THE@INT Software Systems

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Outline

Overview

Overall status of Software Systems

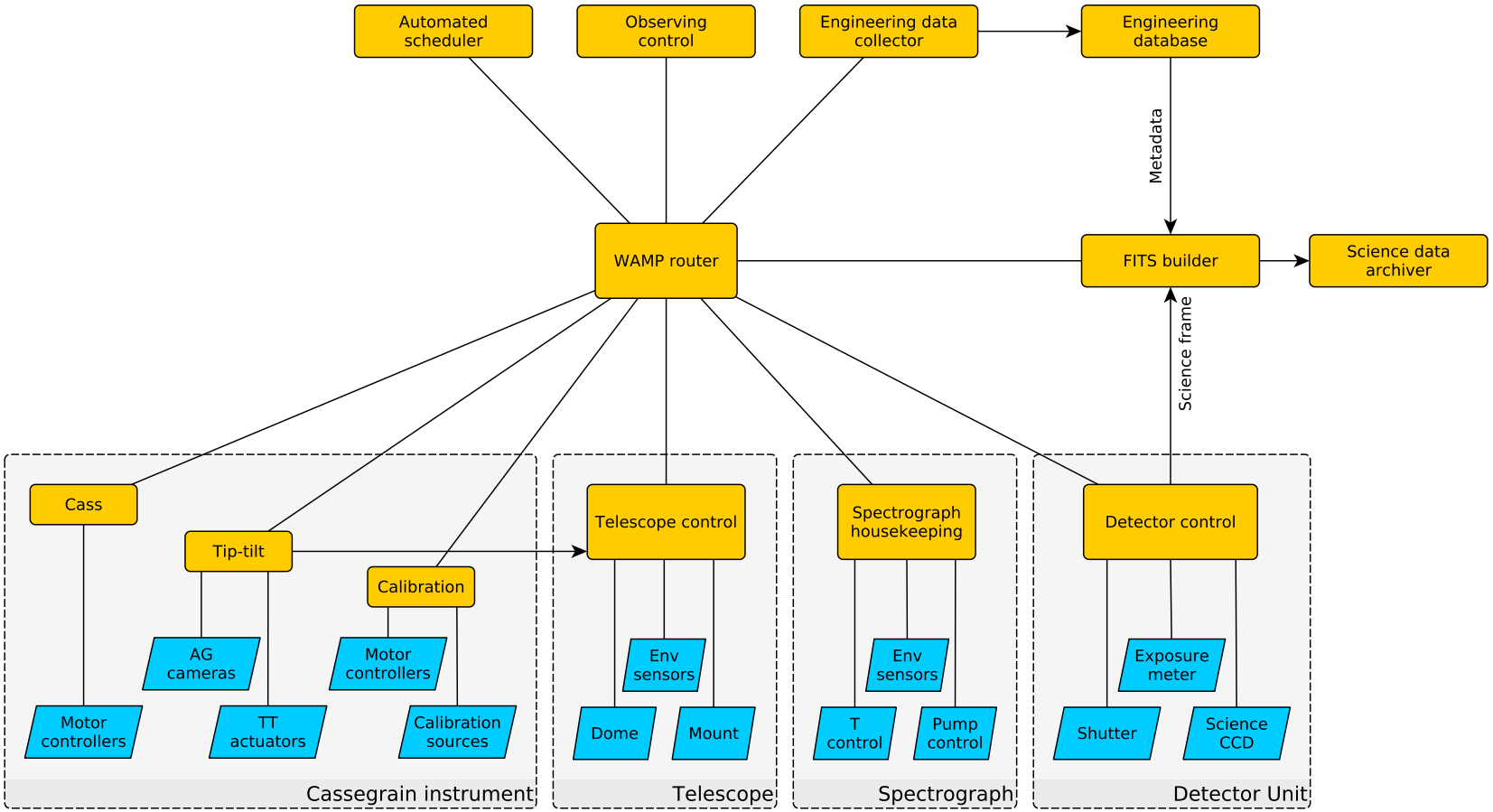
- Preliminary Design Review in May 2017
  - Updated documents needed
- Prototyping partially done
- Final Design Review planned for December 2019
  - Telescope refurb tender on critical path

Mission

- Design and implement a fully robotic control system for the INT and HARPS3
  - To carry out the Terra Hunting Experiment and open time observations
  - Must accommodate a possible companion instrument
  - Must accommodate a possible solar telescope
- Science requirements – see HARPS3-EXE-0004
- Operations model and use cases – see HARPS3-CAM-0007

Overview

Control system architecture



Instrument control software

- Telescope Control System (TCS)
  - Integrates mount, dome and environment sensing
- Cass Instrument Control Software (CICS)
  - Cass Unit
    - ADC
    - Cassegrain Fibre Adapter
    - Polarimeter
  - Acquisition and guiding (2 fields)
  - Calibration Unit
- Spectrograph Control Software (SCS)
- Detector Control Software (DCS)

Supervisory software

- Automated scheduler
  - Schedules daytime calibrations, nighttime observations, focus, pointing test
- Observing Control Software (OCS)
  - Observation Sequencer, Fault Manager, FITS Builder
- Data handling
  - Engineering data collector and database
    - Local database and automatic transfer to Exeter mirror
  - Science data archiver
    - Local storage, automatic transfer to Exeter, load into database
  - Data Reduction Software
    - Based on ESPRESSO DRS

Overview

Actors

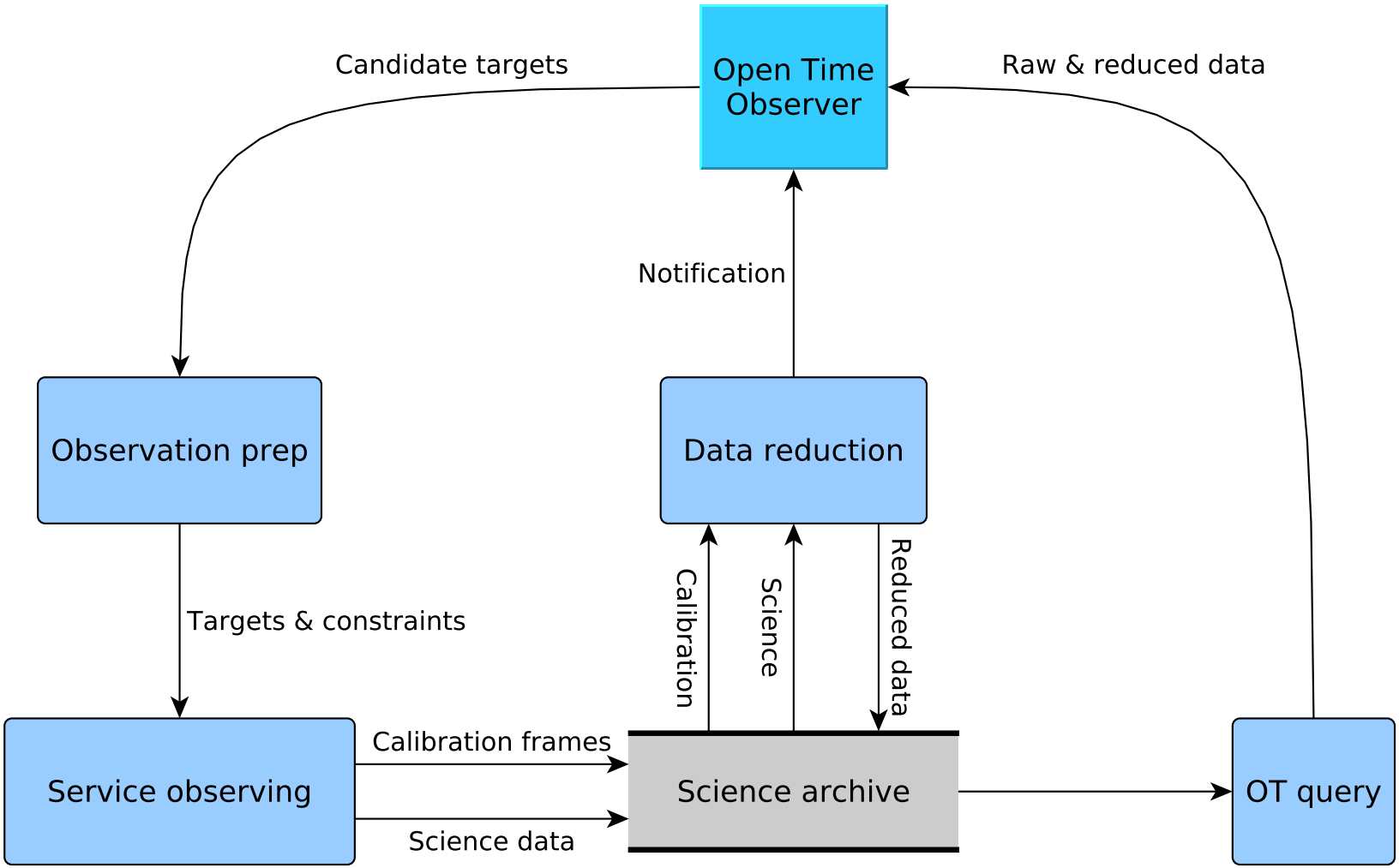
Open time observer A scientist who wishes to carry out observations with the INT, in service mode, and make use of the resulting data

Consortium observer A scientist from the HARPS3 consortium working on the Terra-Hunting Experiment (THE)

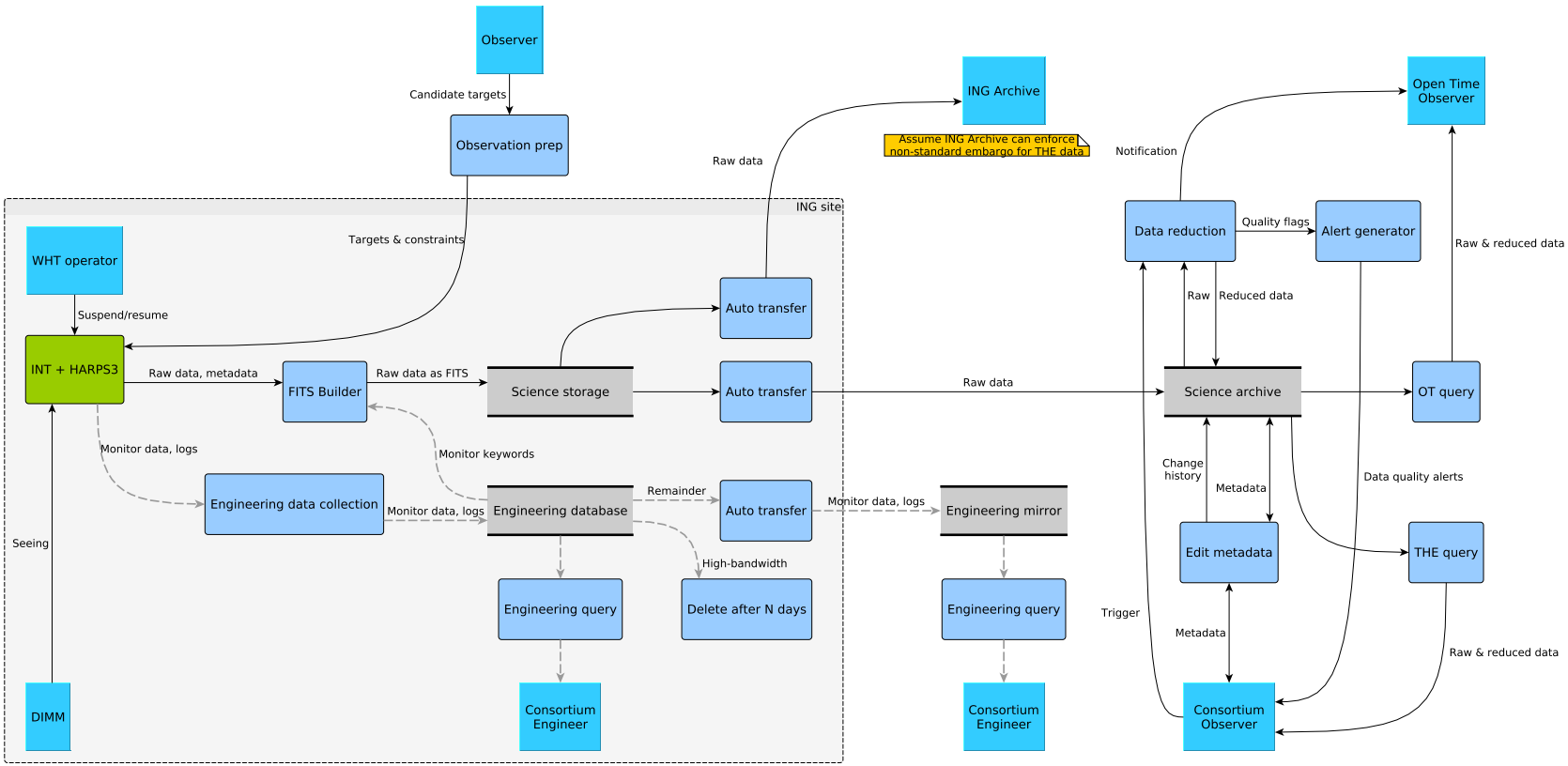
Consortium engineer An engineer from the HARPS3 consortium, responsible for ensuring that both open time and THE observations are carried out successfully

WHT operator Responsible for ensuring safe startup and shutdown of the INT. MoU states that the ING will provide safety override for robotic operation

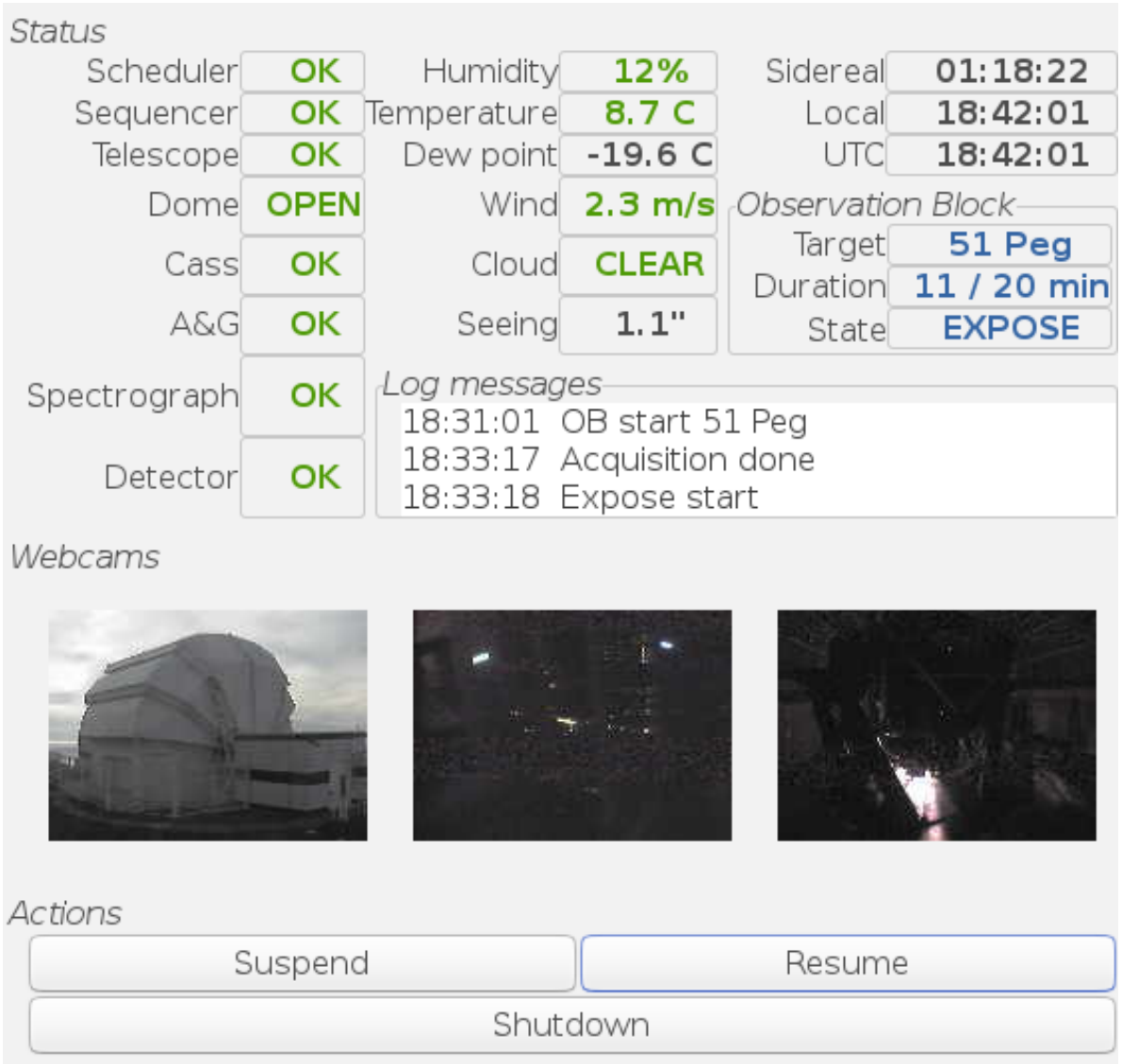
Service mode observing and data reduction



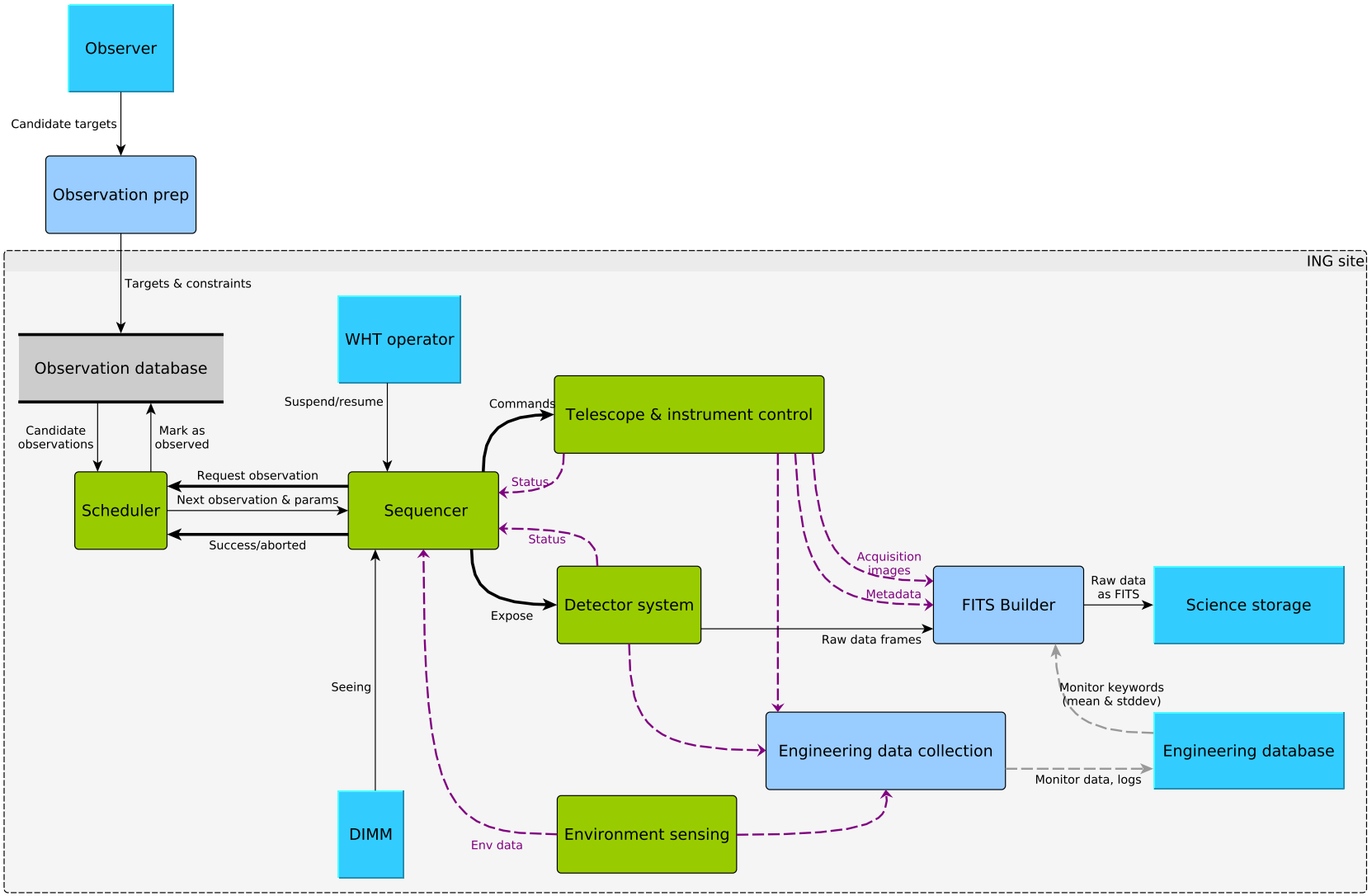
Data handling overview



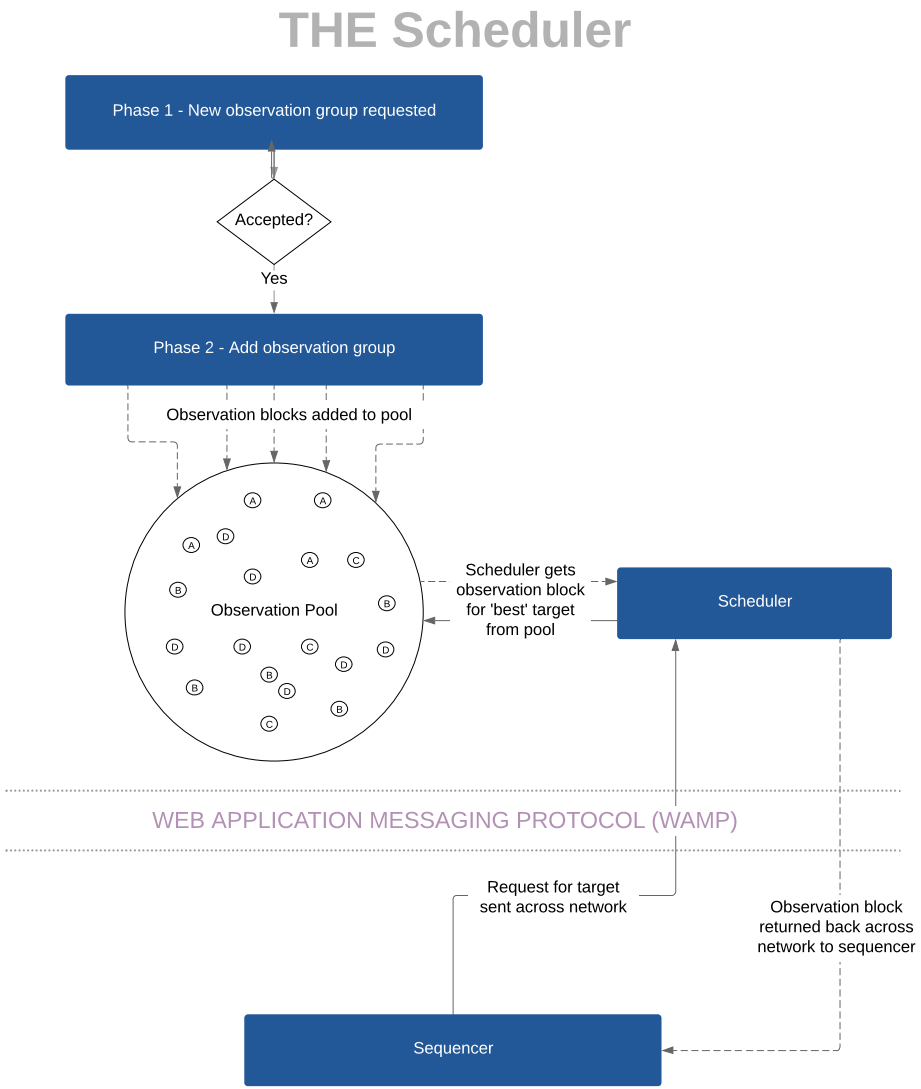
Observing dashboard



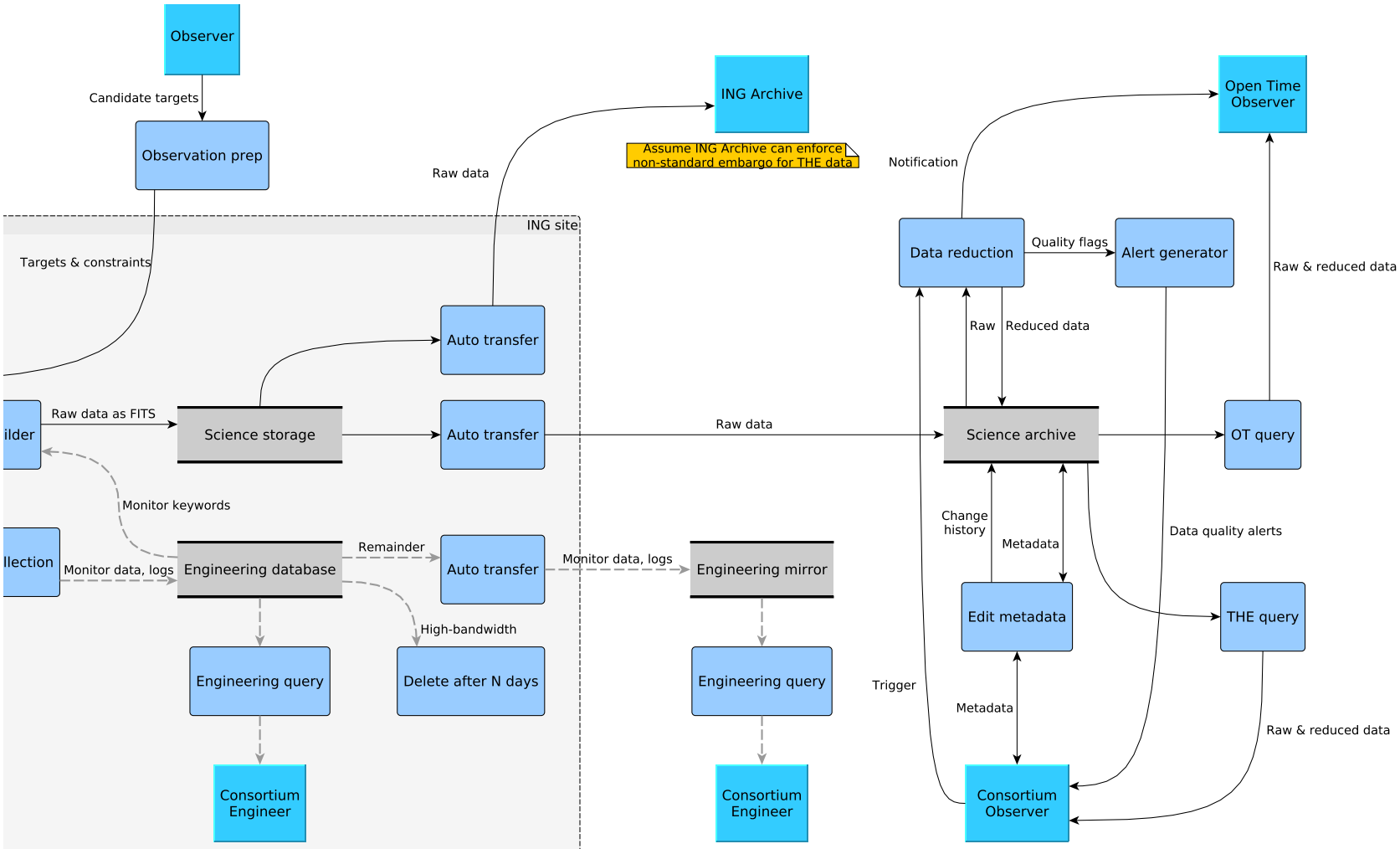
Detail of telescope/instrument control



Automated Scheduler



Detail of post-collection data handling



Engineering data collection

- INT/HARPS3 sub-systems will publish engineering data continuously
- Published data will automatically be collected and stored in the on-site engineering database
  - Data collection must be robust to sub-systems going offline/online
  - Query facility used by OCS FITS Builder
- Database mirrored in Exeter, updated nightly (TBD)
- High-bandwidth data only kept for N days, available for manual transfer
  - Guide camera video
  - Very low-level debug messages

Science/calibration data collection

- FITS files will be assembled from a raw detector frame and ancillary data/metadata provided by the robotic control system
  - Science metadata: required by DRS (timestamp, exposure, target and telescope coordinates, . . .)
  - Engineering metadata: summarise instrument status during exposure
  - Exposure meter time series
  - Acquisition and integrated guide images
- Temporary storage on site
- Transfer to main Archive in Exeter
  - Automatic pipeline reduction on import
  - Retain multiple, traceable reductions of each observation
    - Edit metadata (e.g. spectral type) and re-reduce
    - Upgrade DRS (occasionally) and re-reduce

Backup slides

Data Reduction Software

- ESPRESSO DRS status
  - Validated and operational on Paranal
  - Able to read HARPS data
  - New web-based "trigger" front-end for CPL recipes
- New work for HARPS3
  - Adapt ESPRESSO DRS for HARPS-X data and test (Geneva)
  - FITS Builder (Cambridge)
  - Integrate/adapt Trigger (Cambridge)
    - Details to be discussed with Geneva
  - Interfaces with HARPS3 Archive for pipeline input/output files (Exeter)
  - Science QC tools (includes alerts) for consortium observer (Exeter)

Alerts

- Alerts can be generated from
  - Engineering data
  - DRS-processed data
- Flexibility
  - Use any monitored variables
  - Complex alert criteria?
    - Combinations of variables
    - Linked to events

User interfaces (1)

- Operations UIs (consortium use)
  - Observing dashboard
  - Scheduler “queue” UI
  - Engineering archive access

User interfaces (2)

- Engineering GUIs (view only during robotic operation)
  - Telescope system
  - Cass instrument
  - Spectrograph
  - Detector
- Observer tools (community/consortium use)
  - Exposure Time Calculator
  - Scheduler simulation tool
    - For repeated observation or survey
  - Science archive access

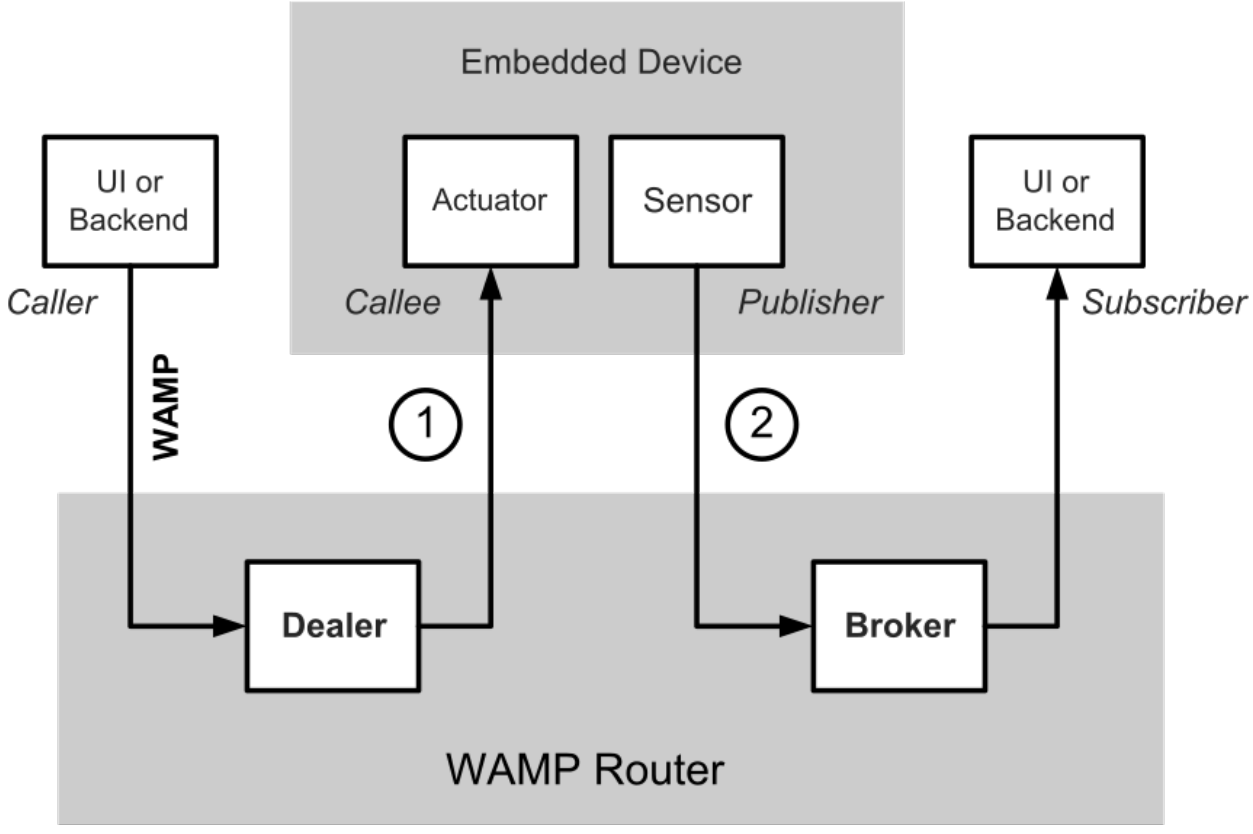
Communications framework

- Robotic control of telescope + instrument requires a distributed event-driven software system
- Components communicate over network using WAMP protocol
  - Open standard WebSocket subprotocol
  - Data serialization using JSON or MsgPack
- Use open-source Crossbar.io router and Autobahn client libs (many languages)

WAMP

WAMP implements two communications patterns:

1. Remote Procedure Call (command/response)
2. Publish Subscribe



Realistic WAMP example