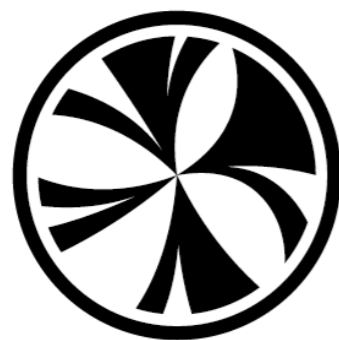# Construction of real-time monitoring system for Grid services based on log analysis at the Tokyo Tier-2 center

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Contents

✓ Introduction about ICEPP

✓ Status and configuration of the Tokyo Tier–2 center
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  - Site status in the ATLAS experiment
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  - Test cluster using the ELK stack
  - Example of new monitors for Grid services
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✓ Summary
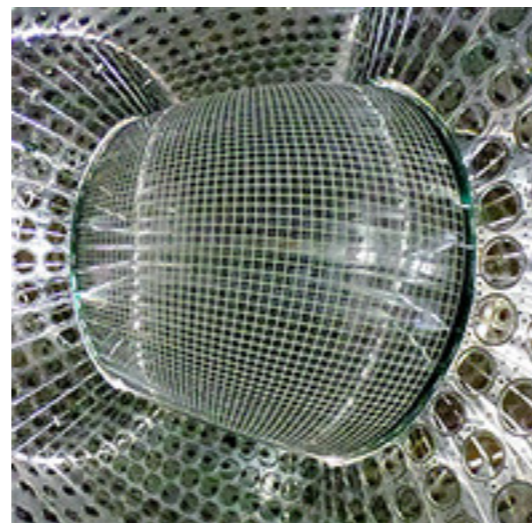
International Center for Elementary Particle Physics

✓ Main projects in ICEPP

東京大学
素粒子物理国際研究センター
International Center for Elementary Particle Physics
The University of Tokyo

**ATLAS experiment
at LHC**

**MEG experiment
at PSI
(μ→eγ rare decay)**
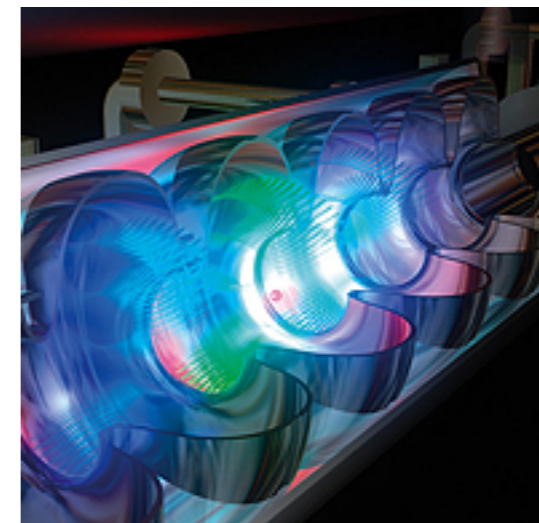
R & D for ILC

ATLAS
Japan

✓ ATLAS-Japan group

– 17 institutes and ~150 members
– Tokyo Tier2 is the only WLCG site in ATLAS-Japan

ICEPP regional analysis center

✓ Resource overview

- – Support only ATLAS VO in WLCG (**Tier2**) and provide ATLAS–Japan dedicated resources (local use)

- – <u>Hardwares are leased, and are replaced in every three years</u>

- – ~10000 CPU cores including service instances and ~10 PB disk storage (T2 + local use)
    - ‣ 18.11HS06/core (Intel Xenon E5–2680 v3)

4th system (2016–2018)

<u>**Single VO and uniform architecture**</u>

✓ Operation team

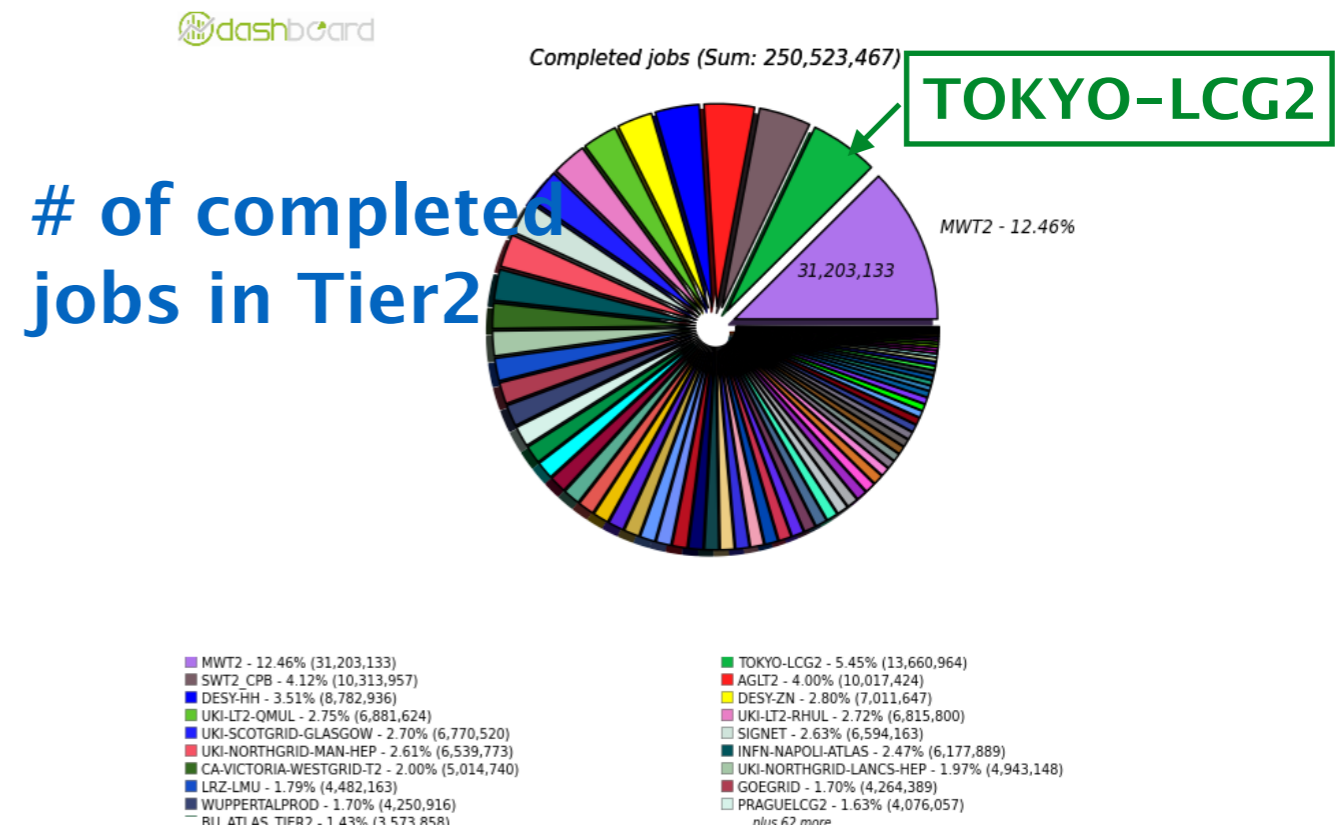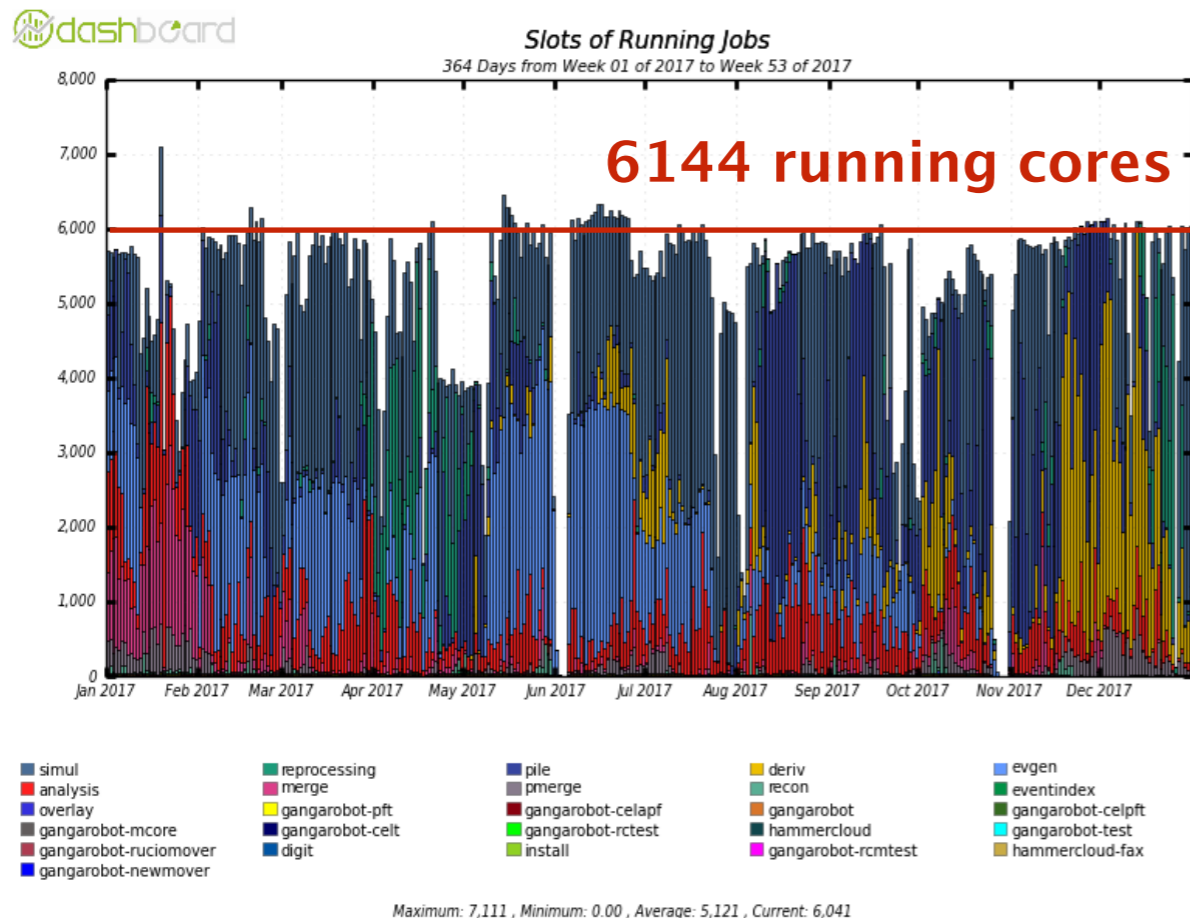- – H.Sakamoto (will retire in this Mar.), J.Tanaka, T.Mashimo, N.Tomoaki, T.Kishimoto, N.Matsui

worker nodes

Disk arrays

WLCG pledge

		CPU [HS06]	DISK [TB]	(*)LOCALGROUPDISK [TB]
2017	Pledge	34,000	4,000	-
	Deployed	111,268 (6144 CPU cores)	4,000	1,000
2018	Pledge	40,000	4,800	-
	Deployed	111,268 (6144 CPU cores)	4,800	1,000

(*) Grid disks for ATLAS–Japan group

✓ Tier2 resources
- The current system (4th system) satisfies 2018 WLCG pledge
- New system will be provided for 2019–2021
  ▸ (Need to migrate 5.8 PB data to the new system…)

Status in ATLAS experiment

6144 running cores

# of completed jobs in Tier2

TOKYO−LCG2

Completed jobs (Sum: 250,523,467)

MWT2 - 12.46%

31,203,133

Maximum: 7,111 , Minimum: 0.00 , Average: 5,121 , Current: 6,041

✓ Fraction of # of completed jobs for the last year:

  – Production: **4.0% (Tier2)**, 2.2% (All)

  – Analysis: **6.3% (Tier2)**, 4.1% (All)

    ← <u>Good contributions</u>

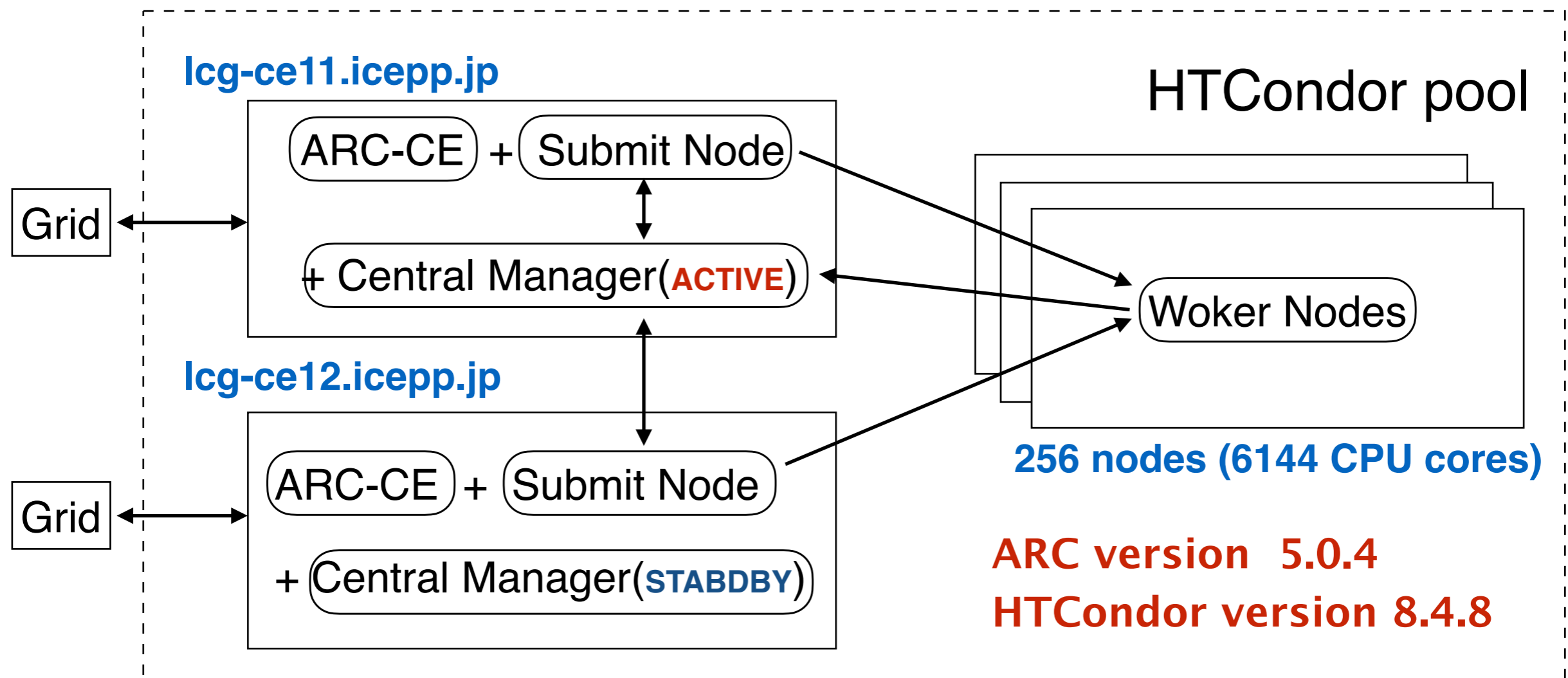**# of ATLAS−J authors ∼ 150**
# of ATLAS authors ∼ 3000

✓ > 99% site availability has been achieved using the 4th system (for 2 years)

Grid services – CE

✓ Computing element:
  – Two **ARC-CEs** for redundancy
  – **HTCondor** as the local resource batch system
  – High availability of central managers

HTCondor pool

lcg-ce11.icepp.jp

ARC-CE + Submit Node

+ Central Manager(**ACTIVE**)

Grid

lcg-ce12.icepp.jp

ARC-CE + Submit Node

+ Central Manager(**STABDBY**)

Grid

Woker Nodes

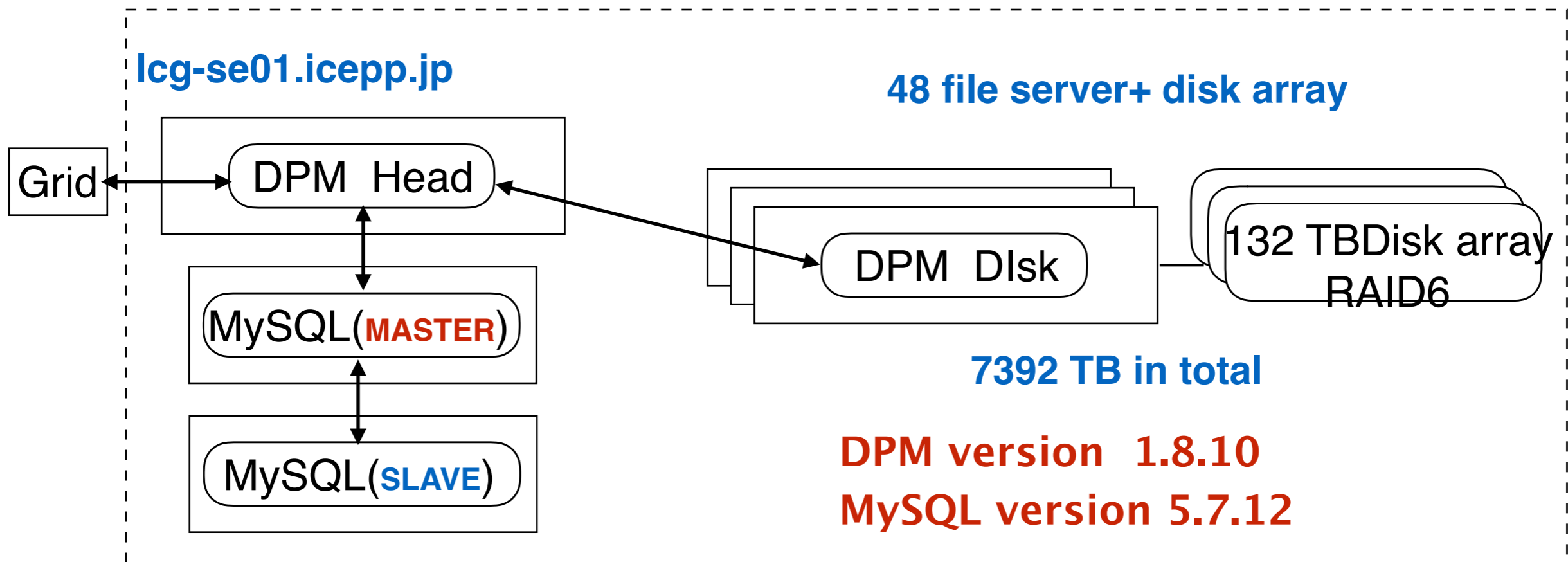**256 nodes (6144 CPU cores)**

ARC version 5.0.4
HTCondor version 8.4.8

Grid services – SE and other

✓ Storage element:
  - **DPM** speaks GridFTP, XRoodD, https, SRM..
  - Replication of MySQL DB

lcg-se01.icepp.jp

48 file server+ disk array

Grid ⟷ DPM Head → DPM DIsk — 132 TBDisk array RAID6

MySQL(**MASTER**)

MySQL(**SLAVE**)

7392 TB in total

DPM version 1.8.10
MySQL version 5.7.12

✓ perfSONAR, BDII, Argus, APEL..

perfSONAR

Grid service logs

✓ "Logs" produced by the Grid services provide useful
   information to check health of the services
   ← Important for a stable and reliable operation

✓ e.g. ARC-CE log:

Time	Severity		Job global ID	State transition

```
[2018-02-05 04:05:23] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: ACCEPTED: parsing job description
[2018-02-05 04:05:23] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: ACCEPTED: moving to PREPARING
[2018-02-05 04:05:23] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: PREPARING from ACCEPTED
[2018-02-05 04:05:31] [Arc.DataStaging.DTR] [INFO] [6734/7] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: All downloads finished
successfully
[2018-02-05 04:05:31] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: SUBMIT from PREPARING
[2018-02-05 04:05:31] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: state SUBMIT: starting child: /usr/share/
arc/submit-condor-job
[2018-02-05 04:05:32] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: state SUBMIT: child exited with code 0
[2018-02-05 04:05:32] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: INLRMS from SUBMIT
[2018-02-05 04:22:01] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: Job finished
[2018-02-05 04:22:01] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: FINISHING from INLRMS
[2018-02-05 04:22:03] [Arc] [INFO] [6734/2] roaNDm7Cn2rnG457in1NHNUqABFKDmABFKDmVi1XDmABFKDmpGQQXn: State: FINISHED from FINISHING
```

– We can judge that the job was processed at CE without errors

Monitoring system

✓ Constructing a new real-time monitoring system based on log analysis using the **ELK stack**

– ELK stack provides efficient way of log processing, storing, query and visualization
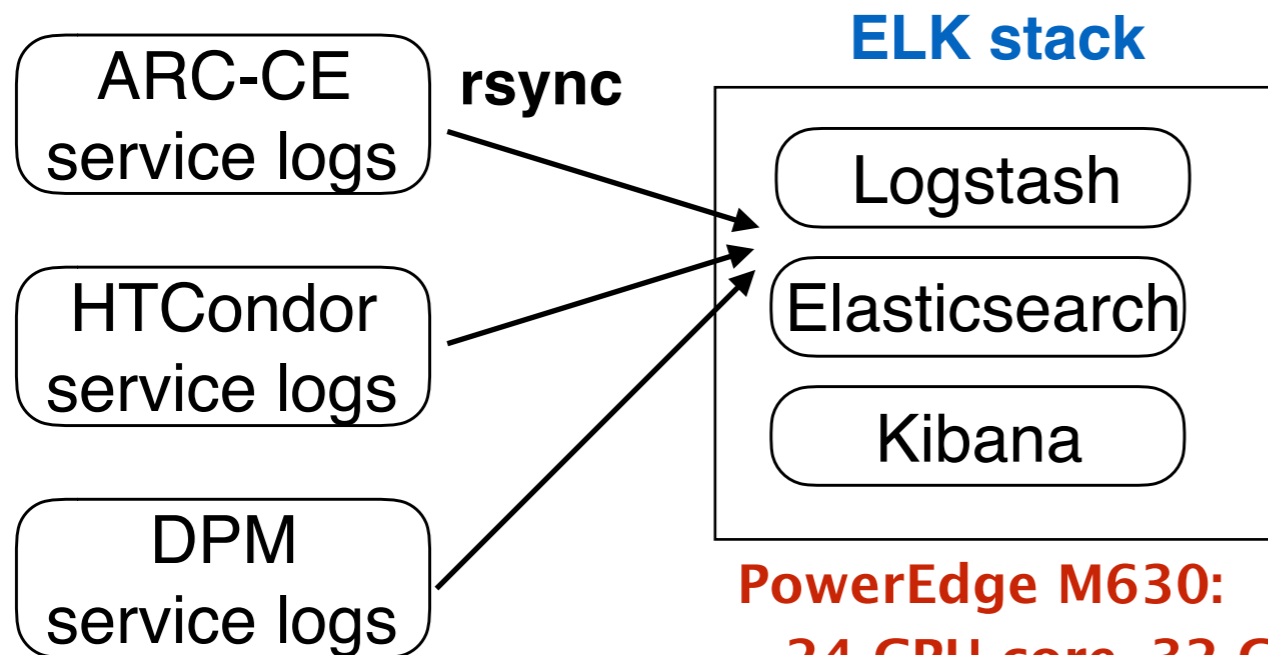

Log processing

```
[2018-02-05 08:39:45] [Arc] [INFO] [6734/2]
UVZMDmQUr2rnG457in1NHNUqABFKDmABFKDmWy8aDmA
BFKDmWQcvdn: State: INLRMS from SUBMIT
```

1 log line = 1 record in DB

Test environment

✓ Simple configuration: 1 host for the ELK stack

ELK stack

ARC-CE service logs → **rsync** →

HTCondor service logs →

DPM service logs →

[Logstash / Elasticsearch / Kibana]

PowerEdge M630:
24 CPU core, 32 GB memory
ELK version 5.6

– Currently, rsync is used to collect logs (can be replaced with Filebeat)
– Dedicated log analysis (logstash conf.) for each service

✓ Log frequency

	ARC-CE	HTCondor	DPM
Records (log lines)	~300/min	~5,000/min	~50,000/min

– DPM is the dominant sources of records

Resource usage of ELK host

Metricbeat CPU Usage Histogram

Metricbeat CPU Usage Table

| Username	CPU [%]	Resident Memory [%]	Memory [MB]	Shared Memory [MB]
logstash	151.21	38.11	12,147.094	5.859
elasticsearch	23.264	31.786	10,131.22	77.385
kibana	0.471	0.2	58.387	3.983
dbus	0.02	0	1.473	1.09
polkitd	0.013	0	2.109	1.553
root	0.004	0.001	0.522	0.419
elastalert	0.001	0.1	28.568	2.049
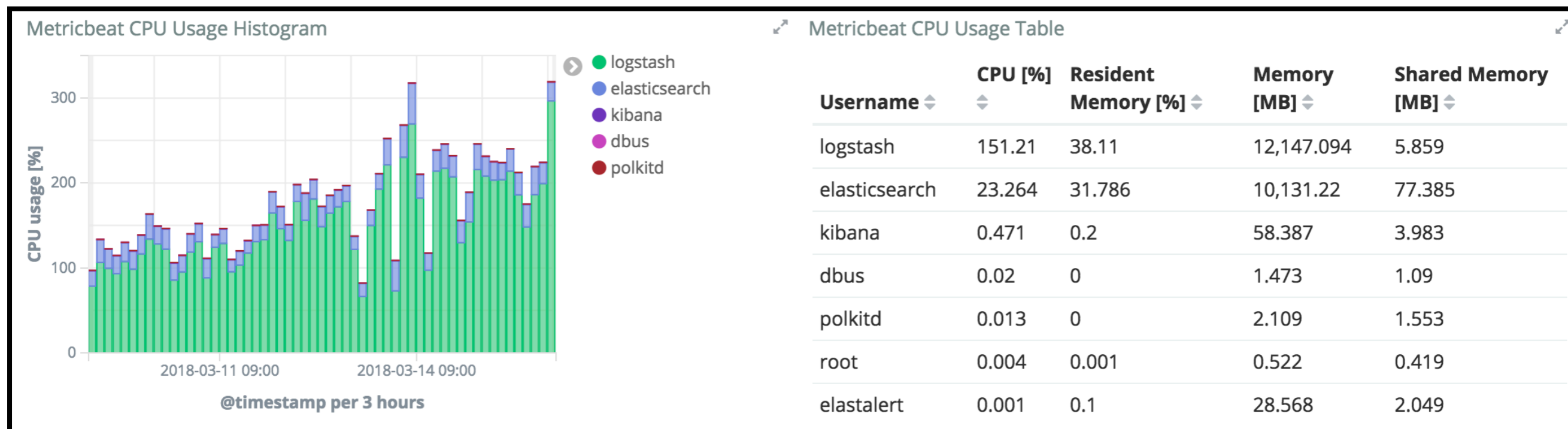
- Average CPU usage is ~200% (24 cores = max 2400%), logstash is the dominant source
  - Correlated with DPM loads
- JVM heap size is 12GB for logstash and eastcsearch
- Elasticsearch DB increases ~20 GB per day
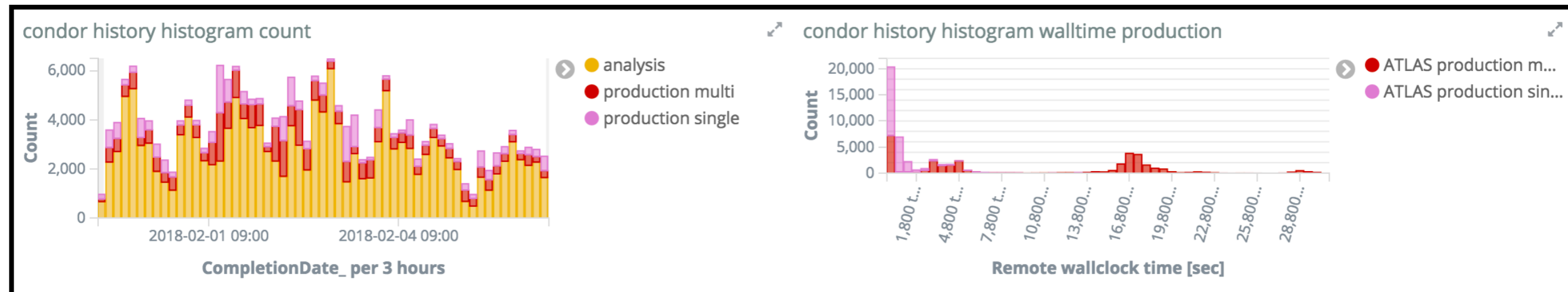 - Delete records, which is passed 1 month

ARC–CE and HTCondor monitoring

ARC-CE
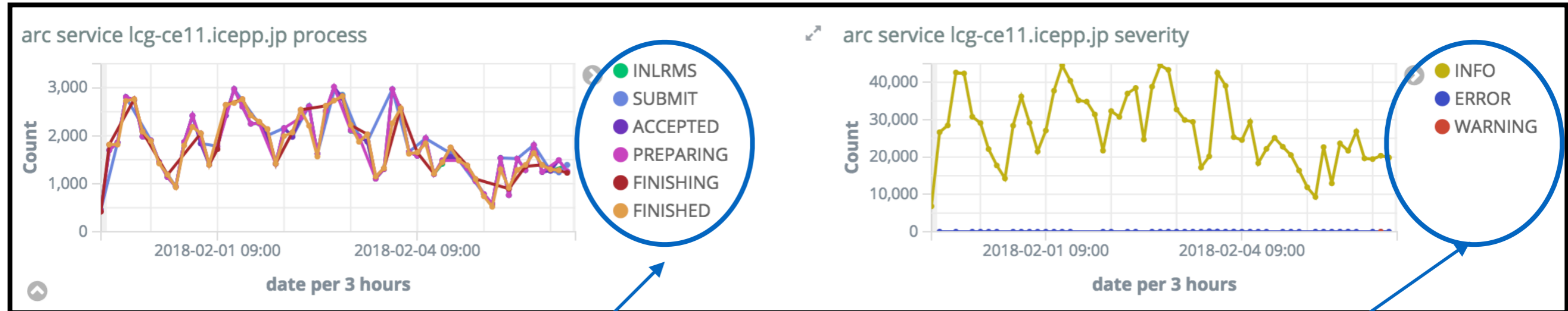
Counts of job status
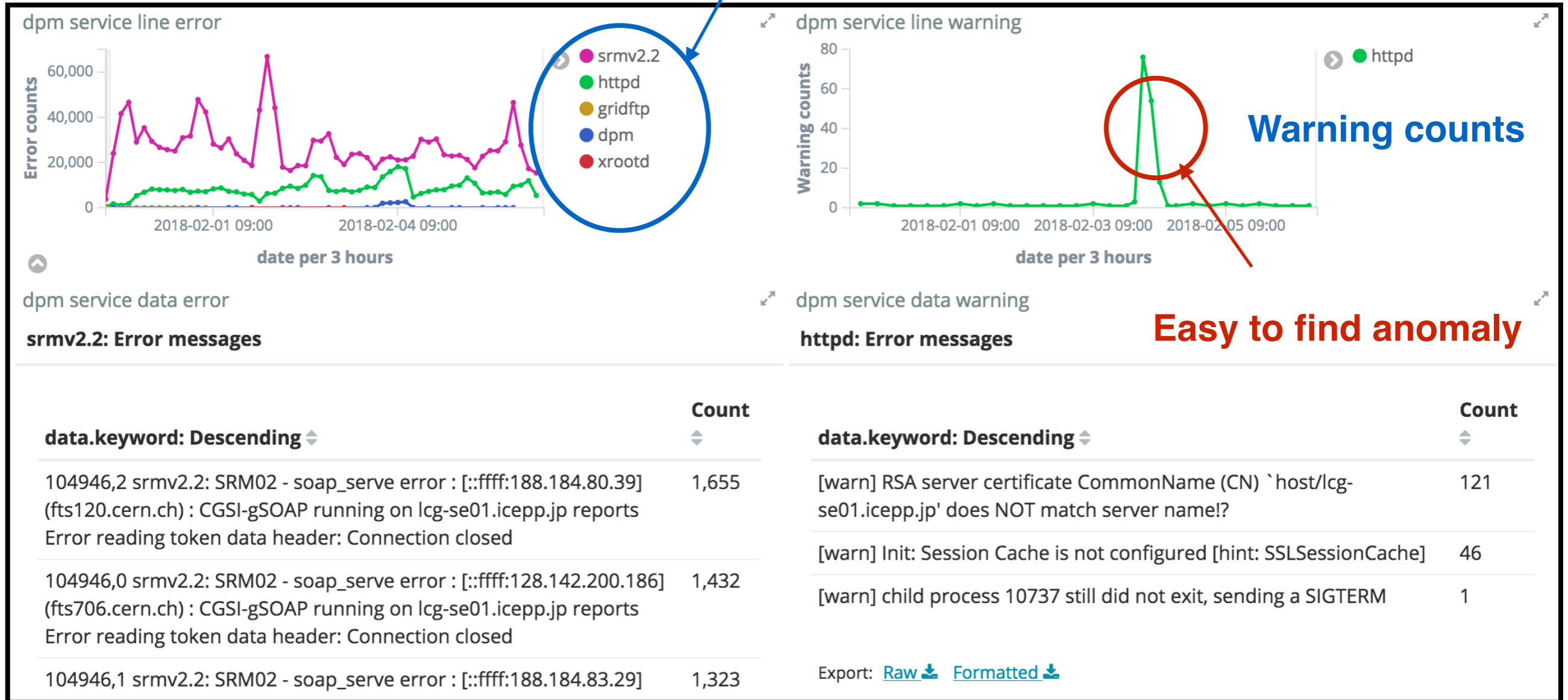**→ Can detect pending status**

log severity

HTCondor

Job throughput

Job duration

DPM monitoring

Error counts for each protocol

Warning counts

Easy to find anomaly

✓ Gird service logs are well visualized.

✓ Alerting is implemented using 'elastalert'

   – https://github.com/Yelp/elastalert

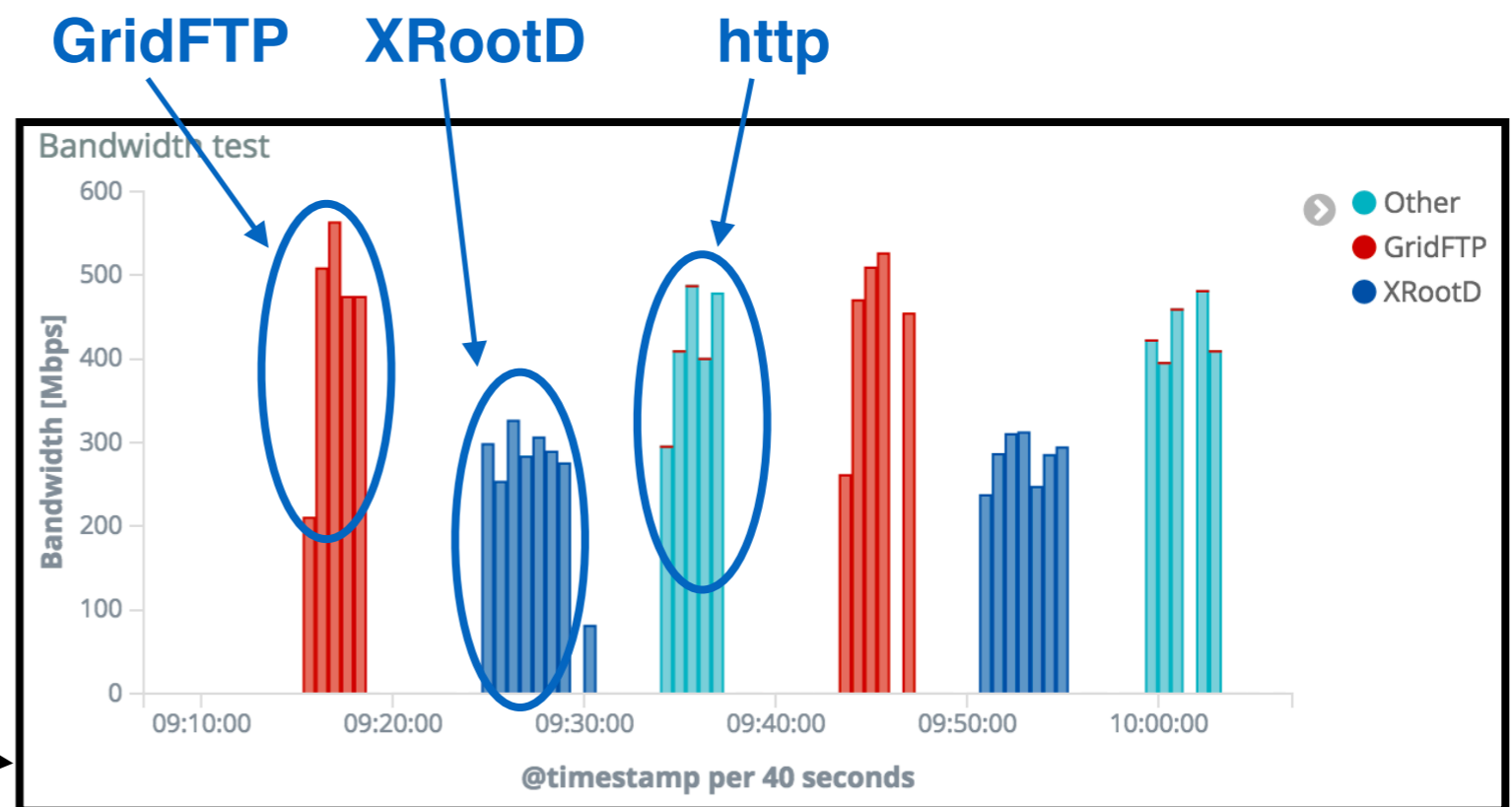# iftopbeat

✓ DPM supports several protocols for data transfer

✓ Developed 'iftopbeat' to measure real-time throughput of data transfer for each protocol
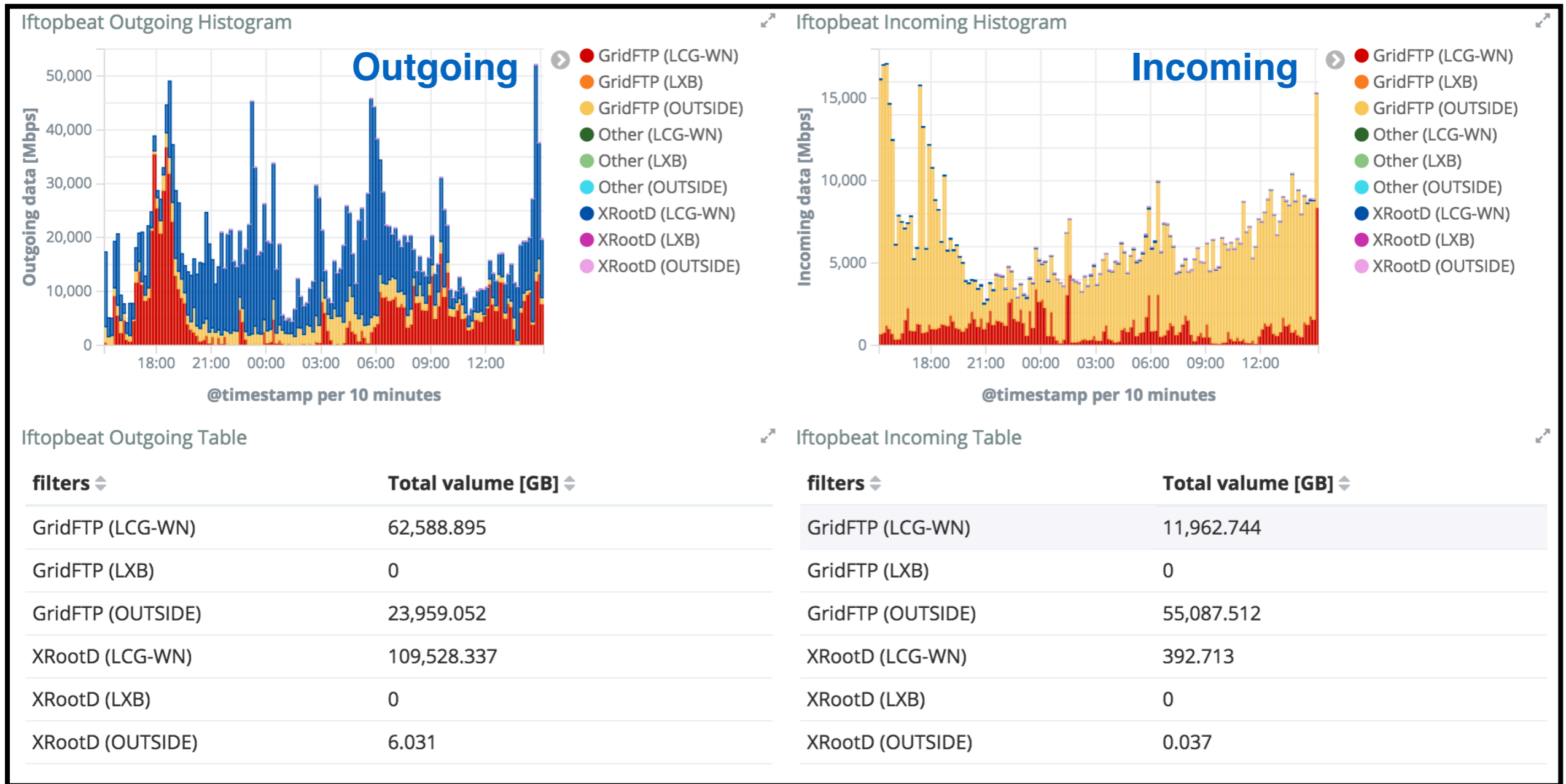
Beats: lightweight data shipper

– Data are measured by iftop command, and are directly sent to elasticserach using libbeat platform

– Written by golang

– Test of a 10GB file transfer

GridFTP   **XRootD**   **http**

Well measured/visualized

iftopbeat

✓ Monitoring for real data transfers

Easy to check correlation between service logs and transfer loads

Summary

✓ Tokyo Tier2 center with the 4th system is running

- – Providing enough computing resources for ATLAS
- – > 99% site availability is achieved

✓ Constructing a new monitoring system for Grid services using the ELK stack

- – ELK stack can handle the logs produced at TOKYO Tier2 center so far
- – Logs are well visualized, and easy to check correlations between the Grid services
- – Beats libraries provides efficient way to ship data to elasticsearch
  - ▸ Developed iftopbeat as an example