Cosylab Switzerland and SKA

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COSYLAB

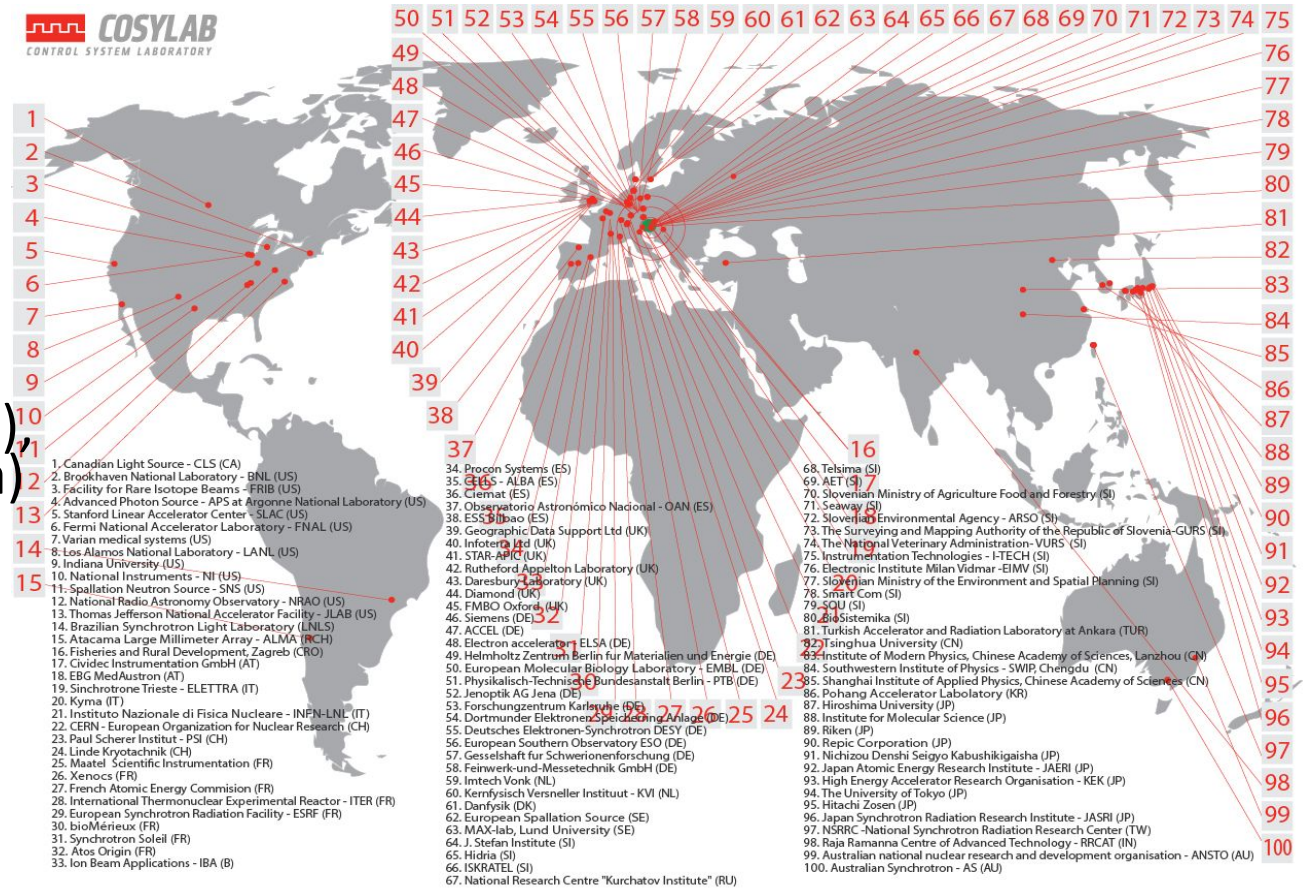
Your TRUSTED Control System Partner

Cosylab in short

- Innovator and global leader in software for the world's most complex, precise and advanced machines
  - Particle accelerators, nuclear fusion, radio-telescopes
  - Atomic force microscopes, real-time single-seed classification
- Founded in 2001. Now 300 people (250 FTE engineering)
- HQ in Slovenia with branches and teams in **Switzerland**, USA, China, Japan, Sweden, South Korea, Ukraine
- Reliability, PA/QA, careful integration
  - **ISO 9001** Quality management systems - Requirements
  - **ISO 13485** Medical devices - Quality management systems
  - **ISO 14971** Medical devices - Application of risk management to medical devices

Cosylab

- World leader in **System Integration and Software** for particle accelerators for research and cancer therapy
  - 43% market share
- Selected references:
  - **Accelerators**: FAIR (Darmstadt), LHC, White Rabbit (CERN), SwissFEL (PSI), LCLS/LCLS-II (SLAC)
  - **Neutron sources**: SNS (Oak Ridge), ESS (Lund)
  - **Cancer therapy**: MedAustron (Austria), iBNCT (Japan), HIMM (Lanzhou, China)
  - **Astronomy & Astrophysics**: ALMA (Munich, Atacama Desert), ESO E-ELT (Cerro Amazones), CTA (Cherenkov Telescope Array)
  - **Fusion**: ITER (Cadarache)



Cosylab Switzerland GmbH

- Founded in 2014
- Staff: 15 experts
  - 1 computer scientist
  - 7 engineers (2 PhD)
  - 1 mathematician
  - 5 physicists (1 PhD)
  - 1 lawyer
- Sites:
  - Technopark Aargau, Brugg (main office)
  - Meyrin (Geneva)
- Projects and domain knowledge:
  - SKA
  - SwissFEL, SLS, PANDA at PSI
  - Proton therapy for cancer treatment
  - QualySense, industrial automation
  - Quantum
- Focus:
  - Control systems
  - Integration & synchronization of heterogeneous devices
  - Fast real-time control, synchronization
  - SW engineering

The SKA and its challenges

The technological challenges

- Complexity
  - Biggest radio telescope up to date
  - Long baseline interferometer arrays
  - Data from clusters of single telescopes / antennas sent around the globe
  - Enormous amount of data to be processed
- Telescope management
  - Equipment orchestration
  - Monitoring
- Data handling – (~300PB/year)
  - Transfer across globe
  - Storage in data centers
- Computational needs – ~300 PFlops
- Time synchronization and event correlation
  - Local cluster synchronization and proper event time-stamping – at the cluster processor
  - Global time synchronization & correlation

The organizational challenge

- Many people
- Different cultures
- Same goal!

From
http://ska-sdp.org/sites/default/files/attachments/overview_of_ska_project_and_current_status_1.pdf

The longevity challenge

- Construction
  - 8 years construction (SKA1)
  - + 7 years (SKA2)

- Decades of operations -> Knowledge Management!

Careful planning and choice of technological solutions, upgrade strategies and application (software) life-cycle management is essential

Relevant Cosylab Experience

- Astronomy and astrophysics
  - ALMA Common Software
  - ESO E-ELT Core Integration Infrastructure Software
  - Cherenkov Telescope Array
- TANGO
  - A free, open source and object-oriented **Distributed Control Systems framework**
  - Cosylab Experience
    - SOLARIS Synchrotron, Poland
    - MAX IV Synchrotron, Sweden
    - ONERA wind-tunnels, France
    - NICA - Nuclotron-based Ion Collider fAcility, Dubna, Russia
- Timing & Synchronization
  - Event based & time distribution systems experience:
    - Micro Research Finland (MRF) Event Based systems used on particle accelerators (European Spallation Source, PAL-XFEL, Solaris, MedAustron, etc)
    - IEEE 1558 Precision Time Protocol
    - CERN WhiteRabbit time distribution
    - GPS synchronized timestamping and clock signals

The organizational & longevity challenge

- ITER CODAC (Control, Data Access and Communication) use-case
  - https://www.iter.org/mach/Codac
  - Since 2009 Cosylab has been contracted by ITER to **engineer, maintain & evolve** the core software Control System framework for one of the world's largest collaborative scientific projects
- **Similar organizational challenge as SKA!**
  - ~100 organizations world-wide use CODAC to build sub-systems that will all come together at the ITER site in Cadarache, France
  - Research institutions & industry alike
- Strong emphasis on:
  - Standardization, both of software distribution and hardware catalog
  - Well defined and documented processes
  - Complete life-cycle management
  - Obsolescence planning
  - Documentation, training materials and hand-on training workshops
  - User support (engineering users)
- Setting similar infrastructure for CTA now

SKA work by Cosylab Switzerland

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Bridging phase

- EPFL has funded 2 FTEs
- From June 2021 to March 2022
- Alexander Söderqvist
  - M.Sc. Electrical Eng, Embedded systems
  - 8 years exp. in control systems
- Ivana Novak
  - M.Sc. Physics, Astronomy
  - 5 years exp. in control systems
- Works on SKA with Observation Management and Control (OMC)
- Software dev. follows practices from Scaled Agile Framework (SAFe)
  - Planning is done on quarterly basis
  - Business owners assign business value to features
  - Features are distributed over the teams

First Program increment

- Joined CREAM team
  - Lead by INAF in Italy
  - 5 IT, 1 PT, 1 IN, 2 CH
  - Part of OMC Agile Release Train
  - Focus on:
    - Central Signal Processor Local Monitoring and Control (LMC)
    - Taranta: tool for creating web-based engineering UIs

- Achievements
  - SKA onboarding, PI10 inspect and Adapt and PI11 planning events
  - SAFe (Scaled Agile Framework) PO/PM certification
  - DevOps technologies (docker, kubernetes, Gitlab)
  - PyTango
  - Prototype integration of Pulsar Search (PSS)

Control System Overview

Operator

Operations/Analyst

Queries and Commands

Monitoring, Archiving, Events, Alarms

Exchange of information with EMS TBD

Observation Execution Tool

Telescope Monitor and Control

Engineering Management System

Synch. and Timing

Network Manager

Digitized astronomical data

Central Signal Processor

Data products

Science Data Processor

ODA

EDA

Central Logging Repository

Networks

Infrastructure (power, building management system, weather station, RFI detector)

Courtesy of Sonja Vrcic

Central Signal Processor (CSP)

Mid.CBF:

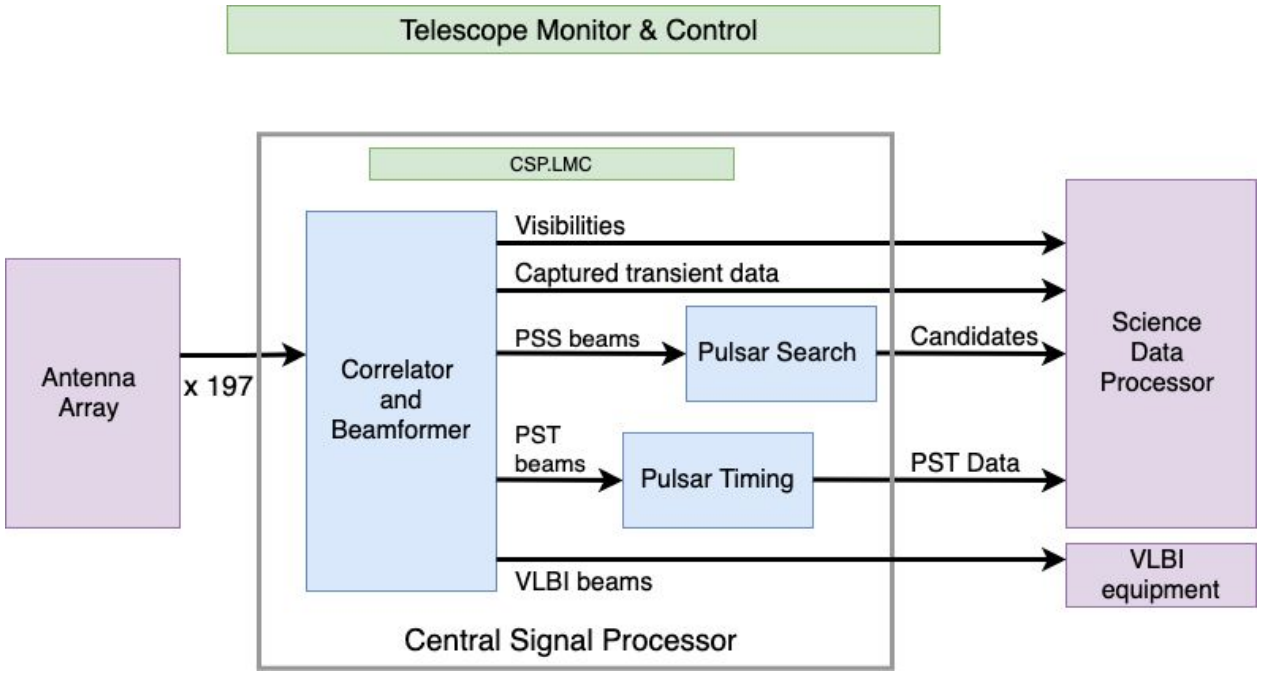
- Master Server + 780 TALON Boards
- Intel Stratix10 SoC (ARM processor + FPGA)
- TANGO S/w on embedded processors.

Mid.PSS:

- Master Server + 500 LRUs
- Compute Nodes (CPU, GPU, FPGAs)
- 3 PSS Pipelines running on the same Compute Node.

Mid.PST:

- Master Server + 16 LRUs (CPU + GPUs)

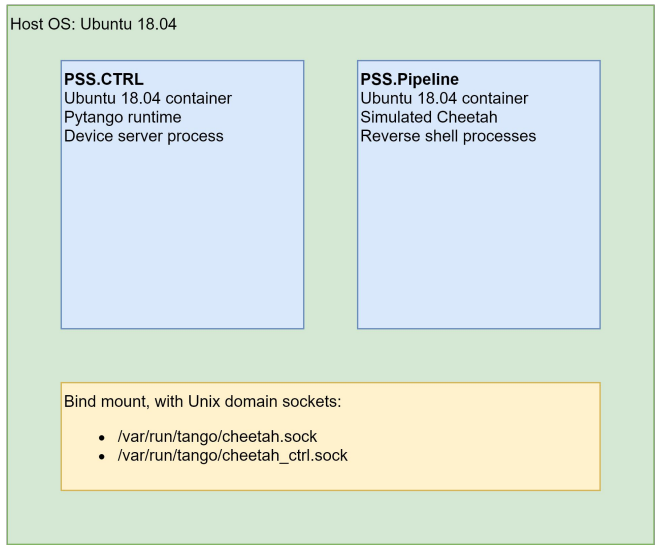


Additional equipment: network switches, PDUs, UPS

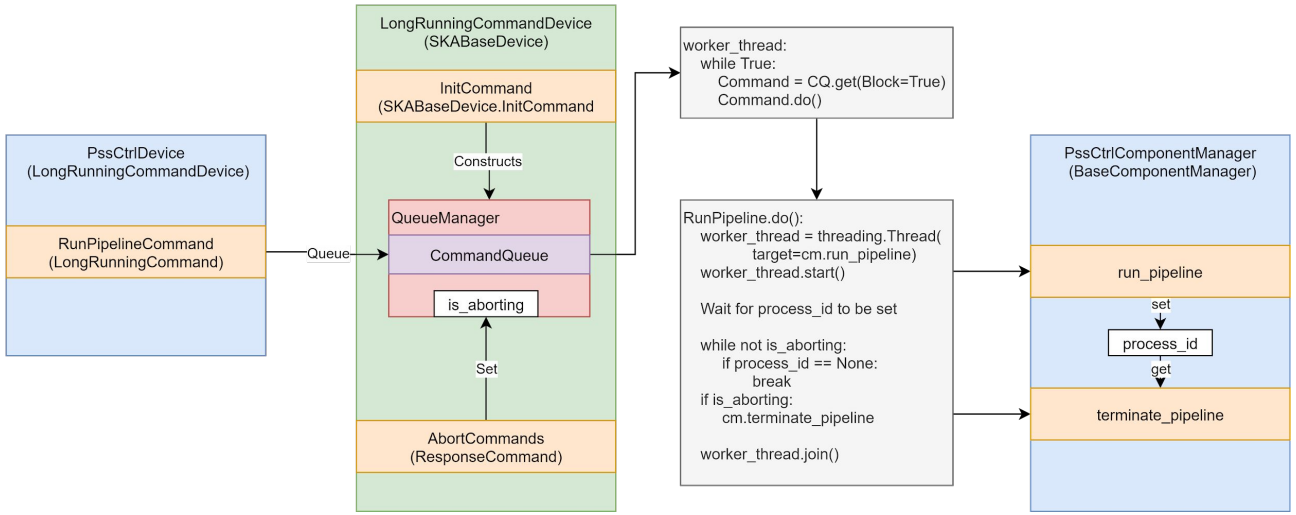
Courtesy of Sonja Vrcic

Prototype of PSS integration

- PSS Control problem
  - Runs computations on GPUs and FPGAs, need dedicated access to hardware
  - Uses non-standard OS
  - Command line tool that runs indefinitely, inter process communication with UNIX signals



- Solution
  - Open reverse shells on PSS OS
  - Run LMC SW on standard container
  - Use multi threaded design to allow multiple concurrent access points to PSS



Next program increment

Potential features to work on:

- SP-1514 Refactoring of CSP.LMC part 3 - Master/Control Refactoring
- SP-1515 CSP.LMC fault detection and handling
- SP-983 CSP_Low.LMC Sub-array
- SP-1367 Rudimentary control of the Cheetah pipeline via PSS.LMC

Cosylab Switzerland & SKAO

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- **CSL CH is the ideal partner of SKA**
  - Mentality, know-how, and experience perfectly match!
- **Switzerland is already contributing to the OMC SW development**
  - Budget on top of proposed financing for SKA-1 construction
- **Switzerland offered one entire agile team for the OMC as in-kind**
  - Creation of a dedicated Swiss team for SKA Telescope Management and Element Monitoring & Control

THANK YOU!

Cosylab Switzerland GmbH
Web: www.cosylab.com

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