

South Africa: SKA Regional Centre Activity

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IDIA



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA





Overview

- MeerKAT RC / Tier 2 facilities
- SDP DELIV
 - Data delivery architecture for the SKA
- Data distribution and data processing for MeerKAT data
 - Collaboration between IDIA, ASTRON and SKA-SA
- SKA-SA activities
 - MeerKAT commissioning / production
- CyberSKA portal and visualisation activities

MeerKAT International Large Survey Projects



imaging

- **LADUMA (Deep atomic hydrogen)**
- **MIGHTEE (Deep continuum imaging of the early universe)**
- **Fornax (Deep HI Survey of the Fornax cluster)**
- **MHONGOOSE (targeted nearby galaxies HI)**
- **MeerKAT Absorption Line Survey (extragalactic HI absorption)**

Time domain

- **ThunderKAT (exotic phenomena, variables and transients)**
- **TRAPUM (pulsar search)**
- **Pulsar Timing (no acronym)**

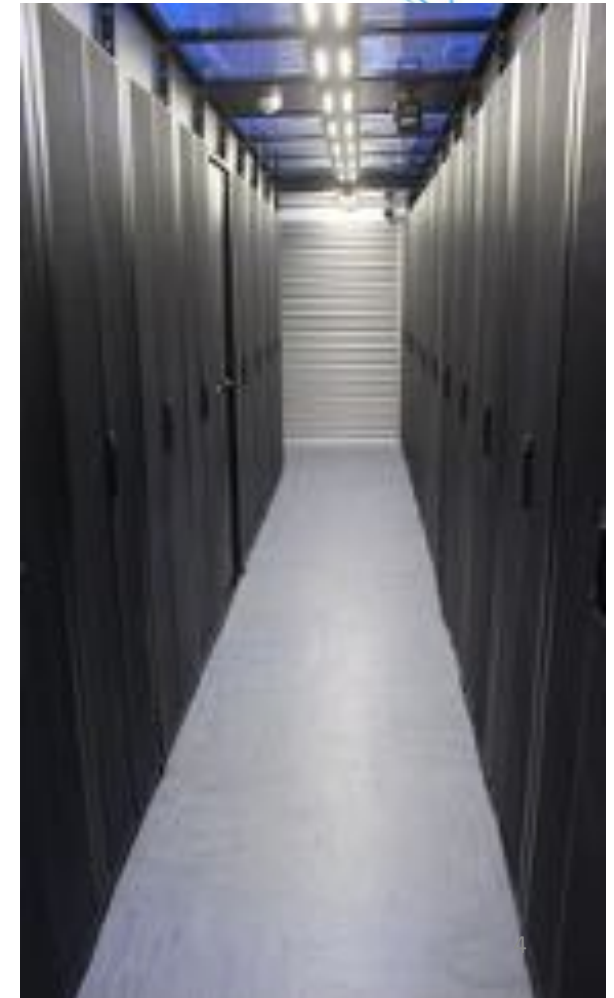
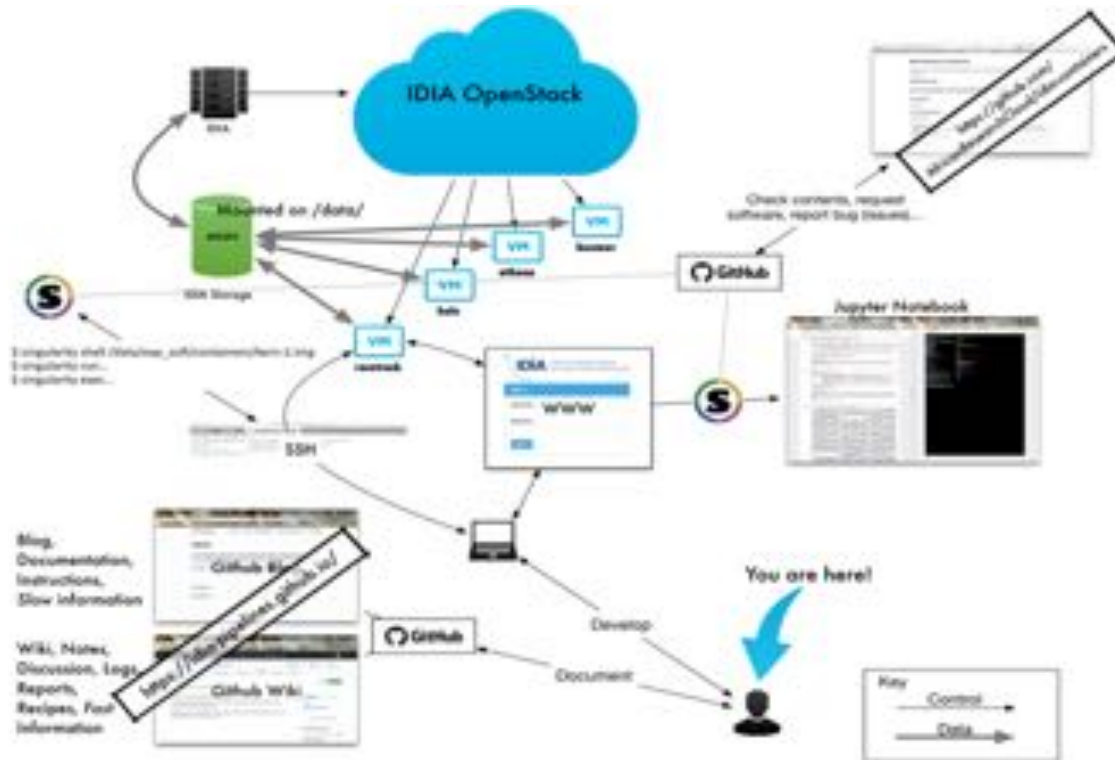


<http://public.ska.ac.za/meerkat/meerkat-large-survey-projects>

IDIA Data-Intensive Cloud: Jan 2017



R11M IDIA investment



Data Intensive Astronomy Cloud



racetrack.idia.ac.za
notebooks/pipeline/ Jupyter Hub

IDIA Inter-University Institute for Data Intensive Astronomy

Sign in

Username:
russ

Password:

Sign In

```
1 # data =  
2 # pipeline =  
3 # class =  
4 #  
5 # do this  
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racetrack.idia.ac.za
notebooks/pipeline/ calibrate

IDIA calibrate Last Checkpoint: Last Wednesday at 3:13 PM (unsaved changes) Control Panel Logout

File Edit View Insert Cell Kernel Help Trusted Jupyter-Case

First Stage Calibration Script

This script runs standard full-polarization calibration on raw visibility data sets. Russ Taylor: 07 June 2017, Adapted from casa python script.

Set preflag=True to flag the data before calibration

Set postflag=True to flag again after calibration

Select the data set to process with "data = <dataset>"

Other parameters are explained if the Set Parameters cell.

```
In [1]: 1 import os, time, sys, string, shutil  
2 import numpy as np  
3 sys.path.append("/users/russ/data/")  
4 from datasets import *  
5 execfile("/users/russ/data/merkat_pol.py")
```

Set Parameters

```
In [2]: 1 ionosphere = False      # create ionosphere correction calibration table as first step  
2 preflag = False        # flag the data before calibration  
3 postflag = True       # flag the data again after calibration  
4  
5 data = DEEP2  
6 print "Using %s data set %s with %d observations." % (data.telescope, data.name, len(data.observat  
7  
8 if (data.telescope=="MerKAT"):  
9     gainchannels = '1028-3068' # channel range to use for time-dependent gain calibration  
10    splitchannels = '100-4000' # channels to split for imaging  
11    subplotval = 821  
12 else:  
13    gainchannels = '40-216'    # channel range to use for time-dependent gain calibration  
14    splitchannels = '12-243'  # channels to split for imaging  
15    subplotval = 931  
16
```

Data Intensive Astronomy Cloud



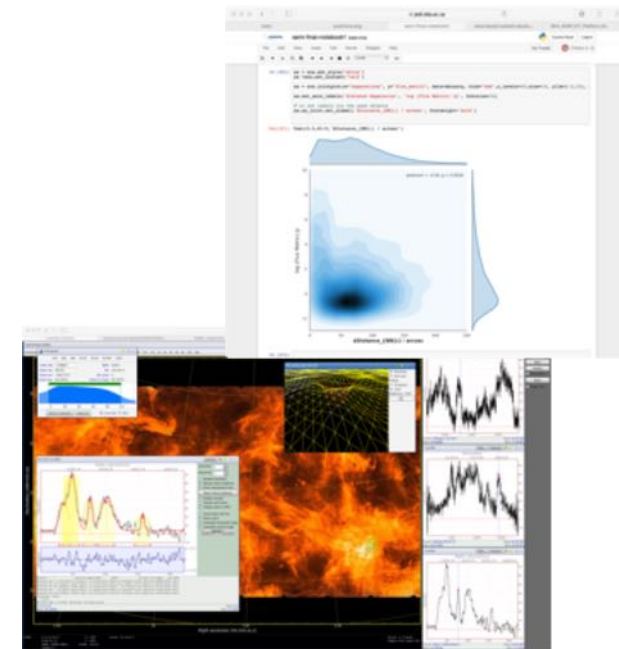
Image: MeerKAT AR1.5 Deep Observation

A screenshot of a JupyterLab web interface. On the left, a code editor displays Python code for data processing and visualization. The central pane shows a large, dark astronomical image with numerous bright spots, identified as a MeerKAT AR1.5 Deep Observation. On the right, a control panel includes a 'Control Panel' button, a 'Logout' button, and a 'Trusted' status indicator. Below the image, a URL is provided: <https://ca.cyberska.org/file/read/52799/deep-2-mfssc7imagett0fits>. The interface also shows a 'Sign in' form with fields for 'Username' (containing 'russ') and 'Password', and a 'Sign In' button.

IDIA Cloud-based MeerKAT Large Projects

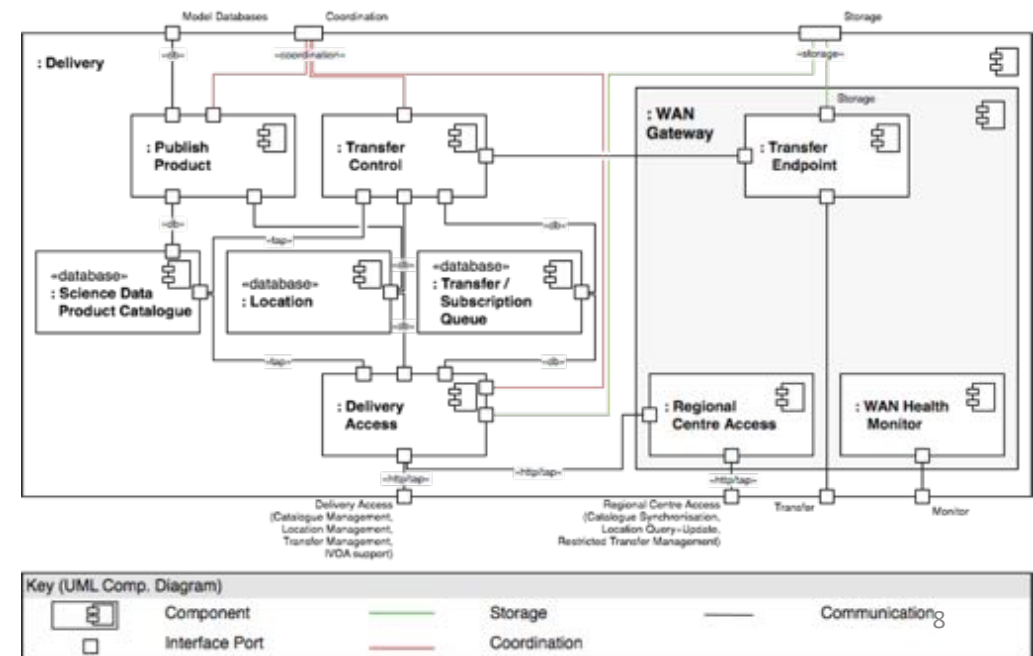
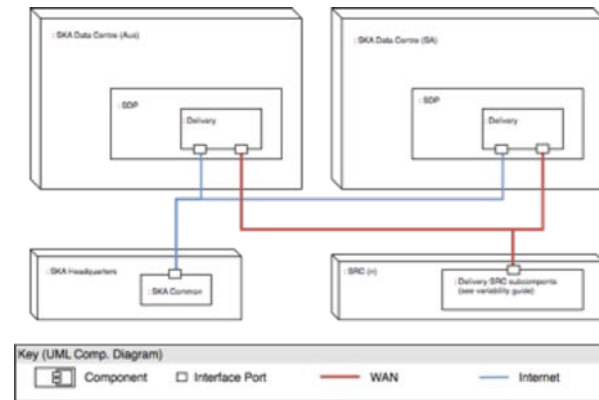


- **A Transient IDIA**
 - Pipelines processing and joint post-processing analytics for **ThunderKAT** radio and **MeerLICHT** optical observations
- **Pipeline Development for the MeerKAT Imaging Large Survey Projects**
 - Collaboration among **5 MeerKAT LSPs** to jointly develop pipeline processing of MeerKAT data
- **IDIA Visualization Toolkit: Converting Data Into Discoveries**
 - Development of visualization and visual analytics for **MeerKAT big image data sets** and use cases.
- **HIPPO: HELP-IDIA Panchromatic Project**
 - Multi-wavelength data fusion and analysis
 - Machine learning for classification from multi-wavelength data
- **Data Intensive Astronomy with LADUMA**
 - analytics and simulations for **LADUMA** HI science
- **How do Galaxies Form and Evolve**
 - Analytics and simulations for **MONGHOOSE** study of nearby galaxies
- **HI Intensity Mapping**
 - **MeerKLASS** preparatory studies
- **Very Long Baseline Interferometry**
 - Calibration, imaging and analytics of VLBI data sets
- **Open time science projects**
 - E.g. **MHISHAPS, VELA**,...



SDP Delivery Design

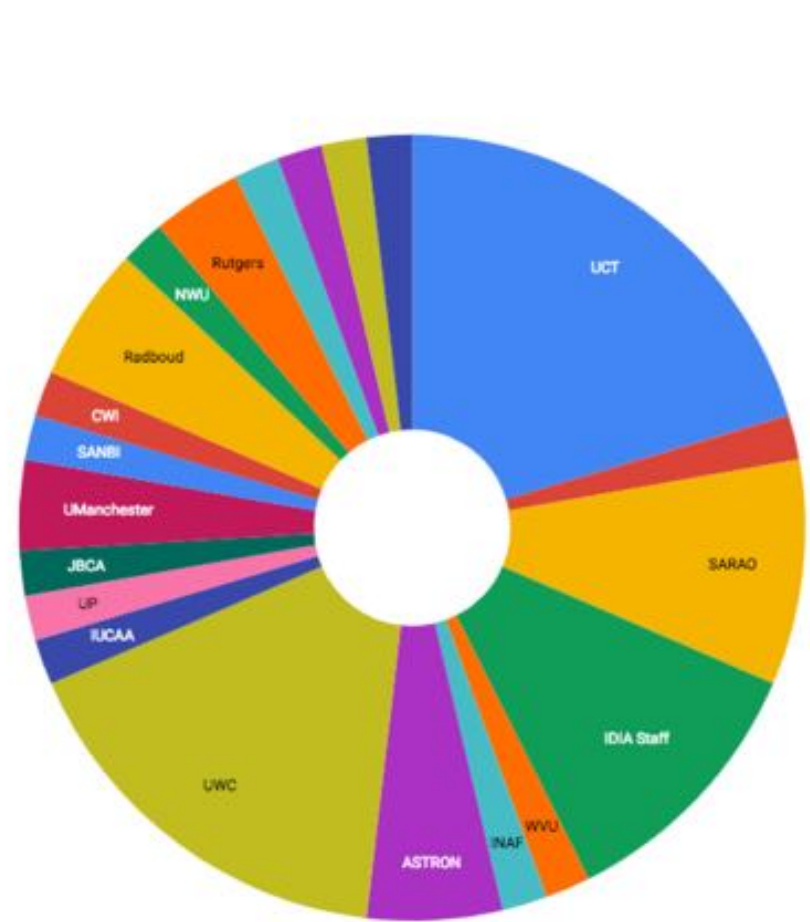
- IDIA leading SKA Data delivery design
 - Current group members from IDIA, CADC, ASTRON and IAA
- CDR version of architecture document to be delivered to GHQ at end of Oct.
- Parts being prototyped on IDIA cluster and supporting MeerKAT LSPs
 - Data delivery in place
 - Transfers from SARAO node, IDIA and ASTRON
 - IVOA deployment delayed
- Latest C&C diagram shown ->



IDIA Cloud MeerKAT LSP Users

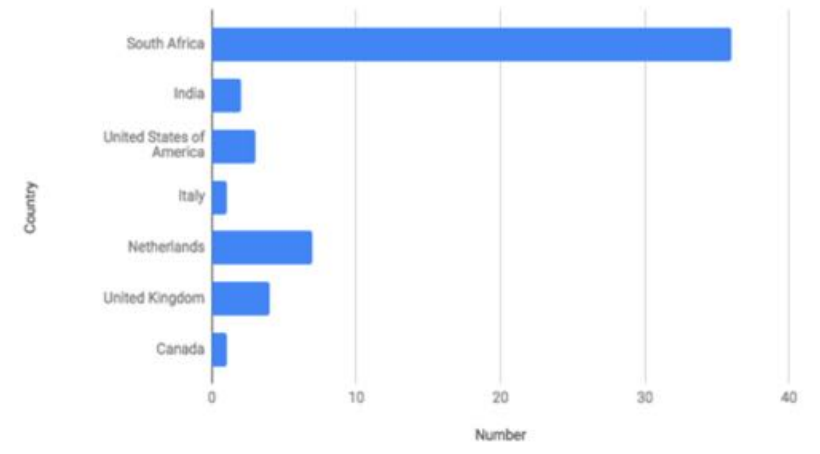


Science User Institutions



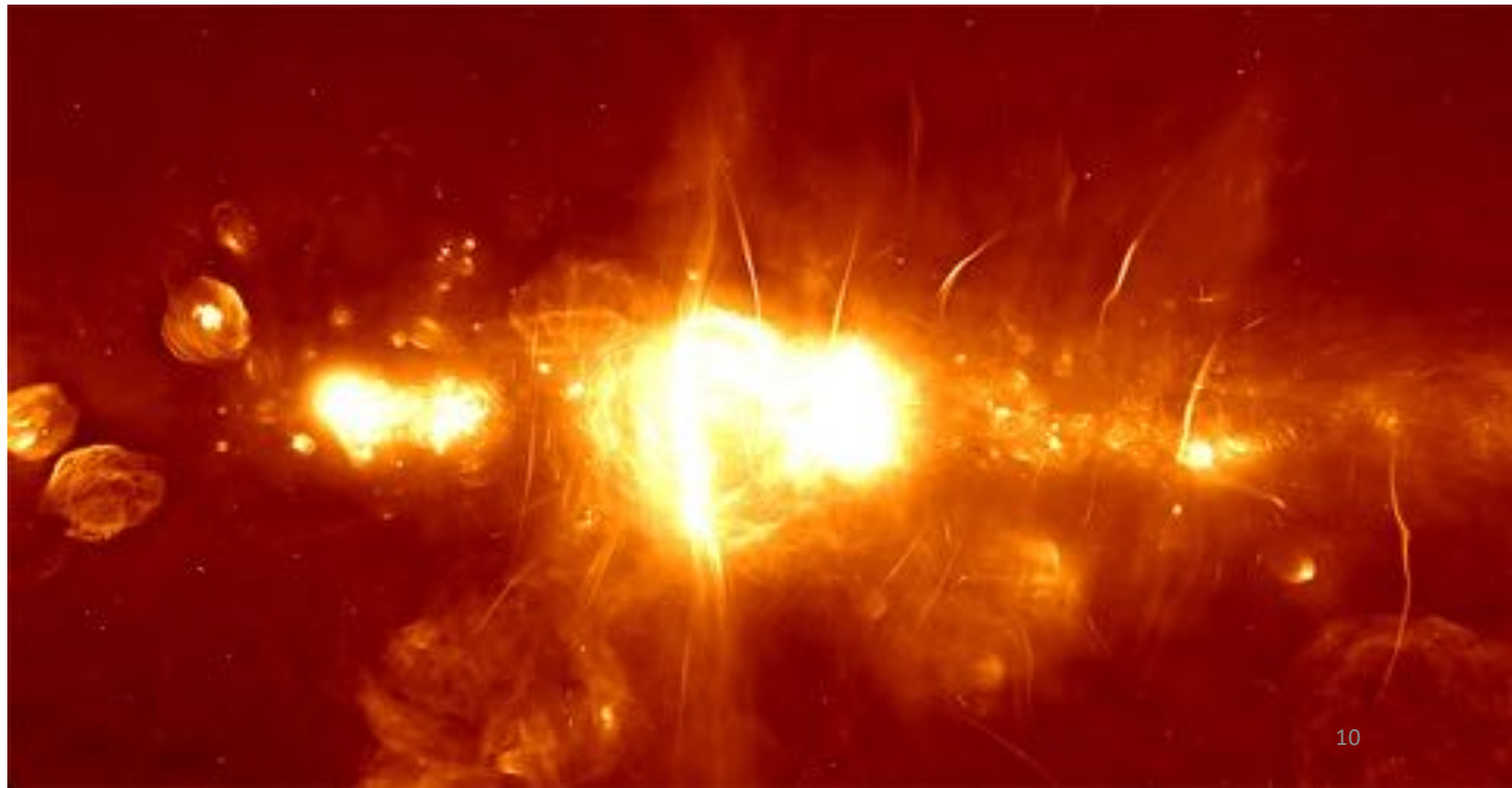
- UCT
- NCRA-TIFR
- SARAO
- IDIA Staff
- WVU
- INAF
- ASTRON
- UWC
- IUCAA
- IP
- JBCA
- UManchester
- SANBI
- CWI
- Radboud
- NWU
- Rutgers
- Oxford
- HartRAO
- IDIA (UWC)
- University of Pretoria

Science Users: Country



MeerKAT survey of galactic centre

- Survey performed by SARAO
- Imaged by Ian Heywood
 - much of the image processing done on IDIA Cloud





Data Sizes

- Example: MIGHTEE data
- Currently 55-dishes, 4096 channels over 856MHz, ~6-hr duration
 - 1.5-2.0 TB datasets
- Soon moving to 32k channels
 - > 40 TB datasets
- Looking at different models for processing
 - Initially all visibility processing at IDIA
 - Aim to move initial visibility processing to SARA0 during next year

ILIFU: Tier 2 Data Intensive Research Facility

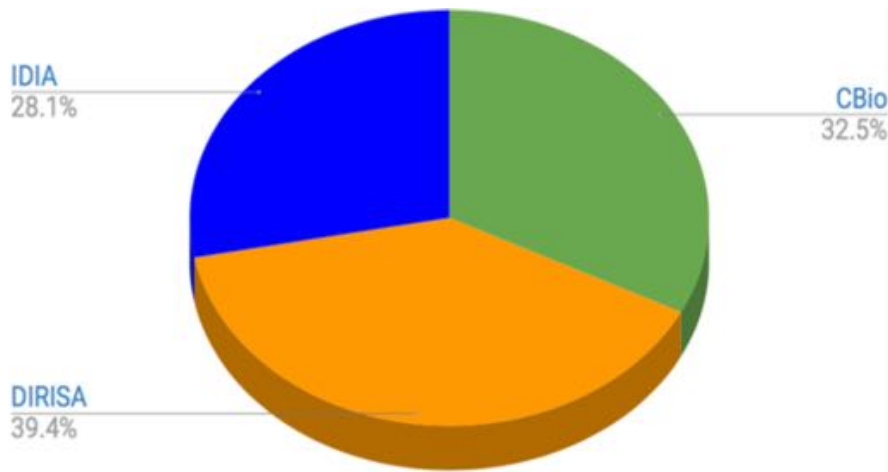


Joint investment DST/DIRISA, IDIA, Computational Biology (NIH)

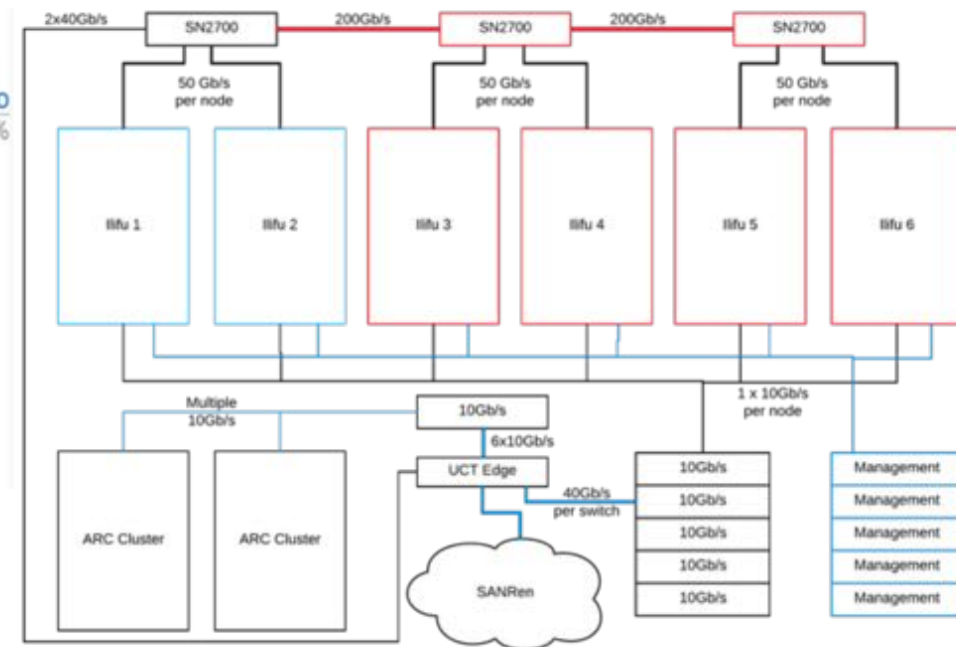
- Astronomy (IDIA, SARAO)
 - Data Intensive Astronomy with priority on MeerKAT Large Survey Programs
 - Precursor SKA Regional Science Centre
- Data Intensive Bioinformatics
 - Tuberculosis Surveillance in Africa (UWC)
 - Imputation service for African human genetics (UCT)
 - Omics for Precision Medicine (SU)
- Research Data Management (CPUT)
- South African Data Intensive Research Cloud federation with T1 and T3 infrastructure



ILIFU Cloud Staged Roll out 2018-2019



Infrastructure contributions by 2019

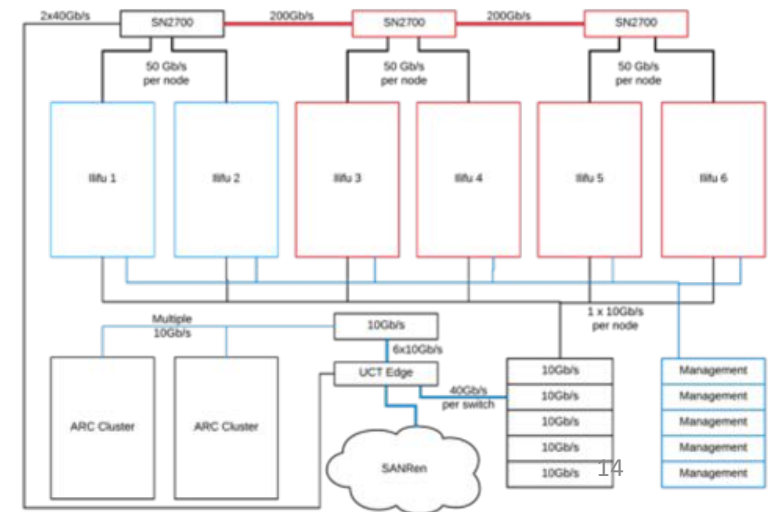


- System scheduled using fair share aided with appropriate limits to guild this
- IaaS system managed by OpenStack
- 2/3 of DIRISA funds still to be spent



Ilifu cloud components (in place so far)

- ARC nodes provide spare management, 8 compute nodes and 300TB (usable) from CEPH targets
- ILIFU racks 1-2 provide 40 (Intel E5-2697A) compute nodes, 8 GPUs (Nvidia p100) and 0.5PB (usable) storage (BeeGFS)
- ILIFU 4-6 provide 80 (Intel gold 6142) compute nodes and over 2PB (raw) of disk storage (CEPH) and management nodes
- ILIFU 7 (not shown) provides 0.5PB of off site backup storage
- Currently connected to SANReN at 10 Gb/s
 - Will upgrade to 100Gb/s when SANReN core upgrade takes place
- Storage a mix of CEPH and BeeGFS, with Manila used for user level file-system provisioning





Pipelines

- IDIA pipeline framework being used for MeeKAT LSP processing continues to be developed
 - Adopted notebook code from JIVE project code that was more robust than our initial prototype
- Presented in Singularity containers with:
 - CASA, drive-casa, python libraries, JupyterHub Notebooks
- Being combined with data transport system to provide automated archive to product execution
- Moving to spawning JupyterLab instances to avoid contention
- Using elastically constructed for batch and spawned lab instances

CyberSKA Portal / Gateway

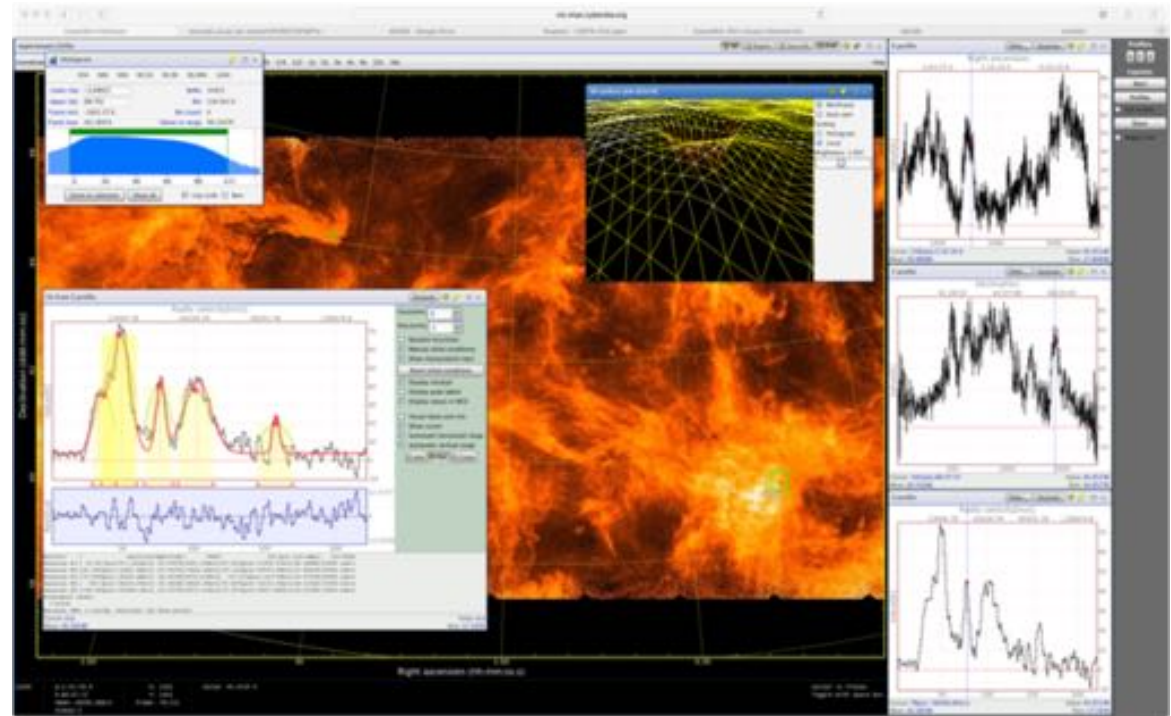


A screenshot of the CyberSKA Portal interface. The header features the 'CYBERSKA' logo and the tagline 'A Cyberinfrastructure platform to meet the needs of data intensive radio astronomy on route to the SKA'. Below the header is a navigation bar with links for Home, Profile, Settings, myDashboard, myGroups, Tools, About, and Help. The main content area is divided into several panels: a left sidebar with user navigation options; a 'CONTACTS' panel showing a grid of user avatars; an 'Event calendar' panel with upcoming events like 'Imaging Science Technical Meeting' and 'CANARIE Site Visit'; a 'Recent Astro-ph Eprints' panel with links to scientific papers; an 'Active Users' panel showing recent activity; and a 'Group membership' panel listing various project groups like 'DMS support of Astronomical Data' and 'CyberSKA Sys Admins'. An 'Activity' panel at the bottom shows recent forum posts and comments.

- Over 900 users
- Latest version enables federation of multiple portals
- iRods used for data management
- Provides access to data sharing, collaboration, visualisation and data search tools

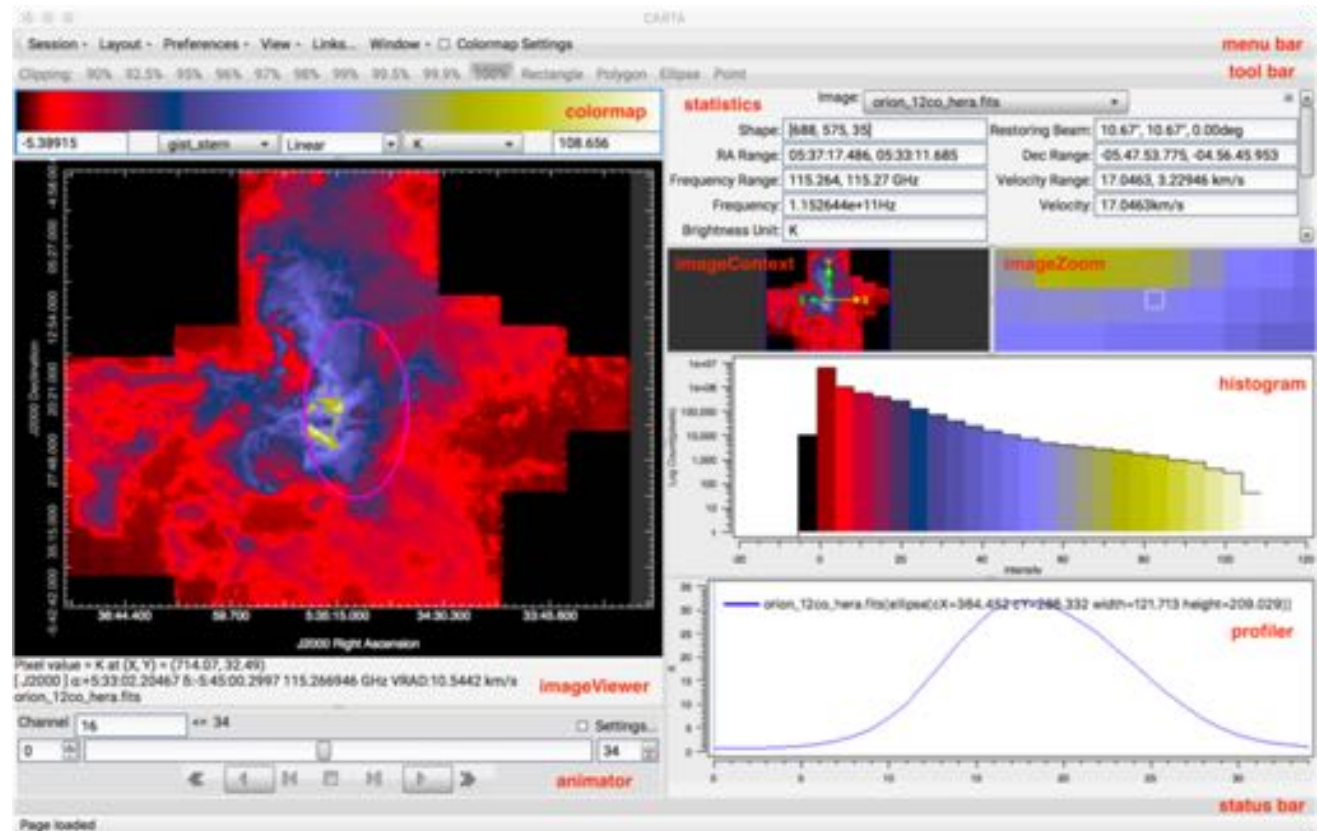
Visualisation

- CyberSKA remote radio astronomy viewer is primary visualization tool in CyberSKA portal
- Current system works with 360 GB data cubes
- Provides range of visual analytics algorithms
- Enables sharing of visualization sessions between distributed participants



CARTA viewer

- Developing new viewer
 - NRAO collaboration
 - Will replace CASA and cyberSKA viewers
- Aim to scale visualisation and analytics to multi-terabyte cubes with remote viewing
- Now using HDF5 to better support parallel I/O
 - See ADASS 2018 paper on new schema
- Initial release due before end of 2018





SRC operations planning

- Discussions going on between stake holders on how SA SRC will be operated
- Major stakeholders include:
 - DST and Meraka (CSIR) from government
 - SRAO (SKA-SA)
 - IDIA
- Working on best ways to distribute SKA work between organizations with discussions led by DST

Summary



- SDP has developed baseline architecture for delivering data to SRCs. Updated SRC interface definition document in progress.
- MeerKAT RC framework being developed in multi-partner collaboration and data is being distributed
- CyberSKA portal and CARTA viewer development is ongoing with CARTA architecture update to unify GUI across platforms
- South Africa planning to have SRC in addition to SKA1 Mid Processing Centre; operations plan in development

