DECam Community Pipeline Review

NCSA

August 30-31, 2010

DTS – The NOAO Data Transport System

NOAO SDM

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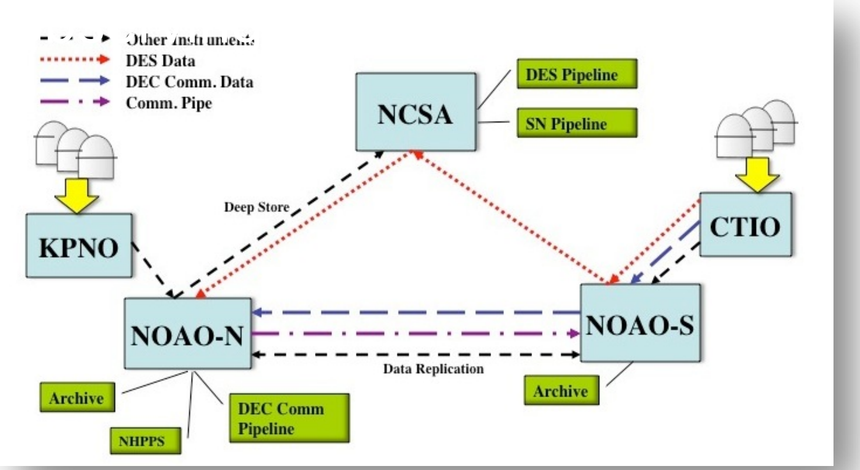
DARK ENERGY
SURVEY

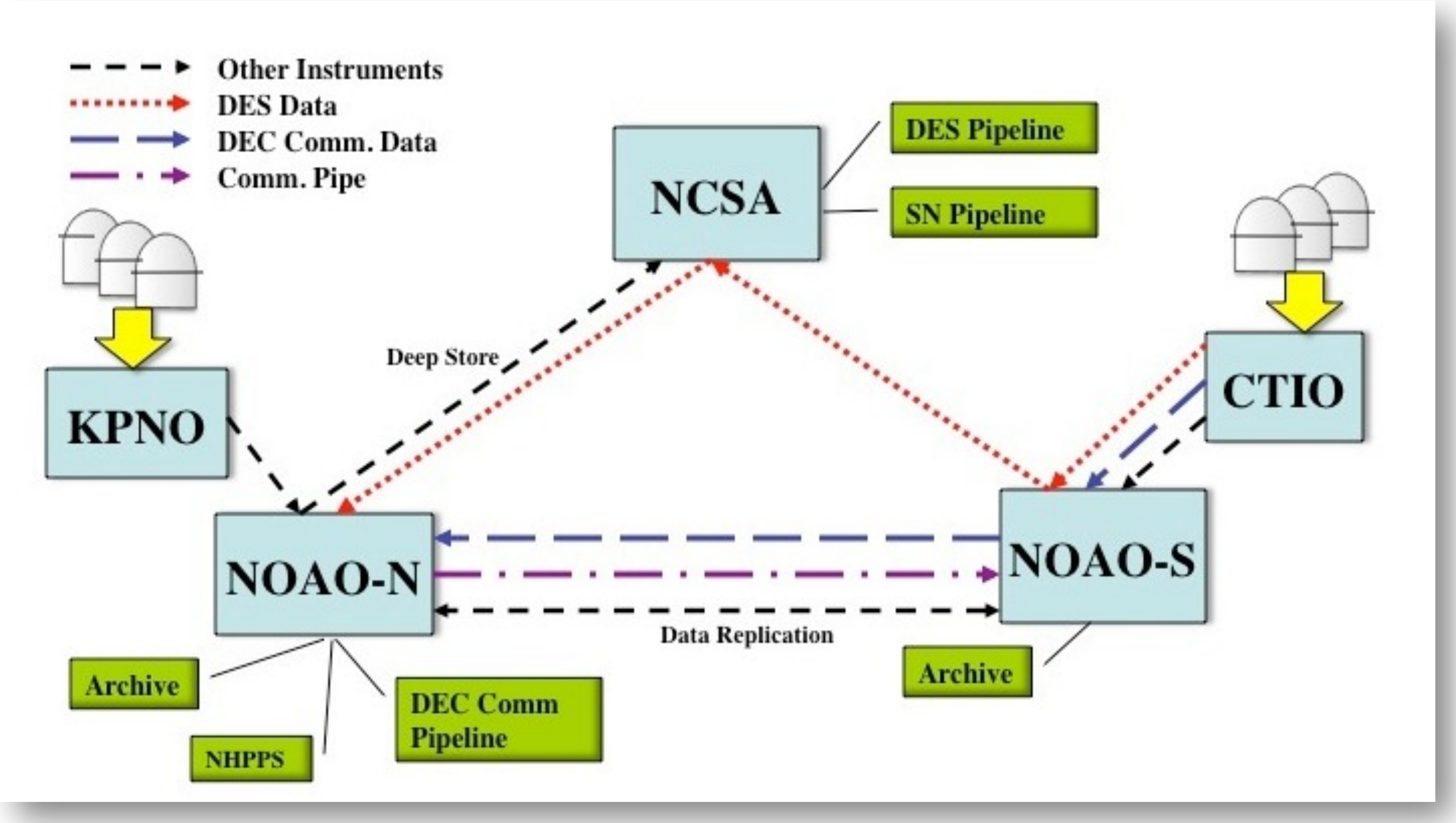
DTS Project Background

DTS is designed for DECam, but it will eventually be used throughout the NOAO E2E system:



- Must make better use of network
- Must allow data to be routed based on DES/Community use
- Must interface with both NOAO and DECam systems
- Must be configurable for data rates and sizes other than DES
- Must operate in variety of network environments

DTS Dataflow



Other Instruments

DES Data

DEC Comm. Data

Comm. Pipe

NCSA

DES Pipeline

SN Pipeline

KPNO

CTIO

Deep Store

NOAO-N

NOAO-S

Data Replication

Archive

NHPPS

DEC Comm Pipeline

Archive

DTS Requirements

- Must transfer a *typical* DES night in 18 hrs. So, what is *typical* ?
  - 350 images (60 are bias/flat calibrations, remainder are science frames in various filters)
  - Differing sizes
    - ~389 MB for a Bias thru ~701 MB for *z*-band object
    - Average file size: 589 MB
    - Total for the night: ~206 GB
- Must play nice with the rest of the network
  - To meet transfer requirement, we need a sustained 27 Mbps assuming we use only 75% of current bandwidth
- Must interface with external entities
  - Not all of which are NOAO-controlled

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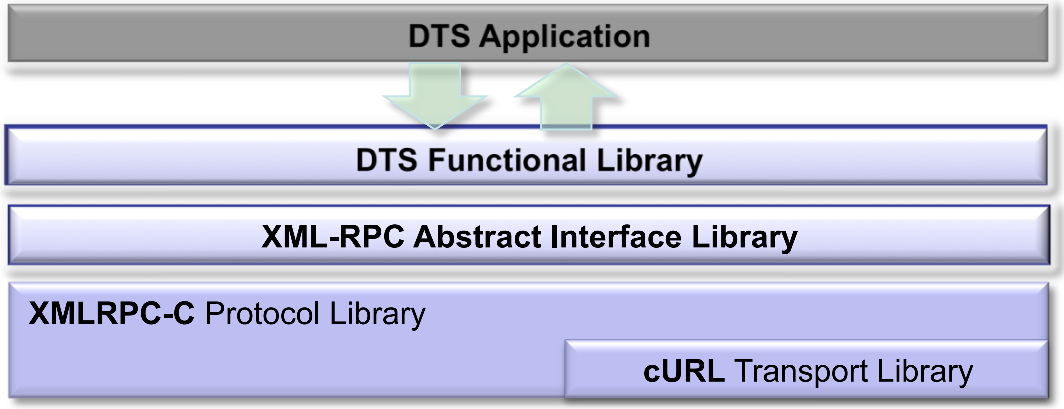
External Entities

- At the telescope
  - SISPI must queue the data for transport
- On the mountain
  - iSTB must modify the headers to add archiving keywords
- NOAO-S (La Serena)
  - Save copy of raw data saved to local data store
- NCSA / DES-DM
  - Delivery to DM for (DES) pipeline processing
  - Separate Delivery for SN pipeline (?)
- NOAO-N (Tucson)
  - Ingest into NSA
- Ad-hoc Transport
  - SLAC-Fermi for eng, DB sync, PreCam, etc

DTS Implementation

- SOA based on XML-RPC
  - Provide and consume basic services without requiring persistent connections
  - Can be configured as *Unix* service for automatic recovery in case of crash
  - Allows for remote monitoring and management
  - Client applications are language independent
  - Common DTS process providing services at each site
  - Highly multi-threaded and configurable
- Written in ANSI-C
  - Self-contained
  - Currently ~30 KLOC



DTS Application

DTS Functional Library

XML-RPC Abstract Interface Library

XMLRPC-C Protocol Library

cURL Transport Library

DTS Features

- XML-RPC Based
  - Designed for remote monitoring/control, automated operation
  - Fully configurable at each node in the network
- Multiple, independent transport queues
  - Continuous FIFO, scheduled or priority
  - Queues define the data routing, transfer can be *tee*’d
- Multiple transport methods permitted
  - Parallel TCP/IP sockets (current), UDP packets/other TBD
  - Configurable to optimize for few large files, many small ones or particular network characteristics (e.g. more threads for slow links)
- Allows processing at each stage in transfer
  - Interface with external entities
- Guarantees file integrity and graceful error recovery

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Bulk Transport Models

The *transport model* is independent of *transport method.* One describes the direction of transport and the RPC activity, the other refers to the actual network protocol used.

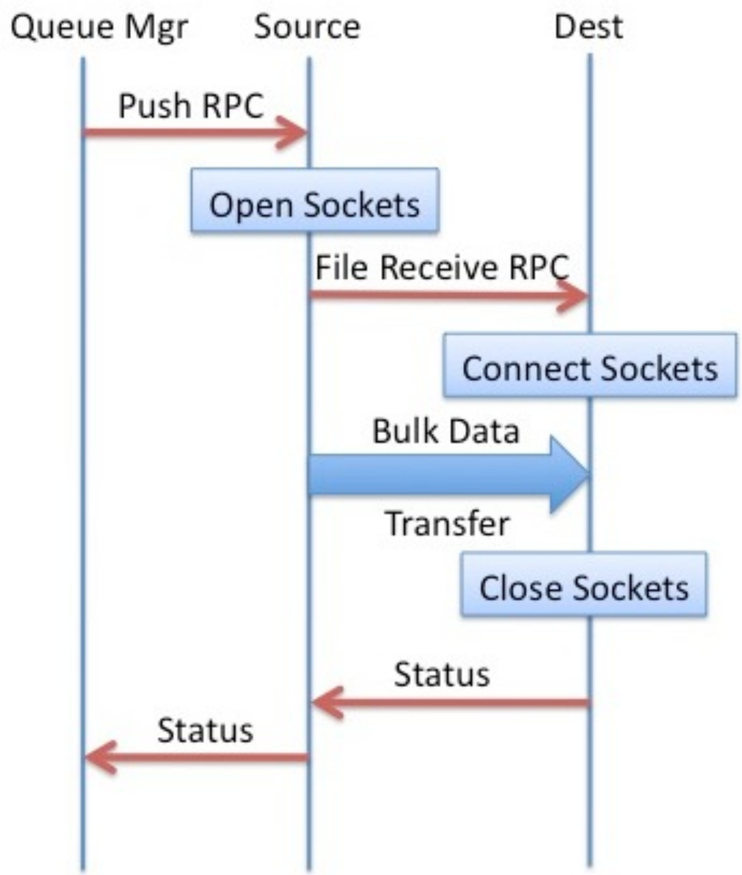
PUSH / PULL

- A *push-to* or *pull-from* a node assumes that node is offering a transport service and is willing to supply the transport sockets

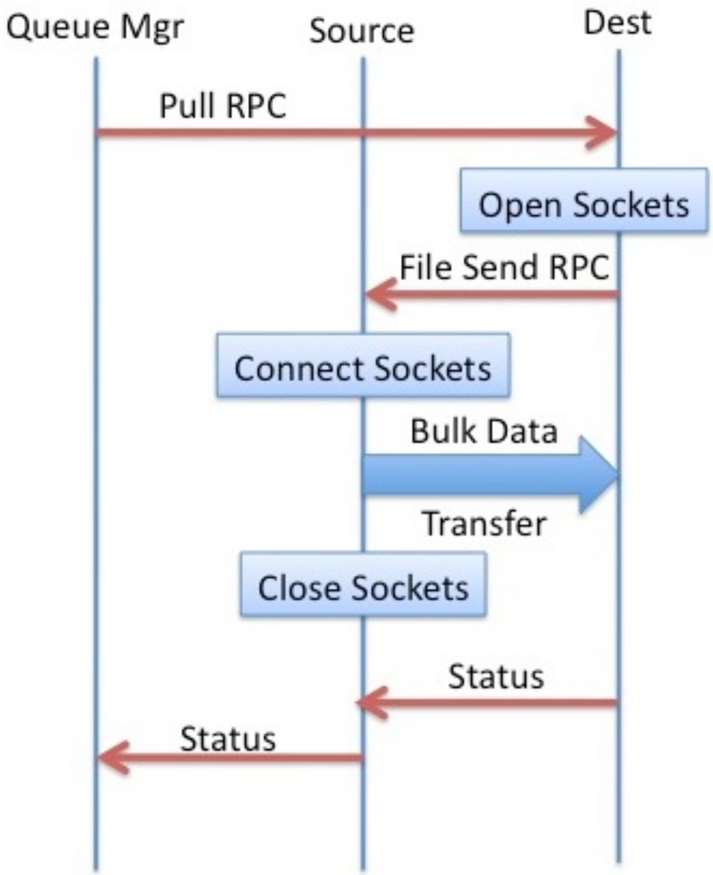
GIVE / TAKE

- A *give-to* or *take-from* a node is used when we're willing to provide the service and sockets to ensure successful transport

Bulk Transport Models



Push Transfer Model



Pull Transfer Model

Bulk Transport Methods

- Currently only implements a Parallel TCP/IP Socket transfer method
  - Number of threads allocated used to regulate bandwidth usage
  - Multiple levels of checksum validation allowed (not all used):
    - Chunk – data transferred in one request, e.g. 64Kb
    - Stripe – data transferred on each thread
    - File – whole-file checksum value
  - Multiple checksum values available (BSD/SYSV, MD5, etc)
  - No assumptions made about contents of files being transferred
- Other methods can (theoretically) be added for use in all transport modes

Queue Types & Modes

Queue Types:

- Ingest -- Entry point to DTS
  - Can modify data for before transport using Delivery App
- Transfer -- Midpoint node in the data path
  - Normal delivery mechanism
- Endpoint -- Terminal point of data path
  - Data can be removed from queue on completion

Queue Modes:

- Normal – FIFO processing as long as data available
- Scheduled – Transfers at specific times / intervals
- Priority – Blocks all other queues until complete

Configurability

Sample DTS (daemon) configuration file.

The configuration file is made up of one or more entries with the following structure:

```
 <global values>            # debug, verbose, etc
dts                         # define DTS node
  <dts parameters>          #
    queue                   # define a queue
      <queue parameters>    #
```

Configurability

Sample Queue Configuration

```
# Queue configuration
queue
    name            test              # queue name
    node            transfer          # ingest, transfer, or endpoint
    type            normal            # normal, scheduled, priority
    mode            push              # push or give
    method          dts               # dts or [TBD]
    nthreads        4                 # No. of outbound threads
    port            3001              # base transfer port
    src             denali            # source machine
    dest            tucana            # destination machine
    deliveryDir     /tmp/foo.crux     # spool or /path/to/copy
    deliveryCmd     /home/fitz/imtest -i $inst $F
```

DTS Components

① **DTSD** – The DTS Daemon

② **DTSQ** – The DTS Queuing Agent

③ **DTSH** – A DTS shell and command-line tool

④ **DTSMON** – A DTS monitoring application

DTS Components

DTSD – The DTS Daemon

- Provides all DTS services on the machine
  - assumed there is one per '*site*'
- Responsible for managing transport queues
  - separate threads manage each queue
- Requires only command port be open to firewall
  - Transport sockets can be managed in configuration
- Sandboxed filesystem view for security
- Can be run as *xinetd* service or run entirely in user-space
- *Set/Get* methods permit remote management, *Status* methods permit monitoring

DTS Components

DTSQ – DTS Queuing Agent

- Queues data for ingestion into the DTS system
- Provides quick response so it won't block caller
- Acts as a ***dtsd*** to provide its own transport methods to the DTS,
    - i.e. SISPI requires no other DTS components to be installed
- Logs all requests
- Verifies DTS status before allowing transfer
- Permits recovery of failed requests for later re-queuing
- Leaves a “token” file with details of transfer on success

DTS Components

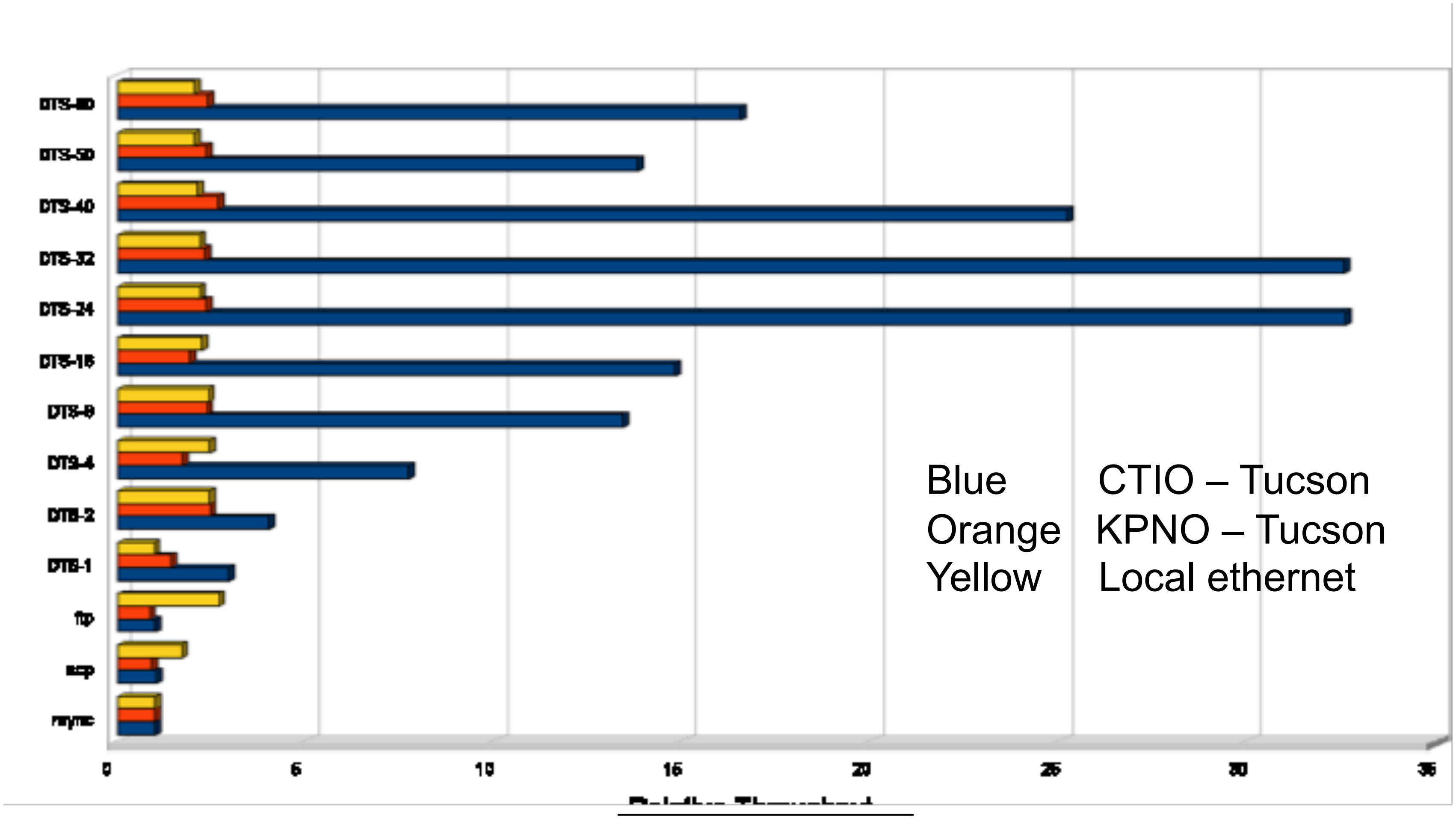
DTSH – A DTS shell and command-line tool

- Allows direct communication with a DTSD site
- Provides scripting capability for DTS commands
  - E.g. cron jobs to collect transport logs, monitor/restart services
  - Full access to all DTSD functionality

DTSMON – A DTS monitoring application

- Simple monitoring application
  - echoes messages generated by remote DTS components
  - Advanced tool / GUI planned for later development
- Runs on a reserved port
- Primarily meant for operations and development use
  - not required for routine use of DTS

DTS Relative Throughput



Blue	CTIO – Tucson
Orange	KPNO – Tucson
Yellow	Local ethernet

SISPI-DTS Interface

At the telescope: IB system invokes *dtsq* as e.g.

```
dtsq -q des -f inst=decam /path/image.fits
```

- The '*-q*' names the transport queue (i.e. *data route*) to be used
- The '-f' forks the command after verifying DTS is ready
  - transfer happens in child process
- The '*inst=decam*' shows use of a *pass-thru parameter*
- IB gets (near) immediate **OK/ERR** response
- On successful completion of transfer, details of transfer (time of request, time of completion, comments, etc) left on calling system logfile
- On error of transfer, request is logged for later recovery

DESDM-DTS Interface

At the DES (or SN) Pipeline:

- DTS invokes an external '*delivery application*'.
- This application:
  - *Requires* a single argument: the local path to the file
    - Additional parameters may be passed through from DTSQ
  - Is free to modify the file, the delivery app runs on a copy of the file in the configured 'delivery directory'
  - Must be provided by DES
    - DES knows best how to interface to their system

SDM-DTS Interface

On the mountain:

- iSTB invoked as '*delivery application*’ for DTS ingestion
  - Modifies image to add necessary archiving keywords
  - This modified image is what is transferred through the system

At NOAO Archive Centers:

- A TBD delivery application is used to trigger an NSA ingest of the file
  - File will be moved from delivery directory to final mass-store location

DTS Status

- Functional development complete
- Final documentation still pending
  - DESDM-DTS ICD document awaiting sign-off
- System currently undergoing stress-testing, e.g.
  - 10,000+ file transfers to eliminate memory leaks
  - Artificial failures of network connectivity, checksum failures, etc
  - Validate there is a proper recovery
- First real-world test expected with PreCam
- Likely requires small additional development for use in final E2E deployment
- Final throughput test waiting for CTIO network upgrade