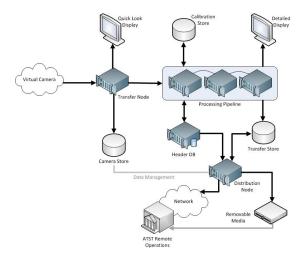
DKIST Data Handling System (DHS):



Handling the large amounts of data created by the DKIST instruments with their high framerate large-format cameras is challenging. DKIST provides a telescope wide DHS that unifies the way data and metadata are transported and stored at the Haleakalā summit and manages their transfer off the mountain. DKIST Facility Instruments also use this system to provide near-real time quality assurance images to the telescope operators.

Concepts and Changeover Times:

The DKIST DHS is designed to transport and store the data volumes generated by the most data demanding facility instruments, the Visible Broadband Imager (VBI) and the Visible Tunable Filter (VTF). These instruments are capable of utilizing the full capabilities of the large-format high-speed DKIST cameras, yielding data streams of up to 960 MB/s *per camera*.

To satisfy the aggregate instrument demands of multiple instruments used simultaneously in standard configurations, the DHS provides five dedicated data pipelines, each capable of transporting data at the highest bandwidth generated by a single DKIST camera. When not all cameras are running at the highest speed and/or with reduced frame sizes, one pipeline can be shared among multiple cameras with some loss in total bandwidth performance.

The DKIST DHS is designed to accommodate average multi-instrument scenarios with all instruments running at standard data output rates that are typically lower than the maximum possible data output rates of each instrument. The baseline configuration for networking hardware encodes the sharing of bandwidth of the pipelines between instrument cameras.

When a special use case requires an instrument to exceed its standard data output rate, the DHS must be reconfigured to be prepared for the increased use of bandwidth by that instrument. Changing the configuration requires manual interaction with software tools and assumes that the current observations have completely ceased. Reconfiguration of the networking hardware can occur *within minutes*.

The design of the DKIST DHS storage capacity is based on the (same) average multi-instrument scenario. Very data demanding use cases requiring the highest bandwidth in the pipelines *may have to be limited in total duration* in order to not exceed the maximum daily storage capacity or adversely impact DKISTS's ability to transport the data off-summit to free up the resources for the next day.

Notes on Use Cases Underlying DHS Baseline Configuration (below):

- 1. The VBI will in the majority of all cases reconstruct its data in near real-time, effectively resulting in a reduction of its data volume with a ratio of 80:1. Therefore, VBI raw data is typically deleted at the end of the day of observation. This dramatically reduces the amount of data that needs to be transported off the summit.
- 2. The VTF use presented is based on its 'binned polarimetry' mode.
- 3. The ViSP data rates are based on the current ViSP design using the 2048² Andor Zyla camera format.
- 4. Cryo-NIRSP runs standalone only and so does not share bandwidth with the Adaptive Optics, Target Acquisition Telescope, and DL-NIRSP data in Pipeline 5.

DHS Baseline Configuration (subject to change):

| Pipeline | Cameras | Individual bandwidth | Assumed Final Volume after 1 day |
|----------|-------------------------------|----------------------|----------------------------------|
| _ | | [960 MB/s maximum] | [target: 4h observation] |
| 1 | VBI blue | 960 MiB/s | 14 TiB ¹ |
| 2 | VBI red | 960 MiB/s | 14 TiB ¹ |
| 3 | VTF 1 ² | 240 MiB/s | 4 TiB |
| | VTF 2 ² | 240 MiB/s | 4 TiB |
| | VTF 3 ² | 240 MiB/s | 4 TiB |
| | | 720 MiB/s + overhead | Sub-Total: 12 TiB |
| 4 | ViSP 1 ³ | 130 MiB/s | 2 TiB |
| | ViSP 2 ³ | 130 MiB/s | 2 TiB |
| | ViSP 3 ³ | 130 MiB/s | 2 TiB |
| | | 390 MiB/s + overhead | Sub-Total: 6 TiB |
| 5 | AO data ⁴ | 18 MiB/s | 0.5 TiB |
| | Target Telescope ⁴ | 80 MiB/s | not stored |
| | AO Context View ⁴ | 80 MiB/s | not stored |
| | DL-NIRSP 1 ⁴ | 200 MiB/s | 3 TiB |
| | DL-NIRSP 2 ⁴ | 50 MiB/s | 1 TiB |
| | DL-NIRSP 3 ⁴ | <u>50 MiB/s</u> | <u>1 TiB</u> |
| | | 478 MiB/s + overhead | 5.5 TiB |
| | Cryo-NIRSP 1 ⁴ | 80 MiB/s | 1.1 TiB |
| | Cryo-NIRSP 2 ⁴ | 80 MiB/s | 1.1 TiB |
| | | 160 MiB/s + overhead | 2.2 TiB |
| | | | Sub-total: 8 TiB |
| | | Total: 3508 MiB/s | Total: 54 TiB ¹ |

NOTE:

The above table should be understood with the following considerations:

While the DKIST Data Handling System was *designed to* the handle the numbers in the above table, it is *unlikely* that this scenario will be achieved on a daily basis.

Current projections of data volume exported by DKIST show an *average* of about 11 TiB per day (averaged over the course of one year of early operations). Nonetheless, infrequent peak export data volumes will be supported.

Beamsplitter and Data Rate Tool:

The DKIST Team provides a tool to analyze whether a certain desired combination of instruments is feasible with the DHS. This tool is combined with an analysis of whether envisioned instrument combination is feasible optically.

Please see the FIDO description document for more information on the tool.