



History of the African VLBI Network: An African Story of Science

Contributors:

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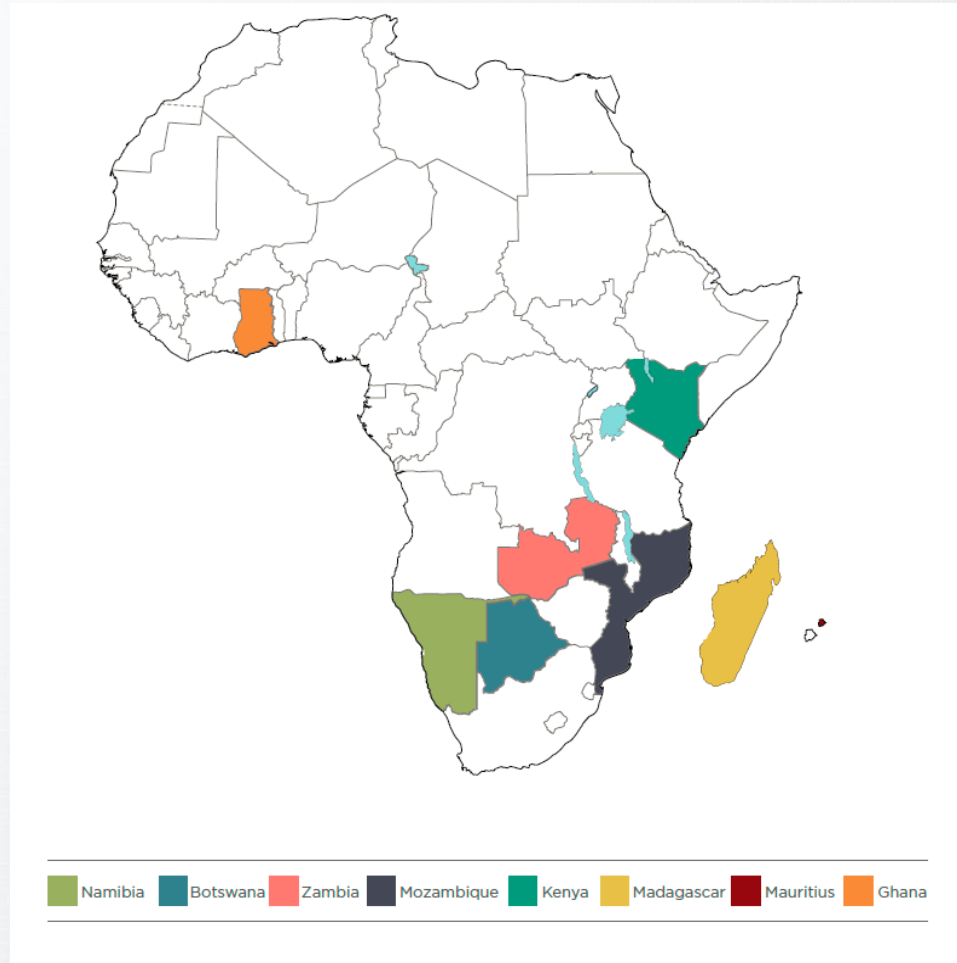
Dr Gordon MacLeod

Dr George Nicolson

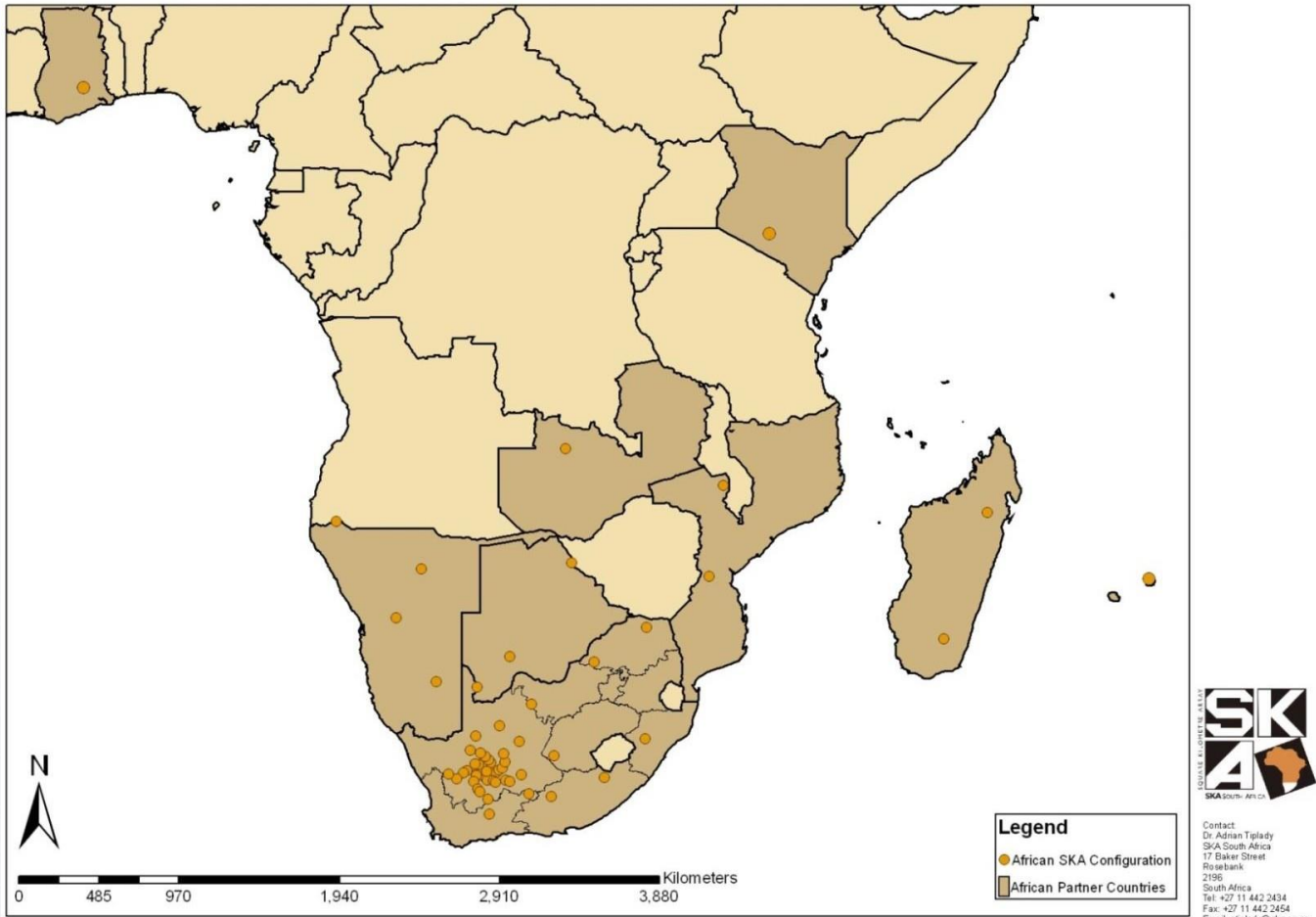
Where did it start?

- Decision to submit African SKA bid in 2003/4 was undoubtedly *the* catalyst for the development of radio astronomy on the African continent
- Reasons for bid decision
 - Science
 - Substantially increased the potential scientific return of the Square Kilometre Array (longer baselines > 3,000km)
 - Enhanced existing global radio astronomy infrastructure
 - Socio-economic development
 - Establishment of basic research infrastructure supports the development of a knowledge economy in Africa
 - Radio astronomy attractive to youth to enter careers of science, engineering, technology
 - A driver for the development of next-generation skills, for next-generation jobs – Africa as the next great business destination

African Partner Countries

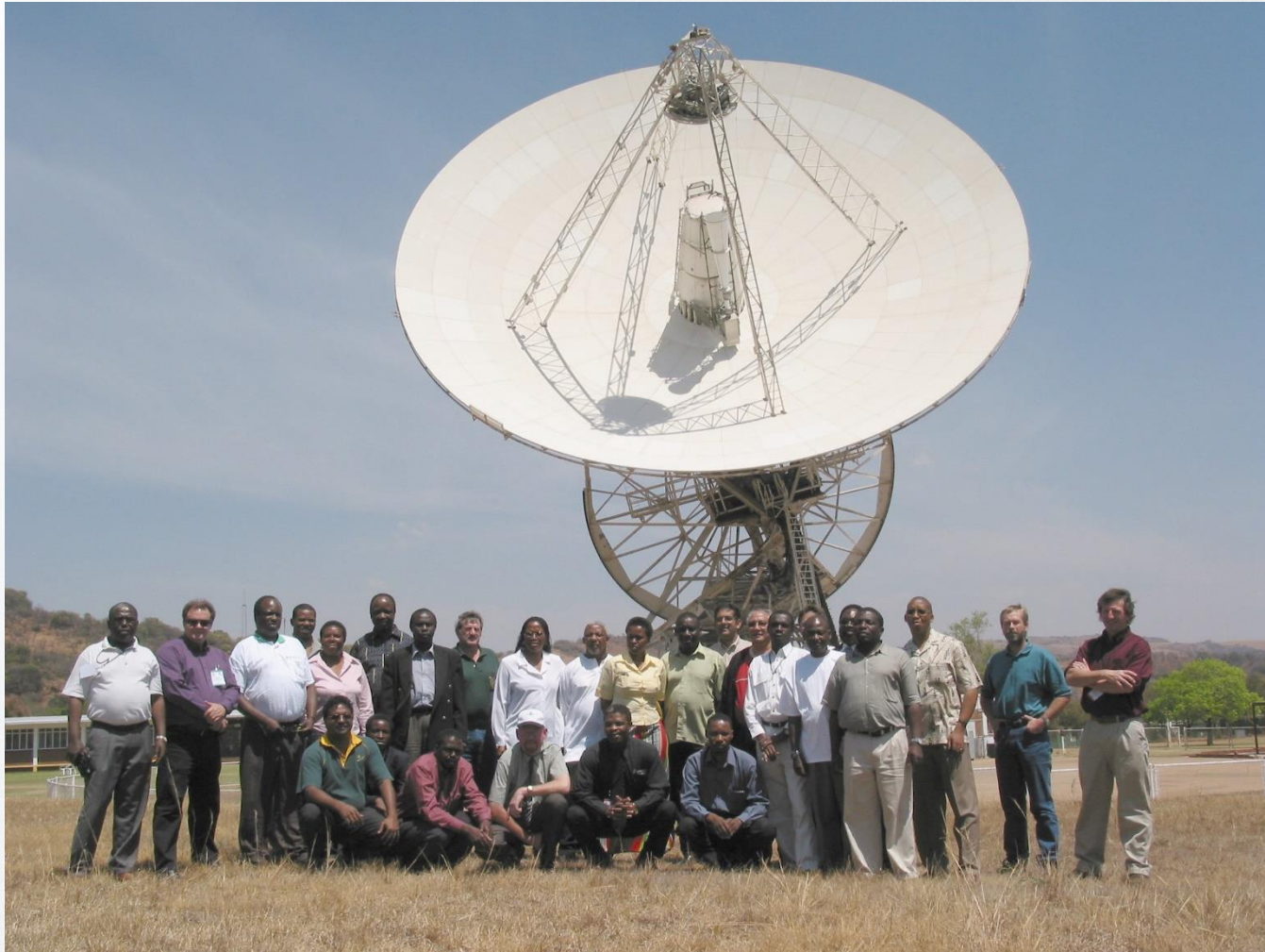


Proposed configuration of the SKA defined who would be partner countries.



Early African Engagement

African Partner Country 1st Meeting: October 2003



2006-2011

Preparing for the SKA

- African preparation for SKA
 - Development of governance structures
 - African SKA Ministerial Forum
 - African SKA Steering Committee and Working Group
 - Development of technical reports
 - Assessment of infrastructure and radio frequency environment for hosting of radio astronomy facilities
 - Development of African research community
 - Human capital development program to establish research programs and groups in African universities

Key stages in AVN evolution

- **2004** - Athol Kemball proposed an 18 cm (OH) network of 12m dishes close to SA universities working with HartRAO 26m to develop expertise in interferometry/VLBI.
- GDN asked to cost, based on SKA development antennas – e.g. 12m version of ATA, Indian pre-tensioned PPD 12m structure.
- This and other early proposals for a South African SKA Demonstrator were superseded later in 2004 by the original 25 x 12m KAT. Anita Loots was appointed as technology manager.
- Various people over the years suggested that small VLBI stations be installed in African partner countries in order to develop expertise in those countries and to demonstrate the Africa could support the SKA in the future

Formalised African Engagement: 2008

African Partner Country Working Group

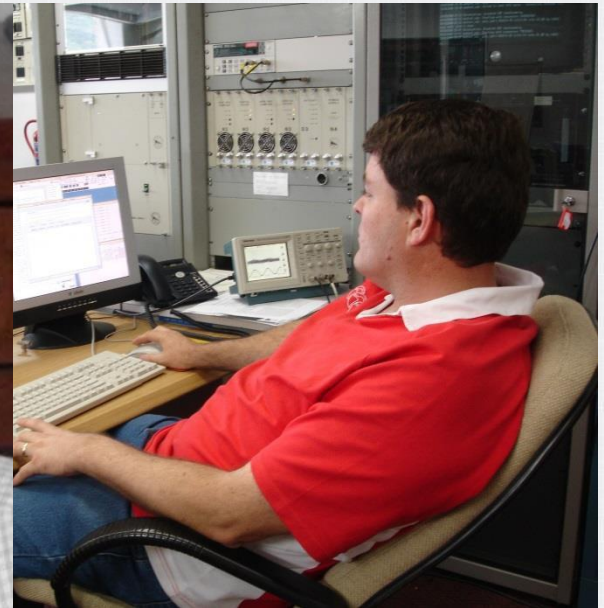


At this meeting the suggestion was made....

- Build a MeerKAT-type telescope in each partner country (from minutes of 1st ASPWG, Pretoria 2008)
- At this stage KAT-7, the seven antenna test bed for MeerKAT was still under design and the design of the MeerKAT antennas was undecided.
- The first formal proposal to build an African VLBI network was made in 2009 by Dr Gordon MacLeod, who was Director for Radio Astronomy in the Department of Science and Technology at the time.
- In conjunction with former colleagues at HartRAO he proposed an initial network of GPS stations in up to eleven African countries and later adding 12-m geodetic VLBI antennas.
- Focus on HCD – Training African Students, Graduates and Researchers in support of the SKA bid, and demonstrate competence in SKA related Technology.

HartRAO staff involved in DST Proposal

- Mike Gaylard, Ludwig Combrinck & Jon Quick discussed science that could be done with a network of 12-m antennas (June 2009)
- The proposal was not viewed favourably by SASKA SKA



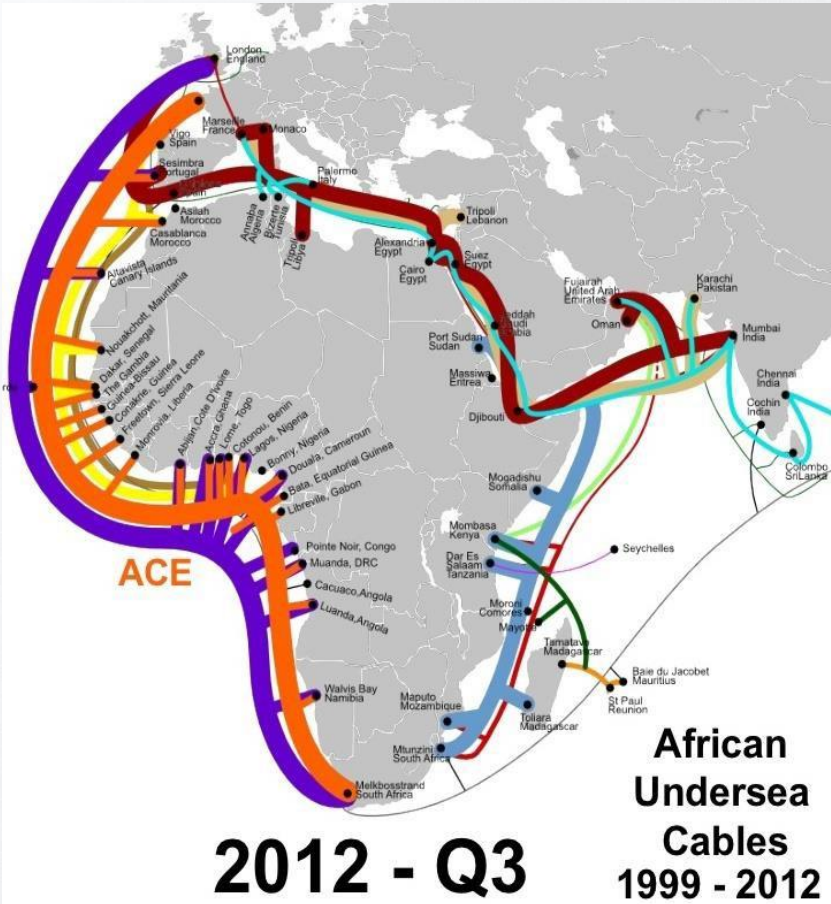
Fresh Impetus for The AVN ...

On a visit to HartRAO Prof. Lameck Mwena, Polytech Namibia, pointed out that there was a disused 32m antenna in Zambia.



Mike Gaylard used the internet and Google Earth to locate over 20 unused satellite communication antennas in Africa

The reason for this was the rapid and continuing growth of international undersea fibre optic cables



Ghana Steps Up...

Minister Sherry Ayittey and Ms. Adelaide Asante convinced Vodafone to donate 32m antenna in 2010



DST Raised the Money...

- Drs. Tshepo Seekoe, Wilson Matakenya and Gordon MacLeod raised R120 million from ARF
- DST wanted money to go to HartRAO
- Ultimately it was decided to run the AVN Project from the SA SKA Offices in Cape Town and Anita Loots was appointed to head the project.

2011

Africa HCD Workshop – visit to KAT-7



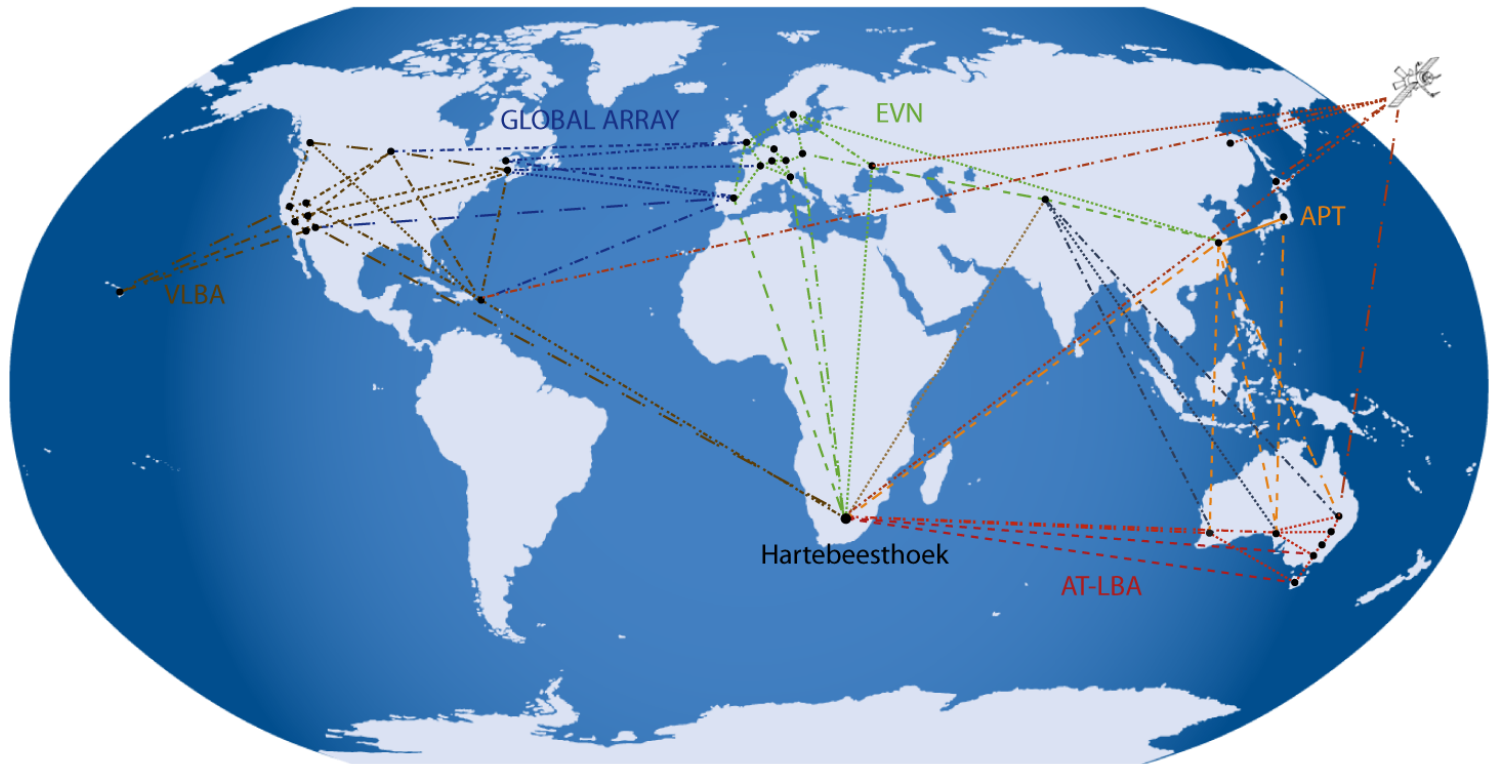
After the SKA Bid Decision (2012)

Split Site, Phased SKA (Phase 1 and Phase 2)

- Recognition that Africa doesn't need to wait for the SKA (Phase 2) to
 - be part of, and contribute to, the global radio astronomy community
 - do cutting edge science
 - participate in, and develop the skills in, next-generation technologies
 - take advantage of opportunities posed by existing competencies, infrastructure

African VLBI Network

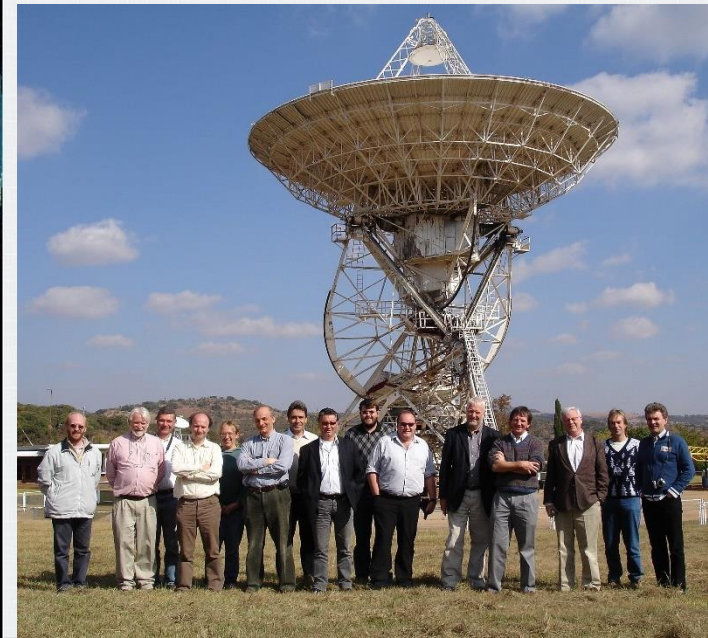
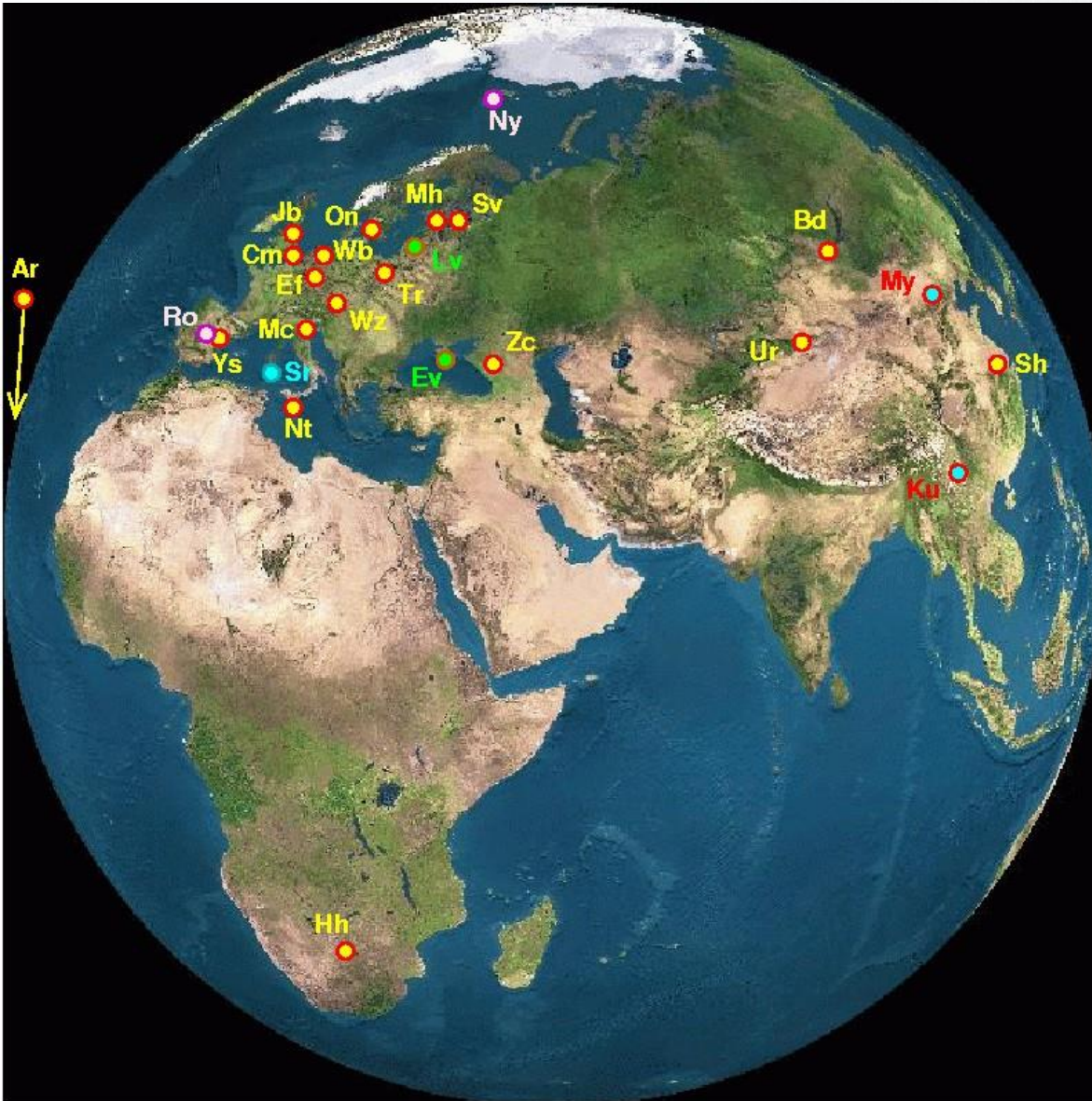
- Project launched to convert obsolete 32m class satellite telecommunication dishes in Africa into radio astronomy facilities
- Result in the creation of VLBI network to complement the EVN and SKA and improve existing VLBI network UV coverage and performance



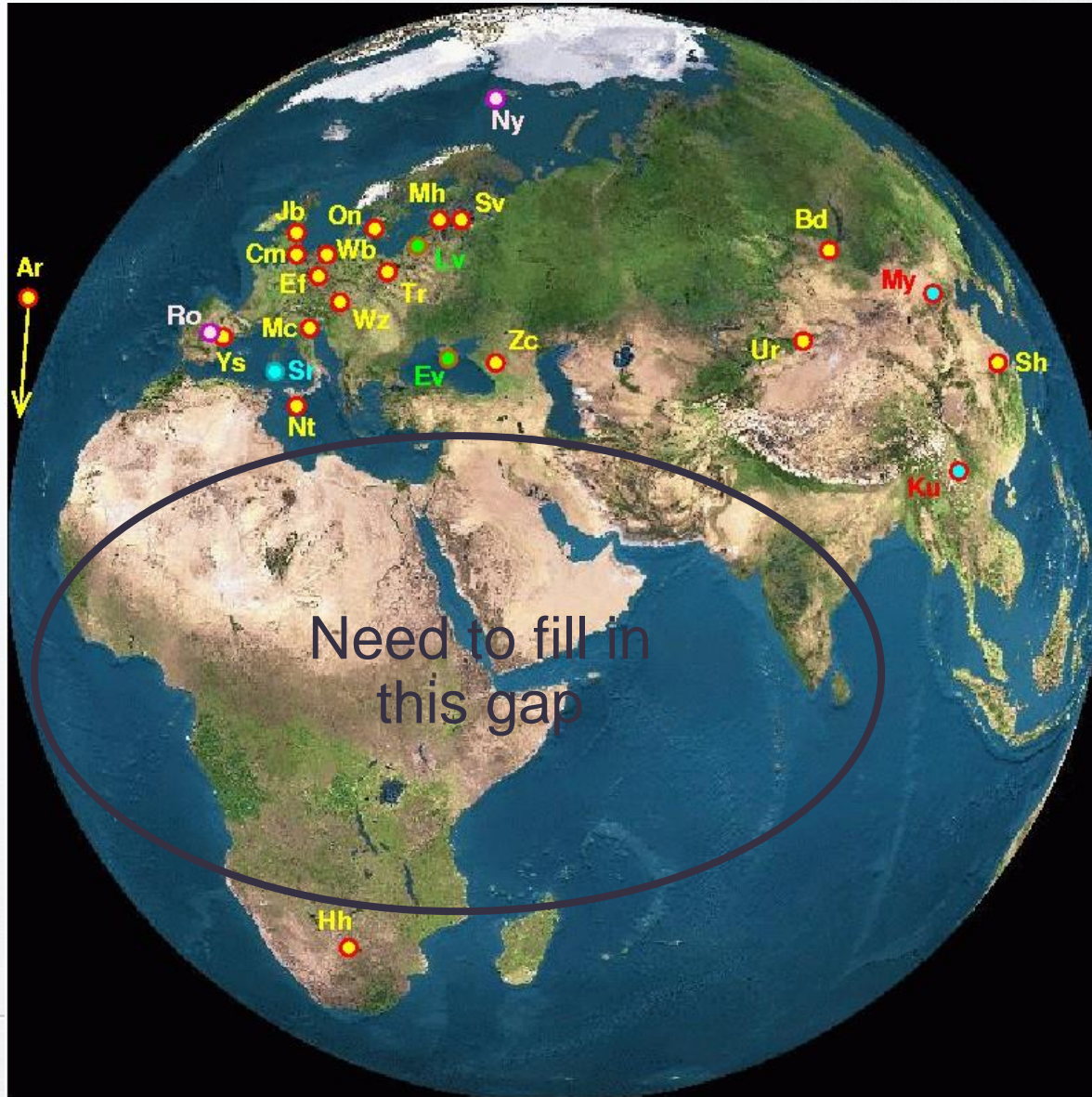
Existing VLBI Networks



European VLBI Network



Mind the Gap



30-m class antennas in Africa



Image IBCAO
© 2010 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

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Galvanisation of Support for the Africa Program

- Readiness Strategy (2013)
 - 3 Pillars: African VLBI Network, Human Capital Development (radio astronomy, Big Data), SKA (governance)
- Pretoria Resolutions (2014)
 - Strong political support for Africa Program and vision of “Africa as a hub for astronomy sciences and facilities”
- Memorandum of Understanding and Joint Action Plan (2017)
 - Re-affirms Pretoria Resolutions
 - Strengthens cooperation amongst African countries

Africa Program

Current Framework: Readiness Strategy & Joint Implementation Plan (2015)

- SKA AVN Readiness Strategy & Joint Implementation Plan
 - Primary purpose of AVN
 - VLBI on the African continent, and joint operations with EVN (and others)
 - Establish skilled capacity in Africa in anticipation of SKA (2020)



African VLBI Network

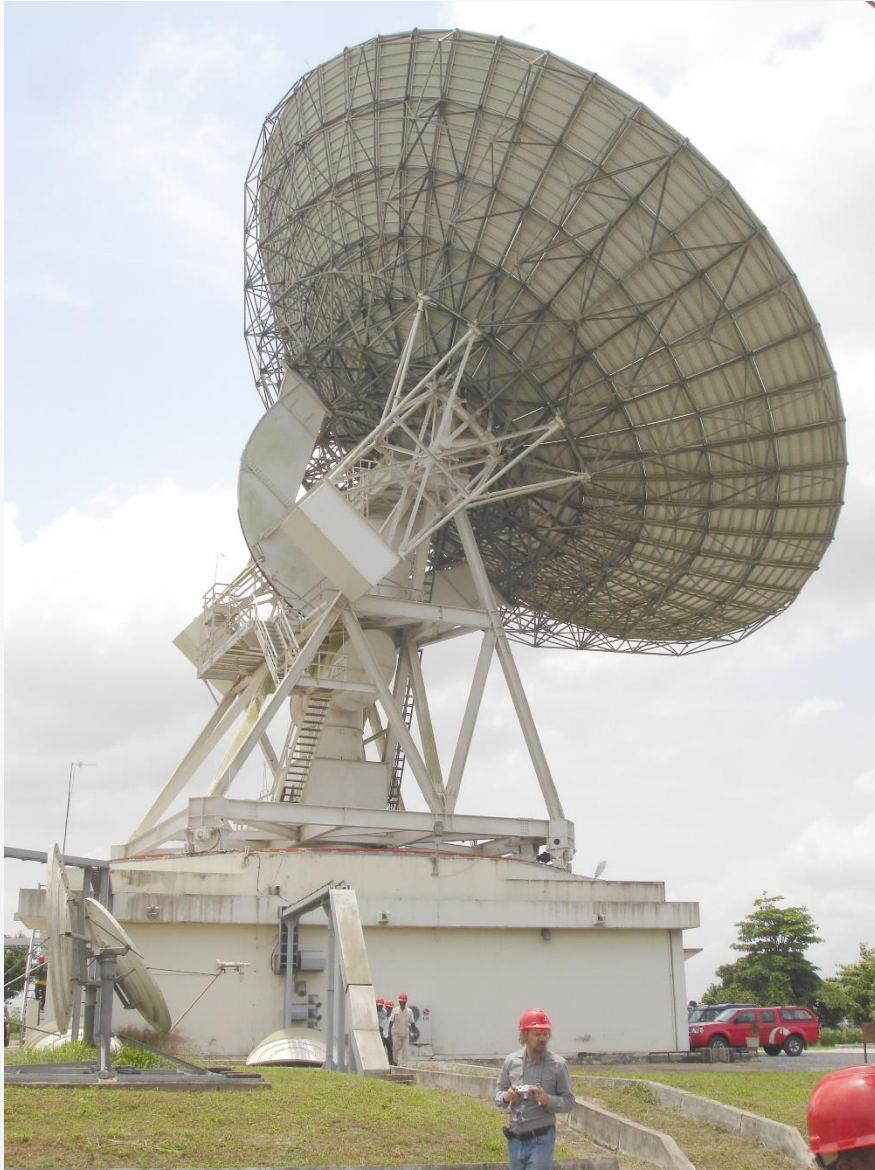
Establishing Radio Astronomy Infrastructure in the African Partner Countries

- Establishment of radio astronomy infrastructure through
 - Re-furbishment of redundant satellite telecommunication ground stations
 - Construction of new 30m class radio telescopes
- Take advantage of existing uv coverage gaps
 - Enhances scientific return of global VLBI networks
 - Enables establishment of key science infrastructure in Africa that can operate independently
- Capital costs funded by the South African government
 - Facilities to be operated and maintained by the African Partner Countries
- Support by other activities in the Africa Program
 - Human Capital Development – bursaries, training
 - High performance computing infrastructure deployment and training

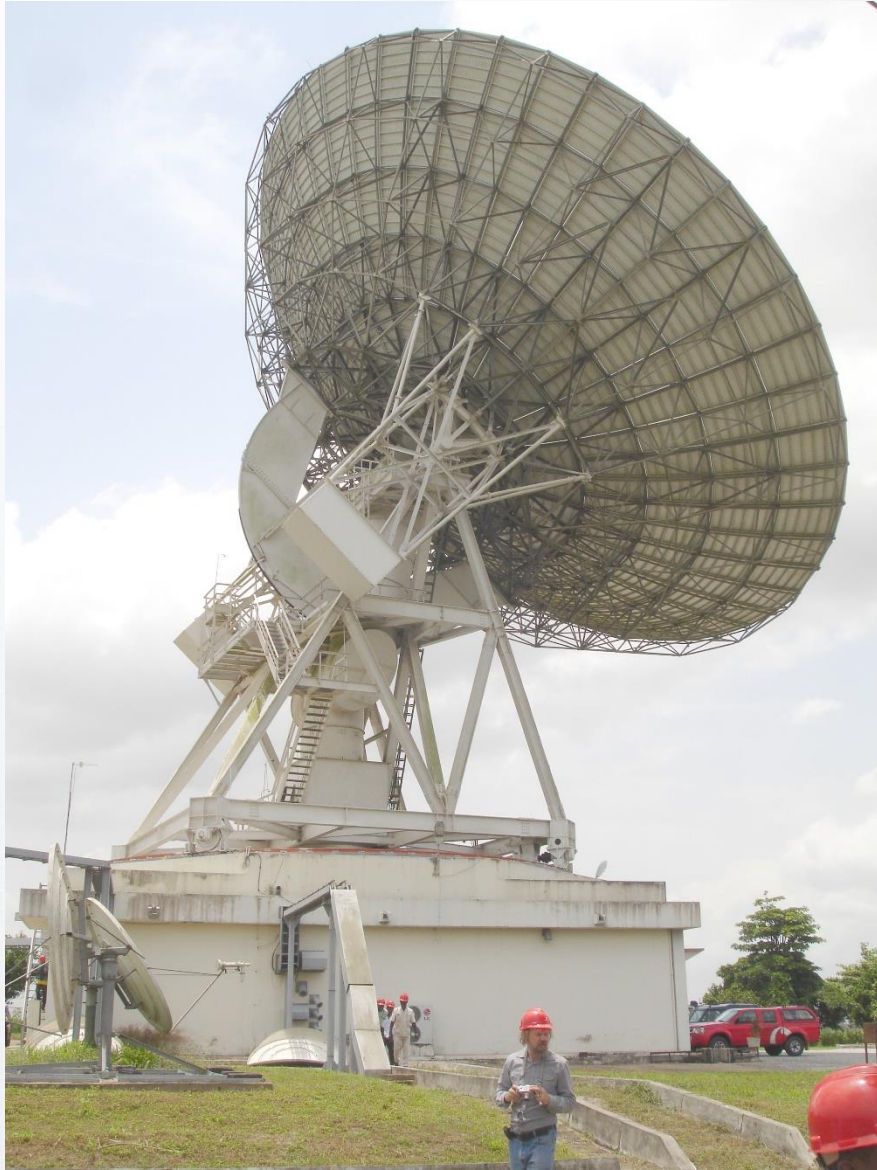


Phased Rollout: Ghana

- Opportunity to commence rollout with Ghana
 - Existing 32m class dish, previously operated by Vodafone

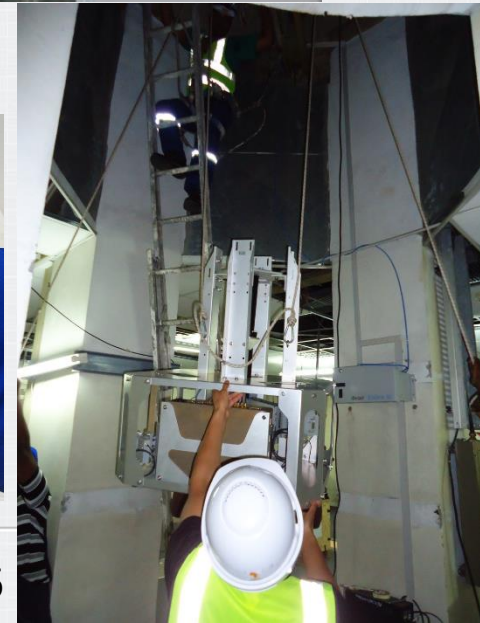


And its twin – Medicina, Italy



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AVN - Ghana upgrade



Ghana Timeline

2011	2012	2013	2014-2016	2016-2017
<p>Engineering feasibility visits.</p> <p>Core team formation.</p> <p>Manual rotation of the antenna.</p> <p>Discovery that the control system had to be replaced.</p> <p>Ghanaian team visit to South Africa.</p>	<p>Discussions between Vodafone and the Ministry for transfer of asset.</p> <p>Discussions between SKA SA and GAEC to agree governance and engineering roles and responsibilities in preparation for the current phase of GRAO.</p> <p>Discussion between SKA SA and GAEC to resolve governance and conversion-phase management issues.</p>	<p>MoA signed for the asset transfer in Ghana and between SKA SA and GAEC to officially start the engineering programme.</p> <p>Training of a team of 7 GAEC core observatory staff members in South Africa for 6 months.</p>	<p>Collaborative engineering activities.</p> <p>First round of engineering completed in November 2016.</p> <p>Training of user / science community.</p>	<p>Engineering commissioning activities in progress.</p> <p>Planning for post-launch engineering work.</p> <p>Preparation for independent operations by Ghana.</p>

Ghana Team at Kutunse



Current Status

- Ghana First Light: July 2017
 - VLBI fringes, pulsar observations, maser detection
- Other African Partner Countries
 - Currently assessing sites and opportunities for next deployment
 - Implementing other programs that support the establishment of the African VLBI Network
 - Capacity development through training initiatives, human capital development
 - High performance computing infrastructure establishment and training

Current Status

- Namibia
 - Two HPC installations and training
 - Sites assessed
- Botswana
 - HPC utilization
 - 10 PC lab established
 - Sites assessed
 - 2 dish interferometer acquired for training
- Zambia
 - HPC installation and training
- Mozambique
 - 20 PC lab delivered
- Mauritius
 - Sites assessed and being analysed
- Madagascar
 - Institute being established
 - HPC delivered
- Kenya
 - Coordination committee established
 - Site assessed
- Ghana
 - GRAO launched
 - Phase 2 engineering set to commence
 - HPC delivered

Spin-Off Programs, Activities and Opportunities

- DARA
- Science Communication
 - Support and collaboration amongst African science communicators
- African Data Intensive Research Cloud
 - Research cloud infrastructure to link African Partner Countries
 - Starts in radio astronomy, but extended application to bioinformatics and geoscience – relevant for achievement of the UN Sustainable Development Goals
 - Catalyses the development of skills in big data, high performance computing

Spin-Off Programs, Activities and Opportunities

Launch of Big Data Project in Ghana – July 2017



Attendees at the one-day work session which was held on 11 July 2017 at the Ministry of Environment, Science, Technology and Innovation in Ghana to kick off the High Performance Computing training programme in Ghana.

Thank you!