



# Scalable Time Series Documents Store



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A large, white, geodesic radio telescope dish is shown against a blue sky with scattered white clouds. The dish is mounted on a tall, white, cylindrical pedestal. In the background, other similar dishes are visible on the horizon. The foreground is a flat, dry, brownish landscape.

## MeerKAT

64-dish Instrument

Situated in the sparsely populated, semi-desert, Karoo region of South Africa

- 64 dish interferometer
- Precursor to SKA
- 8 km longest baseline
- 4 bands (L,S,X,UHF)

## MeerKAT

each Dish

- 42 tons
- 19.5 m high
- Offset Gregorian
- 13.5 m diameter
- 3.8 m sub-reflector
- 40 aluminium panels
- Multiple receivers - bands
- Mechanical band selection
- Az: 2 deg/s (185° to 275°)
- El: 1 deg/s (15° to 92°)
- 40 GbE fibre network
- ~35 Gbps data



## **CAM**

(Control and  
Monitoring  
Sub-system)

CAM = Glue  
Links systems  
Abstraction layer  
Not real time

Domain specific  
Multiple Subarray  
Obs Scripts (Python)  
Schedule Blocks  
Resource  
Management

Use KATCP  
Client-server  
TCP  
Requests  
Sensors

Monitoring at the  
Application layer  
Agg Sensors  
Alarms  
Specialised UI  
Katportalclient  
Archive



## KATCP

Control protocol used for all internal communications

- Text based over TCP/IP
- Client-server
- Tooling (Telnet etc.)
- Used in all subsystems
- Requests
- Sensors
- Advanced sampling strategies
- Open sourced



## Archive Objective

Need a fast and efficient solution to store sensor samples:

- Not affect operations
- Not only numeric values
- Associated information
- No decimation
- Variable rate (0.1Hz - 10Hz)
- Dynamic sensor creation
- Large values (200KB)
- High volume (72K sample/s)
- Grow without slowdown



## Query Objective

Troubleshooting, verify operations  
and decisions making

- Near realtime
- Complete lifetime
- Resampling for plotting
- Fast-ish queries
- Not affect archiving
- Many simultaneous
- Sensor attributes
- Queries in Karoo and Cape Town



## Messaging System



- Simple, high performance open source messaging system
- Clustered and scalable out of the box
- CAM components publish to NATS, archive workers queue subscribe to subjects
- Only for monitoring data, KATCP for control
- Thursday's poster session THPHA137



## Sensor Sample as a Document

- Simplified implementation
- Future-proof implementation
- Store Information  
(not only data)
- Use JSON

```
{  
  "name": "m000_cryostat_pressure",  
  "time": 1505982067.202219,  
  "value": 1013.25,  
  "status": "nominal",  
  "value_ts": 1505977839.44  
}
```

## Two stage storage pipeline

- Message bus
- Buffer Table
- Archive Table
- Single DB server
- Reduced complexity
- Reduced cost





**Buffer**  
samples\_buffer

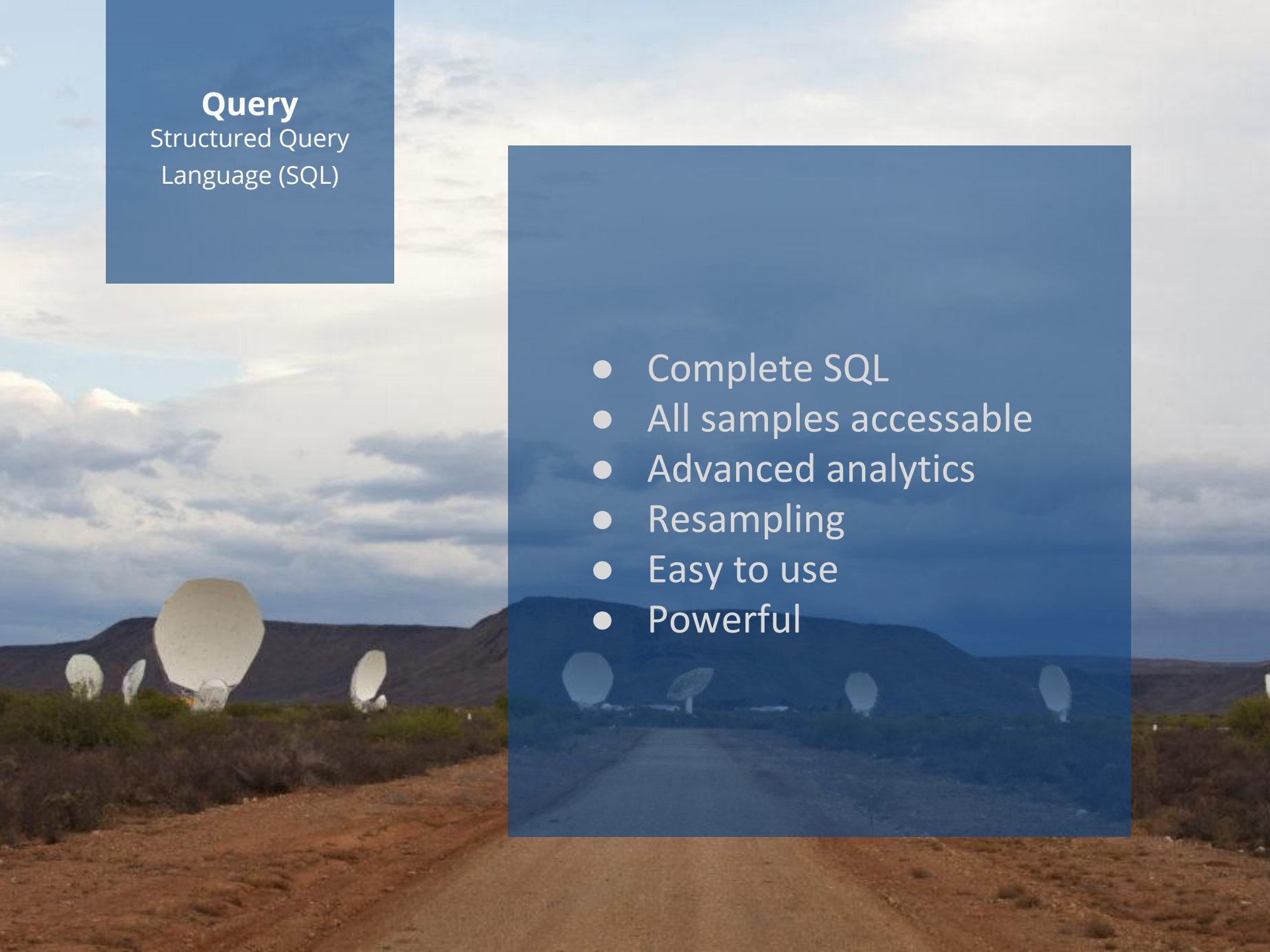
- Bus2Db
- TimescaleDB
- SSD
- time - Timestamp
- name - Text
- sample - JSONB
- archived - Boolean



## Archive

`samples_archive`

- Federated Table
- FDW in Python3
- Ceph Rados
- Object per Day per Sensor
- Capable of PB
- Low DB overhead
- Move sample from buffer to archive in the DB; using a stored procedure



## Query

Structured Query  
Language (SQL)

- Complete SQL
- All samples accessible
- Advanced analytics
- Resampling
- Easy to use
- Powerful





## PostgreSQL extension

```
sudo make install  
sudo -u postgres psql katstore  
CREATE EXTENSION katstore;
```

- Simpler deployment
- Versioning of procedures and schema
- Testing of SQL
- Depend on Katstore Python module





## Conclusion

- Can handle 90k samples per second
- Tested with 200K sensors
- Mean query for 64 concurrent queries for 86400 samples ~ 8 seconds
- Ceph Rados is easy to work with and offers huge scalability
- PostgreSQL is a very powerful database



# Questions?

Thank you





**science  
& technology**

Department:  
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REPUBLIC OF SOUTH AFRICA



**National  
Research  
Foundation**



SKA South Africa, a Business Unit of the National Research Foundation.

We are building the Square Kilometre Array radio telescope (SKA), located in South Africa and eight other African countries, with part in Australia. The SKA will be the largest radio telescope ever built and will produce science that changes our understanding of the universe

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