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ICALEPCS

Logging and Tracing in the SKA Telescope Control System

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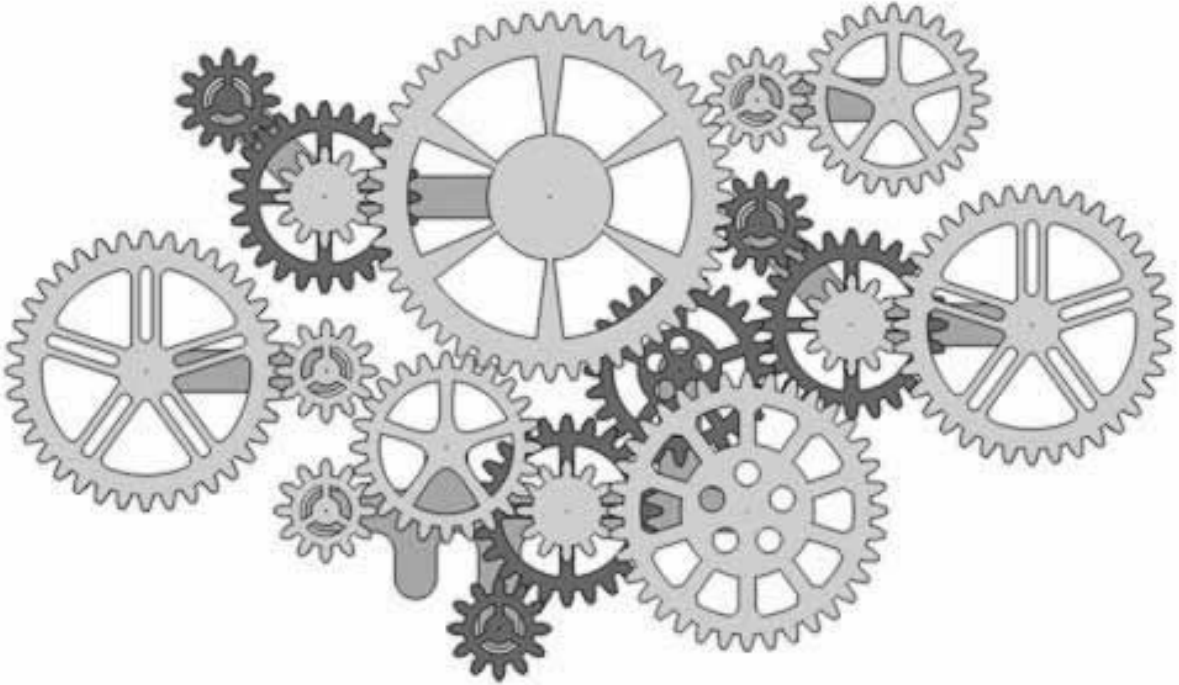
Preview to Theory



Crossing the lines from being clueless to having full understanding of your system's internal state is a function of the observability of your distributed system

Image credits in order of left to right:
https://www.giftstogive.org/lightbulb-1/
https://www.gearswalldecor.com/
https://www.pngwing.com/en/free-png-tattv

The 3 Pillars of Observability

Logs

records of activity within the system

Metrics

measurement of various activities in a system

Tracing

the path taken by a request as it moves through a distributed system

Observability: inferring the internal state of a system from its external outputs

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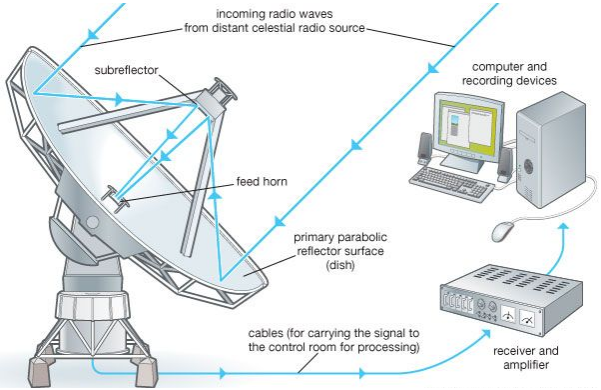
Cloud Native Observability for DevOps Teams by J. Heather (2021)

The SKA Control System Architecture (Overview)



In a typical radio telescope, a large parabolic antenna, or dish, collects incoming radio waves and focuses them onto a smaller antenna called the feed horn. The signal is then carried to the radio receiver.

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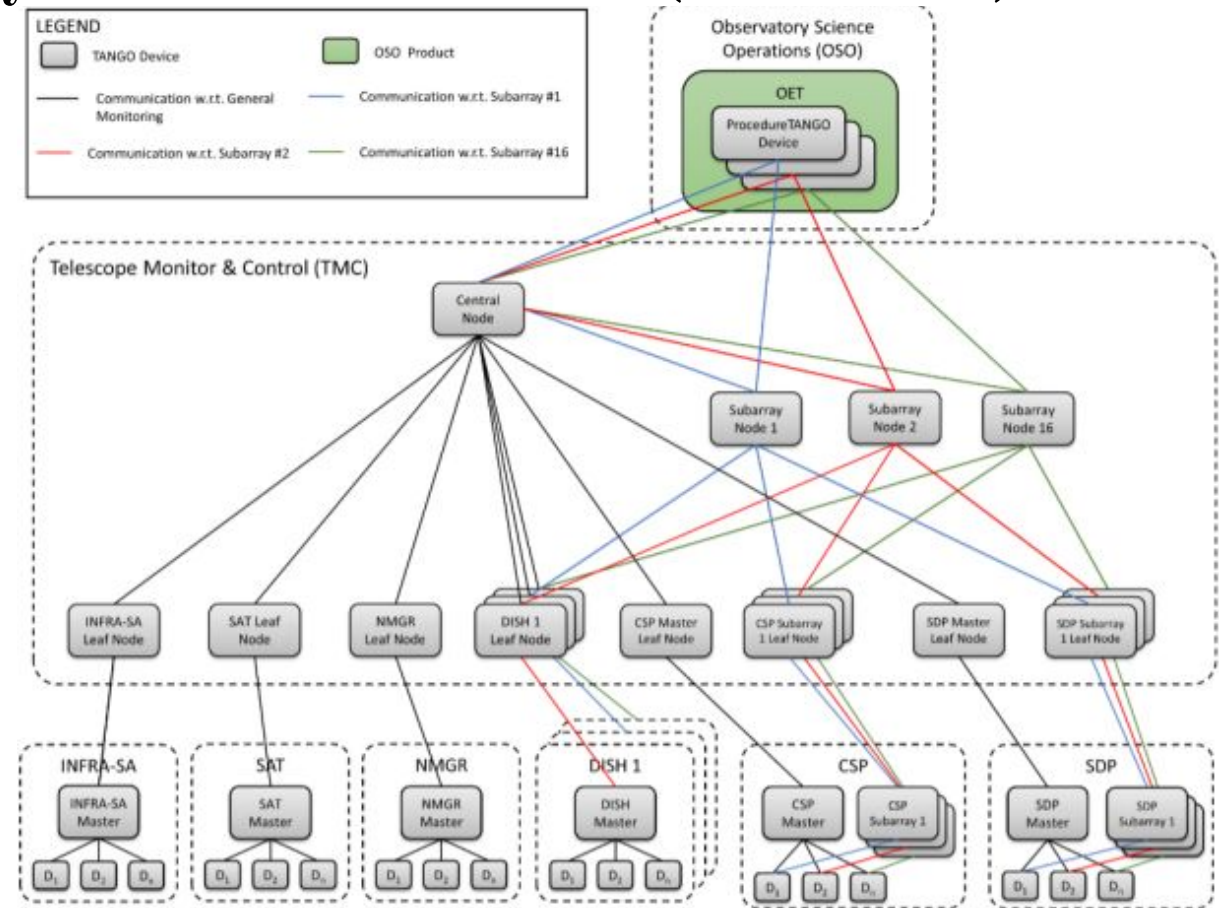
Encyclopedia Britannica, 2010



Hierarchy of tango devices demonstrating the control of the Mid telescopes

Road Map to Tracing Solution

- Harmonised logging to provide consistently formatted logs across all applications
- Provisioned a unique ID generator to be used as tags in the logs
- Provisioned a context handler that emits ska formatted logs with a transaction ID injected

SKA Log Message Format

SKA log message:

```
VERSION "|" TIMESTAMP "|" SEVERITY "|" [THREAD-ID] "|" [FUNCTION] "|" [LINE-LOC] "|" [TAGS] "|" MESSAGE
LF
```

Examples:

```
1|2019-12-31T23:12:37.526Z|INFO||testpackage.testmodule.TestDevice.test_fn|test.py#1|tango-device:my/dev/name| Regular
information should be logged like this FYI
1|2019-12-31T23:45:42.328Z|DEBUG||testpackage.testmodule.TestDevice.test_fn|test.py#150|| x = 67, y = 24
1|2019-12-31T23:49:53.543Z|WARNING||testpackage.testmodule.TestDevice.test_fn|test.py#16|| z is unspecified, defaulting to 0!
1|2019-12-31T23:50:17.124Z|ERROR||testpackage.testmodule.TestDevice.test_fn|test.py#165|site:Element| Could not connect to
database!
1|2019-12-31T23:51:23.036Z|CRITICAL||testpackage.testmodule.TestDevice.test_fn|test.py#16|| Invalid operation. Cannot continue.
```

The Log Message Standard is not an extension of syslog/RFC5234 format. Read the SKA Developer Portal for more details

The SKA Logging Configuration Library

```
import logging
from ska_ser_logging import configure_logging

def main():
    configure_logging()
    logger = logging.getLogger("ska.example")
    logger.info("Logging started for Example application")
main()
```

```
1|2021-10-12T21:58:41.222Z|INFO|MainThread|main|<ipython-input-4-13a3535fcc78>#4||Logging started for
Example application
```

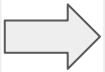
SKA Unique Identifier (SKUID) Library

```
import os

from ska_ser_skuid.client import SkuidClient

def get_transaction_id():
    if "SKUID_URL" in os.environ and os.environ["SKUID_URL"]:
        client = SkuidClient(os.environ["SKUID_URL"])
        return client.fetch_transaction_id()
    return SkuidClient.get_local_transaction_id()

transaction_id = get_transaction_id()
print(transaction_id)
```

```
txn-local-20211012-643313143
                OR
txn-t0001-20200914-123456789
```

SKA Log Transactions Library

```
with transaction('My Command') as
transaction_id:
    # do stuff
    ...
```



```
from ska_ser_log_transactions  import transaction

def command(self, parameter_json):
   parameters = json.reads(parameter_json)
   with transaction('My Command', parameters) as
transaction_id:
       # ...
       parameters['transaction_id'] = transaction_id
       device.further_command(json.dumps( parameters))
       # ...
```

Transaction Message Formats:

- On Entry:
  - Transaction[id]: Enter[name] with parameters [arguments] marker[marker]
- On Exit:
  - Transaction[id]: Exit[name] marker[marker]
- On Exception
  - Transaction[id]: Exception[name] marker[marker] -- Stacktrace --

The marker can be used to match entry/exception/exit log messages.

SKA Log Transactions Library

Example ska formatted logs for successful transaction:

```
1|2020-10-01T12:49:31.119Z|INFO|Thread-210|log_entry|transactions.py #154||Transaction[txn-local-20201001-981667980]: Enter[Command] with parameters [{}] marker[52764]
```

```
1|2020-10-01T12:49:31.129Z|INFO|Thread-210|log_exit|transactions.py #154||Transaction[txn-local-20201001-981667980]: Exit[Command] marker[52764]
```

Example ska formatted logs for failed transaction:

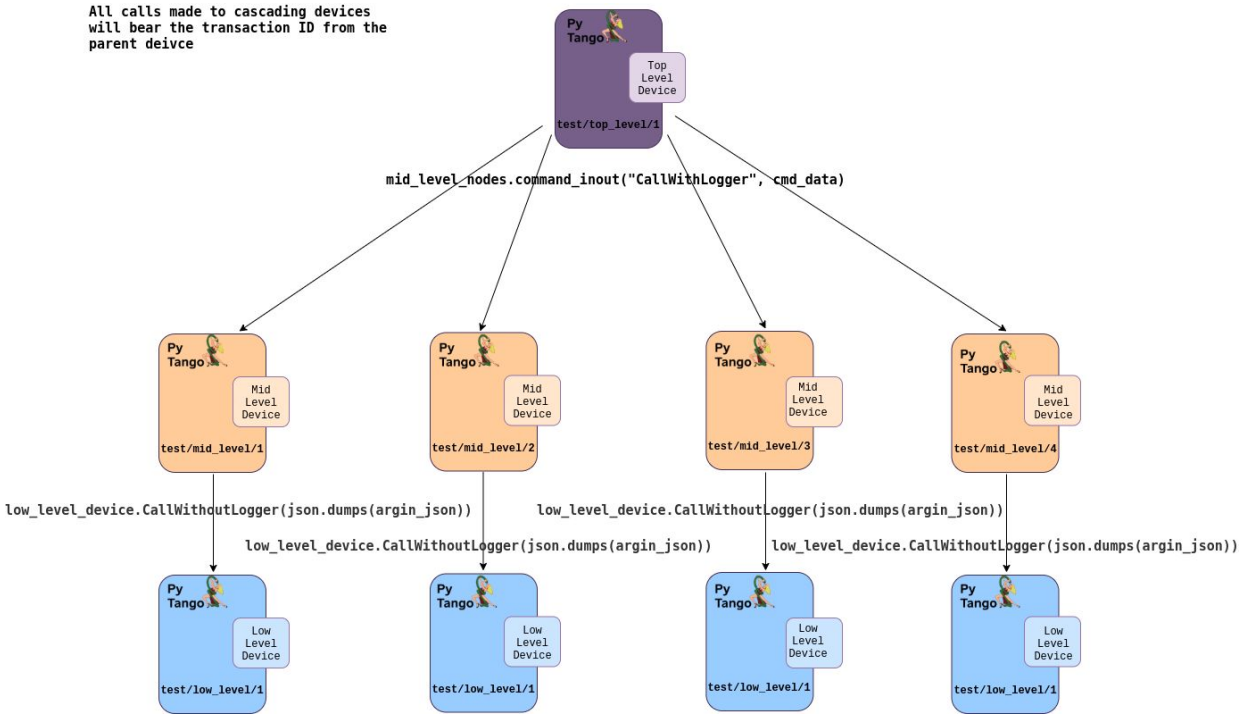
```
1|2020-10-01T12:51:35.588Z|INFO|Thread-204|log_entry|transactions.py #154||Transaction[txn-local-20201001-354400050]: Enter[Transaction thread [7]] with parameters [{}] marker[21454]
```

```
1|2020-10-01T12:51:35.598Z|ERROR|Thread-204|log_exit|transactions.py #149||Transaction[txn-local-20201001-354400050]: Exception[Transaction thread [7]] marker[21454]
Traceback (most recent call last):
 File "python_file.py", line 27, in thread_with_transaction_exception
   raise RuntimeError("An exception has occurred")
RuntimeError: An exception has occurred
```

```
1|2020-10-01T12:51:35.601Z|INFO|Thread-204|log_exit|transactions.py #154||Transaction[txn-local-20201001-354400050]: Exit[Transaction thread [7]] marker[21454]
```

It does not support a multithreaded case at the moment

Log Transaction Illustration in Tango Example



Tango-example: a project that demonstrates how to structure an SKA project that provides some simple Tango devices coded in PyTango.

Closing

- Future work
  - Build the tooling we need to visualise the traces from this working iteration
- Conclusion
  - To fully understand a distributed system requires distributed tracing
  - All the work done are available in public repositories under the ska-telescope organisation in: ska-ser-logging, ska-ser-skuid and ska-ser-log-transactions