The Cherenkov Telescope Array Observatory

top level use cases

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The Cherenkov Telescope Array Observatory Top Level Use Cases

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ABSTRACT

Today the scientific community is facing an increasing complexity of the scientific projects, from both a technological and a management point of view. The reason for this is in the advance of science itself, where new experiments with unprecedented levels of accuracy, precision and coverage (time and spatial) are realised. Astronomy is one of the fields of the physical sciences where a strong interaction between the scientists, the instrument and software developers is necessary to achieve the goals of any Big Science Project. The Cherenkov Telescope Array (CTA) will be the largest ground-based very high-energy gamma-ray observatory of the next decades. To achieve the full potential of the CTA Observatory, the system must be put into place to enable users to operate the telescopes productively. The software will cover all stages of the CTA system, from the preparation of the observing proposals to the final data reduction, and must also fit into the overall system. Scientists, engineers, operators and others will use the system to operate the Observatory, hence they should be involved in the design process from the beginning.

We have organised a workgroup and a workflow for the definition of the CTA Top Level Use Cases in the context of the Requirement Management activities of the CTA Observatory. Scientists, instrument and software developers are collaborating and sharing information to provide a common and general understanding of the Observatory from a functional point of view. Scientists that will use the CTA Observatory will provide mainly Science Driven Use Cases, whereas software engineers will subsequently provide more detailed Use Cases, comments and feedbacks. The main purposes are to define observing modes and strategies, and to provide a framework for the flow down of the Use Cases and requirements to check missing requirements and the already developed Use-Case models at CTA sub-system level. Use Cases will also provide the basis for the definition of the Acceptance Test Plan for the validation of the overall CTA system. In this contribution we present the organisation and the workflow of the Top Level Use Cases workgroup.

Keywords: Big Science, Cherenkov Telescope Array Observatory, Use Cases, Requirements.

1. INTRODUCTION

The Cherenkov Telescope Array (CTA) [1] will be the biggest ground-based very-high-energy (VHE) γ-ray observatory of the future. At the time of writing, the international CTA consortium counts more than 1200 scientists from 32 countries. CTA will consist of two arrays of tens of telescopes: one in the southern hemisphere, to mainly observe the wealth of sources in the central region of our Galaxy, and one in the North, optimised to the study of the Extragalactic sky, Active Galactic Nuclei (AGN) and galaxies at cosmological distances, and their star formation and evolution. To accomplish the science goals three different telescope types will be required: a small number of Large Sized Telescopes (LST) for the lowest energies (20 GeV - 1 TeV), 20-30 Medium Sized Telescopes (MST) for the 100 GeV - 10 TeV energy domain, and, in the southern hemisphere, tens of Small Sized Telescopes (SST) for the highest energies (few TeV - beyond 100 TeV). Thanks to this configuration CTA will achieve a factor of 10 improvement in sensitivity from some tens of GeV to beyond 100 TeV with respect to existing Cherenkov observatories (H.E.S.S.[2], MAGIC[3] and VERITAS[4]). With a total collection area of ~ 10 km^2, and the improved < 0.1° angular resolution, CTA will open a large discovery potential in astrophysics and fundamental physics.

The CTA Collaboration is organised in many Work Packages that cover all aspect of the construction of the CTA: science (the PHYS working group), telescopes (LST, Large Size Telescopes, MST, Medium Size Telescopes, SST, Small Size Telescopes), software (ACTL and DATA), infrastructures (INFRA), calibration (CCF), and the management of the Observatory (OBS).

A working group of scientists and engineers follows a workflow for the definition of the CTA Top Level Use Cases in the context of the Requirement Management activities of the CTA Observatory and under the Observatory responsibility. The Top Level Use Cases will cover the entire CTA system providing a common view, although at high-level, of the Observatory, regardless to the Work Packages that will realise a specific subsystem. At the end of this process, the Project Office must approve these use cases.

In this contribution we present the workflow and the organisation of this Top Level Use Cases workgroup.

2. THE CONTEXT IS AN ASTRONOMICAL OBSERVATORY

2.1 A Big Science project

Today the scientific community is facing an increasing complexity of the scientific projects, from both a technological and a management point of view. The reason for this is in the advance of science itself, where new experiments with unprecedented levels of accuracy, precision and coverage (time and spatial) are built, but the realization of these experiments is only possible through an international collaboration.

Astronomy is one of the fields of the physical science where a strong interaction between the scientists, the instrument and software developers is necessary to achieve the goals of any Big Science Project.

2.2 The Use Case model

The “system” for which we are collecting use cases is an open Observatory serving multiple types of scientific users, including Guest Observers, Archive Users, and members of the CTA Consortium. Guest Observers request access to CTA observation time and will have their proposals submitted for an independent and neutral evaluation and ranking to a Time Allocation Committee appointed by the Observatory. Guest Observers will receive standard data products as well as user support. In addition, these use cases address the interaction of the CTA Observatory with the astronomical community through ToO (Target of Opportunity) observations based on alerts by other instruments, and through alerts issued by the CTA Observatory. Guest Observers will usually be granted exclusive and proprietary access to science data for a certain period. The proprietary period may depend on the type of observation. To maximize the scientific return of the Observatory we have also to understand how to optimize each single observation (taking into account the constraints of the telescopes that are working as an array).

To capture the greatest possible number of points of view during the *requirement inception* phase, the Use Cases [6] are divided into two categories:

- science-related use cases: the goal is to understand how to perform an observation with a specific scientific objective;

- observatory-related use cases: the goal is to understand how to serve scientific users and ToO observations with conflicting scientific objectives.

We will converge in a unique Use Case Model during the *requirement analysis* process.

Science-related use cases
The focus of each Use Case is the science and the operations to perform science. The purpose is to find an agreement between scientists and engineers in term of content and language and to understand the workflow to realize scientific objectives. The starting point of this work are the main scientific requirements of CTA, which could be identified as

- provide high flexibility of operation and scheduling, operating in a wide range of configurations, enabling observations with multiple sub-arrays targeting and simultaneous monitoring of different objects or energy ranges;
- provide synergy with other telescopes; such a synergy is a key factor because:
    - we need rapid reconfiguration of the observing mode in response to internal or externally generated triggers;
    - the CTA Observatory must be capable of issuing alerts to other instruments, to maximise science return on time-variable and transient phenomena;
- provide ready access to archive data for Guest Observers and Archive Users.

Observatory-related use cases
The Observatory-related use cases will describe how to perform observations with the CTA Observatory from a user point of view, with conflicting scientific objectives. In addition, they describe the *commonalities* of all the science-related use cases. Some basic use cases are

- Submit a proposal
- Review a proposal
- Prepare an Observation Programme
- Execute a Programme
- Manage ToOs
- Process data
- Manage archives
- Explore data (i.e. perform scientific analysis)
- Disseminate the results
- Provide user support

The identification and analysis of some of such use cases will permit to reveal relationships between observatory-related and science-related use cases and then optimize the scientific return.
Just to provide an example of the relationship between observatory-related and science-related use cases, for the Target of Opportunity management for transients, thousands of alert per night will be received from the future transient factories. What the CTA Observatory will need is to filter out the relevant ones, and react in an appropriate fashion; reaction could range from, e.g.

- without any human intervention, reposition the telescopes and start data taking;
- have a scientist look at ToO and associated multi-wavelength data next day and decide what to do.

How to filter ToOs and select valid ones and the type of reaction is a science problem that is described in a science-related use case. Enabling appropriate response to selected ToO is an observatory problem and is described with an observatory-related use case.

3. REQUIREMENT ENGINEERING PRACTICES COVERED BY THE WORKGROUP

The main purpose of the requirement engineering process is producing functional and quality (a.k.a. non-functional) requirements [7].

Generating requirements is a process that could begin with a set of documents that are necessary, but not sufficient to ensure that the system you get is the system you want. The next mandatory step is that the process iterates as a collaboration between the astronomers and the development team. As a general rule, developers are not domain experts; this means that they need more details and guidance as implementation proceeds.

In the CTA Top Level Use Cases working group we are covering these aspects of the requirement engineering:

- *requirement inception*, to collect the requirements from users and other stakeholders;
- *requirement analysis*, determining and refining the user's needs and constraints, to provide a unique view of the use case model under development, and to resolve conflicts. The requirements are documented and should be actionable, measurable, testable, and traceable;
- *requirement identification*: identify new or missing requirements;
- early definition of an *Acceptance Test Plan.*

To generate requirements, we are developing Use Cases. A Use Case is a description of system behaviour in response to a request from one of the stakeholders, called the primary actors (in our context, mainly the scientists and the operators of the CTA Arrays). We are collecting Use Cases (and related scenarios) starting from goals of the various stakeholders, to

- describe a possible solution regarding functions and workflows of the CTA Observatory;
- encourage a common understanding of requirements on system behaviour;
- improve communication among project members;
- discover and document issues in the early phase of the CTA pre-construction and construction phases;
- give context to quality factors (a.k.a non-functional requirements).

For the purpose of this work the use cases must be readable by all project members, this means that we are using simple text without technical jargon, and the system is considered as a black box.

4. REQUIREMENT INCEPTION FOR A BIG SCIENCE PROJECT

An effective process of *requirement inception* could contribute managing the increasing complexity of a Big Science project like CTA and therefore to

- understand the workflow, starting with user expectations;
- maintain costs within a chosen envelope, deciding precisely what to build, what the system must do, how it must behave, the properties it must exhibit, the qualities it must possess, and the constraints that the system and its development must satisfy [5];
- map the functionalities to the science requirements.

With such context, a requirement inception process is a challenge because there are many different problems that we should avoid:

- *Problem of scope*: the user specifies technical details (that are outside the scope of the *requirement inception*) and/or the boundary of the system is not well defined.
- *Problem of understanding*: the users do not have a full understanding of the problem domain, have trouble communicating needs to the system/software engineers, omit information that is believed to be “obvious,” specify requirements that conflict with the needs of other customers/users.
- *Requirements volatility*: the requirements change over time.

A Big Science project has no similar examples that could be followed, due to its uniqueness. The current Cherenkov experiments help us in collecting experience, but the CTA Observatory is one order of magnitude bigger than current experiments. For these reasons is important to manage the problems of scope and understanding, because they could affect the requirement inception. About the volatility, in a Big Science project the requirements could change over time for many different reasons:

- the organizational complexity (and its evolution) is a cause of requirement volatility. Organizational goals, policies and roles of intended end users all may change during the development of the system. The organization of the CTA Top Level Use Cases workgroup described in the following section should take under control the organizational complexity of a Big Science project like CTA;

- the requirements are the product of the contributions of many individuals, and these individuals often have conflicting needs and goals. To keep this aspect under control we have selected the CTA Key Science Programme (KSP) as an input of this process (the scientific programme contained within is already the result of a discussion), and the people that has developed this scientific programme as key participants;
- increasing knowledge during the development: (i) people are learning/will learn new things during the prototyping activities or during testing and commissioning phases, and will learn during the operations. This knowledge should be included in the project starting from the requirement management to keep hardware and software development in sync; (ii) one of the most important cause of requirements volatility is that user needs evolve over time, because the science evolves over time thanks to new scientific discoveries.

An iterative process

To keep the problems depicted above (scope, understanding and volatility) under control, we have adopted an iterative process, "so that solutions can be reworked in the light of increased knowledge" [9].

In addition, due to the problems of understanding and scope, user needs might not be clearly expressed initially in the requirements, and the developer or requirements analyst could make some incorrect assumptions based on this ambiguity. With an iterative process that will involve all stakeholders, those mistaken assumptions can be detected and corrected.

The starting input of the requirement inception process is the KSPs (as already mentioned before), and the Level-A requirements of the CTA Observatory, in particular:

- The top level requirements, that depict the main concepts and the basic requirements of the Observatory;
- Science requirements, those provide an introduction to the science of CTA, its main expectations and unique reach, and define the minimum system parameters that would allow such science to happen;
- The user requirements, those define the basic requirements for the interaction between the CTA Observatory and its science users.

5. REQUIREMENT IDENTIFICATION AND ACCEPTANCE PLAN

In the development of CTA Top Level Use Cases we have taken into account that there are no existing examples of similar Big Science projects with similar scientific objectives, because it is the first time that we are building an array of one hundred Cherenkov telescopes. For this reason, the *requirement identification* phase is critical. The Top Level Use Case model will provide a framework for the flow down of the Use Cases and Requirements (from general to detailed Use Cases and specifications), to check missing requirements at Work Package level (Level-B requirements) and the already developed Use-Case Models at CTA Work Package level.

The Use Cases will also provide the basis for the definition of the Acceptance Test Plan for the validation of the overall CTA system.

6. WORKGROUP ORGANIZATION AND PROCESS

6.1 Workgroup organization

We have divided the Top Level Use Cases workgroup in different sub-workgroups.

The first group has scientists (the PHYS people) that will use the CTA Observatory and provide science-related Use Cases.

The second group are engineers (the TECH people), one representative from each CTA Work Package and some people with experience in specific topics. The TECH people have the responsibility to circulate the information and collect comments from the Work Package they represent; support the development of Top Level Use Cases providing information; make decisions for the information contained within the Top Level Use Cases for the Work Package they represent. If the representatives do not have the knowledge or authority to make a decision, they have to propagate it appropriately in their group to obtain a decision or further information, i.e. they must report the problem to their group asking for further information and discussing before taking decision. Last but not least, the representative has to move the information contained in the CTA Top Level Use Cases to the workgroup they represent, so that all CTA people have a unique view of the CTA Observatory from a functional point of view.

The last group of people is the coordination team (COOR people) with software engineers, the CTA Project Scientist, a representative from the Project Office and some experienced people in different topics. The COOR people manage the entire process, has in charge to "harmonize" the science-related use cases coming from different groups, provide an interface between PHYS, TECH people and the Project Office, and define the first version of the observatory-related use cases, extracting also commonalities contained within the science-related use cases, i.e. perform the requirement analysis.

6.2 The preparatory phase for the science-related use cases

The first step of the process is the definition of a possible list of use cases that scientist has to develop. This helped us to manage at the same time some aspects of the "problem of scope" (i.e. stay in the boundary of the system) and of the "problem of understanding" (i.e. to focus people on the problem domain in which they are really experts). In addition, the selection of these use cases from the list of the CTA Key Science Programme has helped us avoid conflicts between different scientific targets.

The second step is the definition of a template used to write science-related use cases. This has helped us to take under control some aspect of the "problem of understanding". The scientists have a full understanding of their problem domain (the scientific objectives reachable with one use case), but to avoid troubles in communicating needs to the system engineers, and to avoid to omit information that is believed to be "obvious" or that is mandatory to extract a workflow from use cases, we have provided a template organized in many different sections and where some key questions are presents. In parallel the CTA Project Office has defined a more formal template that must be used to develop observatory-related and Work Package level use cases.

From the list of possible use cases and with the template, the next step was to call on scientists, to express their interest to participate in the definition of these use cases and to find a coordinator and a team for each use case to be developed.

First iteration

With these groups the development of science-related use cases is started filling the template, with a deadline and a face-to-face meeting. This iteration lasted two months.

During this iteration the following use cases were discussed:

- Perform a long term Monitoring of an AGN
- Perform an AGN Snapshots
- Observe a transient discovered with RTA (Real-Time Analysis)
- Observe a ToO following an alert from gravitational wave observatories
- Observe a ToO following an alert from high-energy neutrino telescopes
- Observe a GRB after external alerts
- Observe an XRB/gamma binary from external alert
- Perform a Survey of a region of the sky

Beyond the technical points and the description of the workflow, this first iteration helped us to bring up many technical issues and some policy aspects that could be clarified with the CTA Management. For each Use Case, during the development of the main scenario, we have identified

- the purpose of the use case;
- the context;
- the assumptions, trying to extract them also from the discussions made during development;
- the observing strategy, and the list of related observing modes;

- the observing mode execution, i.e. the main scenario (that also describe when and how to use the different observing modes), the reaction to failures, which kind of analysis and data products are foreseen.

Three simplified examples are reported: a planned observation, the reaction to an internal alert and a reaction to an external alert (without reaction to failures).

Title	**Observe a transient discovered with a Real-Time Analysis**
Purpose	The purpose is to consider the potential variable sources CTA may discover, their likelihood and how to identify them, and the follow-up strategy. This Use Case represents the “discovery space” of CTA and will have strong synergy with other wavebands, thus will be of great interest to radio/Optical-Infrared/X-ray programs.
Context	A transient discovered serendipitously (i.e. via the Real-Time Analysis during ongoing observations, either Guest Observer or Key Science Programs) falls under this Use Case. This Use Case does not cover serendipitous transient discoveries by Archive users. This Use Case is also triggered by other Use Cases (e.g. the AGN Snapshot UC) during their execution. In case a transient is detected, the Observatory will routinely issue an alert to the community.
Assumptions	A real-time analysis is present and runs during the scheduled observations at all times.
Observing strategy	The potential serendipitous transients associated with known transient sources that could be found are Galactic (flares from known and unknown Gamma-binaries, XRBs and pulsar/ns-related sources like the Crab and unknown type of sources) and extra-Galactic. The variability time-scale of the detection should help in the decision of a possible source type (to help to build a decision tree). The Observing Mode where the serendipitous detection is made is determined by the “parent” observations. An Observing Mode template is needed to manage the alerts issued by a Real-Time Analysis in case a transient is detected. The template could depend on the association with a possible counterpart. For the selection of a template the “parent” Observing Mode should be taken into account.
Observing mode execution	**Main scenario (simplified)** 1) A serendipitous source is detected automatically with the Real-Time Analysis. In case a transient is detected, the Observatory will routinely issue an alert to the community 2) Search databases for counterparts in a catalog of known sources. Mechanisms should be in place to check recent events in the same region. Decide the class of priority. 3) Interrupt current schedule and put telescopes on the new transient, while simultaneously getting the first data products (flux, spectrum, light curve) and comparing the initial products to known source templates. 4) Perform observations 4.1) If source has a known counterpart perform a dedicated strategy 4.2) If detection is not associated with known sources: highest priority, observe with full array, and trigger multi-wavelength facilities exploiting existing MoUs 5) Determine longer term follow-up strategy to rework the schedule to fit this into the prior observing schedule.
Scientific Analysis	Real-Time Analysis should detect new transients within tens of seconds/one-minute, to maximize the scientific return and multi-wavelength campaigns.

	Automatic generation of maximum likelihood results, counts map, light-curves over a wide range of timescales.
Data Products	Counts maps, light-curves, spectra and associated significance.

Title	**Perform a long-term monitoring of AGNs**
Purpose	Observations of a set of individual AGN with known positions, on a regular (weekly) temporal sampling over several years (single target, the same position in FoV) to provide long-term VHE light-curves.
Context	CTA has a much better sensitivity to rapid variability than Fermi satellite in the overlap region (a few 10 GeV). KSP proposal as very long-term observations requested
Assumptions	A representative sample of 15 known VHE AGNs of all types is selected (2 to 3 sources per class). The list of targets will be reviewed after five years and reduced to the ten most interesting objects in terms of variability patterns, for further monitoring over at least ten years, ideally over the full CTA time.
Observing strategy	The best regular time sampling as possible on single targets should be planned with the CTA full array. Observations are simple pointed, based on predefined templates. In any case, tools to help selecting the best configuration of the array and estimating data quality expected is mandatory. In case of unusual (flaring) level of activity (how much needs to be defined), an alert will be sent. A Real-Time Analysis may be needed as not all flares last long.
Observing mode execution	**Main scenario (simplified)** 1) Prepare proposal 1.1. determine optimal parameters from flux requirements/spectra, using three pre-defined bands 1.2. check the feasibility of monitoring cadence 1.3. define communication frequency 1.4. determine the level of unusual (flaring) activity for the target that will be recognized for sending out a ToO (both for CTA and external facilities) 2) Perform observations 2.1. receive notification before observation 2.2. check sky conditions, assess if observation feasible 2.3. check hardware conditions 2.4. point telescope(s) 2.5. check for flares during data taking at the end of one observing block (using a Real-Time Analysis) 2.6. in case of flaring state (as defined above), send alert 2.7. receive email at completion with a basic summary 3) perform final science analysis (offline)

	3.1. create the best sampled as possible light curve 3.2. make spectra for each light curve bin when possible 4) disseminate
Scientific Analysis	High-resolution light-curve: from less than 30 min to 30 min exposure once a week during the period of detectability. Time-resolved spectra in different source states (spectra on a weekly or monthly basis for the brightest sources).
Data Products	Counts maps, light-curves, spectra and associated significance.

Title	**Observe a ToO following an alert from gravitational wave (GW) observatories**
Purpose	Manage a ToO from an external LIGO/VIRGO trigger.
Context	The observations described here are ToO observations part of the Transient KSP. Origin of GW signal can be better constrained, and scientific output increased by obtained an electromagnetic counterpart to the GW signal.
Assumptions	MoU(s) signed between CTA and gravitational wave observatories. "CTA GW-team": a team of CTA members responsible for GW-ToOs (e.g. flare advocates), privileged to request follow-up observations. Automatic data exchange on the basis of GCN or VO Event notices. Alerts are received at both CTA sites. A real-time analysis is present and runs during the scheduled observations at all times. An off-line analysis is run at the latest during the day following the data taking with results being available in time for CTA GW-team/flare advocates to manually check them and provide feedback for the short-term schedule of the following night.
Observing strategy	Triggers might have large localization uncertainties, that requires dedicated strategies to observe highest probability regions available when the trigger arrives, typically shared between N and S CTA arrays. Both arrays will take part in the follow-up depending on the localization of the GW error box. A tool to convert the GW uncertainty maps into a grid of CTA pointings is needed. This tool must take into account the overlapping regions visible from both sites. The output will be a series of pointings to be executed by each CTA site. Templates are required for a rapid response needed for observations.
Observing mode execution	**Main scenario (simplified)** 1) The Observatory receives an external trigger for a GW alert, monitoring the private stream of GCN notices/VO events. Notify the Operator and the GW team that an alert has been received. A visibility calculator tool automatically translates this information in CTA pointing directions. 2) If parts of the GW error region is reachable and if all constraints are satisfied a new observation is planned automatically (initial scanning of the GW error region). The system notifies the Operator and the CTA GW team about the starting observations. 3) The requested telescopes are repointed. When the telescopes are in the right position, the system starts the data taking and proceeds to tile the sky within the available GW error

	region. 4) The Real-Time Analysis automatically starts the data analysis. The best source data analysis algorithm is selected automatically. The Real-Time Analysis checks if a new source is detected in each pointing in sequence. 5) If there is no source detection within 2 hours from the start of the observation, puts back the telescopes in the previous (pre-alert) scheduled configuration. END of GW follow-up. 6) If a new source is detected an alert is sent to to the CTA GW team and a new observation with the full array right away (full-array follow-up) or once the current search is over (delayed, full-array follow-up). 7) If the CTA GW team is informed by the GW-EM follow-up group of the detection of potential EM-counterpart new observations with the full array may be requested. 8) If a new source is detected next day, the CTA GW team is alerted. The GW team will manually decide if deeper, full-array observations are requested and define their priority. 9) If the CTA GW team is informed by the GW-EM follow-up group of the detection of a potential EM-counterpart outside the CTA GW observations, the CTA GW team will manually decide if deep, full-array observations are requested and define their priority.
Scientific Analysis	To be able to detect a (transient) source during the scanning of the GW error region the real-time analysis is needed. It should be able to detect variability at various timescales (corresponding to various potential source scenarios), but most importantly be sensitive at short timescales. For example, it should be able to detect the fading GRB afterglow during data taking to re-schedule deeper observations. Correlation of detected sources with catalogues (e.g. galaxies) will be very useful.
Data Products	Counts maps, light-curves, spectra and associated significance, correlation with galaxies or other objects.

Second iteration

Thanks to the feedback received during the face-to-face meeting and from the CTA Management, a new iteration of two months was started. At the end of the second iteration the first version (V1.0) of the science-related use cases has been closed and published in the CTA Requirement Management Tool (a Jama system [8]). Comments have been collected from different CTA Work Packages for two months.

Third iteration

The third iteration is ready to start, where the comments of existing science-related use cases will be included, new science-related use cases (also suggested during the commenting phase) will be developed and the workflow and of the selected observatory-related use cases will be discussed to reconsider and revise them.

6.3 The preparatory phase for the observatory-related use cases

In the meantime, the COOR people has developed the first version of the observatory-related use cases. What has been defined is the top level Observatory workflow (to define the system scope and boundaries), the primary actors, the goal of the system, the observing objects (e.g. Proposals, Targets, Observing Programmes and Scheduling Blocks), the type of proposals that the observatory should manage, how an observing mode is defined, and the list of the use cases that will be developed (to capture the outermost summary use cases to see who really cares).

7. CONCLUSION

The main purpose of the Top Level Use Cases workgroup is to find a common view of the CTA Observatory. Scientists, instrument and software engineers are collaborating and sharing information to provide a common and general understanding of the Observatory from a functional point of view, to define a sketch of the Observatory workflow, and to define observing modes and strategies starting from scientific objectives.

Some important discussion has been raised up around the workflow coming from science-related use cases and around the identification of the parameter space of each case (parameters that characterize an observation, e.g. energy range, sensitivity, etc, and observing mode parameters). A common agreement was to consider an initial period of 'training' of the parameters space of a science-related use case, e.g. during the "early science" phase, to perform a better tuning of these parameters.

During the discussion some tools have been identified:

- target selection tool;
- array simulator or simulation tool, to provide a link between technical and physical parameters;
- proposal preparation tool.

In this process, the choice to start from the Key Science Programme, i.e. from big scientific programmes, was effective to start immediately with some important use cases but has defocused us in the development of some basic use cases. This gap will be closed in the third iteration.

All these discussions and the comments received for the first version of the science-related use cases show us that the communication among project members of the different workgroups and the shared information is increased and that the Top Level Use Cases workgroup has provided focus to some issues and common problems in an effective way.

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