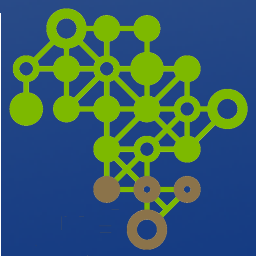
Progress in multigigabit Point to Point Connectivity between South Africa and GEANT.

Applications to Radio Astronomy

M J Gaylard[1], J F H Quick[1], B. Becker[2]

1 HartRAO, P. O. Box 443, Krugersdorp 1740, South Africa
2 South African National Grid and SANReN Advanced Services, C.S.I.R. Pretoria



Outline

- Astronomy in Southern Africa
- Radio astronomy and interferometry cases
- Recent achievements – an analysis of the situation
- Moving into the future of digital science in Africa – service oriented network
- Conclusions

Astronomy in Southern Africa

Several observational multiwavelength platforms:

Radio :

- Hartebeeshoek Radio telescope
- MeerKAT/KAT7 (Northern Cape)

Optical:

- Infrared
- 0.5 – 1.9m optical telescopes
- Southern African Large Telescope

Gamma-Ray

- High-Energy Spectroscopic System (Namibia)

Human Capital Development

- Supporting these instruments is a top-to-bottom plan to develop research capacity, from government all the way to high-school :

  National Astrophysics and Space Science Programme

  - http://www.star.ac.za/

  South African Research Chairs Programme

  - http://www.nrf.ac.za/projects.php?pid=61

  African Institute of Mathematical Sciences (AIMS)

  - http://www.aims.ac.za/

- **Result** : 40 % of MeerKAT SKA pathfinder research projects are led by South Africans

  http://en.wikipedia.org/wiki/MeerKAT#MeerKAT_Science

Astronomy is a digital (e) science

Instruments:

Number and complexity of instruments has increased significantly in the last 20 years.

Usage model has evolved - from almost exclusively “on-site”, to large increase in remote usage

Data rates:

- SALT O(1TB)/ year
- Typical Radio Dish – O(1GB/s) ~ 36TB/day

Computational intensity

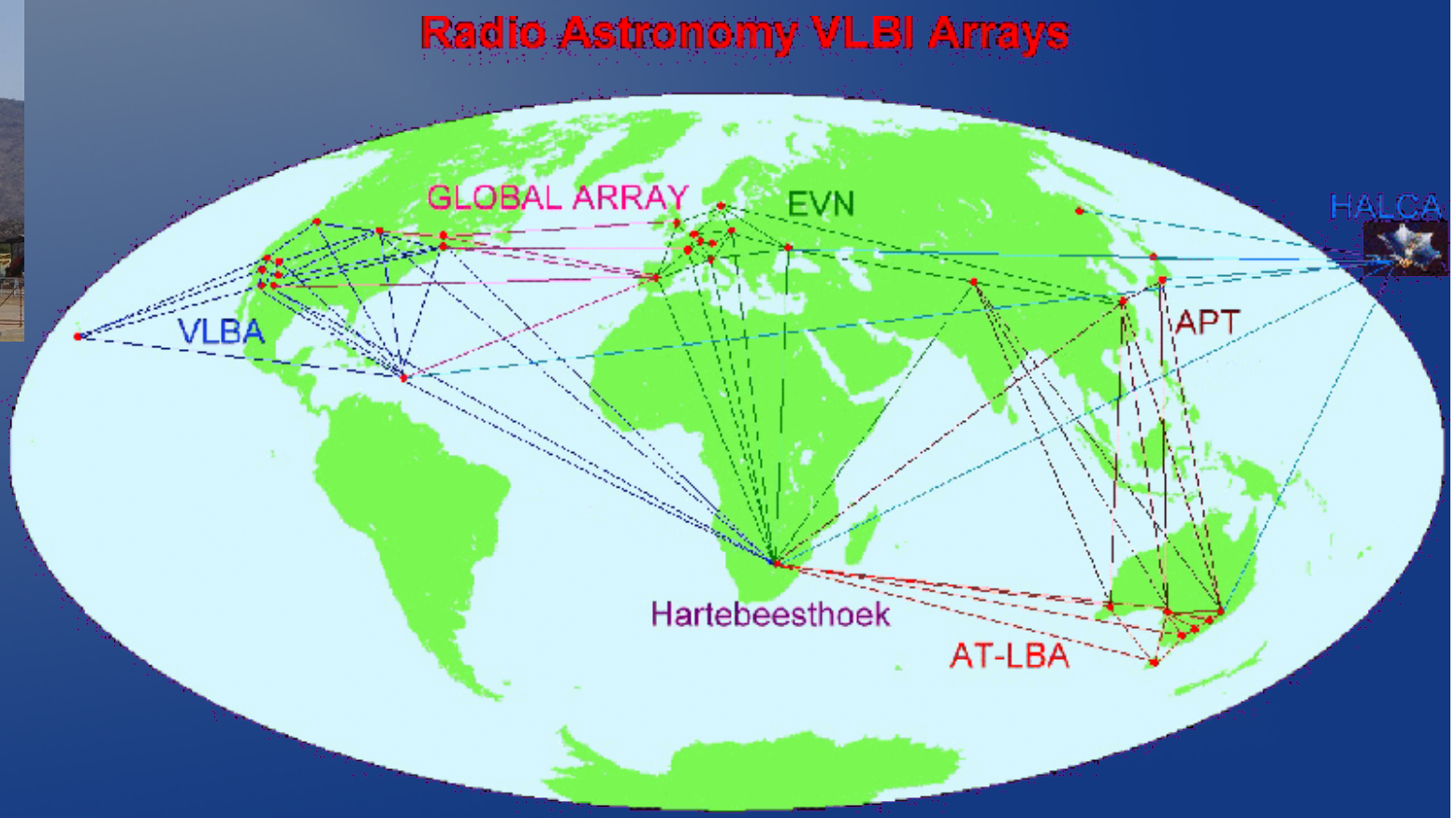
Without data processing capacity, much data is useless – development of computational infrastructure essential

Global observations
Very Long Baseline Interferometry

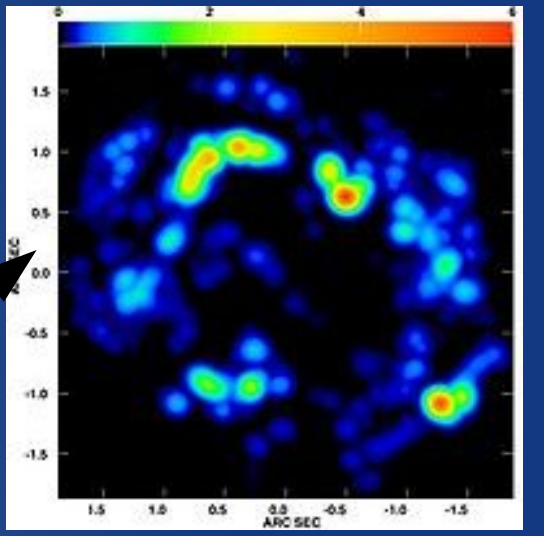
- Sensitivity of measurements can be increased dramatically by artificially increasing the aperture – put telescopes far apart
- Reconstruction of images is done through interferometry
  - Accurate clock to synchronise timing
  - Data reconstruction done via software “correlator”
- Data rates become “interesting”
  - All data needs to be correlated at a central point
  - **total data rate scales with number of participating telescopes – can reach O(100GB/s)**

Current Operational Radio Telescopes – only 1 in Africa

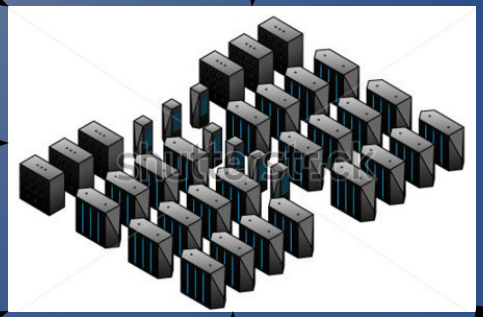
26m Radio Telescope,
HartRAO,
South Africa



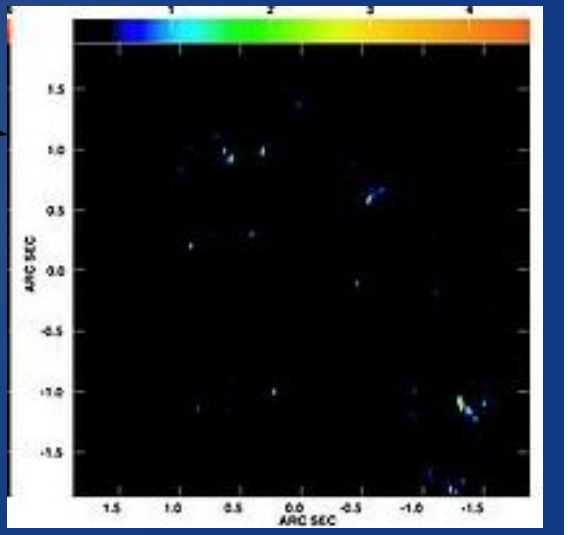
The VLBI principle



Low-res image

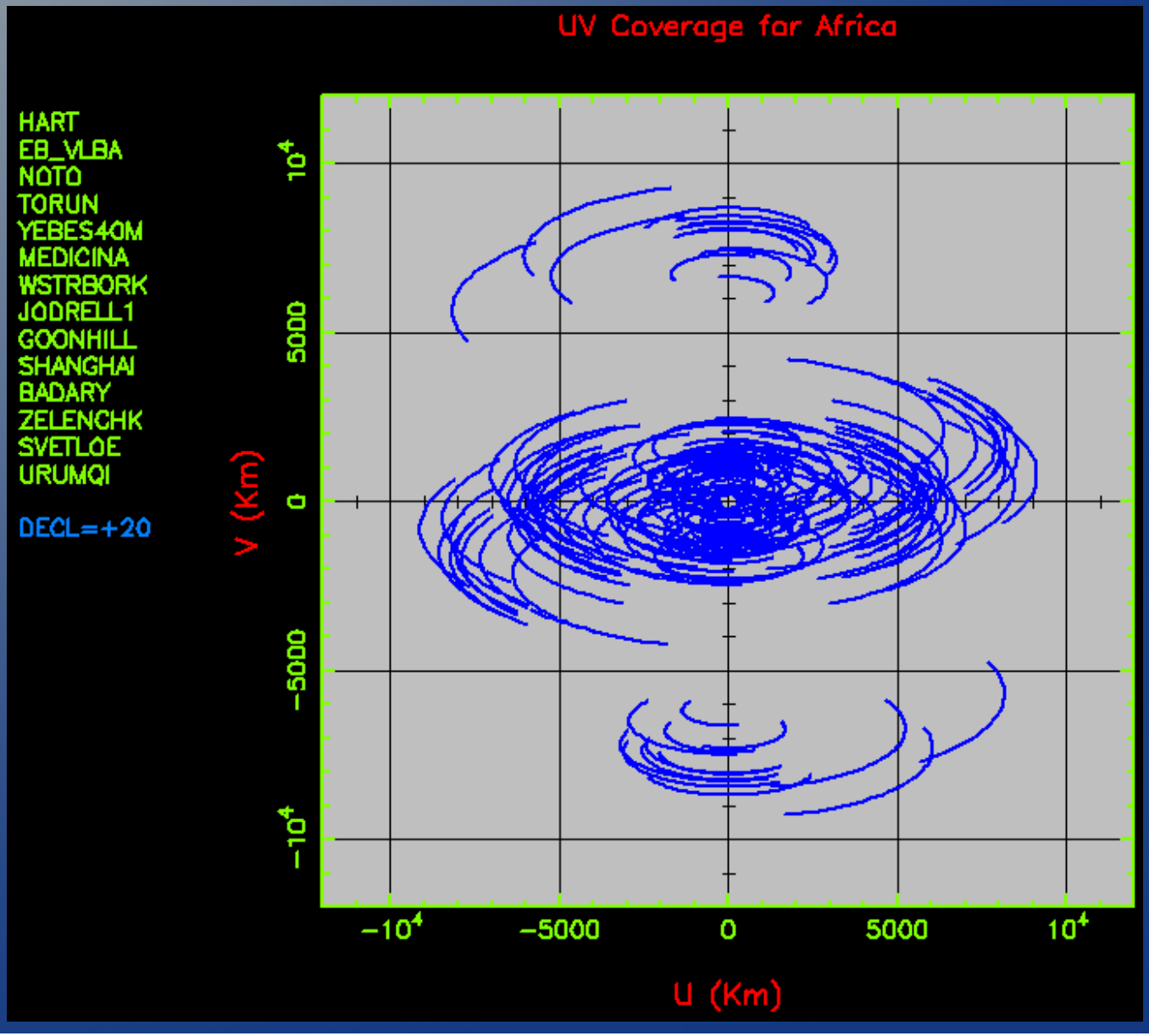


offline
Correlator



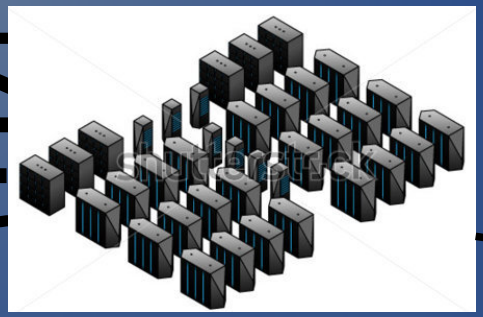
high-res image

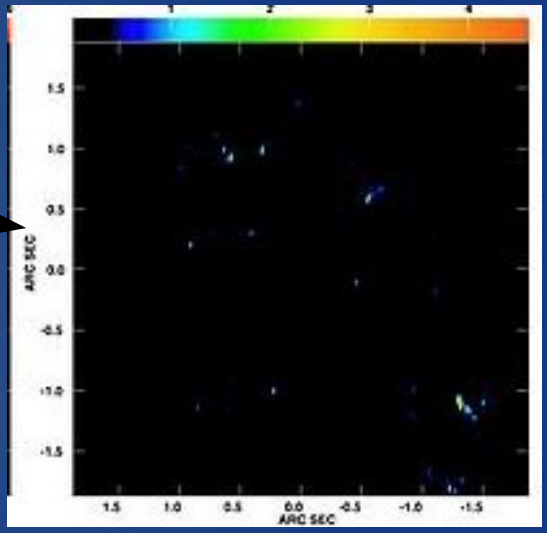
European VLBI Network + HartRAO



What if it could be done in real time ? - eVLBI

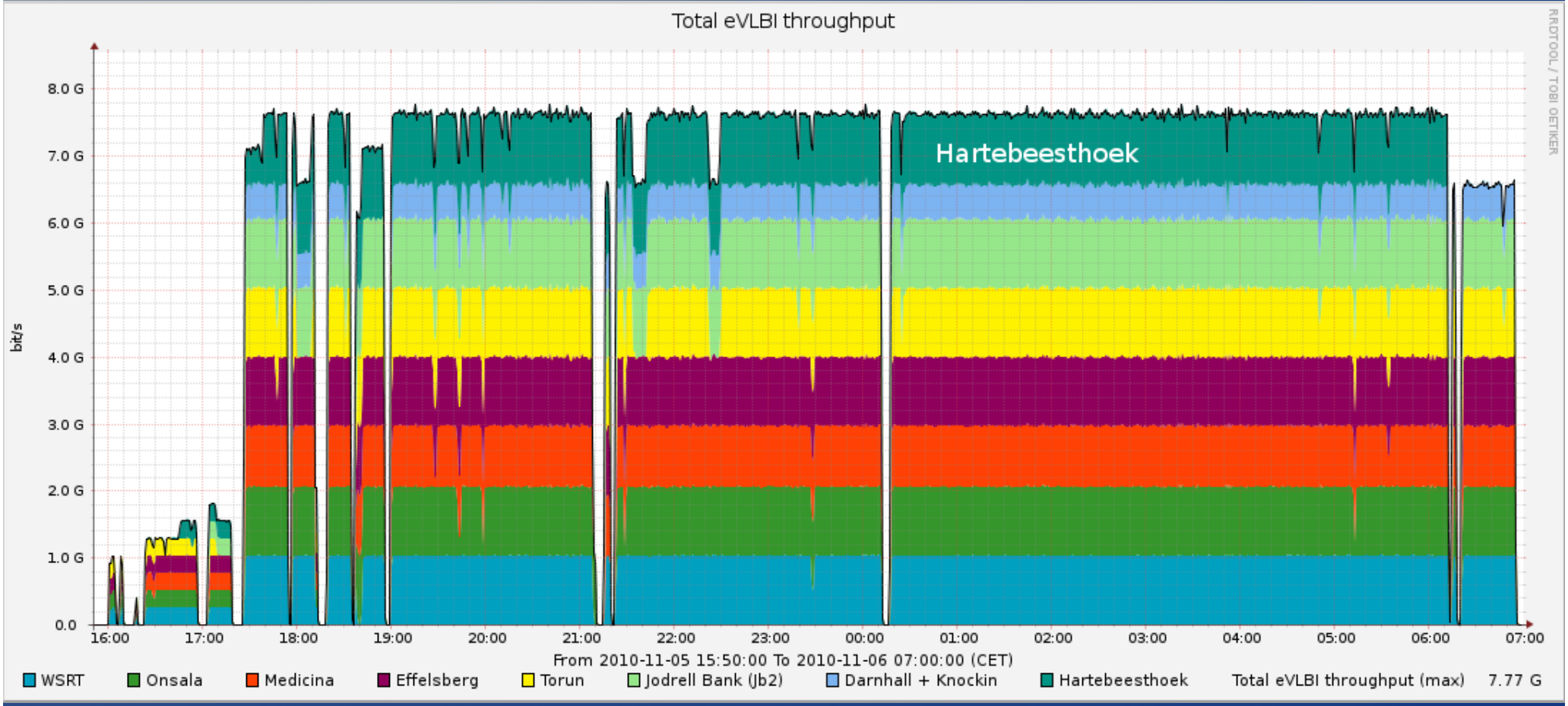
online Correlator





Real-time high-res image

Integration of HartRAO into EVN: one of the main driving forces behind the development of SANReN



Submarine capacity reserved for research data

Press Release: "New high-speed 15,000km international link seamlessly connects African radio astronomers to Europe through GÉANT and UbuntuNet" -

http://www.ubuntunet.net/African_radio_astronomers

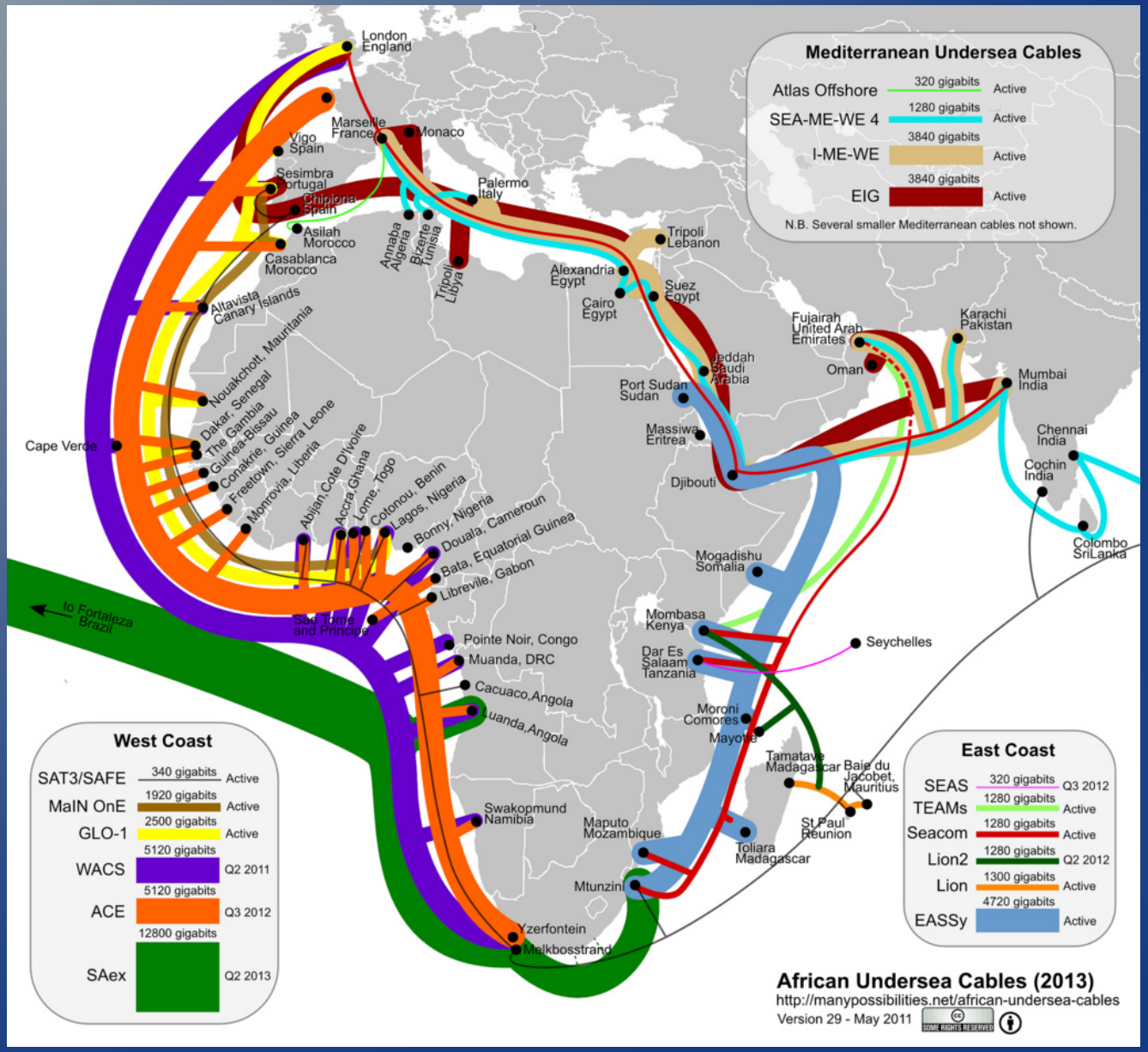
"The 2Gbps point-to-point circuit will enable astronomers at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa to stream observational data to the Joint Institute for VLBI in Europe (JIVE) in the Netherlands for processing and correlation, and is the first point-to-point circuit between GÉANT and UbuntuNet."

UbuntuNet Alliance

Africa Connect

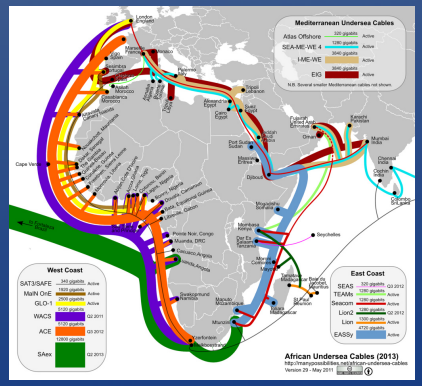
GÉANT

Africa – one of the best connected continents

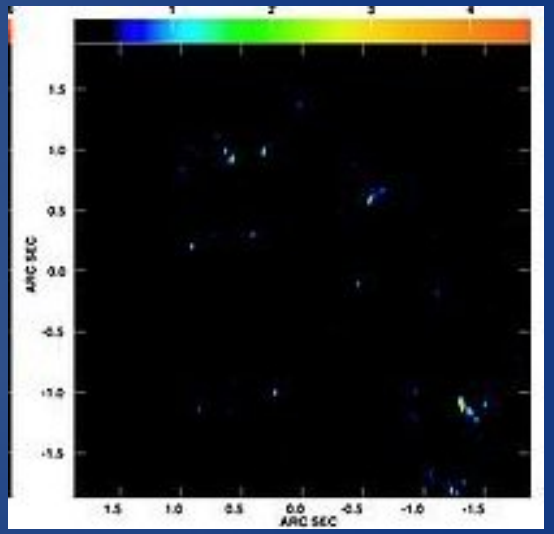


But success is not a simple equation

+



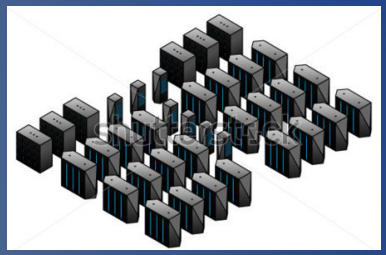
≠



Success requires an ecosystem

instruments

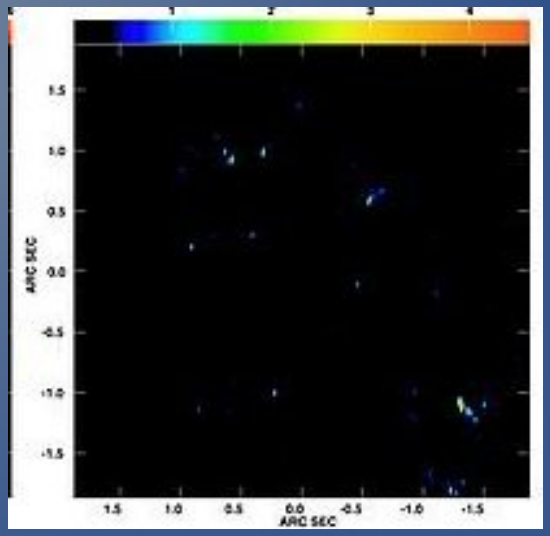
Computing infrastructure



network

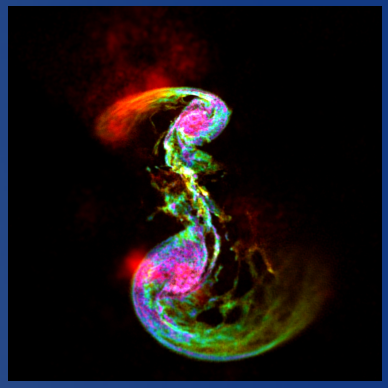
Human Capital Development

NASSP



SKA AFRICA
SQUARE KILOMETRE ARRAY

Software and applications



Data storage

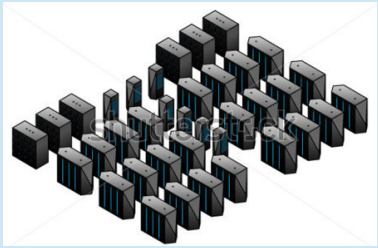
Data archiving and managemnt

World class researchers

science & technology

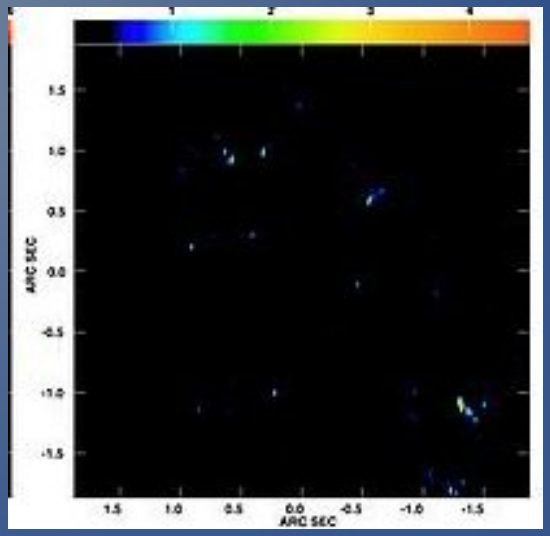
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

Invested political will

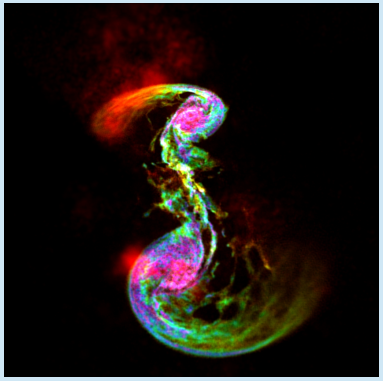


NASSP

SKA AFRICA
SQUARE KILOMETRE ARRAY



e-infrastructure



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

SANReN Enabling e-Science
www.sanren.ac.za

National backbone connects :
> 100 sites at at least 1 GB/s

> 20 sites at > 10 GB/s

Thousands of researchers connected

Proposal to DST for International bandwidth capacity :
2x10Gbps = 20Gbps circuits on submarine cables for research and education as needed

SANReN
South African National Research Network

Coordination role of network infrastructures

- Coordination needed at international level to achieve this success
- Regional network alliances play important role in coordinating national research networks.

  Cross-border links

  Regional telecommunication policies
- Transform the **bandwidth** into an ***NREN***, by designing and providing ***services***

Invested political will

A “science-aware” network to bring Africa to the centre of science

- Connect instruments to computing/data platforms

- Computing and data infrastructure interoperable with international infrastructure

- Advanced services : Identity Federations (IdF, e.g. eduroam), Data-aware network (Science DMZ)

Africa VLBI Network Potential

Large satellite antenna locations

Ghana - Kuntunse

South Africa - Hartebeesthoek

Conclusions

- >1GB/s point-to-point networking between GEANT and UbuntuNet has enabled cutting-edge scientific research
- Success relies on a systematic and integrated approach to enabling research
- Research networking has particular challenges which can provide advanced services (not just bandwidth)
- Outlook for grand-challenge African science looks good : http://www.ska.ac.za/releases/20120329.php