High performance Timeseries storage in ISIS

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• A CNES Initiative
• A Set of Standards
• A Mission Control Center Product Line
Typical Control Center

MCS is Event-Driven

User Input

Planned Operations

Telemetry

External Requests
Typical Control Center in 2030?
Or rather...

Lots of Data.
Many machines.
And also...

Reasonable Amount of Data.

On my laptop.
All the data. All the time.
In any case, performance matters.
How to design a storage system for space data that scales?
Requirements...
Timeseries are first class citizens
Lightweight and easy to install
Scalable
CCSDS Mission Operations

Interoperability at the Application Level
Technology & Transport Agnostic

Monitoring & Control Services Specifications

And more to come...

A Toolkit to define new Service Specifications
Message Abstraction Layer

LIST SONGS, PLAY, STOP, PAUSE...
Message Abstraction Layer

LIST SONGS, PLAY, STOP, PAUSE...
Message Abstraction Layer

Defines the common vocabulary to exchange messages

SEND, RECEIVE, SUBSCRIBE, UNSUBSCRIBE...

Not the technology.
Common Object Model

Meta-Data
ID, Timestamp, one parent, one source (tracability)

Opaque Payload
Common Object Model

Defines the common vocabulary to identify and search for space data

WHAT, WHERE, WHO, WHEN...

Not the technology.
Introducing DataStore

ØMQ

redis

levelDB
**Fast, Small, Open-source, dependency-free, embedded key/value data store**

Arbitrary byte arrays  
Sorted by keys  
Compressed storage  
Basic operations:  
   Get(), Put(), Del(), Batch()
Find all parameter values for SATMODE between 2014-02-14 15:00 and 2014-04-13 02:00

Iterate on all keys between

<table>
<thead>
<tr>
<th>SATMODE</th>
<th>2014-02-14 15:00</th>
<th>00000000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATMODE</td>
<td>2014-04-13 02:00</td>
<td>00000000</td>
</tr>
</tbody>
</table>
LevelDB: version 1.1
Date: Sun May 1 12:11:26 2011
CPU: 4 x Intel(R) Core(TM)2 Quad CPU Q6600 @ 2.40GHz
CPUCache: 4096 KB
Keys: 16 bytes each
Values: 100 bytes each (50 bytes after compression)
Entries: 1000000
Raw Size: 110.6 MB (estimated)
File Size: 62.9 MB (estimated)

readrandom : 60,000 ops/sec;
readseq : 0.476 micros/op; 2.1 million ops/sec
Telemetry / Events

Decom

Reduce

Map

leveldb

leveldb

leveldb

leveldb

leveldb
ØMQ

Intelligent socket library for messaging

Many kinds of connection patterns
REQ/REP, PUB/SUB, PUSH/PULL...

Multiplatform, multi-language (30+)

Fast (8M msg/sec, 30usec latency)

Small (20K lines of C++ code)

Open source LGPL (large community)
```python
# Hello World client in Python
# Connects REQ socket to tcp://localhost:5555
# Sends "Hello" to server, expects "World" back
#
import zmq

context = zmq.Context()

# Socket to talk to server
print("Connecting to hello world server...")
socket = context.socket(zmq.REQ)
socket.connect("tcp://localhost:5555")

# Do 10 requests, waiting each time for a response
for request in range(10):
    print("Sending request %s ..." % request)
socket.send(b"Hello")

    # Get the reply.
message = socket.recv()
print("Received reply %s [ %s ]" % (request, message))```
An open source in-memory key-value cache and store.

Contains strings, hashes, lists, sets, sorted sets...

Fast Master / Slave replication across many machines.
Mission Database

Ground Catalogs

{JSON}

{JSON}
Average battery voltage from AOS to LOS?
Average battery voltage from AOS to LOS?
AVG(VBAT) FROM 2015-10-22T10:15:02Z TO 2015-10-2T11-28:07Z
AVG(VBAT) FROM 2015-10-22T10:15:02Z TO 2015-10-2T11-28:07Z
Performances

Prototype

ISIS Target

Core I7 laptop

270 K param/s

1 Million param/s

1 Million param/s

1 Million param/s
Now just scale it

Core I7 laptop → Multi-mission MCS cluster
Questions ?