Software for the New General detector Controller

Developing the software for a common Optical/Infrared detector controller

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NGC is the ESO New General detector Controller, designed to handle the detectors of both optical and infrared new instruments, for scientific imaging as well as advanced signal sensing applications. It is being developed on the base of the experience with the current ESO standard controllers - FIERA (for the optical domain) and IRACE (for the Infrared) - and the requirements coming from the new generation of detectors.

To merge optical and infrared detector controllers is an interesting challenge also under the software point of view.

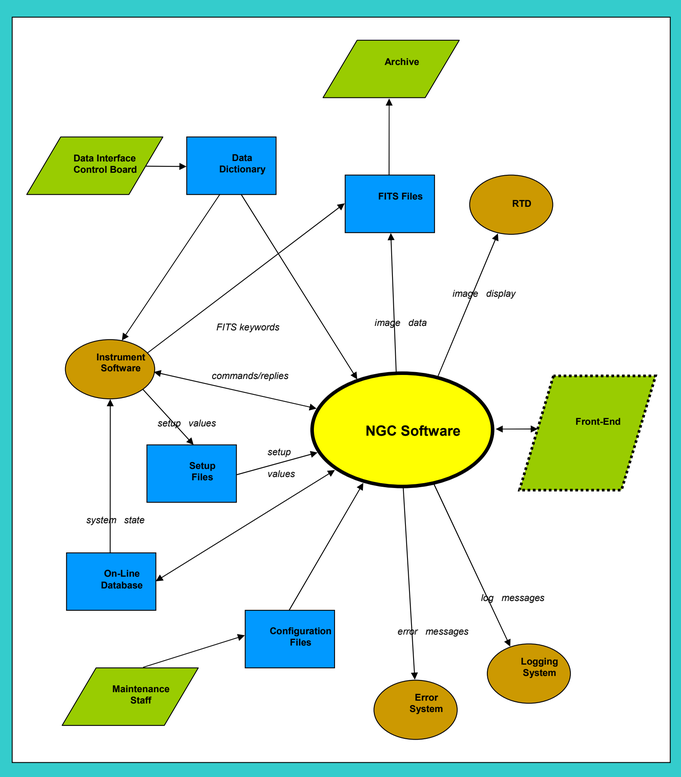
Different requirements come from the different domains: huge on-the-fly processing of the acquired data (infrared), shutter handling (optical), strict timing requirements (interferometry or high time resolution imaging or spectroscopy), synchronization with external signals (multiple cameras, va-et-vien, nodding, chopping), interface to real-time-computers (adaptive optics), fast image assembly and storage in FITS files (big detector mosaics), continuous readout and storage in FITS files (drift-scanning).

All these functionalities must be achieved along with stiff **performance** requirements (speed, time accuracy, error recovery, etc.).

Moreover, the experience has shown that it is important that the same code which is used for operation at the telescope is also used in the **laboratory** for rapid prototyping, testing and calibration. This requires a detector control software which is **flexible** enough to let the engineers test a system deeply and extensively during its whole life-cycle (from early prototype to final product), but at the same time defines well and carefully different levels of operational freedom, to ensure **safety** during the normal operation.
In order to guarantee **reusability**, the software for the NGC has also started to define Use Cases and Design Patterns which should become the future "building blocks" in the ESO detector control software area. All this is developed within the framework of the ESO VLT control software paradigm.

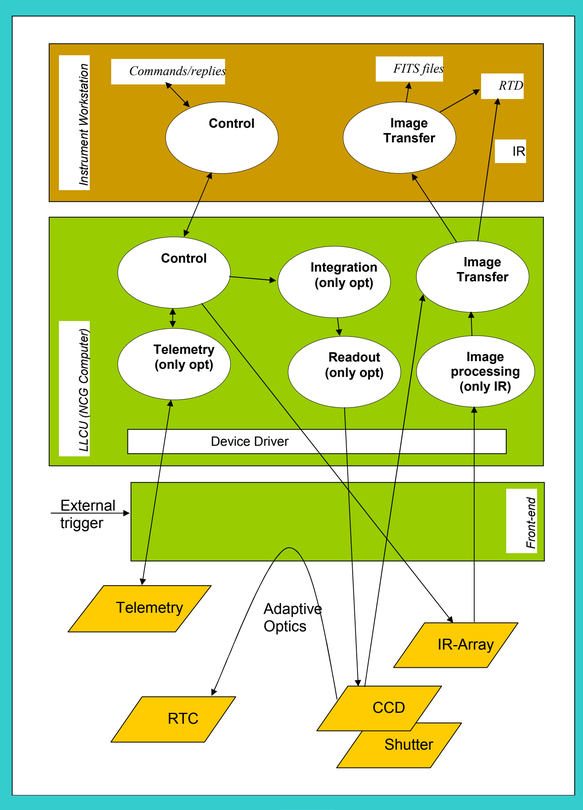
High level requirements

Replace the FIERA and IRACE controllers in a way that is transparent to the VLT environment.



Intermediate level requirements

Interface with optical/infrared/adaptive optics/etc systems ("*Keep control: PULPO II Eso's new housekeeping unit*", by C.Geimer et al.).

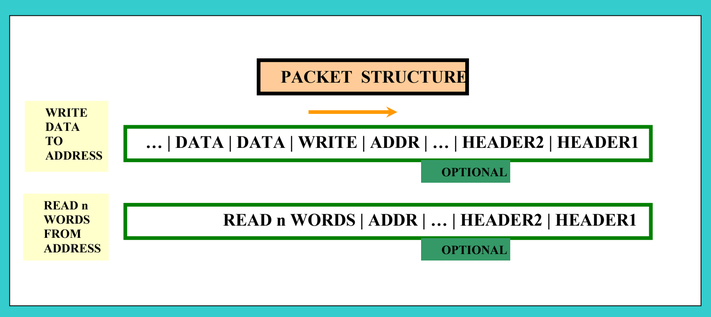


Low level requirements

Interface with NCG modules

(See talk "*NGC Detector Array Controller Based on High Speed Serial*" by M. Meyer and poster "*NGC Front-end for CCDs and AO applications*" by J.Reyes et al.).

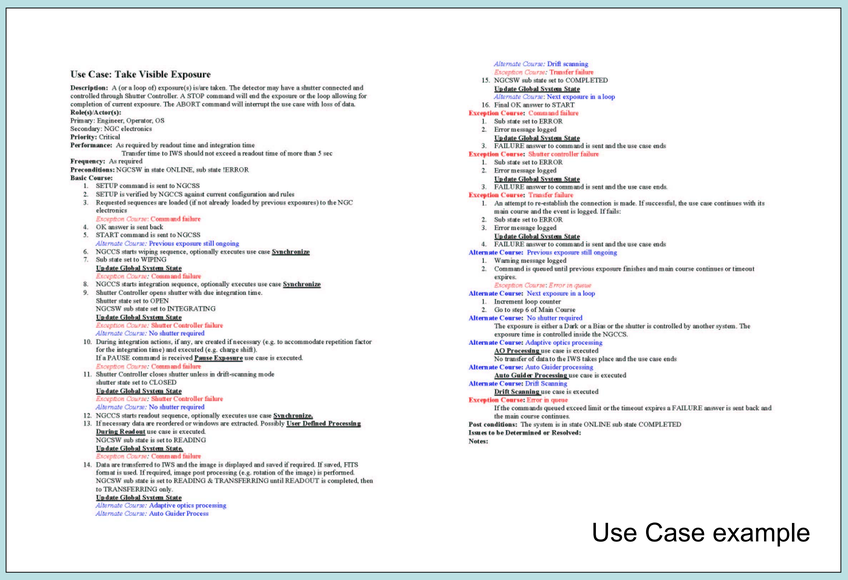
- Sequencer on the FPGA of each board
- Elementary detector timings are stored in patterns / voltages are stored in configuration files
- Patterns can be executed in series and/or loops, at different speeds, with different intervals
- Patterns built by packets with a well defined structure
- Changes in pattern execution can be performed on the fly



Software development

- **Maintenance**: software must be simple, open to evolution of requirements (functionalities) and environment (new hardware and software)
- EUP (Enterprise Unified Process), **iterative approach** is being used
- Extensive usage of "**Use cases**" (see below) has been the base for the software requirements.
- DOORS usage: tool for easy management of requirements/design/implementation/test documentation, with mutual references and easy **traceability**

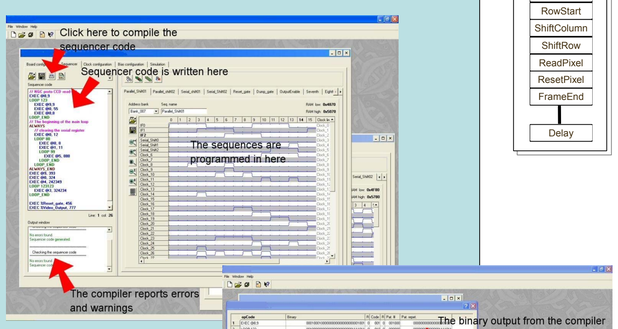
- high and intermediate levels: the differences between Optical and Infrared operations suggest having different designs for Optical and Infrared
- low level: implementation can be common.
  At this level, a Controller Interface provides modular objects to control the Sequencer and the ADCs on the front-end modules, for interfacing to the Acquisition Process and for the Asynchronous Data Reception. The objects can be assembled in an arbitrary way to reflect all functionalities of any NGC hardware configuration.
  A graphic tool for the pattern creation is under development.



Use Case: Take Visible Exposure

Description: A (or a loop of) exposure(s) is/are taken. The detector may have a shutter connected and controlled through Shutter Controller. A STOP command will end the exposure or the loop allowing for completion of current exposure. The ABORT command will interrupt the use case with loss of data.
Role(s)/Actor(s):
Primary: Engineer, Operator, OS
Secondary: NGC electronics
Priority: Critical
Performance: As required by readout time and integration time
Transfer time to IWS should not exceed a readout time of more than 5 sec
Frequency: As required
Preconditions: NGCSW in state ONLINE, sub state !ERROR
Basic Course:
1. SETUP command is sent to NGCSS
2. SETUP is verified by NGCCS against current configuration and rules
3. Requested sequences are loaded (if not already loaded by previous exposures) to the NGC electronics
Exception Course: **Command failure**
4. OK answer is sent back
5. START command is sent to NGCSS
Alternate Course: **Previous exposure still ongoing**
6. NGCCS starts wiping sequence, optionally executes use case **Synchronize**
7. Sub state set to WIPING
Update Global System State
Exception Course: **Command failure**
8. NGCCS starts integration sequence, optionally executes use case **Synchronize**
9. Shutter Controller opens shutter with due integration time.
Shutter state set to OPEN
NGCSW sub state set to INTEGRATING
Update Global System State
Exception Course: **Shutter Controller failure**
Alternate Course: **No shutter required**
10. During integration actions, if any, are created if necessary (e.g. to accommodate repetition factor for the integration time) and executed (e.g. charge shift).
If a PAUSE command is received **Pause Exposure** use case is executed.
Exception Course: **Command failure**
11. Shutter Controller closes shutter unless in drift-scanning mode
shutter state set to CLOSED
Update Global System State
Exception Course: **Shutter Controller failure**
Alternate Course: **No shutter required**
12. NGCCS starts readout sequence, optionally executes use case **Synchronize.**
13. If necessary data are reordered or windows are extracted. Possibly **User Defined Processing**
During Readout use case is executed.
NGCSW sub state is set to READING
Update Global System State.
Exception Course: **Command failure**
14. Data are transferred to IWS and the image is displayed and saved if required. If saved, FITS format is used. If required, image post processing (e.g. rotation of the image) is performed.
NGCSW sub state is set to READING & TRANSFERRING until READOUT is completed, then to TRANSFERRING only.
Update Global System State
Alternate Course: **Adaptive optics processing**
Alternate Course: **Auto Guider Process**
Alternate Course: **Drift scanning**
Exception Course: **Transfer failure**
15. NGCSW sub state set to COMPLETED
Update Global System State
Alternate Course: **Next exposure in a loop**
16. Final OK answer to START
Exception Course: **Command failure**
1. Sub state set to ERROR
2. Error message logged
Update Global System State
3. FAILURE answer to command is sent and the use case ends
Exception Course: **Shutter controller failure**
1. Sub state set to ERROR
2. Error message logged
Update Global System State
3. FAILURE answer to command is sent and the use case ends.
Exception Course: **Transfer failure**
1. An attempt to re-establish the connection is made. If successful, the use case continues with its main course and the event is logged. If fails:
2. Sub state set to ERROR
3. Error message logged
Update Global System State
4. FAILURE answer to command is sent and the use case ends
Alternate Course: **Previous exposure still ongoing**
1. Warning message logged
2. Command is queued until previous exposure finishes and main course continues or timeout expires.
Exception Course: *Error in queue*
Alternate Course: **Next exposure in a loop**
1. Increment loop counter
2. Go to step 6 of Main Course
Alternate Course: **No shutter required**
The exposure is either a Dark or a Bias or the shutter is controlled by another system. The exposure time is controlled inside the NGCCS.
Alternate Course: **Adaptive optics processing**
AO Proceeding use case is executed
No transfer of data to the IWS takes place and the use case ends
Alternate Course: **Auto Guider processing**
Auto Guider Processing use case is executed
Alternate Course: **Drift Scanning**
Drift Scanning use case is executed
Exception Course: **Error in queue**
If the commands queued exceed limit or the timeout expires a FAILURE answer is sent back and the main course continues.
Post conditions: The system is in state ONLINE sub state COMPLETED
Issues to be Determined or Resolved:
Notes:

Use Case example



Sequencer UIF