for 'system: judge'. Each cell in the grid shows a grid of colored squares representing job allocation on different resources.

## Improved job localization

- **adjustable** minimum rectangle size
- currently set to 7 px
- ensure, that rectangle width/height are at least 7 px large, if possible take more space



The screenshot displays a system monitoring application with the following components:

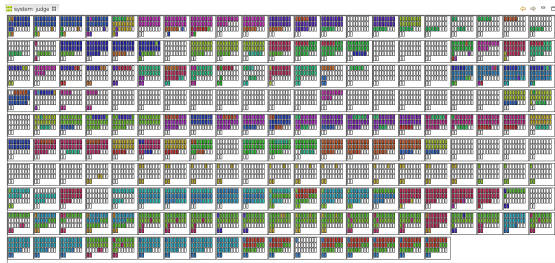
- Monitors:** A table listing connections and their configurations.
 

Status	Connection Name	Configuration Name
	Juqueen	IBM LoadLeveler (Blue Gene)
	Judge	de-fz-juelich-judge.torque.batch
	Judge	de-fz-juelich-judge3.torque.batch
	Juropa	de-fz-juelich-juropa.torque.batch
- Active Jobs:** A table showing the status of active jobs.
 

step	queue	wall	qu	dspa	totalc	status
1004472	inter	28600	8-27 14	8-27 14	1	RUNNING
1004277	comm86400	8-27 11	8-27 11	64	64	RUNNING
1004275	comm86400	8-27 11	8-27 11	64	64	RUNNING
1004276	comm86400	8-27 11	8-27 11	64	64	RUNNING
1004061	comm18000	8-27 11	8-27 11	40	40	RUNNING
- Grid Visualization:** A large grid representing resource usage across different connections. The grid is divided into sections for 'Juqueen', 'Judge', and 'Juropa'. Each cell in the grid is colored to represent the status of a job, with colors corresponding to the 'step' column in the Active Jobs table (e.g., purple, green, orange, yellow, blue, red).

## Provide customized LML layouts

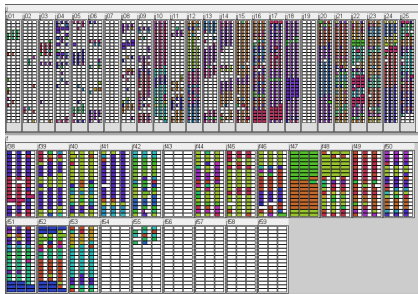
- get familiar with system architectures of supported target systems
- map system **topology** into LML layout
- great potential in **customized layouts**:  
level of detail, job filtering, showing node names



- define own grid

## Provide customized LML layouts

- get familiar with system architectures of supported target systems
- map system **topology** into LML layout
- great potential in **customized layouts**:  
level of detail, job filtering, showing node names



- hierarchy
- level of detail

## Job handling and additional job list

### Completed jobs

- jobs submitted externally disappear when completed
- if batch system does not list them, the job entries are lost
- **idea:** keep track of user's running jobs, which are removed on update

### New job list

- currently: active and inactive jobs
- better: submitted, active and completed jobs

# Part III: Long term enhancements

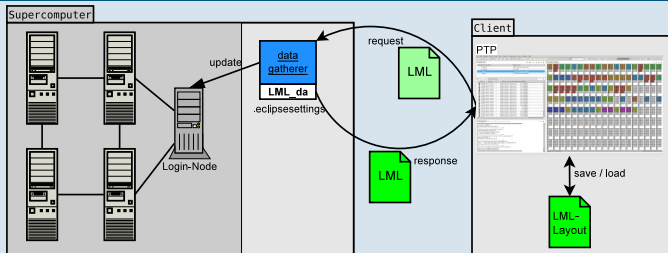
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## Caching LML files

- **multiple users** on the same target system
- currently each user triggers separate LML\_DA workflow
- **cache** LML file in public directory (e.g. /tmp), use LML cache as data source

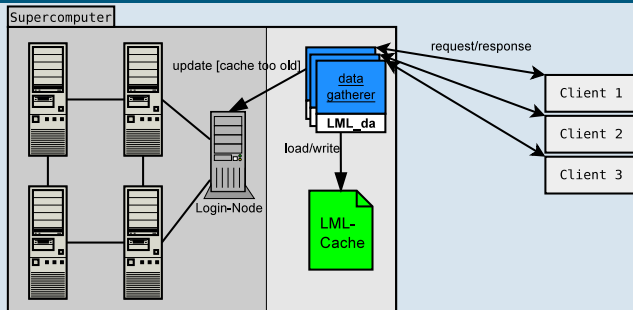
### Current workflow



## Caching LML files

- **multiple users** on the same target system
- currently each user triggers separate LML\_DA workflow
- **cache** LML file in public directory (e.g. /tmp), use LML cache as data source

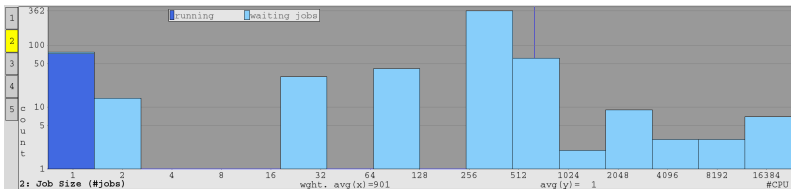
### Cache workflow



## New monitoring views

- derived from LLview, new monitoring types are possible
- fast overview on system statistics, history and prediction
- data description is **already included** in LML
- todo: data generation and visualization for new diagrams

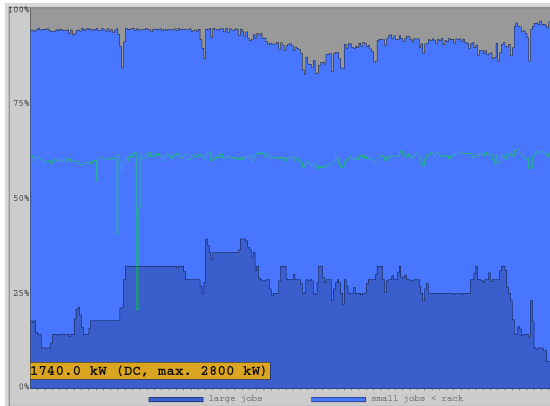
# Histograms



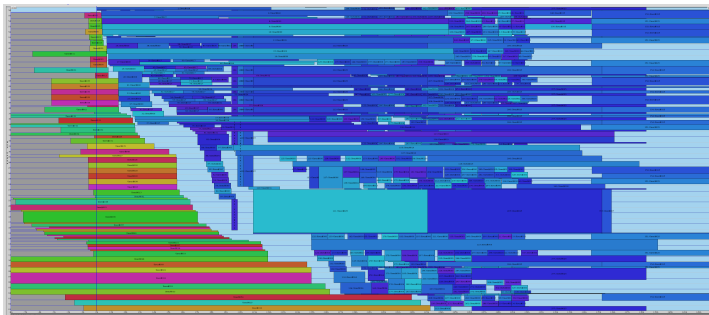
- statistical data rendered as histograms
- visualization of job parameter distribution: queue, size, waiting time

## Load history

- **usage history** of the target system (e.g. last 3 days)
- extendable for power/memory/accelerator usage
- requires **LML log**, switch to **stateful** server



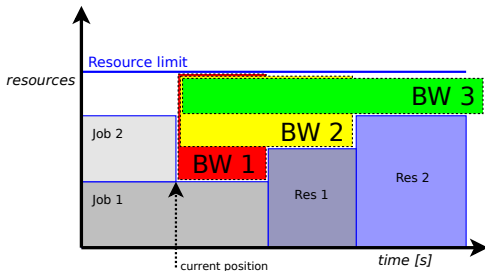
## Prediction diagram



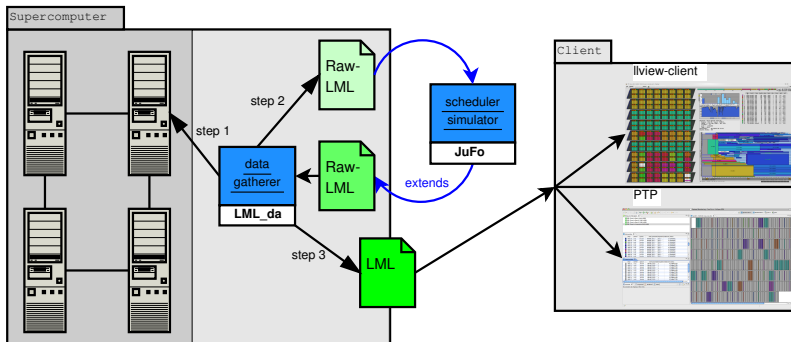
- Gantt chart visualization of **future workload**
- each rectangle represents one job, x-axis → time, y-axis → resources
- requires **JuFo** integration (see next slides) for simulation of future schedule

## JuFo – Overview

- **configurable** simulator for global job schedulers for **on-line prediction** of job dispatch dates
- based on analysis of JSC batch systems **Moab** and **Loadleveler**
- **integrated** with monitoring system **LLview**
- **LML** as configuration and communication data format
- **use-cases:**
  - **user** predicts start dates of submitted jobs
  - **administrator** simulates job scheduler performance with various input parameters, verifies scheduling rules



## JuFo integration



- implemented in C++, additional installation step required
- simulation duration: 1-90 seconds  $\Rightarrow$  caching



## JuFo – Features

- supported **scheduling algorithms**
  - First-Come-First-Served
  - List-Scheduling
  - Backfilling
- available **simulation parameters**
  - generic job **prioritization**
  - advanced **reservations**
  - jobs can request CPUs, GPUs, memory
  - **nodesharing**
  - **queue** constraints
- test framework for evaluating JuFo's accuracy

# Part IV: Conclusion

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## Conclusion

- PTP provides monitoring system for large-scale supercomputers
- monitoring views: job lists, nodes view
- short term enhancements:
  - adjust job **selection**, multiple jobs
  - simpler **detection** of small jobs
  - create **customized LML layouts**
- long term enhancements:
  - LML file **caching**
  - new monitoring views: histograms, history, prediction
  - integration of **JuFo**



## Contact

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- **LML** → <http://llview.zam.kfa-juelich.de/LML>