Cluster Science Data System
Software Requirements for the Scandinavian Data Centre

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1   Introduction

1.1   Purpose of the document

This document contains the software requirements for the CSDS Scandinavian Data Centre (SDC).

1.2   Scope of the software

The scope of the software is to provide means to accommodate the services and products of the SDC as defined in the SDC Interface Control Document [Ref. ?].

1.3   Definitions, acronyms, and abbreviations

A complete list of acronyms is given in an appendix.

1.4   Documents

The CSDS Requirements Specifications [Ref. ?] is considered superior to this document as well as to the SDC User Requirements Document [Ref. ?]. Other, in general relevant documents are the Data delivery Interface Document [Ref. ?], the Command Request Interface Document [Ref. ?], and the Network Interface document [Ref. ?]. All referenced documents are listed under chapter Bibliography.

1.5   Overview

The structure of this document basically follows the ESA software Engineering Standards [Ref. ?] and [Ref. ?].

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General Description

2   Relation to current projects

2.1   Freja

A prototype of the ISDAT[1] will be built and used in connection with the Freja F4 experiment.

2.2   EISCAT

The ISDAT is used within the Eiscat analysis work at IRF-U. No formal inclusion of the Eiscat project is required in connection with the CEDAS.

2.3   Cluster EFW tests

A prototype of the ISDAT system is used in connection with EFW hardware integrations and tests.

3   Relation to predecessor and future projects

3.1   Viking

Viking data and analysis software modules are used to build a prototype of the detailed analysis software, ISDAT.

3.2   Polar

A self consistent software package for analysis of Polar data is under development at UCB. Possibilities to coordinate the UCB system, applied to Cluster EFW, with ISDAT is being studied, but no formal requirements of such a coordination is expressed.

4   Function and purpose

See section ??.

5   Environmental considerations

5.1   Physical environment

The detailed data analysis shall take place within EFW CoI institutions by the individual scientists. The CSDS data base production shall take place at the Royal Institute of Technology (KTH), institute of plasma physics.

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[1] Interactive Science Data Analysis Tool

5.2   Hardware

The ISDAT shall run on UNIX workstations, while the SDC will mainly operate in a Vax/VMS environment. It shall be tested whether ISDAT can be implemented on VAX/POSIX systems.

5.3   Operating system and software

There will be a mix of VMS and UNIX, see **??**.

6   Relation to other systems

6.1   CSDS

The SDC component of CEDAS constitutes an integral part of the CSDS, while the ISDAT and data distribution parts are not directly related to the CSDS.

6.2   JSOC

Connections to JSOC is handled via ESIS.

6.3   ESIS

The SDC part of CEDAS depends strongly on the future of ESIS.

6.4   WEC

A certain coordination of the detailed data analysis will take place within WEC. The level of coordination is currently under investigation.

7   General constraints

See section **??**.

8   Model description

8.1   CEDAS

No rigorous analysis method will be used in connection with this CEDAS user requirements. However, we present a model influenced by the structured analysis (SADT) method to the extent that we describe the system in terms of data flow diagrams. Figure **??** shows the high level model of the CEDAS, and the top level interfaces are specified as follows:

process, CEDAS This includes all[2] processing associated with the EFW experiment. It may also involve data from other instruments.

input, EFW command log A copy from ESOC of the EFW command sequence sent to the spacecraft.

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[2]both full resolution and CSDS associated

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Figure 1: CEDAS top level data flow

input, Cluster raw (RDM) data The raw data are received from ESOC on a TBD[3] RDM[4]. The RDM contains all scientific data from all four satellites and all instruments. In addition the RDM contains auxiliary data.

input, EFW DDS data EFW part of the DDS file. Obtained from ESOC via networks on request. Used for instrument health check and quick science analysis.

input, External CSDS products These are PPD, SPD and SPlots for all instruments except EFW.

input, FGM DDS file The FGM part of the DDS file.

control, PI The EFW PI or his authorised representative can influence several processes, for example quality control of CSDS products, EFW command sequences etc.

control, JSOC JSOC provides input for commanding, magnetospheric models, orbit information etc.

control, ESIS ESIS provides s/w for data retrieval, makes access control etc.

control, Cal These are calibration files for non-EFW instruments, in particular the FGM instrument. These files are provided via the CSDS from other DC:s.

output, EFW Detailed Analysis products These are all high resolution data, resulting from the detailed EFW data analysis, with or without additional non-EFW data. Normally these products are produced by the individual scientists at their home institutions.

output, EFW commands Command files for the EFW instrument. Communicated to JSOC for merging with WEC and other Cluster instruments.

output, CSDS products All CSDS[5] products for all instruments including EFW.

output, EFW N/RT products The EFW products produced in near real time. These products are mainly based on the DDS file.

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[3]most likely the medium will be CD-ROM
[4]Raw Data Medium
[5]See the SDC ICD [Ref. **?**] for a specification

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Figure 2: CEDAS data flow

The CEDAS subsystems are shown in Figure **??**, where the content of the processes are:

process, DD The data distribution process depends on what medium is selected for the RDM. If CD-ROM is selected, multiple copies will be distributed directly from ESOC to the EFW CoI:s. I such case, the DD process within the CEDAS will become almost obsolete.

process, ISDAT This is the complete detailed EFW data handling process. It will be performed at the EFW CoI institutions. Copies of the ISDAT software has to be distributed to all EFW CoI institutions.

process, SDC This is the process to produce all EFW related CSDS products.

control, scientist This process is controlled by individual scientists at CoI institutions.

control, operator This process is controlled by an operator.

8.2 Raw data distribution (DD)

(This section is not subject to examination by the CSDS requirements review)

It is required to provide means to access the raw data at all EFW CoI institutions. The amount of data in question is so large (see [Ref. **?**]) that distribution via computer networks is precluded. Hard copy

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Figure 3: ISDAT data flow

distribution has to be provided for. There are in total 16 EFW CoI institutions. Some of them have CoI:s in other Cluster experiments as well as the EFW, so they may have access to the raw data by other means than distribution via the CEDAS. It is probable that ESA will provide RDM copies to all Cluster CoI:s, in which case raw data copying is not needed within CEDAS. This is indicated by the dashed box in Figure **??**.

8.3 Detailed analysis (ISDAT)

(This section is not subject to examination by the CSDS requirements review)

An expansion of the ISDAT data flow is shown in Figure **??** and the components are explained as follows:

proc, Prepare A certain preparation of data is done in order to speed up the interactive data analysis. This may involve copying of data to magnetic disk, generation of index files, status files etc.

proc, DBH Data is formatted[6], calibrated and selected for eventual display and analysis.

proc, Applications Here, the analysis of data and final formatting for display is made.

control, scientist This process is controlled by individual scientists at the CoI institutions.

data, raw data This consist of all instrument raw data.

data, aux data Auxiliary data needed for the analysis. All this data is extracted from the RDM.

data, selected data Subset of the data according to time interval and instrument selected.

8.4 Generate EFW CSDS products (SDC)

An expansion of the SDC data flow is shown in Figure **??** and the components are explained as follows:

process, Receive This process includes reception, cataloguing, quality control etc of the RDM copy.

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[6]for example in logical instruments

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Figure 4: SDC data flow

input, RDM The raw data are received from ESOC on a TBD[7] RDM[8]. The RDM contains all scientific data from all four satellites and all instruments. In addition the RDM contains auxiliary data.

data, selected data This is the raw data subset needed to produce the EFW part of the CSDS products.

control, operator The Data centre operator.

process, Generate Generation of the EFW CSDS products including EFW parameters, updating of EFW calibration files, EFW command sequences etc.

input, EFW command log A copy from ESOC of the EFW command sequence sent to the spacecraft.

input, FGM DDS file The FGM part of the DDS file.

input, EFW DDS data EFW part of the DDS file. Obtained from ESOC via networks on request. Used for instrument health check and quick science analysis.

output, EFW commands Command files for the EFW instrument. Communicated to JSOC for merging with WEC and other Cluster instruments.

output, EFW N/RT products The EFW products produced in near real time. These products are mainly based on the DDS file.

data, EFW products EFW CSDS parameters and calibration files to be merged with other CSDS products.

control, PI The EFW PI or his authorised representative can influence several processes, for example quality control of CSDS products, EFW command sequences etc.

control, JSOC JSOC provides input for commanding, magnetospheric models, orbit information etc.

control, Cal These are calibration files for non-EFW instruments, in particular the FGM instrument. These files are provided via the CSDS from other DC:s.

process, Store Merge and store all CSDS products and make them available to the Scandinavian community via ESIS.

input, External CSDS products These are PPD, SPD and SPlots for all instruments except EFW.

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[7]most likely the medium will be CD-ROM
[8]Raw Data Medium

Product	fraction	disk space
Cluster PPDB	4 months	1.8 GB
Cluster SPDB	all	168 MB
Cluster SPlots	all	200 MB
EFW CSDS products	all	650 MB

Table 1: Estimated disk space required for the CSDS products at the SDC

output, CSDS products All CSDS[9] products for all instruments including EFW.

control, ESIS ESIS provides s/w for data retrieval, makes access control etc.

The estimated disk space needed to store the CSDS data bases at the SDC is shown in Table **??**.

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[9]See the SDC ICD [Ref. **?**] for a specification

Specific Requirements   The specific requirements are divided according to the already identified subsystems DD, ISDAT and SDC. Only the SDC part will be subject to examination at the CSDS requirements review. Within each subsystem, the requirements are grouped according to their logical connection. Where applicable, the specific requirements are labelled as essential or desirable.

Since the CEDAS User Requirements [Ref. **?**] are written in considerable detail, many of the software requirements are identical to the user requirements.

9   Raw data (RDM) distribution (DD)

(This section is not subject to examination by the CSDS requirements review)

9.1   Functional requirements

SR-DD-1 Means shall be provided to give access to raw (RDM format) data at all EFW CoI institutions. It is an essential requirement. Source: UR-DD-001.

SR-DD-2 CD-ROM distribution shall be utilised if offered by ESA. Source: UR-DD-502.

9.2   Performance requirements

No formal requirements.

9.3   Interface requirements

No formal requirements.

9.4   Operational requirements

No formal requirements.

9.5   Resource requirements

SR-DD-3 All costs for RDM distributions must be covered outside CEDAS. Source: UR-DD-501.

9.6   Verification requirements

SR-DD-4 Verification of each individual RDM copy is the responsibility of the recipient at the CoI institution. Source: Not in the user requirements.

9.7   Acceptance testing requirements

No formal requirements.

9.8   Documentation requirements

No formal requirements.

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9.9 Security requirements

No formal requirements.

9.10 Portability requirements

No formal requirements.

9.11 Quality requirements

No formal requirements.

9.12 Reliability requirements

No formal requirements.

9.13 Maintainability requirements

No formal requirements.

9.14 Safety requirements

No formal requirements.

10 Detailed data analysis (ISDAT)

(This section is not subject to examination by the CSDS requirements review)

11 Scandinavian data centre (SDC)

The SDC should accomodate both functions specific to EFW users and CSDS associated functions. Only requirements specifically derived from CSDS requirements are subject to examination by the CSDS requirements review.

11.1 Functional requirements

11.1.1 CDDS related functions

SR-SDC-1 SDC shall provide a facility to query the catalogues of on-line data at the CDDS. Need: Essential. Source: UR-SDC-105.

SR-SDC-2 SDC shall obtain, on behalf of the EFW PI, subsets of the CDDS file. Need: Essential. Source: UR-SDC-105

SR-SDC-3 SDC shall provide temporary storage of data obtained from the CDDS. Need: Essential. Source: UR-SDC-105

SR-SDC-4 SDC shall maintain a catalogue of locally stored CDDS data. Need: Essential. Source: UR-SDC-105

11.1.2   Quick look, health and safety

SR-SDC-5 SDC shall provide means to analyse EFW CDDS data to enable quick look, health and safety analysis. Need: Essential. Source: UR-SDC-106

SR-SDC-6 SDC should provide access to ASPOC data as input for near real time analysis. Need: Desirable. Source: UR-SDC-106

SR-SDC-7 SDC should provide access to FGM data as input for near real time analysis. Need: Desirable. Source: UR-SDC-106

11.1.3   RDM related functions

SR-SDC-8 SDC shall receive, verify, catalogue and archive one copy of the RDM. Need: Essential. Source: UR-SDC-003, UR-SDC-124

SR-SDC-9 SDC shall make the RDM catalogue available on line to EFW CoI:s. Need: Desirable Source: UR-SDC-124

SR-SDC-10 SDC shall provide[10] and maintain software to include EFW data in CFC level 1 format if requested by WEC. Need: Essential. Source: UR-SDC-126

11.1.4   Prime parameter production and storage

SR-SDC-11 SDC shall produce EFW prime parameters on a regular basis. Need: Essential. Source: UR-SDC-101

SR-SDC-12 SDC shall install[11] and maintain software for production of prime parameters, including version history. Need: Essential. Source: UR-SDC-111, UR-SDC-115

SR-SDC-13 SDC shall provide means for the PI to validate the produced prime parameters. Need: Essential. Source: UR-SDC-116

SR-SDC-14 SDC shall provide validated EFW prime parameters in a database available to other CSDS DC:s for a limited time (TBD). Need: Essential. Source: UR-SDC-101

SR-SDC-15 SDC shall import non-EFW prime parameters from other CSDS DC:s. Need: Essential. Source: UR-SDC-104

SR-SDC-16 SDC shall merge non-EFW and EFW prime parameters into one Cluster PPDB on a regular basis. Need: Essential. Source: UR-SDC-104, UR-SDC-112

SR-SDC-17 SDC shall keep the Cluster PPDB on line for TBD weeks. Need: Essential. Source: UR-SDC-104

SR-SDC-18 The on-line Cluster PPDB shall be accessible by Scandinavian[12] Cluster scientists. Need: Essential. Source: UR-SDC-104

11.1.5   Summary parameter production and storage

SR-SDC-19 SDC shall produce EFW summary parameters on a regular basis. Need: Essential. Source: UR-SDC-101, UR-SDC-102

SR-SDC-20 SDC shall maintain software for production of summary parameters, including version history. Need: Essential. Source: UR-SDC-111, UR-SDC-115

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[10]The original EFW algorithms is the responsibility of the EFW PI to provide

[11]It is the responsibility of the EFW PI to provide the SDC with the original EFW algorithms

[12]By Scandinavian we mean Sweden, Norway, Finland and Denmark

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SR-SDC-21 SDC shall provide means for the PI to validate the produced summary parameters. Need: Essential. Source: UR-SDC-116

SR-SDC-22 SDC shall provide validated EFW summary parameters in a database available to other CSDS DC:s. Need: Essential. Source: UR-SDC-101, 102

SR-SDC-23 SDC shall import non-EFW summary parameters from other CSDS DC:s. Need: Essential. Source: UR-SDC-103

SR-SDC-24 SDC shall merge non-EFW and EFW summary parameters into one Cluster SPDB on a regular basis. Need: Essential. Source: UR-SDC-103, UR-SDC-112

SR-SDC-25 SDC shall keep the Cluster SPDB on line during the lifetime[13] of the mission. Need: Essential. Source: UR-SDC-103

SR-SDC-26 The on-line Cluster SPDB shall be accessible by Scandinavian scientists. Need: Essential. Source: UR-SDC-103

SR-SDC-27 SDC shall provide EFW SPlots to other CSDS DC:s. Need: Essential. Source: UR-SDC-102

SR-SDC-28 SDC shall provide access to Cluster SPlots to Scandinavian Cluster Experimentalists. Need: Essential. Source: UR-SDC-102, UR-SDC-110

11.1.6   Data base catalogues

SR-SDC-29 SDC shall keep an on-line catalogue of the contents of all databases kept on line. Need: Essential. Source: UR-SDC-112

SR-SDC-30 SDC shall provide a mechanism to trace the software version used in the data base production. Need: Essential. Source: UR-SDC-115

SR-SDC-31 SDC shall provide a mechanism to trace the calibration file version used in the data base production. Need: Essential. Source: UR-SDC-115

11.1.7   Instrument calibration

SR-SDC-32 SDC shall provide software tools for the EFW PI or his delegate to update the EFW calibration files. Need: Essential. Source: UR-SDC-107

SR-SDC-33 SDC shall make EFW calibration files available to other CSDS DC:s through the networks. Need: Essential. Source: UR-SDC-107

SR-SDC-34 SDC shall keep record over EFW calibration file versions. Need: Essential. Source: UR-SDC-115

SR-SDC-35 SDC shall provide EFW data to other DC:s during the initial data taking phase to be used for intercalibration with other instruments. Need: Desirable. Source: UR-SDC-114

SR-SDC-36 SDC shall import data from other DC:s during the initial data taking phase to be used for intercalibration with other instruments. Need: Desirable. Source: UR-SDC-114

11.1.8   Instrument commanding

SR-SDC-37 SDC shall provide a mechanism to communicate EFW instrument command sequences to the JSOC. Need: Essential. Source: UR-SDC-109

SR-SDC-38 SDC shall provide software to generate EFW instrument command sequences. Need: Essential. Source: UR-SDC-121

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[13]the project lifetime is defined as the data taking period (2 years) plus two years.

SR-SDC-39 SDC shall provide software tools to update and store a library of EFW instrument command sequences. Need: Essential. Source: UR-SDC-120

SR-SDC-40 SDC shall maintain an EFW command log. Need: Essential. Source: UR-SDC-125

11.1.9   JSOC access

SR-SDC-41 SDC shall provide access to the JSOC services for Scandinavian Cluster experimentalists. Need: Essential. Source: UR-SDC-108

11.1.10   SDC access

SR-SDC-42 SDC shall provide direct network access to the SDC for EFW CoI:s. Need: Essential. Source: UR-SDC-127

SR-SDC-43 SDC shall provide access control for access points that are not controlled by ESIS. Need: Essential. Source: UR-SDC-113

11.2   Performance requirements

SR-SDC-44 The SDC development and implementation should be synchronised with the CSDS time schedule. Need: Desirable. Source: UR-SDC-504

11.3   Interface requirements

SR-SDC-45 SDC shall, in general, comply with CSDS interfaces as described in the Data delivery Interface Document [Ref. **?**], the Command Request Interface Document [Ref. **?**], the Network Interface document [Ref. **?**], and the SDC interface control document [Ref. **?**]. Need: Essential. Source: UR-SDC-002.

11.3.1   Formats and standards

SR-SDC-46 SDC shall support data exchange in the NSSDC Common Data Format (CDF). Need: Essential. Source: UR-SDC-502

SR-SDC-47 All high level software shall be written in the standard FORTRAN or ANSI C languages. Need: Essential. Source: UR-SDC-502

SR-SDC-48 All documents shall be written in the English language. Need: Essential. Source: UR-CEDAS-501

SR-SDC-49 The choice of data base management system should be coordinated with the other CSDS DC:s. Need: Desirable. Source: UR-CEDAS-504

SR-SDC-50 CSDS related parts of the SDC shall in general comply with CSDS hardware standards. This applies essentially only to the ESANet and ESIS interfaces. Need: Desirable. Source: UR-SDC-503

11.4   Operational requirements

SR-SDC-51 SDC shall be physically located at the Royal Institute of Technology, Stockholm. Need: Essential. Source: UR-SDC-001, 501

SR-SDC-52 SDC shall contain an operator interface. Need: Essential. Source: UR-SDC-122

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SR-SDC-53 SDC shall contain an EFW experimentalist interface. Need: Essential. Source: UR-SDC-123

SR-SDC-101 Reprocessing of the EFW CSDS databases shall be possible. Source: UR-SDC-117.

11.5 Resource requirements

SR-SDC-54 The SDC implementation and operations should be done as a joint responsibility by the Scandinavian EFW institutions with contributions from other EFW institutions. Need: Essential. Source: UR-CEDAS-502

11.6 Verification requirements

SR-SDC-55 EFW Prime- and summary parameters shall be validated by the EFW PI or his representative before release. Need: Essential. Source: UR-SDC-116

11.7 Acceptance testing requirements

No formal requirements.

11.8 Documentation requirements

SR-SDC-56 An SDC interface control document [Ref. ?] shall be generated and maintained. Need: Desirable. Source: UR-SDC-002

SR-SDC-57 An SDC users requirements document [Ref. ?] shall be generated and maintained. Need: Desirable. Source: UR-SDC-002

SR-SDC-58 An SDC software requirements document [Ref. ?] shall be generated and maintained. Need: Desirable. Source: UR-SDC-002

11.9 Security requirements

See SDC access in section ??.

11.10 Portability requirements

See section ??.

11.11 Quality requirements

No formal requirements.

11.12 Reliability requirements

No formal requirements.

11.13 Maintainability requirements

No formal requirements.

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11.14   Safety requirements

No formal requirements.

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12   Requirements traceability matrix

The relations between the user requirements and the software requirements are shown in Tables **??** and **??**.

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A   Acronyms

Acronym	Meaning
ANSI	American National Standards Institute
APX	A computer architecture
ASPOC	Active Spacecraft Potential Control
C	A programming language
Cal	Calibration
CD-ROM	Compact Disc Read Only Memory
CDF	Common Data Format
CEDAS	Cluster EFW Data Analysis System
CFC	Centre Français Cluster
CoI	Co-investigator
CDDS	Cluster Data Disposition System
CSDS	Cluster Science data System, replaces CSDC
D/A	Detailed Analysis
DC	Data Centre
DD	Data Distribution
DDS file	Data Disposition System file
EFW	Electric Field and Wave Experiment
EISCAT	European Incoherent Scatter Radar Facility
ESA	European Space Agency
ESANET	European Space Agency Network
ESIS	European Space Information System
ESOC	European Space Operations Centre
FGM	Flux Gate Magnetometer
FORTRAN	FORmula TRANslator
Freja F4	Wave experiment on the Freja satellite
ICD	Interface Control Document
IRF-U	Institutet för Rymdfysik, Uppsalaavdelningen
	Swedish Inst. of Space Phys., Uppsala Division
ISDAT	Interactive Science Data Analysis Tool

Table 2: Acronyms part 1

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Acronym	Meaning
ISDAT	Interactive Science Data Analysis Tool
JSOC	Joint Science Operations Centre
KTH	Kungliga Tekniska Högskolan Royal Institute of Technology
MB	Mega-byte
N/RT	Near Real Time
NSSDC	National Space Science Data Center
PI	Principal Investigator
POSIX	Operating system
PPD	Prime Parameter Data
PPDB	Prime Parameter Data Base
RDM	Raw Data Medium
SDC	Scandinavian Data Centre
SPD	Summary Parameter Data
SPDB	Summary Parameter Data Base
SPlots	Summary Plots
SR	Software Requirements
TBD	To be defined
UCB	University of California at Berkeley
Unix	Operating system
UR	User Requirement
VAX	A computer architecture
VMS	Operating system
WEC	Wave Experiment Consortium
s/w	software

Table 3: Acronyms part 2