Requirement Analysis for CTA On-Site Pipelines

Author	*Laboratory*
A. Bulgarelli, V. Fioretti **INAF/IASF Bologna**	

Approved by	*Laboratory*

History		
Version	Date	Observation
1.0	30 April 2013	First versione of this document, used for the definition of the requirements of the (old) OSA-URD and OSA-SRD.

Distribution	cta-wp-dm@cta-observatory.org

- Table of Contents -

1. INTRODUCTION

1.1 Scope of the document

According to the DM PBS [R2], the CTA On-Site Analysis shall realize a first scientific analysis of CTA data through the following software products:

- **Data Quality Analysis (DQA):** on-site reconstruction pipeline software aimed to be a reduced and fast version of the off-site reconstruction aiming to a data quality assessment of the scheduled observations to check the performance of current observation (data quality);
- **Real-time Analysis (RTA):** software components for quick alerts follow-up and assess and distribute a notification of a VHE alert (i.e. a "flaring" event) to detect new, transient or highly variable sources.

1.2 Purpose of the document

This document contains the **Requirement Analysis** for the CTA On-Site Analysis.

1.3 List of acronyms

OS	On-Site
OSA	On-Site Analysis
HL	High Level
UC	Use Case
UR	User Requirement
RTA	Real-Time Analysis
PM	Performance Monitoring

1.4 Reference documents

R1: "High-Level Users Requirements for CTA Data Management", J.D. Ponz, R. Walter version 0.6

R2: "CTA-DATA MANAGEMET PBS & WBS", DATA-PM/110126, V14.2, 25/4/2013

R3: MAN-PO-121011_TOPreq_1.4, The CTA Observatory, 1.4 - Werner HOFMANN

R4: SCI-LINK-121120_CTA_Scien, Science Requirements for CTA, V 2.1, D. Torres et al.

R5: MAN-PO-121004_PerfReq_1.5, Performance Requirements for CTA, A-PERF - V 1.5 - Jim Hinton

R6: MAN-PO-121018_RAMSReq_1.3, Reliability, Availability, Maintainability and Safety Requirements for CTA, V 1.3 - José Miguel MIRANDA

R7: MAN-PO-121022_USERreq_1.2, User Requirements for CTA, V 1.2 - Werner HOFMANN

R8: MAN-PO-120918_EnvReq_1.4, Environmental Requirements for CTA, John Carr

R9: MAN-PO-121202_GovReq_1.2, Requirements regarding CTA Governance, Policy and Operations, S. Wagner

R10: MAN-PO-121201_ACTLReq_1.5, ACTL Requirements, Werner HOFMANN

R11: MAN-PO-121203_OBSReq_1.1, Observatory Operations Requirements, Werner HOFMANN

R12: MAN-PO-121204_DataReq_1.3, Data Management Requirements, Catherine BOISSON

R13: MAN-PO-120726_BasicDef_1.9, Basic Definitions, J. A. Hinton

2. SYSTEM ENGINEERING PERSPECTIVE FOR THE REQUIREMENT ANALYSIS OF THE CTA ON-SITE ANALYSIS/PIPELINES

Requirements analysis in software engineering encompasses those tasks that go into determining the needs or conditions to meet for a new product.

Requirements analysis is critical to the success of a software project.

Conceptually, requirements analysis includes some activities:

- Eliciting requirements: the task of identifying the various types of requirements from various sources including project documentation, (e.g. the project charter or definition), business process documentation, and interviews. This is sometimes also called requirements gathering.
- Analyzing requirements: determining whether the stated requirements are clear, complete, consistent and unambiguous, and resolving any apparent conflicts.

The main inputs used for the requirement analysis for the CTA On-Site Analysis are shown in Figure 1 (see Reference section for a complete list of the documents).

This work is preliminary to the definition of the On-Site Analysis Software Requirement Document. With this kind of analysis the most important requirements applicable to the On-Site Analysis are identified.

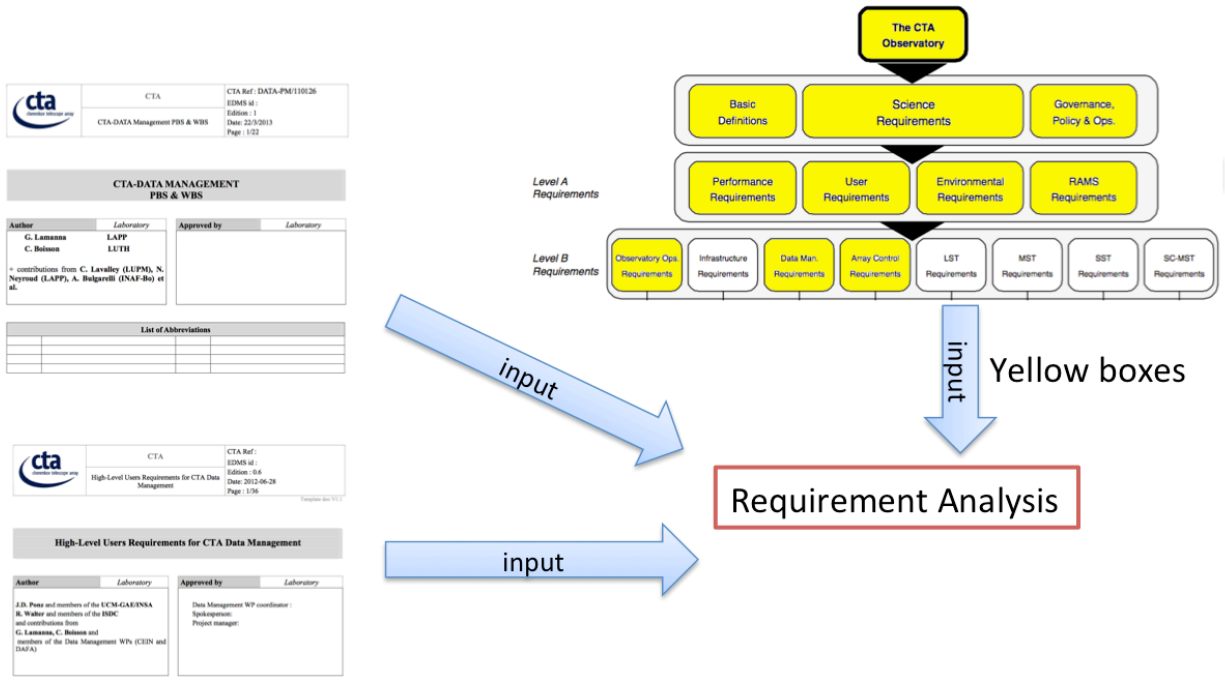

Figure 1: main inputs for the Requirement Analysis for the CTA On-Site Analysis

3. REQUIREMENTS ANALYSIS OF "CTA HIGH-LEVEL DOCUMENTATION" FOR CTA ON-SITE ANALYSIS SOFTWARE REQUIREMENTS

In this section is reported the Requirement Analysis of the CTA requirements (general, level A and B, see R3-R13) for the CTA On-Site Analysis products.

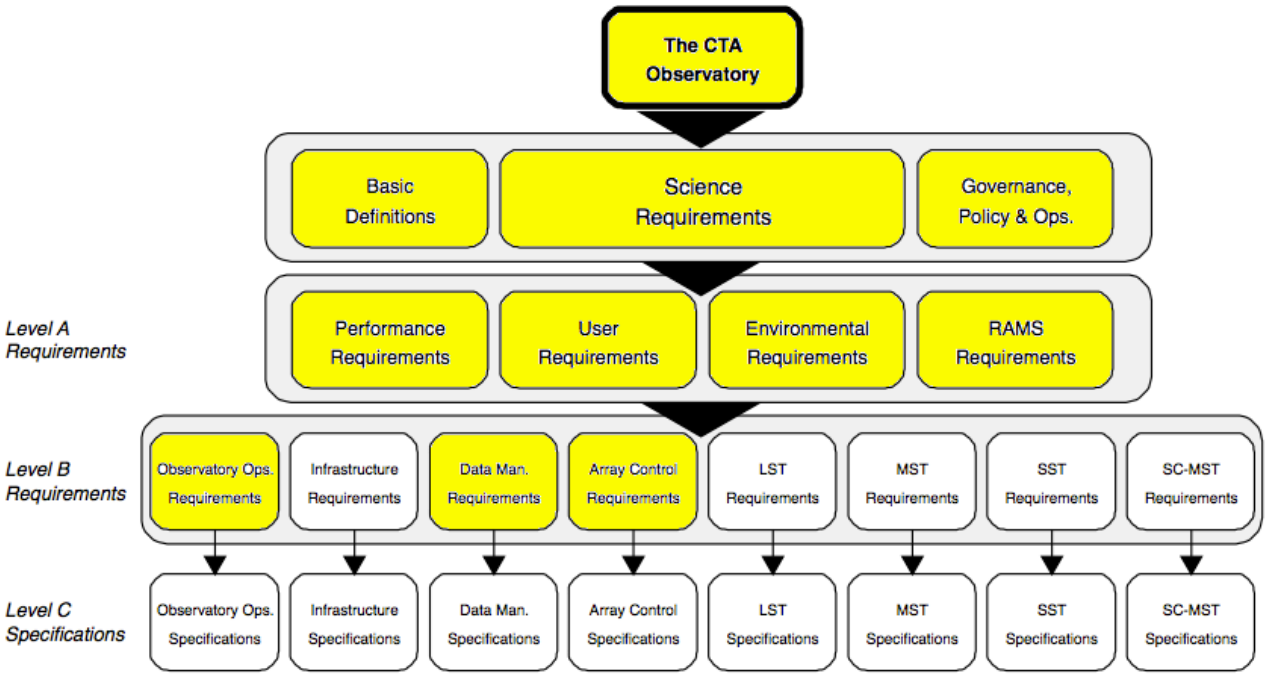

Figure 2: Structure of the high-level documentation of CTA and document analyzed (in yellow) for this impact analysis

3.1 Analysis Diagrams

Analysis Diagram helps to identify all model elements that are related to a specific model element. It provides a visual way to view which model elements will be affected if you were to make changes to that element.

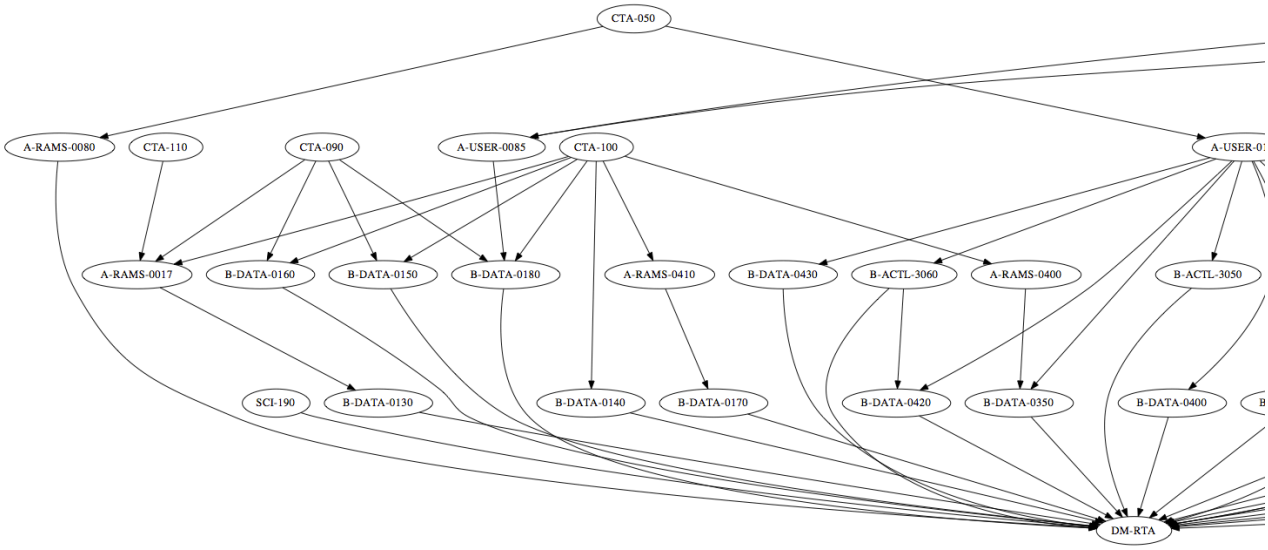

Figure 3: Analysis Diagram for RTA (part 1)

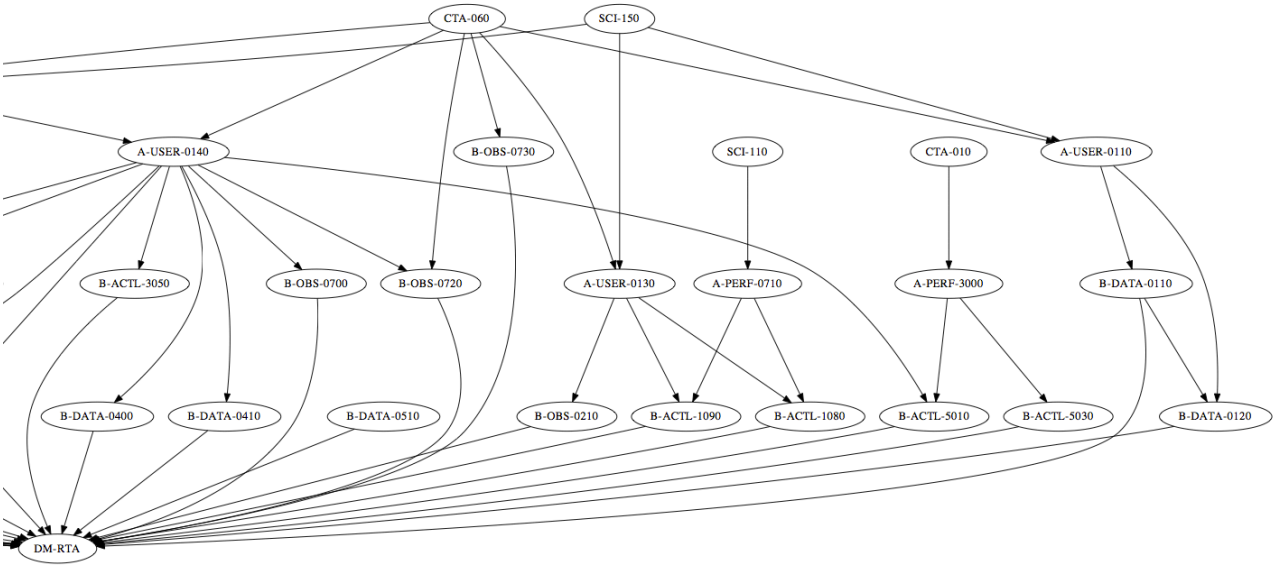

Figure 4: Analysis Diagram for RTA (part 2)

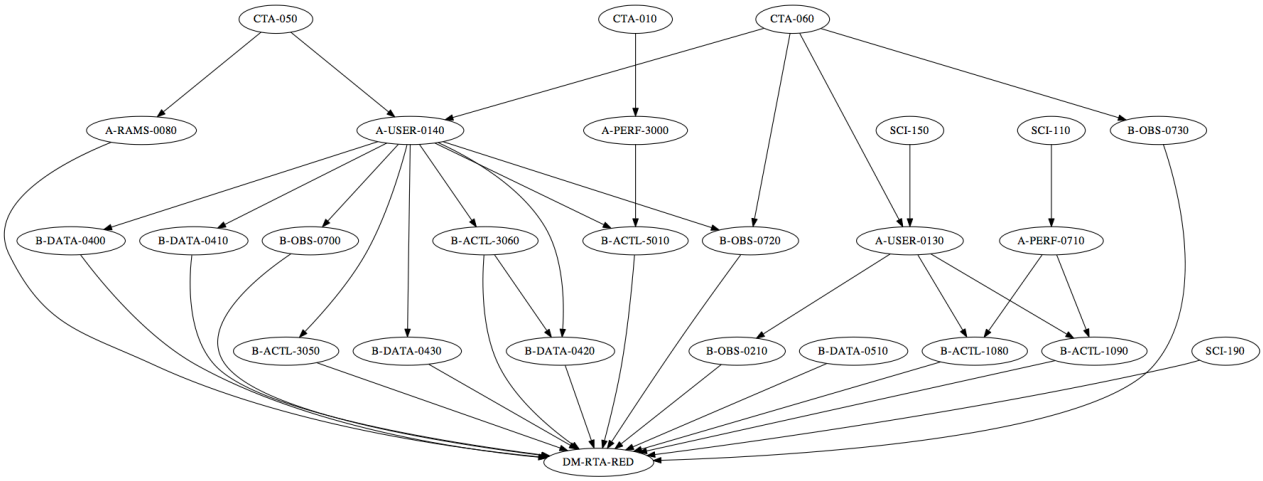

Figure 5: Analysis Diagram for RTA where the most important requirements are reported

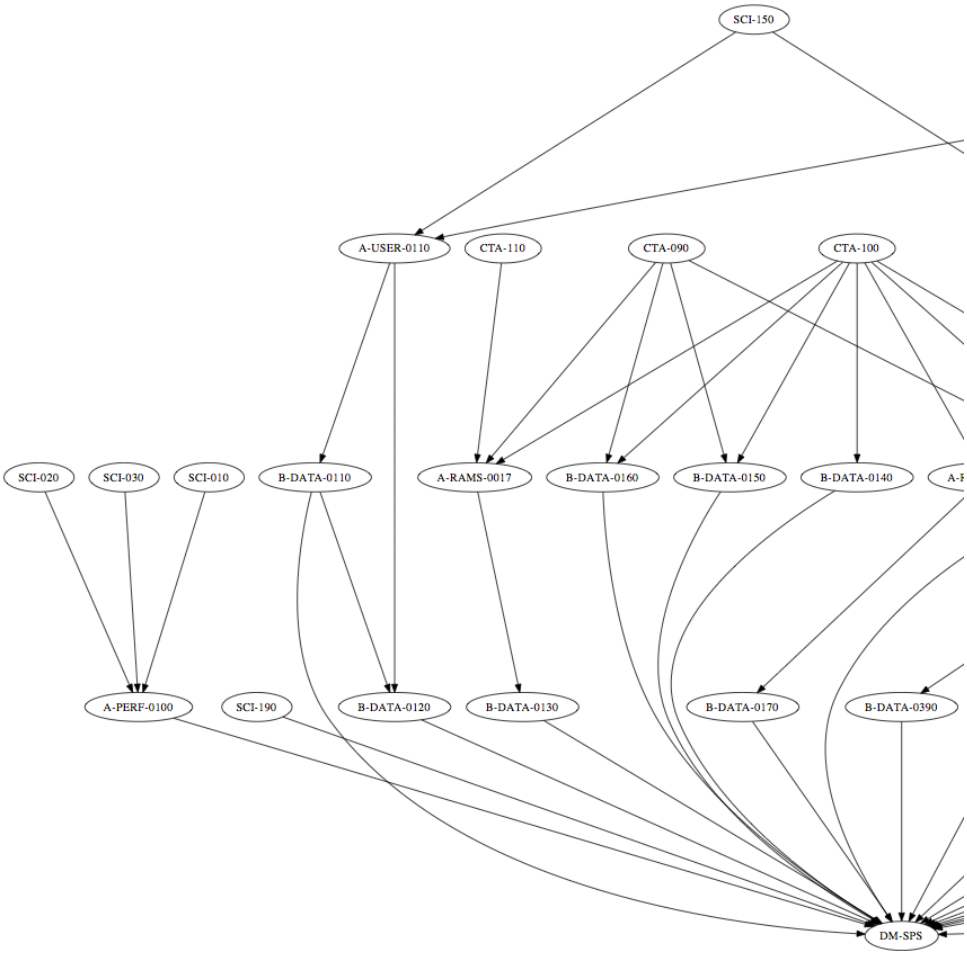

Figure 6: Analysis Diagram for DQA (part 1)

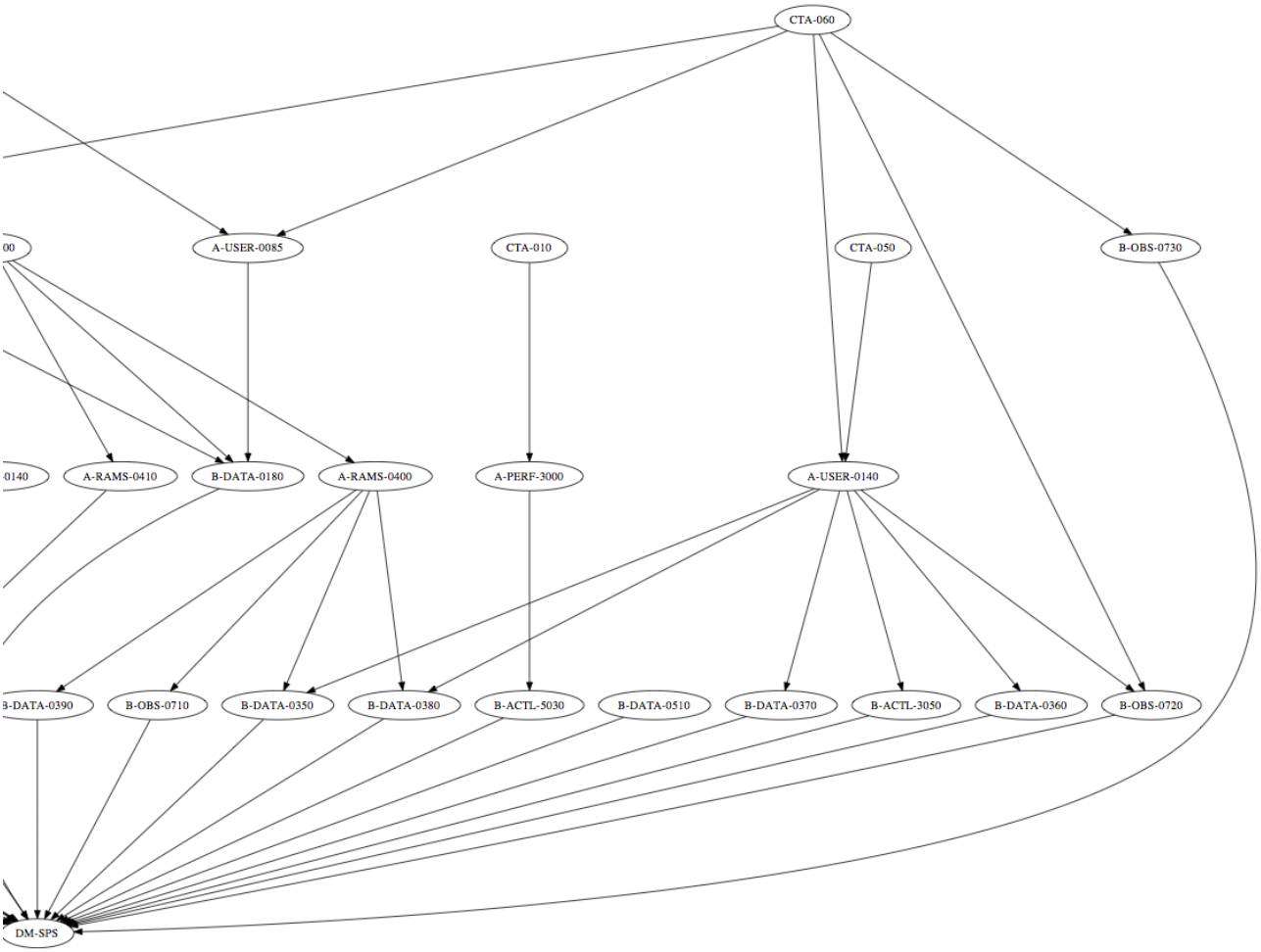

Figure 7: Analysis Diagram for DQA (part 2)

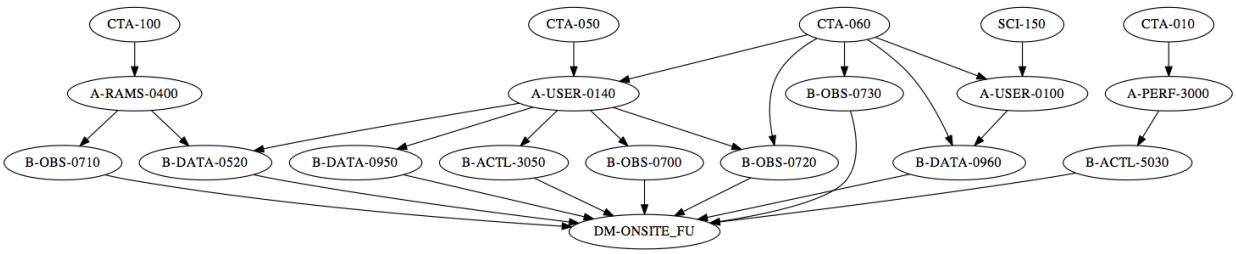

Figure 8: Analysis Diagram for common requirements of the on-site analysis

3.2 High level requirements applicable to on-site pipelines: table

The following table contains the most important CTA High Level requirements applicable to On-Site Analysis.
The requirement with some red corrections are proposed changes.

Requirement ID	Title	Description	Comments
CTA-010	Flux sensitivity.	CTA will provide significant improvement in flux sensitivity over existing facilities - typically one order of magnitude - allowing to address both specific questions arising from current knowledge as well as providing high discovery potential.	
CTA-050	Multiwavelength and multi-messenger coverage.	CTA will require coverage of other wavebands and other messengers to exploit its full potential. CTA will closely interact with, and promote corresponding facilities of astronomy and astrophysics. CTA will accept triggers from, and issue triggers to other facilities.	
CTA-060	Operation as a user facility with high quality of service.	CTA will be operated as an open user facility aiming to offer high quality of service, and data provision compliant with standards for major astronomical observatories.	
CTA-090	Cost-effective implementation and operation.	A basic design criterion of CTA will be to maximise the science performance over cost-ratio for construction and operation.	
CTA-100	High reliability of the instrument.	CTA aims for high reliability of components and minimum maintenance and repair to maximise availability and reduce operating costs.	
CTA-110	Safety of construction and operation.	The safety of those involved in the construction and operation of CTA is of the upmost importance.	
SCI-010	Sensitivity @50 GeV - 50 hours.	8x10-12 erg cm-2 s-1 (SOUTHERN ARRAY), 8x10-12 erg cm-2 s-1 (NORTHERN ARRAY)	
SCI-020	Sensitivity @1 TeV - 50 hours.	2x10-13 erg cm-2 s-1 (SOUTHERN ARRAY), 2x10-13	

		erg cm-2 s-1 (NORTHERN ARRAY)	
SCI-030	Sensitivity @50 TeV - 50 hours.	3x10-13 erg cm-2 s-1 (SOUTHERN ARRAY)	
SCI-110	Telescope Repointing.	50 s for low energies (<100 GeV) (longest repointing) & 20 s as a goal. 90 s for mid energy (0.1-10 TeV) & 60 s as a goal. Too reaction time to possible GRBs and other transients	
SCI-120	Availability of observatory to realize scientific runs	Close to 100% of all time at disposal (SOUTHERN and NORTHERN ARRAY)	
SCI-150	Prompt analysis and dynamic rescheduling.	Needed for ... (SOUTHERN and NORTHERN ARRAY) enabling CTA to realize an effective follow-up of transient phenomena and generate/accept alerts.	OK Important for RTA
SCI-190	Flexibility of operation.	Operation as multiple (e.g., different energy band) sub-arrays (SOUTHERN and NORTHERN ARRAY)	OK
A-PERF-0100	Differential Sensitivity.	The required point-source differential sensitivity is shown in Figure 2.	OK
A-PERF-0710	Target change time.	The system as a whole must be able to change to a new target (i.e. transition from data-taking on one target to data-taking on another target) anywhere within the observable sky (see A-PERF-0720) within 90 s.	OK
A-PERF-3000	Supporting infrastructure.	The CTA sites must possess all the infrastructure necessary to ensure that the required performance of the individual telescopes and the system as a whole are met.	OK
A-RAMS-0017	Documentation.	All CTA Products must be fully documented to ensure effective and safe operation.	OK
A-RAMS-0080	**Real-Time Analysis** Availability.	The availability of the Real-Time Analysis during observations must be >98 %.	OK
A-RAMS-0090		The availability of communications for transmission and receipt of trigger signals from the sites to the outside world, during observations, must be >98 %.	OK
A-RAMS-	**Performance Monitoring**	CTA elements must provide	OK

0400		detailed **performance monitoring** information (or provide data which allows this information to be generated by higher-level systems) which can be used to identify emerging problems and ensure the reliable functioning of the instrument.	
A-RAMS-0410	Logging.	Comprehensive logging of conditions, actions, incidents, errors and warnings must take place to ensure that problems and failures can be analysed and avoided in the future.	OK
A-USER-0085	Software framework.	The software framework provided for User data analysis should be minimal in terms of complexity, but fully featured.	OK
A-USER-0100	Access to data.	All science data taken by the CTA Observatory must be made available via a CTA Data Archive, after the proprietary period, together with analysis tools, the required instrument response functions, and documentation. Access to the archive must be in accordance with CTA Data Access Policy [3].	OK
A-USER-0110	Data processing.	The CTA Observatory must ensure that data processing is traceable and reproducible.	OK
A-USER-0130	Triggered observations.	As part of its access policies, the CTA Observatory must establish a mechanism to propose and carry out Target of Opportunity observations, and to react to time-variable phenomena or unanticipated events.	OK
A-USER-0140	Alerts from CTA.	The CTA Observatory must be capable of issuing alerts to other instruments, to maximise science return on time-variable and transient phenomena.	OK
A-GOV-0520	Observations and Calibration	The Observatory must conduct all necessary observations and calibrations required for the scientific exploitation of the facilities. The time required for such technical observations is not subject to a peer-review process	OK. It uses the same terms of the On-Site Analysis SRD.

		but must be justified to the scientific program committee. Measurements obtained as part of the calibration and **performance monitoring** program must be made available to the data archive without delay.	
B-ACTL B-ACTL contains requirements about the "Performance Monitoring" and the "Real-Time Analyses". B-ACTL and OS-STD are full compliant.			
B-ACTL-1080	Reaction to TOO observations.	For ToOs of highest priority, which interrupt ongoing data taking, TOO observations must be scheduled within 1 s.	OK
B-ACTL-1090	Interface to array control.	The scheduler must be able to interface directly to array control, for automatic execution of schedules.	OK
B-ACTL-2020 (=)	**3.2.1.1.1.1 Monitoring**	ACTL must provide a framework to monitor the functioning of all instruments on a CTA site.	3.2.1.1.1.2 OK
B-ACTL-2030 (=)	Error handling	ACTL must provide a framework for handling of errors, alerts, warnings from instruments on a CTA site.	3.2.1.1.1.3 OK
B-ACTL-2070 (=)	Semiautomatic operation	The control framework must be capable of semi-automatic operation throughout the night, with the operator monitoring its performance and reacting in case of errors and emergencies.	3.2.1.1.1.4 OK
B-ACTL-3050		ACTL must allow the on-line execution of a variant of the off-line reconstruction software, which runs in ~~(pseudo)~~-soft real-time.	3.2.1.1.1.5 **Near/Pseudo** = it is used to specify "as soon as possible". 3.2.1.1.1.6 **Soft** = the usefulness of a result degrades after its deadline, thereby degrading the system's quality of service. Due to B-ACTL-3060 this

			is a soft real-time system
B-ACTL-3060	Latency of **real-time analysis**.	ACTL must provide an ~~online~~ real-time analysis capability with a latency of less than 30 s.	There is discordance between title and requirement. We focus on real-time analysis capability.
B-ACTL-5010	Computing power.	The ACTL project must provide sufficient computing power to allow the **real-time analysis (RTA)** of the events. The algorithms executed may be simplified in comparison to the standard off-line pipeline, to reduce resource requirements, the required sensitivity of the RTA is defined in DATA-0360.	A typo. In addition, the requirement of the "sensitivity" should be removed from this requirement, that is related to "computing power".
B-ACTL-5030	Networking.	ACTL must provide network infrastructure (for example fibre-optic cables and ethernet switches) with sufficient capacity to meet the required readout rate of all the instruments on site, and to ensure the maximum latencies for communication are not exceeded.	OK
B-DATA			
B-DATA-0110	Reproducibility.	Data processing must be reproducible. This can be ensured by saving versions of the software and calibration data used to generate a data product and identifying these versions within a data product or in an associated database.	OK
B-DATA-0120	Version control.	Software used for CTA data processing must be fully version controlled such that reproducibility is possible.	OK
B-DATA-0130	Documentation.	Software used for CTA data processing must be appropriately documented.	OK
B-DATA-0140	Testing mechanisms.	CTA data-processing software components should have internal testing mechanisms implemented to verify functionality of the software and the validity of the processing results.	OK
B-DATA-0150	Existing software.	Existing software should be made use of where appropriate, but must be maintainable, as well as fully tested, documented and stable.	OK

B-DATA-0160	Modularity.	Software must be modular, separating the functionality of a program into independent, interchangeable modules, such that each contains everything necessary to execute only one aspect of the desired functionality	OK
B-DATA-0170	Logging.	A record of all data processing activities that result in available CTA data products must be automatically and persistently logged.	OK
B-DATA-0180	Maintainability.	The maintainability of the software components must be guaranteed over the period of operations. This can be ensured for example by minimizing the code complexity and the number of lines of code.	OK
B-DATA-0350	Simplified data analysis pipeline.	~~An on-~~line A simplified data analysis pipeline is required for early analysis of CTA that reads raw data, applies best-available (but most likely preliminary) calibration parameters, reconstructs Events and produces Event list data and intermediate level data products. The ~~on-line~~ simplified data analysis has a dual purpose of delivering relatively rapid science feedback from the CTA data and monitoring of the instrument performance/data quality. This pipeline may be performed off-site if data transfer bandwidth is sufficient.	I put in evidence that the analysis is simplified (according with on-site analysis terms and definitions). On-line means "during the data acquisition".
B-DATA-0360	~~Online~~ Simplified data analysis sensitivity.	The ~~online~~ simplified data analysis pipeline must meet the differential sensitivity requirements for the system (A-PERF-0100), but with an acceptable performance reduction factor of <2 .	I put in evidence that the analysis is simplified (according with on-site analysis terms and definitions). On-line means "during the data acquisition".
B-DATA-0370	~~Online~~ Simplified data analysis latency.	The ~~online~~ simplified data analysis pipeline must be run on all Events within 10 hours of the end of observations for a given night.	I put in evidence that the analysis is simplified (according with on-site analysis terms and definitions). The original requirement is in contrast with the on-site analysis definition of the "on-line analysis" (during data acquisition).

B-DATA-0380	~~Online~~ Simplified data analysis results.	The results of the ~~online~~ simplified data analysis pipeline must be displayable to the array operators in a compact and comprehensible way and stored in a database.	I put in evidence that the analysis is simplified (according with on-site analysis terms and definitions). On-line means "during the data acquisition".
B-DATA-0390	**3.2.1.1.1.7 Data Quality Monitoring .**	The ~~online~~ performance analysis must serve as the primary mechanism for **Data Quality Monitoring**. As such it must contain explicit tests for the proper functioning of all elements down to at least the assembly level. The analysis should be performed on-line.	OK. Already in accordance with On-Site Analysis SRD
B-DATA-0400	**Real-time analysis** pipeline.	A ~~(pseudo-)~~ soft real-time analysis (**RTA**) pipeline is required for CTA, such that science alerts can be generated by the system during observations. The RTA must read raw data, apply a preliminary calibration and reconstruct Events. An Event list should be produced and a full FoV search for transient phenomena on multiple timescales performed.	**Near/Pseudo** = it is used to specify "as soon as possible". **Soft** = the usefulness of a result degrades after its deadline, thereby degrading the system's quality of service. Due to B-ACTL-3060 this is a soft real-time system
B-DATA-0410	Real-time analysis sensitivity.	The **RTA** pipeline must reach an integral sensitivity which is worse than the standard pipeline (for the detection of a dN/dE ~ $E^{-2.5}$ spectrum source on a timescale of one minute) by a factor <3 .	OK
B-DATA-0420	Real-time analysis latency.	The RTA pipeline latency requirement is provided by B-ACTL-3060.	OK
B-DATA-0430	Real-time analysis results.	The RTA pipeline must be capable of generating science alerts associated with a range of statistical significance values, which may be used for automatic telescope rescheduling or repointing, and issuing of alerts to other instruments. At lower levels of significance the array operators should be informed. RTA results should be stored in a database.	OK
B-DATA-0510	On-site processing.	DATA must provide tools for on-site data processing (processing itself is the responsibility of OBS), including archive/database facilities	I put in evidence that the analysis is simplified (according with on-site analysis terms and

		for camera and auxiliary data and for the RTA and (likely) ~~on-line~~ simplified data analysis pipelines.	definitions). On-line means "during the data acquisition".
B-DATA-0520	Calibration.	Calibration data must be processed on-site and extracted calibration parameters stored in association with (or at least linked to/from) the data to which they apply.	OK
B-DATA-0950	Link to site.	The communications network to the sites must provide sufficient capacity to transfer event-level reconstruction parameters (but not the raw data) within 5 hours, for one night's data.	OK
B-DATA-0960	Raw data latency.	Transfer of all acquired raw data from the site to the off-site ICT infrastructure must have a latency of < 10 days.	OK
B-OBS			
B-OBS-0130	Scope	Operation of observatory sites involves site administration, operation and maintenance of the site infrastructure and facilities, maintenance of the instruments, calibration and **performance monitoring** of the instruments, operation of the instruments for observation, and related data processing. Detailed requirements are described later in this document and in the related requirement documents.	OK. It uses the same terms of the On-Site Analysis SRD.
B-OBS-0190	Logging	Actions during observatory operation must be logged, as specified below in detail. Logging implies recording in a persistent data base, to the extent possible in pre-defined, computer-parseable formats. Logs serve to pass information between shift personnel, maintenance personnel, and remote personnel, and to evaluate the **performance** of the instrument and pertinent maintenance and repair actions.	OK.
B-OBS-0210	Schedule Updates.	The observing schedule may be updated remotely, during night operation, for example in reaction to TOO alerts or alerts triggered by the Real-Time Analysis.	Changes in red.

B-OBS-0220	Schedule Updates	The schedule may be updated, or interrupted, by the night operators in reaction to local conditions such as weather conditions, **instrument performance**, **or alerts**. A complete rescheduling of observations for one night must be possible in under 30 seconds.	OK
B-OBS-0230	Coordination between Sites	Real-time information on the status and schedule of each observatory site of CTA at the remaining site is desirable to optimise the overall observing programme and exploit scientific opportunities.	OK
B-OBS-0500	Regular **performance monitoring**	Observatory personnel must monitor system and instrument performance on a regular basis with the goal of detecting sudden as well as gradual performance changes. **Performance monitoring** will be provided by a combination of means, with calibration procedures and on-line **data quality monitoring** and data analysis playing an important role. The performance monitoring on daily basis is appropriate. A subset of critical parameters are monitored in real-time with the on-line data quality monitoring system.	Changes in red. There is a contrast between the "monitoring on regular basis" and the "on-line data quality monitoring. "**data quality monitoring"** is the same term used in the On-Site Analysis SRD.
B-OBS-0510	Performance Documentation	**Performance** parameters must be logged automatically.	OK
B-OBS-0700	~~Near~~ Soft **real-time analysis**.	Events recorded must be analysed and analysis summaries be displayed in a comprehensive format on a time scale given in B-ACTL-3060, to provide feedback to the operators and science alert generation capability to the Observatory.	**Near/Pseudo** = it is used to specify "as soon as possible". **Soft** = the usefulness of a result degrades after its deadline, thereby degrading the system's quality of service. Due to B-ACTL-3060 this is a soft real-time system
B-OBS-0710	~~Online~~ **Performance monitoring.**	~~On-site~~ ~~analysis~~ Performance monitoring must verify the basic functionality of the instrument, and alert operators in case of malfunction. The analysis should be performed on-site.	There is a discrepancy between title and description related to on-line/on-site. Use performance monitoring instead of on-line analysis. See also the A-RAMS-400 requirement.

B-OBS-0720	~~Online~~ On-site source analysis.	**On-site analysis** must be able to detect activity in a defined source region, or elsewhere in the field of view, with a sensitivity not worse than the final analysis by more than a factor 3 .	There is a discrepancy between title and description related to on-line/on-site.
B-OBS-0730	Analysis software.	**On-site analysis** software should be identical to off-site (final processing) software to the maximum extent possible; simplifications may be required regarding calibration and event reconstruction.	OK

4. REQUIREMENT ANALYSIS OF "HIGH-LEVEL USERS REQUIREMENTS FOR CTA DATA MANAGEMENT" V 0.6 FOR CTA ON-SITE ANALYSIS SOFTWARE REQUIREMENTS

4.1 Relationships

This technical note covers the relationships between [R1] and the On-Site Analysis use cases and user requirements.

The following relationship are taken into consideration:

1) UC and **related (related to)** UR

2) HL UC and **refined (refine)** OS UC: in this case it is necessary to specify which HL UR *related to* HL UC are applicable to OS scope
3) HL UR and **refined (refine)** OS UR

4) HL UR **applicable (copy)** to OS UR

5) HL UC or UR can **derive (derive)** OS UC or UR

6) Some OS UC can **realize** HL UC.

7) Some OS UCs **participate** in the realization of most general HL UC.

4.2 Operations planning

Use Case ID	Use Case Description	Related User Requirements
UC6.4.2.5	The CTA Array Operator updates the short-term planning with the result of the daily short-term operations, reactions to real-time science alert monitoring and to the external triggers that generate re-pointing.	**UR4.070**: The short-term planning will be done at each Array Operation Centre on a daily basis and could be modified in real-time due to environmental and system conditions (AB: and as reaction to unexpected triggered events.), **UR4.090**: The short-term planning must accommodate the allocation of observing time for Targets of Opportunity with a reaction time of TBD minutes, the external trigger re-pointing with a reaction time of TBD seconds and the observations triggered by the real-time science alert monitoring within TBD seconds. In this latter case it is possible to continue the current observation or change the current observation with a reaction time of TBD seconds after the alert generation (if a re-pointing is needed), **UR4.110**: The scheduled observations, together with the proposal information (for guest observer and ToO observation) or the origin of the alerts (for real-time science alert monitoring or external trigger repointing) and the results of the performance evaluation should be

		stored in a special purpose database repository at both CTA sites., **UR4.120**: To help in the observation planning, a Visibility Checker tool should be available at both CTA sites.

This do not impose UC (because the update of the short-term planning is outside the purpose of the ONSITE), but it impose **derived** URs:

- the DQ and science alert are sent to scheduler/Array Operator
- there are database of DQ and science alerts
- the Visibility Checker is an input for DQA and RTA. In addition, catalogues of source in the TeV domain with related expected flux should be present for both DQA and RTA

UC6.4.2.5 is not applicable, but DQA and RTA **participate** in the realization of the UC6.4.2.5 with alert generation.

4.3 Performance monitoring

Use Case ID	Use Case Description	Related User Requirements
UC6.5.2.1	UC6.5.2.1 The **CTA Array Operator monitors the on-going observation using** several **standard displays** of the real-time data. A hierarchy of displays will allow to monitor operational configurations al different complexity levels.	**UR5.010**: The Array Operator at the Array Operation Centres will monitor and supervise the control of the individual telescopes in the array at each CTA site. **UR5.020**: A dedicated application will be used to monitor and control the observatory encompassing: (1) the complete array, (2) the individual telescopes and (3) associated subsystems, via a single graphical user interface. **UR5.030**: This application should incorporate a hierarchy of displays to allow the monitoring of the operational configurations at different complexity levels. **UR5.040**: Status information of the telescope array should be recorded during operations with a periodicity TBD, to allow for the reconstruction of historical behaviour of the system.
UC6.5.2.2	UC6.5.2.2 The **CTA Array Operator enters an anomaly in the observing log.**	**UR5.060**: Incidents and alarms during an observation will be registered by the Array Operator in an electronic logbook.
UC6.5.2.3	UC6.5.2.3 The **CTA Array Operator generates a new schedule** of the observing plan in case of severe anomaly due to instrument or weather conditions.	**UR5.050**: Observatory status information will include atmospheric and weather parameters with a periodicity TBD. Is this UC6.5.2.3 already contained into the UC6.4.2.5?
UC6.5.2.4	UC6.5.2.4 The **CTA Array Operator collects data on individual telescopes to**	**UR5.070**: To complete the performance monitoring cycle, a Quick-Look Facility associated to the on-site

	monitor performances of the individual cameras.	analysis will be used by the Array Operator to assess on the quality of the observations in near real-time. **UR5.080**: As part of the monitoring activity, the Array operator will collect camera performance data to be used for array calibration.

The HL UC impose ONSITE UC:

- UC6.5.2.1 and related URs **UR5.010, UR5.020, UR5.030, UR5.040** are applicable
- **UR5.050** is outside the scope of the DQA and it is not applicable, but there is a derived requirement:
  - The DQA and RTA should access to status information of the telescopes (auxiliary data)
- UC6.5.2.2 and related UR **UR5.060** is applicable
- UC6.5.2.3 is not applicable, but there is a derived requirement
  - the DQ and science alert are sent to scheduler/Array Operator
- UC6.5.2.4 is applicable for the related part of the science performance monitoring. The **UR5.070** is applicable

4.4 Telescope operations

Use Case ID	Use Case Description	Related User Requirements
UC6.6.2.1	UC6.6.2.1 The **CTA Array Operator** interrupts current operations and **submits a new schedule** to operate the CTA array in case of **severe anomaly** due to instrument or weather condition. The event is recorded automatically in the operations log.	**UR6.050**: The Array Operator will supervise the execution of the command sequences at the Array Operation Centre, using the monitoring and control application indicated in the previous section. **UR6.060**: During an observation, the Quick-Look Facility will be used to assess on the current performance of the array. **UR6.071**: Contingency procedures to react to any alarm during operations must be available to the Array Operators. **UR6.070**: An alert system to issue alarms during telescope operations shall be included in the telescope control system. The alerts are related to engineering and science monitoring activities. **UR6.072**: System components will be able to generate an alert in case of failure detected in the hardware or software component. **UR6.074**: Alerts should have a unique identification with a pre-defined classification that will be used to assign the operations procedure. **UR6.075**: Alerts should at least include the following information: **UR6.076**: A tracking mechanism will be implemented to handle the alerts and to associate them with the corresponding raw

		and auxiliary data. **UR6.077**: The alert tracking mechanism should have the following features: Select alerts by time range, alert type, system component and / or status Display list of alerts Add comments to the alerts Change status of the alert. Generate statistics based on the selection critteria
UC6.6.2.2	UC6.6.2.2 The **CTA Array Operator** interrupts current operations and **executes the specific observing procedure in case of ToO alert.** The event is recorded automatically in the operations log.	**UR6.050**: The Array Operator will supervise the execution of the command sequences at the Array Operation Centre, using the monitoring and control application indicated in the previous section. **UR6.070**: Contingency procedures to react to any alarm during operations must be available to the Array Operators. **UR6.071**: An alert system to issue alarms during telescope operations shall be included in the telescope control system. The alerts are related to engineering and science monitoring activities. **UR6.073**: Alerts should be generated in case of unexpected flux values or out-of-limits levels when a new source is detected. **UR6.074**: Alerts should have a unique identification with a pre-defined classification that will be used to assign the operations procedure. **UR6.075**: Alerts should at least include the following information: **UR6.076**: A tracking mechanism will be implemented to handle the alerts and to associate them with the corresponding raw and auxiliary data. **UR6.077**: The alert tracking mechanism should have the following features: **UR6.080**: Guest Observers could have limited interaction with the telescope operations cycle to access real- time data products via the On-site Analysis Unit and, in case of critical events, to request changes in the observing plan via the Operations Planning Unit. **UR6.090**: Guest Observers will be informed on the intended schedule of his/her programme and will receive the status report of the observation upon completion, as described in the Data Delivery Policy document [R4].
UC6.6.2.3	UC6.6.2.3 An **automatic re-pointing system**	**UR6.050**: The Array Operator will

	interrupts current operations and executes the specific observing procedure in case of external triggered alert and records the event in the operations log.	supervise the execution of the command sequences at the Array Operation Centre, using the monitoring and control application indicated in the previous section. **UR6.070**: Contingency procedures to react to any alarm during operations must be available to the Array Operators. **UR6.074**: Alerts should have a unique identification with a pre-defined classification that will be used to assign the operations procedure. **UR6.075**: Alerts should at least include the following information: **UR6.076**: A tracking mechanism will be implemented to handle the alerts and to associate them with the corresponding raw and auxiliary data.
UC6.6.2.4	UC6.6.2.4 When an alert is generated by the **real-time science alert monitoring** the current observation is continued for TBD hours interrupting the planed observations. It is also possible a re-pointing to put the flaring source in the centre of the FOV. If the alert is generated when the observation that has generated the alert is finished, an automatic re-pointing system interrupts current observation and executes the specific observing procedure to follow the current alert for TBD hours	**UR6.050**: The Array Operator will supervise the execution of the command sequences at the Array Operation Centre, using the monitoring and control application indicated in the previous section. **UR6.070**: Contingency procedures to react to any alarm during operations must be available to the Array Operators. **UR6.071**: An alert system to issue alarms during telescope operations shall be included in the telescope control system. The alerts are related to engineering and science monitoring activities. **UR6.073**: Alerts should be generated in case of unexpected flux values or out-of-limits levels when a new source is detected. **UR6.074**: Alerts should have a unique identification with a pre-defined classification that will be used to assign the operations procedure. **UR6.075**: Alerts should at least include the following information: **UR6.076**: A tracking mechanism will be implemented to handle the alerts and to associate them with the corresponding raw and auxiliary data. **UR6.077**: The alert tracking mechanism should have the following features: **UR6.080**: Guest Observers could have limited interaction with the telescope operations cycle to access real- time data products via the On-site Analysis Unit and,

		in case of critical events, to request changes in the observing plan via the Operations Planning Unit. **UR6.090**: Guest Observers will be informed on the intended schedule of his/her programme and will receive the status report of the observation upon completion, as described in the Data Delivery Policy document [R4].

- UC6.6.2.1 is not applicable but the DQA should sent DQ alerts to Array Operator.
  - Some OS UC can participate in the realization of the UC6.6.2.1 (the OS UCs related to DQA). For this reason
    - **UR6.050** is not applicable
    - **UR6.060** is applicable
    - **UR6.071** is not applicable
    - **UR6.070, UR6.072** are applicable for the part related to the DQA and RTA
    - **UR6.073** is applicable
    - **UR6.074** is applicable
    - **UR6.075** is applicable
    - **UR6.076** is applicable
    - **UR6.077** is applicable
- UC6.6.2.2 is not applicable, but the DQA and RTA should process the data in an automated way to analyse the ToO: for this reason RTA UCs can **participate** in the realization of the UC6.6.2.2
  - From **UR6.080** it is possible to derive that the DQA and RTA store real- time data products
  - From **UR6.090** it is possible to derive that DQA and RTA generate status reports of the observation
- UC6.6.2.3 is not applicable, but the DQA and RTA should process the data in an automated way to analyse the external triggered event: for this reason RTA UCs can **participate** in the realization of the UC6.6.2.3
- UC6.6.2.4 is not applicable, but the RTA generate science alerts, but
  - Some OS UC can participate in the realization of the UC6.6.2.4 (the OS UCs related to DQA). For this reason
    - **UR6.050** is not applicable
    - **UR6.070** is not applicable
    - **UR6.071** is applicable for the part related to the DQA and RTA
    - **UR6.073** is applicable
    - **UR6.074** is applicable
    - **UR6.075** is applicable
    - **UR6.076** is applicable
    - **UR6.077** is applicable
    - From **UR6.080** it is possible to derive that the DQA and RTA store real- time data products
    - From **UR6.090** it is possible to derive that DQA and RTA generate status reports of the observation

4.5 Data Acquisition

Use Case ID	Use Case Description	Related User Requirements
		UR7.030: A science alert monitoring mechanism will be implemented to identify

		the events to be processed with the on-site analysis facility at the Array Operation Centre. **UR7.180**: The Data Acquisition system will keep up with the incoming data rate with a delay <10 seconds.

- **UR7.030** is applicable
- **UR7.180** is applicable

4.6 On-site Analysis

Use Case ID	Use Case Description	Related User Requirements
UC6.8.2.1	UC6.8.2.1 The **CTA Array Operator executes the on-site analysis pipeline** using the last available calibration for the site.	**UR8.010**: There are two On-site Analysis Units associated to each Telescope Array, to perform on-site data analysis and performance monitoring., **UR8.015** The On-Site Analysis Unit will generate engineering and science monitoring alerts., **UR8.020**: On-site Analysis must be able to process the data within three time windows: Window 1 within the observation for engineering performance monitoring of the telescopes, Window 2 before the next observation night, and Window 3 for real-time science alert monitoring and external trigger reaction analysis., **UR8.045**: The engineering and science performance monitoring pipeline and the real-time science alert monitoring pipeline process the observations continuously and automatically.
UC6.8.2.2	UC6.8.2.2 The **CTA Array Operator records the quality result** of the on-site analysis in the operations log.	**UR5.010**: The Array Operator at the Array Operation Centres will monitor and supervise the control of the individual telescopes in the array at each CTA site., **UR5.040**: Status information of the telescope array should be recorded during operations with a periodicity TBD, to allow for the reconstruction of historical behaviour of the system., **UR8.015** The On-Site Analysis Unit will generate engineering and science monitoring alerts., **UR8.030**: Processing of data in Window 1 must be able to detect problems in the hardware. The results will be used to verify the quality of the measurements and generates engineering performance monitoring alerts., **UR8.040**: Processing of data in Window 2 must yield significances of observations, fluxes and light curves, using approximate calibrations and standard CTA software. “Final data processing”, using interpolated calibrations, will be performed at the Data Reduction Units., **UR8.042**: The on-site analysis subsystem (engineering and science performance monitoring) will generate a

		report for each exposure containing , **UR8.043**: The above report will be sent to the Guest observer.
UC6.8.2.3	UC6.8.2.3 The **CTA Array Operator submits an anomaly report** in the quality control system.	**UR8.015** The On-Site Analysis Unit will generate engineering and science monitoring alerts., **UR8.042**: The on-site analysis subsystem (engineering and science performance monitoring) will generate a report for each exposure containing , **UR8.044**: In case of failures or problems detected during the on-site analysis, an anomaly report (engineering monitoring alert) should be submitted by the Data Processing engineer to the Quality Control reporting system., **UR8.043**: The above report will be sent to the Guest observer.
UC6.8.2.4	UC6.8.2.4 The **CTA Array Operator records the scientific alerts and the automatic reaction** of the telescope array to the real-time analysis/external trigger re-pointing in the operations log.	**UR8.015** The On-Site Analysis Unit will generate engineering and science monitoring alerts., **UR8.020**: On-site Analysis must be able to process the data within three time windows: Window 1 within the observation for engineering performance monitoring of the telescopes, Window 2 before the next observation night, and Window 3 for real-time science alert monitoring and external trigger reaction analysis., **UR8.030**: Processing of data in Window 1 must be able to detect problems in the hardware. The results will be used to verify the quality of the measurements and generates engineering performance monitoring alerts., **UR8.040**: Processing of data in Window 2 must yield significances of observations, fluxes and light curves, using approximate calibrations and standard CTA software. “Final data processing”, using interpolated calibrations, will be performed at the Data Reduction Units., **UR8.041**: The real-time science alert monitoring must be able to process the data in Window 3 to detect high level activity of sources and generates science alerts, albeit with reduced sensitivity and to react to unexpected events. The result of the monitoring is also used to verify the quality of the measurements., **UR8.042**: The on-site analysis subsystem (engineering and science performance monitoring) will generate a report for each exposure containing , **UR8.043**: The above report will be sent to the Guest observer., **UR8.050**: A Quick-Look Facility will be used to display processed data corresponding to both Windows indicated above., **UR8.070**: Science alerts should be generated in case of unexpected flux values from known sources or when a new source is detected, above a TBD detection significance threshold.,

		UR8.090: The real-time science alert monitoring will generate a report for each alert containing
UC6.8.2.5	UC6.8.2.5 The **CTA Array Operator updates the short-term planning** after the triggers from the real-time science alert monitoring or external triggers.	**UR8.015** The On-Site Analysis Unit will generate engineering and science monitoring alerts., **UR8.020**: On-site Analysis must be able to process the data within three time windows: Window 1 within the observation for engineering performance monitoring of the telescopes, Window 2 before the next observation night, and Window 3 for real-time science alert monitoring and external trigger reaction analysis., **UR8.080**: Alerts generate a change in the short-term schedule. The reaction to an external triggered alert is the re-pointing of the array (some or all telescopes); the reaction to alerts generated by real-time science alert monitoring system will be , **UR8.090**: The real-time science alert monitoring will generate a report for each alert containing

All the UC and related UR are applicable, except the UC6.8.2.5 that it is not applicable but DQA and RTA **participate** in the realization UC6.8.2.5.