

STARLINK USER GUIDE

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CHAPTER 1 ... INTRODUCTION

The purpose of this guide is to help users and programmers make effective use of the image and data processing facilities provided by the SERC under the name of the Starlink project. By its nature, the project is rapidly evolving and we believe it is impractical to issue a "manual" in the conventional sense giving detailed instructions on the various modes of use. Rather, this guide should be used as a pointer to the location of more detailed information and, to this end, it attempts to provide an overview of the components of the project and the types of information available.

It is foreseen that a new user will start with this basic guide and add that information to it which is most relevant to the required application. It is with this in mind that the loose-leaf format has been adopted. The intention is that most of the extra information will be found on the machines themselves; this however is not always practical, particularly where complex diagrams are required, and recourse may have to be made to other sources such as computer manuals and the Starlink site managers.

Updating of this guide will take place on a chapter by chapter basis. The version number of each chapter will be found in the heading. Thus, the heading 'SUG/1.2' means that the page belongs to version 2 of chapter 1 of the Starlink User Guide. The date of issue is printed at the bottom of each page in the form 'day.month.year'. A new user will receive the complete guide. Thereafter, it is his or her responsibility to keep it up to date. The updates will be available only from the machine. How to do this is explained in Chapter 5. Comments and criticisms from users are most welcome: please send these via the MAIL system to RLVAD::STAR (see Chapter 4).

Starlink will be a greater success if people not only use its facilities but also contribute to them. This contribution will most often be in the form of applications software and one of the major objects of the guide is to encourage and help users to make their efforts available to others, both nationally and internationally.

CHAPTER 2 ... STARLINK

2.1 Starlink

Starlink is a computing facility available for the use of all UK astronomers. It is primarily for the reduction of observational data, with the emphasis on interactive processing. The hardware centres on a UK-wide network of VAX-11 computers, and a standard set of astronomical software (the Starlink Software Collection) is provided on all of these. As far as the standard Software Collection is concerned, the network nodes appear identical; there are however hardware differences which are determined by the particular needs of local users.

The initial acquisition of six VAXs has been supplemented by the addition of a seventh computer, extra memory and disc drives for the existing ones, and the provision of remote access terminals at certain locations not conveniently near any of the present nodes. An eighth machine is shortly to be installed (a VAX-11/750 at Birmingham University), but this has not been included in the following statistics.

2.2 Hardware

Starlink is based on seven computers, six VAX-11/780s and one 11/750. The 780s are located at Cambridge University, University College London, Manchester University, the two Royal Observatories and the Rutherford Appleton Laboratory at Chilton. The 750 is located at Durham University.

The VAX-11 series, a high performance 32-bit multi-programming computer system, is the successor to the DEC PDP-11 range. A summary of the major resources at each Starlink site is as follows:

	Processor	Memory	Disc	Tape	ARGS
Cambridge	780	4 Mbyte	1120 Mbyte	2x 45 ips	2
UCL	780	4	1120	2x 45	2
RGO	780	4	1120	2x 45	2
RAL	780	4	987	2x 45	2
ROE	780	4	864	2x 45	2
Manchester	780	3	864	2x 45	2
Durham	750	2	(636)	1x125	1

The Durham disc figure is provisional.

Each computer supports one or two identical image display systems - the Advanced Raster Graphics System (ARGS) manufactured by Sigma Electronics. This system allows the display of colour images consisting of a matrix of up to 512 x 512 picture elements. It can switch between pictures, transform the colour mappings to highlight particular features, scroll, pan, zoom, generate and superimpose graphics and perform many other functions.

All the sites (except Durham) are presently linked by dedicated telecommunications lines in a star network centred on Chilton, using DECnet protocols. The communications run at a speed of 2400 bits per second (apart from RG0 which is 4800 bps). This is not suitable for large data transfers but quite adequate for exchanging software, reports, messages, etc.

Work on VAX/VMS X-25 network development is in progress. The plan is to run DECnet over the SERCNET network once an X-25 protocol version of DECnet is available. Standard SERCNET high level protocols will also be available as an alternative to DECnet. The Chilton and ROE nodes are already connected to SERCNET, and the Durham node is in the process of being connected.

Certain users not located at nodes of the network (the so-called 'remote users') are able to access and use Starlink in various ways, for example by direct or dial-up lines to a nearby node, or via SERCNET. In some cases Starlink has provided lines and terminals to facilitate this access.

2.3 Software

The term 'Starlink Software' is ambiguous. In its broadest sense, it refers to all the software being developed by or on the Starlink project. In a narrower sense, it refers to a formally defined set of software which is managed by a single individual. This set of software is called the Starlink Software Collection and the individual who looks after it is called the Starlink Software Librarian.

It is Starlink policy to have the Starlink Software Collection available at all nodes, on devices that are as similar as possible to each other, so that essentially the same aspect is presented to users everywhere. It is the site manager's responsibility to implement this policy at his node. Certain rarely used items in the collection may be stored offline but will be available on request from the site manager.

Wherever possible, generally accepted software and standards are being adopted. The Numerical Algorithms Group (NAG) mathematical library has been adopted as a Starlink standard. The device

independent Graphics Kernel System (GKS) is already available, and the Flexible Image Transport System (FITS) is specified for bulk data transport.

Applications software, although being coordinated from Chilton, is being developed at a large number of sites within the astronomical community, and it is the intention that in many cases software being produced by astronomers in the course of their own research will eventually be taken over and supported by Starlink. Astronomers are encouraged to implement new or existing software on the VAX and publish it (via the Software Librarian) for others to use. Full credit for contributed software is given.

Initially, Starlink has implemented the more commonly needed image-handling and processing routines so that data from the AAT, IUE, etc could be processed at least as efficiently as with existing packages running on other machines.

Starlink is implementing a "Software Environment" into which all applications software can be integrated. This will provide a command language enabling the astronomer at an interactive terminal to manipulate data and run data reduction programs by expressing operations in a concise but natural way. This language will also help a novice to obtain documentation and prompting to take him through the system. The environment will also specify a set of subroutine interfaces which will give applications programs efficient and easy access to command parameters, images and other bulk data, graphics devices, etc. This should allow the build-up of compatible sets of applications software, both new and converted from current packages. The systems software is still under development and the current state of affairs is described in Chapter 7. In the interim, users are encouraged to mount existing packages in an ad hoc way on the VAX, and the network will be available to distribute such software.

2.4 Operation and Management

The staff of Starlink:

- a) manage the project, both centrally and at the nodes,
- b) provide systems software,
- c) provide and organise the provision of astronomical applications software,
- d) support and educate users and programmers,
- e) give astronomical direction to the project,
- f) maintain contact with interested groups elsewhere.

As well as SERC employees working directly for Starlink, there are contracts with universities to employ site managers and applications programmers. These people are mostly based at the nodes of the network but applications programmers can be at universities which are not nodes.

The central management is provided by the Chilton node. Local management is in the hands of Local Management Committees (LMCs) at each site, which operate under terms of reference set out in Starlink General Paper No 8 (SGP/8). Through the local site manager, they have the power to determine local priorities and are responsible for ensuring that the Starlink standards are maintained.

A committee known as the Starlink Scientific Advisory Group (SSAG) has the function of overall monitoring of the progress of the project. The present Chairman is Prof J L Culhane (MSSL), and the present secretary is Mr M D Lawden of the Starlink project team.

Starlink has set up Special Interest Groups (SIGs) in various areas of astronomical interest. These exist to monitor progress in the development of applications software in their own areas and to advise Starlink on improvements to the software collection.

There are presently six SIGs, as follows:

Spectroscopy	chairman: Dr R A E Fosbury
2-d image processing	Dr R S Ellis
Databases	Dr D J Carnochan
IUE	Dr G E Bromage
X-ray astronomy	Prof A C Fabian
Software Environment	Dr R J Dickens

A number of contracts have been placed with universities for the employment of applications programmers. These programmers develop new Starlink software and adapt existing software to Starlink standards. The astronomical area for which the software is written is chosen to coincide with the interests of the astronomers in the department where the programmer works. The programmer also works closely with the appropriate SIG.

2.5 New Users

Starlink is an SERC national facility and its users must be formally accredited and allocated resources. Initial applicants have to complete the form 'Application for Starlink Resources' and send it to Starlink via the local site manager. Approval will normally be given quickly for projects that fall within the areas outlined in 2.1 above. After approval, a new user is given a username and password on the local machine. Users may be registered at more than one node if desired. (Users of more than one node must designate a primary node which will be responsible for providing them with appropriate documentation.) Users will thereafter liaise directly with the manager at whichever node(s) they use.

2.6 Addresses and Contacts

Starlink sites, addresses and site managers are as follows. (This list is kept up to date in file ADMINDIR:MANAGERS.LIS)

CAMBRIDGE

Dr Carol A Robinson

Institute of Astronomy,
Madingley Road, CAMBRIDGE, CB3 0HA
Tel: 0223-62204 X67
0223-66785
Tx: 817297 ASTRON G

DURHAM

Mr Alan P Lotts

Dept. of Physics,
Science Laboratories,
University of Durham, South Road,
DURHAM, DH1 3LE
Tel: 0385-64971 X216
Tx: None

MANCHESTER

Dr Dave L Terrett

Dept. of Astronomy,
University of Manchester,
Oxford Road,
MANCHESTER, M13 9PL
Tel: 061-273-7121 X5249/8733
Tx: None

RAL

Mrs Lorna J Claringbold

Atlas Centre,
Rutherford Appleton Laboratory,
Chilton, Didcot, Oxon, OX11 0QX
Tel: 0235-21900 X372/6281/6471
Tx: 83159

RGO

Mr Dave J King

Royal Greenwich Observatory,
Herstmonceux Castle, HAILSHAM,
Sussex, BN27 1RP
Tel: 0323-833171 X241/227
Tx: 87451

ROE

Mr Bernie McNally

Royal Observatory Edinburgh,
Blackford Hill, EDINBURGH, EH9 3HJ
Tel: 031-667-3321 X267
Tx: 72383 ROEDIN G

UCL

Dr Sid L Wright

Dept. of Physics and Astronomy,
University College London,
Gower Street, LONDON, WC1E 6BT
Tel: 01-387-7050 X752
Tx: 28722

Formal correspondence, general enquiries, requests for papers, application forms, etc should be addressed to the Starlink Office at the Rutherford and Appleton Laboratories. Specific enquiries may be directed to the appropriate named individuals as follows:

Mr P T Wallace	Project Manager
Dr K P Tritton	Project Scientist
Mrs S J Mitchell	Secretary
Mr M D Lawden	Documentation, Software Librarian
Mr A J H Walter	Software Environment
Mr D Pearce	Software Environment
Mr J R Gallop	ARGS, Graphics
Mr S W L Yip	Systems Software

CHAPTER 3 ... INTRODUCTION TO THE VAX

3.1 VAX Documentation

DEC produce a vast quantity of documentation describing the VAX 11 computer and its software. A complete set is held at each site. The following documentation is of particular interest to new users:

VAX/VMS Primer:

This introduces the machine to beginners. In particular it describes how to gain access to the system, how to develop programs and introduces the command language (DCL).

VAX-11 Fortran Language Reference Manual

This describes the VAX dialect of the Fortran-77 Language. Fortran-77 is the preferred language for application programs for the Starlink project.

VAX-11 Fortran User's Guide

This describes how to use Fortran on the VAX.

Two other documents which give an overview of the VAX and its software, but which avoid the detail of the main reference set, are:

VAX - Technical Summary**VAX - Software Handbook**

In addition, DEC offer a series of courses which teach users and programmers more about the VAX. However, unless you intend to become deeply involved with the VAX at a programming level, the Primer together with the support of the local site should suffice. If you do have to consult the manuals, look at the VAX 11 Information Directory and Index in volume 1 first; it gives a very good guide to their contents.

It is not financially possible to provide all users with a comprehensive set of VAX documentation. The only VAX manual that will be provided to all users is the VAX/VMS Primer. A small number of copies of the Fortran manuals have been purchased for loan to some users and a few copies of some other manuals are also available. Requests for specific manuals should be made to your site manager. However, as a general rule, users who require their own copies of VAX manuals are expected to purchase them out of their own funds. Users wanting to do this should obtain the address of their local DEC

salesman from their Site Manager.

Two helpful audio-visual courses may be viewed on request at the Chilton node:

1. Introduction to the VAX-11: concepts
2. VAX-11: instruction set

For information about the Starlink documentation scheme, see Chapter 5.

3.2 The Operating System

The standard VAX operating system is called VMS (Virtual Memory System). The basic facilities offered by VMS are described in the Primer. In addition there is a very useful table of DCL (Digital Command Language) commands in VAX/VMS Command Language User's Guide in volume 2A of the VAX/VMS reference manuals (Table 1-2). It may be useful to keep a copy of this table in your Guide. The current version of VMS changes at irregular intervals but it tells you which it is when you login. It may be useful to know this when transferring software to or from a VAX outside the Starlink network.

VMS offers on-line documentation for programs and commands. One system is based on the "HELP" command. This is accessed by typing

HELP <keyword>

where <keyword> is the name of a command or facility for which information is required. The subject on which help is required may be made more precise by the use of further keywords or qualifiers. You are, in fact, interrogating a HELP tree since information is held at various levels. Each level will tell you about information which exists at the next lower level. Some examples are shown below.

HELP.....describes the HELP system.

HELP COPY.....describes the COPY command for file copying.

HELP SET DEFAULT.....describes the SET DEFAULT command for setting your default directory.

HELP SHOW QUEUE/BRIEF.....describes the SHOW QUEUE command when qualified by the /BRIEF qualifier.

3.3 A Terminal session

The terminals at your node may be subject to a booking system; ask the site manager to explain the procedure.

A new user will need to acquire a username and a password from the local Site Manager. (To see how to reset your password, type HELP SET PASSWORD when you have logged in.) Once you have a terminal which is connected to the VAX, to get started press the "RETURN" key and you will be prompted for your username. Type this in and press "RETURN". If you can remember the answer to the next question you will be welcomed to the current version of the operating system and given a string of messages specific to the local node. To see what to do next, refer to the Primer. At the end of the session, type LO followed by "RETURN".

As an aid to typing at the terminal and recovering from typing errors, look at table 1-1 of the VAX/VMS Command Language User's Guide in volume 2A of the VAX/VMS Manuals.

3.4 Resources

Associated with your username will be a "directory" which resides on one of the discs. The Site Manager will tell you its name when your application to use Starlink is accepted. You store your files in this directory. It is a good idea to structure your file store into subdirectories. Suppose you start off with a single directory [ABC] and you want to store your programs together in a subdirectory [ABC.PROGS] and your documents together in a subdirectory [ABC.DOCS]. You can create these directories by the commands:

```
CREATE/DIR [ABC.PROGS]  
CREATE/DIR [ABC.DOCS]
```

You can make either of these directories your default directory by using the SET DEFAULT command. The command DIR (an abbreviation of DIRECTORY) will tell you the names of any files you have stored in a specified directory.

When you were given your username, the site manager will have assigned you a "quota" of disc space measured in "blocks" (1 block = 512 bytes): how much will depend on your application form and on how big and fierce you are. The command SHOW QUOTA will tell you how much of this quota you have used, and the command DIR/SIZE=ALL will give you the size of each of your files in blocks in the format USED/ALLOCATED. The 'allocated' space is the amount of space reserved on disk for your file. None of this space can be used by anyone else, so each time you create a file on a disk the space allocated is subtracted from your disk quota, even if you do not use all of it. Space is allocated in units called 'clusters'. The cluster size is set to some small number of blocks (at the time of writing this

number is 3). For this reason, your allocated space is normally slightly larger than your used space (which is the number of blocks that you have actually written to).

There are a number of traps that can cause users to run out of disc allocation unnecessarily:

1. There are some rogue programs that allocate large amounts of disc space when creating a file but which may only use a small amount of this space. GEROFF is the prime example of such a program. You can retrieve this unused space by typing the following commands:

```
MCR PIP
PIP>.*./TR
PIP>(cntrl/Z)
```

These commands cause a program called PIP to run which prompts for instructions with the text string 'PIP>'. You tell this program to truncate every file in your current directory.

2. If you copy one of your files into somebody else's directory the file will be written with your UIC assigned to it. The UIC determines whose quota is used when a file is written so a file in somebody else's directory written by you will always be charged to your disc quota. So always get other people to copy files they want from your directories. Never do the copying for them.

As a run-of-the-mill user you will also be given a set of "privileges" which essentially only allows you to alter things in your own directory, although you can copy things into it from elsewhere. Your disc files can be protected against access by other users, and you can set this protection separately for reading, writing, executing or deleting a file. The command DIR/PROTECTION tells you what protection is in effect, and SET PROTECTION may be used to alter it. HELP DIR, HELP SHOW and HELP SET will give you more information.

Each site has at most two magnetic tape drives. Since this is a multiuser system, users are strongly encouraged not to use tapes on-line. In other words, get the data you want to process onto disc as quickly as possible and work on them there.

CHAPTER 4 ... THE NETWORK

4.1 Introduction

At the time of writing, six of the Starlink VAX computers are linked together in a network via DECnet, with the Chilton (Rutherford Appleton Laboratory) site at the centre and the other nodes connected radially from Chilton. The DCL command SHOW NETWORK indicates the current status of your site's connection to the network. The DECnet names for the nodes are as follows:

RGVAD::	RGO
REVAD::	Edinburgh
RLVAD::	Chilton
ZUVAD::	UCL
CAVAD::	Cambridge
MAVAD::	Manchester

The Durham node is not yet connected to this network.

The DECnet Users Guide gives details of the facilities of the network, but a summary is given here.

4.2 Sending messages and copying files

Messages can be exchanged with users at your own or other nodes by using the MAIL facility, which is invoked by typing MAIL. The facility prompts with the symbol ">" for a MAIL command. To send a message, issue the command SEND. You will be prompted for the username of the recipient, which (unless at your own node) must be prefixed with the node name, e.g. RLVAD::OPER. To read incoming messages, type READ; to exit from the mail facility, type EXIT. Further details on MAIL can be obtained from the VAX 11 Utilities Reference Manual in volume 4A, or by typing HELP MAIL.

A list of local users and their usernames should be maintained at each node (except Chilton) in the file LADMINDIR:USERNAMES. The contents of these files will be collated (with the Chilton names) and stored at Chilton in the file ADMINDIR:USERNAMES.

It is possible to send and copy files across the network, provided of course you have the appropriate access to the files. For example, to copy the file INFO.LIS in the directory [USER] on disc DBAO: at UCL,

a user would type

```
COPY ZUVAD::DBAO:[USER]INFO.LIS *
```

INFO.LIS would then be copied into his current default directory. The syntax is

```
node::device:[directory]filename.filetype
```

The line speed is slow (2400 baud, except to RGO 4800 baud) and unsuitable for copying bulk data. Since files are copied at a rate of only about 1000 blocks per hour, even small files are best transferred by submitting the COPY command as a batch job (see the Primer, section 6.3).

Other DCL commands that allow node names in file specifications are APPEND, ASSIGN, DEASSIGN, DEFINE, DELETE, DIRECTORY, SUBMIT and TYPE.

4.3 Logging in to remote sites

To log in remotely, e.g. to Chilton, use the command SET HOST RLVAD. This replies with username and password requests, as for normal login. Usernames and passwords have been set up on each Starlink VAX for the use of each of the other sites. You can log in to another Starlink VAX using your own node's username or any other which exists on that VAX, assuming you know the username and password. The site usernames are RGO, ROE, RAL, UCL, CAM and MAN and the passwords are the same.

When you have logged in to a remote site, you may use any of the DCL commands as if you had logged in locally. This enables you, if you wish, to search directories, copy files, execute programs, and so on, always providing you have the necessary privilege.

4.4 SERCNET

The Chilton and ROE VAXs are also connected to SERCNET and so may be accessed from a number of GEC, PRIME and other computers on this network. For details of access routes, see System Note SSN/17, "Communications Routes into Starlink". The RAL VAX machine name is RLVSI, and the ROE name is REVSI. Once logged in to RAL or ROE, the DECnet facilities described above become available for accessing the other Starlink machines on DECnet.

The Durham VAX is also being connected to SERCNET.

Starlink plans to connect all its other machines to SERCNET in the near future. This will eliminate the dependence on the RAL VAX, provide faster links and give access to the other SERCNET machines.

The change is being delayed until file transfer becomes available for VAXs on SERCNET. (Without file transfer users cannot copy files from one VAX to another, send MAIL across the Starlink network, etc.)

CHAPTER 5 ... STARLINK DOCUMENTATION

5.1 Types of documentation

Documentation about Starlink can be classified as:

1. Paper documentation.
2. On-line documentation.

On-line documentation is that which is stored in the VAX computers and which is accessible at a terminal or printable on a line-printer. Paper documentation is self explanatory. Much of the paper documentation is actually produced using the computer and therefore it exists in both forms.

5.2 Paper documentation

Starlink paper documentation is issued within the following classification series:

SUG Starlink User Guide

SUN	Starlink User Notes	LUN	Local User Notes
SGP	Starlink General Papers	LGP	Local General Papers
SSN	Starlink System Notes	LSN	Local System Notes
		LUB	Local User Bulletins

In addition, a Starlink Information Bulletin called "ENTERPRISE" is distributed periodically to a wide audience.

USER NOTES contain material aimed at general users of the system and typically contain descriptions of how to use particular programs. GENERAL PAPERS contain a wide variety of material concerning the development and management of Starlink. SYSTEM NOTES document internal system software matters. A document is released as a STARLINK document if it concerns the project as a whole (e.g. Starlink User Notes document software in the Starlink Software Collection), or as a LOCAL document if it concerns only a single site. Local User Bulletins contain ephemeral information such as notices of shutdowns. There is, therefore, a set of 'Local' documents for each of the Starlink nodes, plus one set of general 'Starlink' documents. In the Starlink User Guide the 'Local' document is issued

as Chapter 9 which will differ between sites. Not all these documents will exist on-line as not all will have been produced on the computer.

A complete, regularly updated index of Starlink documentation issued within these classifications is stored in file

RLVAD::DOCSDIR:DOCS

Other sites should maintain an index of purely local documentation in file

<site code>::LDOCSDIR:DOCS

A subject index to the Starlink documentation is stored in file

RLVAD::DOCSDIR:SUBJECT

Paper documentation, such as this guide, is practically impossible to keep up to date. Users should, therefore, use the on-line documentation described in the next section as much as possible, since this is more likely to be valid. In particular, you should use the on-line information summaries described in section 5.4.

New users are normally given a 'New User Documentation Pack' which includes this guide and a Starlink loose leaf binder. The Site Manager of your primary node is responsible for providing you with 'Starlink' user documentation and 'Local' user documentation for that node. The Site Manager of each of your secondary nodes (if any) is responsible for providing you with 'Local' user documentation for that node. Because of the very large number of registered users, Site Managers may adopt a policy of distributing some documents of limited interest on a request basis only. If this is done, the manager should maintain a file DOCSDIR:NEWS which lists the names of recently issued documents. You should look at this file regularly to see if there is anything you want.

5.3 On-line documentation

Starlink on-line documentation exists in a number of forms. There are two basic methods for referencing it:

1. Use the HELP system described in section 3.2.
2. Display or print out files containing documentation.

Currently, very little Starlink documentation has been incorporated in the VAX HELP system, which is mainly concerned with DEC's own VAX software. Therefore, you must rely on displaying or printing out documentation files. Some software packages, eg. SPICA, incorporate a private HELP system.

There are two types of information source which are useful when searching on-line documentation:

1. Directory listings obtained by using the DIR command.
2. The information summaries described in section 5.4.

These information sources should enable you to identify the file containing the documentation you are looking for. Any paper documents which have been issued in one of the Starlink document series and which are available on-line are stored in one of the two standard Starlink documentation directories. Their logical names are:

DOCSDIR: for 'Starlink' documentation (SUG, SUN, SGP, SSN).

LDOCSDIR: for 'Local' documentation (LUN, LGP, LSN).

Thus, paper SUN/2 may be examined at a terminal by the command:

TYPE DOCSDIR:SUN2

You will have to control the output by using cntrl/S to stop the flow and cntrl/Q to start it again.

Notice that the file name above is formed from the name of the class (SUN) followed by the serial number (2) of the document. This is the general convention in DOCSDIR. In the local directory, the file name is formed from the node name followed by the class followed by the number, eg.

RALLSN10	holds	LSN/10 (Chilton)
CAMLUN9	holds	LUN/9 (CAM)

A 'DIR LDOCSDIR' command should make it all blindingly clear.

Unfortunately, there is no Starlink standard convention for file type names. People use .LIS, .DOC, .TXT, .AID and .HLP to identify text files. Any of these types may be output on a terminal or lineprinter, but files of type .AID and .HLP are usually associated with some form of HELP system. The default file type for the TYPE command is .LIS so that the TYPE command shown above will display file DOCSDIR:SUN2.LIS. The PRINT command defaults to the latest filetype in the file list, although the initial assumption is also .LIS. One problem that can arise in files produced by the GEROFF text formatting program concerns text underlining. Text which is underlined properly on the lineprinter is completely obliterated on a VDU. Underlined text which appears on a VDU is only partially underlined on printer output. Thus, files for the lineprinter which contain underlining are virtually useless when displayed on a VDU, but files for a VDU are just a bit messy when printed. The convention used in DOCSDIR: is for VDU files to be of type .LIS and for lineprinter files to be of type .DOC. If only one of these types exist, it should be printable.

Anyone may contribute documentation to the Starlink series. The preferred method is for authors to use the GEROFF text formatting program (see SUN/2) and prepare their original text as a .GRF file. Some helpful hints are contained in LGP/31 (Chilton). Please use the standard GEROFF macros held in file DOCSDIR:PRELUDE.GRF by making the first line in your file:

```
.af DOCSDIR:PRELUDE.GRF
```

This makes life much easier for the Starlink Software Librarian. Many potential traps have been thought out and SOLVED in these macros. Most documents in DOCSDIR: are stored in GEROFF form. These are by far the easiest form from which to prepare new versions of documents. You can use them yourself to examine documents easily. For example, SUN/2 can be studied at a terminal by entering the statement:

```
GEROFF DOCSDIR:SUN2 TT: DEV=TERM
```

and pressing 'RETURN' to get each new frame. Try it!

5.4 Information summaries

Chilton maintains several information summaries on its computer as a reference aid. It is hoped that other sites will do the same. However, such summaries take quite a lot of effort to set up and maintain and this effort may not always be available.

The following summaries should exist:

<u>INFORMATION</u>	<u>PROJECT WIDE</u>	<u>LOCAL SITE</u>
Documentation	DOCSDIR:DOCS DOCSDIR:SUBJECT DOCSDIR:BUGS	LDOCSDIR:DOCS
Software	ADMINDIR:SSI ADMINDIR:SSF	LADMINDIR:SOFTWARE
VAX Usernames	ADMINDIR:USERNAMES	LADMINDIR:USERNAMES
Known users	ADMINDIR:PERSONAL	

The 'project wide' files are only maintained at Chilton but they may be copied to other nodes. They all specify the date on which they were last updated. The 'USERNAMES' files are designed to help users use the MAIL system to send messages to other users. They contain the usernames through which users can be contacted.

5.5 How to find information on a particular topic

If you want to find information on an item of software that has been installed in the Starlink Software Collection you should look at its entry in the Starlink Software Index stored in ADMINDIR:SSI. This will direct you to a Starlink paper on the item.

If you want to find all the Starlink documentation on a particular topic (eg. Graphics), look in the subject index stored in file DOCSDIR:SUBJECT.

If you are thinking of using a package or analysing a standard type of data (eg. IUE images), your best strategy is to seek out and make friends with other users of that package or data. You will then be talking to the real experts on the subject and they can give you the information that the documentation leaves out or gets wrong. They have solved the problems that are worrying you, so go and talk to them. Starlink staff are usually not experts on these matters.

5.6 Bugs

All software of any size contains bugs. Starlink software is no exception. This also applies to documentation. If you find one, please send a MAIL message to RLVAD::STAR giving as much helpful information as possible; (what are you using? what did you do? what happened? when did it happen? can you get over it?). Bugs will be eliminated whenever time and resources permit. This will usually end up with a modified release of software and/or documentation. However, this process takes time. To deal with the interim period, a report of all bugs known to the Starlink Software Librarian will be maintained in file DOCSDIR:BUGS. If you have a problem with a Starlink Software Item, examine this file. It may contain a solution to your problem.

CHAPTER 6 ... APPLICATIONS SOFTWARE

6.1 The Software Problem

At the time of writing, there are over 400 registered users of the Starlink computers. All of these people are potential software writers. Much of this software is only relevant to particular individuals or groups. It exists in private directories and the Starlink project as a whole is unaware of its existence, apart from its resource consumption (disc space, CPU time, etc).

In order for software to be generally useful, prospective users must be able to find out: 1. what is available; 2. how to use it. Two methods are used to communicate this information: 1. informal contact; 2. documentation. Starlink as a whole is restricted to the second method, but the first can be very effective if you get to know the right people. The problem with the second method is that it involves a large amount of overhead in time and effort, and in order to be practicable, its scope must be restricted to bring it in line with the capacity of the manpower devoted to it.

These considerations have led to the concept and implementation of the "Starlink Software Collection". Basically, this is the set of software that the Starlink project recognises as being within its domain of responsibility, as far as the general user is concerned. The definition and management of the Collection is described in SGP/20. It is called a "Collection" rather than a "Package" because it consists of a collection of largely autonomous "software items" rather than an interdependent "system" of software.

6.2 Software Development

Starlink General Paper SGP/13 - "The development of Starlink applications software" - gives an extended discussion of the nature, philosophy and proposed development of applications software on Starlink.

Anyone can submit software for the Collection, but he should discuss his plans at an early stage with the Project Manager so as to fit in with the overall development plan. The project staff are developing particular items of software, such as the environment and graphics facilities. Also, contract applications programmers are developing applications software. When software has reached a state of development where it is generally useful, it should be submitted for inclusion in the Collection. This process is described in SGP/19.

An attempt is made to keep aware of what software is generally available at each site, but its effectiveness is limited by the effort required to maintain such records and by the willingness of people to supply information about their software.

6.3 The Starlink Software Collection

The items in the Starlink Software Collection are specified in ADMINDIR:SSI. This file tells you the location of the files and documentation for every item in the Collection. The items are grouped into sections on the basis of their functions. You should print out ADMINDIR:SSI and keep it with your SUG as this is the basic source of information on Starlink software.

The Collection is undergoing continuous development and file ADMINDIR:SSI should be referred to for a specification of its current state. At the time of writing, your attention is particularly drawn to the following powerful items of software in the Collection. Starlink documentation referring to each item is indicated in parentheses.

1.3 IDL - Interactive Data Language.

This is a commercial data analysis system purchased from Research Systems Inc., Denver, CO, USA. Its use is confined to private work and it will not be built into Starlink applications software. (SUN/17)

1.6 SPICA - Spectral Data Reduction System.

This system is derived from a previous UCL system called DRUGS. It is well documented and user friendly and has a large number of application programs. (SUN/19 and ENTERPRISE 6)

1.9 ASPIC - A collection of image processing programs.

The application programs in this system are based on the current Starlink subroutine library. It incorporates a powerful user interface language and has an extensive library of application programs. (SUN/23)

1.13 IUE - An IUE data reduction package.

This collection of programs is specifically designed for the analysis of IUE data. The package includes the programs ANIUE, STAK, TRAK and DRP. (SUN/9)

1.14 VLBI - Very Long Baseline Interferometry package.

A VLBI data reduction package obtained from CALTECH. (SUN/20)

2.1 NAG - Mathematical subroutine library.

This is a widely used commercial library of robust subroutines. They are well documented and a full

document set is held at each Starlink site. It is permissible for NAG routines to be called by Starlink applications software. (SUN/28)

2.2 GKS - Graphics Package.

This is the ISO standard graphics kernel system. It has been adopted as the Starlink graphics standard. The present implementation (version 6.2) is a commercial package; the next (version 7.0) is being developed in-house at RAL and will be distributed to bona-fide astronomical institutions free of charge (subject to certain restrictions). (SUN/11, SUN/12)

2.8 VERSAPLOT - Plotting on the Versatec.

This is a commercial package sold by Versatec to support graphical output on their electrostatic printer/plotter device. It is supplied as an interim measure only. Its role will be taken over fully by GKS and Starlink software. (Versatec manual)

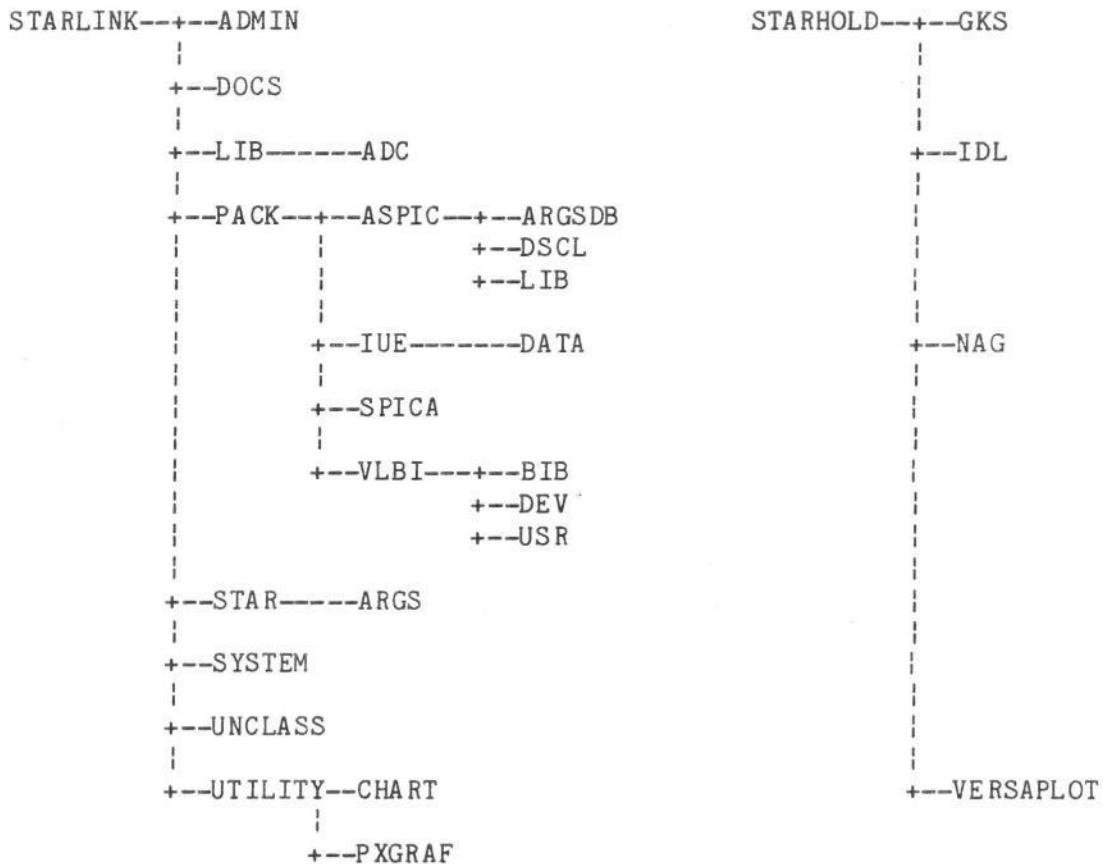
2.10 HIGR - High Level Graphics Routines.

This is the standard Starlink high level graphics interface and it is based on GKS. It comprises three separate packages of routines:

CONTOUR - Contour graphics package. (SUN/14)
DRPLOT - Graphs and histogram package. (SUN/13)
HIST3D - 3-dimensional histogram package. (SUN/16)

6.4 Starlink Directory Structure

The directory structure used to store the files comprising the Starlink Software Collection is shown below. An up-to-date version can be obtained by using the command "DT SSC" and listing the resulting file TREE.LIS.



Where possible, you should refer to Starlink directories and subdirectories by their logical names since their physical locations may change. Also, logical names are usually much shorter than the specifications they represent. The standard set of logical name definitions can be found in file SSC:STARTUP.COM and LSSC:STARTUP.COM. Other logical names may be specified in the documentation of specific packages. Logical names are used when referring to files, e.g. DOCSDIR:DOCS.LIS refers to file DOCS.LIS in the directory DOCSDIR. Starlink directories are normally held on a device with logical name STARDISK. You only need to use this when no logical name is defined for a Starlink directory.

The software is held in three directories (with their sub-directories). Their logical names are:

- | | |
|------|--|
| SSC | (directory name STARDISK:[STARLINK]) holds project generated software which the Project Manager can distribute on his own authority. |
| HSSC | (directory name STARDISK:[STARHOLD]) holds proprietary software which is used by Starlink, but |

which cannot be distributed without a licence.

LSSC (directory name STARDISK:[STARLOCAL]) holds local additions or modifications to the Collection. This should have the same basic structure as the directory SSC. The contents are decided upon by the local Site Manager.

The directory SSC contains 8 first level sub-directories whose logical names are:

ADMINDIR	holds information used in the management and administration of Starlink.
DOCSDIR	holds Starlink documentation. In particular, it holds copies of all Starlink classified documents (SGP, SSN, SUG and SUN) available in on-line form, together with associated indexes.
LIBDIR	holds libraries of subroutines used by the linker, (of file type .OLB).
PACKDIR	holds software which is released in the form of self contained packages, (e.g. SPICA).
STARDIR	holds the Starlink environment and the programs which depend on it.
SYSTEMDIR	holds system software that is associated with Starlink.
UNCLASSDIR	holds software which does not fall naturally into other directories.
UTILITYDIR	holds programs which do not depend on the Starlink environment. Usually, these are single programs which carry out simple tasks like copying a magnetic tape.

The directory HSSC contains 4 sub-directories with logical names:

GKSDIR	holds the GKS graphics package.
IDLDIR	holds the IDL language software.
NAGDIR	holds the NAG scientific subroutine library.
VERSADIR	holds the Versatec proprietary software.

The correspondence between these logical names and the directory names shown on page 3 is the obvious one.

The directory LSSC has no standard form, but it is suggested to every Site Manager that its structure be similar to that of SSC. It is also suggested that the subdirectories be given logical names starting with an 'L' and followed by the logical name used for the associated SSC directory. Thus, the following logical names should be defined:

```
LADMINDIR  
LDOCSDIR  
LLIBDIR  
LPACKDIR  
LSTARDIR  
LSYSTEMDIR  
LUNCLASSDIR  
LUTILITYDIR
```

6.5 Other Applications Software

A lot of useful software is available which has not been installed in the Starlink Software Collection. Some of it is software which is under development and will eventually be added to the Collection. Some of it consists of packages that are local products of individual Starlink sites. It is the responsibility of the local Site Manager to document what local software is available. He may maintain an on-line index of local software. If so, it should be stored in file:

```
LADMINDIR:SOFTWARE
```

Some examples of useful local packages that may be available at several nodes are:

E2D (Edinburgh 2-D package) - (ROE)

An interactive 2-D photometry package, working on Starlink images and using the ARGS display. A manual is available from ROE.

ESP (Edinburgh Spectral Processing system) - (ROE)

A spectral processing system basically geared to interactive reduction of IPCS data. A manual has been circulated to all nodes.

TVS (Tololo-Vienna interactive image processing System) - (RGO)

A general astronomical data reduction system for 1D and 2D data. Accepts IUE, IPCS, PDS and SDRSYS tapes.

CHAPTER 7 ... RUNNING APPLICATIONS PROGRAMS

7.1 Running non-Starlink programs

Non-Starlink programs may be run under VMS in the usual way, using the DEC command language (DCL). The simplest command is

```
RUN <program name>
```

Alternatively, this command may be included in a command file, which may be used to run the program either interactively or, using the SUBMIT command, as a batch job. Further details are in the VAX/VMS Primer.

Before running any program, the user must assign any devices or files that are referenced by it. This may be done by using the OPEN statement in the program itself, or by using the ASSIGN command. If this is not done, the program will try to access default files with names like FOR00n.DAT, with results that may be unacceptable to the user. ASSIGN commands may be included in the command file. Again, further explanation can be found in the Primer.

7.2 The Starlink command language

In the long term, Starlink programs will be run through the Starlink command language (SCL), which is presently under development. This will allow much easier handling of program parameters, the passing of parameters from one program to another, and the creation of command files which may be called by name or submitted as batch jobs. It will also be possible to use loop and branch structures at command level. However, at present only the simplest feature of SCL is available, namely the command RUNSTAR, which must be used in place of RUN for Starlink programs. Another interim command language, called DSCL, is available and is described below.

7.3 Running Starlink programs in the interim environment

A Starlink program is one that makes use of Starlink subroutines. In the period before the SCL is implemented, an "interim environment" has been provided for the execution of such programs, and this is more fully described in SUN/4 and SUN/15. (Note that these documents

were written before the implementation of the current directory structure and they should therefore be read in conjunction with SUG/6 and SUN/27.) The command RUNSTAR must be used to run Starlink programs. RUNSTAR may be used in exactly the same ways as RUN. However, RUNSTAR also allows parameters to be set for the duration of the run. Assume that the program requires parameters P1 and P2. Then the command

```
RUNSTAR <program name>/P1=value1/P2=value2
```

may be used, or more simply

```
RUNSTAR <program name>
```

In the latter case, the system will either pick up default values or prompt the user, with or without defaults, for each parameter in turn, depending on how the program was written.

Note that a "connection file" of type .CON must be associated with and in the same directory as an executable Starlink program. Parameters, default values and error messages must be stored in the connection file.

7.4 DSCL

An interim Command Language called DSCL has been developed. This will be replaced by the Starlink Command Language (SCL) eventually, but for the time being DSCL provides an on-line HELP facility, a procedure mechanism for creating new applications, an image stack for intermediate image storage and a convenient way of handling parameters by position, keyword or default.

DSCL was developed for the ASPIC set of application programs, but may be used to run any program held in any directory. It is fully described in SUN/23.

7.5 The Starlink internal data format

Starlink programs access bulk data in files of type .BDF by referring to the filename. Further information is available in SUN/4.

A completely new internal data format is under development.

CHAPTER 8 ... DEVELOPING STARLINK PROGRAMS

8.1 The Starlink software environment

The Starlink software environment will contain an "end-user interface" designed for the astronomer together with a "system software interface" for the development and implementation of applications software. The user interface, in particular the Starlink command language (SCL), will be used by the astronomer to run programs and communicate with devices. The software interface is essentially a set of library subroutines which can be used by the applications programmer to access bulk data, graphics devices and the user's terminal. In effect all program input and output will be done through one of these subroutines, and nothing done by Fortran I/O. The routines allow application programs quick, direct access to bulk data independent of the format and provide a consistent scheme for accessing parameters.

These two parts of the environment are connected by an command interpreter responsible for driving applications programs in response to commands in the command language. This command interpreter, with the Starlink subroutine libraries, shields the user and the application from irrelevant details of the particular machine being used.

Development of applications programs - compiling, editing, etc. - will be performed under the VMS operating system. Users will be able to create their own libraries of applications programs either for their own use or for later integration into the general Starlink system.

To be able to incorporate such programs properly into Starlink, they will need to be written in VAX-11 FORTRAN (or any other language with compatible calling sequences), adopt the standard data formats, and interface with the command language so as to give a consistent appearance to the interactive user. They should use the Starlink subroutines for input and output. Users are encouraged to write relatively short programs which apply one process to a set of data. The individual programs can then be integrated into a single package by the command language.

VAX-11 FORTRAN is a dialect of FORTRAN 77, for which a suggested textbook is "Programming in Standard FORTRAN 77" by Balfour and Marwick, published by Heinemann. Programmers are also strongly recommended to read and follow the guidelines of the entertaining

paper SGP/16, "Starlink Applications Programming Standards".

8.2 Developing Starlink programs in the interim environment

An interim environment exists for the development and execution of applications programs which use the Starlink subroutines. This is described in SUN/4 and SUN/15. Remember that the current directory structure is different from the one assumed in these two documents. In particular, note that after compilation, the object program must be linked with the library STARDIR:INTERIM.OLB to resolve Starlink subroutine references. For example:

```
LINK <program>,STARDIR:INTERIM/LIBRARY
```

8.3 Contributing applications programs

If you have developed software that you think may be of a wider use and are willing to allow its distribution through the Starlink network, contact your local site manager. You should also read SGP/19, "How to Submit Software for Inclusion in the Starlink Software Collection".