LIGO

CDS Computing and Software February 2026 Update

LIGO Systems Meeting
February 11, 2026

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Olivia Godwin, Jonathan Hanks, Jameson Rollins,
Michael Thomas, Patrick Thomas, Erik von Reis, Caleb Wheeler

IR1 Readiness Summary

Already done/in-progress:

- New models and front-ends
- DAQ reconfiguration for Arrakis support
- New ndscope release

Remaining tasks:

- Deploy new ethernet-based IPC fabric
- DAQD improvements
- RTS release
- OS upgrades

New Ethernet-based IPC Fabric

EJ Dohmen

Ready to deploy new Ethernet IPC to replace Dolphin.

- Many improvements over Dolphin:
  - Cheaper: uses COTS low-latency Ethernet NICs (going with NVidia ConnectX-6).
  - Higher bandwidth: more IPCs per host.
  - Lower long-link latency: slightly slower in short links, but well within tolerance.
  - Significantly more robust: front-ends fully isolated, no lock-ups on host restarts.
  - Better availability: better support for smaller systems, tests stands, etc.
- Currently requires dedicated receiver CPU on front end machines (all IPC front ends have spare CPUs).
  - Future releases may eliminate this need.

New Ethernet-based IPC Fabric

EJ Dohmen

Ready to deploy new Ethernet IPC to replace Dolphin.

- Multiple months of stability testing on DTS1 have completed with *no IPC errors*.
  - DTS1 testing done with 10G transceivers, will replace with 25G when available.
- Existing 4km fiber links are suitable.
- Almost all hardware in hand.
  - LHO still waiting on long-lead switches (probably need to push on this).
- ECR E2600038: Production Replacement of Dolphin with Ethernet IPC (in progres)

DAQD improvements

Jonathan Hanks

New frame writer:

- Have demonstrated byte-for-byte identical frames to old frame writer.
- Able to consume either DAQD or Arrakis data streams.
- Support v9 frame spec.
- Review initiated, Stuart Anderson is lead.
- ECR E2500271: replace daqd framewriter in CDS (pending)

Replace DAQD interconnect with ethernet:

- Use standard network transport instead of Dolphin (distinct from ethernet IPC)
- ECR E2500243: Replace Dolphin DAQD interconnect with Ethernet (pending)

Front end hardware testing

Evaluating new systems for front end computers:

- The Intel Xeon Silver chip tested was RT compatible but slow (low CPU clock speed).
- Unable to find a real-time compatible configuration for the AMD EPYC 9124 16-core machines.
  - Rare long-tail latencies (+15 us) in simple benchmarks.

Have yet to identify suitable FE replacement hardware.

Need to formulate a plan for broader testing of new hardware…

New LIGO DAC and ADC cards

- RTS already supports new DACs (thanks to **EJ**), with QOL updates in upcoming RTS 5.5.2 release.
  - 11 LIGO DACs already in production at LHO.
- Upcoming RTS release will include support for new ADCs, but more ADC testing is needed.
- Will need to continue to support General Standards devices for a while.
  - To support existing test-stand/CyMAC deployments, 40m, LASTI, etc.
- New cards require LIGO timing interface.
  - CyMACs will require LIGO timing cards in the future if they want to use new ADCs/DACs.
- Hoping to provide better support for CyMACs and other small systems with these new devices.

LIGO OS testing

- Production systems are currently Debian 10
- Debian 11 is LTS, 13 is latest release (2025-08).
- **Targeting Debian 13 for IR1.**
  - For all front ends, DAQ machines, guardian.
  - Minor packaging issues need to be resolved.
- DTS1 will be upgraded to Debian 13 soon for full-scale testing.

New model code version tracking capabilities

EJ, Dave

Model builds previously based just on the head of the USERAPPS repo. This caused multiple problems, made it difficult to track deployments, manage upgrades, etc.

New **rtcds** “rev-lock” and “rev-build” features address these issues:

- Requires all dependencies be checked into SVN to “lock” a model.
- Feedback on which dependencies are being updated, can choose not to update common files.
- Produces replicable builds that are captured with revision control.
- Models built from fresh export of dependencies, ignores current SVN head.
- Production systems only allow the installation of rev-built models.

Measurement tools development

Much work done on measurement tools libraries as basis for unifying **DTT** and **ndscope** into an improved GUI/UX with better time- and frequency- domain workflows for commissioners.

Erik von Reis
Patrick Thomas

New data cache backend (rust):

- **NDS** and **Arrakis** data source support.

dttlib: new core DTT measurement library (rust):

- Fully double precision.
- Supports custom python code, and most features of ffttools.
- Todo: swept-sine, sine-response measurements.
- Eventually support measurement scripting.

Measurement tools development

New **ndscope** release **v0.20**:

- Uses new dttlib and data cache.
- Supports Arrakis.
- Numerous small improvements:
  - Live minute trends
  - Improved channel search
  - Better text resizing, aligned axes, etc.
- Upcoming improvements:
  - Arbitrary time domain transformations using custom python data pipelines from dttlib.
  - Better display bit-field channels.

Erik von Reis
Patrick Thomas

Near future release will support *frequency domain plotting and measurements*.

Longer term development roadmap

RCG rewrite

- Python library interface.

Model design/layout GUI

- Exploring alternatives to Simulink, eliminate dependency on MATLAB.
- Would enable *many* UX improvements.
- Considering various options (custom software, repurposed tool, etc.)

Sequencer rewrite

- Manage kernel modules, awgtpman directly.
- git tracking of model data files.

Math improvements

- Vector processing, complex values, double-precision test points

Longer term development roadmap

Real-time processing in userspace

- Via existing kernel CPU isolation interface, no kernel patching required.
- Kernel development in this area continues to look promising.
- Already have some support for this in RTS.

Better support for neural networks

- Better support for on-the-fly network parameter loading (similar to foton, state space).

MEDM replacement

- Candidates identified and being evaluated.
- Momentous task to convert and validate all screens.

Foton library parser

- Better integration into other tools.
- Saner file format.

LIGO Beckhoff

Patrick T., Caleb, Michael T.

CDS working to provide better support for the Beckhoff systems at the sites.

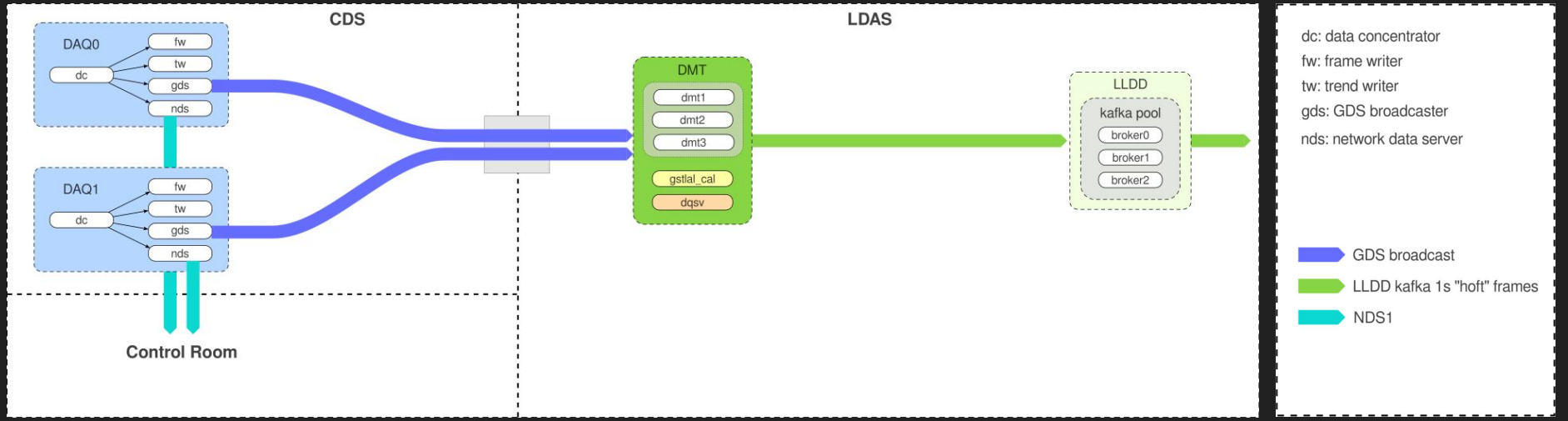
- New chassis for CHETA.
  - Includes new code for linear translation stage.
  - Adding CHETA lasers to existing safety interlock system.
- New support for JAC.
- **Patrick** leading rewrite of EPICS IOC code to address various issues.
- Future work: Beckhoff direct data acquisition by DAQ.

Arrakis for IR1

Olivia Godwin, Jonathan Hanks, Martin Beroiz, JR

- New Arrakis stream processing systems to fully replace end-of-life DMT and NDS systems at LIGO sites by O5.
- Were expecting two more years of development and testing.
  - For both core Arrakis infrastructure and critical stream processing application replacements (calibration, detchar, etc).
- Aggressive new run schedule curtails development/testing period.
- Need to retire DMT risk ASAP, but also need to be ready for IR1.
- Staged deployment plan balances risk.

O4 system: Data Monitoring Tool (DMT)



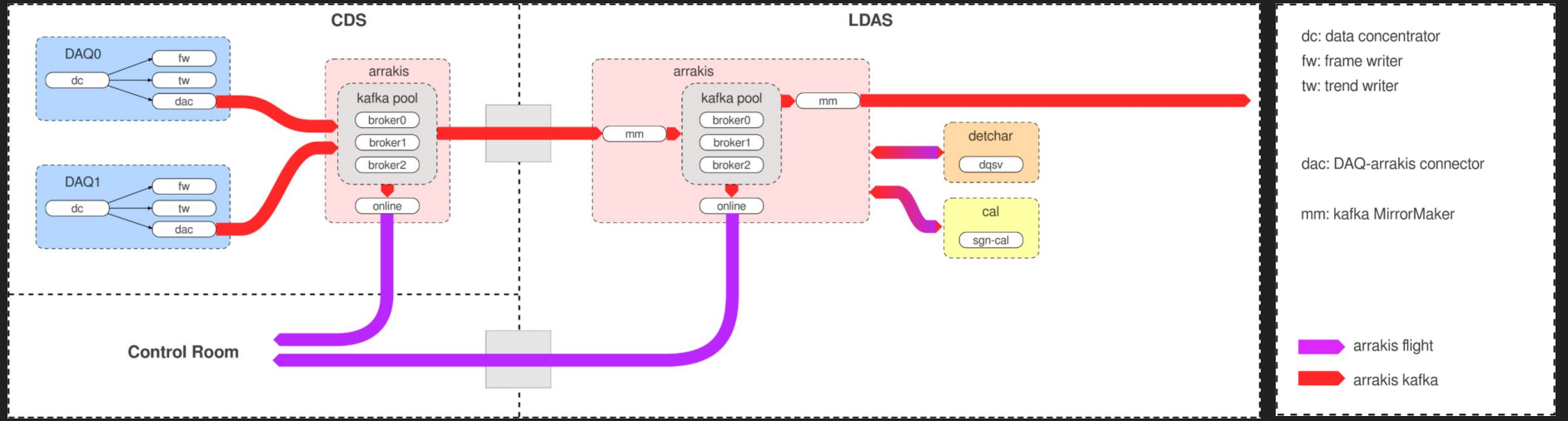
DMT current handles all critical stream processing functionality:

- Calibration pipeline
- Detchar state vector calculation
- HOFT 1s frame generation and injection into low-latency data distribution (LLDD)

DMT is end of life.

- No longer supported.
- Difficult to maintain.
- Can’t be scaled, improved, sped up, etc.
- **Presents significant risk to continue to operate.**

O5 target: full Arrakis deployment



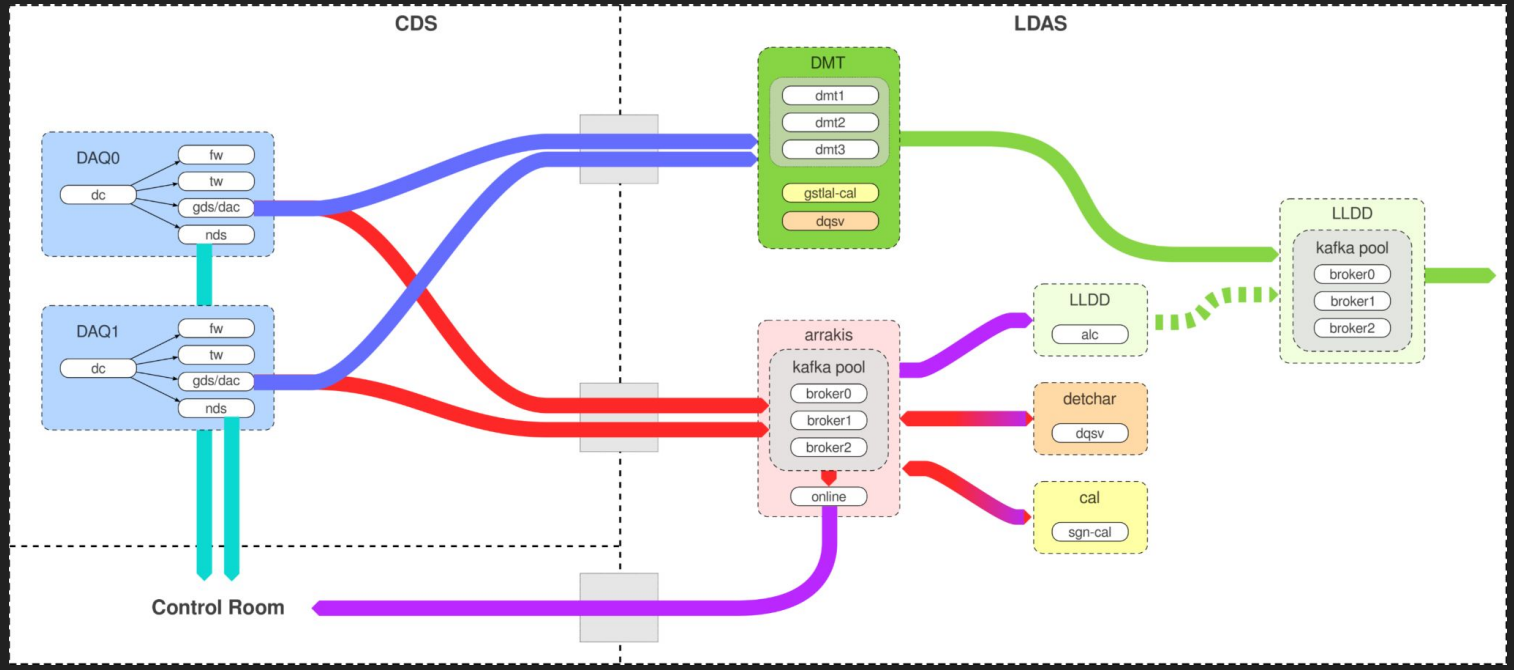
Arrakis replaces:

- DMT
- NDS
- LLDD

New Arrakis stream processor apps handle critical low-latency calculations:

- calibration: *sgn-cal*
- detchar: *dqsv*
- *gwistat* (range calc)
- (hopefully many new applications!)

IR1 plan: Arrakis with DMT backup



- Put DMT “on ice”; leave existing system alone, **no system updates**.
- Parallel Arrakis deployment → transition after sufficient testing/review.

Arrakis for IR1

- **All O4 systems will remain in place untouched at both sites for IR1.**
  - DMT, NDS, LLDD, gstlal calibration pipeline, dqsv, etc.
- Parallel Arrakis deployment will allow full-scale testing/validation/review between new and old data products.
  - DAQD reconfiguration to support this already complete.
  - ECR E2500314 - Reconfigure DAQD arrangement for NGDD support (approved)
- **Goal to transition to Arrakis by IR1.**
  - Arrakis infrastructure nearly all in place, about to start full-scale testing.
  - New calibration pipeline (sgn-cal) is the long pole.
- John Zweizig being retained as consultant until transition complete.
- Final ECR for transition will be created when we're closer to being ready.

CDS thoughts on AI

https://dcc.ligo.org/LIGO-G2501482

Feedback, issues, suggestions welcome

Please create *issues* on the CDS “help desk” project for *any* CDS related issues, help requests, feedback, needs, suggestions, questions, etc:

https://git.ligo.org/cds/helpdesk

For issues related to DMT replacement and NGDD in general please create issues with CDS helpdesk and they will be redirected appropriately.

DTS1 Ethernet IPC Setup