

SKA Presentation to Portfolio Committee

Progress Update on SKA Project

Dr Phil Mjwara

Director-General

Department of Science and Innovation

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M Making sure it's possible



science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



Executive Summary

- “... expenditure has had a significant positive impact on the South African economy, and is expected to continue once all construction is complete. These positive impacts have been critical in contributing to the developmental objectives of both the Northern Cape and South Africa.”
- “... the project has had a largely positive and significant impact on the national socio-economic conditions and scientific activity. Substantial contribution has been made towards education, skills development and employment opportunities in

Quoted from the 2023 independent socio-economic study (Urban Econ Development Economists company) for 2011-2022 period

Overview

- Progress Update and Benefits/Returns Framework
 - Scientific returns - scientific outputs
 - HCD and skills development
 - Technological returns - reviving local manufacturing industry, innovations, commercialisation and big data
 - Socio-economic returns – community upliftment, educational improvements, job creation and growth of SMMEs
 - Pan-African development – strengthening institutional and human capacities
 - International partnerships - attracting foreign direct investment, skills transfer and technology exchange and science diplomacy

Development of Multiwavelength Astronomy in SA

- Optical Astronomy as the front runner
 - ❑ SAAO with smaller telescopes and investments - smaller impact – 203 years old (Heritage Site)
 - ❑ SALT with significant investment and bigger impact – 20 years since start of construction in 2003
- Radio Astronomy - SARAO
 - ❑ HartRAO with smaller investment and limited impact - over 60 years old
 - ❑ KAT7, MeerKAT and SKA and AVN - huge investment and huge impact – 21 years since SKA project office was established in SA in 2003
- Participation in Gamma Ray (HESS) telescope in Namibia – 20 yrs of participation

Multiwavelength Astronomy Strategy (2015)

Vision: Developing SA into a hub of astronomy sciences and facilities

Facilities & Instrumentation

- Establishment
- Maintenance
- Hosting

Science advancement

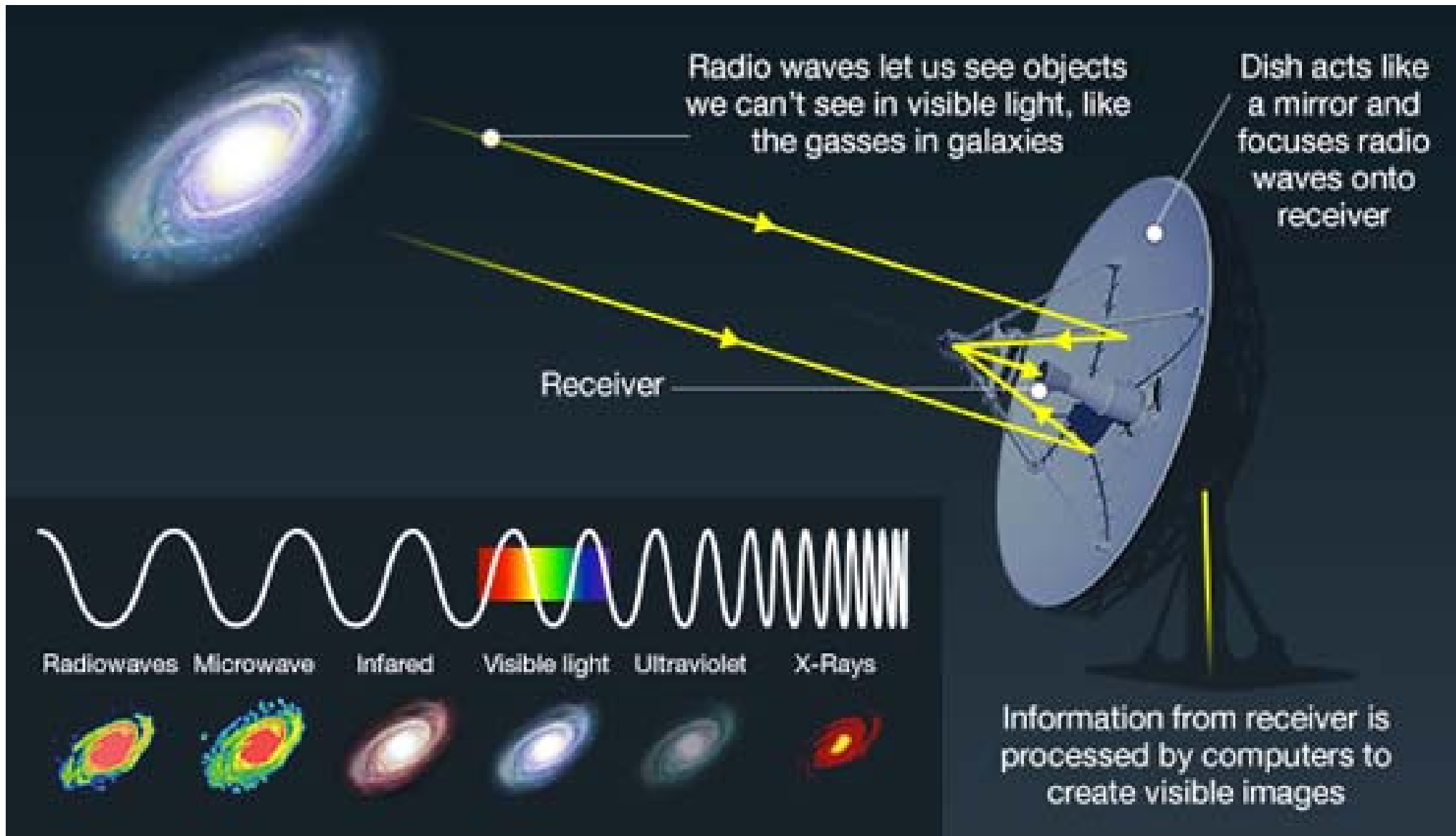
**Human Resource Development
(SKA HCD Programme & NASSP)**

Socio-economic and commercial benefit

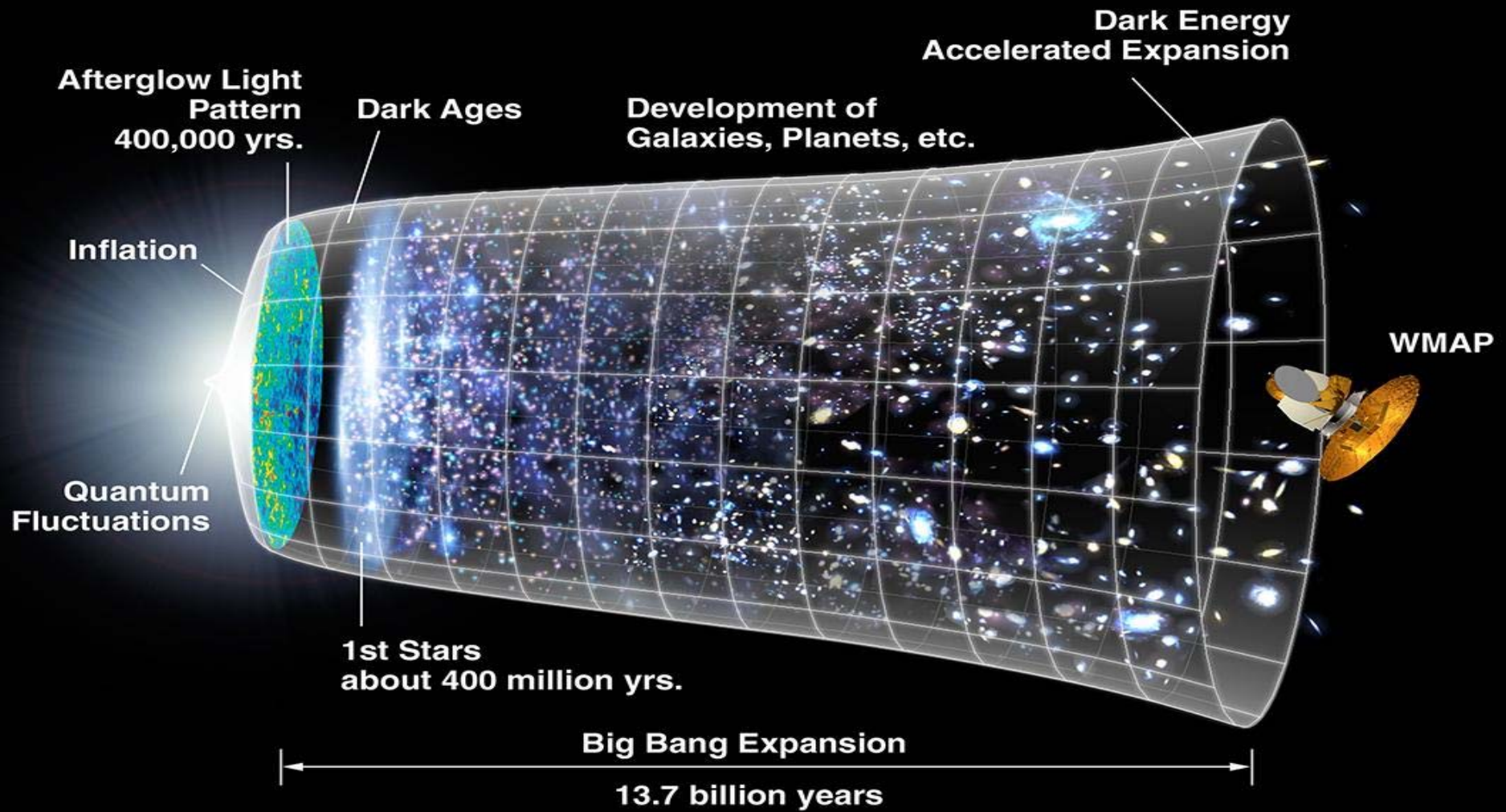
Protection of Karoo Astronomy Reserve (AGA Act,) & Co-existence

Policy, Strategy, Funding Support & Stakeholder Management

Understanding Radio Astronomy



Key Outstanding Questions: Understanding of the Universe



What is the SKA ?

- It's a global mega-infrastructure science project that endeavours to build the largest radio telescope ever built - and will become the largest scientific infrastructure in Africa and the world
- Original concept to build a surface collecting area of 1 square kilometre
 - 5 times more sensitive than existing instruments
 - Data rates exceed the entire global internet traffic
 - Will require the fastest supercomputer ever built
- Declared a SIP-16 project, reporting into the Presidential Infrastructure Coordinating Commission (PICC)

MeerKAT and SKA Roll Out

- SKA rolled out in a phased approach
- KAT-7 completed in 2010 as an engineering test bed - did some good science as well
- MeerKAT 64-dishes launched on 13 July 2018 by Deputy President Mabuza
- MeerKAT Expansion (2020-2024) - additional 13 dishes)
- SKA Phase 1 (2022-2028)
 - MeerKAT (64+13) + 133 dishes = 210 dishes in SA
 - Up to 150 km baseline to core
- SKA Phase 2 (beyond 2028) – still to be discussed
 - Full dish requirement (3000 dishes, 3000km baseline) in Africa
 - Full dense aperture array requirement (250 stations, 180km baseline) in Australia

One Observatory, One Telescope and 3 Sites

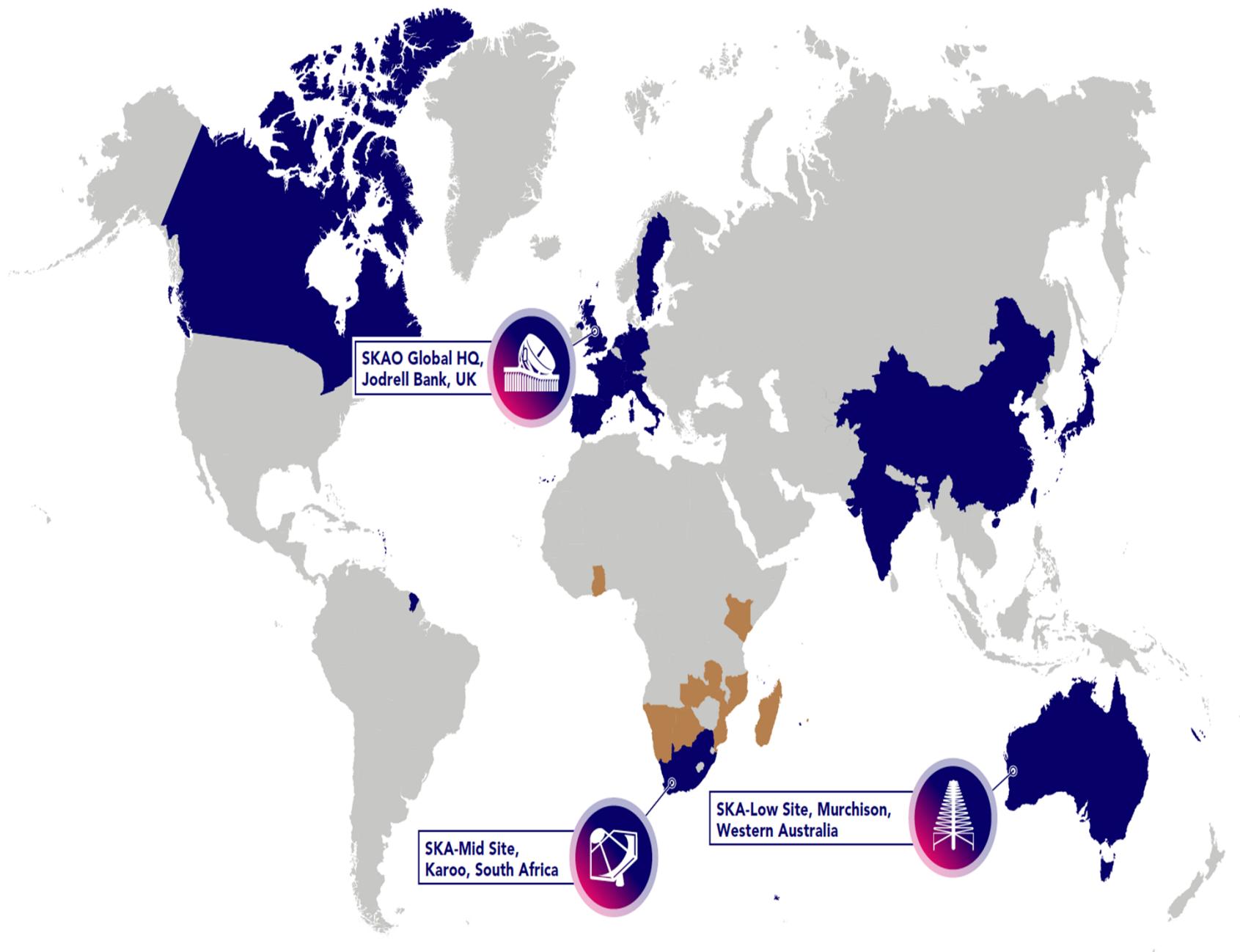


Global Headquarter (Manchester, UK)



Carnarvon,
South Africa

Geraldton,
Australia



SKAO Partnership - includes SKAO Member States* and SKAO Observers (as of June 2022)



African Partner Countries



SKAO Membership Status

Full membership

Australia, China, Italy, Netherlands, Portugal, South Africa, Switzerland, UK, Spain and India (10 Countries)

Accession stage

Germany – Cabinet approved full membership in Dec 2023 and now finalising parliamentary processes

Membership negotiations

Canada: Announced intention to join as full member in January 2023

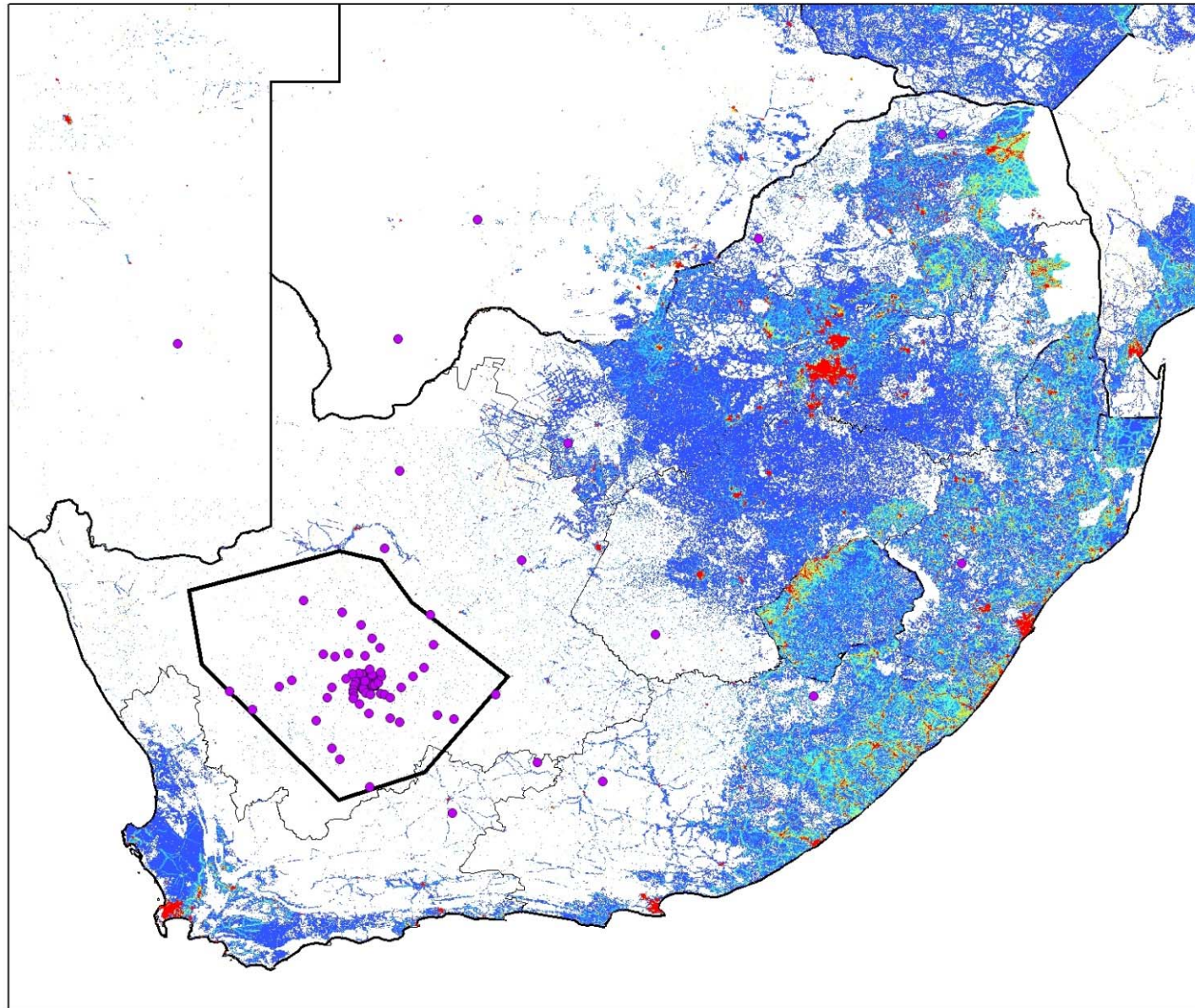
Awaiting government decisions to join SKAO

Sweden and France: awaiting government processes

Early stages

Japan and South Korea:
Early-stage discussions

Geographic Advantage - Karoo SKA Site & Population Density



Legend

- SKA_Configuration_SPDO_Dish_Full
- AA1_SPDO_Version1
- AA2_SPDO_Version2
- KCAAAA1

Population (per sq km)

Value

- 0 - 4
- 4.000000001 - 14
- 14.000000001 - 29
- 29.000000001 - 47
- 47.000000001 - 68
- 68.000000001 - 91
- 91.000000001 - 116
- 116.000000001 - 142
- 142.000000001 - 169
- 169.000000001 - 197
- 197.000000001 - 225
- 225.000000001 - 255

0 145 290 580 870 1,160 Kilometers



Contact:
Dr. Adrian Tiplady
SKA South Africa
17 Baker Street
Rosebank
2196
South Africa
Tel: +27 11 442 2434
Fax: +27 11 442 2454
Email: atiplady@ska.ac.za

MeerKAT Plus Extension & Benefits

- MeerKAT Expansion – extra 13 dishes to bring it to 77 - project jointly-funded to the value of R890m by Max-Planck-Gesellschaft (Germany, R400m), SARA0 (R400m) and INAF (Italy, R90m).
- Involves additional infrastructure benefits for South Africa - foundations, roads, power, fibre, water supply – local work
- Provides early construction with following benefits:
 - Enhances the science capability of MeerKAT - improves baseline from 8km to 17km increased sensitivity and resolution of images.
 - Reduces the schedule pressure for the SKA1
 - Demonstrates concrete progress to SKA funding stakeholders and boosts confidence in the project.
 - Mitigates the risk of losing the capabilities at SARA0

MeerKAT Plus Extension Dish Handover

- Technical handover of the 1st Dish took place at the SKA site on 21 Feb 2024



MeerKAT+: the...
www.sarao.ac.za



MeerKAT@5 Anniversary Celebration Conference

- Took place in Stellenbosch on 20-23 February 2024 with 250 participants including SKA HCD beneficiaries and alumni
- To date, 259 papers have been published using MeerKAT data – with 40% in the last year alone. However, we are just scraping the surface, with huge amounts of scientific data available for deeper exploration for many years to come.
- In its citation, the Royal Astronomy Society of London said this when awarding the MeerKAT Team Award in January 2023: “After more than a decade of development and operations, the MeerKAT team have, in a short time, achieved spectacular advances in radio astronomy”

MeerKAT@5 Anniversary Celebration Conference



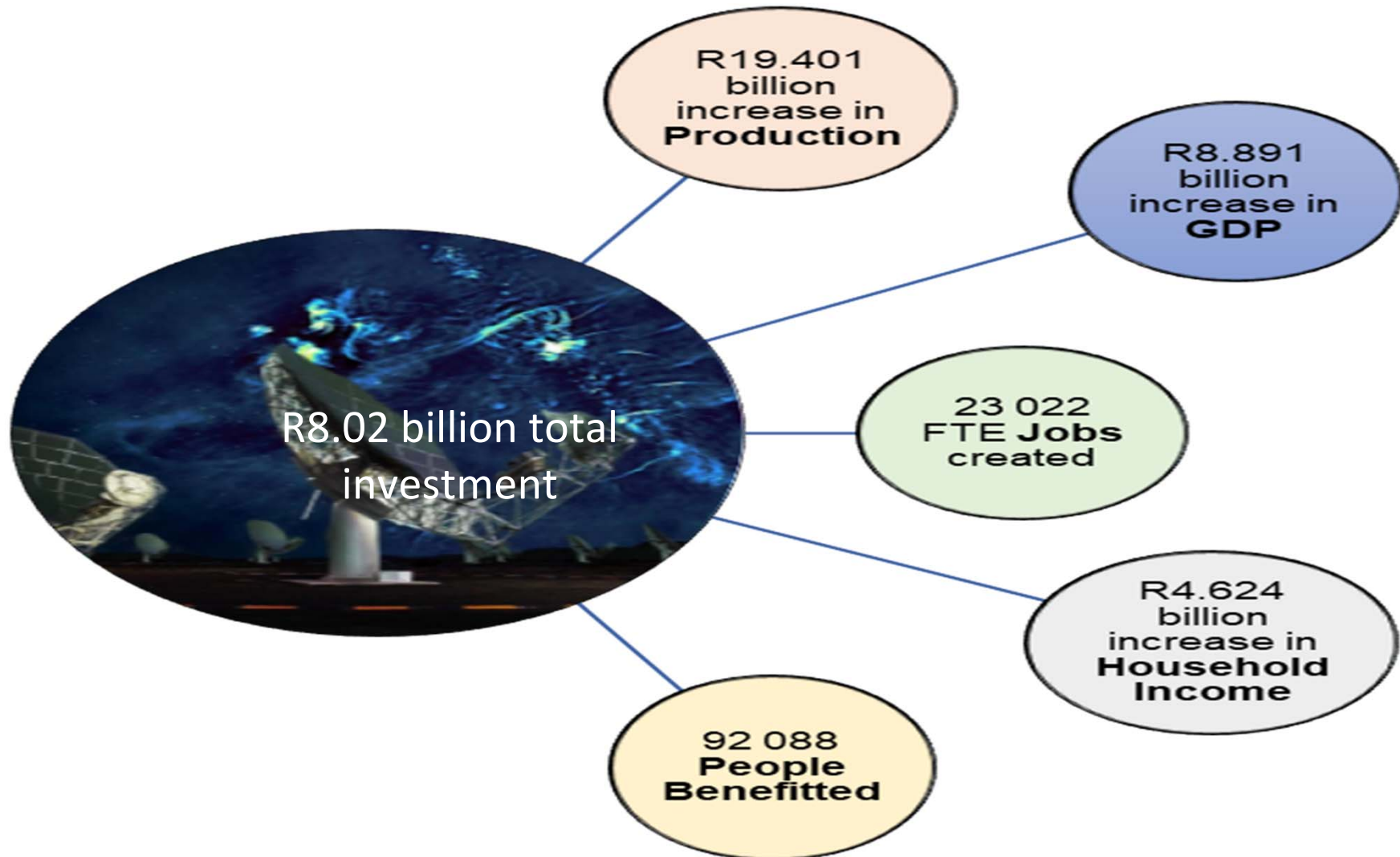
Global Benefits from Radio Astronomy

Some Examples of Past Inventions: How astronomers changed the world

- Invention of WiFi: Techniques which were developed for analysing and transferring radio signals from black holes later found expression in modern day WiFi applications
- Medical imaging: use of Very Long Baseline Interferometry (VLBI) technique to produce high resolution images from multiple telescopes found application in Magnetic Resonance Imaging (MRI) – which uses magnets & pulses to emit radio waves to enhance the imaging details for scanning in medical diagnoses.
- Accurate time-keeping and reference frame for telescopes (geodesy) – using the position of the Earth relative to the fixed position of the stars in the sky has found application in improving GPS navigation technology

Outcomes of Socio-economic Study – MeerKAT/SKA

- Study covered design, construction and operation of MeerKAT
- Study largely positive in favour of MeerKAT/SKA – demonstrates significant returns on the project



Scientific and HCD Returns

- Scientific outputs grown from below average to twice above the global average – global ranking in astronomy increased from 33 to 21 – one of the fastest growing science in SA with several discoveries being made.
- Size of astronomy community tripled over 15yrs from 60 PhD astronomers to over 200 and pipeline is increasing fast
- Significant HCD programme through SKA Bursary Programme
 - Over 1600 bursaries awarded (15% to African SKA partner countries)
 - Bursaries span from undergraduate to postdocs in astrophysics, engineering and computing studies as well as artisanal/technical skills
- 6 astronomy Research Chairs awarded at various universities to develop local scientific capacity

Recommendations of the Study – MeerkAT/SKA (1)

- a) Run a national awareness campaign - current efforts will be reviewed to improve further in partnership with NRF/SARAO/DSI Comms, GCIS, media, SAASTA, etc
- b) Foster collaboration and partnerships – stakeholder matrix will be reviewed at all levels to improve further
- c) Enhance industry engagement – being strengthened to include partnerships on commercialisation and innovations
- d) Ensure dissemination of knowledge – as in (a) above
- e) Develop an improved system for record-keeping - will be reviewed and implemented

Recommendations of the Study – MeerkAT/SKA (2)

- f) Promotion and investment into Astro Tourism – Astro-tourism strategy finalized in partnership with Dept of Tourism - and awaiting both Ministers' approval for tabling in Cabinet
- g) Improve communication with local communities - Community Stakeholder Forum will be reviewed to improve this
- h) Investigate long-term employment opportunities for artisans (especially electricians) – engagements will be pursued further with SETAs and industry

MeerKAT@5th Anniversary Conference

- Pilot phase with first dataset was launched online in 2021 by Oxford University (Dr Rob Fender) – attracted 1000 volunteers across the globe who discovered 142 variable stars
- Launched by Minister at the opening of National Science Week at University of Venda on 22 July 2023 - released second dataset to the South African public to access and participate in the science of MeerKAT
- Training started with a group of students and teachers in Carnarvon
- Online training sessions have started to accommodate the African community

MeerKAT Citizen Science Project

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Technological Returns

- Revived local high-end Printed Circuit Boards (PCB) manufacturing industry – ROACH (Reconfigurable Open Architecture Computing Hardware) boards developed further into advanced generation (SKARAB) – used on MeerKAT telescope and other telescopes worldwide
- Digitiser Innovation: 1st design to sample and convert analogue signal to digital directly at receiver
 - Performs without generating electromagnetic interference
 - Robust design to withstand extreme Karoo weather
- MeerKAT locally designed and 75% of components were sourced locally



MeerKAT Supercomputer : Scientific and Technological



- Home-grown technology solutions for super-computing infrastructure
 - Fastest supercomputer in Africa and deployed by SARAo at 30% the commercial cost
 - Cost saving of R103 million per annum as a result of non-commercial implementation of computing technologies
- Has potential to be developed for other local needs

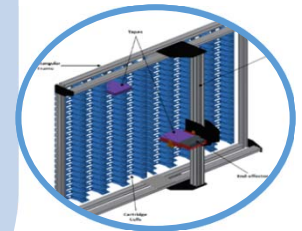
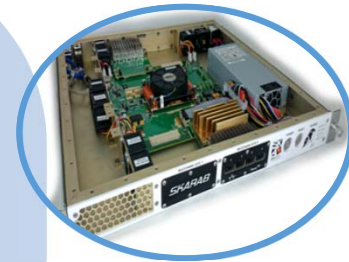
MeerKAT Benefits: Commercialisation

IP Portfolio

- 3 patents granted
- 3 registered trademarks
- 40 Open Source software packages
- 110 Closed Source software packages
- 60 disclosure (know how, engineering ingenuity and competence)

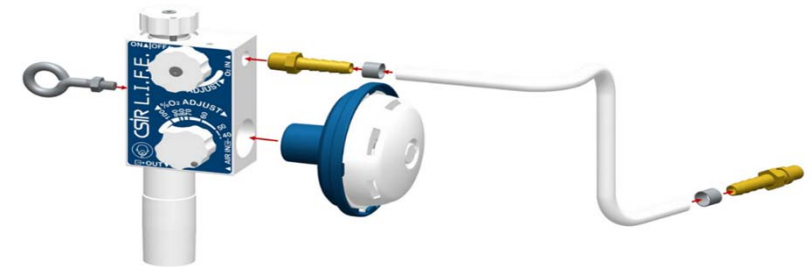
Products Developed

- Open Source Computing Technologies
 - R100m+ saving (storage and data processing) compared to commercial products
- SKARAB
 - Low cost general computing platform
- IRON HIVE
 - Low cost, high power efficiency, ruggedized high performance computing platform
- TAPE LIBRARY
 - High capacity data storage solution at 30% of commercial cost of ownership
- COMRAD
 - Passive radar solution for aircraft tracking
 - Application in border monitoring, anti-poaching



MeerKAT National Benefits: System Engineering

- ‘Data Cube’ deployed at SANSA
 - Facilitates development of earth observation data products
 - Installed infrastructure
 - Skills transfer to SANSA (system engineering)
- National Ventilator Project for Covid19
 - Seamlessly project managed process from initiation to delivery - system engineering
 - Demonstrated value add - ●4000 hrs committed by SARAO engineers
 - 20 000 ventilators being manufactured locally



* Research Professional News

UK Europe USA Australia & NZ Africa World Opinion Funding Insight Covid-19 Funding Oppor

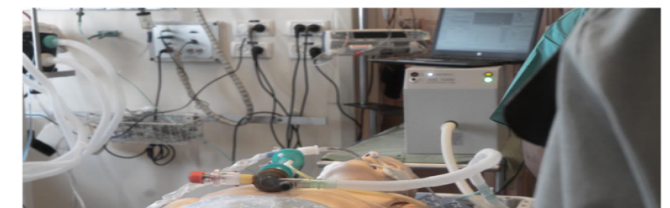
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SOUTH AFRICA 17 JUN 2021

South Africa's ventilator project shows value of basic research

By Christiaan van der Merwe

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MeerKAT Local Socio-Economic Benefits: Community Development

- South African Radio Astronomy Observatory (SARAO) is implementing agent for radio astronomy investments
- Northern Cape investment in five focus areas:



Community knowledge centre and upliftment programmes



Developing small to medium enterprises (SMEs)



Nurturing talent and youth



Provision of alternative radio astronomy friendly telecommunication infrastructure and devices



Local youth at the Carnarvon Knowledge Centre

MeerKAT Local Socio-Economic Benefits: Community Development



- Over 300 subsidized broadband satellite services to farms (owners and workers)



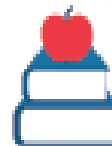
- 130,000ha national park declared and to be managed by SANParks



- 8,800 local job opportunities created + 400 permanent jobs at SARAO
- 1,252 local women directly employed by SARAO and contractors between 2015 and 2017
 - Supplier development programs
- 90% of Karoo staff from local community



- R4.7 million in community development initiatives
- R169 million spent with local suppliers and contractors
- R8.4 million on local catering, tourism and accommodation



- Artisan training centre established
- Knowledge centre established
- R2.5 million for training of local community

Pan-African Development

SKA Stations in Africa - Phase II



Kutunse Dish - Ghana



Pan-African Development

- All 8 SKA African Partner Countries now have astronomy programmes and high performance computing facilities in their universities (Only Mauritius had astronomy programme before)
- African VLBI (AVN) - Ghana Radio Astronomy Observatory established
- Development in Africa through Radio Astronomy (DARA)
 - Co-funded by SA and UK's Newton Fund
 - Conducting workshops and training programmes in data techniques across Africa
 - Over 300 students trained in Data Analytics
- Big Data Africa Programme
 - Rollout of High Performance Computing and training programmes in all African SKA partner countries - Skills applicable to areas outside astronomy such as health and climate change

International Partnerships: Benefits

- Science Diplomacy – SA increasingly respected and recognised in international forums. Changing perceptions about Africa as a destination for high-tech big infrastructure science projects
- Foreign Direct Investments to the Karoo Site (about R1 billion)
 - ✓ MeerLICHT (twin sister telescope to MeerKAT) in Sutherland – partnership between South Africa, Netherlands and UK
 - ✓ Guest instruments: HERA (USA, UK), C-BASS (UK, USA)
 - ✓ MeerKAT investments
 - S-band receivers (MPG, Germany)
 - MeerKAT expansion with Germany and Italy
- Attracted several international astronomy conferences and won the rights to host the 2024 International Astronomical Union (IAU) General Assembly for the first time in over 100 yrs of existence of the IAU (bringing over 3 000 astronomers)

SKA Phase 1 (MID): Socio-Economic Benefits to South Africa (1)

- Estimate contracts to be awarded to SA over the next 10 years = R8.bn – split as follows:
 - ✓ Construction Contracts - approximately R3.4bn
 - Infrastructure work package (roads, fibre, electricity, etc) to be done by local companies
 - High-tech work packages
 - ✓ Operations Contracts to SARAQ – R 4.7bn over the next 10 years and R1bn thereafter per year for 50 years span life of the project
- Jobs Created - Additional job opportunities over the next 7 years
- Bursaries and Grants – Skills Development
 - ✓ Doubling of bursary recipients (100 per year) in next 15 years to over 2 800 in total
 - ✓ Skills include artisans, technicians, scientists, engineers and data professionals

SKA Phase 1: Socio-Economic Benefits to South Africa (2)

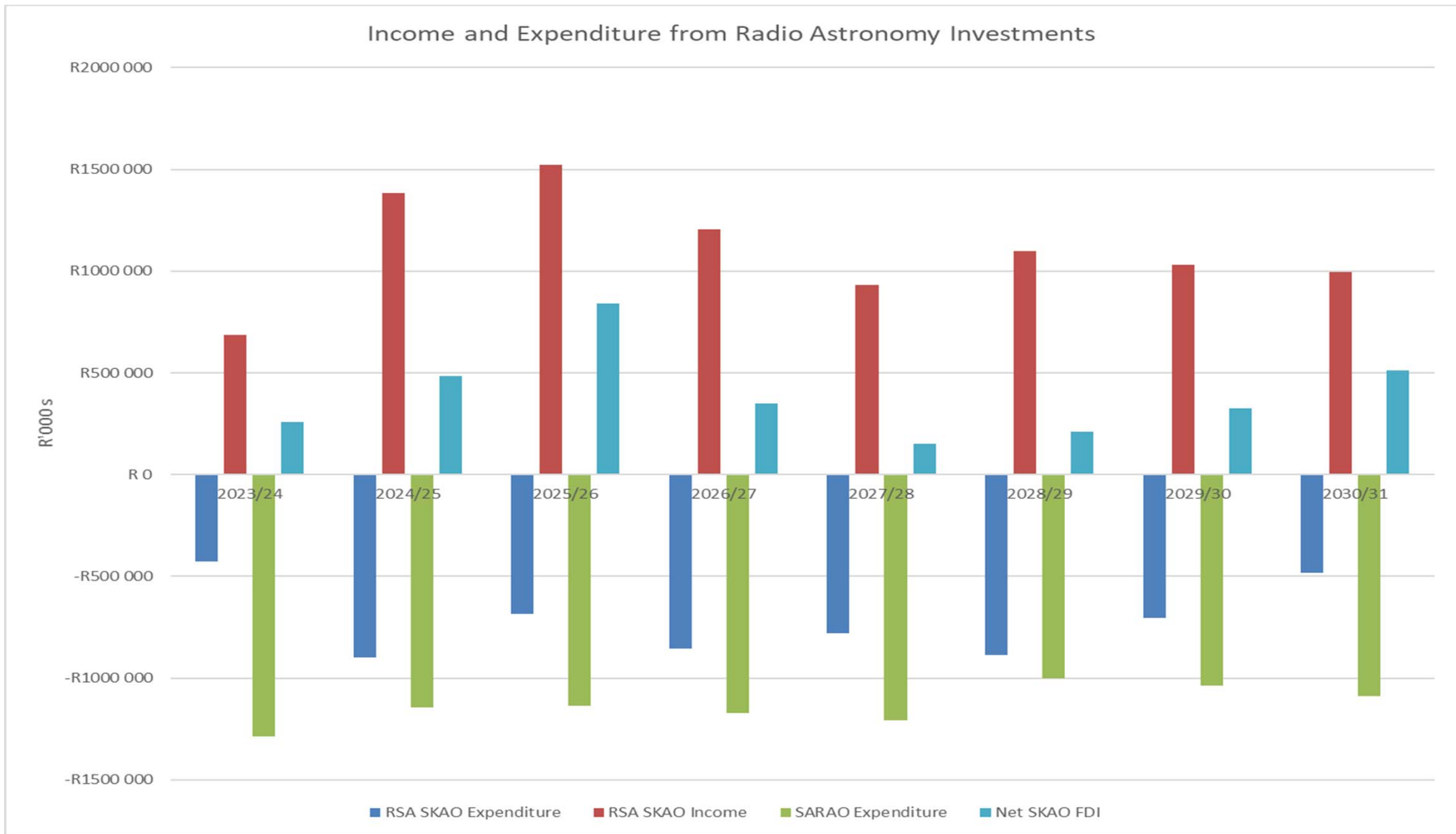
- Scientific Returns
 - ✓ Astronomy community will continue to increase exponentially
 - ✓ Scientific papers expected to also increase significantly and will propel SA to the top 10 leading countries in this field (current ranking is 21)
 - ✓ SA will meaningfully participate in the science of the SKA – generating amazing discoveries and innovations
- Market Opportunities and Commercialisation
 - ✓ Continued commercialisation pipeline and technology development
 - ✓ Exposure of South African high-tech industry to international market opportunities
- Community Development
 - ✓ Continued community development projects supported
 - ✓ Continued Karoo supplier development and training (SMME)

Status on SKA Contracts Awarded to SA

Contract	Entity	Value [M Euros]	Comments
Placed			
Software Development (SDH&P)	SARAO & SA Industry	9.8	
Infrastructure Professional Services	SARAO & SA Industry	6.6	
AIV	SARAO	19.3	Excl. expenses.
Infrastructure: Civils (MK+)	SA Industry	14.6	BEE Level 1 contributor Requirements for participation of Karoo SMMEs
Infrastructure: Civils	SA Industry	52.7	BEE Level 1 contributor Minimum 10% Civils Contract Value (R890M) to be placed with Karoo SMMEs
Infrastructure: Radio Network	SA Industry	0.9	
Digitisation	SARAO	0.47	
Currently In Procurement Pipeline [Values are Estimates]			
Infrastructure: Buildings	To be confirmed	11.9	
Future Expected Opportunities			
MeerKAT Integration	SARAO	3.4	
Networks	SA Industry	9.4	
Dish Structure Professional Services	SARAO	14.9	
Dish Receivers and Services	SA Industry	18.7	
Estimated Total		162.67	

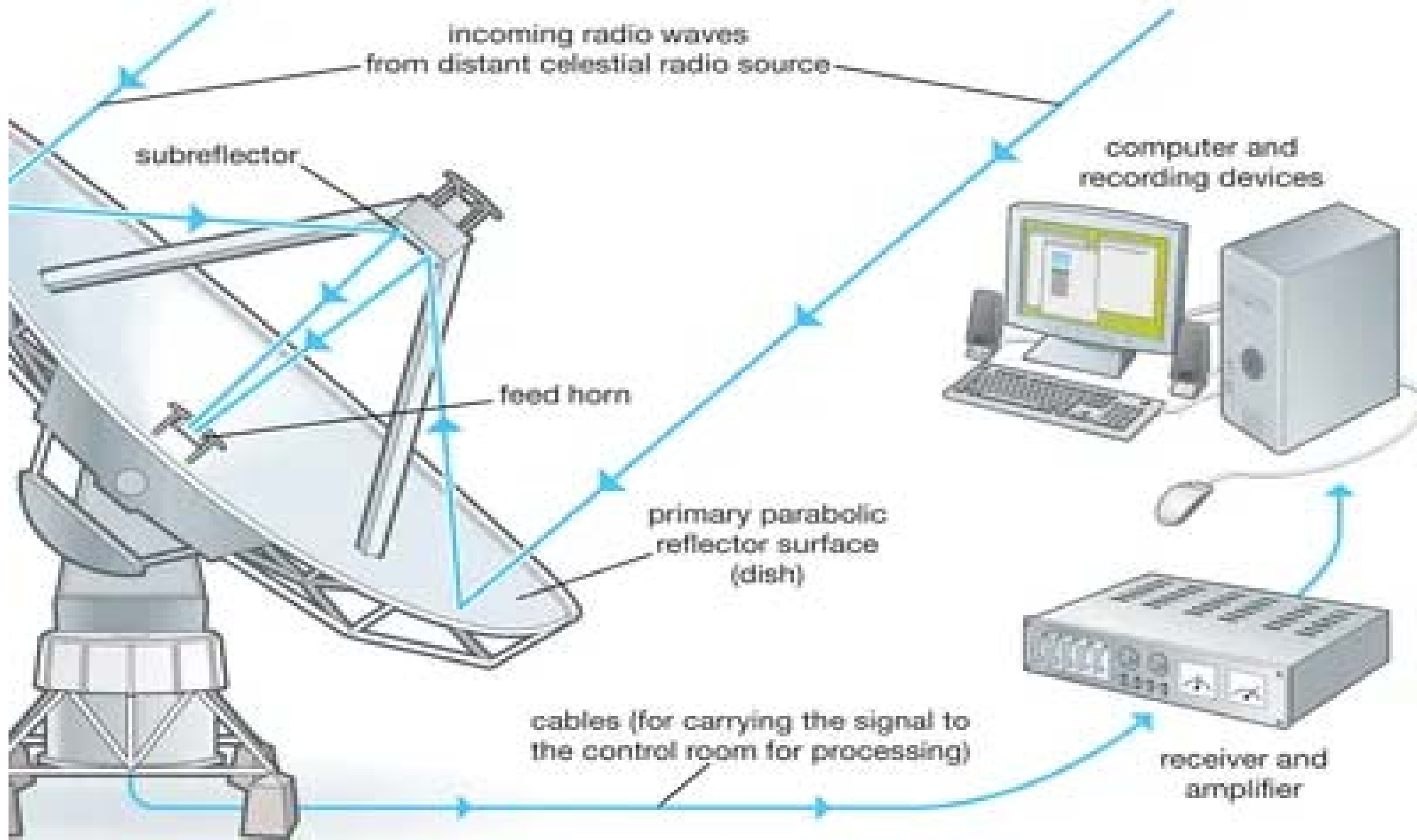
NB R3.1 bn contracts to RSA entities to date - 107% cash return on RSA investment in SKA construction

Net Positive FDI on SKA Investments 2023-2030



- Note: Net FDI on “SKA Cost Centre” is positive It is Informed by construction contracts awarded to SA Inc and operations expenditure within SA**

From Radio Signal to Big Data



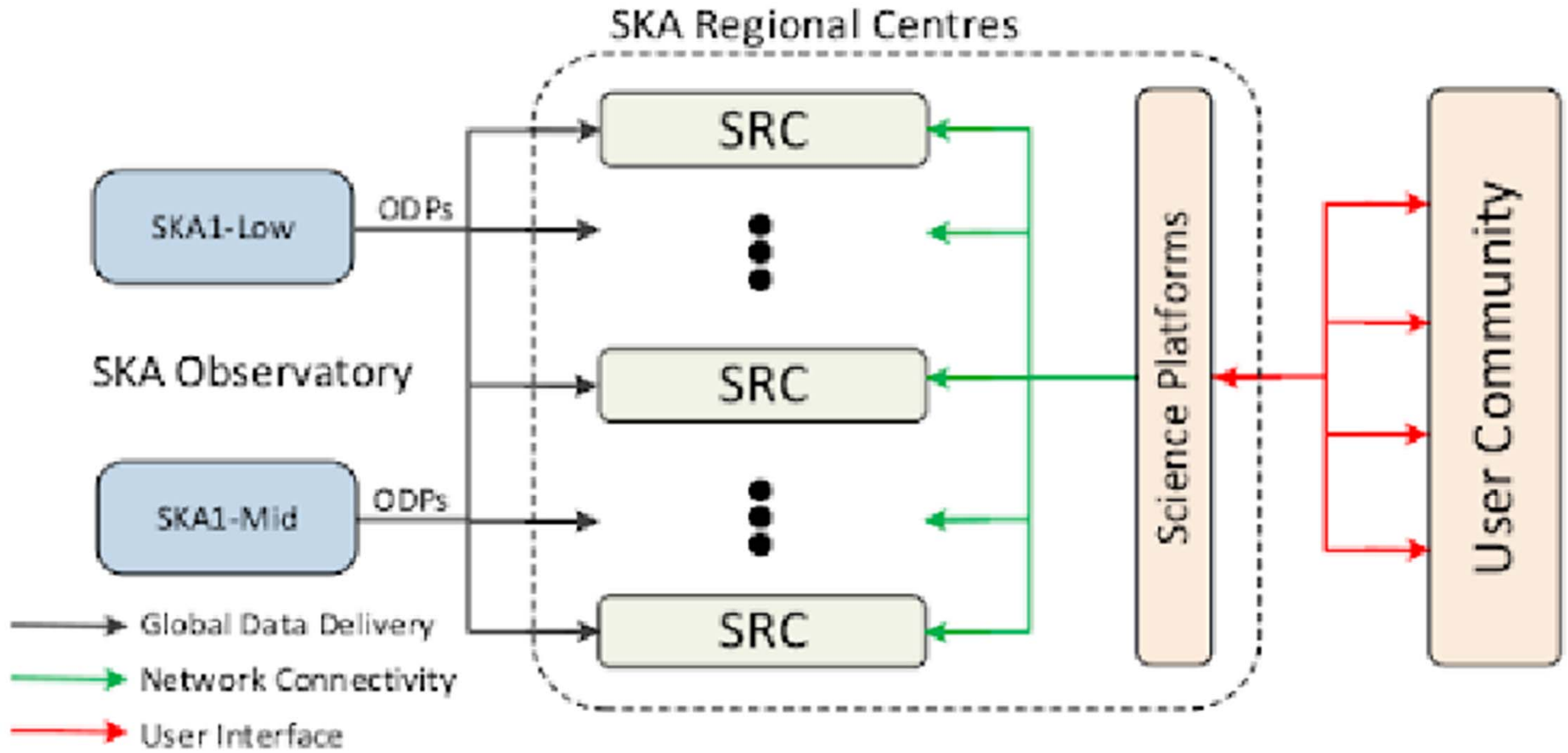
Budget Facility for Infrastructure (BFI)

- An amount of R1,26 billion has been secured from the BFI for the following items:
 - ✓ 250km game fence for the MeerKAT national park – tender process underway
 - ✓ For the development of the SKA data infrastructure which include the Engineering Operations Centre (EOC), Science Processing Centre (SPC) and the SKA Operations Centre (SOC)
- Data for the end-users will be handled through the SKA Regional Centres (SRC)

SKA Science Regional Data Centres Network (SRC-Net)

- Once the signal from the telescope has been digitized, the data storage and processing begins until it is distributed to the scientists for research purposes
- The SKA Observatory will coordinate a network of SKA Regional Data Centres (SRCs) that will provide the telescope data access, data analysis, data archive and user support interfaces with the user community.
- The South African SRC would be implemented as part of the MeerKAT/SKA Data Infrastructure in partnership with the other key DSI initiatives aimed at the development of data driven science and the digital economy. These include the National Integrated Cyber Infrastructure System (NICIS) and Foundational Digital Capabilities Research (FDCR).

SKA Science Regional Centres Network (SRC-Net)



Key Messages

- Although SA invested R9 bn to date through MeerKAT/SKA, it has resulted in significant scientific capabilities and outputs, human capital development, local content/ industrial development, community development, improvement of educational outcomes and youth programmes.
- The MeerKAT/SKA will have a net positive FDI in the long-term.
- The commercialisation of IP innovations underway is also expected to bring additional economic and financial benefits if we can invest more funding.

Key Challenges

- Attraction and retention of critical skills (ICT specialists and engineers) and working on the following solutions
 - ✓ Joint appointments between SARAO, SKAO and Universities on critical areas such as commissioning, upgrades, etc
 - ✓ Extending the search for critical skills
- Funding shortfall in the short-term – exacerbated by global financial pressures including inflation, Covid19, etc.
 - ✓ Ongoing engagements with Treasury
 - ✓ Reprioritisation of DSI budgets where possible
 - ✓ Concerted lobbying for other countries to join the SKA project

**Dankie
Enkosi
Ha khensa
Re a leboga
Ro livhuwa
Siyabonga
Siyathokoza
Thank you**



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