MONITORING SYSTEM OF THE AMS
SCIENCE OPERATION CENTRE

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AMS EXPERIMENT

• The Alpha Magnetic Spectrometer (AMS) is a high energy physics experiment on board the International Space Station (ISS), featured:
  • Geometrical acceptance: 0.5 m$^2$•sr
  • Number of Read-out Channels: $\approx$200K
  • Main payload of Space Shuttle Endeavour’s last flight (May 16, 2011)
  • Installed on ISS on May 19, 2011
  • 7x24 running
  • Up to now, over 122 billion events collected
  • Max. event rate: 2KHz
AMS DATA FLOW

• Data transferred via relay satellites to Marshall Space Flight Center, then to CERN, nearly real-time, in form of one-minute *frames*

• **Preproduction**: Frames $\rightarrow$ runs *(RAW)*: 1 run = $\frac{1}{4}$ orbit (~23 minutes)

• **Standard Production**
  – Runs 7x24 on freshly arrived data
  – Initial data validation and indexing
  – Produces Data Summary Files and Event Tags *(ROOT)* for fast events selection
  – Usually be available within 2 hours after flight data arriving
  – Used to produce various calibrations for the second production as well as quick performance evaluation
SCIENCE OPERATION CENTER (SOC)

• Processing of the AMS science data for detector evaluation and physics analysis
  • Data production
  • Monte-Carlo simulation
• Maintaining local production farm
  • 20 hosts, 302 cores
  • 400 TB storage
• Operations on the services/resources provided by CERN IT
  • Batch (HTCondor & LSF), EOS, CASTOR, AFS, CVMFS, ELOG, PDB-R, etc.

Monitoring (all of the above) is important and challenging!
CHALLENGES OF SOC MONITORING

- Data taking and processing is 7x24 running
  - For detector performance evaluation
- Long data transmission path
- Widely distributed compute facilities
  - Europe: CERN, RWTH, CNAF, IN2P3, ...
  - Asia: SEU, Acad. Scinica, ...
  - America: NERSC, ALCF, ...
- Various service providers
WHAT WE ALREADY HAVE

• Frame monitor
  • delay of frames
• Production monitor
  • standard production jobs
• Data files list
  • Summary of raw and ROOT files
• NetMonitor
  • Hardware/storage monitoring of local production farm

We need more centralized monitoring
WHAT CERN IT PROVIDES

• MONIT Infrastructure [1]

ROADMAP – CERN IT SERVICES/METRICS

• Sources
  • Taken care of service providers (EOS/batch/FTS/... teams)

• Transport, processing, and storage
  • Taken care by MONIT

• Access
  • Modify dashboards from service providers to concentrate on the services/hosts which affect us
  • Create relevant Alerts with notifications
ROADMAP – OUR SERVICES/METRICS

• Sources
  • Modify our existing monitoring tools to send “Metrics” to InfluxDB
  • Use Collectd to gather the standard hardware/storage data of hosts
  • Log files to HDFS
  • And more...
  • Transport, processing, and storage
    • Taken care by MONIT

• Access
  • Build dashboards
  • With Alerts
IMPLEMENTATION

• Request a new organization in monit-grafana
• Request the access right for the data sources we concern
  • monit_idb_eos, monit_idb_tape, monit_idb_transfers, monit_idb_collectd_XXX
• Request to create our own InfluxDB data source
  • monit_idb_amsassoc
  • Modify/write scripts/programs to send data to the data source
• Modify/write dashboards for data access
EXAMPLE – EOS QUOTA

• Digging data from monit_idb_eos
• Singlestat to show the percentage of byte usage
• Graph to show the data and history of:
  • used_bytes and quota_bytes
  • used_files and quota_files
• Alert to warn when approaching the quotas
EXAMPLE – HOST LOAD

- Digging data from monit_idb_collectd_load: load
- Graph to show the data and history of the load of specific host(s)
EXAMPLE – STANDARD PRODUCTION DELAYS

- Data format and structure
  - The last frame data arriving time
  - The last frame data collecting time
  - The last raw file validation time
  - The last ROOT file validation time
  - The latest reconstructed run collecting time
- A script running every 15 minutes to get the above data and post to http://monit-metrics:10012/
EXAMPLE – STANDARD PRODUCTION DELAYS (CONT.)

SELECT last("frame_arr_delay") AS "Frame_arrival" FROM "metric" WHERE $timeFilter GROUP BY time($__interval) fill(none)

SELECT last("frame_delay") AS "Frame" FROM "metric" WHERE $timeFilter GROUP BY time($__interval) fill(none)

SELECT last("raw_delay") AS "RAW" FROM "metric" WHERE $timeFilter GROUP BY time($__interval) fill(none)

SELECT last("root_delay") AS "ROOT" FROM "metric" WHERE $timeFilter GROUP BY time($__interval) fill(none)

SELECT last("fresh_run_delay") AS "FRESHRUN" FROM "metric" WHERE $timeFilter GROUP BY time($__interval) fill(none)
FURTHER WORKS

• Add more data sources:
  • Hardware: CPU/memory/disk/…
  • Batch service: under negotiation
  • MC production monitoring
  • Data from remote computing centers
• Add more alerts and connect to our FE
• Tune the dashboard structure
SUMMARY

• 7x24 data taking and processing brings more challenges for monitoring.

• SOC monitoring tools have been modified for the integration with MONIT infrastructure.

• Metrics Source provides a flexible way for our monitoring data ingestion.

• Grafana dashboard is used for visualization of the monitoring data from our own monitoring tools as well as from the CERN IT public services (EOS, Condor, FTS, etc.)
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