

## STARLINK USER GUIDE

## CONTENTS

## 1 INTRODUCTION

## 2 STARLINK

- 2.1 Starlink
- 2.2 Hardware
- 2.3 Software
- 2.4 New Users
- 2.5 Addresses and Contacts

## 3 INTRODUCTION TO THE VAX

- 3.1 VAX Documentation
- 3.2 The Operating System
- 3.3 A Terminal session
- 3.4 Resources
- 3.5 The Standard File Structure

## 4 THE NETWORK

- 4.1 Introduction
- 4.2 Sending messages and copying files
- 4.3 Logging in to remote sites

## 5 STARLINK DOCUMENTATION

- 5.1 Types of documentation
- 5.2 Paper documentation
- 5.3 On-line documentation
- 5.4 Information summaries

## 6 APPLICATIONS SOFTWARE

- 6.1 Applications software on Starlink
- 6.2 Software support
  - 6.3 Available software: fully supported
  - 6.4 : partly supported
  - 6.5 : local

## 7 RUNNING APPLICATIONS PROGRAMS

- 7.1 Running non-Starlink programs
- 7.2 The Starlink command language
- 7.3 Running Starlink programs in the interim environment
- 7.4 The Starlink internal data format

## 8 DEVELOPING STARLINK PROGRAMS

- 8.1 The Starlink software environment
- 8.2 The software interface
- 8.3 Developing Starlink programs in the interim environment
- 8.4 Contributing applications programs

## 9 LOCAL CONVENTIONS (To be added by site managers)



## 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 SRC 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 a particular piece of 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 the 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/2 V1' means that the page belongs to version 1 of chapter 2 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 either send these via the MAIL system to RLVAD::STAR (see Chapter 4) or directly to K P Tritton at the Royal Observatory Edinburgh (address in section 2.5).

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 has three components, a network of computer hardware, a group of people and a collection of software. These components are described in the following subsections. Individual users will attach different weights to these components and it is clear that their evolutionary properties are not the same.

The initial hardware acquisition is now essentially complete and, although there will be some evolution, this will at first be mostly concerned with the network-wide provision of hard-copy devices and the addition of some remote terminals. As far as the standard software is concerned, the network nodes appear identical; there will however be hardware differences which are driven by the particular needs of local users.

The people associated with Starlink have the functions of:

- a) managing the project, both centrally and at the nodes,
- b) providing systems software,
- c) providing and organising the provision of astronomical applications software,
- d) supporting and educating users and programmers,
- e) giving astronomical direction to the project,
- f) maintaining contact with interested groups elsewhere.

These people are usually based at the nodes of the network but this is not necessarily the case. In particular, applications programmers can be at universities which are not nodes. They may be able to access Starlink through a remote terminal. As well as SRC employees working directly for Starlink, there are contracts with universities for site managers and applications programmers. In addition, a number of astronomers spend a proportion of their time assisting the project.

The most rapid evolution is associated with the software and a document such as this Guide cannot be relied upon to give the current status. It should be used however for information about how to interrogate one of the machines to get appropriate help.

### 2.2 Hardware

Starlink is based on six VAX 11/780 computers, located at Cambridge, University College London, Manchester, the two Royal

Observatories and the Rutherford and Appleton Laboratories at Chilton, linked in a communications network.

The VAX 11/780, a high performance 32-bit multi-programming computer system, is the successor to the DEC PDP11 range. Four of the Starlink nodes each have 2Mbytes of main memory and two 176Mbyte and two 250Mbyte disc drives. At Chilton, the configuration is the same except that there is only one 250Mbyte disc drive, and Manchester has 1.5 Mbytes of memory and only the two 176Mbyte disc drives. Each site also has two 800/1600 bit per inch tape decks.

Hard copy text output can be obtained from Printronix P300 lineprinters. Alternatively, Versatec 11-inch electrostatic printer/plotters serve both as 200 dots per inch graph plotters (pseudo grey-scale images are also possible) and line printers. Two Lear Siegler terminals are provided, one with a graphics option which allows Tektronix 4010 emulation at a low resolution, suitable for program development. There are also two raster graphics terminals, Sigma type T5670 (sometimes referred to as GOCs) with 512 x 768 (1 bit) resolution. These also have a 4010 emulation mode.

Some sites have attached other terminals from their own resources (notably Tektronix 4010 or 4014) in addition to these.

Each computer supports 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, zoom in on parts of the picture, generate lines and other graphics and perform many other functions.

Through the network, the astronomer will have access to devices such as larger plotters and camera systems to produce colour prints and slides of astronomical objects.

The systems are linked by leased Post Office lines in a star network centred on Chilton. Initially, DECNET communications protocols are being used; ultimately it is intended to adopt an X25 packet switched network to connect Starlink to the large Science Research Council network. All the communications run at a speed of 2400 bits per second (apart from that to RGO which is 4800 bps). This is not suitable for large data transfers but quite adequate for exchanging software, reports, etc.

### 2.3 Software

It is intended to implement 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 enable 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 at the Chilton site and the current situation is described in Chapter 7. In the interim, users are encouraged to mount current packages in an ad hoc way on the VAX, and the network will be available to distribute such software.

Applications software, although being coordinated from Chilton, is being undertaken 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 being encouraged to implement new or existing software on the VAX and publish it on the network for others to use. Full credit for contributed software is given.

Initially, Starlink will try to implement the more commonly needed image-handling and processing primitives so that data from the AAT, IUE, etc can be processed at least as efficiently as with existing packages running on other machines. Wherever possible, generally accepted software and standards are being adopted. Thus the Numerical Algorithms Group (NAG) mathematical library has been adopted as a Starlink standard, and is already available. The device independent Graphics Kernel System (GKS) will be implemented shortly, and the Flexible Image Transport System (FITS) is recommended for bulk data transport.

It is Starlink policy to have all Starlink software 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.

#### 2.4 New Users

Starlink is an SRC national facility and its users must be formally accredited, and allocated resources. However, it is recognised that many astronomers could make use of the VAX computers now, even without Starlink software, and wish to do so without a tedious authorisation process. For this reason initial applicants simply have to complete the form 'Application for Starlink Resources' and send it to the Head of Starlink, either directly or via the local site manager. Workers on

current SRC projects will be accredited without further ado (non grant-holders have to be approved at a higher level but this will be a formality in most cases). 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 will thereafter liaise directly with the manager at whichever node(s) they use.

Eventually, potential users will need to apply for Starlink time as part of grant applications or allocation of establishment resources and these will be considered by ASR Board Committees in the usual way.

## 2.5 Addresses and Contacts

Starlink sites, addresses and site managers are as follows:

Rutherford and Appleton Laboratories Chilton Didcot Oxfordshire OX11 0QX	Mrs L J Claringbold (0235)-21900
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Royal Greenwich Observatory Herstmonceux Castle Hailsham Sussex BN27 1RP	Mr D J King (032181)-3171
---	------------------------------

Royal Observatory Blackford Hill Edinburgh EH9 3JZ	Mr B V McNally (031)-667-3321
--	----------------------------------

University College London Department of Physics and Astronomy Gower Street London WC1E 6BT	Dr S L Wright (01)-387-7050
---	--------------------------------

Institute of Astronomy Madingley Road Cambridge CB3 0HA	Dr C A Robinson (0223)-62204
---	---------------------------------

University of Manchester Department of Astronomy Oxford Road Manchester M13 9PL	Dr D L Terrett (061)-273-7127
--	----------------------------------

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

Dr R J Dickens	Head of Starlink	RAL or RGO
Mrs S Cole	Secretary	RAL
Dr E Dunford	Project Manager	RAL
Mr P T Wallace	Applications Software	RAL
Mr M D Lawden	User Support Software Maintenance and Distribution Documentation	RAL
Mr A J H Walter	Systems Software	RAL
Mr D Pearce	Systems Software	RAL
Dr R A E Fosbury	Project Scientist	RGO
Mrs L J Claringbold	Secretary, Scientific Advisory Group	RAL

## CHAPTER 3 ... INTRODUCTION TO THE VAX

### 3.1 VAX Documentation

DEC produce a vast quantity of documentation describing the VAX 11/780 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 Language.

#### 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 11/780 - Technical Summary

#### VAX 11 - 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 audio-visual courses are available at the Chilton node which may be of use to new users:

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, page 1-10). 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. For example

`HELP COPY` ...gives help on the COPY command for file copying  
`HELP HELP` ...gives help on the HELP command.

### 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 full work-station consists of an ARGUS, a SIGMA T5670 graphics terminal and a normal alphanumeric terminal; however, these are often split up when the full facility is not required.

A new user will need to acquire a username (e.g. USERNAME) and a password from the local node 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, page 1-9 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" usually called [USERNAME] which resides on one of the discs. The command DIR (an abbreviation of DIRECTORY) will tell you the names of any files you have stored there. 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/ALLOCATION.

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 only 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.

### 3.5 The Standard File Structure

The directory structure within which Starlink software is stored is being revised in the light of experience to make it easier to use. Currently, there are two separate systems.

In the first system, different components of a program or package are stored separately in one of the following directories:

[USERSRC]	[STARSRC]	source code
[USERLIB]	[STARLIB]	libraries of object code which are scanned when the linker produces executable programs
[USEREXE]	[STAREXE]	executable programs
[USERCOM]	[STARCOM]	command procedures
[USERDOC]	[STARDOC]	documentation

The USER.... directories hold software used directly by the users and applications programmers. The STAR.... directories hold systems software.

In the second system, complete packages are stored in separate subdirectories of a directory [STARPACK]:

[STARPACK.package]

In this case, 'STARPACK' stands for 'Starlink Package' and does not imply that the software is systems software.

Any Starlink directory can contain a local subdirectory of the form

[directory.LOCAL]

This enables software which has not been released as standard Starlink software to be stored in association with it. Thus, there may exist a parallel set of directories

[USERSRC.LOCAL]	[STARSRC.LOCAL]
[USERLIB.LOCAL]	[STARLIB.LOCAL]
[USEREXE.LOCAL]	[STAREXE.LOCAL]
[USERCOM.LOCAL]	[STARCOM.LOCAL]
[USERDOC.LOCAL]	[STARDOC.LOCAL]

[STARPACK.LOCAL]

Every Starlink directory should contain a file called INFO.LIS which should describe the files in the directory.

## CHAPTER 4 ... THE NETWORK

## 4.1 Introduction

The six Starlink VAX computers are linked together in a network, with the Chilton (Rutherford and Appleton) site at the centre and the other nodes connected radially from Chilton. The DECnet Users Guide gives extensive details of the facilities of the network, but a summary of the more useful facilities is given here. The network names for the nodes are as follows:

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

The DCL command SHOW NETWORK indicates the current status of your site's connection to the network: this must be ON in order to use the network. At a satellite node this command will show connection to RLVAD only, and not to the other sites accessed via there.

## 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. To send a message, type 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. Note that all connections between satellite nodes must be made via the Chilton node, so a message from (for example) Cambridge to user OPER at RGO is sent to RLVAD::RGVAD::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 3A, or by typing HELP MAIL.

A list of users and their usernames should be maintained at each node in the file SYS\$SYSDISK:[STARDOC.LOCAL]USERNAMES. These files will be collated and stored at Chilton in the file SYS\$SYSDISK:[STARDOC]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 at (for example) ROE would type

```
COPY RLVAD::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. Even small files are best transferred by submitting the COPY command as a batch job (see the Primer, section 6.3).

#### 4.3 Logging in to remote sites

To login 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 login 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 appropriate, users must login to RLVAD first and then to any other Starlink VAX.

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.

## 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

'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 standard Starlink software), or as a 'Local' document if it concerns a single site. Local User Bulletins contain ephemeral information such as notices of shutdowns. There are, therefore, six sets of 'Local' documents and one set of '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, up-to-date index of Starlink documentation issued within these classifications is stored in file

RLVAD::SYS\$SYSDISK:[STARDOC]DOCS.LIS

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

<site name>::SYS\$SYSDISK:[STARDOC.LOCAL]DOCS.LIS

Paper documentation 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.

### 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. Type or print out files containing documentation.

Currently, very little Starlink documentation has been incorporated in the HELP system, which is mainly concerned with DEC's own VAX software. Therefore, you must rely on typing or printing out documentation files. Chapter 6 contains the names of specific files storing documentation for specific software items. However, you may wish to search for other documentation, or just browse to see what is currently available.

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

1. Directory listings obtained by using the DIR command.
2. The INFO.LIS file contained in most Starlink directories. This file contains a description of the other files in the directory.
3. The documentation and software summaries described in section 5.4.

These information sources enable you to identify the file which contains the documentation for which you are looking. 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 standard Starlink documentation directories. The top level Starlink documentation directories are:

[USERDOC] for user documentation  
[STARDOC] for systems documentation

Each series of documents is stored in a separate directory as follows:

[USERDOC.SUG]	Starlink User Guide
[USERDOC.SUN]	Starlink User Notes
[STARDOC.SGP]	Starlink General Papers
[STARDOC.SSN]	Starlink System Notes

There will also be a set of local directories specific to each site:

[USERDOC.LOCAL.LUN]	Local User Notes
[STARDOC.LOCAL.LGP]	Local General Papers
[STARDOC.LOCAL.LSN]	Local System Notes
[USERDOC.LOCAL.LUB]	Local User Bulletins

These directories are not complete as not all documents in the Starlink series are produced on the computer.

Other on-line documentation will exist in one of the other Starlink directories (see section 3.5). Files containing such documentation can be recognised by their 'file type'. This is usually .LIS, but people sometimes use .DOC, .TXT, .AID, .HLP, etc.. The file name should indicate what the documentation is about; thus, MTRU.LIS contains documentation for the executable program MTRU.EXE. For documentation on programs, you should look first in the directories [USEREXE] and [STAREXE]. Some large programs and packages have extensive manuals stored on-line. These are usually referenced in other Starlink documentation.

#### 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 be available:

INFORMATION	PROJECT WIDE	LOCAL SITE
Documentation	[STARDOC]DOCS	[STARDOC.LOCAL]DOCS
Software	[STARDOC]SSI	[STARDOC.LOCAL]SOFTWARE
User details	[STARDOC]ACCOUNTS	[STARDOC.LOCAL]USERS
User names	[STARDOC]USERNAMES	[STARDOC.LOCAL]USERNAMES

The 'project wide' files are only maintained at Chilton. All the files are of type '.LIS'. 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.

## CHAPTER 6 ... APPLICATIONS SOFTWARE

### 6.1 Applications software on Starlink

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.

### 6.2 Software support

There will be several categories of software and several levels of support, depending on the source and quality of the software.

At the lowest level, locally written software that is not supported centrally may be available at a particular site.

At an intermediate level, Starlink advertises and distributes locally written programs, offering general guidance to potential users. To qualify for this minimal level of support, such a program has to be (supposedly) bug-free, of general use, reasonably well coded (including adequate comments), and be provided with user documentation. Also, it must not interfere with the normal running of a Starlink node, avoid extravagant or eccentric use of disc space, memory, cpu or peripherals, and must be runnable, without special privileges, on standard Starlink equipment. The author is expected to give detailed advice to users, to fix bugs, and to maintain compatibility between his programs and the changing environment (e.g. operating system updates, new peripherals, etc).

The highest level of support frees an author completely from support commitments. All user education, bug fixing and program enhancement is handled by Starlink staff. This level requires coding of a high standard and excellent program documentation as well as complete and well written user documentation.

At the lower support levels the author is ultimately responsible for the correctness of his programs. At the higher levels Starlink assumes this responsibility.

### 6.3 Available software: fully supported

The software listed here is available and identical at all nodes. The list has been divided into astronomical programs and packages, subroutine libraries, and utilities. For each item, a brief description is given, followed where appropriate by the file location, the location of any on-line documentation, and a reference to any other documentation. A complete index of the current Starlink Software Items which have been installed is stored in RLVAD::SYS\$SYSDISK:[STARDOC]SSI.LIS.

#### i) Astronomical programs and packages

These may be run by the specific commands described in the documentation.

Name: AATGS  
Description: Predicts guide star probe positions for the AAT  
Documentation: SUN/6 (partially available on-line)

Name: ASTROM  
Description: General astrometric reduction program  
Documentation: SUN/5 (partially available on-line)

Name: SPICA  
Description: Spectral Data Reduction System derived from UCL's DRUGS. Capable of accepting IPCS, IUE, SDRSYS, PDS or FITS format data  
Documentation: SPICA manual (available at sites). File [STARPACK.SPICA]SPICA.DOC describes how to obtain information about SPICA

#### ii) Subroutine libraries

These are stored in files of type .OLB and hence must be linked with an object program.

Name: NAG  
Description: Large mathematical subroutine library; the current version is Mark 6 but this is being enhanced to Mark 8.  
Location: [USERLIB]NAG.OLB  
On-line documentation: [USERLIB]NAG.LIS  
Other documentation: NAG manual (at nodes); Chilton LUN/9

Name: FINGS  
 Description: Interim graphics package; backends exist  
 for Tektronix 4010 and Versatec  
 Location: [USERLIB]FINGSLIB.OLB  
 On-line documentation: [USERLIB]FINGSLIB.LIS  
 Other documentation: FINGS primer/manual (at nodes); see also  
 Chilton LUN/3 for notes on use with  
 Tektronix or Versatec

Name: TAPEIO  
 Description: Routines for handling 'foreign' magnetic  
 tapes  
 Location: [STARLIB]TAPEIO  
 Documentation: SSN/7 (available on-line)

### iii) Utilities.

These are stored in executable files of type .EXE and are run either by specific commands or by means of RUN or (for Starlink programs) RUNSTAR.

Name: IPCSIN  
 Description: Converts raw IPCS data from magnetic tape  
 to Starlink data format; Starlink program  
 Location: [USERREXE]IPCSIN  
 Documentation: SUN/3 (available on-line)

Name: VICARIN  
 Description: Converts VICAR format (including IUE) data  
 from magnetic tape to Starlink format;  
 Starlink program  
 Location: [USERREXE]VICARIN  
 Documentation: SUN/7 (available on-line)

Name: GEROFF  
 Description: Text formatting program  
 Location: [USERREXE]GEROFF  
 On-line documentation: use HELP GEROFF  
 Other documentation: GEROFF users guide (at nodes); SUN/2

Name: MTRU  
 Description: General magnetic tape reading utility  
 Location: [STAREXE]MTRU.EXE  
 On-line documentation: [STAREXE]MTRU.LIS  
 Other documentation: none

Name: MTANAL  
 Description: Magnetic tape analyser  
 Location: [STAREXE]MTANAL  
 Documentation: SSN/8 (available on-line)

Name: MTDUMP  
Description: Dumps from magnetic tape  
Location: [STAREXE]MTDUMP  
Documentation: SSN/8 (available on-line)

There are also VAX provided utilities including the text editor TECO and a powerful SORT routine. Manuals are available for these at the sites.

#### 6.4 Available software: partly supported

The software listed below comprises existing local packages mounted on the VAX and available to the user on request, or interim Starlink packages under development. In many cases a package will already be available at the user's node: in other cases it may need to be acquired via the network. A certain amount of further information is available in the references cited. In all cases the prospective user should first contact the local site manager.

Presently available:

**ESP (Edinburgh Spectral Processing System)**

This is a spectral processing system basically geared to interactive reduction of IPCS data. A manual has been circulated to all nodes. (Enterprise 2).

**RGODR (RGO Data Reduction System)**

An extended version of the UCL IPCS reduction system, which caters for images as well as spectral data. (Enterprise 2).

**IDL (Interactive Data Language)**

An interactive programming language. (Enterprise 2).

**ANIUE, STAK, TRAK and DRP**

A set of programs for analysing IUE tapes, applying photometric and geometric corrections, and reducing spectroscopic data. Available from UCL.

**ARGS (Advanced Raster Graphics System)**

A set of programs for using the ARGS display. Documentation in [USEREXE.ARGS]ARGSLIB. Available at Chilton.

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

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

Available shortly:

GKS (Graphics Kernel System)

The first version of this graphics package will support the ARGS. (Enterprise 3).

TVS (Tololo-Vienna Interactive Image Processing System)

A general astronomical data reduction system for 1D and 2D data. Accepts IUE, IPCS, PDS and SDRSYS tapes. (Enterprise 2,3).

IDLP1

Translates Starlink images into IDL format. (Enterprise 3).

PDSIN, SDRSYSIN, FITSIN

These are all programs converting various magnetic tape data formats into Starlink internal format. The tape formats are respectively the PDS, SDRSYS and FITS. (Enterprise 3).

### 6.5 Available software: local

Additional software may be available at the local node. This will probably be the subject of local user notes or other local documentation. See Chapter 9 for possible information. Also, see if the local [STARDOC.LOCAL]SOFTWARE file contains any useful information.

## 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, 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.

### 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. 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 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 consist of two parts, 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 on the one hand and the user's terminal on the other. In effect all program input and output should be done through one of these subroutines, and nothing done by Fortran I/O. The routines allow quick, direct access to bulk data independant of the format and provide a consistent scheme of defaults for parameters.

These two parts of the environment are connected by a system command process responsible for driving applications programs in response to commands in the command language. This command process, 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 generally 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. It is in the nature of these subroutines that users are encouraged to write relatively short programs which apply one process to a set of data. The individual programs become integrated into a single package by the command language.

VAX 11 FORTRAN is a dialect of FORTRAN 77. A recommended textbook for FORTRAN 77 is "Programming in Standard FORTRAN 77" by Balfour and Marwick, published by Heinemann.

### 8.2 The software interface

A full description of the software interface is given in SUN/4 and will not be repeated here. SUN/4 includes general descriptions of the methods of access to the user terminal and to bulk data, an explanation of the use of the connection file, and detailed specifications of the available Starlink subroutines.

### 8.3 Developing Starlink programs in the interim environment

The Starlink end-user interface (i.e. the command language SCL) has yet to be implemented. However an interim environment exists for the development and execution of applications programs which use the Starlink subroutines. This is also described in SUN/4.

In particular, note that after compilation, the object program must be linked with the library SYS\$SYSDISK:[USERLIB]STARLINK.OJB to resolve Starlink subroutine references. For example:

```
LINK ----,SYS$SYSDISK:[USERLIB]STARLINK/LIB/INC=(STL_DATA)
```

### 8.4 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.