



# Accounting and monitoring infrastructure for Distributed Computing in the ATLAS experiment

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# Outline

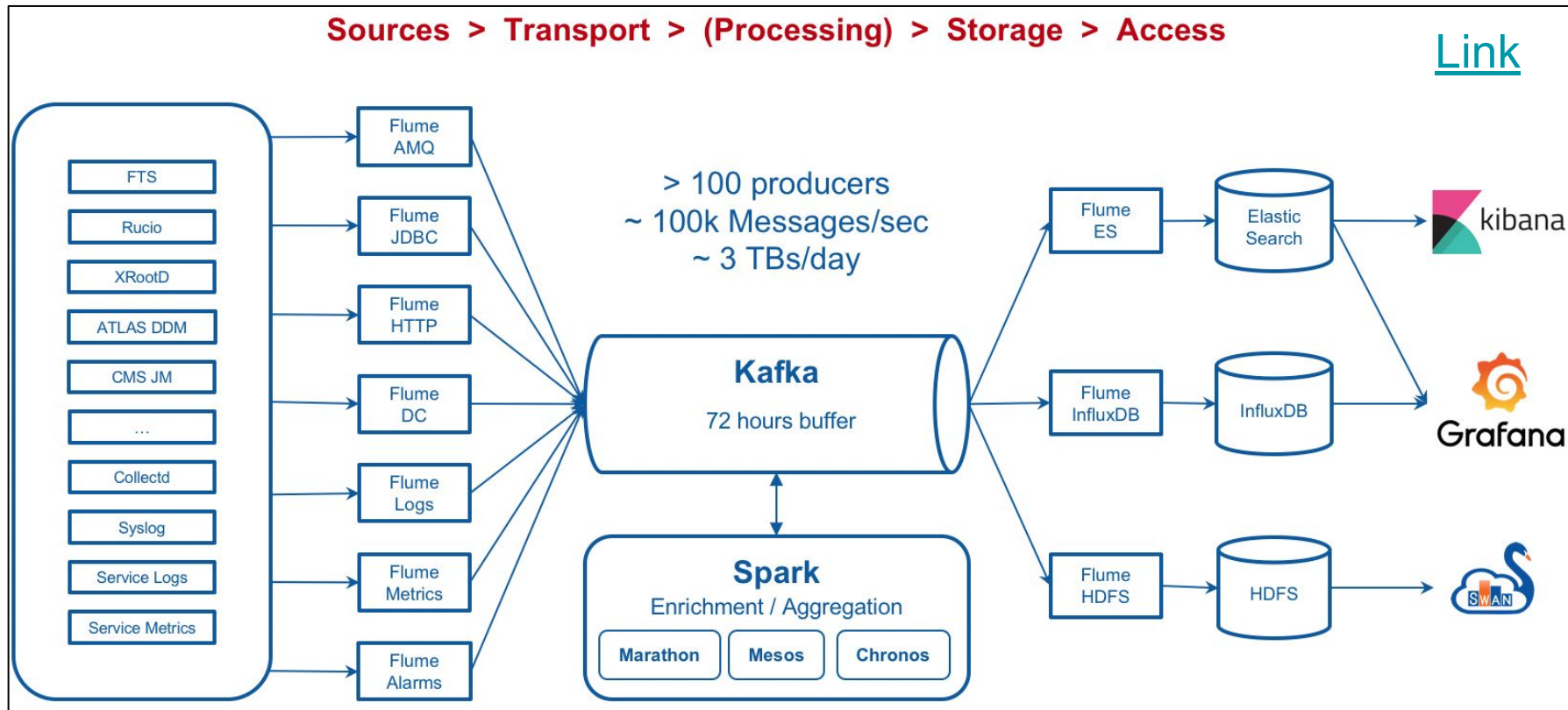
- Introduction
- CERN MonIT Unified Monitoring Infrastructure (UMA)
- ATLAS Monitoring production dashboards in UMA
- Jobs Dashboards
- DDM Dashboards
- Sites Dashboards
- Summary

# Introduction

- The old monitoring and accounting infrastructure based on custom frameworks was developed by CERN IT and ADC more than 10 years ago to monitor workload management (PanDA) and distributed data management (Rucio) systems
- The old infrastructure had significant limitations in performance, scalability and data visualization
- Since 2016 CERN-IT MonIT group started developing a new unified infrastructure and environment for monitoring and accounting applications based on modern and efficient open-source software stack
- The stack is adapted for the ATLAS experiment and allows the development of dedicated monitoring and accounting applications in Grafana and Kibana visualization environments
- The current state of the monitoring and accounting infrastructure are presented in this talk

# CERN MonIT Unified Monitoring Infrastructure (UMA)

Sources > Transport > (Processing) > Storage > Access



# UMA overview

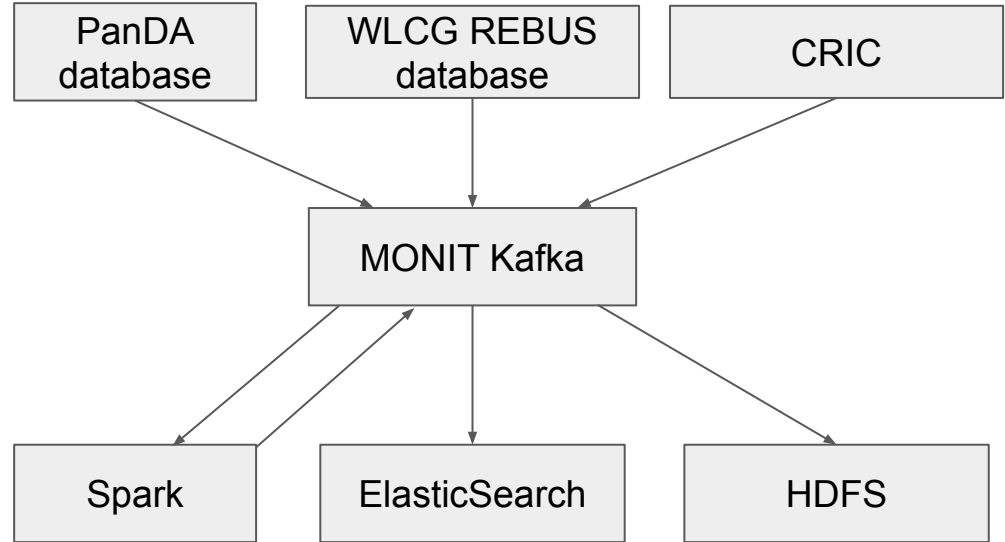
- Data Sources
  - PanDA database
  - Rucio database
  - Rucio trace server
  - Pilot
  - CRIC API
- Collectors
  - ActiveMQ (AMQ)
  - HTTP
  - Java Database Connectivity (JDBC)
- Storages
  - Hadoop File System (HDFS) for long-term data archival and offline analytics
  - Elasticsearch for short-term and long-term data
  - InfluxDB for the medium-term data
- Data access
  - Grafana: access to all data in the MONIT infrastructure
  - Kibana
    - Short-term: access to data for operations
    - Long-term: access to data for accounting
  - Service for Web based Analysis (SWAN)

# ATLAS Monitoring production dashboards in UMA

- Jobs monitoring and accounting
  - Job Accounting
  - Jobs Monitoring (Monit ElasticSearch)
  - HS06 Reports
- DDM transfers and accounting
  - DDM Global Accounting (Historical)
  - DDM Global Accounting (Snapshot)
  - DDM Site Accounting
  - DDM Transfers
  - DDM Transfers (Historical data)
- Sites Monitoring
  - Site-oriented dashboard
  - Site Status Board Overview
  - Site Status Board - Panda Jobs
  - Site Status Board - SAM3

# Jobs Dashboard Overview

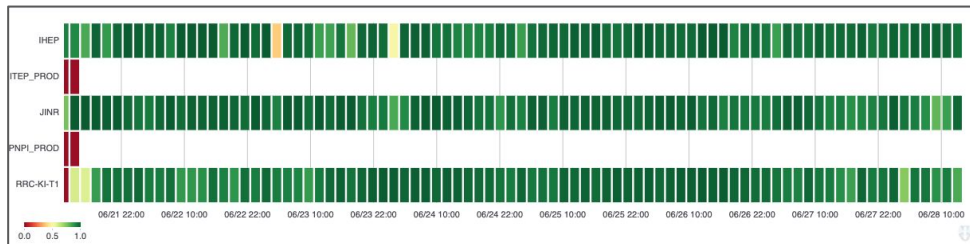
- Flume JDBC extracts information from jobs tables in PanDA database every ten minutes
- Pledge information from the WLCG REBUS database
- Topology Information is taken from CRIC
- SPARK job for processing data consist of the following steps:
  - In the first step, job computes additional information for each job (ADC activities, error messages, walltime)
  - In the next step, data is enriched with topology information from CRIC
  - In the last step, processed data is written back to Kafka
- Kafka keep aggregated data into five separate indices for each jobs statuses (completed, finilising, pending, running and submitted jobs) in the ElasticSearch
- Aggregated information about jobs also keep into HDFS storage



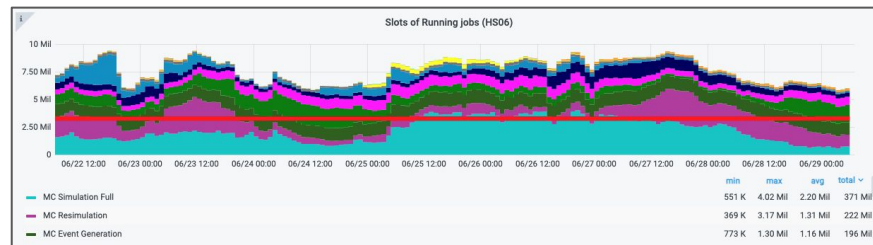
# Jobs Accounting dashboard

- The job accounting dashboard is used by shifters, experts and management to spot problems with the workflow management system
- Special ATLAS styles
- Information about jobs is available since 2010
- 87 plots, 25 filters, 23 options to group data
- Binning: 1h, 1d, 1w, 1M

Efficiency based on success/all accomplished jobs  
(by computingsite)



Slots of Running jobs HS06  
(by adactivity)





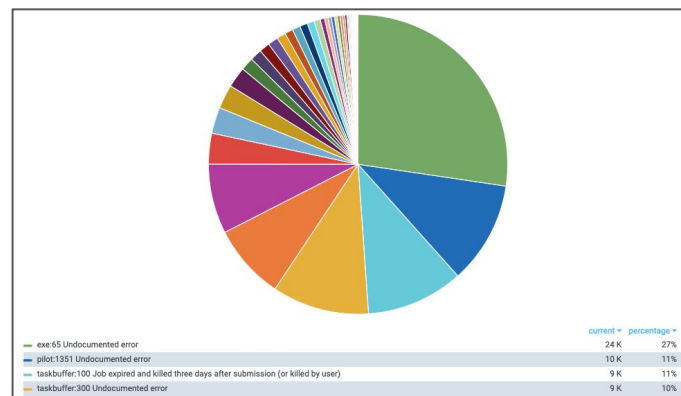
# Jobs Monitoring dashboard

- The dashboard provides extended information about completed jobs for 2 months
- It is useful to monitor separate job(s), task(s) or request(s)
- The data is processed in the same as for Jobs accounting dashboard
- Kafka keeps aggregated data into dedicated index for completed jobs in the ElasticSearch storage
- 21 plots, 24 options to group data, 27 filters
- Binning: 10m, 30m, 1h, 6h, 12h, 1d, 7d, 14d, 30d

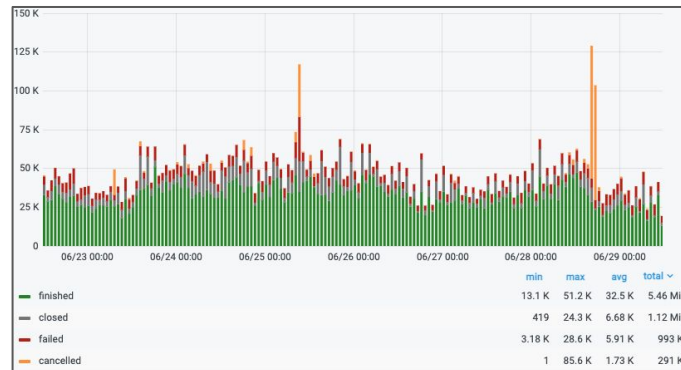
## Jobs list

data.pandaid	data.jeditaskid	data.reqid	data.statechangetime	data.jobstatus	data.computingsite	data.cpuconsumptiontime
<a href="#">5100926126</a>	<a href="#">25917255</a>	<a href="#">37930</a>	2021-06-28 14:08:30	finished	OU_OSCER_ATLAS	214331
<a href="#">5100926121</a>	<a href="#">25917255</a>	<a href="#">37930</a>	2021-06-28 14:08:29	finished	OU_OSCER_ATLAS	219882
<a href="#">5100926111</a>	<a href="#">25917255</a>	<a href="#">37930</a>	2021-06-28 14:08:28	finished	OU_OSCER_ATLAS	204202
<a href="#">5100926105</a>	<a href="#">25917255</a>	<a href="#">37930</a>	2021-06-28 14:08:28	finished	OU_OSCER_ATLAS	219196

## Panda Failures by ExitCode



## Number of Successful and Failed jobs



# HS06 Reports

- The dashboard is used by management to generate HS06 Reports
- The dashboard uses aggregated data from ElasticSearch index for completed jobs (job accounting dashboard)
- Information is split into separate tables: for Computing sites, Sites, Federations, Tiers
- Data from the tables can be exported to CSV reports using Grafana API and python script

## Computing sites

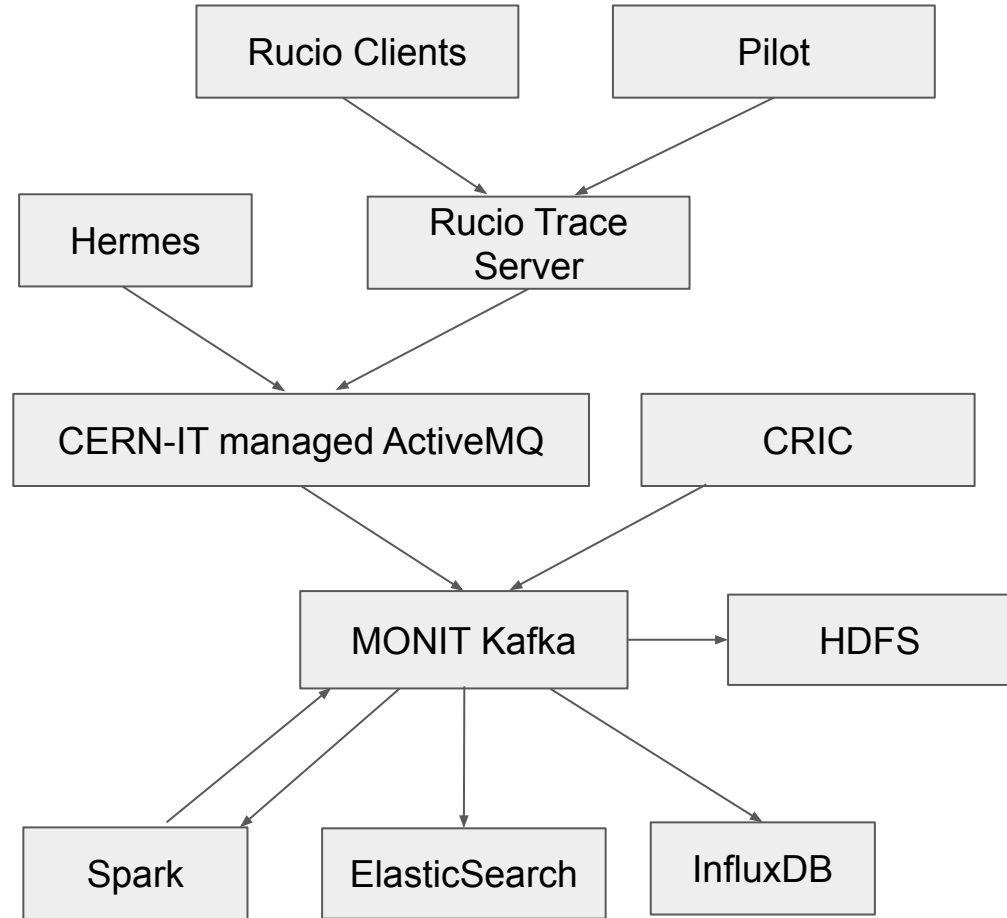
Computingsite	Site	Federation	Tier	Resource	HS06_sec	cpu_in_sec	wc_in_sec	ratio ^
NERSC_Corl_p2_ES_Test	LBNI_DSD_ITB	NON-MOU-Federation	3	hpc_special	2487922770	0	1037807674	0
CERN-EXTENSION_KUBERNETES_TEST	CERN-EXTENSION	CH-CERN	3	cloud	156640	17	15664	0.109
LUNARC	SE-SNIC-T2	SE-SNIC-T2	2	GRID	255859670	430365	39053375	1.10
UIO_CLOUD_LOPRI	NDGF-T1	NDGF	1	cloud	5124628225	28314702	823865456	3.44

## Tiers

Tier	HS06_sec	cpu_in_sec	wc_in_sec	ratio ^
3	3227395911963	223121109837	373193368651	59.8
2	11195514192460	650800087912	867061161428	75.1
0	1163183490625	100947515960	129452327052	78.0
1	3571252247759	232805786536	271874012296	85.6
-1	0	103474	103657	99.8

# DDM Dashboard Overview

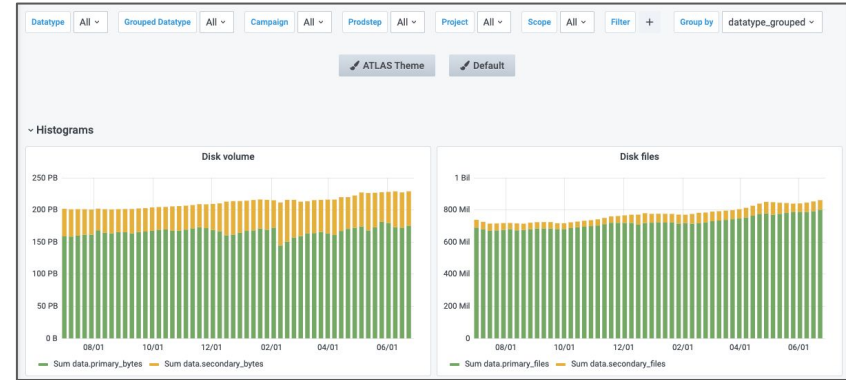
- MONIT infrastructure collects events and traces and injects them into Kafka pipeline
- Furthermore, the infrastructure also regularly reads topology information from CRIC and add them to Kafka
- SPARK job for processing data consist of the following steps:
  - In the first step of data processing. SPARK job transforms the events and traces so they fit in a similar structure
  - In the next step they are enriched with topology information from CRIC
  - In last step everything is aggregated in 1 minute bin by source/destination, activity, cloud, federation, country, tier, etc. and the number of failed and successful transfers are counted
- This data is written back to Kafka and then stored in Elasticsearch/InfluxDB/HDFS



# DDM Global accounting dashboards

- Historical dashboard
  - Dataset based. Counts for each dataset how many file replicas are available split by primary/secondary/tier/disk/tape/dataset metadata
  - Shows the evolution of replicas over time
  - 13 plots, 6 filters, 5 options to group data
- Snapshot dashboard
  - Same as the Historical dashboard but shows the numbers for the last week
  - 13 plots + tables from overview part, 6 filters, 5 options to group data
- The data for these dashboards is aggregated once a week

## DDM Global accounting (Historical)



## DDM Global accounting (Snapshot)

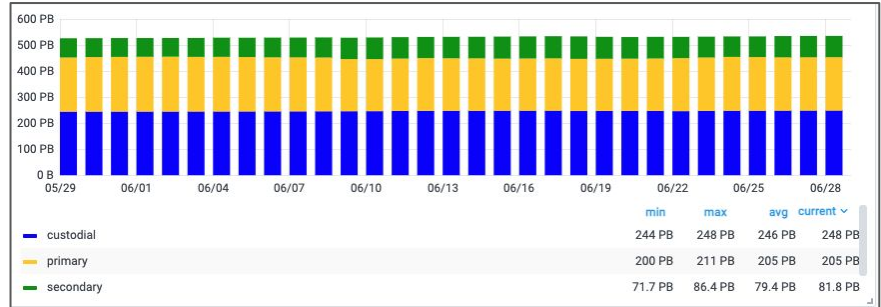
~ Overview

Logical Size	Disk Size	Primary Size	Disk Files	Primary Files
323 PB	229 PB	176 PB	861141756	801006681
Number of Events	Tape Size	Secondary Size	Tape Files	Secondary Files
2422057168088	269 PB	53.4 PB	209308738	60135075
Total Size		Total Files		
498 PB		1070450494		

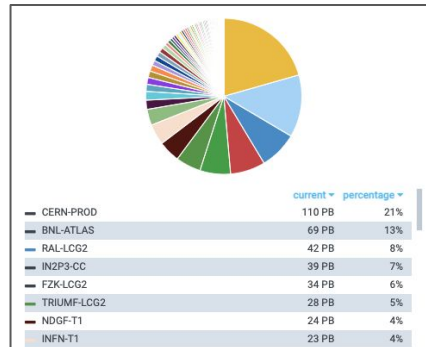
# DDM Site accounting dashboard

- Interesting for operations and site admins
- RSE (Rucio Storage Element) based
- Counts the number of replicas for each endpoint
- Can be aggregated/split by topology/dataset metadata
- For example show volume/number of files for all primary DAOD datasets on US Tier-2 DATADISK
- 233 plots, 17 filters, 18 options to group data

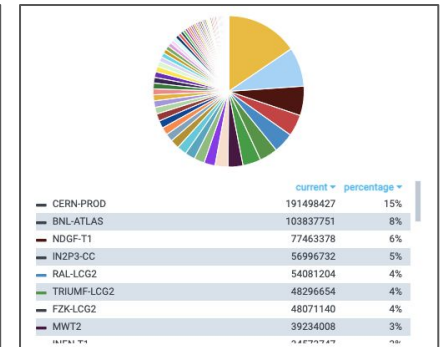
## Volume per tombstone



## Volume by site



## Files by site



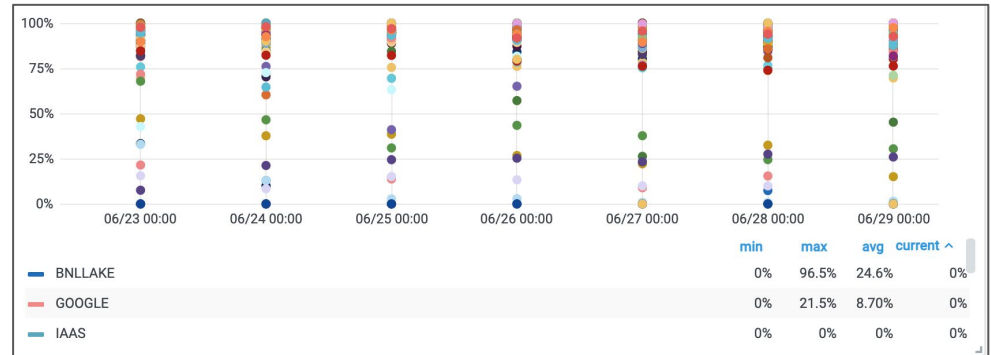
# DDM transfers dashboards

- The DDM transfer dashboards are mainly used by shifters and experts to monitor the worldwide transfer on the grid and spot problems
- The main dashboard has a granularity of 1 minute for 30 days
- It is using both InfluxDB and Elasticsearch at the same time. The time-series information in the plots is coming from IDB. The transfer details are coming from Elasticsearch
- 35 plots, 18 filters, 17 options to group data
- Binning: 10m, 1h, 6h, 12h, 1d
- Historical transfer dashboard has a minimum granularity of 1h for up to 5 years
- The historical dashboard contains: 39 plots, 16 filters, 23 options to group data. Binning the same

Efficiency (by cloud)

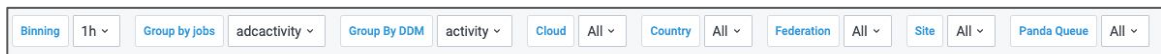
	CA	CERN	DE	ES	FR	IT	ND	NL	RU	TW	UK	US
CA	98%	92%	90%	83%	95%	100%	58%	100%	97%	99%	95%	63%
CERN	94%	99%	93%	100%	99%	100%	100%	100%	100%	100%	98%	98%
DE	87%	94%	63%	75%	96%	91%	97%	96%	96%	93%	95%	53%
ES	76%	85%	70%	90%	93%	99%	89%	99%	99%	96%	92%	76%
FR	91%	96%	84%	78%	92%	97%	94%	94%	96%	94%	91%	78%
IT	83%	99%	91%	98%	98%	99%	100%	100%	100%	100%	96%	88%
ND	86%	99%	74%	63%	97%	94%	98%	100%	100%	98%	99%	95%
NL	99%	100%	80%	99%	98%	100%	99%	100%	100%	100%	96%	75%
RU	100%	100%	92%	100%	100%	100%	100%	100%	100%	100%	94%	70%
TW	98%	92%	85%	44%	97%	65%	75%	99%	100%	-	81%	75%
UK	87%	80%	69%	72%	95%	94%	93%	98%	94%	98%	90%	63%
US	78%	85%	88%	68%	95%	91%	97%	88%	97%	84%	96%	89%

Transfer Efficiency (by dst site)

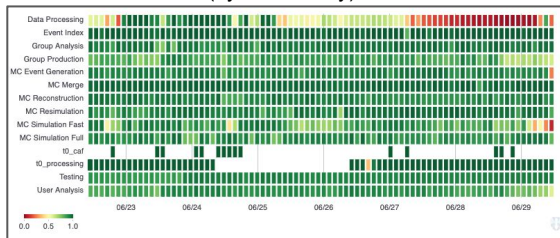


# Site-oriented dashboard

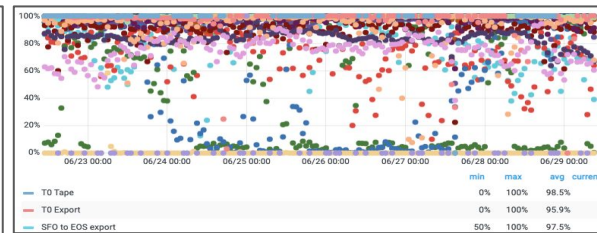
- This dashboard combines information from Jobs Accounting and DDM transfer dashboards
- Allows to monitor and analyse computing sites efficiency
- 8 plots (6 Jobs + 2 DDM), 5 filters, 55 options to group data



Efficiency based on success/all accomplished jobs  
(by adc activity)



Transfer Efficiency (by activity)



CPU Efficiency of good jobs

Group By	CPU consumption	Walltime	CPU Efficiency
FMPH-UNIBA	308.86 Mil	310.63 Mil	0.99
GRIF-LAL	1.24 Bil	1.27 Bil	0.98
RU-Protvino-IHEP	512.60 Mil	526.56 Mil	0.97
UKI-SCOTGRID-GLASGOW	5.15 Bil	5.30 Bil	0.97
WEIZMANN-LCG2	793.15 Mil	815.84 Mil	0.97
IL-TAU-HEP	292.77 Mil	303.54 Mil	0.96
UTA_SWT2	1.23 Bil	1.27 Bil	0.96
UKI-LT2-IC-HEP	1.63 Bil	1.70 Bil	0.96



# Site Status Board Overview

Tier		Country		All		Cloud		Federation		Site		All		Choose Panel		Fast	
		CRIC Downtime Status		DDM Downtime Status		DDM Transfer Efficiency		SAM3 Site Availability		Panda Queues Status		Jobs Efficiency		Frontier Squid Status		GGUS tickets	
						source		destination				analysis		production			
AGLT2	active	online	97.5%	96.6%	98.6%	online	82.0%	83.0%	ok	1							
Australia-ATLAS	active	online	91.7%	100.0%	98.6%	online	72.0%	98.0%	ok	0							
BEIJING-LCG2	active	online	94.3%	78.1%	98.6%	online	0%	99.0%	ok	0							
BNL-ATLAS	active	online	93.1%	98.5%	98.6%	online	82.0%	80.0%	ok	0							
BNLLAKE	active	online	100.0%	100.0%	98.6%	online	94.0%	95.0%	ok	n/a							
BU_ATLAS_Tier2	active	online	98.2%	99.4%	86.3%	online	83.0%	97.0%	ok	0							
CA-SFU-T2	active	online	97.8%	97.9%	98.6%	online	75.0%	97.0%	ok	1							
CA-VICTORIA-WESTGRID-T2	active	online	89.7%	95.2%	98.6%	online	63.0%	98.0%	ok	0							
CA-WATERLOO-T2	active	online	99.2%	98.3%	98.6%	online	88.0%	91.0%	degraded	1							
CSCS-LCG2	active	online	94.1%	84.9%	98.6%	online	87.0%	88.0%	ok	0							
CYFRONET-LCG2	active	online	97.1%	96.3%	98.6%	online	99.0%	93.0%	ok	0							
DESY-HH	active	online	99.3%	95.0%	98.6%	online	82.0%	98.0%	ok	1							
DESY-ZN	active	online	98.3%	87.0%	98.6%	online	95.0%	90.0%	ok	0							
EELA-UTFSM	active	online	95.0%	99.2%	98.6%	online	97.0%	100.0%	ok	2							
FMPiH-UNIBA	active	online	94.3%	91.1%	98.6%	online	86.0%	92.0%	ok	0							
FZK-LCG2	active	online	95.2%	97.8%	98.6%	online	84.0%	98.0%	ok	1							
GRIF-IRFU	active	online	97.2%	97.0%	98.6%	online	79.0%	98.0%	ok	n/a							
GRIF-LAL	active	online	56.1%	13.0%	76.1%	test	57.0%	80.0%	n/a	n/a							
GRIF-LPNHE	active	online	98.5%	97.8%	98.6%	online	66.0%	100.0%	ok	n/a							



# Site Status Board - Panda Jobs



# Site Status Board - SAM3

SAM3 Site Availability				SAM3 SRM test counts			SAM3 GRIFTP test counts		
		OK	Warning	Critical	OK	Warning	Critical		
AGLT2	100.0%	286	0	0	288	0	0		
Australia-ATLAS	100.0%	286	0	0	0	0	0		
BEIJING-LCG2	100.0%	0	0	0	288	0	0		
BNL-ATLAS	100.0%	286	0	0	286	0	0		
BNLLAKE	100.0%	0	0	0	0	0	0		
BU_ATLAS_Tier2	87.7%	0	0	0	0	0	0		
CA-SFU-T2	100.0%	288	0	0	0	0	0		
CA-VICTORIA-WESTGRID-T2	100.0%	336	0	0	0	0	0		
CA-WATERLOO-T2	100.0%	287	0	0	0	0	0		
CSCS-LCG2	100.0%	288	0	0	0	0	0		
CYFRONET-LCG2	100.0%	0	0	0	287	0	0		
DESY-HH	100.0%	286	0	0	0	0	0		
DESY-ZN	100.0%	287	0	0	0	0	0		
EELA-UTFSM	100.0%	288	0	0	0	0	0		
FMPH-UNIBA	100.0%	0	0	0	312	0	0		
FZK-LCG2	100.0%	288	0	0	0	0	0		
GRIF-IRFU	100.0%	0	0	0	0	0	0		

# Summary

- Since 2016 CERN-IT MonIT group started developing a new unified infrastructure (UMA)
- The UMA infrastructure uses modern and efficient open-source solutions such as Kafka, InfluxDB, ElasticSearch, Kibana and Grafana to collect, store and visualize metadata produced by data (Rucio) and workflow management (PanDA) systems
- This software stack is adapted for the ATLAS experiment and allows the development of dedicated monitoring and accounting dashboards in Grafana visualization environment.
- ATLAS Monitoring has 12 production dashboards for Sites, Jobs and DDM monitoring
- The monitoring based on UMA is constantly being improved

## Acknowledgements:

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Thanks!