CIWS Framework (CIWS-FW)
User Requirement Document (URD)

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3.0	10/12/2012	Revised all by introducing the Framework concept.
3.1	21/01/2013	Detailed section 2.4. Added some use cases, plus minor revisions. Presented at the CIWS PM n.14

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1. Introduction

The target system for the *Customizable Instrument Workstation Software* (CIWS) project is the Instrument Workstation (CIWS IW) that is exploited to monitor and assess the instrument functionalities and performances during the development, integration, commissioning and operation activities on scientific instrument for space-borne or ground-based telescopes.

The CIWS IW participates to the test / operation set-up as a Server system that receives the Instrument data from a Client system gathering the data from the scientific instrument under testing / operation. In some cases the CIWS IW has on-line access also to auxiliary data, related to some aspects of the test / operation set-up (e.g. calibration, telescope pointing), that the CIWS IW acquires and correlates with the instrument data.

The CIWS IW stores the input data and allows the instrument team / test operator to perform in either on-line or retrieval mode the processing and quick look tasks required to support the instrument test / operation activities.

Eventually, the CIWS IW is able to make available the archived data to external systems for off-line permanent archiving and for off-line analysis purposes that are out of the scope of the CIWS IW.

The CIWS framework (CIWS-FW) is aimed at facilitating the development of the CIWS IW.

The CIWS-FW shall provide software mechanisms, libraries and suitable APIs for the implementation of the CIWS IW.

1.1 Purpose

The present document represents the output of the User Requirement phase of the CIWS-FW software life cycle, and is formally reviewed during the User Requirements Review.

According to RD[1], it is devoted to the definition of the user requirements by providing a general description of what the user expects the software to do.

To this purpose, the present document defines:

1) all known user requirements;
2) the operations the user wants to perform with the software system;
3) all the constraints that the user wishes to impose upon any solution;
4) the external interfaces to the software system or appropriate references to the ICDs that exist or are to be written.

In addition, the following RD[1] guidelines are taken into accounts:

5) for incremental delivery, each user requirement shall include a measure of priority so that the developer can decide the production schedule;
6) the source of each user requirement shall be stated;
7) each user requirement shall be verifiable;
8) the user shall describe the consequences of losses of availability, or breaches of security, so that developers can fully appreciate the criticality of each function.

The requirements are marked with the “UR” label.

The text not marked shall be considered as explanation text.

1.2 Scope

The scope of the CIWS-FW is limited to data handling tasks. The instrument command generation and command handling tasks is out of the CIWS-FW scope.

1.3 Glossary, acronyms and abbreviations

1.3.1 Glossary

Name	Aliases	Labels	Description
acquisition pipeline	Pipeline		a chain of processes that manage the data flow
broadcast event			A pipeline event sent to the overall running processes.
campaign			A name that identify some other (free) parameters like the test equipment used to acquire the data or the place where the session is performed or other usuful configuration
CIWS developers			They will exploit the CIWS-FW in order to build the CIWS IW. They will take advantage of support programs, code libraries or other software included in the CIWS-FW and exposed through an API.
data flow			The data flow is the flow of data (from input to output) managed by pipeline. A data flow is compound by different datatype.
datatype	data type		A dataype define a type of data managed by IW system.
idle mode			An idle mode is a mode of the acquisition pipeline when the instrument is in pause or under configuration.
input datatype			A dataype define a type of data used as input by one component of the DPS pipeline.
instrument			the instrument under test
instrument source data			the data generated by the instrument.
auxiliary source data			the data generated by other devices participating to the measurement setup, e.g. Calibration facilities devices, weather stations.
Instrument workstation	IW		The instrument workstation is a workstation that support the verification and monitoring activities to be carried out on the instrument during the development and operative phases of space-borne or ground-based telescopes. The system system is limited to data handling tasks, and does not include the instrument command generation and command handling tasks.
level 0	L0		The acquired data level that contains the source data in the original format (e.g. Telemetry Source Packets).
level 1	L1		The data level that contains the data after the pre-

Name	Aliases	Labels	Description
			processing (e.g. telemetry packet translated into FITS format).
level 2	L2		The data level that contains the data after processing (e.g. high level data products like spectra, images, time profiles).
log			A record about actions or operations performed by the system.
measure	run, measurement		A set of data with a logic and scientific correlation. Each measure starts with a start event (typically a start command) and end with a stop event (typically a stop command). For example, a measure could be the data of a particular test or, during the calibration activities, the data of a particular source.
measure log	measurement log, run log		A log of the current measure from the acquired data point of view
mode period			A mode is the status of a measure. A measure is divided in run mode (when the acquired data are used for analysis) and idle mode (when the instrument is in pause or under configuration)
model			the model of the instrument (e.g. SEM, PFM)
node			A node is a computer or machine where the data is acquired
off-line mode	deferred mode, offline period, deferred period		In this mode the acquisition is performed in a different period with respect to the data flow of the instrument under test.
on-line mode	live mode, online period		In this mode the acquisition is performed with the same rate and with the same data flow of the instrument under test.
output datatype			A datatype define a type of data generated by one component of the DPS pipeline.
pipe level	pipelevel		A pipe level is the level of the component into the DPS pipeline based on a tree schema
pipeline event	Event		Something that change the pipeline status
pipeline log			The log of the acquisition from the pipeline point of view (e.g. running processes, number of acquired telemetry packets, stored files, etc)....
processor			A processor is a software component that convert the data from one format to another format (e.g. form L0 to L1)
quick-look software			A software that display the acquired data in a quick-look way
retrieval mode			In this mode the input data are retrieved from the archive with rates that does not depend on the instrument, which could also not be active.
run mode			A run mode is a mode of the acquisition pipeline when the acquired data are used for analysis.
RUNID	Runid		The RUNID is an incremental number that identify a

Name	Aliases	Labels	Description
			measure within a session.
source data			Input data to the IW.
session measurement	session		A set of measure(s).
session log			A manual log written by users related to the main purpose of the session
start event			A start event is a pipeline event that changes the status of the pipeline from idle mode to run mode.
stop event			A stop event is a pipeline event that changes the status of the pipeline from run mode to idle mode.
test level	testlevel		Describes which parts of the instrument are under test (e.g a subset of the instrument)

1.3.2 Acronyms and abbreviations

API Application Program Interface

AIV Assembly, Integration and Verification

CIWS Customizable Instrument Workstation Software

DAS Data Acquisition System

DDL Data Definition Language

DPS Data Processing System

IW Instrument Workstation

1.4 References

1.4.1 Applicable Documents

AD [1] Packet Lib ICD

1.4.2 Reference documents

RD [1] Guide to applying the ESA software engineering standards to small projects, ESA BSSC(96) Issue 1 May 1996.

RD [2] Tailoring of ECSS Software Engineering Standards for Ground Segments in ESA - Part A: Software Engineering, BSSC 2005(1) Issue 1.0 June 2005

RD [3] ECSS Packet Utilization Standard (PUS), ECSS-E-70-41A, 30 January 2003

RD [4] FITS .....

RD [5] XML ...

2. General Description

2.1 General capabilities

This section describes the process to be supported by the software, the main capabilities required and why they are needed.

The highest level goal of the CIWS project is to provide a software framework (CIWS-FW) to build the Instrument Workstation (IW) that is able to monitor and verify the instrument functionalities and performances throughout the various development, test and operation activities on either space-borne or ground-based telescopes. Eventually, the CIWS IW is able to make available the archived data to external systems for off-line permanent archiving and for off-line analysis purposes that are out of the scope of the CIWS IW itself.

2.1.1 CIWS IW data flow and products

The data flow and the products of the CIWS IW are depicted in Figure 2-1.

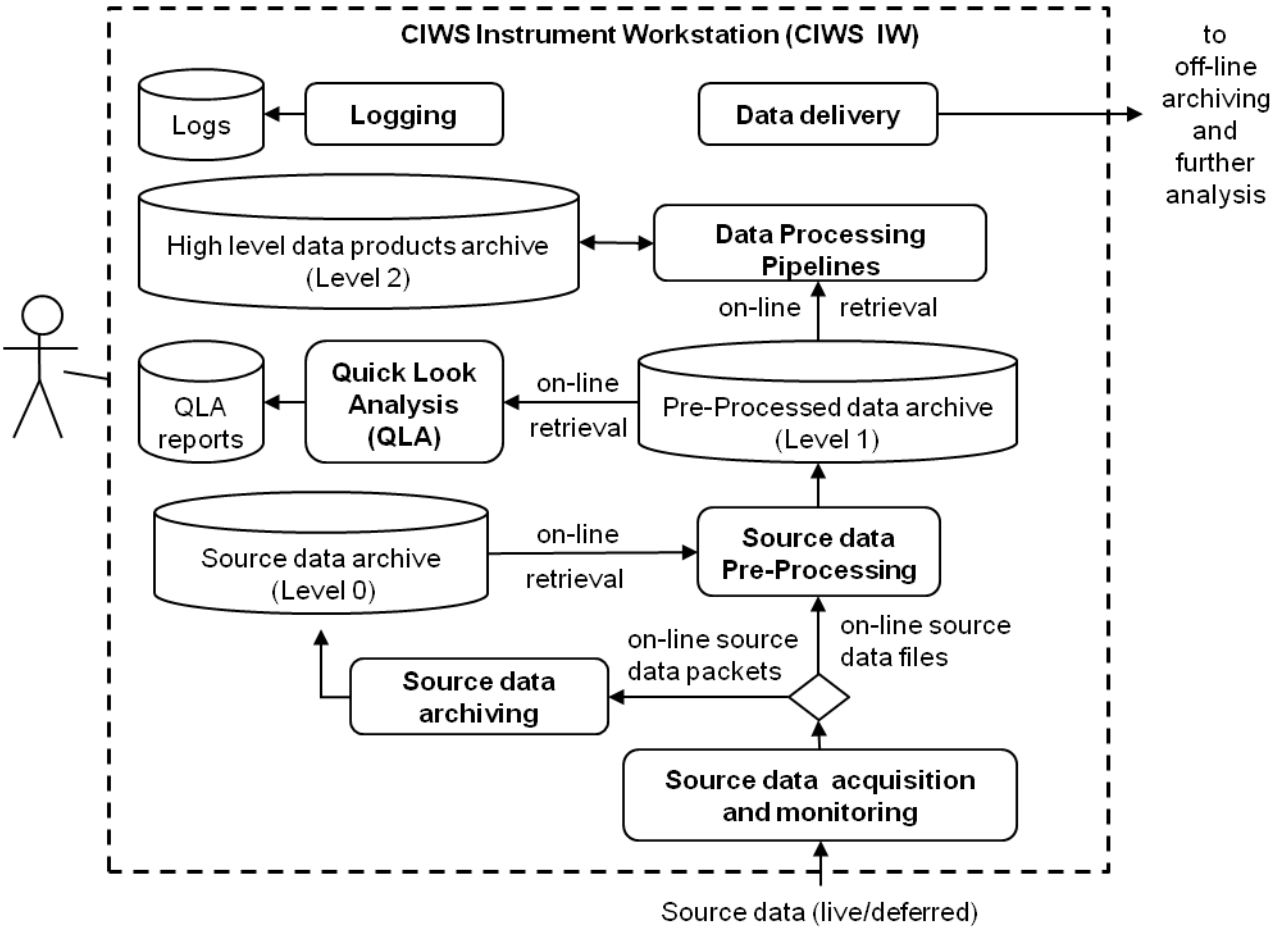


Figure 2-1CIWS IW data flow and products

The CIWS IW shall handle two main classes of input data:

- the data generated by the instrument (**instrument source data**);

- the data generated by other devices participating to the measurement setup, e.g. Calibration facilities devices, weather stations (**auxiliary source data**).

In both cases the CIWS IW shall receive the source data through TCP/IP connections in one of the following modalities:

- in the form of source data packet streams;
- in the form of source data files.

Live/Deferred source data packet streams shall be:

  - acquired and monitored on-line in order to assess the data flow in terms of quality (e.g. missing data, checksum errors), and characteristics (acquisition rate, data statistics on the various data types, etc.);
  - archived on-line in the original format in the Level 0 (L0) archive
  - and pre-processed (either on-line or in retrieval mode) in order to apply on the source data specific transformations (e.g. unpacking, decompression, calibration) and store the resulted data, with additional metadata, in suitable format (e.g. FITS format) in the Level 1 (L1) archive.

Live/Deferred source data files shall be:

  - acquired and monitored on-line in order to assess the data flow in terms of quality (e.g. missing data, checksum errors), and characteristics (acquisition rate, data statistics on the various file data types, etc.)
  - directly pre-processed on-line in order to store them in the Level 1 (L1) archive in the original format (e.g. FITS format), with additional metadata (e.g. adding FITS keywords).

In both cases, the CIWS IW shall provide the following capabilities.

- Data Processing Pipelines shall be performed on the L1 archive, either on-line or in retrieval mode, in case specific processing has to be performed automatically in order to generate higher level data product through suitable combination of single processing task. The results shall be archived in the Level 2 (L2) archive.
- Quick Look Analysis (QLA) shall be performed on the Level 1 archive, either on-line or in retrieval mode, in order to:
  - allow fast verification and assessment of the observation set-up, instrument functionalities and performances, and data-taking statistics;
  - generate interactive Quick Look Reports;
  - generate automatic and periodic Data Quality Reports.
- Reference Catalogues of celestial objects shall be available with access and query capabilities suitable to the purposes of the data QLA and processing;
- Logging capabilities of data item values and system events shall be provided for eventual storage in a data base management system
- Data distribution capabilities shall be provided to make available the archived data to external systems in charge of off-line archiving and further analysis.

As already mentioned, the scope of the CIWS IW shall be limited to data handling tasks, and shall not include instrument command generation and command handling tasks.

2.1.2 CIWS Framework capabilities

The CIWS framework (CIWS-FW) is aimed at facilitating the development of the CIWS IW.

The CIWS-FW shall provide software mechanisms, libraries and suitable APIs for the implementation of the CIWS IW.

Being a framework, the CIWS-FW shall be characterized by:

- inversion of control - In a framework, unlike in libraries or normal user applications, the overall program's flow of control is not dictated by the caller, but by the framework.
- default behaviour - A framework has a default behaviour. This default behaviour must actually be some useful behaviour and not a series of no-ops.
- extensibility - A framework can be extended by the user usually by selective overriding or specialized by user code to provide specific functionality.
- non-modifiable framework code - The framework code, in general, is not allowed to be modified, excepting extensibility. Users can extend the framework, but not modify its code.

2.2 General constraints

This section describes the main constraints that apply and why they exist.

TBD.

2.2.1 Space-borne telescope case

The CIWS-FW shall be able to handle the Telemetry (TM) and Telecommand (TC) Packet Standard (see RD [3]), which is the standard de-facto for space missions.

2.2.2 Ground-based telescope case

TBD.

2.3 User characteristics

This section describes who will use the software and when.

The CIWS-FW shall provide a facility that both instrument development team and instrument maintenance and operation teams can use to maximize the efficient development and operation of the scientific instruments.

Hence, two main classes of CIWS-FW users are identified:

- **CIWS IW developers**, who will exploit the CIWS-FW in order to build the CIWS IW.
  They will take advantage of support programs, code libraries or other software included in the CIWS-FW and exposed through an API.
- **CIWS IW users**, who will exploit the CIWS IW to assess the instrument functionalities and performances during the instrument development, test, integration, commissioning and operation activities.

  This term encompasses different categories:

  - Engineers testing or maintaining the instrument
  - Scientists and technical operators with a deep knowledge of the instrument
  - Scientists with limited training on the use of the instrument.

2.4 Operational environment

This section describes what external systems do and their interfaces with the product.

The CIWS IW shall participate to the test / operation set-up as a Server system that receives the Instrument data from a Client system gathering the data from the scientific instrument. In some cases the CIWS IW shall also have on-line access to auxiliary data, related to some aspects of the test / operation set-up (e.g. calibration, telescope pointing), that the CIWS IW shall acquire and correlate with the instrument data.

The CIWS IW interface also external systems in charge of the permanent archiving and off-line analysis of the data archived by the CIWS IW.

The following operational context are envisaged:

- Space borne telescope context:
    - Instrument/Payload level AIV
    - Spacecraft level AIV
    - Ground Segment
- Ground based telescope context:
    - Instrument level AIV
    - Observatory site.

2.4.1 Space-borne telescope context

In this context the format for the instrument source data is “standard”, as in space missions it has to comply with the Telemetry (TM) and Telecommand (TC) Packet Standard dictated by the Space Agencies (see RD [3]).

This standard is able to accommodate the typical characteristics of the space-borne telescopes, namely:

- the TM data relevant for the CIWS IW are mainly divided into two classes:
    - TM Housekeeping (HK) data packets
    - TM Science data packets
- the HK data have a simple data format, where each TM packet contains a fixed number of values (e.g.: one sample of all the instrument HK);
- there are several kind of Science data packets (usually one for each operating mode of the various detectors forming the Payload complement).
- each kind of Science Data has its own packet format, which usually has variable length, depending on the number of “events” accommodated in the packet; there are cases of very complex packet format containing a variable number of nested structures of variable length.

In this context, usually the EGSE and the Ground Segment equipment interfacing the instrument are procured by the Industry.

The industrial EGSE is a standard equipment which is mainly in charge of the instrument configuration and control, and instrument health monitoring, by inspecting the HK data only.

The CIWS IW is usually procured by the Instrument Team in order to process both the TM HK Data and the TM Science Data, as required for the assessment of the instrument scientific functionalities

and performances during the Assembly, Integration, Verification (AIV) activities at the various levels of integration.

Furthermore, the CIWS IW could be re-used at various levels in the Ground Segment.

It is worth noticing that all these levels the CIWS IW:

- receives the Instrument data encapsulated into TM and TC Source packets, thus allowing a common data format I/F along with all the levels.
- retrieves the Auxiliary data to be correlated with the Instrument data, by querying the Auxiliary Data Server available on-line.

Usually, the CIWS IW has a passive role and does not interfere with the EGSE operations. Only the EGSE is in charge of sending commands to the instrument, and to create and maintain the Instrument Data Base required to encode/decode the command and telemetry packets and to perform instrument parameter display and monitoring. In some cases the Instrument Data Base is provided (off-line) by EGSE to the CIWS IW, that shall use them for CIWS IW software configuration purposes.

2.4.1.1 Instrument/Payload level AIV

The system context diagram for the Instrument/Payload level AIV is shown in Figure 2-2.

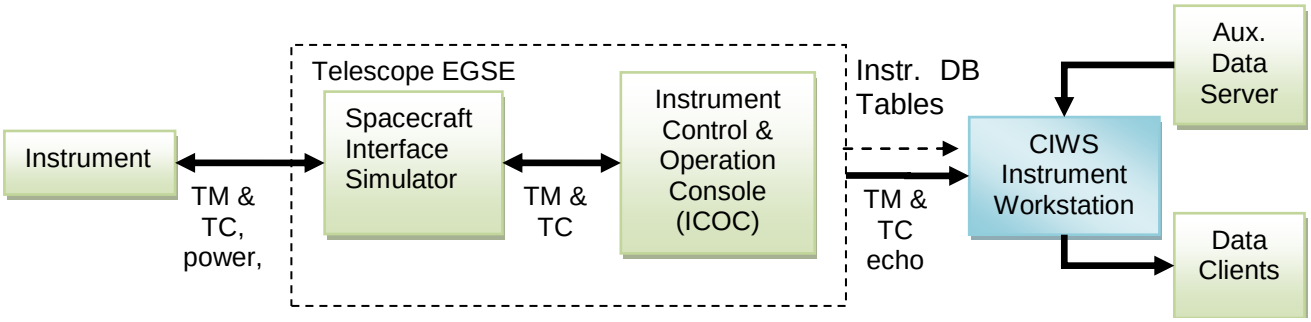


Figure 2-2 CIWS IW context diagram for Payload Level AIV

The following interfaces are envisaged:

- CIWS IW / Telescope EGSE:
  - TM & TC echo is sent by the EGSE to the CIWS IW (e.g.: through a TCP/IP socket on the LAN);
  - Instrument DB Tables (ASCII files) are provided off-line by the EGSE to the CIWS IW.
- CIWS IW / Aux Data Server:

  The CIWS IW will interface the Auxiliary Data Server DBMS in order to retrieve on-line the auxiliary data to be correlated and archived with the instrument data, e.g.:
  - Calibration facility configuration data (e.g. beam energy) are made available to the CIWS IW (e.g.: through TCP/IP or UDP sockets through the LAN);
  - Detector mechanical position data are made available to the CIWS IW by the Mechanical ground support equipment which positions the detector in front of the calibration beam (e.g.: through TCP/IP or UDP sockets through the LAN).

- CIWS IW / Data Client:
    - CIWS IW archived data are made available to Data Client applications (e.g. through Internet).

2.4.1.2 Spacecraft level AIV

The system context diagram for the System level AIV is shown in Figure 2-3.

The following interfaces are envisaged:

- CIWS IW / EGSE:
    - TM & TC echo is sent by the EGSE to the CIWS IW (e.g.: through a TCP/IP sockets on the LAN);
    - Instrument DB Tables (ASCII files) are provided off-line by the EGSE to the CIWS IW.
- CIWS IW / Aux Data Server:
- the CIWS IW will interface the Auxiliary Data Server DBMS in order to retrieve on-line the auxiliary data to be correlated and archived with the instrument data, e.g.:
    - cryo facility housekeeping data (e.g.: temperature)
- CIWS IW / Data Client:
    - CIWS IW archived data are made available to Data Client applications (e.g. through Internet).

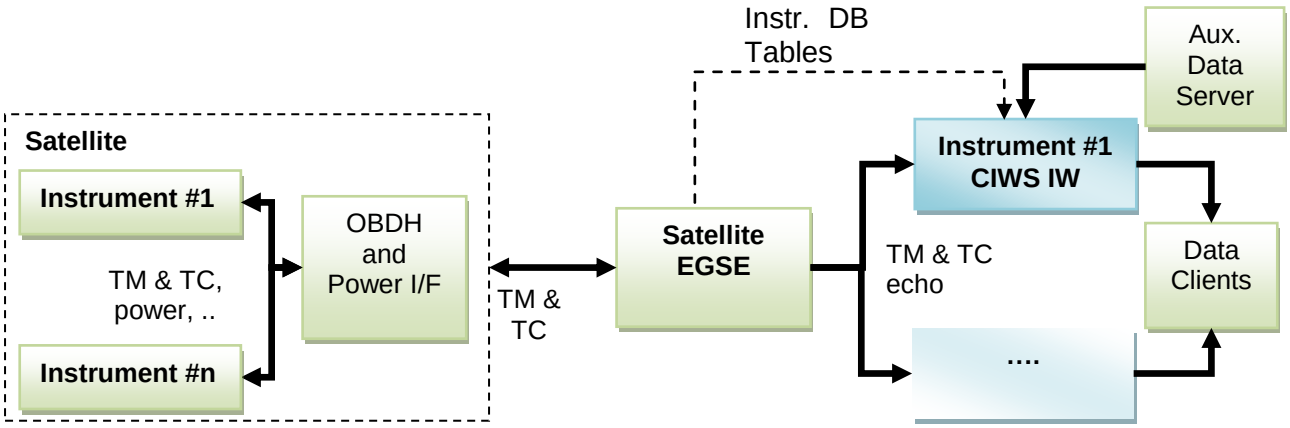


Figure 2-3 CIWS IW context diagram for Spacecraft Level AIV

The CIWS IW is exploited to support the AIV activities up to the launch (i.e. it supports the verifications tests carried out at the launch site).

2.4.1.3 Ground Segment

In the Ground Segment, the CIWS IW could be re-used to support the Commissioning and Science Performance Verification phases.

In some cases (e.g. ESA INTEGRAL), the CIWS IW is kept on-line also in the Operative phase in order to allow remote support by the Instrument Team

The following interfaces are envisaged:

- CIWS IW / EGSE:
  - TM & TC echo is sent by the EGSE to the CIWS IW (e.g.: through a TCP/IP sockets on the LAN);
  - Instrument DB Tables (ASCII files) are provided off-line by the CIWS IW to the EGSE.
- CIWS IW / Aux Data Server:
  - none at spacecraft level
- CIWS IW / Data Client:
  - CIWS IW archived data are made available to Data Client applications (e.g. through Internet).

2.4.2 Ground-based telescope context

In general, this context is less complex than the space-borne telescope context.

Usually the payload consists of only one instrument mounted on the focal plane of the telescope. The instrument Science operating modes are limited to a few cases, and, in most cases, it is operated in imaging mode which produces, at the end of each exposure period, one image having a fixed format. A sequence of exposures taken with a given instrument configuration and with a given telescope pointing forms an *Observation*.

All the parts composing the system (instrument, telescope, auxiliary data sources) are co-located and the data interconnection system can take advantage of the throughput and the flexibility of the local networking.

Usually, the Payload data have the following characteristics:

- they are mainly divided into two classes:
  - Housekeeping (HK) data buffers
  - Science data buffers
- each HK data buffer has a simple data format, it contains a fixed number of values, and it is generated periodically;
- each Science data buffer consists of one image readout, and it is generated at the end of each exposure period.

In this context, usually the whole instrument EGSE is developed and procured by the Instrument Team in order to support the *instrument level AIV*, i.e. during the instrument development and integration phases, and up to the instrument acceptance and delivery to the telescope site.

The EGSE is in charge of the instrument configuration and control, the HK and science data acquisition.

The CIWS IW is in charge of the source data archiving and processing, instrument health monitoring and quick look. In particular, the CIWS IW is in charge of the image quick look and processing. For each exposure, it generates the files containing in suitable format (e.g. FITS) the processed image and suitable auxiliary information.

To this purpose, the CIWS IW interfaces the EGSE in order:

- to receive notification of the start/stop Observation events;

- to receive in near real time the echo of the HK and science data buffers.

In addition, the CIWS IW, interfaces the Auxiliary Data Server in order:

- to retrieve auxiliary information required for the data processing (e.g. to be included in the image FITS file headers) and/or the Quick Look.

It is assumed that:

- each source data buffer acquired from the instrument is made available in near real time to the CIWS IW as TM packet through addition of a standard ESA Packet Header (6 bytes).
- for near real time operations, each start/stop measurement event is notified to the CIWS IW either through start/stop TC packet commands (i.e. buffers complying with the ESA TC packet standard) or other synchronisation mechanisms.
- the off-line mode (i.e. not from the instrument, but from the raw file) does not require these commands.

At the telescope site, the instrument EGSE and the CIWS IW are interfaced to the Telescope Control System (TCS) in order to support the Instrument Commissioning and the Instrument Operations.

The TCS is in charge of coordinating each *Observation* as sequence of instrument exposures, on the basis of the *Observer* commands.

Also in this context:

- The EGSE in charge of the instrument configuration and control, the HK and science data acquisition.
- The CIWS IW is in charge of the source data archiving and processing, instrument health monitoring and quick look. In particular, the CIWS IW is in charge of the image quick look and processing. For each exposure, it generates the files containing in suitable format (e.g. FITS) the processed image and suitable auxiliary information.

To this purpose, the CIWS IW interfaces the EGSE in order:

- to receive notification of the start/stop Observation events;
- to receive in near real time the echo of the HK and science data buffers.

In addition, the CIWS IW interfaces the TCS in order:

- to retrieve auxiliary information required for the data processing (e.g. to be included in the image FITS file headers) and/or the Quick Look.

At the end of each instrument exposure, the CIWS IW makes available the resulting image file to the TCS.

The TCS completes this file with additional auxiliary information derived from the various telescope subsystems and saves the resulting file in the final archive.

2.4.2.1 Instrument Level AIV

The system context diagram for the Instrument level AIV is shown in Figure 2-4.

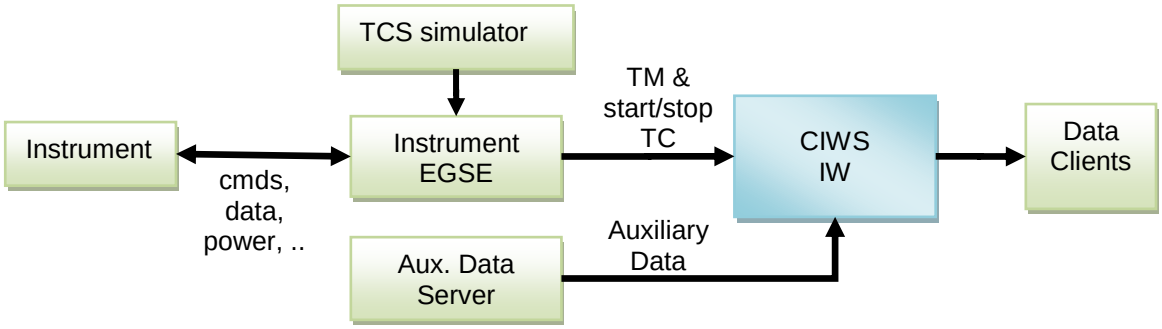


Figure 2-4 CIWS IW context diagram for Payload Level AIV and calibration

The following CIWS IW interfaces are envisaged:

- CIWS IW / EGSE:
  - TM packets;
  - either start/stop TC packets or other synchronisation mechanism for near real-time mode;
- CIWS IW / Aux Data Server:

  The CIWS IW will interface the Auxiliary Data Server at either the level of DBMS or file system in order to retrieve on-line the auxiliary data to be correlated and archived with the instrument data, e.g.:
  - Calibration facility configuration data (e.g. beam energy);
  - Detector mechanical position data are made available to the CIWS IW by the Mechanical ground support equipment which positions the detector in front of the calibration beam.
- CIWS IW / Data Client:
  - CIWS IW archived data and Quick Look products are made to Data Client applications (e.g. through Internet).

It is noted that a Telescope Control System I/F Simulator is used to test the Telescope Control Software (TCS) I/F protocols to be supported at the Telescope Observatory site.

2.4.2.2 Instrument Commissioning and Operations

The system context diagram for the Instrument Commissioning and Operations phases to be carried out at the Observatory site is shown in Figure 2-5.

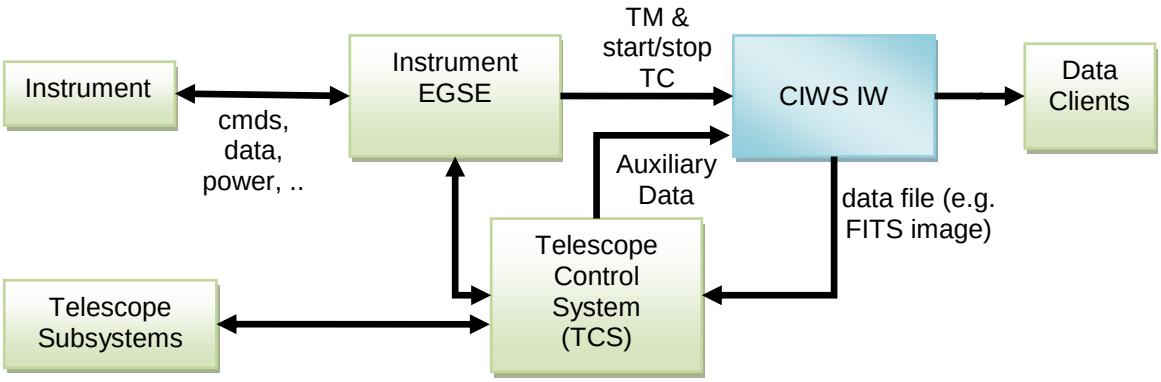


Figure 2-5 CIWS IW context diagram for Instrument Commissioning and Operations phases

The following CIWS IW interfaces are envisaged:

- CIWS IW / EGSE:
  - TM packets;
  - either start/stop TC packets or other synchronisation mechanism for near real-time mode;
- CIWS IW / TCS:
  - the CIWS IW will interface the TCS in order:
    - to retrieve on-line auxiliary data required for the data processing (e.g. to be included in the image FITS file headers) and/or the Quick Look.
    - to make available to the TCS the data file (e.g. FITS image) generated for each instrument exposure.
- CIWS IW / Data Client:
  - CIWS IW archived data and Quick Look products are made available to Data Client applications (e.g. through Internet).

3. CIWS IW scenarios

3.1 CIWS IW User scenario

The following scenarios shall be envisaged for the CIWS IW users:

1. configure, command and control the test session through a GUI;
2. execute on-line acquisition, storage and monitor of instrument live/deferred source data;
3. execute on-line acquisition, storage and monitor of auxiliary live/deferred source data;
4. execute source data Pre-Processing, in order to generate the Level 1 archive (either in on-line mode or in retrieval mode);
5. execute interactive Quick Look Analysis (QLA) on the Level 1 archive (either in on-line or retrieval mode), and generate and archive Quick Look Reports;
6. execute automatic periodic Quick Look Analysis (QLA) on the Level 1 archive (either in on-line or retrieval mode), and generate and archive Data Quality Reports;
7. execute the Data Processing Pipeline (either in on-line or in retrieval mode) in order to produce high level data products (Level 2);
8. execute archive data query and retrieval operations;
9. execute data delivery to make available the source data and the various levels of data products for off-line permanent archiving and for off-line analysis purposes that are out of the scope of the CIWS IW itself;
10. access and query Reference Catalogues of celestial objects for QLA;

3.2 CIWS IW Developer scenarios

The CIWS-FW shall provide to the CIWS IW Developer:

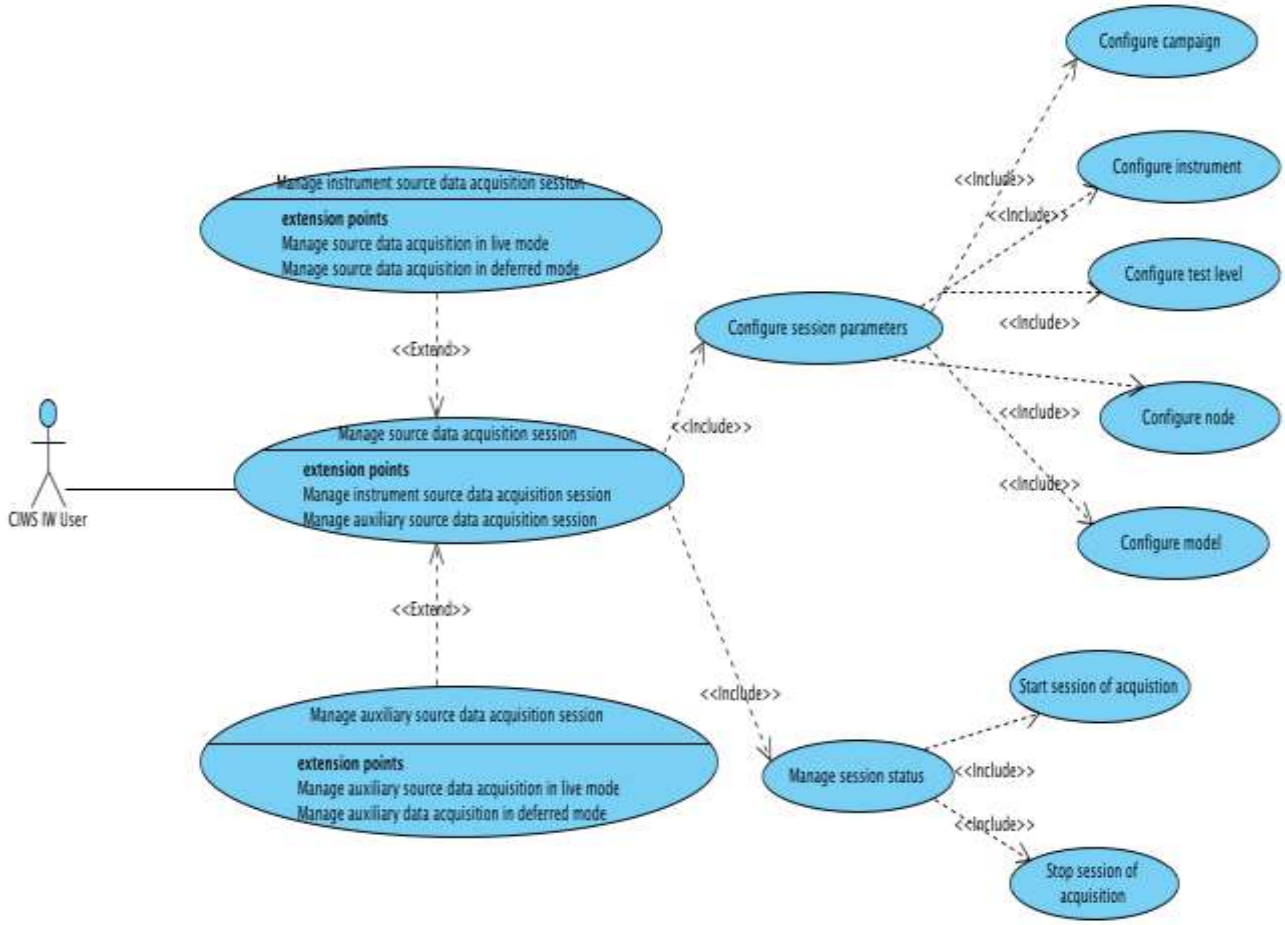
1. a mechanism to configure, command and control the test session through a GUI;
2. a configurable mechanism to build the components for on-line acquisition, storage and monitor of the instrument live/deferred source data;
3. a configurable mechanism to build the components for on-line acquisition, storage and monitor of the auxiliary live/deferred source data;
4. a configurable mechanisms to build the components for source data Pre-Processing, in order to generate the Level 1 archive (either in live or in replay mode), through addition of instrument specific modules to developed by the CIWS IW Developer;
5. a configurable mechanisms to build the components for interactive Quick Look Analysis (QLA) on the Level 1 archive (either in on-line or retrieval mode), and generate and archive QLA data products, through addition of instrument specific modules to developed by the CIWS IW Developer;
6. a configurable mechanisms to build the components for automatic and periodic Quick Look Analysis (QLA) on the Level 1 archive (either in on-line or retrieval mode), and generate and archive QLA data products, through addition of instrument specific modules to developed by the CIWS IW Developer;

7. a configurable mechanism to build the Data Processing Pipelines (on-line or in retrieval mode) in order to produce high level data products (Level 2), through addition of instrument specific modules to developed by the CIWS IW Developer;
8. a mechanism to allow data storage, retrieval and management through suitable API which are independent by the physical implementation and through suitable Data Definition Language (DDL) that provide an abstraction from the data model;
9. Reference Catalogues of celestial objects with access and query capabilities suitable to the purposes of the data QLA;
10. a configurable mechanisms to build the input data simulation subsystem, to be used for CIWS IW test and validation purposes, through addition of instrument specific modules to developed by the CIWS IW Developer.

4. Specific Requirements

4.1 Capabilities requirements

4.1.1 Configure, command and control the test session through a GUI



UR.3.1.1.010 Session configuration

The CIWS-FW shall provide a mechanisms to:

- select the components to be activated for a given session
- configure each session component.

UR.3.1.1.020 Session control

The CIWS-FW shall provide a mechanisms to:

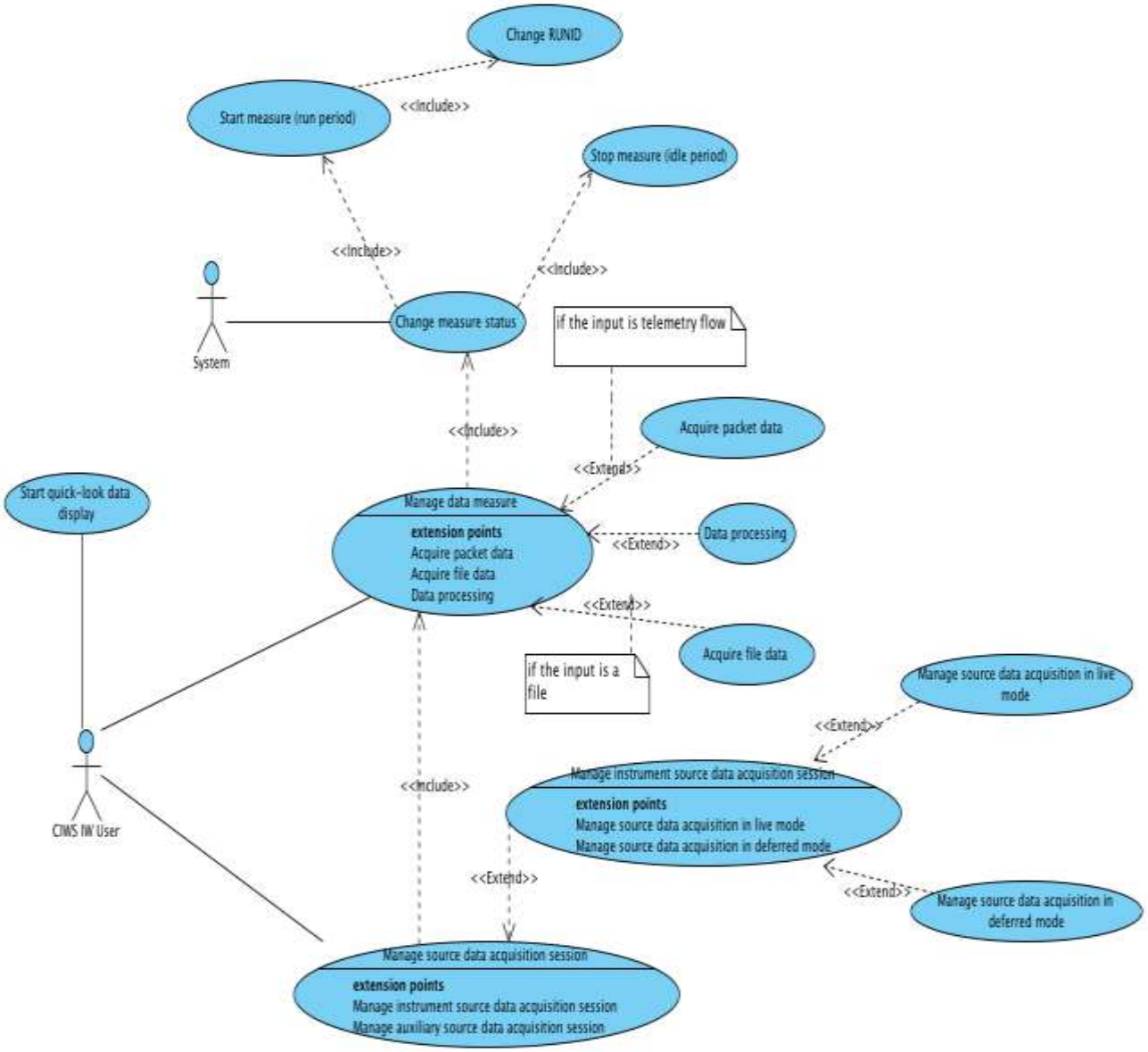
- open a new session
- start session components

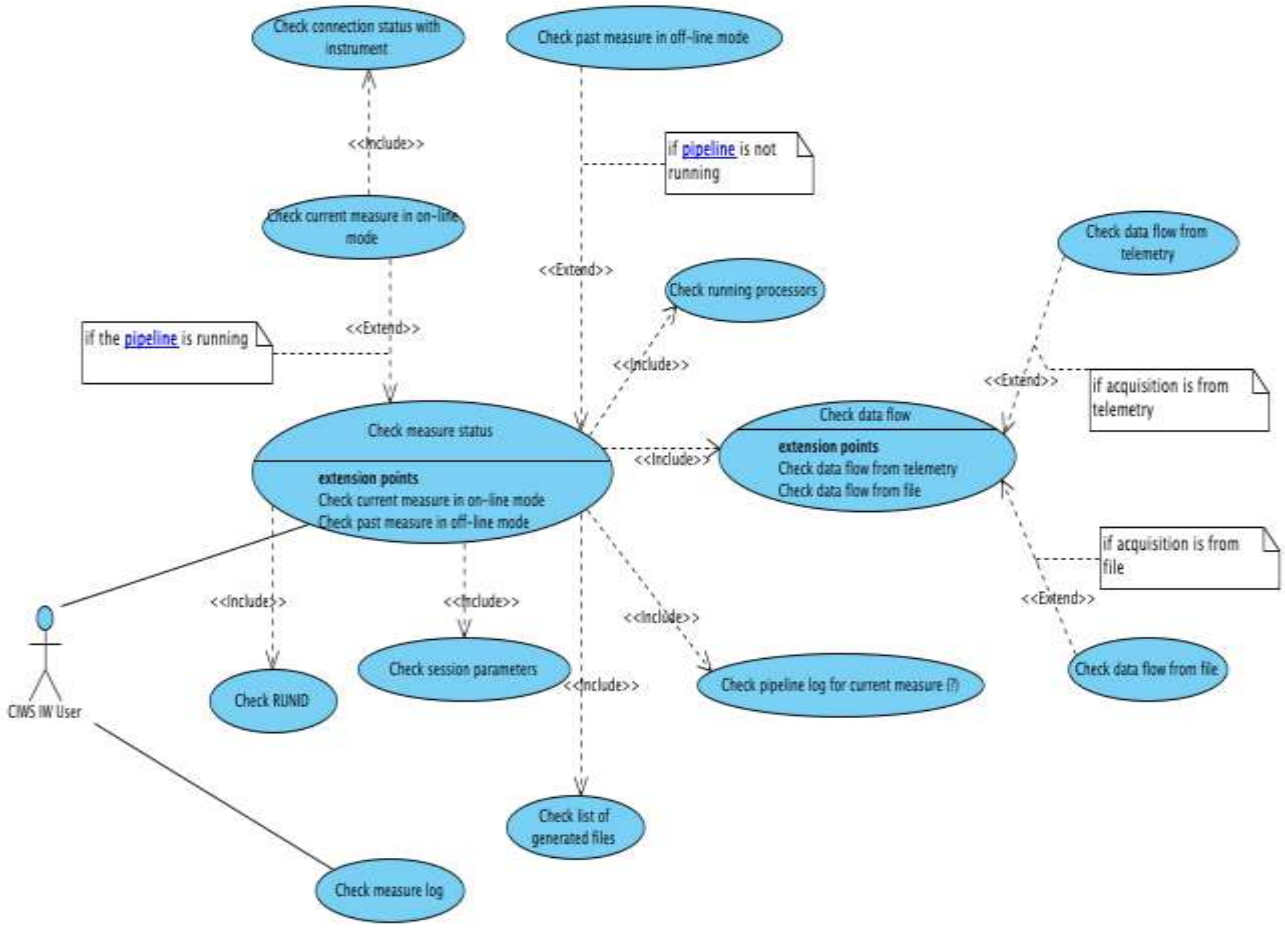
- show session component status
- interrupt session component
    - abort component
    - stop component
- close current session
- show session status
- log session system events

UR.3.1.1.030 Measure control

TBW.

4.1.2 Execute on-line acquisition, storage and monitor of instrument live/deferred source data





UR.3.1.2.010 Data modes

The CIWS-FW shall support the following data modes:

- *packet mode*: the CIWS IW shall receive the source data packet-by-packet;
- *file mode*: the CIWS IW shall receive the source data file-by-file.

UR.3.1.2.020 Packet formats

In this mode the source data shall be encapsulated in data packets according to various layouts.

The CIWS-FW shall support the following packet layouts:

- ECSS PUS layouts, which is compliant with the ECSS standard adopted by Space Agencies for Telemetry/Telecommand source packet of space-born instruments;
- CIWS layouts, defined in AD[1], which identifies the minimum set of ECSS-based layouts supported by the CIWS-FW for the packet format mode. This is meant mainly for ground-based telescopes.

UR.3.1.2.040 File formats

In this mode the source data shall be received through files formatted according one of the following formats:

- FITS (Flexible Image Transport System) format [RD.3];
- Extensible Mark-up Language (XML) format [RD.5];
- TBD format.

UR.3.1.2.050 FITS format typical usage

The FITS file shall consist of one or more headers containing ASCII card images (80 character fixed-length strings) that carry keyword/value pairs, interleaved between data blocks.

The header shall be used to save the metadata describing the contents and context of the data saved into the data block. The data block shall be used to store image data, as well as non-image data, such as spectra, photon lists, data cubes.

A FITS file may contain several extensions, and each of these may contain a data object. For example, it is possible to store x-ray and infrared exposures in the same file.

UR.3.1.2.060 XML format typical usage

XML is a mark-up language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

This shall be one of the format used for Auxiliary Source data.

UR.3.1.2.070 Instrument source data I/F

The CIWS-FW shall provide a mechanisms to acquire the instrument source data through a TCP/IP connection established as a TCP/IP Server with a suitable instrument Front-End Equipment (FEE), with the following characteristics:

- the TCP/IP socket connection shall be configurable;
- the packet mode parameters shall be configurable;
- the file mode parameters shall be configurable;

UR.3.1.2.080 Packet mode data taking

Once the TCP/IP connection has been established, the CIWS IW shall perform on each packet the following operations:

- read the packet from the socket;
- check the packet checksum (if any);
- check the packet sequence counter (if any);
- archive the packet on disk;
- notify and log checksum error;
- notify and log missing packets.

UR.3.1.2.090 Packet mode data archiving

The CIWS IW shall archive the packets by measurement as follows:

- a new file shall be created for each new measurement, or when the current file reaches the maximum allowed size;

- the file name shall be automatically assigned according to a configurable syntax, including the measurement identifier and the file sequence number;
- the file path shall be configurable;
- suitable data base entry shall be automatically created in order to allow file retrieval through DB queries;

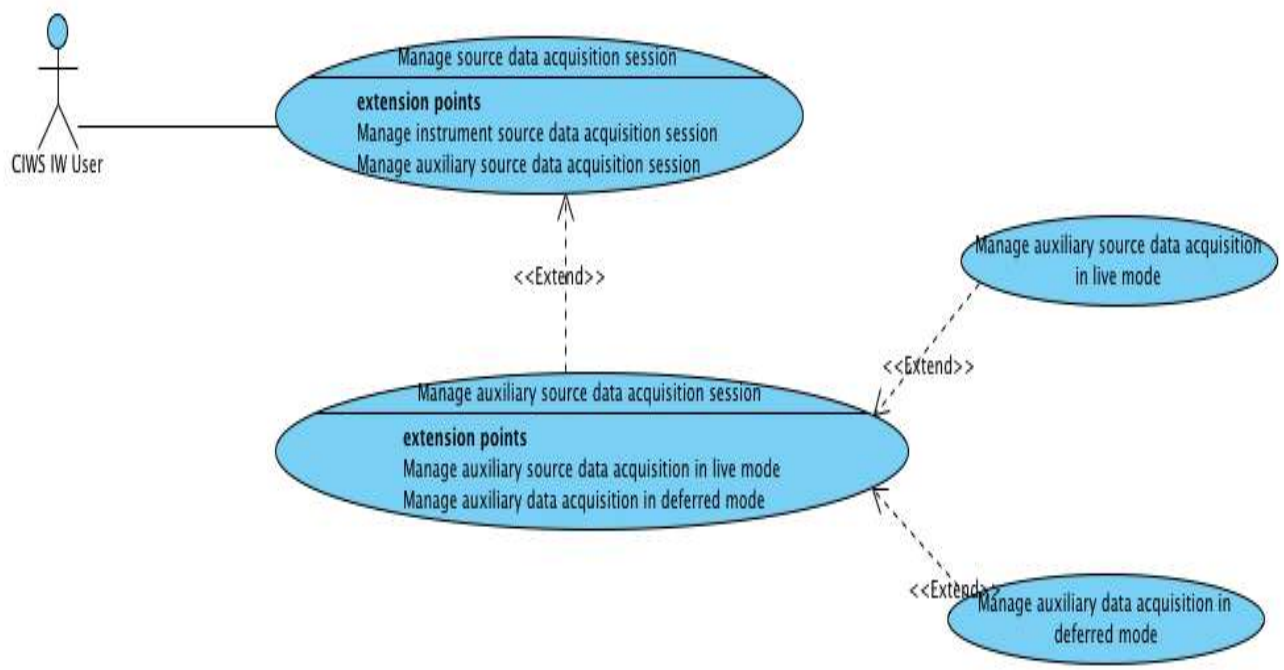
UR.3.1.2.100 File mode data taking

TBW.

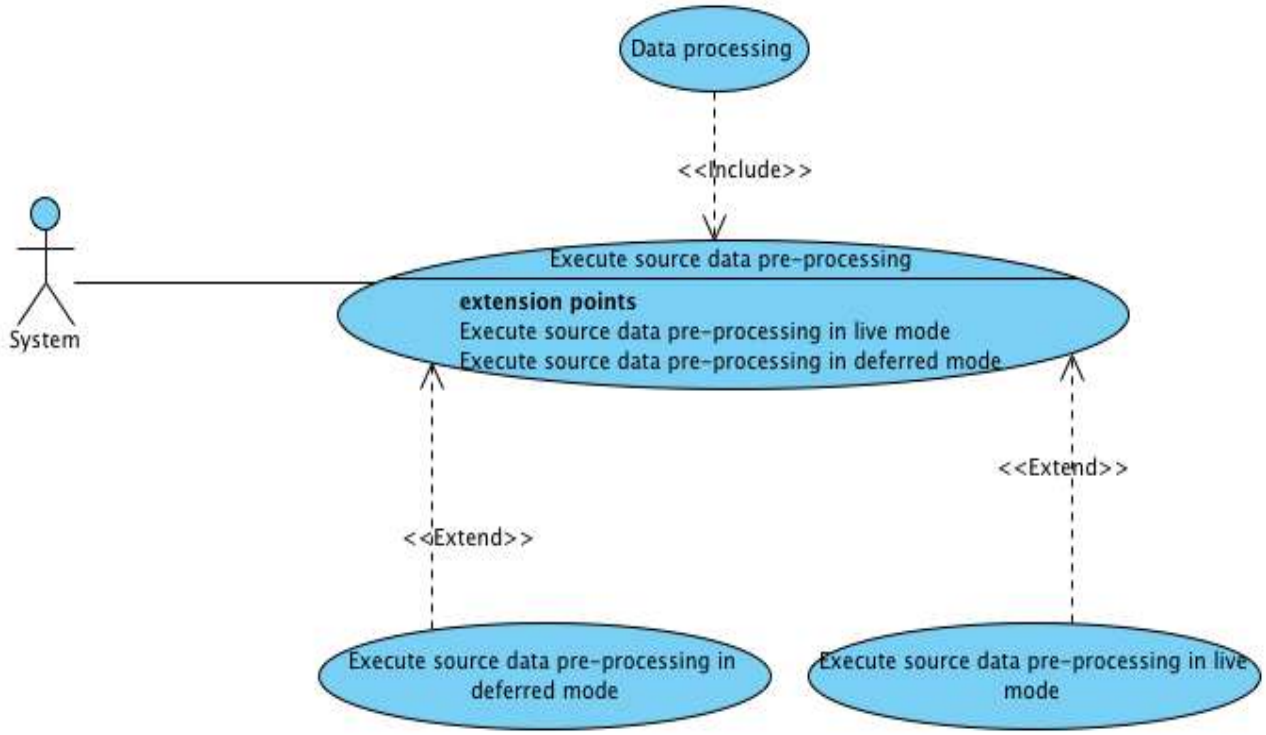
UR.3.1.2.110 File mode data archiving

TBW.

4.1.3 Execute on-line acquisition, storage and monitor of auxiliary live/deferred source data



4.1.4 Execute source data pre-processing, in order to generate the Level 1 archive (either in live mode or in retrieval mode)



UR.3.1.3.010 Pre-processing modes

The pre-processing of the source data shall be performed either in:

- on-line mode;

or

- retrieval mode.

UR.3.1.3.020 Source data access

The CIWS-FW shall provide a mechanism to access in near-real time the source data in order to perform the pre-processing operations through specific pre-processing modules to be developed by the CIWS IW Developer.

UR.3.1.3.030 Packet mode data decoding

The CIWS-FW shall provide a mechanism to easily implement through suitable configuration files the decoding of the packet mode data layouts in the pre-processing modules to be developed by the CIWS IWDeveloper.

UR.3.1.3.040 Instrument DB import

The CIWS-FW shall provide a mechanism to import the Instrument DB (when available) in order to create the configuration files required for the packet mode data decoding.

UR.3.1.3.050 L1 data archiving

TBW.

UR.3.1.3.050 L1 data retrieval

TBW.

4.1.5 L1 processing

UR.3.1.4.010 Pre-processing modes

The processing of the L1 data shall be performed either in:

- on-line mode;

or

- retrieval mode.

UR.3.1.4.020 Source data access

The CIWS-FW shall provide a mechanism to access in near-real time the L1 data in order to perform the L1 processing operations through specific modules to be developed by the CIWS IW Developer.

UR.3.1.4.030 Processing pipelines

The CIWS-FW shall provide a mechanism for the interoperation of processing modules and sequencing of operations between different processing modules to be developed by the CIWS IW Developer.

UR.3.1.3.050 L2 data archiving

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UR.3.1.3.050 L2 data retrieval

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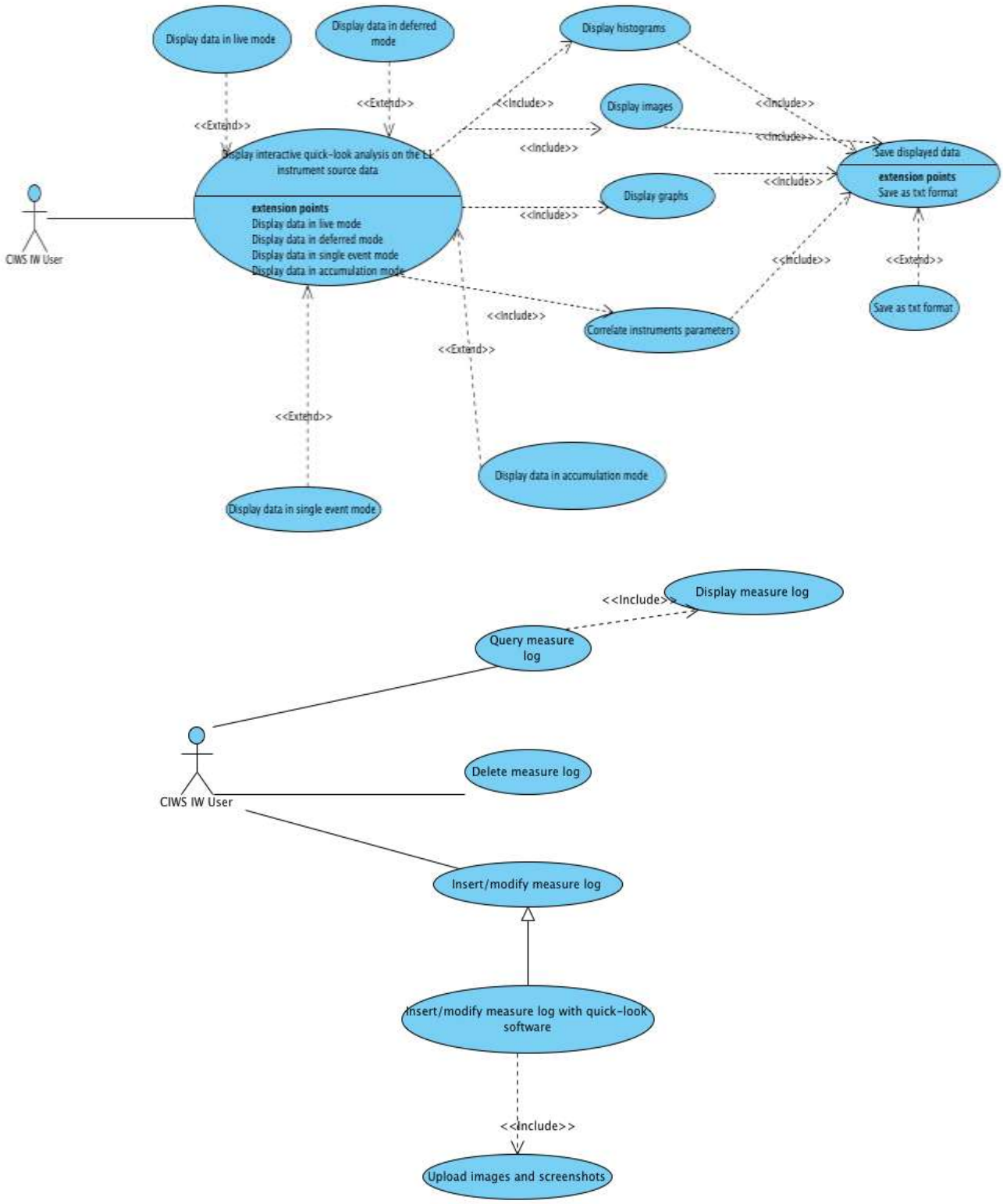
4.1.6 Execute interactive Quick Look Analysis (QLA) on the Level 1 archive (either in live or retrieval mode), and generate and archive Quick Look Reports



UR.3.1.5.010 QLA modes

The QLA of the source data shall be performed either in:

- on-line mode;

or

- retrieval mode.

UR.3.1.5.020 QLA purpose

The QLA shall:

- allow fast verification and assessment of the observation set-up, instrument functionalities and performances, and data-taking statistics;
- generate Quick Look Reports;
- generate Data Quality Reports.

UR.3.1.5.030 L1 data access

The CIWS-FW shall provide a mechanism to access in near-real time the L1 data in order to perform the QLA through specific modules to be developed by the CIWS IW Developer.

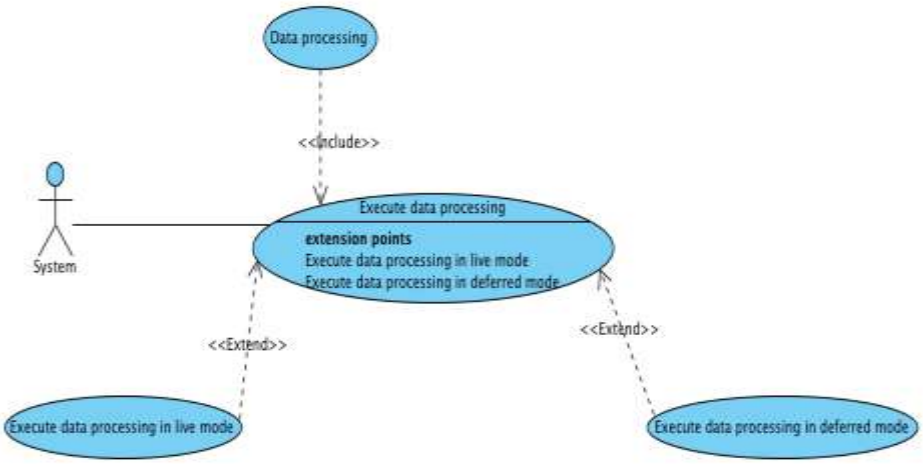
UR.3.1.5.040 QLA data products archiving

TBW.

UR.3.1.5.050 QLA data products retrieval

TBW.

4.1.7 Execute the Data Processing Pipeline (either in live or in retrieval mode) in order to produce high level data products (Level 2);



4.1.8 Data retrieval and delivery

UR.3.1.6.010 Source data retrieval

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UR.3.1.6.020 L1 data retrieval

TBW.

UR.3.1.6.030 L2 data retrieval

TBW.

UR.3.1.6.030 QLA data products retrieval

TBW.

4.1.9 Reference Catalogues

4.1.10 Source data simulation

4.2 Constraints requirements

TBW.