ISDAT
Interactive Scientific Data Analysis Tool
An Introduction

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Chapter 1

Introduction

1.1 Purpose of this document

The purpose of this document is to provide a general description of the ISDAT system to a wide community. The project history, the design principles, the design, and functionality are described in general terms. In chapter 5 we give references to the more detailed documentation.

1.2 Background

In an early phase of the Cluster EFW instrument development, it was decided to start developing software tools for the scientific analysis of data. The software development has led to a software tool, ISDAT, of quite general character, utilising modern software concepts like the client server model, and distributed processing. The early start of the development, has made possible an extensive test of new ideas and software implementation on other projects, and even make use of it in conjunction with the Cluster hardware test procedures.

Chapter 2

Design Guidelines

The design and development of ISDAT is guided by a few, but clear, principles and standards, as described in the three following sections.

2.1 Design goals

ISDAT should be:

- An interactive data analysis environment that allows independent analysis programs (clients) to co-operate, enabling the user to analyse and view data sets from different projects and instruments.
- Designed to work on all common workstations including DEC, HP, SUN, IBM and PC-UNIX[1].
- Designed to do the raw data unpacking and calibration in a data base handler "hidden" from the clients (application processes). This should provide a uniform way to access data from different projects in a uniform manner. Several data bases should be accessible simultaneously, locally or remotely [2].
- Designed to support pipe mechanisms to allow the user to modify the behaviour of existing programs at runtime. The data is piped (passed through) a set of filters set up by the user. Filters are separate programs that can perform time series analysis, data export/import, commercial packages like IDL or MATLAB etc. Filters may have user interface to change parameters.
- Designed to make it easy for scientists with a little programming experience to add new data analysis programs. Extensive library support should aid in such development.
- Designed to easily incorporate analysis programs from external institutes.

2.2 Development model

In order to test the new software concepts in a real environment, the ISDAT development followed an evolutionary model in the first phases, with a prototype built for the already available Viking data. Thereafter, the package was used in practice on the Freja data, involving numerous improvements and enhancements compared to the Viking prototype. For the Cluster application, a somewhat more traditional "waterfall" development model will be followed.

[1] currently, the prototype has been tested on HP, SUN and 486/PC with UNIX

[2] Current implementation supports Viking, Cluster, Freja, EISCAT, ground based riometers and magnetometers

2.3 Standards

The following standards will be followed:

- UNIX: POSIX, X/OPEN, SVID
- Languages: C, FORTRAN
- Windows: X11, Motif
- Graphics: PHIGS and PEXlib[3]

[3]X11R5 or later is required to get PHIGS/PEX

Chapter 3

ISDAT Structure

The core of ISDAT consists of a well defined, project independent, interface between a data base handler (DBH) and the scientific analysis and display software (clients), and a mechanism for communication between the data base handler and the clients.

3.1 General structure

The general structure of ISDAT is shown in Figure 3.1. The circles represent indi-

Figure 3.1: ISDAT general structure

vidual processes running on a common workstation or on several, locally or widely, distributed workstations. The processes are linked together via the ISDAT communication protocol.

3.2 Data base handler, DBH

The data base handler accommodates the unpacking and calibration of experiment data, as well as formatting of the data communicated to the clients requesting the data. The DBH is designed to randomly access the data, and is capable of handling a wide variety of requests in a general manner. Examples of such capabilities are data gap handling, interpolations, delivery of raw or calibrated data, supplying alphanumeric strings corresponding to delivered units, signals etc., warning flags and messages. The DBH is also capable of responding to client queries regarding instrument

descriptions and available data hierarchy at the connected DBH. The available data is specified in terms of *conceptual instruments* that may or may not directly correspond to the actual hardware instruments. The conceptual instrument is described in a hierarchical manner as *project-member-instrument-sensor-signal-channel-parameter*. The DBH can handle multidimensional data up to five dimensions. The detailed descriptions are given in the on line manuals.

Clients can connect locally or remotely using TCP/IP protocol. Several data base handlers can run simultaneously on one workstation. The DBH is built in a modular structure, with all project specific software residing in separate modules. The local installation thus only includes one or several project modules of use for that particular installation.

3.3 Clients

By *clients* we understand data analysis and display program. There are clients of three kinds: project independent clients, project specific clients, and time managers. In principle, the clients are not supplied with the ISDAT package. Most of the clients should be contributed by the scientist since he is the expert on scientific data analysis.

3.3.1 General clients

The *general clients* normally starts by queering the data base handler about the supported projects, and build up menus to support the user in requesting data. At present there are a small number of general clients available:

ts A program for display and basic analysis of time series data.

ghplot A more advanced client for time series analysis and display.

satpos A program to print out the platform position and attitude, as well as model magnetic field parameters.

status A client that graphically shows where, along a time axis, data is available, and permits you to set a desired time by clicking on the display.

3.3.2 Project specific clients

There is a wide variety of existing and planned project specific clients. Examples of such clients are: Programs to interpret instrument status down to bit level, all kinds of scientific special studies.

3.3.3 Time managers

The *time managers* are special *clients* responsible for co-ordination of other clients. The most common function is to update all active clients with the start time and interval selected by the user. The only time manager developed so far is the simple time manager *stm*, which performs the following functions:

- Selection of start time and interval of interest
- Project selection
- Selection and start of client programs
- Display of available time spans for the selected project
- Display of client generated error messages

A time manager can control several clients simultaneously, and thus dynamically assure identical time slots for several clients, and even facilitate analysis of data from separate projects but for identical time slots. Should different time slots be desired, then two or more time managers can be active simultaneously, each controlling its own group of clients and specifying its individual time slots.

Future time managers could accommodate a graphics user interface, e.g. show an image of a model magnetosphere with the satellite orbit highlighted. The time of interest could then be selected by pointing on the orbit with the mouse.

3.4 Filters

By *filters* we mean separate programs executed by the pipe mechanism. Possible functions are FFT:s, digital filtering, MATLAB interface, file export/import, data export to commercial visualisation programs etc. At present, the file functions are implemented.

3.5 Libraries

There are a number of libraries in support of time manager and client development. The currently implemented libraries are:

IsLib Client/manager communication.

IsutilLib Time transformations.

DbLib Data base handler communication

UiLib User interface library for creation of plot panels, buttons, potentiometers etc.

GiLib Plot functions, auto scaled plots, tic marks, labels, scales etc.

TsLib Time series analysis functions, FFT, correlation etc.

PfLib Functions related to the measuring platform, position etc. (under development)

BfLib Magnetic field models

3.6 Interface to other software packages

Currently there is a library, integrating IDL and ISDAT on SUN workstations.

3.7 Running over networks

ISDAT has been used extensively over LAN's, and has been used also over WAN's, for example with the DBH running at Esrange, Kiruna and the STM and clients running at IRF-U in Uppsala for the Freja project. Some possibilities to work with ISDAT over local and wide area networks are illustrated in Figure 3.2.

Figure 3.2: ISDAT distribution over networks

Chapter 4

Distribution and portability

4.1 Distribution policy

[1]

ISDAT policy (draft 921002)

ISDAT is a software package originating at IRF-U for analysis of scientific data from satellite and other space physics related projects. The ISDAT system is available, free of charge, to individual scientists and research groups within the space physics community under the following conditions:

- IRF-U takes no responsibility for errors in the package, nor for any other problems or concequences related to the use of ISDAT.

- No part of the package may be used in any commercial activity, nor may it be redistributed to other parties.

- Instrument specific parts of the system are not included in the open distribution.

- IRF-U takes no responsibility for the maintenance of the system.

- It is the users responsibility to fetch, build and update their packages.

- IRF-U does not guarantee access to the ISDAT ftp account at all times.

- In return for the free usage of ISDAT, qualified users are expected to contribute to the system within their fields of expertise.

- Parts contributed by non-IRF institutions or individuals are subject to the same policy as described above.

4.2 Portability

ISDAT uses the *imake* facility to build the system. Imake uses platform configuration files to adapt the build process to the capabilities provided by the workstation. To port ISDAT to a new platform requires writing a new configuration file and typing: *make isdat.*

4.3 Distribution and maintenance

The baic ISDAT software package, including some test data, can be obtained via anonymous ftp from irfu.se. For further information, plese contact al@irfu.se or gh@irfu.se. All "bugs" should be reported to al@irfu.se.

[1] This is the disclaimer attached to the ftp distribution of ISDAT

Chapter 5

Further Reading

The architectural design of the Cluster WEC implementation of ISDAT is described in [3]. The ISDAT Detailed Design is described in [4]. There is a set of programmers guides [9, 10, 2, 11, 12, 13]. Valuable information for the programmer is also found in the numerous on-line manuals describing all available library calls [6, 15]. An example of an instrument documentation is found in [8]. The ISDAT installation is described in [5]. An ISDAT users manual is provided in [14]. Examples of a time manager users manual is found in [7]. An example of a client users manual is found in [1].

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Appendix A

Acronyms

Acronym	Meaning
CFC	Centre Français Cluster
CSDS	Cluster Science data System, replaces CSDC
DB	Data Base
DC	Data Centre
EFW	Electric Field and Wave Experiment
ESA	European Space Agency
ESANET	European Space Agency Network
ESIS	European Space Information System
ESTEC	European Space Technology Centre
FORTRAN	FORmula TRANslator
ISDAT	Interactive Science Data Analysis Tool
ISDAT	Interactive Science Data Analysis Tool
JSOC	Joint Science Operations Centre
KTH	Kungliga Tekniska Högskolan Royal Institute of Technology
PI	Principal Investigator
PPDB	Prime Parameter Data base
RDM	Raw Data Medium
SDC	Scandinavian Data Centre
SPDB	Summary Parameter Data Base
SPlots	Summary Plots
TBD	To be defined
Unix	Operating system
UR	User Requirement
VAX	A Computer architecture
WBD	Wide Band Data
WEC	Wave Experiment Consortium
WHISPER	Waves of High Frequency and Sounder for Probing of the Electron Density by Relaxation
X11R5	X-Windows, revision 5
s/w	software
2D	Two dimensional
3D	Three dimensional

Table A.1: Acronyms