EUROPEAN SOUTHERN OBSERVATORY

VERY LARGE TELESCOPE

Data Flow for VLT instruments
Requirement Specification

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Chapter 1

Introduction

The VLT Data Flow System (DFS) has first been defined as a concept in 1995, several years after the VLT Control System was specified. It provides a high level integration of tools and utilities needed for the VLT Science Operations. For an efficient operation of the VLT, instruments must be well integrated into the Data Flow System.

1.1 Purpose

This document defines the interface between a VLT Instrument Consortium (VIC) and Data Flow System in terms of deliveries and dependencies. It lists a complete set of Data Flow System related tasks which should be executed by a VIC and the specific product to be delivered. Depending on the complexity of a given instrument, some of these deliveries may be waived by ESO after an explicit agreement.

Dependencies on products provided by ESO are also listed to make it easier for a VIC to perform its planning. A typical schedule for the Data Flow System related tasks linked to a VLT instrument is given with the minimum set of milestones required.

1.2 Scope

The current specifications address all tasks related to the Data Flow System which must be considered by a VIC in the context of building and delivering a VLT instrument. Instruments build internally in ESO follow exactly the same scheme with ESO being in the role of the VIC.

1.3 Applicable Documents

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall be considered as a superseding requirement.

[1]	Data Flow Operations Model for VLT/VLTI Instrumentation	`VLT-PLA-ESO-19000-1183`
[2]	ICD between VCS and P2PP System	`VLT-ICD-ESO-17240-19200`
[3]	Data Interface Control Document	`GEN-SPE-ESO-19400-0794`

[4] Instrument Description and Calibration Database Design — VLT-SPE-ESO-19400-1716

[5] DFS/Quality Control - ETC/Simulation Programmer Manual — VLT-MAN-ESO-19600-1711

1.4 Reference Documents

The following documents are referenced in this document.

[6] Science Operations Plan — VLT-PLA-ESO-10000-0441

[7] HOS/Sequencer - User Manual — VLT-MAN-ESO-17220-0737

[8] VLT On-line Data Flow. Requirement Specification — VLT-SPE-ESO-19000-0749

[9] VLT Instrument Definitions and Calibration Databases - User Requirements — VLT-SPE-ESO-19400-1710

[10] DFS Specifications for Pipeline and Quality Control — VLT-SPE-ESO-19000-1233

1.4.1 Abbreviations and Acronyms

The following abbreviations and acronyms are used in this document as shown below:

CFP	Call for Proposals
DFIR	Data Flow Instrument Responsible
DFO	Data Flow Operations Group of DMD
DFS	Data Flow System
DICB	Data Interface Control Board
DID	Data Interface Dictionary
DMD	Data Management and Operations Division of ESO
DPG	Data Pipeline Group of DMD
DRS	Data Reduction Specifications
EII	European Instrument Integration
EIR	ESO Instrument Responsible
ESO	European Southern Observatory
ETC	Exposure Time Calculator
GUI	Graphical User Interface
FDR	Final Design Review
FID	Final Instrument Delivery
IDC	Instrument Description and Calibration Database
INS	Instrument Division of ESO
OB	Observation Block
P2PP	Phase 2 Proposal Preparation
PDR	Preliminary Design Review
PI	Principal Investigator
RB	Reduction Block
SEG	System Engineering Group of DMD
SAG	Science Archive Group of DMD
SV	Science Verification
USG	User Support Group of DMD

VC	VLT Instrument Commission
VCS	VLT Control Software
VIC	VLT Instrument Consortium
VIT	VLT Instrument Team
VLT	Very Large Telescope
WBS	Work Breakdown Structure
WWW	World Wide Web

1.4.2 Glossary

Acquisition template: A specific operations template to position the telescope and instrument correctly.

Data Interface Dictionary: A computer readable dictionary which defines all terms used by the Data Flow System to describe data e.g. meaning of keywords in FITS headers and setup files.

Exposure: It entails a single set of integrations and is defined by a single set of setup files. It encompasses the setup of an instrument, readout operations of a detector and data storage. It is the minimum the observation software can obtain. It produces a complete data frame.

Frame: Data unit which assembles all relevant information with the scientific data.

Integration: The interval for which a detector is collecting data. The integration is a subunit of an exposure and does not imply a readout operation.

Observation block: A logical unit of exposures needed to obtain a coherent set of data. Encompasses all relevant information for a successful data acquisition on a target. It consists of target information, a set of operation templates (or sequences), parameter files for the templates, conditions, requirements, and comments concerning the specified observation. It represents the entity the short–term scheduler deals with.

Observing program: A set of observations on various targets to answer a specific scientific (or technical) question.

Operation template: A set of instructions for the performance of a standard operation on an instrument, the instrument and detector setups. The templates represent specially devised sequences for often used instrument operations and calibrations.

Pipeline: A set of automatic reduction procedures which is applied to the raw data to remove detector and instrument signatures. The result allows an assessment of the data quality but may not be suitable for ultimate scientific analysis.

Science archive: A Database which stores observational and calibration data, logs, weather data, and reduction procedures. It further contains information on telescope, instruments, and detectors.

Service mode observing: An observing mode where ESO staff performs the actual observations according to a schedule and specific program requirements. The PI may monitor the results but will not modify the schedule in real-time.

Template: General term for any type of template *e.g.* operation and acquisition (see **Operation template**).

Visitor mode observing: An observing mode where the astronomers obtain their observations during fixed, allocated calendar periods and participates in their execution momentarily.

Chapter 2

Overview

The Data Flow System provides users with a consistent, unified view of VLT instruments which makes it easier and more efficient to perform observations with the wide range of instrumentation available at the VLT observatory. This can be achieved only if all VLT instruments implement a fully conforming interface to the Data Flow System. This document details all Data Flow System components and interfaces which an instrument must implement to ensure full compatibility. A summary of the Data Flow concept is given in Ch. 3 where the general infrastructure and terminology used are presented.

The instrument specific components of the Data Flow System are detailed in Ch. 4 which provides a general overview of their functionality and relation to the Data Flow System infrastructure. The explicit items which must be delivered by a VIC are listed in Ch. 5. The dependencies between the individual items and other components are discussed to make possible constraints on the development plan clear.

A generic schedule for Data Flow System related activities of a VIC is given in Ch. 6 with the minimum required set of milestones. A typical phasing of these tasks is presented. Chapter 7 goes through the testing and acceptance procedures for items delivered by the VIC including related ESO activities.

The appendices present information in a summarized form such as the Table of Contents of a typical Calibration Plan (App. A), the list of deliverables (App. B), the standard form used for acceptance of deliveries (App. C), and the table of dependencies between different activities (App. D).

Chapter 3

Data Flow Concept

The Data Flow System provides a high level infrastructure for handling science data within the VLT environment. A consistent, homogeneous view is essential for the efficient operation of the large number of instruments available on the VLT. The general requirements for the Data Flow System are defined in [8]. Many of the design concepts are taken from the object-oriented methodology where one creates a model for the general behavior of the system and hides the detailed implementation. In the same way, the Data Flow System infrastructure deals with the general characteristics of VLT instruments while specific instruments are supported by implementing separated modules which obey the general interface definitions. This chapter gives a short description of the Data Flow System infrastructure while the instrument specific components are discussed in the next chapter (see Ch. 4).

3.1 Basic concept

The top level Data Flow System model defines the prime aim of the system to be: a) support of definition and execution of observing programs, b) archival of data acquired, and c) execution of basic reductions and quality control of data.

Users can propose observing programs to be executed at the facilities to solve astronomical or technical problems. The availability of the facilities is announced through a Call for Proposals (CFP). The proposals are reviewed in a peer–to–peer process which assigns them a rank depending on technical feasibility and scientific merits.

Proposers which have received sufficiently high rank to be considered must detail their observing programs as a collection of Observation Blocks (OB's) which each defines a set of exposures. For Service Mode (SM) observations, a complete set of OB's must be prepared in advance whereas visitor mode (VM) observers can create their OB's at any time before the actual observations.

Each OB consists of an acquisition template and a set of operational templates which control the actual observations where the acquisition template may specify a null operation in some cases e.g. for certain types of calibrations. The Phase 2 Proposal Preparation (P2PP) system provides tools for easy definition of OB's and the associated templates parameters.

Both for the proposal preparation and the detailed specification of OB's, Exposure Time Calculators (ETC's) may be used to optimize the instrument configuration and estimate the exposure time required to achieve the objectives.

The OB's associated to accepted service mode programs will be transfered to the observatory where they will be executed depending on their ranking and requirements for observing conditions. In addition, technical programs must be defined in the Calibration Plan for each instrument. These technical programs specify all OB's required to obtain data for the calibration of all instrument modes offered.

All data acquired are passed to the Science Archive which makes a safe copy of them together with log files generated during the observations. Besides ensuring that no data get lost, the archive also distributes data to other systems *e.g.* data reduction pipeline, quality control and off–line workstation.

In Service Mode, data are forwarded to a first basic Quality Control level 0 check (QC0) which verifies that the conditions specified in the corresponding OB were fulfilled and that no major data acquisition errors occured.

Data are also transfered to the data reduction pipeline which classifies new frames and creates Reduction Blocks (RB's) specifying the reduction tasks to be applied to the frames. The reductions use the calibration data available in the Calibration Database. The general reduction steps are described in the Calibration Plan while the detailed algorithms are specified in the Data Reduction Specification document. Based on these documents, a set of Pipeline Configuration Files (PCF's) are created to control the behavior. The reduced frames are made available to the user and operations.

The final step is the Quality Control level 1 validation (QC1) where a full trend analysis of calibration data acquired by technical programs are conducted and new master calibrations are created. Depending on the stability and performance of instruments, the Technical Programs may be updated. Certified calibration data are placed in the Calibration Database through which they are available to the pipeline. The estimates from ETC's are also compared with the calibration data. If discrepancies are detected, the ETC database is updated to reflect the current performance of the instrument.

Chapter 4

Instrument Specific Components

Besides the general Data Flow System infrastructure which is independent of any specific instrument, several Data Flow System components are dependent on the detailed capabilities of the instrument in question. This chapter describes these instrument specific Data Flow System components and their relation to the general infrastructure.

4.1 Template

Templates define the basic modes of operation for a given instrument. Since OB's are defined as a sequence of templates, a user in general only performs observations which can be specified in terms of templates whereas engineers can also interact at lower levels.

The concept of templates is very similar to encapsulation use in object oriented design in the sense that the Data Flow System only sees the public interface of a template and not the actual implementation. The interface is specified as the Template Signature which defines all formal parameters the user can give and their valid range (see [2]). This information is used by P2PP for the construction of OB's.

The actual template implementation is used by the instrument OS only and is typically written in the VLT Sequencer script language (see [7]). Thus, the template scripts are not considered a part of the Data Flow System specific components.

4.2 Instrument Description Database

The light passing through an instrument is modified by a number of optical elements (*e.g.* mirrors, lenses, filters and gratings) before it reaches the detector. An instrument mode is defined by the specific set of components in the light path. To define all possible mode of an instrument, the complete set of optical components including detectors has to be defined. Further, all valid combinations must be specified.

The full description of all optical components available for an instrument and the valid combination of them are given in the Instrument Description Database (see [4]). It contains unique identifiers and characteristics for each component (see [4,3]). Besides information on the individual components and their relation to instrument modes, availability and historic records are stored. Further, several files defining data formats (*e.g.* instrument specific data dictionaries [3]), OB descriptions and Template Signatures can be accessed through this Database.

4.3 Calibration Database

All data required to calibrate raw frames from the instrument are stored in the Calibration Database (see [4]). These include calibration frames (*e.g.* certified dark and flat field frames), tables (*e.g.* photometric and spectroscopic calibration tables) and physical data required (*e.g.* wavelength tables and photometric standards).

The Database is first populated with tentative data from the European Instrument Integration (EII) of the instrument which are refined during the Commissioning Phases at the VLT. The first official version is created after VLT Commission-2 (VC2) and checked by ESO using data obtained during the Science Verification (SV).

4.4 Exposure Time Calculator

The basic performance of the instrument is described by the associated Exposure Time Calculator (ETC) which for all available modes estimates the relation between exposure time and expected Signal-to-Noise ratio under a set of conditions (*e.g.* seeing and sky background).

The ETC is used by PI's in their preparation to optimize the observations with respect to instrument modes and parameters. A user accesses the ETC through the World Wide Web while the actual calculations are done by a server located in ESO. This server contains modules for each optical component of the instrument as given in the Instrument Description and Calibration Database [4]. The modules and their general interfaces are defined in [5].

4.5 Data Interface Dictionary

The special keywords used for describing data from an instrument must be defined in a Data Interface Dictionary. This includes e.g. the FITS keywords to describe the instrument state in raw data files, keywords in instrument setup files. It contains a complete list of term (e.g. keywords) defined for the instrument with a detailed description conforming to [3]. It must be submitted to DICB for approval.

4.6 Pipeline and Quality Control

The Pipeline receives raw data frames from the Science Archive and classifies them according to the specifications given in the Pipeline Configuration files (see [10]). Frames which could be classified will be reduced by applying a set of reduction recipes or procedures. These reductions will use calibration data available in the Calibration Database. The resulting reduced frames are then made available to subscribers *e.g.* Science Archive, Quality Control and Off-line User Workstation.

Although several general reduction recipes will be available, all instrument specific recipes must be defined and implemented. This is done by writing routines and modules according to specifications defined by ESO (see [1]).

Two levels of Quality Control are defined for Service Mode observations, namely: `QC0` which verifies that raw data frames were obtained under the conditions specified in the ObservationBlock and that basic data properties are within limits, and `QC1` which checks

the quality of reduced frames, generates certified calibration data, performs trend analysis of the calibration solutions and finally compares the instrument performance with the model described by the instrument ETC.

Chapter 5

Deliverables

The explicit deliverables associated with the instrument specific Data Flow System components (Ch.4) are listed in this chapter while a summary is given in Appendix B.

5.1 Data Flow System User Requirements

The general scope of the Data Flow System for the instrument is described in the Data Flow System User Requirements document. It defines the user requirements including operational scenarios which must be supported and therefore may impact definition of templates, ETC or pipeline procedures. Other Data Flow System documents (e.g. Calibration Plan) are based on these requirements. Depending on the complexity of the instruments, this document may be omitted.

Explicit deliveries: 1. DFS User Requirements document

Usage by ESO: This document defines the high level scope of the Data Flow System for the instrument.

5.2 Calibration Plan

The Calibration Plan is the prime document which describes the different instrument specific components of the Data Flow System. It defines the following items:

1. all templates available for the instrument,
2. formats of all raw data frames produced,
3. data and procedures required for calibration,
4. observing programs to acquire calibration data,
5. procedures required for verification of instrument performance.

The detailed content and layout of the Calibration Plan are described in Appendix A.

Explicit deliveries: 1. Calibration Plan document

Usage by ESO: This document defines detailed scope of the Data Flow System implementation for the instrument.

5.3 Template Signatures

The parameters of a template are defined as its signature which is specified in the Calibration Plan. This information is coded in a file for each template (see [2]) and used by the P2PP system for definition of OB's. The valid range of the individual parameters are also given to make it possible for P2PP to perform sanity checks. Parameters which specify the use of optical components must refer to items defined in the Instrument Description and Calibration Database (IDC).

Explicit deliveries:
1. one Template Signature file for each template defined in the Calibration Plan including detailed descriptions its function and parameters.

Usage by ESO: The Template Signatures will be used by the P2PP tool to create OB's for the instrument.

5.4 Instrument Description and Calibration Database

All detector and optical components which can be used in the instrument must be defined in the Instrument Description and Calibration Database (see [4]). Further, all physical data required for calibrations and quality control must be defined as specified in the Calibration Plan (see [4]) if they are specific to the instrument. This may include tables of wavelengths for spectral calibration lamps and lists of standard stars with their magnitudes and positions.

Explicit deliveries:
1. one file for each detector or optical component defining its properties,
2. one file for each physical data set defined in the Calibration Plan.

Usage by ESO: The data will be integrated into the Instrument Description and Calibration Database by ESO. They will be used by a) P2PP to define available components, b) ETC to define optical characteristics of components and c) reduction pipeline to access physical data required.

5.5 Exposure Time Calculator

An Exposure Time Calculator must be available for all instrument mode. It is used by people during the proposal preparation phases to estimate the exposure time required for a given instrument configuration. Calibrations are also checked against the values predicted by the ETC to verify that it reflects the current state of the instrument. Modules, not yet available, must be delivered together with verification procedures as specified in [5]. Further, a ETC instrument setup template and associated dictionary must be provided.

Explicit deliveries:
1. one instrument setup template including the associated dictionary,
2. one source code file for each component, not yet available, including full documentation,
3. one source code file of the instrument model with documentation if not yet available,
4. one file for each instrument setup with a verification procedure.

Usage by ESO: The additional modules will be included in the general ETC library whereas the verification procedures will be included in the ESO regression tests of ETC's. ESO will create the GUI's required for the instrument ETC either by adding to existing ones or creating a new.

5.6 Data Interface Dictionary

All data generated by the instrument are described by a set of data definitions e.g. keywords for FITS files (see [3]). These data definitions describe the instrument state at acquisition and are used by the pipeline and quality control. The Dictionary is reviewed by DICB to ensure that it conforms to the standards (see [3]).

Explicit deliveries:
1. one file defining the Data Interface Dictionary for the instrument conforming to the DICB standard.

Usage by ESO: The DID will be reviewed and accepted by DICB. After the acceptance, it will serve as the reference for the data description of raw data frames when used by the Science Archive, Pipeline and Quality Control.

5.7 Data Reduction Specifications

This document defines all special algorithms required for the reduction of raw data from the instrument. The Data Flow System pipeline will provide a set of standard functions (e.g. arithmetic on images, manipulations on table). Only algorithms which are not available and therefore must be developed should be specified in this document. The high level usage of these algorithms is defined in the Calibration Plan.

Explicit deliveries:
1. Data Reduction Specifications document

Usage by ESO: This document defines the detailed data reduction procedures to be applied to raw data frames including input data and algorithms required.

5.8 Data Reduction Procedures

The special algorithms, defined in the Data Reduction Specification, must be implemented and delivered according the ESO specifications (see [1]). The set of procedures implementing these algorithms will be integrated into the Data Flow System Pipeline for the instrument by ESO. The configuration of the Pipeline will also be made by ESO based on the Calibration Plan.

Explicit deliveries:
1. one source code file of each data reduction procedure, not yet available, including full documentation,
2. one set of test data for each of these procedures.
3. one verification procedure for each of these procedures,

Usage by ESO: The procedures will be integrated into the DFS pipeline by ESO who also will configure it.

5.9 Test and Calibration Data

It is essential that all raw data produced by the instrument are fully documented as defined by the Data Interface Dictionary. Further, it must be possible to calibrate and reduce data from instrument modes offered in Service Mode. A full set of raw data frames from the instrument must be provided to verify the conformance of the data to the Data Interface Dictionary. These data will also be used for the testing of the Pipeline by ESO. Finally, calibration data must be generated for the configurations offered in Service Mode. They will be used to generate a set of master calibration frames in the Calibration Database.

Explicit deliveries:
1. one full set of raw data frames produced by each template,
2. one full data set required to generate each calibration frame defined by the Calibration Plan.

Usage by ESO: The data sets define the reference data for the instrument. They will be used the check the DID/DICB compliance of raw data and verify pipeline reduction procedures. Further, the calibration frames produced will initiate the first version of the Calibration Database. Estimated provided by the ETC will also be verified using these data.

Chapter 6

Generic Schedule

A typical schedule of the Data Flow System related tasks is presented together with the minimum set of milestones.

6.1 Milestones

The following minimum set of milestones must be defined for an instrument project:

Act ID	Milestone	Pred. List
M-01	PDR	DFS User Requirements v0.5, Calibration Plan v0.5, Data Reduction Specifications v0.5
M-02	FDR	DFS User Requirements v1.0, Calibration Plan v1.0, Data Reduction Specifications v1.0
M-03	EII	Data Interface Dictionary v0.5, Data Reduction Procedures v0.9
M-04	CFP	Exposure Time Calculator v1.0
M-05	VC1	Data Interface Dictionary v0.9
M-06	VC2	Data Interface Dictionary v1.0, Template Signatures v0.9
M-08	FID	Instrument Description and Calibration Database v1.0, Data Interface Dictionary v1.0, Exposure Time Calculator v1.1, Template Signatures v1.0, Data Reduction Procedures v1.0

The Final Instrument Delivery (FID) for the Data Flow System denotes the termination of the project and the transfer of responsibilities to the VLT Instrument Operations Team.

6.2 Generic Schedule

A generic schedule is shown in Fig. 6.1 while the logical network of dependencies is given in Fig. 6.2.

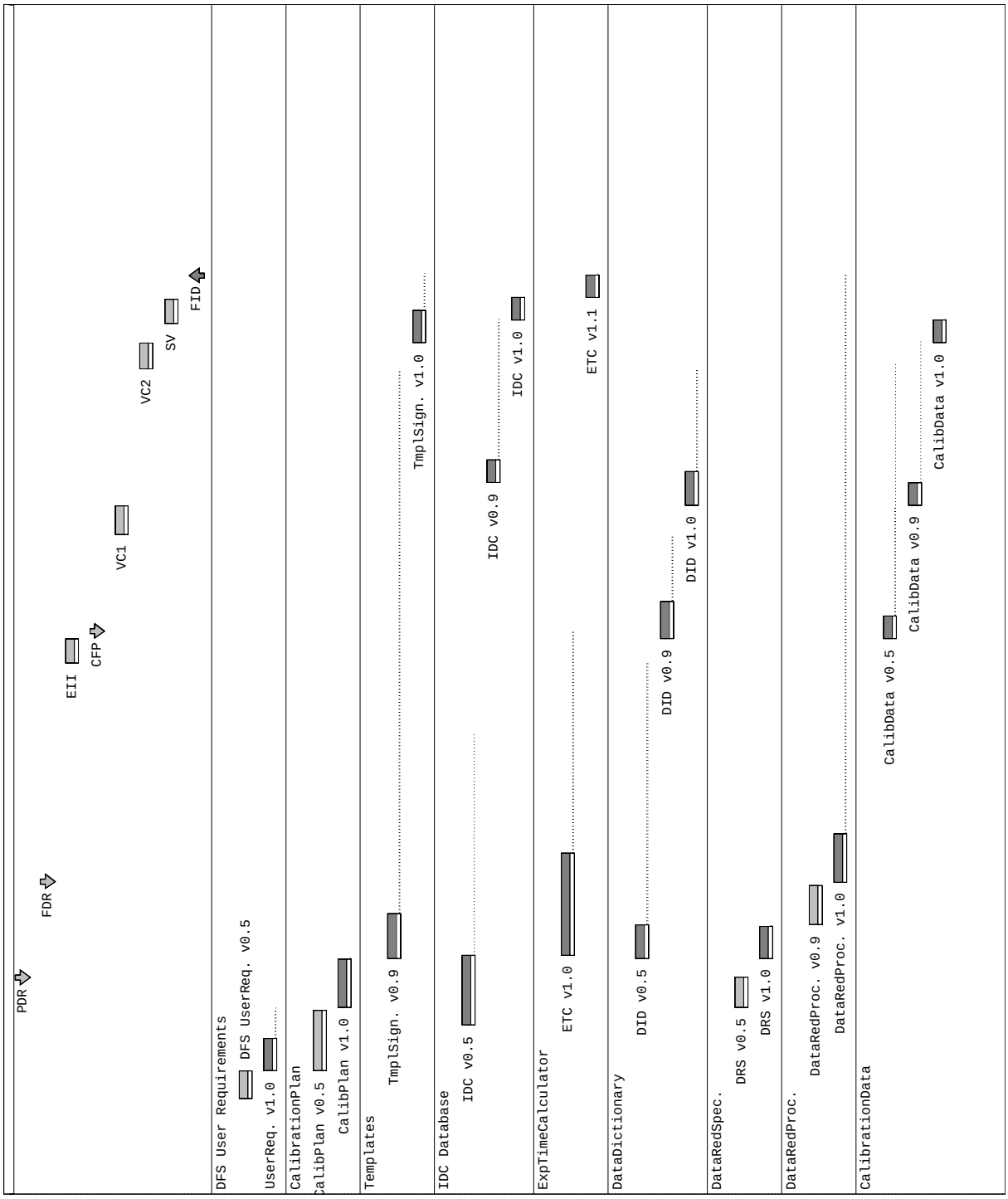

Figure 6.1: Generic schedule for Data Flow System tasks

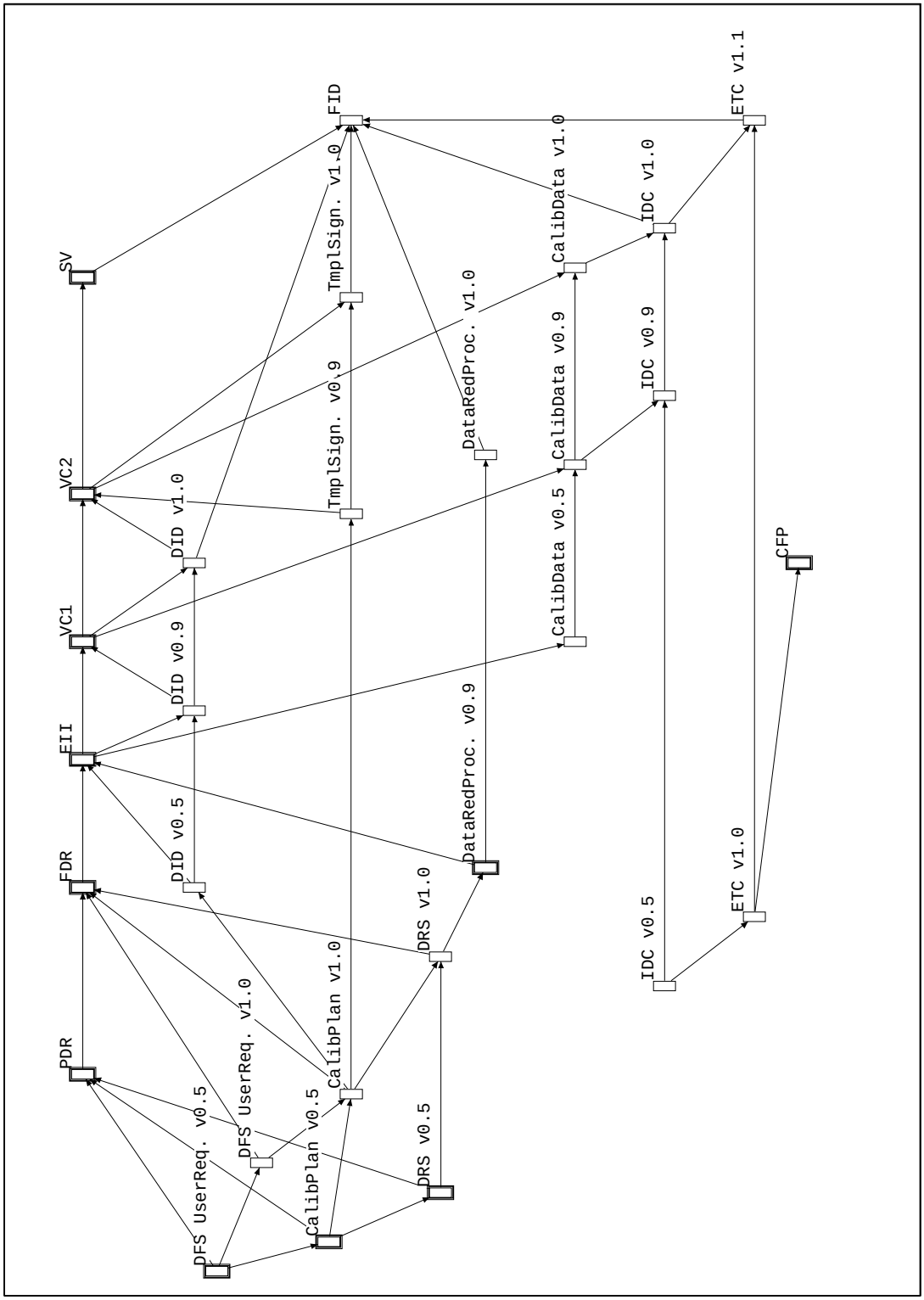

Figure 6.2: Logical network diagram for Data Flow System tasks.

Chapter 7

Reviews and Acceptance Tests

Designs and specifications for a VLT instrument are assessed during the two major Design Review. The explicit review items related to Data Flow System components are listed in this chapter. Further, the major delivery milestones for the project are discussed in terms of their relation to Data Flow System deliveries and acceptance tests. The Data Flow System objectives during the different test and commissioning phases are also shown.

7.1 Preliminary Design Review

The following items must be included in the PDR:

1. preliminary schedule for the Data Flow System related activities
2. draft version of the Data Flow System User Requirements document if appropriate
3. draft version of the Calibration Plan including a list of all planned templates
4. table of content of the Data Reduction Specifications including a list of major reduction algorithms which must be developed

7.2 Final Design Review

The following items must be included in the FDR:

1. schedule for the Data Flow System related activities
2. Data Flow System User Requirements document, if appropriate
3. first version of Calibration Plan
4. first version of Data Reduction Specifications

7.3 European Instrument Integration

The following activities must be performed during the European Integration test:

1. execution of calibration Templates
2. production of a set of raw data frames corresponding to the calibration Templates

The test results will be used by ESO to execute the tasks listed below:

1. verify the basic set of pipeline and quality control procedures for calibration data
2. create the Calibration Database v0.5
3. check DID conformance of raw data

7.4 Call for Proposals

The following activities must be concluded before the Call for Proposals:

1. preliminary version of the IDC Database must be delivered
2. Version 1.0 of the ETC must be delivered and its results verified
3. User level description of the Data Flow System for the instrument must be available (e.g. based on the Data Flow System User Requirements)

7.5 VLT Instrument Commissioning 1

The following activities must be performed during the Commissioning 1 of the instrument:

1. execution of calibration Templates
2. production of a full set of raw frames from the instrument

The test results will be used by ESO to execute the tasks listed below:

1. verify all pipeline and quality control procedures
2. create the Calibration Database v0.9
3. check DID conformance of raw data frames
4. verify Instrument Description and Calibration Database

7.6 VLT Instrument Commissioning 2

The following activities must be performed during the Commissioning 2 of the instrument:

1. final test of all templates
2. creation of a full set of raw frames from the instrument
3. production of data set to verify the ETC performance
4. test creation of OB's including all types of templates (by ESO)
5. test all on-line pipeline and quality control procedures (by ESO)

The test results will be used by ESO to execute the tasks listed below:

1. certify DID conformance of all raw data frames
2. create the Calibration Database v1.0
3. delivery of instrument specific pipeline and quality control procedures

7.7 Final Instrument Delivery

All Data Flow System related deliveries must be accepted before Final Instrument Delivery. The last items are:

1. version 1.0 of IDC Database must be delivered
2. version 1.1 of the ETC must be delivered and its results verified

The following activities will be performed by ESO based on the results obtained during Science Verification of the instrument:

1. verify accuracy of ETC v1.1
2. verify performance of pipeline and quality control procedures
3. evaluate execution of calibration procedures according the Calibration Plan

Appendix A

Layout of Calibration Plan

The Calibration Plan is one of the most important documents for the Data Flow System related components in a VLT instrument project as it defines all instrument modes visible to the general user and their calibrations. The general layout of this document is specified in this appendix.

A.1 Table of Content

The Calibration Plan is the prime document which describes the different instrument specific components of the Data Flow System. It must define the following items:

Templates: all templates available for the instrument are listed with a detailed description of the function they perform. Their signatures are defined with all parameters which can be specified by the user.

Raw Frames: the format of all raw data frames produced by templates are described with the reduction procedures applicable for them.

Calibrations: data and procedures required for calibration of all instrument modes are detailed.

Technical Programs: observing programs to acquire calibration data are defined with preliminary estimates of the frequency with which they should be executed. This should be done by defining a complete set of calibration OB's for the instrument i.e. including the targets used.

Quality Control: procedures required for verification of the instrument performance and technical quality of the data should be given.

It should include the sections listed in the Table of Content below. Additional sections may be added depending on the actual instrument.

Calibration Plan
Table of Content

A.2 Template specifications

Each Template specification must at least define the following items:

1. **Name:**
   User friendly name for template (see [3])
2. **Identifier:**
   Unique identifier for template (see [3])
3. **Description:**
   A description of the operations performed by the template is given. The purpose and main applications for the template should also be discussed.
4. **Parameters:**
   A complete list of parameters to the template is given. A detailed description, type and valid range for each parameter are also specified. Default values are given for optional parameters.
5. **Raw frames:**
   All raw data frames produced by the template are described.
6. **Pipeline procedures:**
   The pipeline procedures required to process the data produced by the template are described. This includes a list of major processing steps, their input parameters, and resulting data products. Required calibration data must also be listed.

A.3 Technical Programs

Each Technical Program must define the following items:

1. **Name:**
   Title of the Technical Program
2. **Program Identifier:**
   A Quality Control naming scheme will be defined to attribute a unique identifier to each Technical Program. These programs when submitted to the Proposal Handling system will receive a program ID reference.
3. **Purpose:**
   A description of the purpose of the Technical Program.
4. **Description:**
   A complete description of the program. Which target is observed, under which conditions, with which instrument configuration. Template names and their signature are explicitly given. Observation Blocks are described.
5. **Observation Conditions:**
   Observation condition under which the program must be performed.
6. **Frequency:**
   The frequency and conditions under which the Technical Program is submitted.
7. **Special Conditions:**
   Any special condition under which the program must be scheduled.
8. **Analysis Procedure:**
   The associated Quality Control procedure is described. What reduction is applied, which results are generated. What consistency tests are applied to verify the data are proper.
9. **Products:**
   Name of the generated products (Quality Control report, Tables, Documents, WWW).
10. **Accuracies:**
    The expected accuracies are indicated.
11. **Responsible Person:**
    In a first time TBD, later the name of the DFIR who will follow the Technical Program.

The following example shows a simple technical program for periodic measurements of the photometric zero point for a set of filters:

```
1) Name:     U,B,V,R,I throughput measurements

2) Program Identifier:    TP-xxx-IMA-THRU-0001

3) Purpose:   Bi-monthly measurement of instrumental throughput

4) Description:
     The standard star HR4554 (spectral type A0V) is observed with
     different filters to measure the system throughput in the bands
     U,B,V,R,I. For each star three (3) exposures of 150, 300, 450 s are
     performed.
```

```
     - For each exposure time t=150, 300, 450 seconds, the following
       templates are executed:
       a) Template xxx-C-T-ILAT99, filter=ESO#640 (U)
       b) Template xxx-C-T-ILAT99, filter=ESO#639 (B)
       c) Template xxx-C-T-ILAT99, filter=ESO#641 (V)
       d) Template xxx-C-T-ILAT99, filter=ESO#642 (R)
       e) Template xxx-C-T-ILAT99, filter=ESO#705 (Gunn i)
   - A bias template is executed:
      f) Template xxx-C-T-BIAS01

5) Observation Conditions
     The observation is performed under photometric conditions
     at airmass between 1.0 and 1.2 and seeing between 0.4 and 0.9 arcsec.

6) Frequency:    bi-monthly

7) Special Conditions:
     The technical program must be scheduled just after each cleaning
     or realuminisation of the optics of the telescope or instrument.

8) Analysis Procedure:
     The routine STDPHOT is applied to each image and the count rates
     in electrons/sec and scaled to an airmass of 1.0 are generated
     for each band.

9) Products:
     A throughput Quality Control report is generated, using the
     template QC-CAM-THRU

10) Accuracies:
     In each band the measurements for the 3 different exposure times
     should not differ by more than 2%, and the throughput should not
     deviate by more than 20% from the nominal throughput:
     900 e/s in U, 1200 e/s in B, 1400 e/s in V, 1300 e/s in R, 900 e/s in I.

11) Responsible Person:   John Dfir
```

Appendix B

Summary of Deliveries

This appendix lists all items related to the Data Flow System which must be delivered by a VLT Instrument Consortium. All items are delivered directly to the EIR who officially accepts them after they have been checked and accepted by the groups listed in the '*Accepted by*' entry of the forms below. For each delivery an **Acceptance Form** is issued and signed by the parties (see App. C).

B.1 Data Flow System User Requirements

	Description
Activity	DFS User Requirements v0.5
Accepted by	INS, USG, DFO, DPG
Dependencies	1) Instrument specifications
Deliveries	1) Document defining the top level user requirements for the instrument dependent part of Data Flow System. It should also consider operational scenarios important for Data Flow System. The version 0.5 must outline major requirements and operational scenarios.

	Description
Activity	DFS User Requirements v1.0
Accepted by	INS, USG, DFO, DPG
Dependencies	1) Data Flow System User Requirements v0.5
Deliveries	1) First version of the DFS User Requirements document

B.2 Calibration Plan

	Description
Activity	Calibration Plan v0.5
Accepted by	INS, USG, DFO, DPG
Dependencies	1) Instrument specifications, DFS User Requirements
Deliveries	1) Document defining all calibration procedures for the instrument including all templates, raw frame formats, reduction procedures and data quality control measures. Version 0.5 must list all templates with their most important parameters.

	Description
Activity	Calibration Plan v1.0
Accepted by	INS, USG, DFO, DPG
Dependencies	1) Calibration Plan v0.5
Deliveries	1) First version of the Calibration Plan

B.3 Template

	Description
Activity	Template Signatures v0.9
Accepted by	INS, USG
Dependencies	1) Calibration Plan which defines the complete set of templates for the instrument 2) FDR
Deliveries	1) One file with the signature for each template 2) One documentation file for each template

	Description
Activity	Template Signatures v1.0
Accepted by	INS, USG
Dependencies	1) Calibration Plan 2) VC1
Deliveries	1) One file with the signature for each template 2) One documentation file for each template

B.4 Instrument Description and Calibration Database

	Description
Activity Accepted by	Instrument Description and Calibration Database 0.5 INS, SAG, DPG, USG, DFO
Dependencies	1) Instrument specifications 2) Calibration Plan
Deliveries	1) List of all detector or optical components in or available for the instruments 2) One file for each component defining its characteristics 3) Document giving the user level description of the instrument for CFP

	Description
Activity Accepted by	Instrument Description and Calibration Database v0.9 INS, SAG, DPG, USG, DFO
Dependencies	1) Instrument specifications 2) VC1
Deliveries	1) List of all detector or optical components in or available for the instruments 2) One file for each component defining its characteristics

	Description
Activity Accepted by	Instrument Description and Calibration Database v1.0 INS, SAG, DPG, USG, DFO
Dependencies	1) Instrument specifications 2) VC2
Deliveries	1) List of all detector or optical components in or available for the instruments 2) One file for each component defining its characteristics 3) Document giving the user level description of the instrument for CFP

B.5 Exposure Time Calculator

	Description
Activity Accepted by Constrain	Exposure Time Calculator v1.0 INS, USG, DFO, DPG must be delivered and verified 2 month before CFP
Dependencies	1) Instrument Description and Calibration Database v0.5 2) ETC library provided by ESO
Deliveries	1) Instrument setup template with associated dictionary 2) Set of server routines for each special component of the instrument which is not already included in the ESO library 3) Set of instrument models for each mode which is not already included by ESO 4) Verification procedures for ETC 5) Documentation of the ETC 6) Verification data set

	Description
Activity Accepted by Constrain	Exposure Time Calculator v1.1 INS, USG, DFO, DPG must be delivered and verified 1 month after VC2
Dependencies	1) Instrument Description and Calibration Database v1.0 2) ETC library provided by ESO
Deliveries	1) Instrument setup template with associated dictionary 2) Set of server routines for each special component of the instrument which is not already included in the ESO library 3) Set of instrument models for each mode which is not already included by ESO 4) Verification procedures for ETC 5) Documentation of the ETC 6) Verification data set

B.6 Data Reduction Specifications

	Description
Activity Accepted by	Data Reduction Specification v0.5 INS, DFO, DPG
Dependencies	1) Calibration Plan v0.5
Deliveries	1) Draft of Data Reduction Specification document

	Description
Activity Accepted by	Data Reduction Specification v1.0 INS, DFO, DPG
Dependencies	1) Calibration Plan v1.0
Deliveries	1) First version of Data Reduction Specification document

B.7 Data Reduction Procedures

	Description
Activity Accepted by Constraint	Data Reduction Procedures v0.9 DPG must be delivered 3 month before EII
Dependencies	1) Data Reduction Specification document 2) Set of reduction procedures provided by ESO
Deliveries	1) Source code of the implementation of each special reduction procedure which is not provided by ESO 2) Test routine including possible test data for each reduction procedure

	Description
Activity Accepted by Constraint	Data Reduction Procedures v1.0 DPG must be delivered 1 month before VC2
Dependencies	1) Data Reduction Specification document 2) Set of reduction procedures provided by ESO
Deliveries	1) Final source code of the implementation of each special reduction procedure which is not provided by ESO 2) Test routine including possible test data for each reduction procedure

B.8 Data Interface Definitions

	Description
Activity Accepted by Constraint	Data Interface Definitions v0.5 DICB, INS, USG, DPG must be delivered 1 months before EII
Dependencies	1) Calibration Plan which defines all raw data formats
Deliveries	1) File defining all special FITS keywords for the instrument

	Description
Activity Delivered to Accepted by Constraint	Data Interface Definitions v0.9 DICB DICB, INS, USG, DPG must be delivered 1 months before VC1
Dependencies	1) Calibration Plan which defines all raw data formats
Deliveries	1) File defining all special FITS keywords for the instrument

	Description
Activity Accepted by Constrain	Data Interface Definitions v1.0 DICB, INS, USG, DPG must be delivered 1 month before VC2
Dependencies	1) Calibration Plan which defines all raw data formats
Deliveries	1) File defining all special FITS keywords for the instrument

B.9 Calibration Data

	Description
Activity Accepted by Constrain	Calibration Data v0.5 INS, DFO, USG, DPG must be delivered 2 weeks after EII
Dependencies	1) Calibration Plan 2) Data Interface Definitions v0.5 3) European integration test
Deliveries	1) Set of raw frames for each calibration template which can be executed during the European tests 2) All tables of physical calibration data e.g. standard wavelength tables and standard stars for astrometric, photometric and spectroscopic calibration

	Description
Activity Accepted by Constrain	Calibration Data v0.9 INS, DFO, USG, DPG must be delivered 2 weeks after VC1
Dependencies	1) Calibration Plan 2) Data Interface Definitions v0.9 3) Commission 1
Deliveries	1) Set of raw frames for each template defined in the calibration plan

	Description
Activity Accepted by Constrain	Calibration Data v1.0 INS, DFO, USG, DPG must be delivered 2 weeks after VC2
Dependencies	1) Calibration Plan 2) Data Interface Definitions v1.0 3) Commission 2
Deliveries	1) Set of raw frames for each template defined in the calibration plan

Appendix C

Acceptance Forms

For each item to be delivered, an **Acceptance Form** is issued in the format shown below:

ESO/DFS Delivery Acceptance Form

Instrument : _____

Work-Package : _____

Activity name : _____

Activity ID : _____ Version: _____

Delivered by :

Date: _____ Name: _____

Received by :

Date: _____ Name: _____ Signature: _____

Remarks:

Accepted Yes/No : _____

Date: _____ Name: _____ Signature: _____

Remarks:

Accepted Yes/No : _____

Date: _____ Name: _____ Signature: _____

Remarks:

Appendix D

Work Breakdown Structure and Dependencies

This Appendix list main milestones (i.e. `M-00`) and activities (i.e. `A-000`) with the WBS and dependencies:

Table D.1: Milestones and tasks for DFS related task

Act ID	Description	WBS	Pred. List
M-01	PDR		A-011, A-071, A-021
M-02	FDR		A-012, A-072, A-022, M-01
M-03	EII		A-081, A-061, M-02
M-04	CFP		A-051
M-05	VC1		A-062, M-03
M-06	VC2		A-062, M-05, A-031
M-07	SV		M-06
M-08	FID		A-082, A-052, M-07, A-032, A-062, A-043
A-010	DFS User Requirements	1	
A-011	DFS UserReq. v0.5	1.1	
A-012	DFS UserReq. v1.0	1.2	A-011
A-020	CalibrationPlan	2	
A-021	CalibPlan v0.5	2.1	A-011
A-022	CalibPlan v1.0	2.2	A-021, A-012
A-030	Templates	3	
A-031	TmplSign. v0.9	3.1	A-022
A-032	TmplSign. v1.0	3.2	A-031, M-06
A-040	IDC Database	4	
A-041	IDC v0.5	4.1	
A-042	IDC v0.9	4.2	A-041, A-092
A-043	IDC v1.0	4.3	A-042, A-093
A-050	ExpTimeCalculator	5	
A-051	ETC v1.0	5.1	A-041
A-052	ETC v1.1	5.2	A-051, A-043
A-060	DataDictionary	6	
A-061	DID v0.5	6.1	A-022
A-062	DID v0.9	6.2	M-03, A-061
A-062	DID v1.0	6.3	M-05, A-062
A-070	DataRedSpec.	7	
A-071	DRS v0.5	7.1	A-021
A-072	DRS v1.0	7.2	A-071, A-022
A-080	DataRedProc.	8	
A-081	DataRedProc. v0.9	8.1	A-072
A-082	DataRedProc. v1.0	8.2	A-081
A-090	CalibrationData	9	
A-091	CalibData v0.5	9.1	M-03
A-092	CalibData v0.9	9.2	M-05, A-091
A-093	CalibData v1.0	9.3	M-06, A-092