

Datacube Services on a Satellite: the ORBiDANSe Project

ESA Phi Week, Frascati, 2018-nov-16
Peter Baumann & the rasdaman team
Jacobs University | rasdaman GmbH

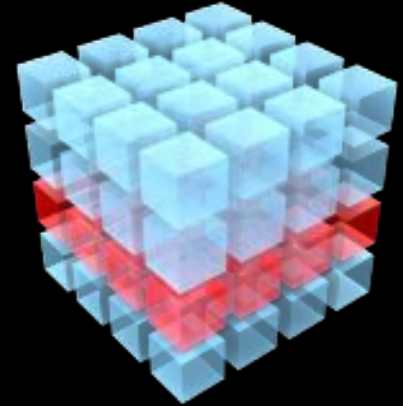
SPONSORED BY THE



Federal Ministry
of Education
and Research

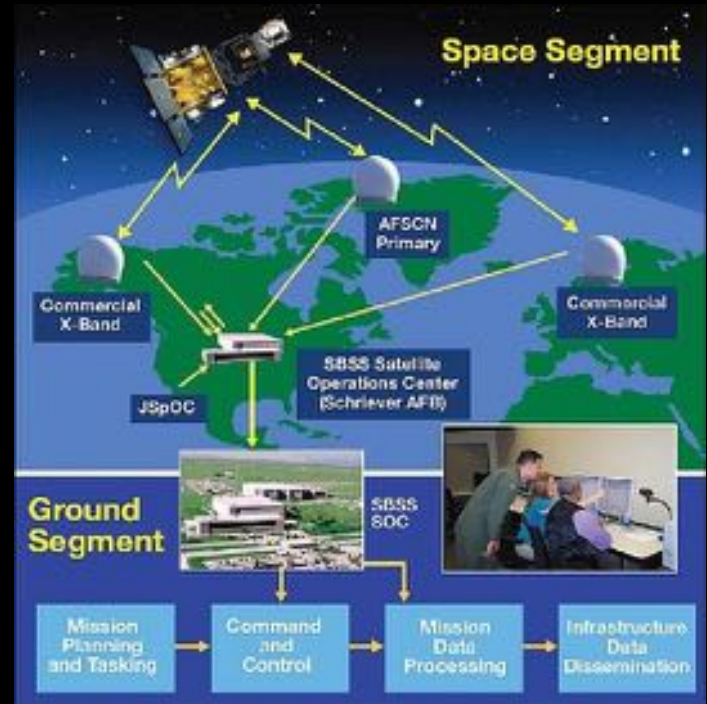
rasdaman: Big Datacube Analytics

- = „raster data manager“: SQL + n-D datacubes
 - massively scalable Big Datacube Analytics engine
 - 2.5+ PB; 1000x parallelization
- „leading technology“ (ESA 2017)
 - Invented datacubes [Baumann 1992]
 - Datacube reference implementation



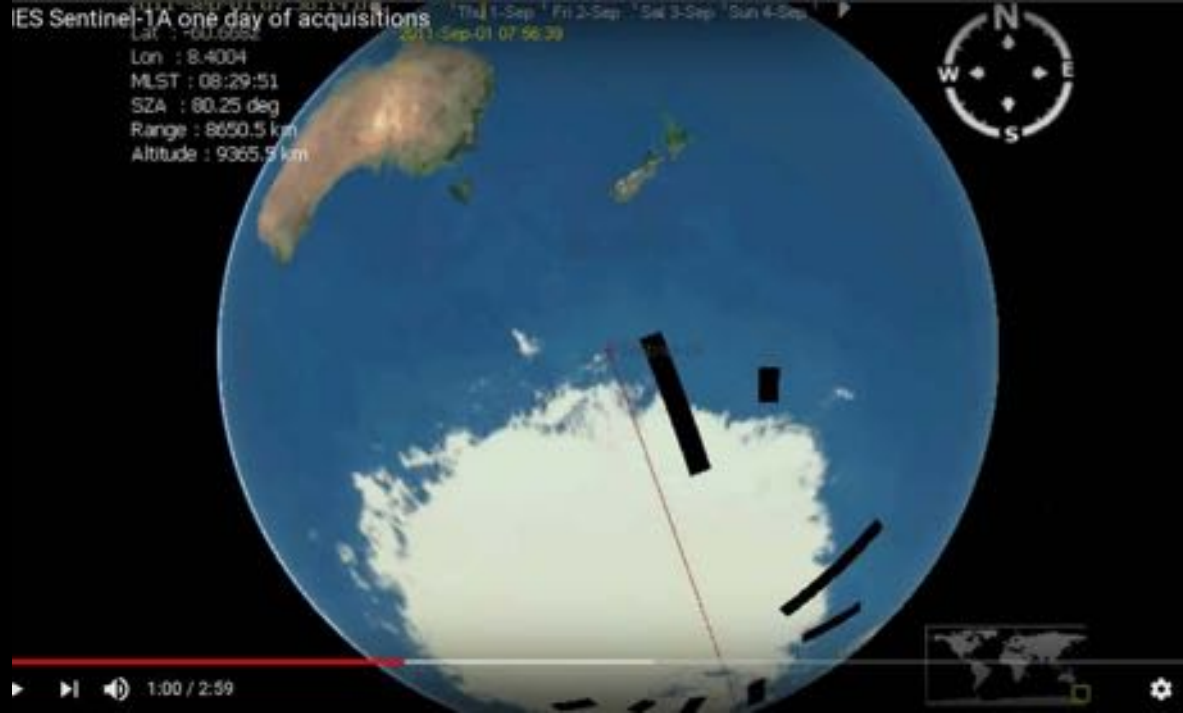
Problem Statement: Satellite Data Access

- Satellite downlink = bottleneck
- Expensive ground segment infrastructure
- No realtime direct user access to acquisition data
- Downlink transmission not comprehensive



[NASA/GAO]

Sentinel-1A: One Day of Acquisitions



https://www.youtube.com/watch?v=Em_1KFq2uLU

ORBiDANSe:

Orbital Big Data Analytics Service

- Idea: reduce download through „what you get is what you need“ paradigm
- „ship code to data“ = on-board processing
 - Ship **query**
get **analysis result**
- satellite → datacube service
 - rasdaman on board



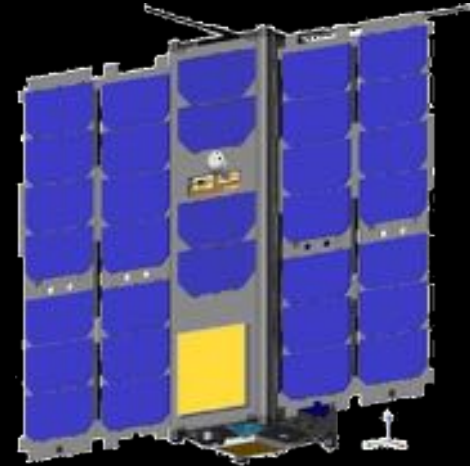
OPS-SAT

- *“OPS-SAT is devoted to demonstrating drastically improved mission control capabilities that will arise when satellites can fly more powerful on-board computers.”*
- *It [...] contains an experimental computer that is ten times more powerful than any current ESA spacecraft.”*
- http://www.esa.int/Our_Activities/Operations/OPS-SAT



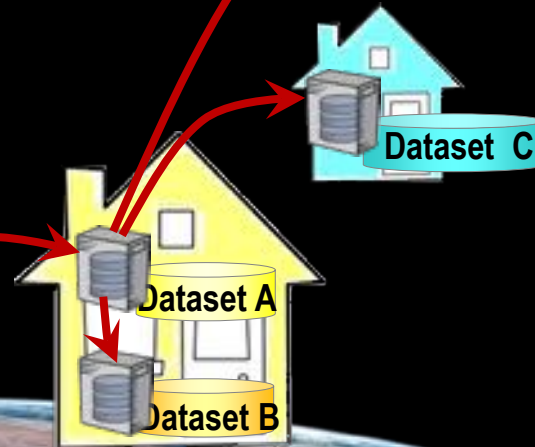
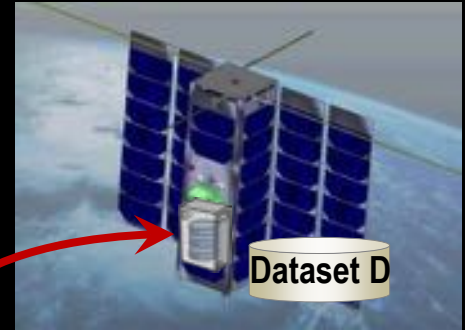
OPS-SAT

- ESA experimental 3U cubesat:
 - „use better hardware, do more on-board processing“
- Problem: radiation → OPS-SAT: 80286 + mityARM
 - 4x (dual ARM A9 @800MHz, FPGA, 1 GB RAM)
 - ADCS, GPS, Nadir-looking RGB camera, SDR + X-band downlink, ...
 - Yocto **Linux**
- planned launch: 2019



ORBiDANSe: Approach

- Swath data + GPS → rasdaman
 - In this experiment: L0, no higher-level processing
...not enough compute capacity
- Experiments:
 - Query satellite via OGC WC[P]S
 - Link into federations
 - DIAS, CODE-DE, ...



Byproduct: Raspberry Pi Cluster

- OPS-SAT porting challenges
 - VM not working (and other issues)
- Raspberry processor
= OPS-SAT processor = ARM
- Raspberry cluster
 - 8 towers x 8 Raspberry 3B
 - 1.4 GHz, 1 GB RAM, 32 GB Sandisk
 - Altogether: 4 TB
 - Wifi connection



ORBiDANSe: Status & Plans

- **Done:** Porting rasdaman to ARM
 - Challenges: libraries, compilation, ...
- **Done:** cluster HW setup
 - Some challenges with hw failures
- **Ongoing:** cluster demo setup
 - Distributed datacube
- **Ongoing:** port to target hw
- Following launch: on-board experiments: querying, federation, ...



Summary

- ORBiDANSe = „ship code to (big) data“ for satellites
 - Intelligent sensors: satellite → queryable database
 - Speed up & simplify EO data access
 - Based on rasdaman = flexible datacube engine
- OPS-SAT = opportunity for feasibility demonstrator
 - To be followed by large-scale experiment
- **Not replacement,**
but addition to conventional downlink



Outlook

- On-board Array Database as a commodity
- Swarms
- Unmanned underwater vehicles
- Vision:
any query, from any source, at any time

