# GSO | Framework for Global Research Infrastructures and How the SKA Aligns

## 1. Core purpose of Global Research Infrastructures

Global Research Infrastructures should address the most pressing global research challenges, i.e. those frontiers of knowledge where a global-critical-mass effort to achieve progress is required. Science, technology, innovation, and advanced research training goals should be fully integrated throughout the infrastructure plans from their early development.

The SKA will be the world's largest radio telescope. With two observing facilities, located in Africa and Australia, the infrastructure will offer a transformational increase in capability over existing facilities. SKA's core science case is centred on study of the most fundamental questions in astronomy, astrophysics and cosmology, whilst also being designed to address more fundamental physics problems which span into other sectors. SKA will operate in an environment where similar generational shifts in scale and ambition are being planned and executed in other areas of astronomy. As such, SKA will play a leading role in the growing world of 'multimessenger and multiwavelength astronomy' alongside comparator ground and space-based missions and observatories. SKA's science is being planned by a global community of researchers, its technology and engineering by a collaboration that spans twenty countries, and its exploitation will be facilitated by a global network of coordinated regional science centres, establishing a new paradigm in the field of astronomy.

## 2. Defining project partnerships for effective management

Global Research Infrastructures initiatives should explicitly and clearly define, as early as possible, the roles and responsibilities of the partners through the different phases of a project's full lifecycle: planning, construction, operation, upgrading, and termination or decommissioning. Rules for future participation should be defined to allow the inclusion of new partners.

SKA currently operates through a UK company structure in which twelve national funding agencies and research bodies are members. The company is responsible for the pre-construction and design phase of the project and funding is provided to support the oprtation of the SKA Office at Jodrell Bank, UK. In time for construction and later operation, the SKA Observatory will be founded as an intergovernmental organisation bound by a Convention. This IGO partnership will assume responsibility for all aspects of the infrastructure, in particular working closely in partnership with the three hosting nations to ensure delivery, operation and then decomissioning of the project. The SKA Observatory is being established as a global collaboration for radio astronomy, into which, at the Council's approval, new partners and cooperation is the ambition.

## 3. Defining scope, schedule, and cost

Stakeholders should agree upon a shared understanding of the foreseen scope, schedule (including a timetable) and cost, addressing inherent uncertainties and any external constraints, and define processes to effectively address deviations.

The SKA Board currently oversees all aspects of the design process, including the cost of SKA1 and schedule. A range of management concepts are being deployed, including a cost cap set by the Board for the deployment cost (currently ~€700M). In the Observatory era, the Convention for the SKA IGO foresees a so-called 'technical document' which will describe scope, costs and other aspects, before construction approval takes place. The SKA Observatory Council will have overall control of ensuring adherance to the scope, cost and schedule plans.

## 4. Project management

Appropriate management structures and professional top level management should be established, consistent with best practices derived from existing recommendations and experience at the international level, to ensure rigorous project management.

Best practice project management and systems engineering techniques and tools are being deployed in SKA's largely 'in kind' design phase. The SKA Board, as the current governing body of the project at this stage, works to constantly review practices and oversee an appropriate top level management structure. These aspects will continue in the Observatory era under the governance control of the Council.

## 5. Funding management

The development of a Global Research Infrastructure should foresee a careful balance between the minimum acceptable percentage of in-cash contributions and the appropriate level of in-kind contributions. The in-kind contributions have to be effectively evaluated regarding quality and schedule.

Rules for managing in-kind contributions in the construction phase are under development presently, including on valuation and management, and are being advised by peer benchmarking and the outputs of other exercises (eg the work of the OECD GSF). A 'test run' of processes is foreseen in the so-called bridging phase between design and construction of the SKA. The balance between cash and in-kind will be addressed in a combination of the negotiation of the SKA1 Funding Schedule (describing the % contributions from members) and in the procurement process. These discussions will commence soon.

## 6. Periodic reviews

The scientific output and strategic goals of Global Research Infrastructures should be periodically evaluated and updated if needed throughout the entire lifecycle to ensure consistent excellence of the scientific output. In addition, an assessment of the quality of the services offered to the scientific communities is necessary to ensure the long-term usefulness and success of the infrastructure. Partnership agreements among funding agencies must enable each nation to fulfil its unique stewardship responsibilities on behalf of its national government for oversight of contributed funds.

SKA's international partners regularly review the strategic scientific priority of the project as part of national roadmapping efforts in their own national and regional domains, and this will undoubtedly continue in the SKA Observatory era of construction and operation. In addition, the current Board commissions periodic management and topical strategic reviews as required. The rules of procedure for the future SKA IGO Council are being designed to ensure appropriate governance authority for all stakeholders, where appropriate, weighted to reflect contribution to the project.

## 7. Termination or decommissioning

Planning for termination or decommissioning of a Global Research Infrastructure initiative should be established early in the development of the facility where possible or relevant, by defining criteria for the conclusion of operation, and establishing exit criteria and procedures for closing down and recognizing future termination liabilities or encumbrances on the sponsors at the conclusion of operation

Decommissioning planning is descibed in the Convention and Financial Protocol and will form part of the initial budget planning (with a decommissioning budget being established in the first years of operation of the Observatory). The three Hosting Agreements for AUS, RSA and UK describe the obligations to define detailed decommissioning plans and the arrangements around such planning.

## 8. Access goal based on merit review

The GRI policies should reflect the global-Excellence-driven Access (gEA) paradigm through publication of a clear and transparent access goal. The goal should incorporate a peerreviewed process that recommends access based on the most promising emergent ideas, regardless of the country of origin or the ability of the proposer to contribute financially.

Access to SKA telescope time will be primarily for SKA Observatory members and associate members, with a limited amount of open time to non-members (although the significant 'large legacy programme' arrangements likely for SKA will modulate this somewhat in practice). Access will however be on a scientific merit basis within a time allocation process that will reflect best practice. In common with many other observatories, observational data will be subject to a proprietary period before being made open to all, with mechanisms being implemented to ensure that appropriate tools are available to ensure the open science goals and ability to ensure interdisciplinary research is enabled.

## 9. E-infrastructure

Global Research Infrastructure initiatives should recognize the utility of the integrated use of advanced e-infrastructures, services for accessing and processing, and curating data, as well as remote participation (interaction) and access to scientific experiments.

In general, astronomers/users of SKA will interact with the Observatory via an SKA Regional Centre (SRC), which are foreseen to be located around the world in SKA Member countries. Under the coordination of the central Observatory, these SRCs will add significantly to the initial analysis and data processing capability to be provided by the infrastructure itself and will act as centres of collaboration for the SKA communities. E-infrastructures will provide the backbone of the global SKA science data network and project partners are playing a leading role in the development of techniques and infrastructures; the very challenge of the project providing a driver to push technologies.

## 10. Data Management

Many Global Research Infrastructures have recognized that the data they produce are of value and utility to a broad scientific community. Effective data management and sharing has the potential to increase the pace of interdisciplinary research and scientific discovery, to inspire innovation, and to promote more efficient and effective use of research resources. Global Research Infrastructures that manage and maintain research datasets in service to the scientific community should have transparent and public data management policies for data preservation and sharing that are mutually agreed to by the users. These policies are encouraged to consider: (1) long-term data curation including metadata; (2) data interoperability; (3) data access and re-use; and (4) alignment with community standards and practices, including standards for openness, while respecting the "as open as possible, as closed as necessary" principle.

SKA's detailed data management and access policies are being designed presently. The project has committed to following the 'FAIR' principles in all aspects of its policies and is working with a range of stakeholders globally to ensure that appropriate systems are in place. In particular our user communities are working to develop pathfinder approaches using the range of SKA 'Precursor' instruments and infrastructures.

## 11. Clustering of Research Infrastructures

Where clustering of complementary Research Infrastructures appears to be consistent with the mission of the Global Research Infrastructure, schemes for access and mobility of researchers, engineers and technicians through the cluster should be actively encouraged.

Clustering of radio astronomy facilities already occurs at an informal level, based around estbalished principles of collaboration. Looking ahead, initiatives (for example in the H2020 programmes ASTERICs and ESCAPE) are underway to develop more formal cluster-based activities around the European (and global) astrophysics research infrastructures. Clustering activities will address potential joint approaches to access, time allocation and other matters. Specific to radio astronomy, these might link to other programmes (eg the UK's DARA programme) to facilitate researcher/engineer mobility.

## 12. International mobility

Measures to facilitate the international mobility of scientists and engineers to participate in Global Research Infrastructures should be promoted.

SKA's decision to move to IGO status is in part driven by the need to ensure easy movement of staff globally. The infrastructure will span three continents, with an operational footprint in three hosting countries and through its regional presecence, more broadly still.

## 13. Innovation, Technology Transfer and Intellectual Property

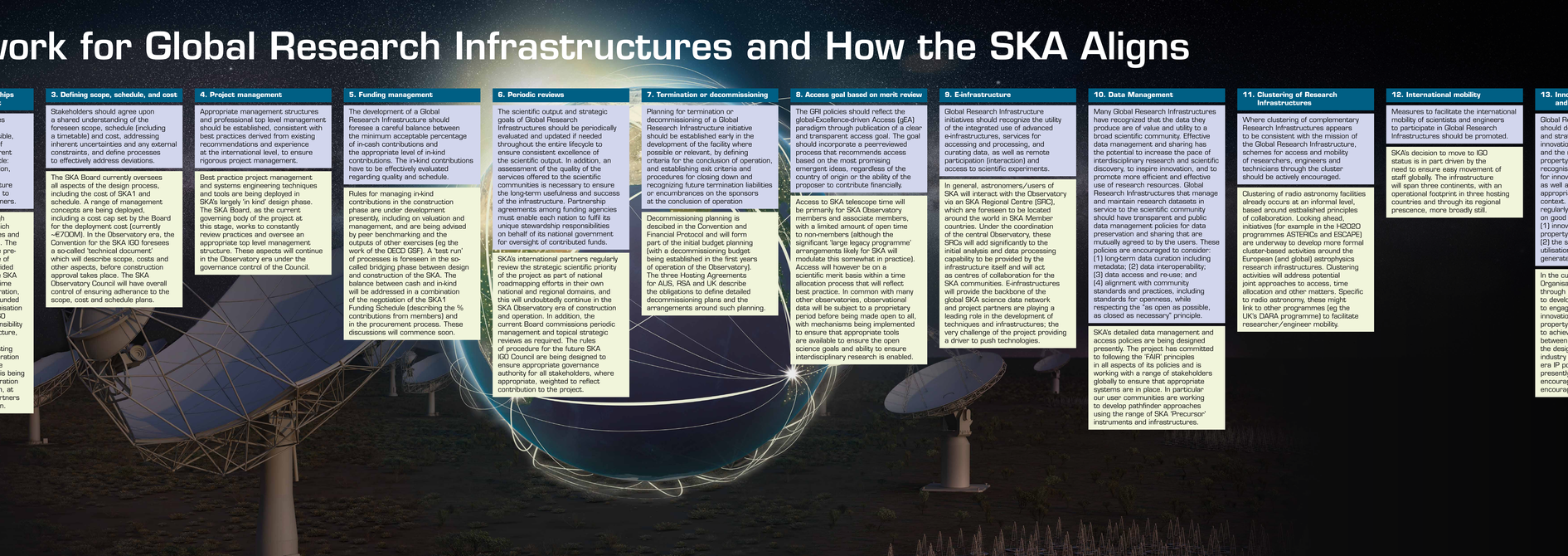
Global Research Infrastructures should develop policies with clear goals and strategies for the promotion of innovation and technology transfer and the management of intellectual property. These policies should recognise the differing opportunities for innovation at each lifecycle stage as well as the barriers and drivers appropriate to the particular GRI context. GRI's are encouraged to regularly exchange information on good practices regarding: (1) innovation and intellectual property rights management; and (2) the sharing, exploitation and utilisation of data and technologies generated by usage of the GRI.

In the current design phase, the SKA Organisation works with its Members through an industry liaison network to develop a coherent approach to engagment with industry and innovation transfer. The intellectual property policy has been designed to achieve an appropriate balance between ensuring access to IP for the design of SKA and encouraging industry participation. The Observatory era IP policy is being developed presently, again attempting to encourage maximum opportunity to encourage and exploit innovation.

## 14. Monitoring socio-economic impact

The socio-economic impact and knowledge transfer issues of Global Research Infrastructures should be assessed not only in the beginning but during the lifecycle of the project. The GSO will refer also to the OECD Global Science Forum work on the socio-economic impact of Research Infrastructure.

SKA has been pleased to participate in the GSF workstream on socio-economic impact, and works to support national study efforts as well. Monitoring impact is essential and the project is designing mechanisms to ensure it is embedded in all aspects of the project's work, enabling useful data to be available to all stakeholders.



■ Current GSO Framework Criteria ■ GRI Alignment

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