SKAO REGIONAL CENTRE NETWORK

Architecture of the SKA Regional Centres Network

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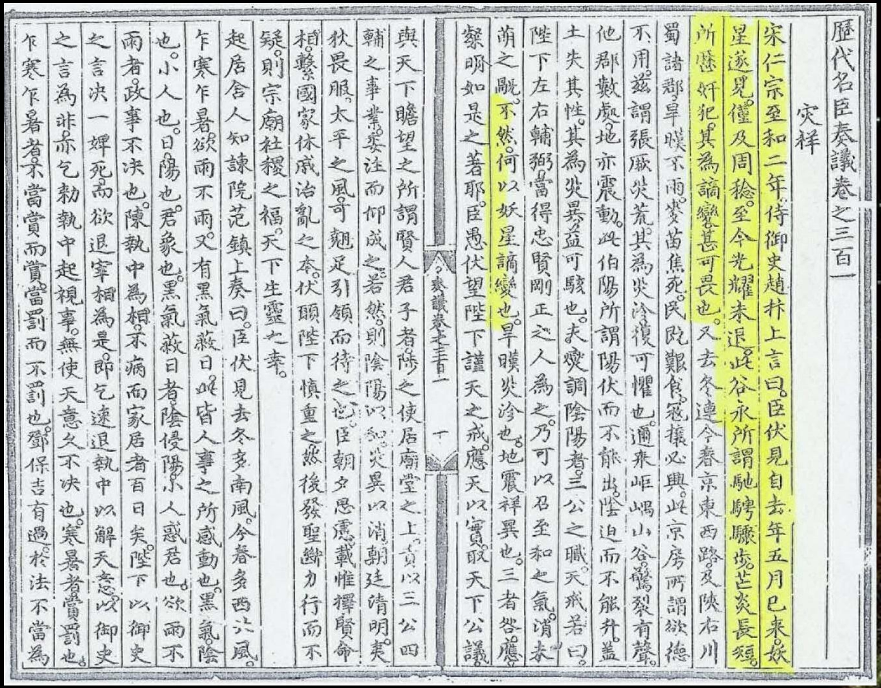
SRCNet Architect

Shanghai 2024


歷代名臣奏議卷之三百一

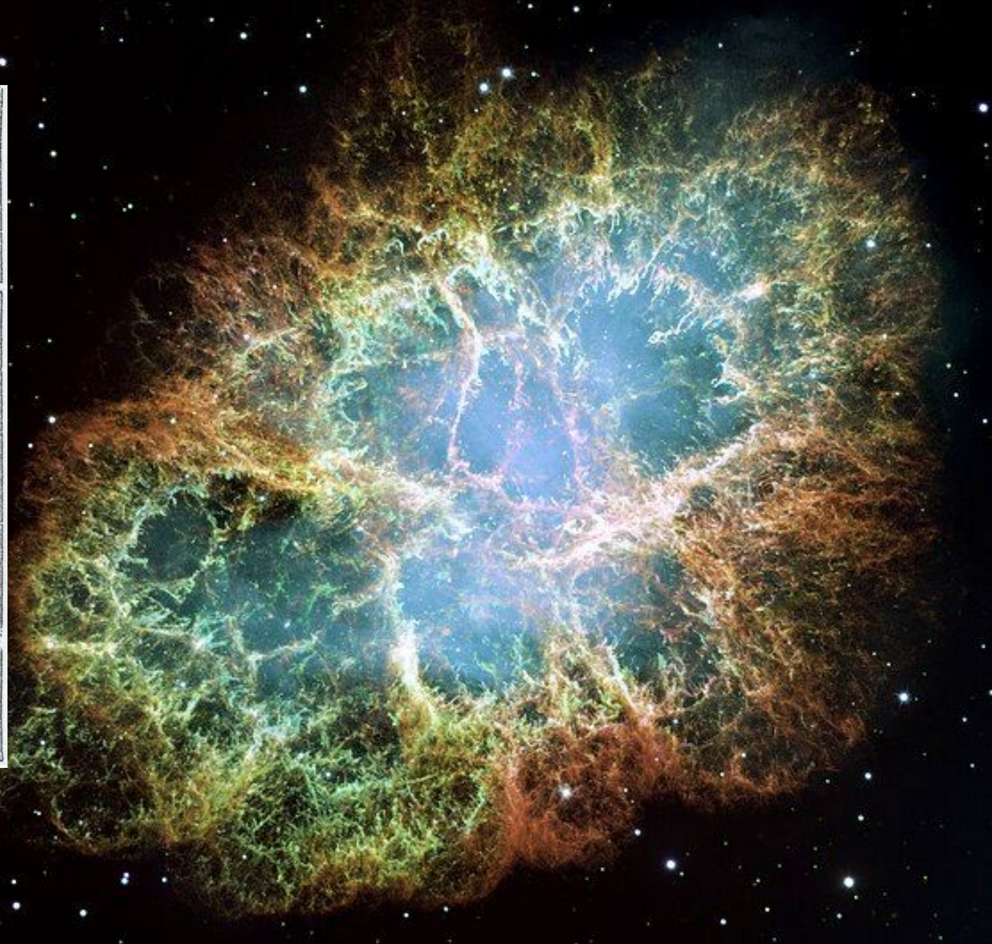
災祥

宋仁宗至和二年侍御史趙抃上言曰臣伏見自去年五月已來妖星遂見僅及周歲至今光耀未退此谷永所謂馳騁驟步芒炎長短所歷奸犯其為譴變甚可畏也又去冬連今春京東西路及陝右川蜀諸郡旱暵不雨麥苗焦死民既艱食寇攘必興此京房所謂欲德不用茲謂張厥災荒其為災沴復可懼也邇來岠嵎山谷驚裂有聲他郡數處地亦震動此伯陽所謂陽伏而不能出陰迫而不能升蓋土失其性其為災異益可駭也夫燮調陰陽者三公之職天戒若曰陛下左右輔弼當得忠賢剛正之人為之乃可以召至和之氣消未萌之戾不然何以妖星譴變也旱暵災沴也地震祥異也三者咎應繁昭如是之著耶臣愚伏望陛下謹天之戒應天以實取天下公議

奏議卷之三百一 十

與天下瞻望之所謂賢人君子者陟之使居廟堂之上貴以三公四輔之事業委注而仰成之若然則陰陽以和災異以消朝廷清明矣狀畏服太平之風可翹足引領而待之也臣朝夕思慮載惟擇賢命相繫國家休戚治亂之本伏願陛下慎重之然後發聖斷力行而不疑則宗廟社稷之福天下生靈之幸

起居舍人知諫院范鎮上奏曰臣伏見去冬多南風今春多西北風乍寒乍暑欲雨不雨又有黑氣蔽日此皆人事之所感動也黑氣陰也小人也日陽也君象也黑氣蔽日者陰侵陽小人惑君也欲雨不雨者政事不決也陳執中為相不病而家居者百日矣陛下以御史之言決一婢死而欲退宰相為是即乞速退執中以解天意以御史之言為非亦乞勅執中起視事無使天意久不決也寒暑者賞罰也乍寒乍暑者不當賞而賞當罰而不罰也鄧保吉有過於法不當為



The guest star reported by Chinese astronomers in 1054 and cited in the highlighted passages in this text from 1414 is identified as SN 1054

SKA Amazing Facts

Sensitive to detect airport on planet tens of light years away

SKA equivalent to 100 times global internet traffic

SKA: World's Biggest Telescope

Central computer equivalent to 100 million PCs

SKA1-low – the SKA's low-frequency instrument

The Square Kilometre Array (SKA) is a next-generation radio astronomy facility that will revolutionise our understanding of the Universe. It will have a uniquely distributed character: **one** observatory operating **two** telescopes on **three** continents. Construction of the SKA will be phased and work is currently focused on the first phase named SKA1, corresponding to a fraction of the full SKA. SKA1 will include two instruments – SKA1-mid and SKA1-low – observing the Universe at different frequencies.

SKAO

Location: Australia

Frequency range: **50 MHz** to **350 MHz**

~131,000 antennas spread between **500 stations**

Total collecting area: **0.4km²**

Maximum distance between stations: **>65km**

SKA1-low

Data transfer rate: **7.2 Terabits** per second

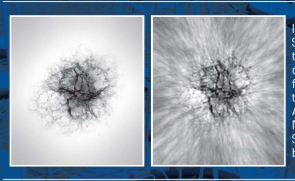


Image quality of SKA1-low (left) versus the best current facility operating in the same frequency range, the LOw Frequency ARray (LOFAR), in the Netherlands (right). SKA-low's resolution will be similar to LOFAR.

Compared to LOFAR Netherlands, the current best similar instrument in the world

25% better resolution

8x more sensitive

135x the survey speed

www.skatelescope.org @SKA_telescope SKAtelescope ska_telescope Square Kilometre Array ska-organisation

SKA1-mid – the SKA's mid-frequency instrument

The Square Kilometre Array (SKA) is a next-generation radio astronomy facility that will revolutionise our understanding of the Universe. It will have a uniquely distributed character: **one** observatory operating **two** telescopes on **three** continents. Construction of the SKA will be phased and work is currently focused on the first phase named SKA1, corresponding to a fraction of the full SKA. SKA1 will include two instruments – SKA1-mid and SKA1-low – observing the Universe at different frequencies.

SKAO

Location: South Africa

Frequency range: **350 MHz** to **15.3 GHz** with a goal of 24 GHz

197 dishes (including 64 MeerKAT dishes)

Total collecting area: **33,000m²**

or **126 tennis courts**

Maximum distance between dishes: **150km**

SKA1-mid

Data transfer rate: **8.8 Terabits** per second

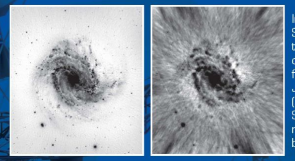


Image quality of SKA1-mid (left) versus the best current facility operating in the same frequency range, the Jansky Very Large Array (JVLA) in the United States (right). SKA-mid's resolution will be 4x better than JVLA.

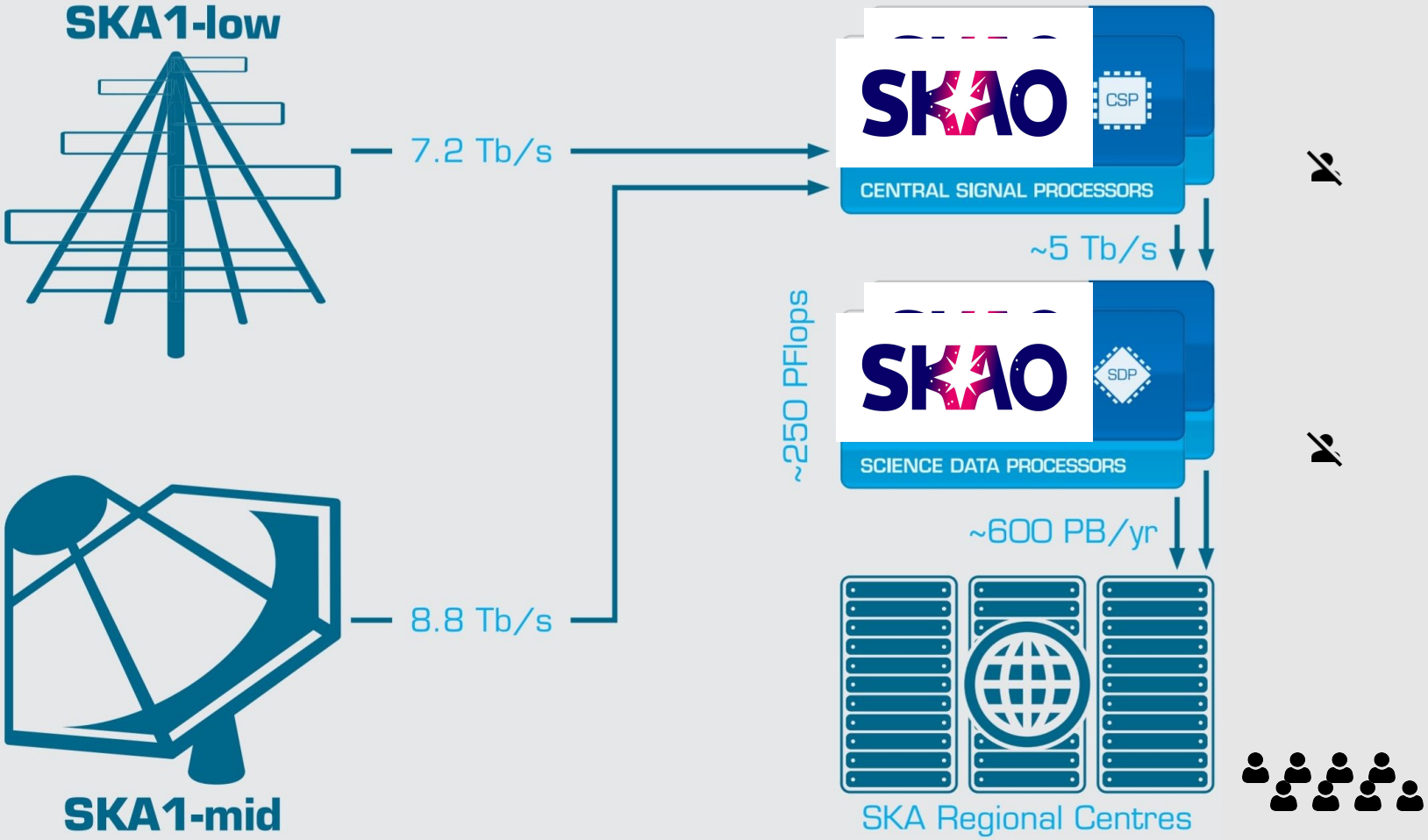
Compared to the JVLA, the current best similar instrument in the world:

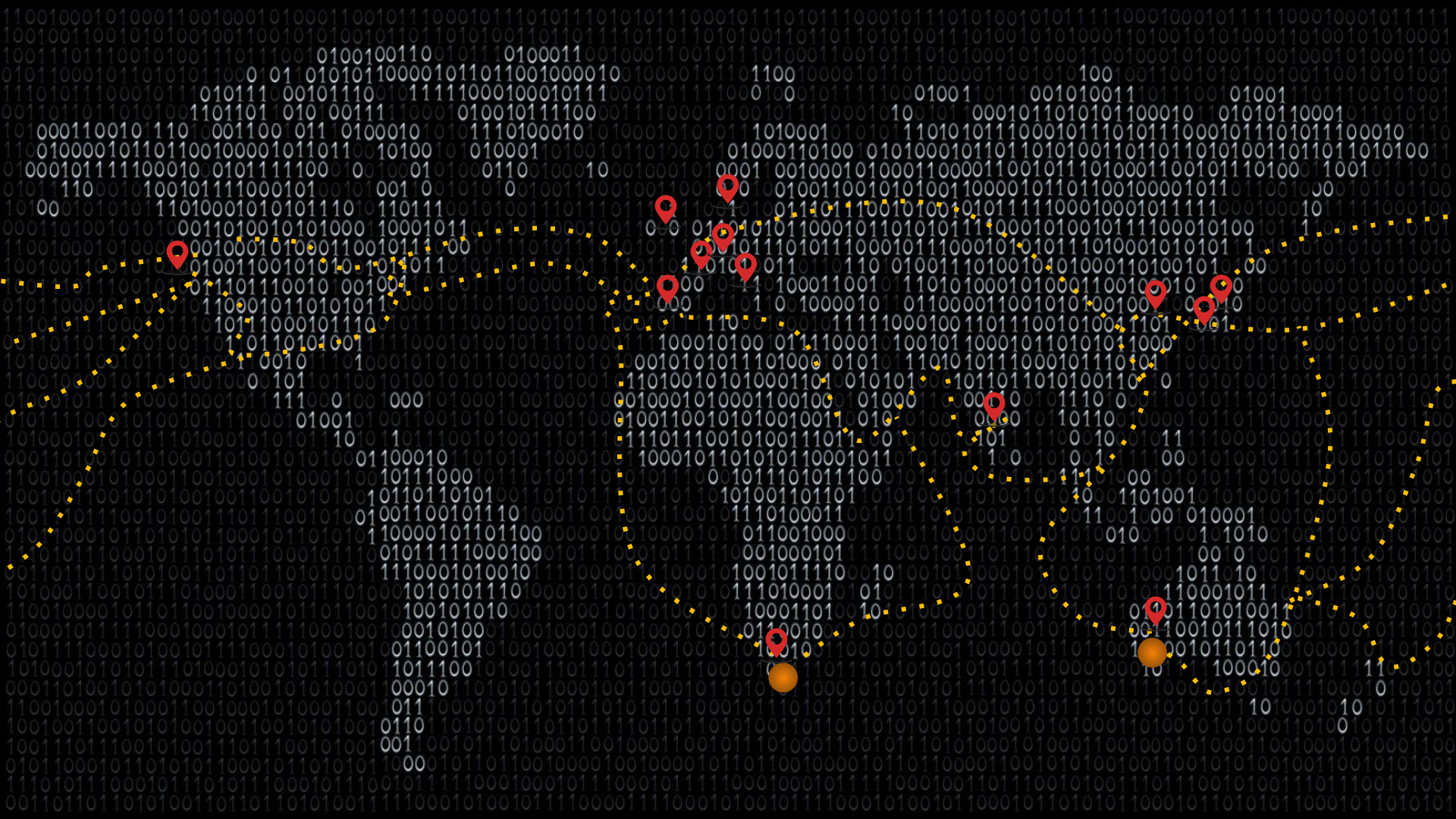
4x the resolution

5x more sensitive

60x the survey speed

www.skatelescope.org @SKA_telescope SKAtelescope ska_telescope Square Kilometre Array ska-organisation

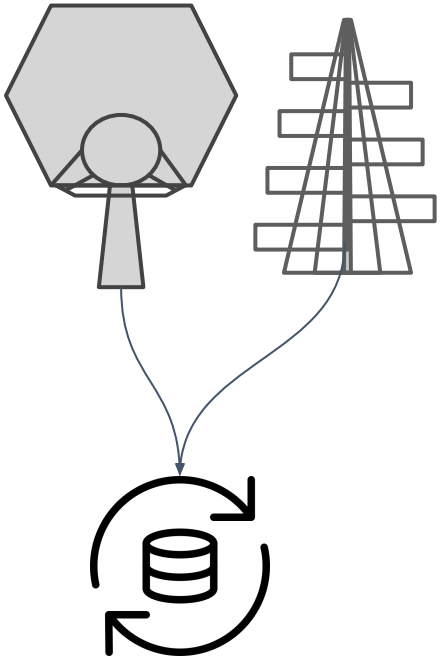

SKA1-low
7.2 Tb/s
SKA1-mid
8.8 Tb/s
SKAO
CSP
CENTRAL SIGNAL PROCESSORS
~5 Tb/s
~250 PFlops
SKAO
SDP
SCIENCE DATA PROCESSORS
~600 PB/yr
SKA Regional Centres



SRCNet principles: Data Management

- Storing SKAO data growing at up to 550 PBytes each year will be a challenge
  - (plus user-generated data toox)
- Roughly 5-10 million dollars per year in new data, for one copy
- Global data management within SRCNet should enable best possible use to be made of available storage resources
- Avoid unnecessary duplication and transfers
- Support mirroring of popular data products to enhance user experience

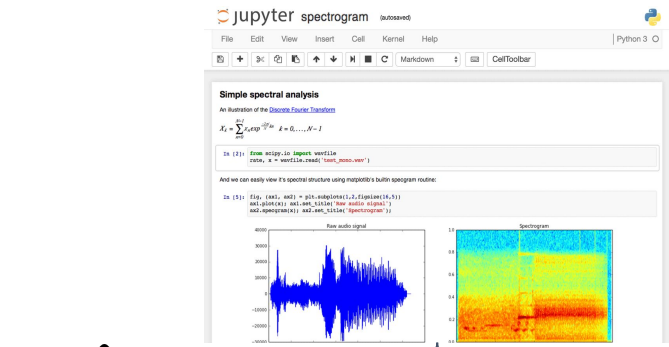
- Exploration of data managements systems able to handle Exabytes

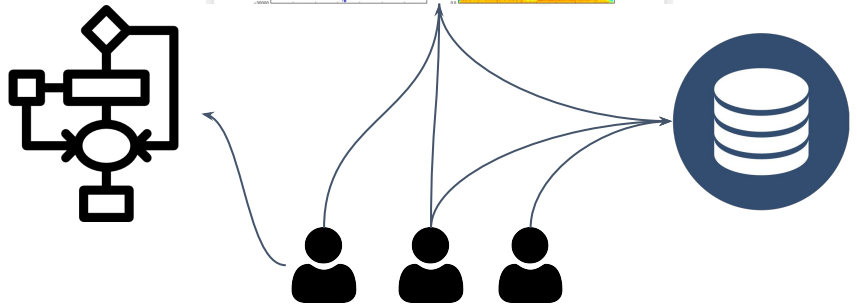


SRCNet principles: Collaboration and Reproducibility

- Most SKA projects will be collaborative
- SRCs will provide collaborative tools
  - Sharing components
  - Single Sign-on

- Support to workflows
- Provenance metadata
- Science Reproducibility at the level of workflows is essential as data should not be downloaded

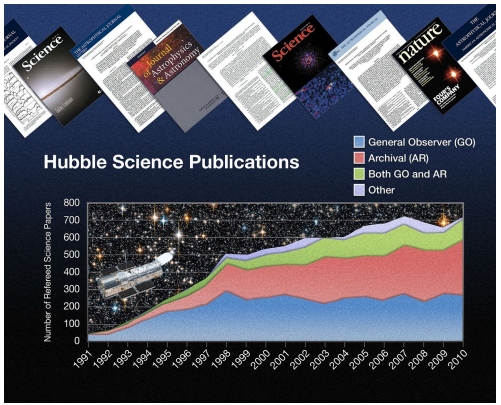




VOSpace

SRCNet principles: Use of Standards

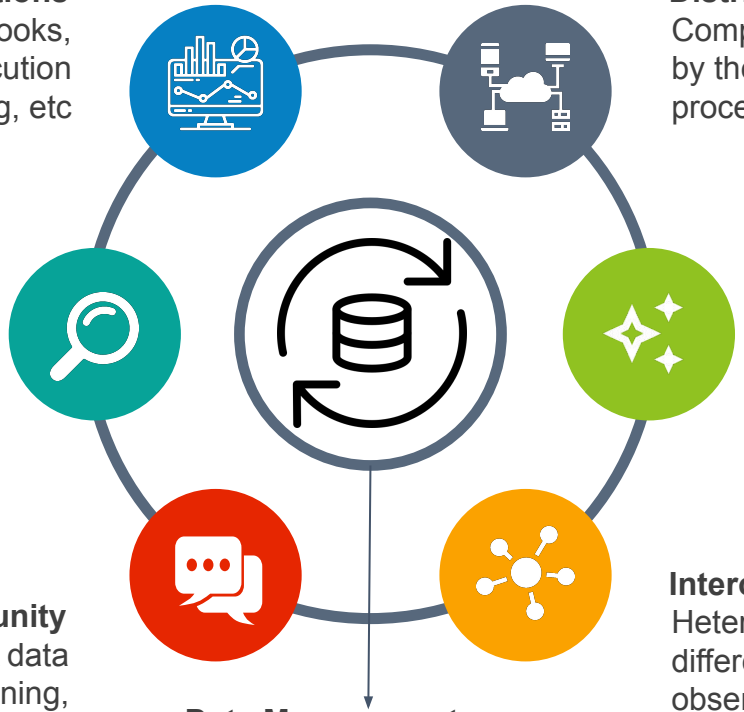
- Build SKA science archive around FAIR and IVOA standards
- Ensure interoperability with other archives and other experiments
- Strong adherence to the FAIR principles
- Give credit appropriately to all contributors to a team



SKA Regional Centre Capabilities Blueprint

Science Enabling Applications
Analysis Tools, Notebooks, Workflows execution Machine Learning, etc

Distributed Data Processing
Computing capabilities provided by the SRCNet to allow data processing



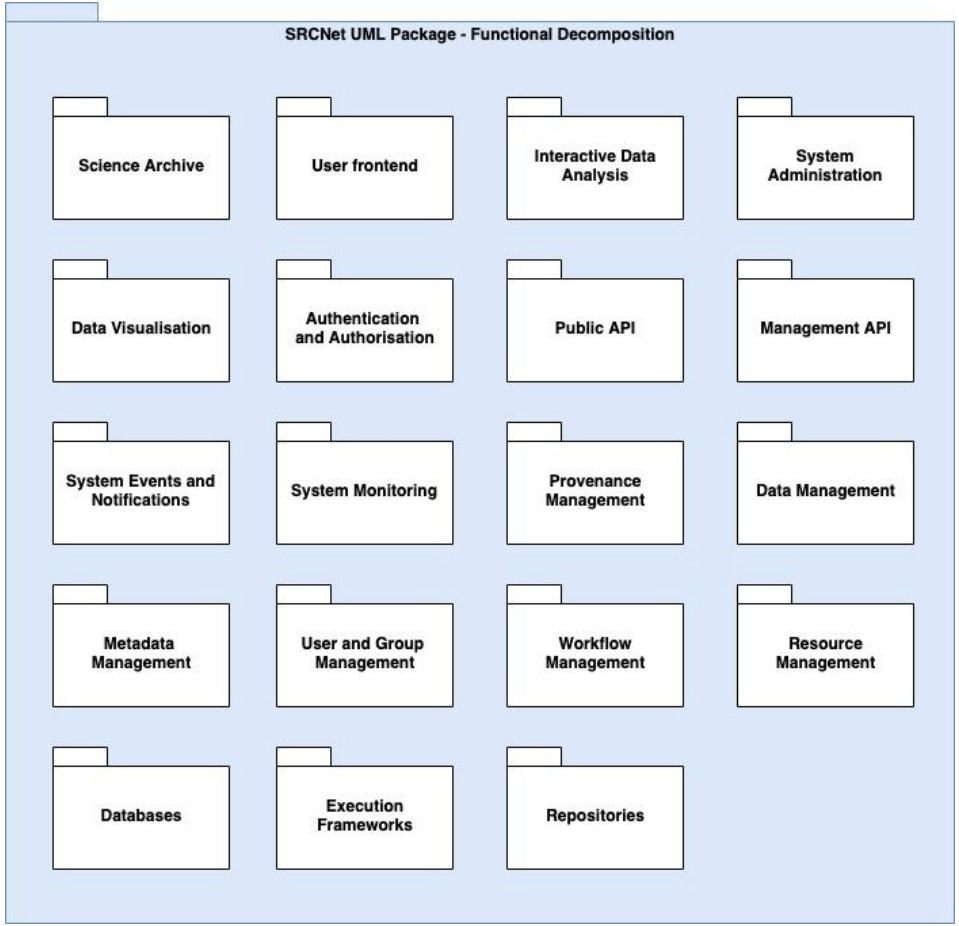
Data Discovery
Discovery of SKA data from the SRCNet, local or remote, transparently to the user

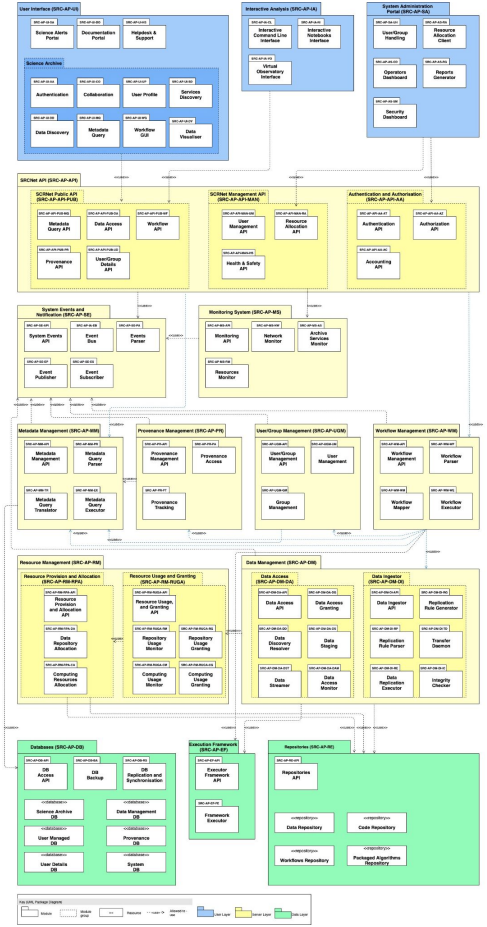
Visualization
Advanced visualizers for SKA data and data from other observatories

Support to Science Community
Support community on SKA data use, SRC services use, Training, Project Impact Dissemination

Interoperability
Heterogeneous SKA data from different SRCs and other observatories

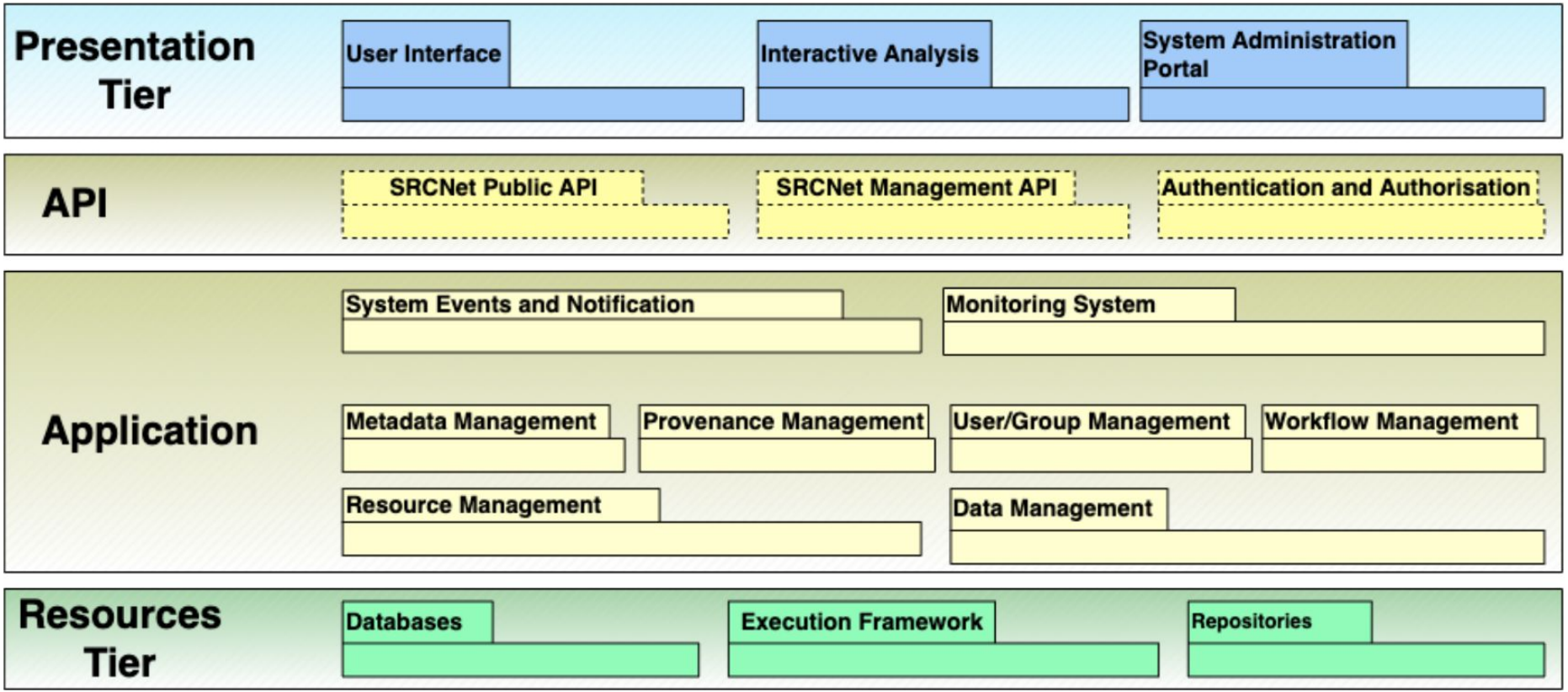
Data Management
Dissemination of Data to SRCs and Distributed Data Storage

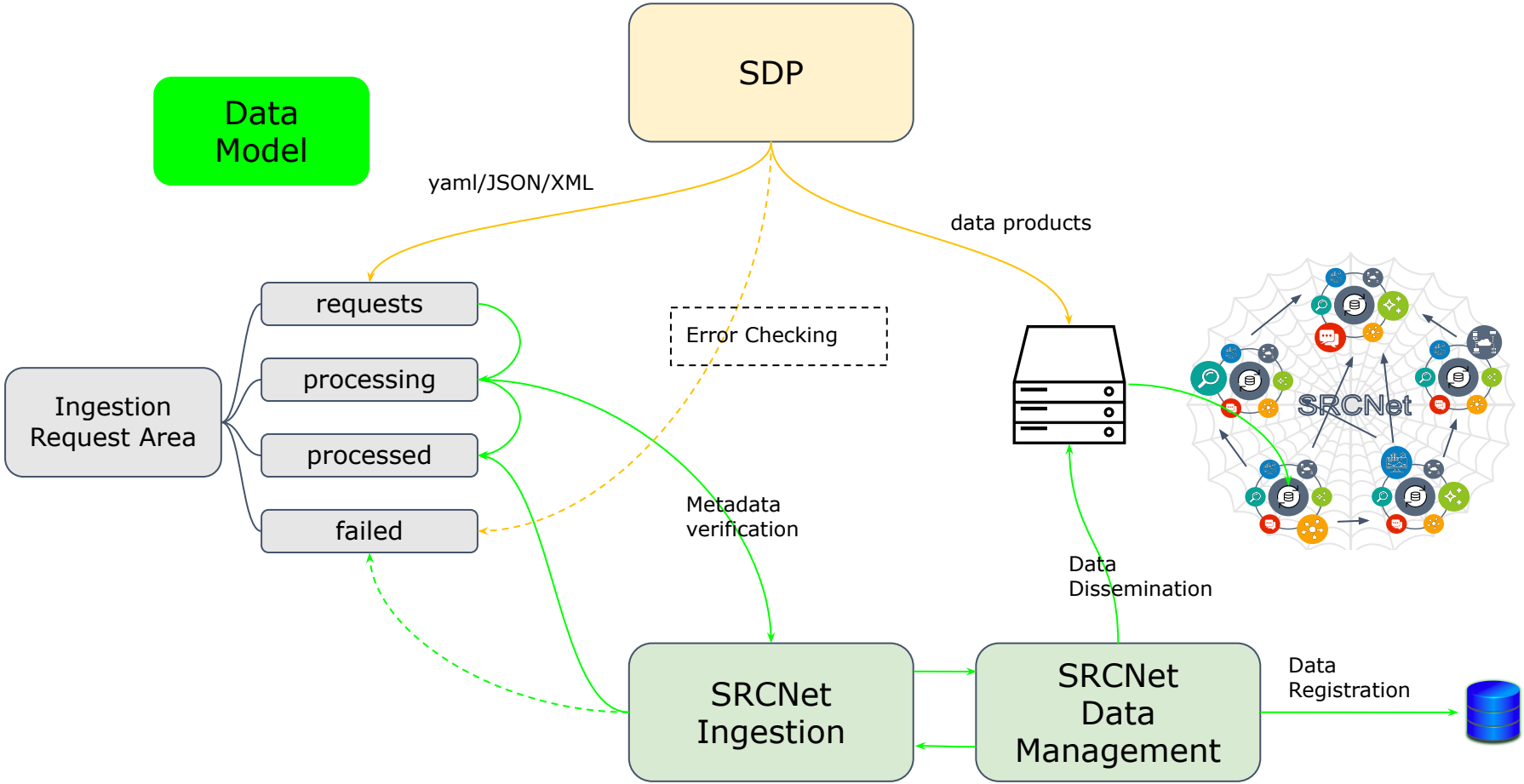




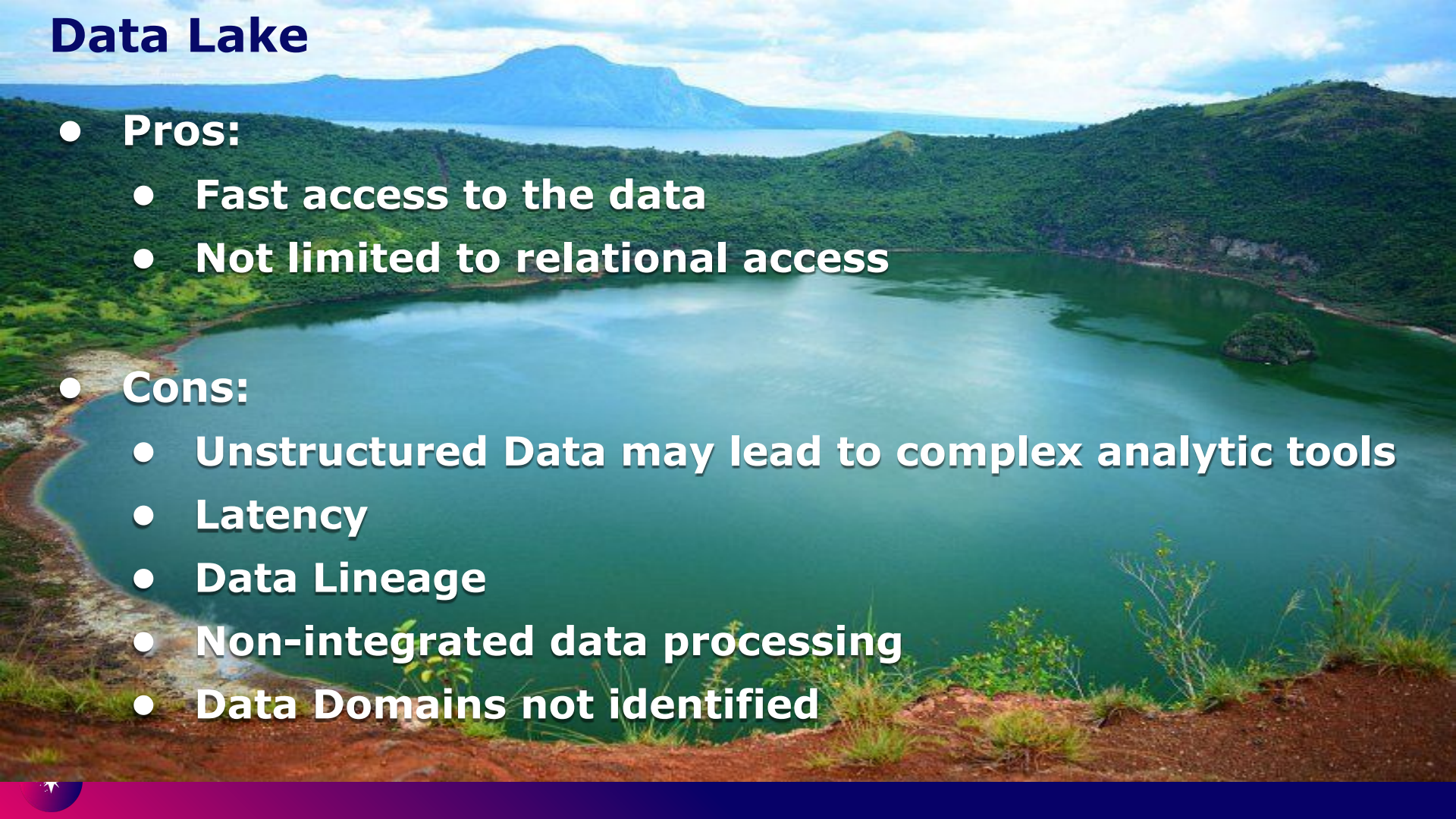
https://tinyurl.com/2nmz4ysv

Nodes Layers



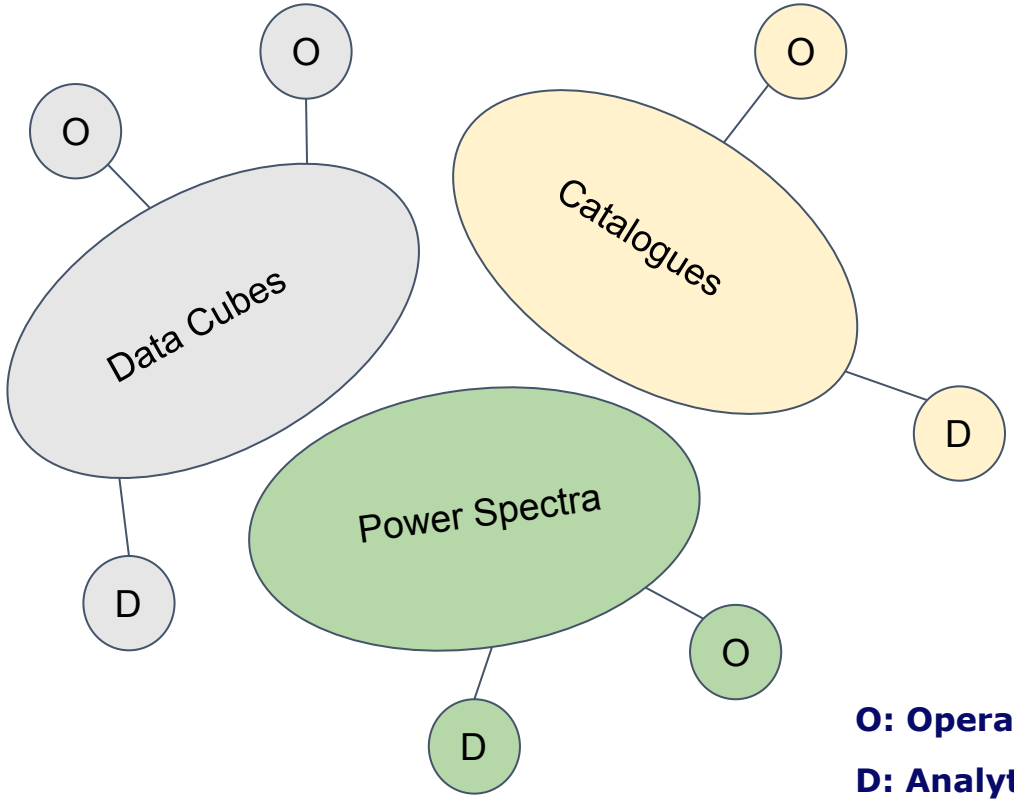

SDP
Data Model
yaml/JSON/XML
data products
requests
processing
processed
failed
Ingestion Request Area
Error Checking
Metadata verification
Data Dissemination
SRCNet
SRCNet Ingestion
SRCNet Data Management
Data Registration

Data Lake



- Pros:
  - Fast access to the data
  - Not limited to relational access
- Cons:
  - Unstructured Data may lead to complex analytic tools
  - Latency
  - Data Lineage
  - Non-integrated data processing
  - Data Domains not identified

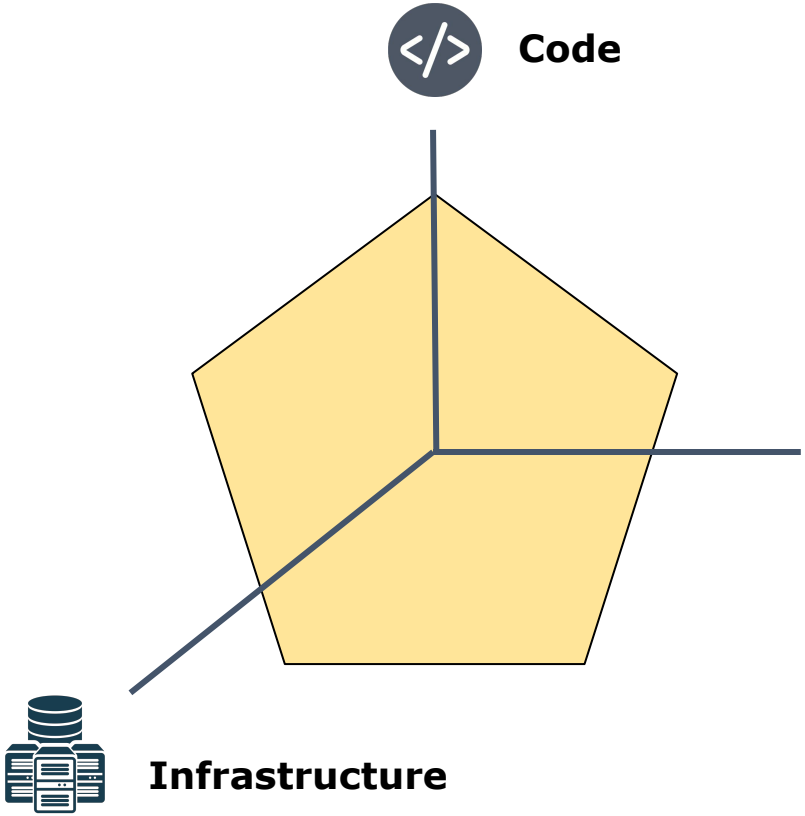
Data Mesh: Domain Oriented



O: Operations

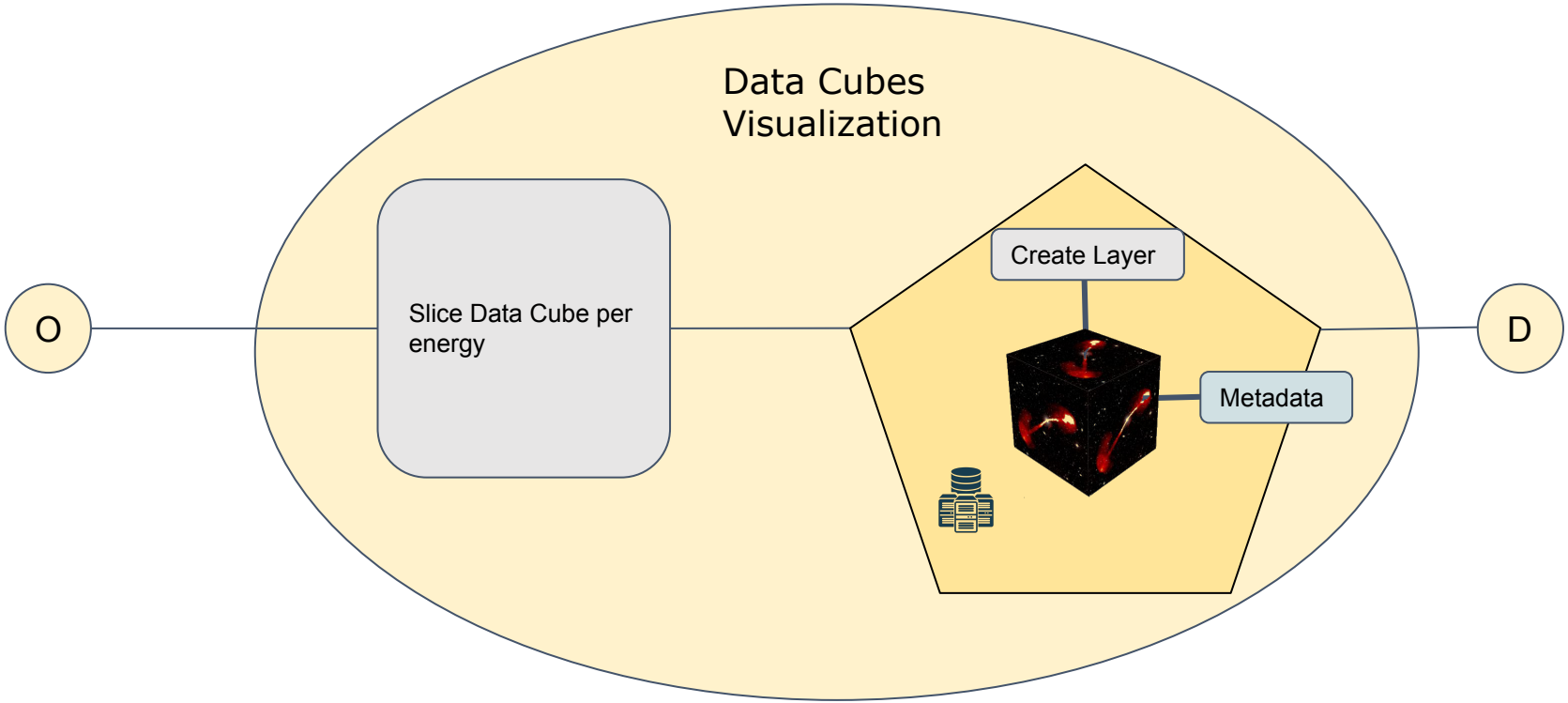
D: Analytics Data

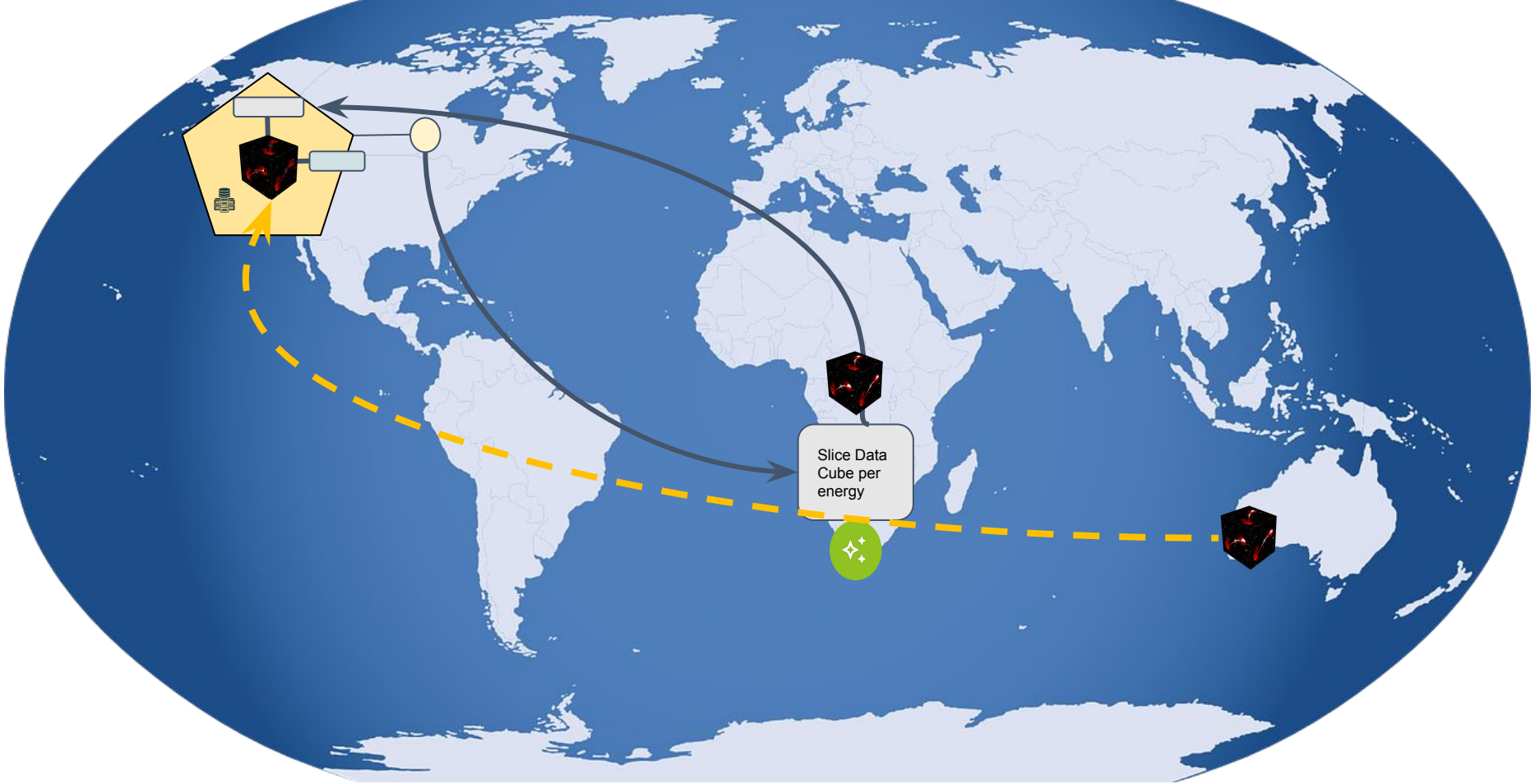
Domain Data as a product



- Discoverable
- Addressable
- Self-describing
- Trustworthy
- Secure
- InterOperable

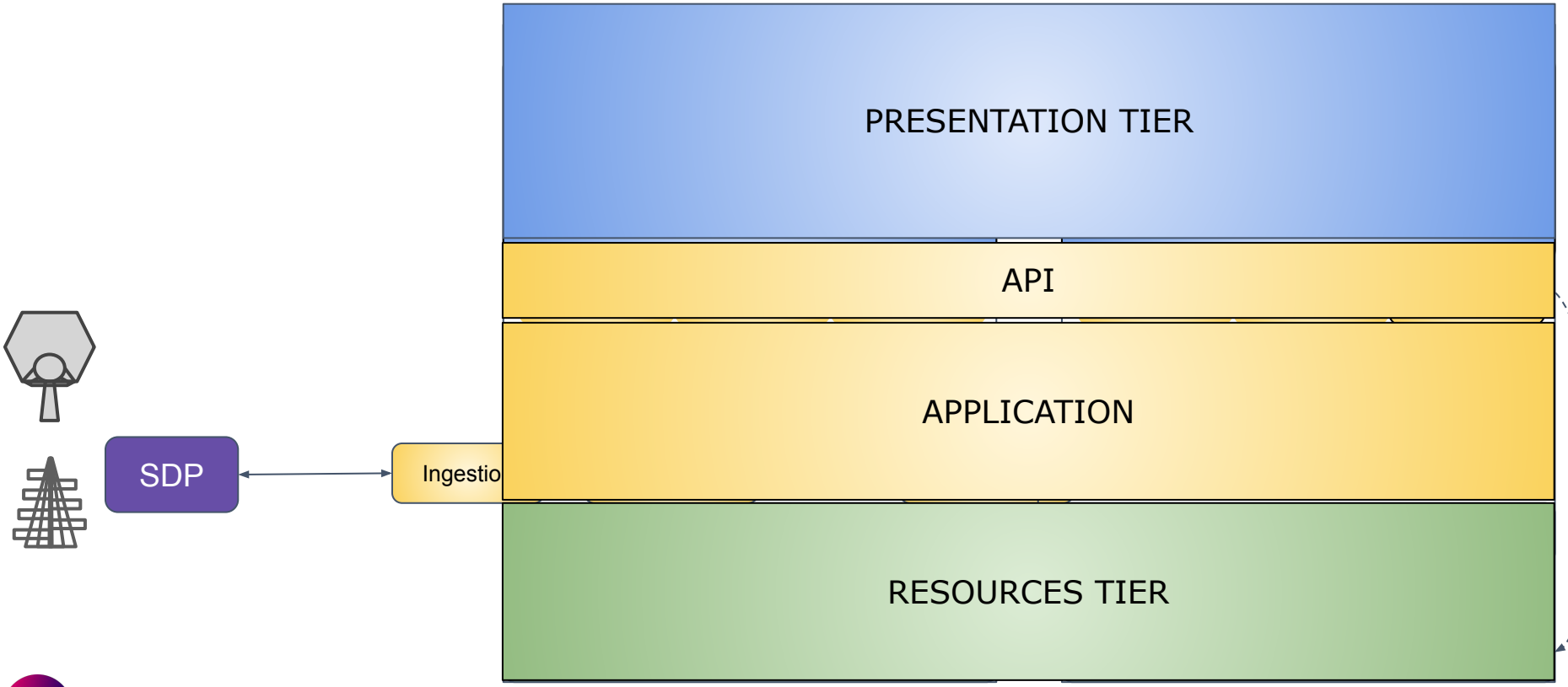
Data Product in Domain




Slice Data
Cube per
energy

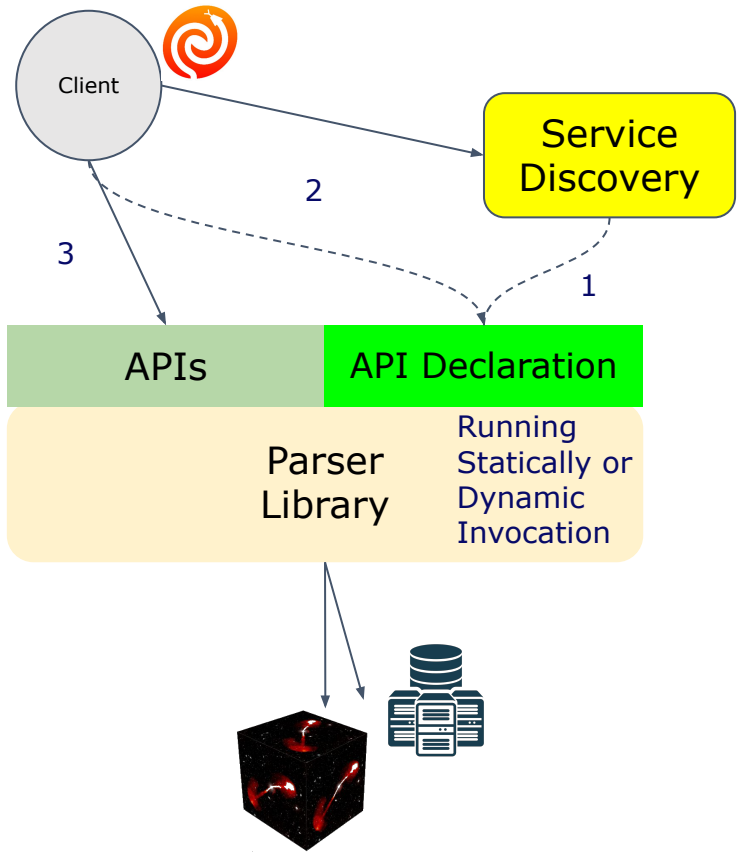
Services View

Core Services View

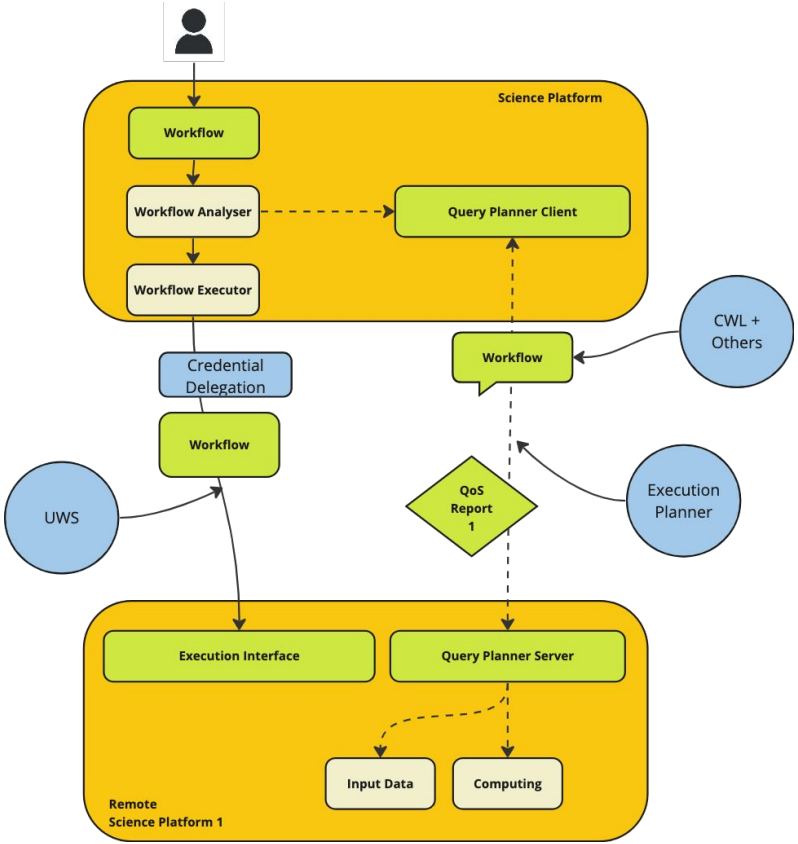


Remote Data Operations

- Protocol close to IVOA SODA including other operations
- Operations to be included will be discussed and agreed due to scientific priority and feasibility (extension of current SODA services)
- Possible use of OpenAPI (this is under discussion at IVOA level)



Computing Services API - IVOA view



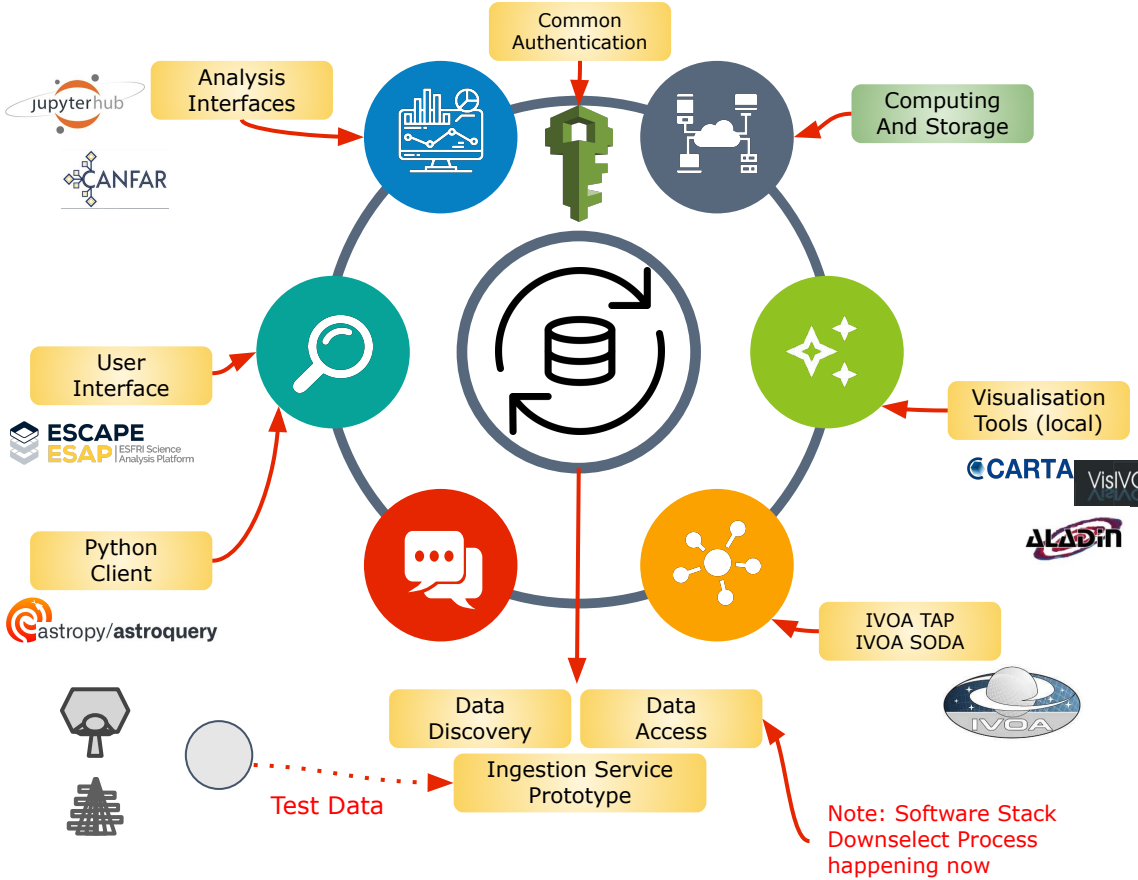
Step by Step

SRCNet v0.1

SRCNet v.1 Scope

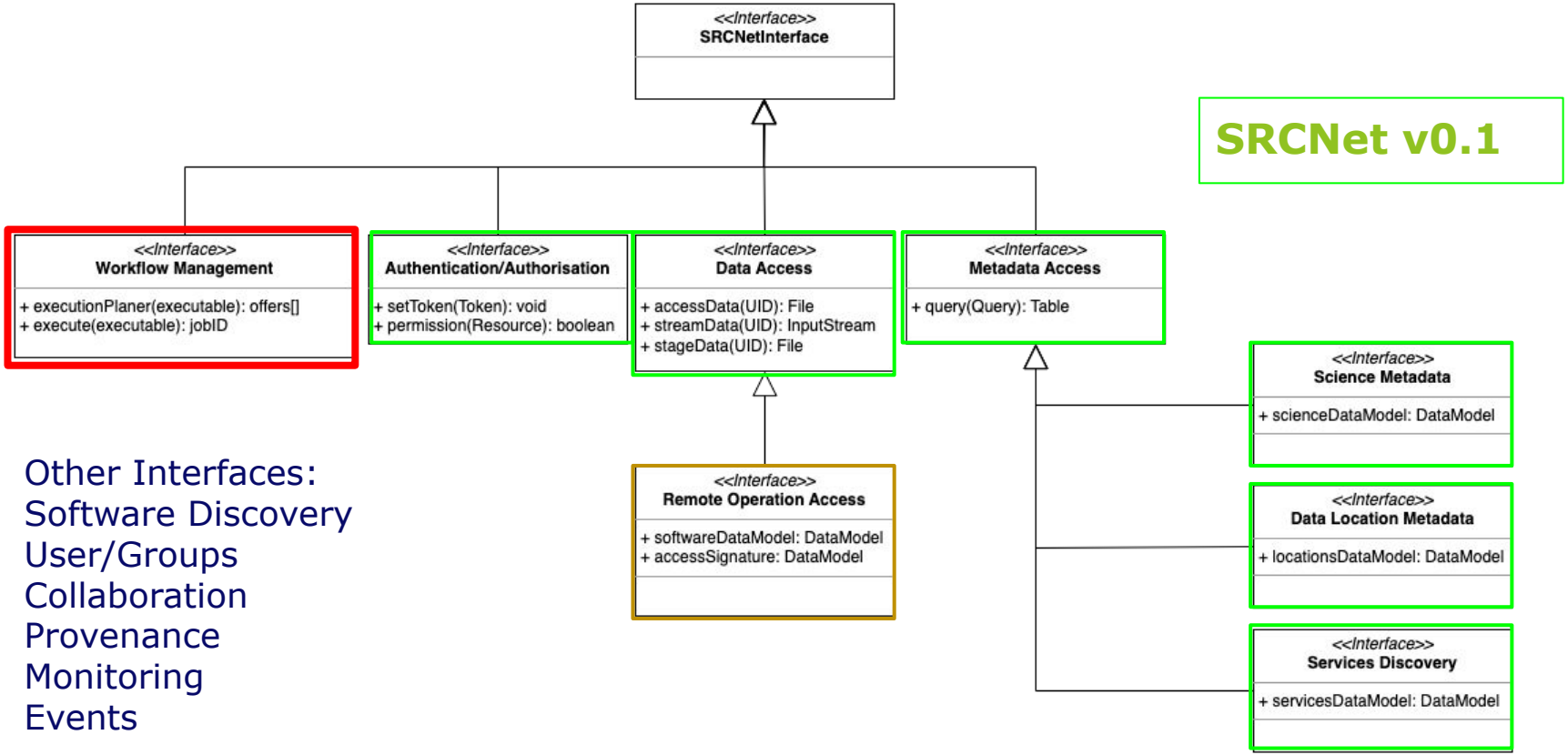
Milestone	Description	SRCNet Functionality	Scope (users)
SRCNet v0.1 First quarter of 2025	Opportunity to engage SRCNet with AA0.5 data transfer and access.	• Test data (and some precursor data) disseminated into a prototype SRCNet • Data can be discovered through queries to the SRCNet • Data dissemination to SRCNet nodes • Data can be accessed through a prototype data lake • Data replication. Data can be moved to a local SRC area where non-connected local interactive analysis portals (notebooks) could allow basic analysis • Unified Authentication System for all the SRCs • Visualisation of imaging data	SRC ART members Members of SKA Commissioning team

Basic Functionality Covered by v0.1



- Common Authentication
  - IAM
- Visualisation Tools (local)
- IVOA Protocols
  - TAP, SODA
- Data Discovery and Access from Data Lake
- Ingestion Service Prototype
- Python Client
  - Astroquery Module
- User Interface
  - ESAP
  - https://esap.srcdev.skao.int/
- Analysis Interfaces
  - JupyterHub
  - CANFAR Science Platform

Architecture Interfaces View



Other Interfaces:
Software Discovery
User/Groups
Collaboration
Provenance
Monitoring
Events

SRCNet v0.1 nodes requirement

https://docs.google.com/document/d/1PZ4Il_RgIs2rtR0XawoAa0Q3FXycI4-4yhmjbbrDzLw/

Thanks for your attention