SKA Regional Centre Networking Requirements update

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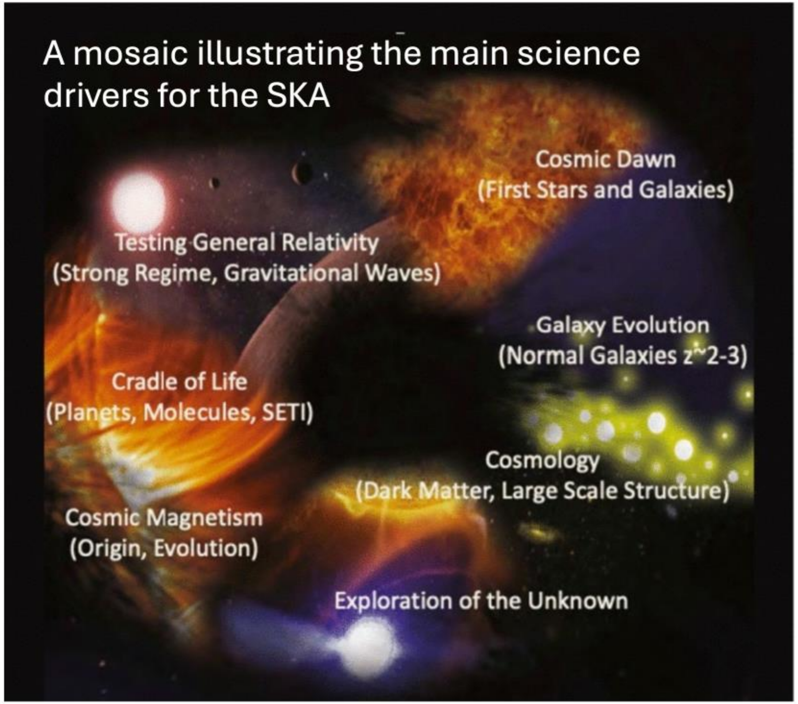
SRCNet Global and Local Network Provisioning

- **Background**
- SRC Distribution & GREN
- Estimating data volumes and bandwidths
- More on data flows
- Summary

Square Kilometer Array: Transforming radio astronomy

The Square Kilometer Array (SKA) Observatory (SKAO) is a next-generation radio astronomy facility which will cover the frequency range from 50 MHz to 15 GHz.

Composite image of the SKA telescopes, blending real hardware already on site with artist's impressions. credit: SKA Observatory

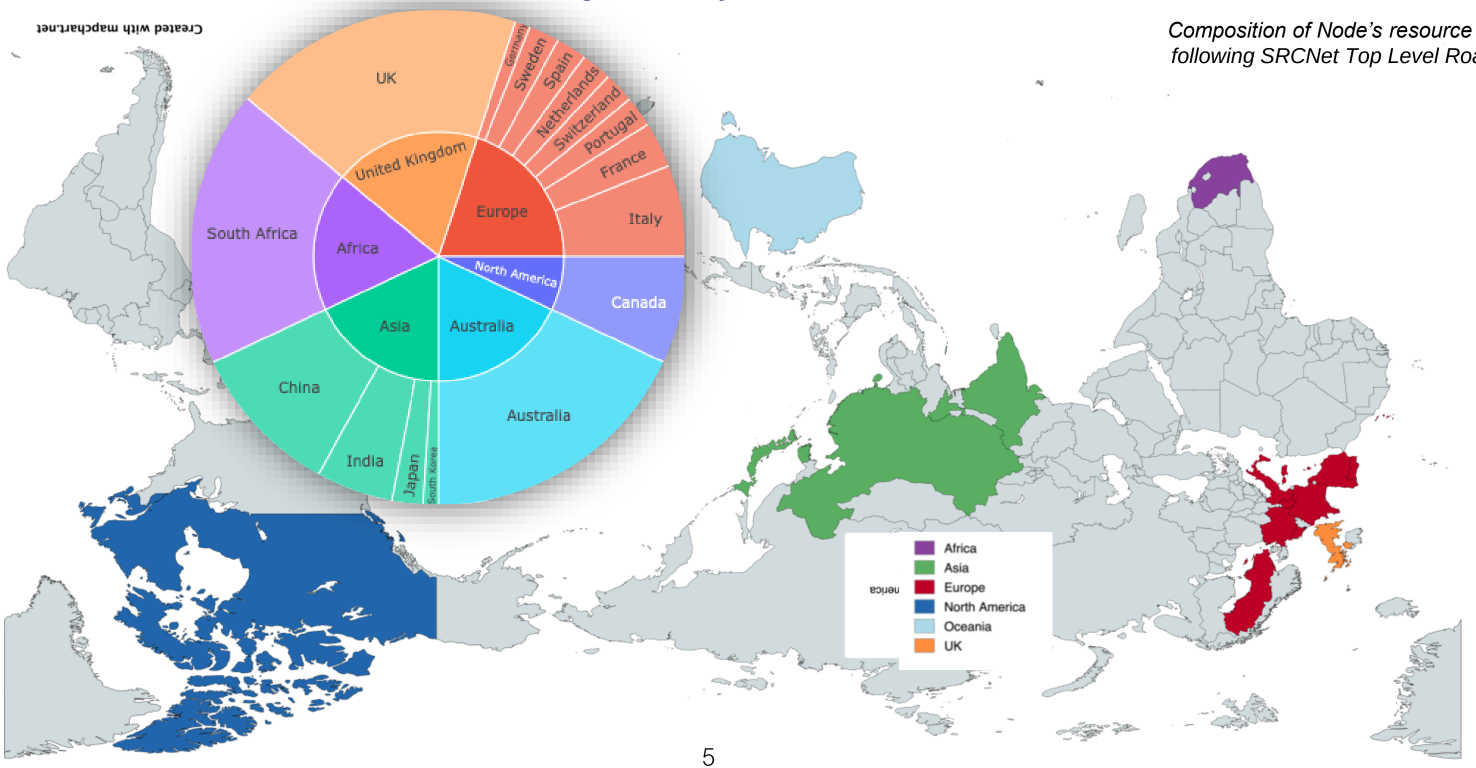


Credit: SKA Observatory


SKAO Global HQ,
Jodrell Bank, UK
SKA-Mid Site,
Karoo, South Africa
SKA-Low Site, Murchison,
Western Australia
SKAO Partnership - includes SKAO Member States* and SKAO Observers (as of August 2025)
African Partner Countries

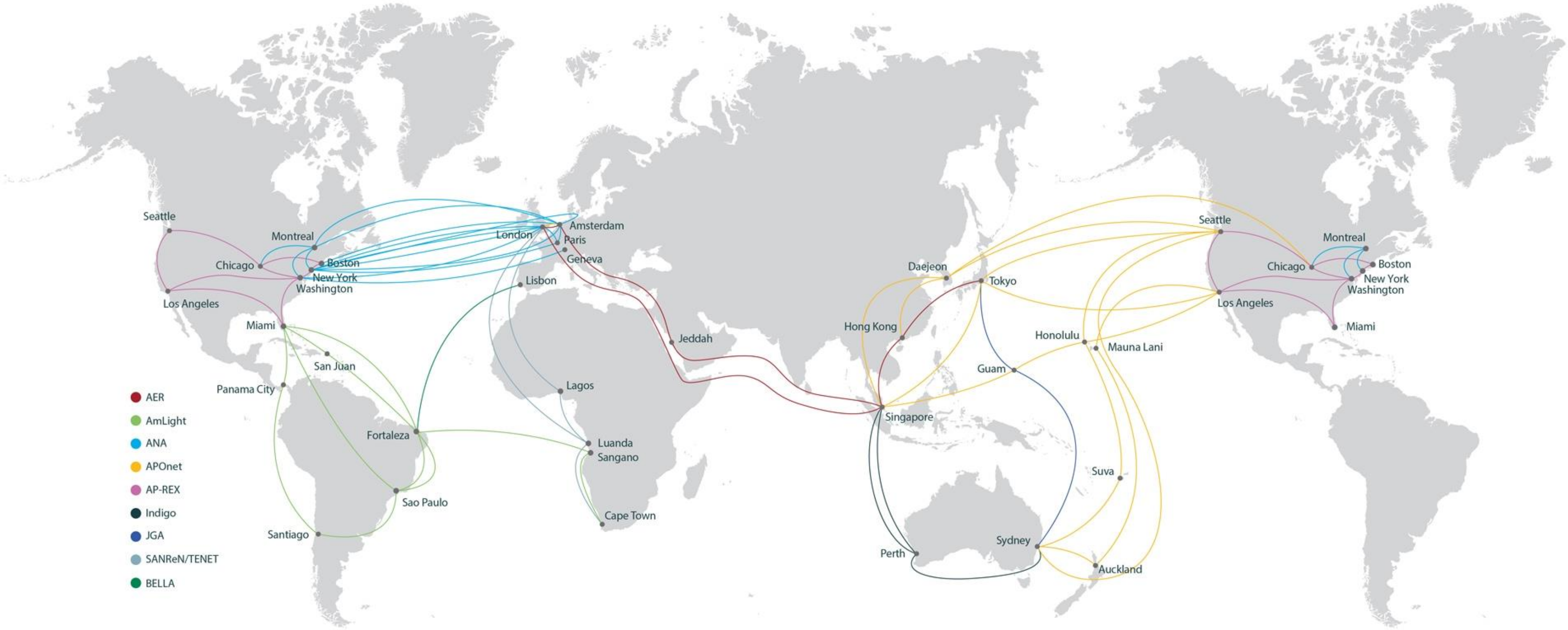
Regional Centre Nodes & distribution

- Current modelling assumes a Regional Centre share of Resources proportionate to their construction share:
  - ~ 6 similar Global Regions (Canada smaller)
- Australia, South Africa, and the UK dominate as single country entities

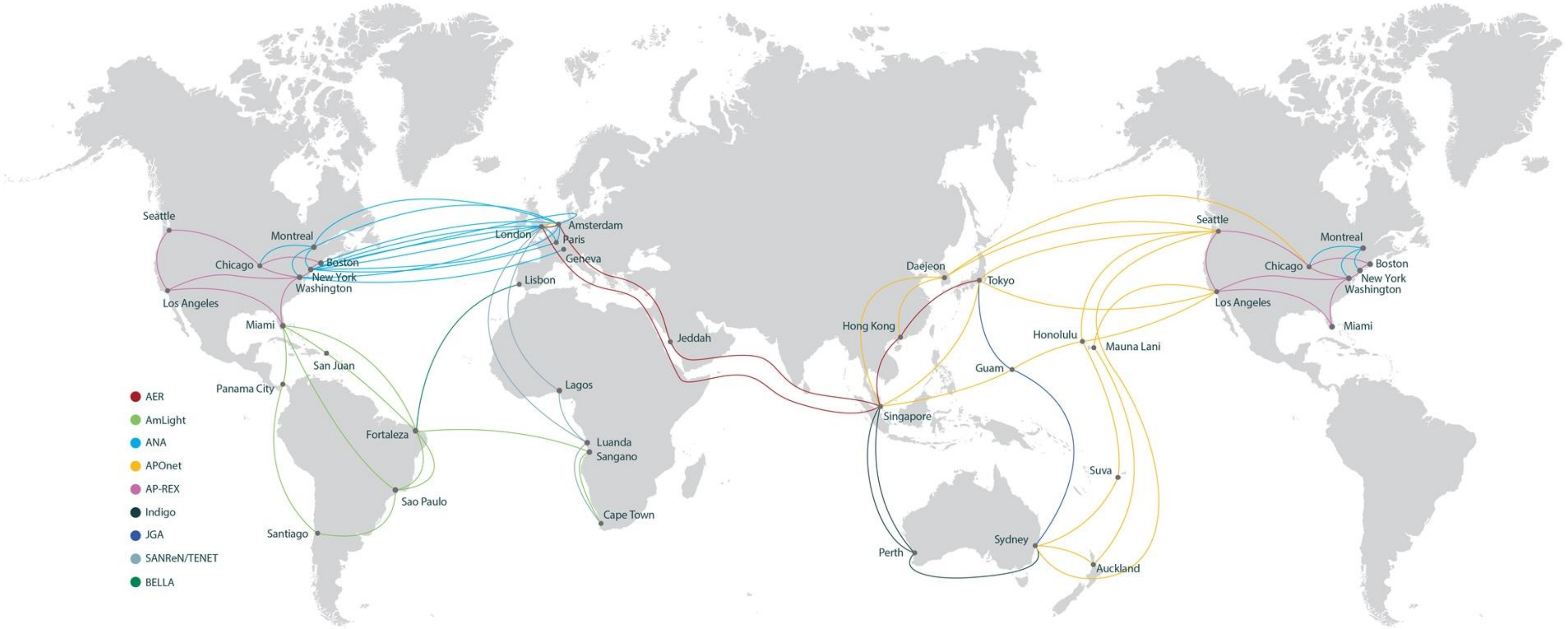


Composition of Node's resource contributions, following SRCNet Top Level Roadmap shares

The Global Research & Education Network



The Global Research & Education Network

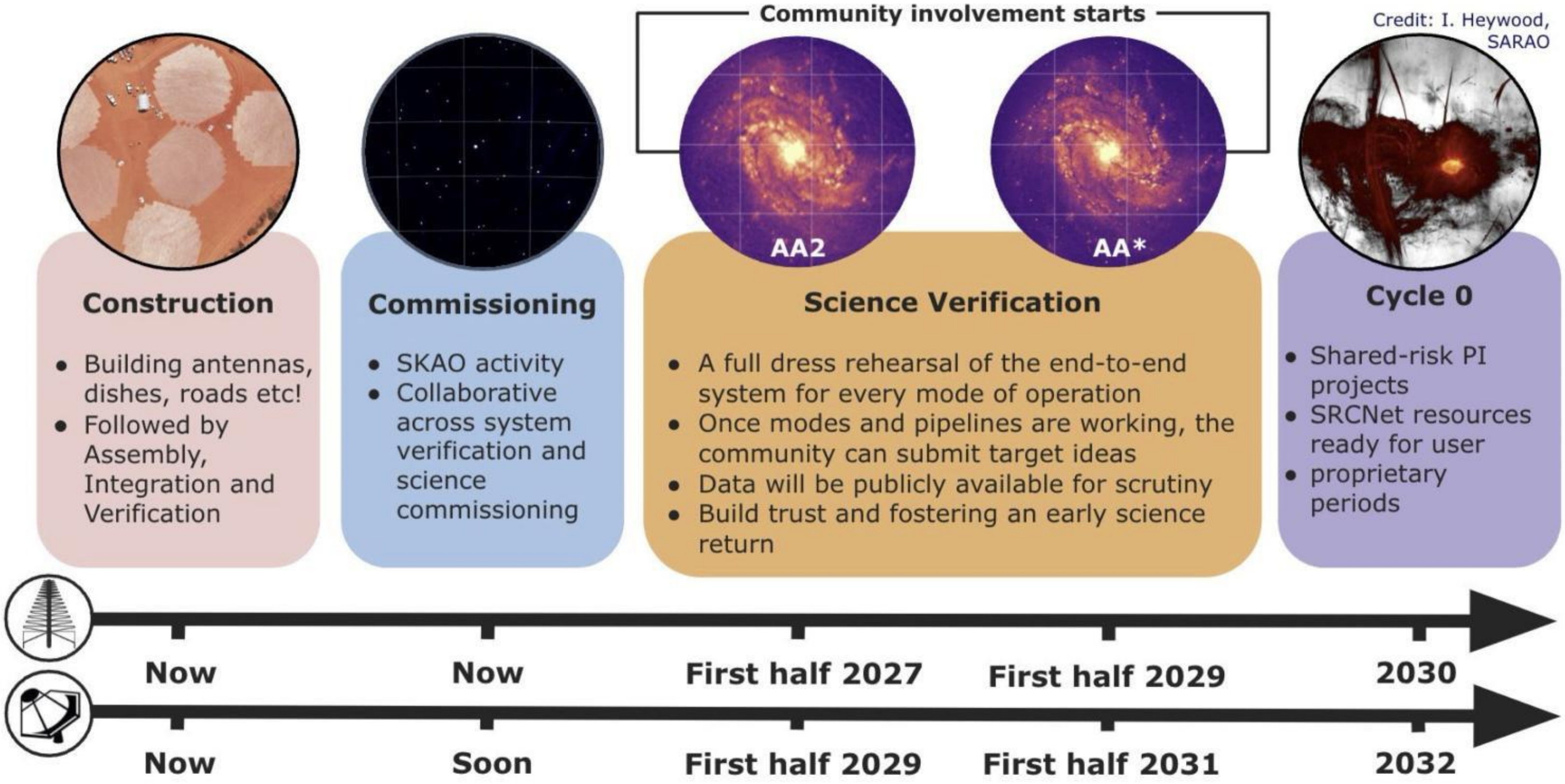


GREN already connects all the places we care about in SRCNet

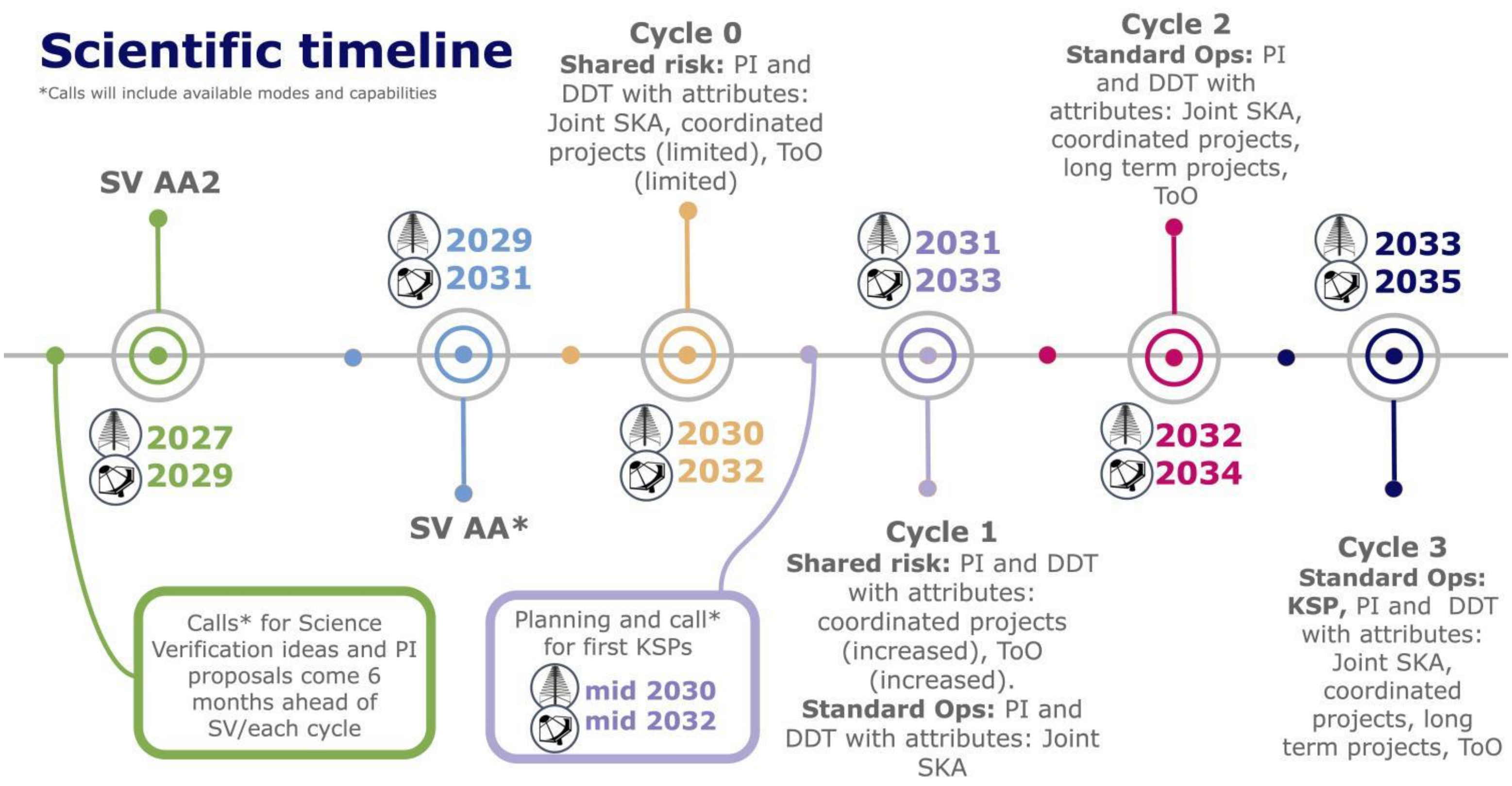
Latest SKAO Expected data rates

- Until very recently SKAO was predicting ~300PB/year by 2029
    - With mean data rates ~50Gb/s from each of Australia & South Africa
- New timeline suggests those rates will now arrive in 2035
- In 2029 expecting 25PB of new data
    - Much, much lower mean network utilization and in turn much lower load on global R&E network than earlier projections
    - BUT this doesn't necessarily mean lower bandwidth requirements at sites

Latest updates - Timeline to science

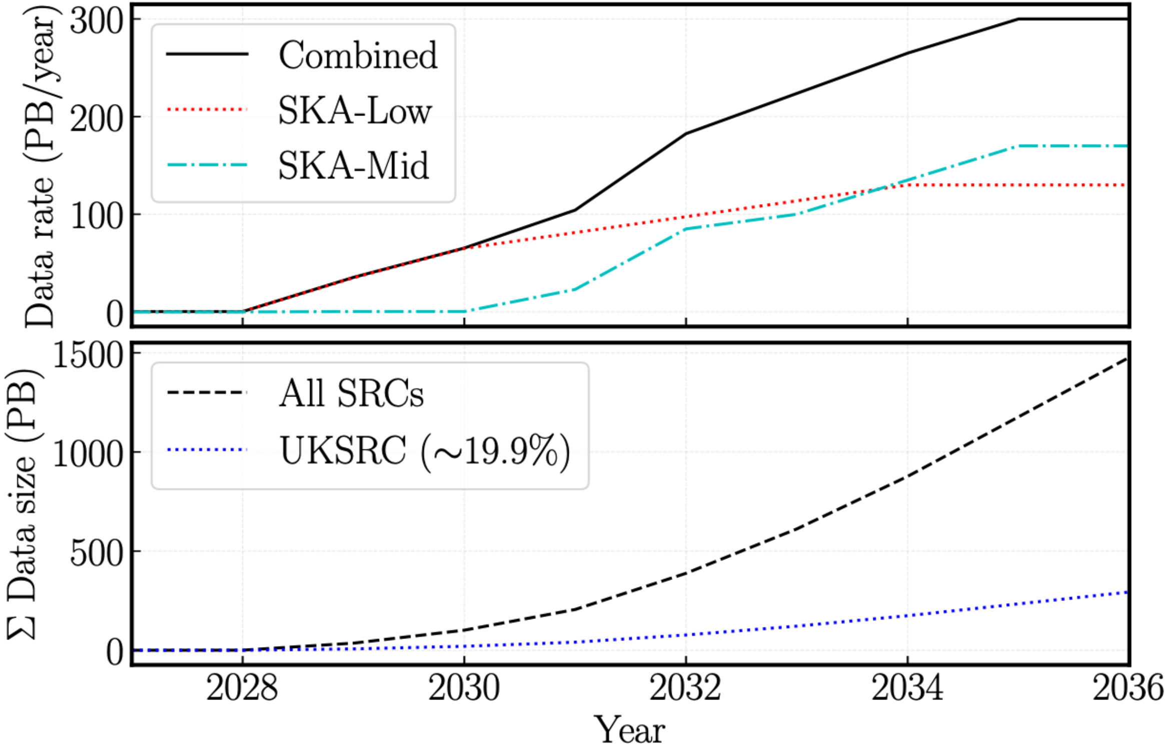


Latest updates - Timeline to science



Implications for data rates

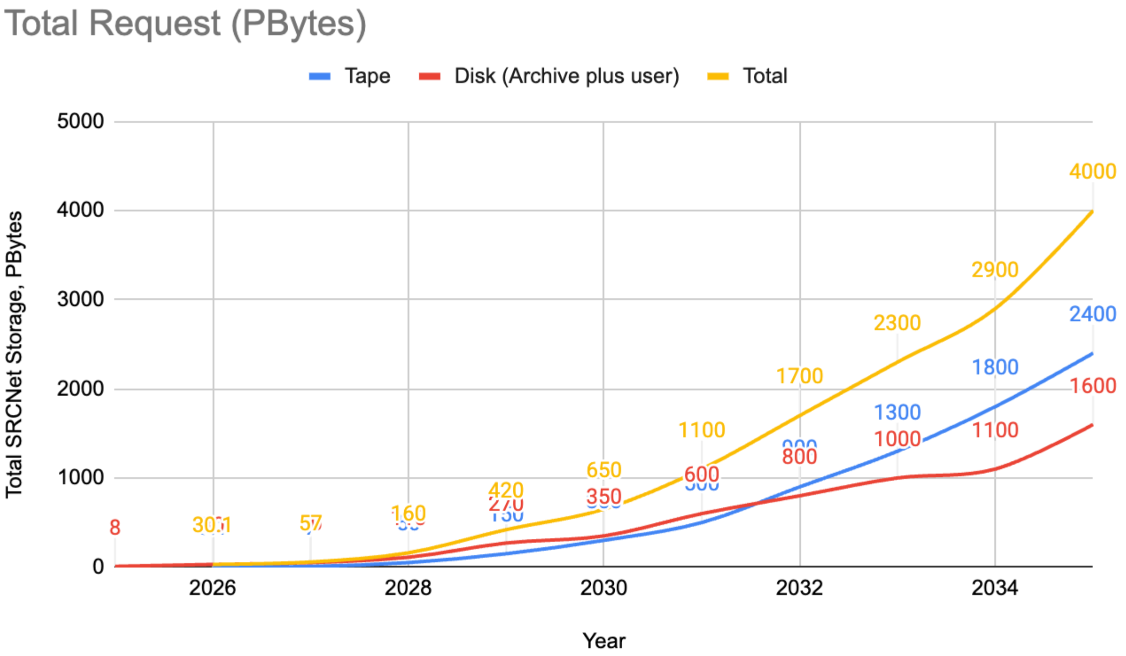
- A factor of ~2.3x reduction in data rate for steady-state SKAO
- Delays mean a slower build-up of resources needed.
- Lower plot shows total disk storage for a large (20% of total) regional centre such as UKSRC



Latest SKAO Expected storage volumes

Updated expected storage growth:

- 2029
  - 110PB disk
  - ~25PB from WA
  - ~10Gb/s average
- 2035
  - 1600PB disk
  - 2400PB tape
  - 4000PB total
  - Archive of data from the instruments + user generated data
  - Mean ~50Gb/s from each of SA & WA



SRCNet Total Storage Requests by Year
(SRCNet as a whole)

Year	Disk - PBytes (Archive + user)	Tape - PBytes	Total - PBytes	2023 Roadmap Figures (PBytes)
2025	0.0	0	8 (SRCNet 0.1 Pledge)	21
2026	~8	0	8	159
2027	7.8	0.2	8	530
2028	18	2	20	**1060**
2029	103	15	118	
2030	270	100	400	
2035	**1530**	2100	3600	

SRCNet Node Requirements - 2029

Category	1% no tape	2% no tape	4% no tape	8% no tape	20% with tape	TOTAL
Online (Disk) Storage	1.03PB	2.06PB	4.12PB	8.24PB	20.6PB	**103PB**
Scratch/cache	50TB (TBC)	100TB (TBC)	150TB (TBC)	300-400TB (TBC)	1.6TB	**~3-4PB**
Tape					5PB	**15PB**
Network	50 Gbps External ≥100 Gbps Internal	50 Gbps External ≥100 Gbps Internal	50 Gbps External ≥100 Gbps Internal	50 Gbps External ≥100 Gbps Internal	50 Gbps External ≥100 Gbps Internal	**50 Gbps External ≥100 Gbps Internal**

SRCNet Node Requirements - 2035

Category	1% no tape	2% no tape	4% no tape	8% no tape	20% with tape	TOTAL
Online (Disk) Storage	15.3PB	30.6PB	61.2PB	122.4PB	306PB	**1530PB**
Scratch/cache	50TB (TBC)	100TB (TBC)	150TB (TBC)	300-400TB (TBC)	1.6TB	**~3-4PB**
Tape					700PB	**2100PB**
Network	100 Gbps External ≥100 Gbps Internal	100 Gbps External ≥100 Gbps Internal	100 Gbps External ≥100 Gbps Internal	180 Gbps External ≥100 Gbps Internal	~300 Gbps External ≥100 Gbps Internal	
Network mean ingress/egress utilisation	~11 Gbps	~22 Gbps	~44 Gbps	~88 Gbps	~145 Gbps	

Still refining modelling of network utilisation

Estimating SRC data volumes and bandwidths

- From these totals we can estimate data volumes at individual SRCs based on % share of total
- In turn we can also estimate mean network utilisations
- These mean network utilisations in turn much lower
  - 50Gb/s from each of SA & WA in 3035
  - Much lower in 2029

SRC Input volume vs Share size

Volume [PB] /Share [15%]	5	10	15
100	13	26	39
250	32.5	65	97.5
500	65	130	195

100

Share [%]	1	2	5	10	15	20
Disk [PB]	3	5	13	26	39	52
Ingress Data [PB]	3	5	13	26	39	52
Egress Data [PB]	1	3	6.5	13	20	26
Ingress Rate [Gb/s]	1	3	6.2	12	19	25
Ingress Peak Rate [Gb/s]	3	5	12	25	37	50
Ingress Peak Bandwidth [Gb/s]	5	10	25	50	74	99
Egress Rate [Gb/s]	1	1	3.1	6.2	9.3	12
Egress Peak Rate [Gb/s]	1	3	6.2	12	19	25
Egress Peak Bandwidth [Gb/s]	3	5	12	25	37	50

250

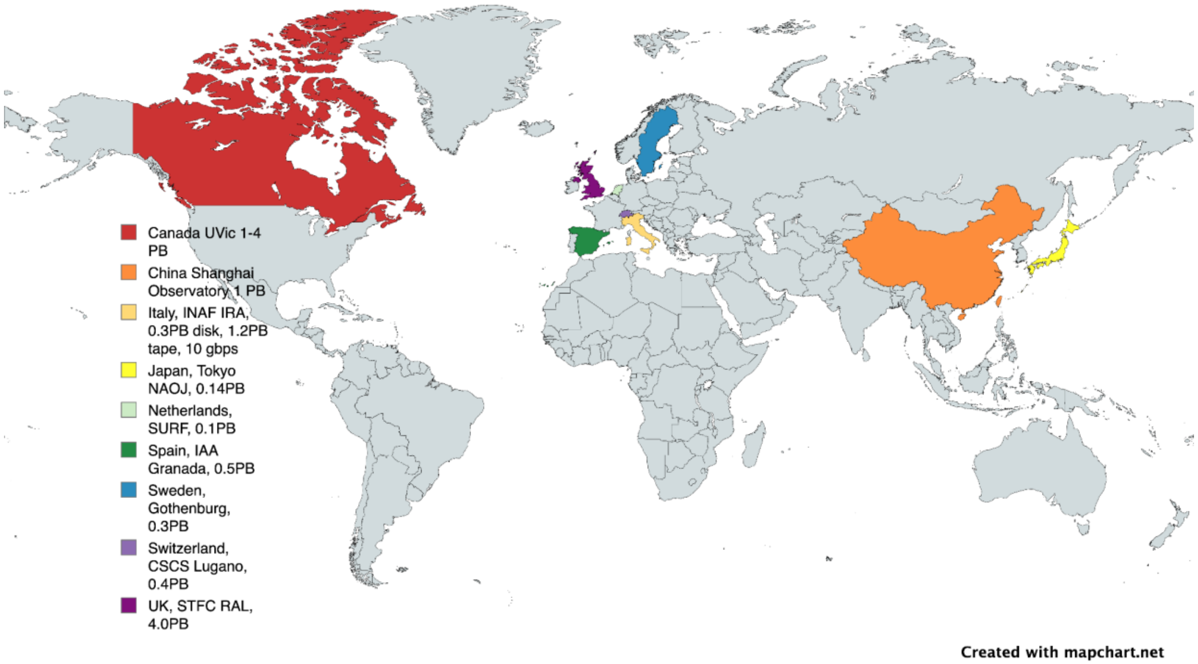
Share [%]	1	2	5	10	15	20
Disk [PB]	6.5	13	33	65	97.5	130
Ingress Data [PB]	6.5	13	33	65	97.5	130
Egress Data [PB]	3.2	6.5	16	32.5	48.8	65
Ingress Rate [Gb/s]	3.1	6.2	16	30.9	46.4	61.8
Ingress Peak Rate [Gb/s]	6.2	12	31	61.8	92.8	124
Ingress Peak Bandwidth [Gb/s]	12	25	62	124	186	247
Egress Rate [Gb/s]	1.5	3.1	7.7	15.5	23.2	30.9
Egress Peak Rate [Gb/s]	3.1	6.2	16	30.9	46.4	61.8
Egress Peak Bandwidth [Gb/s]	6.2	12	31	61.8	92.8	124

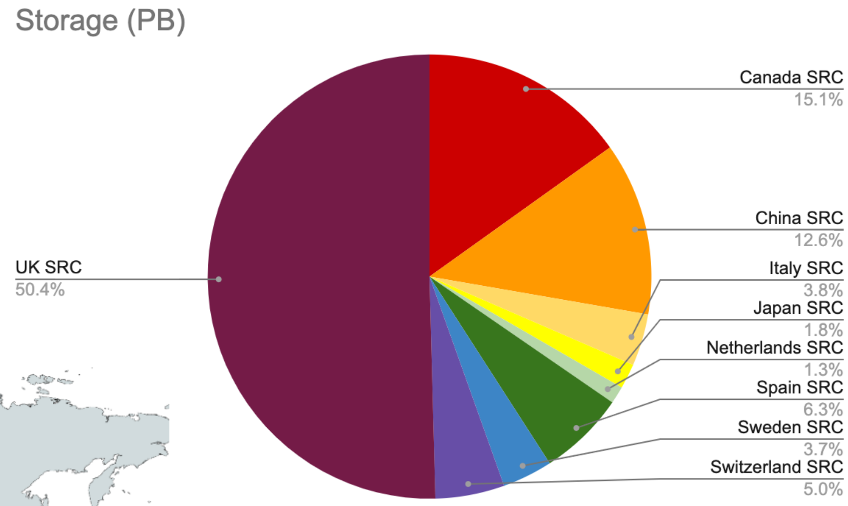
	Input
Annual Disk Volume [PB]	780.00
ADP size fraction	0.30
Annual increase fraction	0.00
Year count	0.00
Number of Replicas	2.00
Data Consolidation / retry factor	1.50
Network overheads factor	1.25
Peak capacity factor	2.00
Network Bandwidth factor	2.00

SRCNet 0.1 testing

8 PBytes total storage offered for SRCNet0.1 (c.f stated target of 20 PB)

Sites have demonstrated they meet all the resource & operational requirements





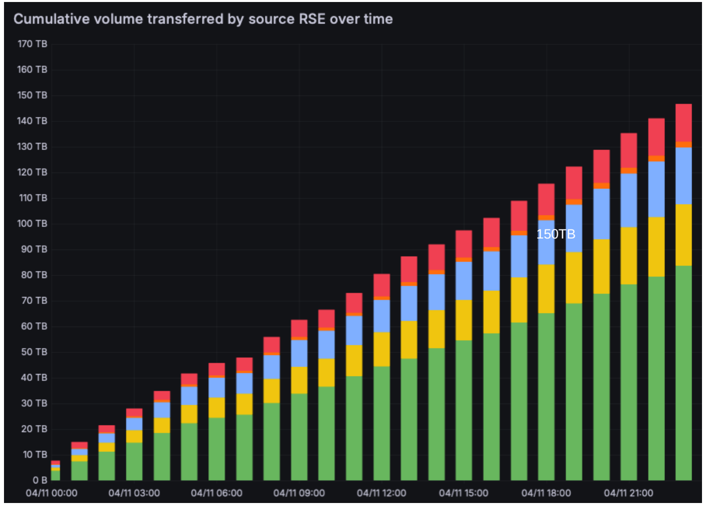
WLCG experience at some sites (Canada, Netherlands, Sweden, Switzerland, UK)

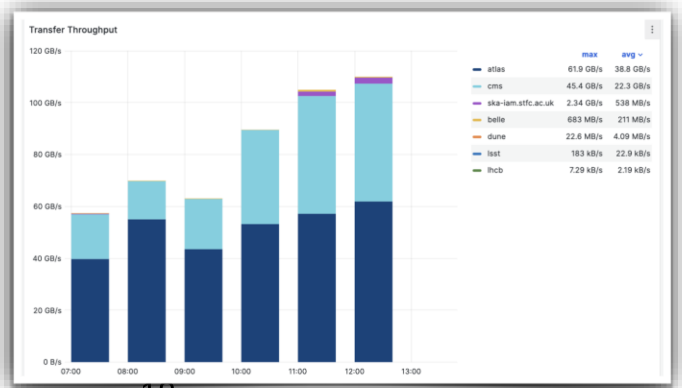
Some sites quite new and teams will learn by being involved

Milestones so far achieved (1)

- Capability tests performed:
  - Replication from Site_A -> Site_B and Site_B->Site_C
    - (Excluding Site_A -> Site_C)
    - Emulating data flow modelling
    - 5GiB files
- Capacity testing:
  - 150TB target in 24hours
    - Target rates for each RSE link-pair
      - Simple modelling emulating movements between larger and smaller RSEs
  - 147TB transferred within the time window

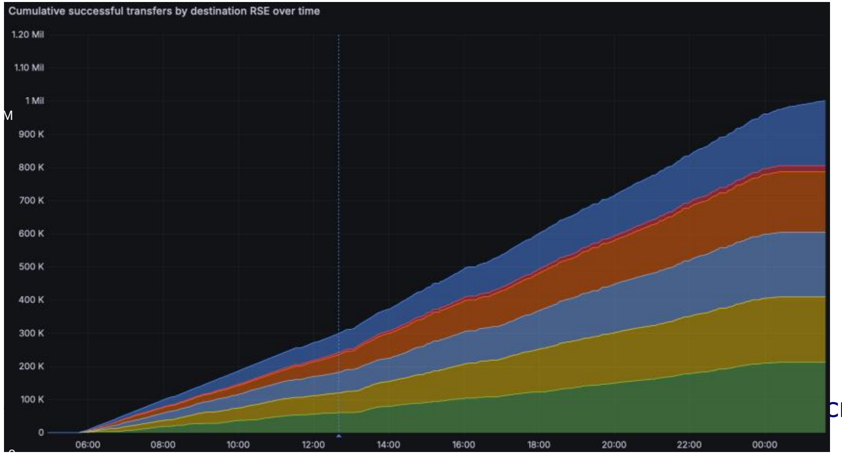
- Improvements in modelling in expected share of resources and long-haul source testing
- SRCNet now visible within the Global FTS Monitoring plots

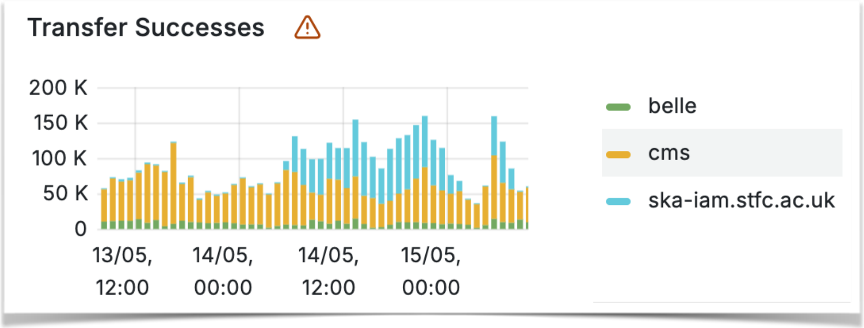




Milestones achieved (2)

- Test of ability of Rucio / FTS to handle higher submission rates, and tests of enabling services (e.g. monitoring)
- 1M x 1MiB files; target to replicate from a single source RSE to other Sites within 24hours
    - Stored as 1k x 1000 file datasets; submitted throughout the test period
    - Storage at Rutherford Appleton Lab used as source for all transfers





crease tested to 100k / hour.

- Rate comparable to e.g. CMS during the period.

Some things we have we learned

- Mean network utilisation will be lower than originally foreseen for some time
- BUT for efficient transfers we will want high bandwidth connections to SRC Nodes – want transfers to complete quickly and reliably
  - And in internally federated SRCs like UK we will need to stage data between sites quickly and efficiently
- Even a “small” SRC node with maybe only a few 10s of PB of storage will benefit from 100Gb links – aim to match output rates of SDPs in South Africa & Australia
  - Can be shared with other use cases
  - Mean utilisation may remain 5-10Gbps for smaller SRCs
  - Will be significantly higher for the large SRCs
    - UK, South Africa, Australia
  - As happened in WLCG we will surely see growth in user/workflow driven transfers - not modelled yet

Science Verification - Next major milestone in 2027

- First “real” science data will arrive from SKA-Low in Australia – planned in 1st half of 2027
  - Will need to be distributed from Australia into and across the SRC network for analysis & verification
  - Relatively modest 0.5PB expected
    - Sizes and cadence of data set releases to be determined
  - Modelling of ingestion plans based on what was achieved in 0.1 testing earlier this year
- 2026 will involve verifying that all SRC nodes can demonstrate required performance reliably

Science Verification – network requirement modelling

- For planning assume 5 lots of 100TB
  - Assume we want to move each 100TB "lot" from Australia to "not Australia withing 24 hours (this is within what we achieved earlier this year – albeit not to and from Australia)
  - Assume we then distribute across the rest of the SRC nodes over one week
  - Then available for analysis and verification
- This suggests that large SRC nodes (UK, Australia) will need ~20Gb/s available *for these ingestion periods*
  - Other SRCs will need ~10Gb/s
  - China SRC in Shanghai will be large ~9% share
- Obviously, mean utilisation over the year will remain low. Shared links with suitable planning should be just fine.

Summary

Data Volumes and Bandwidth estimation

- SKAO is refining its roadmap for how much data will be produced and when
- Can translate that to local bandwidth requirements at SRCNet sites
    - Can map that to the developing requirement
    - **New estimates are much lower than previous ones**
        - Full rates now arriving alongside LHC Run 5
        - Global R & E Networks should be able to cope comfortably
- NRENs and SRCNet sites will need to work together where investment/development is required
    - It continues to be the responsibility of sites to ensure they have the network provision required locally

Data movement tests

- Successfully demonstrated ability to move both large files/datasets and large numbers of files/datasets
- Shaking out network and storage configuration issues
- Will need to optimise throughput significantly

Road to Science Verification - 2027

- 0.5 PB to be produced by SKA-Low in Australia through 2027
    - Distributed across SRCNet network
    - Aiming one week campaign for each data release.

- Implies ~20Gb/s at the larger SRCs and SKA-Low, ~10Gb/s elsewhere
- Reliable data movement to be demonstrated through 2026

- Opportunity of participating/coordinating with DC27

Questions