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# Advanced System Monitoring in PTP

November 19, 2013 | Wolfgang Frings and Carsten Karbach

# Content

1. PTP System Monitoring – status quo
2. Short term enhancements
3. Long term enhancements

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# Part I: System Monitoring – status quo

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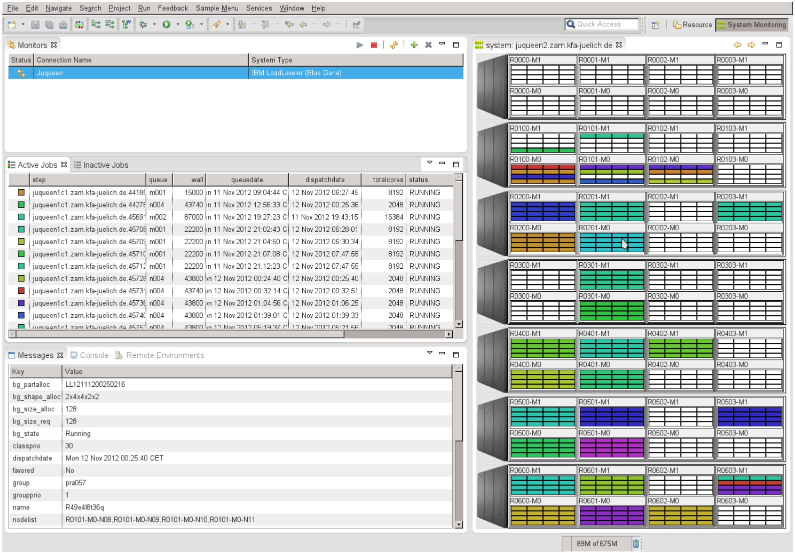
# PTP Monitoring Scope

- 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



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

|  | step | queue | wall | queuedate | dispatchdate | totalcores | status |
|---|---|---|---|---|---|---|---|
| 🟧 | juqueen1c1.zam.kfa-juelich.de.4418 | m001 | 15000 | in 11 Nov 2012 09:04:44 C | 12 Nov 2012 06:27:45 | 8192 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4427 | n004 | 43740 | in 11 Nov 2012 12:56:33 C | 12 Nov 2012 00:25:36 | 2048 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4569 | m002 | 87000 | in 11 Nov 2012 19:27:23 C | 11 Nov 2012 19:43:15 | 16384 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4570 | m001 | 22200 | in 11 Nov 2012 21:02:43 C | 12 Nov 2012 06:28:01 | 8192 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4570 | m001 | 22200 | in 11 Nov 2012 21:04:50 C | 12 Nov 2012 06:30:34 | 8192 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4571 | m001 | 22200 | in 11 Nov 2012 21:07:08 C | 12 Nov 2012 07:47:55 | 8192 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4571 | m001 | 22200 | in 11 Nov 2012 21:12:23 C | 12 Nov 2012 07:47:55 | 8192 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4572 | n004 | 43800 | on 12 Nov 2012 00:24:40 C | 12 Nov 2012 00:25:40 | 2048 | RUNNING |
| 🟥 | juqueen1c1.zam.kfa-juelich.de.4573 | n004 | 43740 | on 12 Nov 2012 00:32:14 C | 12 Nov 2012 00:32:51 | 2048 | RUNNING |
| 🟪 | juqueen1c1.zam.kfa-juelich.de.4573 | n004 | 43800 | on 12 Nov 2012 01:04:56 C | 12 Nov 2012 01:06:25 | 2048 | RUNNING |
| 🟦 | juqueen1c1.zam.kfa-juelich.de.4574 | n004 | 43800 | on 12 Nov 2012 01:39:01 C | 12 Nov 2012 01:39:33 | 2048 | RUNNING |
| 🟩 | juqueen1c1.zam.kfa-juelich.de.4575 | n004 | 43800 | on 12 Nov 2012 05:19:37 C | 12 Nov 2012 05:21:56 | 2048 | RUNNING |

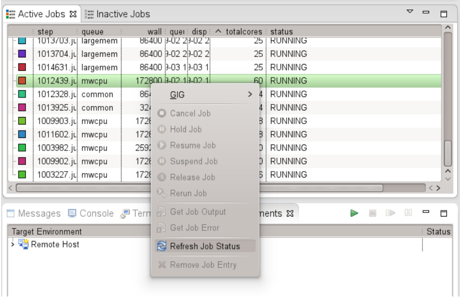
| Key | Value |
|---|---|
| bg_partalloc | LL12111200250216 |
| bg_shape_alloc | 2x4x4x2x2 |
| bg_size_alloc | 128 |
| bg_size_req | 128 |
| bg_state | Running |
| classprio | 30 |
| dispatchdate | Mon 12 Nov 2012 00:25:40 CET |
| favored | No |
| group | pra057 |
| groupprio | 1 |
| name | R49e4l8t36q |
| nodelist | R0101-M0-N08,R0101-M0-N09,R0101-M0-N10,R0101-M0-N11 |

# Monitoring Views

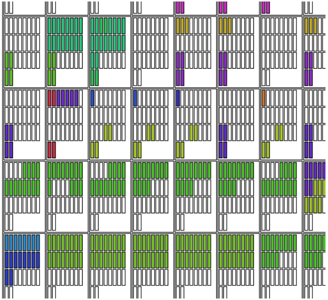
- **Nodes View** renders target system architecture, maps jobs to compute resources
- **Active Jobs View** lists running jobs
- **Inactive Jobs View** lists queued jobs
- **Monitoring View** selects active target system, starts/stops monitoring
- **Message View** shows message of the day

# 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



| | step | queue | wall | quei | disp | totalcores | status |
|---|---|---|---|---|---|---|---|
| 🟦 | 1013703.ju | largemem | 86400 | )-02 2 | )-02 2 | 25 | RUNNING |
| 🟪 | 1013704.ju | largemem | 86400 | )-02 2 | )-02 2 | 25 | RUNNING |
| 🟥 | 1014631.ju | largemem | 86400 | )-03 1 | )-03 1 | 25 | RUNNING |
| 🟧 | 1012439.ju | mwcpu | 172800 | )-02 1 | )-02 1 | 60 | RUNNING |
| 🟩 | 1012328.ju | common | 864 | | | 4 | RUNNING |
| 🟪 | 1013925.ju | common | 324 | | | 4 | RUNNING |
| 🟩 | 1009903.ju | mwcpu | 1728 | | | 8 | RUNNING |
| 🟦 | 1011602.ju | mwcpu | 1728 | | | 8 | RUNNING |
| 🟩 | 1003982.ju | mwcpu | 2592 | | | 0 | RUNNING |
| 🟪 | 1009902.ju | mwcpu | 1728 | | | 0 | RUNNING |
| 🟩 | 1003227.ju | mwcpu | 1728 | | | 6 | RUNNING |



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# Part II: Short term enhancements

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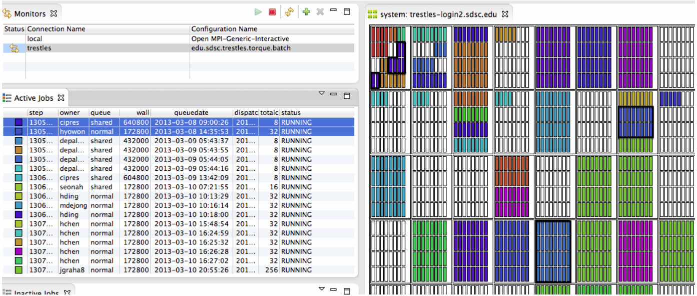
# Job selection

- 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



Monitors

| Status | Connection Name | Configuration Name |
|---|---|---|
| | local | Open MPI-Generic-Interactive |
| ⇆ | trestles | edu.sdsc.trestles.torque.batch |

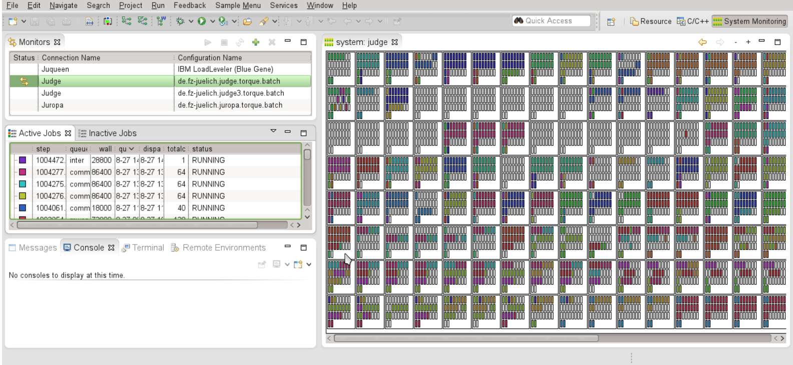
Active Jobs

| | step | owner | queue | wall | queuedate | dispatc | totalc | status |
|---|---|---|---|---|---|---|---|---|
| ■ | 1305... | cipres | shared | 640800 | 2013-03-08 09:00:26 | 201... | 8 | RUNNING |
| ■ | 1305... | hyowon | normal | 172800 | 2013-03-08 14:35:53 | 201... | 32 | RUNNING |
| ■ | 1305... | depal... | shared | 432000 | 2013-03-09 05:43:37 | 201... | 8 | RUNNING |
| ■ | 1305... | depal... | shared | 432000 | 2013-03-09 05:43:55 | 201... | 8 | RUNNING |
| ■ | 1305... | depal... | shared | 432000 | 2013-03-09 05:44:05 | 201... | 8 | RUNNING |
| ■ | 1305... | depal... | shared | 432000 | 2013-03-09 05:44:16 | 201... | 8 | RUNNING |
| ■ | 1306... | cipres | shared | 604800 | 2013-03-09 13:42:09 | 201... | 8 | RUNNING |
| ■ | 1306... | seonah | shared | 172800 | 2013-03-10 07:21:55 | 201... | 16 | RUNNING |
| ■ | 1306... | hding | normal | 172800 | 2013-03-10 10:13:29 | 201... | 32 | RUNNING |
| ■ | 1306... | mdejong | normal | 172800 | 2013-03-10 10:16:14 | 201... | 32 | RUNNING |
| ■ | 1306... | hding | normal | 172800 | 2013-03-10 10:18:00 | 201... | 32 | RUNNING |
| ■ | 1307... | hchen | normal | 172800 | 2013-03-10 15:48:54 | 201... | 32 | RUNNING |
| ■ | 1307... | hchen | normal | 172800 | 2013-03-10 16:24:59 | 201... | 32 | RUNNING |
| ■ | 1307... | hchen | normal | 172800 | 2013-03-10 16:25:32 | 201... | 32 | RUNNING |
| ■ | 1307... | hchen | normal | 172800 | 2013-03-10 16:26:28 | 201... | 32 | RUNNING |
| ■ | 1307... | hchen | normal | 172800 | 2013-03-10 16:27:02 | 201... | 32 | RUNNING |
| ■ | 1307... | jgraha8 | normal | 172800 | 2013-03-10 20:55:26 | 201... | 256 | RUNNING |

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



| 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 |

| | step | queue | wall | qu | dispa | totalc | status |
|---|---|---|---|---|---|---|---|
| 🟪 | 1004472. | inter | 28800 | 8-27 14 | 8-27 14 | 1 | RUNNING |
| 🟥 | 1004277. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004275. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟨 | 1004276. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004061. | comm | 18000 | 8-27 1 | 8-27 1 | 40 | RUNNING |

No consoles to display at this time.

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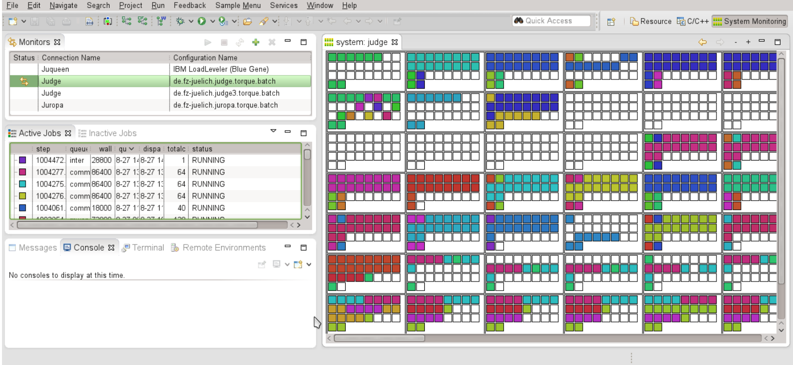

| Status | Connection Name | Configuration Name |
|---|---|---|
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| | Judge | de.fz-juelich.judge.torque.batch |
| | Judge | de.fz-juelich.judge3.torque.batch |
| | Juropa | de.fz-juelich.juropa.torque.batch |

| | step | queue | wall | qu | dispa | totalc | status |
|---|---|---|---|---|---|---|---|
| 🟪 | 1004472. | inter | 28800 | 8-27 14 | 8-27 14 | 1 | RUNNING |
| 🟥 | 1004277. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004275. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟨 | 1004276. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004061. | comm | 18000 | 8-27 11 | 8-27 11 | 40 | RUNNING |

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- currently set to 7 px
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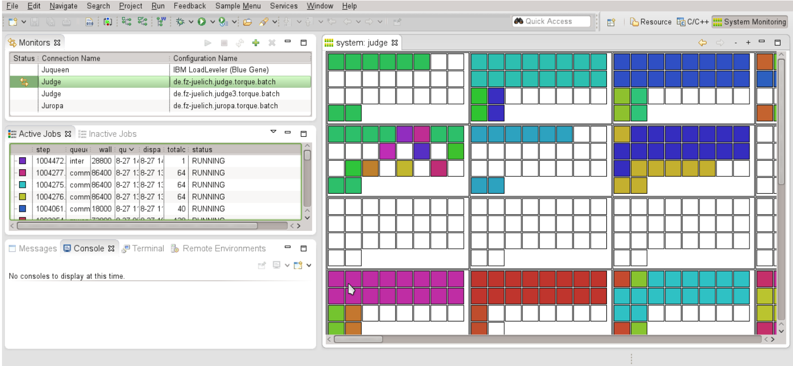


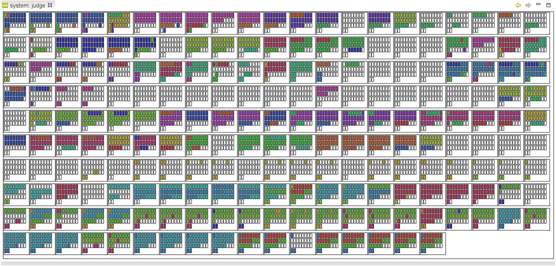
| Status | Connection Name | Configuration Name |
|---|---|---|
| | Juqueen | IBM LoadLeveler (Blue Gene) |
| ⇆ | Judge | de.fz-juelich.judge.torque.batch |
| | Judge | de.fz-juelich.judge3.torque.batch |
| | Juropa | de.fz-juelich.juropa.torque.batch |

| | step | queue | wall | qu | dispa | totalc | status |
|---|---|---|---|---|---|---|---|
| 🟪 | 1004472. | inter | 28800 | 8-27 14 | 8-27 14 | 1 | RUNNING |
| 🟥 | 1004277. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004275. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟨 | 1004276. | comm | 86400 | 8-27 13 | 8-27 13 | 64 | RUNNING |
| 🟦 | 1004061. | comm | 18000 | 8-27 11 | 8-27 11 | 40 | RUNNING |

No consoles to display at this time.

# Provide customized LML layouts

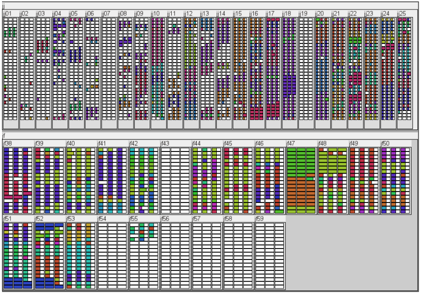
- get familiar with system architectures
  of supported target systems
- map system **topology** into LML layout
- great potential in **customized layouts**:
  level of detail, job filtering, showing node names



- 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

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# Part III: Long term enhancements

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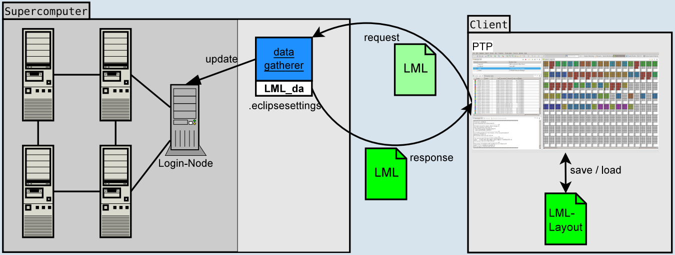
# Caching LML files

- **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

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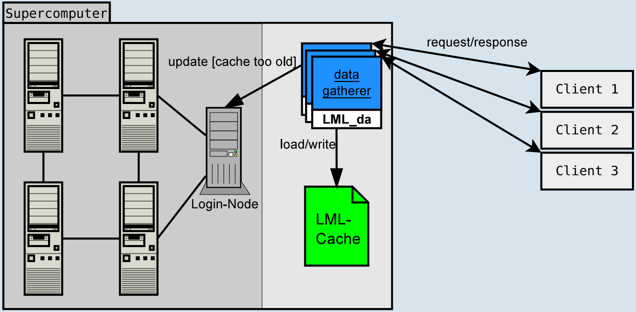
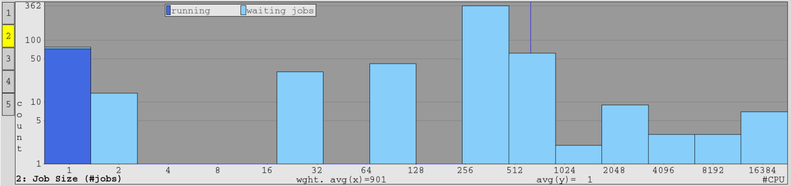
## Cache workflow



# 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

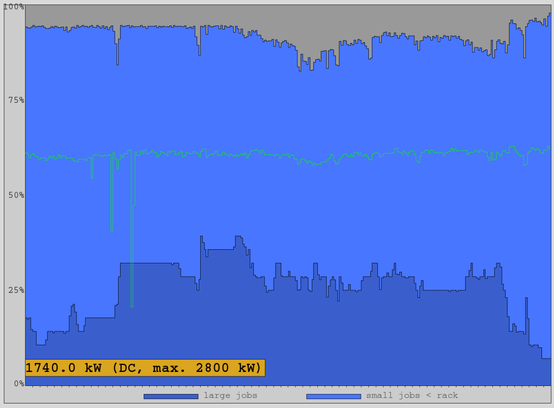
# Histograms



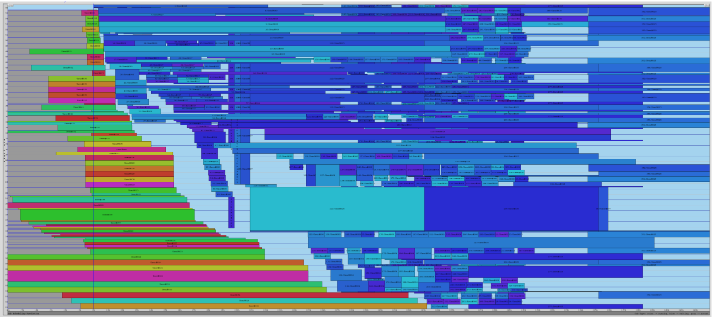
- statistical data rendered as histograms
- visualization of job parameter distribution: queue, size, waiting time

# 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



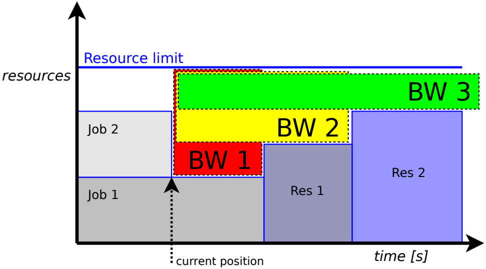
# Prediction diagram



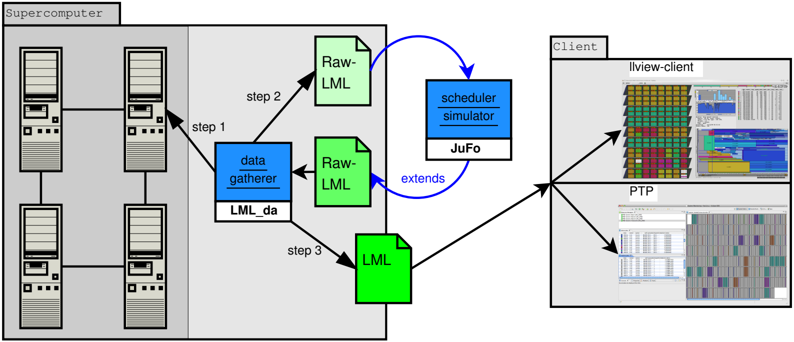
- Gantt chart visualization of **future workload**
- each rectangle represents one job,
  x-axis → time, y-axis → resources
- requires **JuFo** integration (see next slides) for simulation of future schedule

# 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 ⇒ 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

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# Part IV: Conclusion

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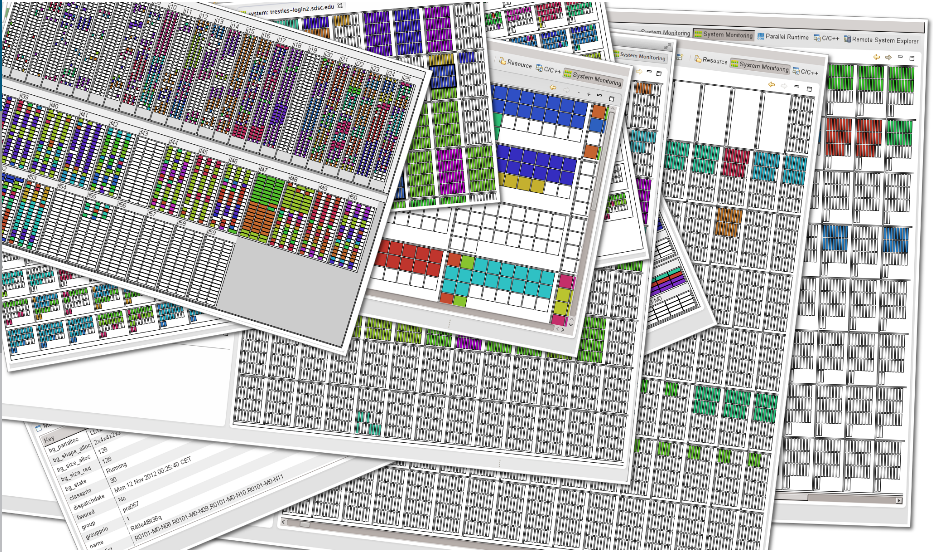
# Conclusion

- 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**

# Your ideas?



| Key | |
|---|---|
| bg_partalloc | LL1 |
| 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 | pra057 |
| groupprio | 1 |
| name | R49e4l8t36q |
| list | R0101-M0-N08,R0101-M0-N09,R0101-M0-N10,R0101-M0-N11 |

# Contact

- **E-mail**:
  c.karbach@fz-juelich.de, w.frings@fz-juelich.de
- **LLview** → `http://www.fz-juelich.de/jsc/llview`
- **LML** → `http://llview.zam.kfa-juelich.de/LML`