COMPUTING

at Rutherford Appleton Laboratory

Alvey Programme

The Alvey programme was launched to mobilise UK technical strengths in Information Technology in order to improve the UK competitive position in world markets. It is a pre-competitive research programme between Government, Industry and academe. The programme is managed by the Alvey Directorate in London and consists of four enabling technologies, Very-Large-Scale Integration (VLSI), Software Engineering (SE), Intelligent Knowledge-Based Systems (IKBS) and the Man-Machine Interface (MMI). Directors and their staff coordinate the activities in each area. To provide computing facilities for SE, IKBS and MMI, an Alvey software/hardware infrastructure has been assembled consisting of multi-user and single-user systems networked with standard software and RAL is concerned with coordination and support. Regular mailshots of trip reports, news, announcements and research reports are made to the community in each area. Workshops, coordination of research activities, advice on grant proposals all help keep the community informed of major activities within and outside the programme. Other Alvey activities at RAL are referred to below, under the headings Pattern Recognition (MMI), and Semiconductor Modelling and Lithography (VLSI).

Software Engineering

Theorem Provers

These software tools aid the process of proving theorems and a major activity this year has been the mounting of a number of theorem prover systems for the user community. In this context, the concern is primarily with proving theorems about programs (for example, that a particular program possesses a particular property). Three current systems, ML/LCF, IOTA and Boyer-Moore have been acquired. ML/LCF was mounted on a VAX and the Atlas 10 under UTS. IOTA is a modular programming system built in Japan which includes a significant verification capability. As IOTA is written in an ancient dialect of LISP, a significant amount of work has had to be done and is still needed before it can be made generally available. RAL is the UK distribution agent for the Boyer-Moore theorem prover.

Formal Specification of Graphics

Alvey and SERC grants have been awarded for work on various aspects of the formal specification of computer graphics systems. As graphical input and output are only approximations to what is defined, proving properties of graphical systems is considerably more difficult than for conventional systems. Parts of the Graphical Kernel System (GKS) standard have been taken and expressed in formal terms (Fig 2.1) and assertions in the standards document have been rigorously analysed. The work has been done in close conjunction with ISO standards activities and has made significant improvements to the formal wording of the standard.

Intelligent Knowledge-Based Systems

Recognising the UK lead in Logic Programming, a major activity has been the creation of a special

$$mk\_DC\_Fill\_Area(f, w, v, b, pa) \triangleq$$
$$\textbf{let} \quad f = ((i, b) \mapsto (cr, fi, \textbf{prp}, \textbf{pw}, \textbf{ph}))$$
$$\textbf{and} \quad ndcpts = i \cup b$$
$$\textbf{and} \quad b = (style, si, fci)$$
$$\textbf{and} \quad wr = rectangle(\textbf{w}_{min}, \textbf{w}_{max})$$
$$\textbf{in} \quad style = PATTERN \Rightarrow$$
$$\{ (\textbf{p} \mapsto ci) \mid \textbf{p} \in$$
$$wstrans(w, v, ndcpts \cap cr \cap wr \cap ppts)$$
$$\wedge (ppts \mapsto ci) \in pattern(\textbf{p}, \textbf{pw}, \textbf{ph}, pa) \}$$

Fig 2.1 Part of the formal specification of GKS.

initiative with a series of workshops aimed at creating a single balanced programme of relevant research projects. On the software side, contracts have been placed at Edinburgh University to develop NIP, a portable Prolog compiler which can be optimised for specific systems, and at Sussex University to make POPLOG (a combined LISP/PROLOG/POP-II environment) generally available. A research project has started in association with the Alvey IKBS Community Finance Club (Alfex). The Club is producing an Expert System for use in the financial sector and the RAL work will use the 'Knowledge Base' which the Club is producing for research into the segmentation of knowledge. This is in order to investigate the extent to which Knowledge in Expert Systems can be made easier to maintain, modify or use for different purposes.

Man-Machine Interface

A major event was the international Workshop on Window Management in April which recommended a series of activities for the near future and longer-term research themes. RAL is coordinating the activities of a number of UK manufacturers to produce a standard application interface to window managers. Work has also started in defining a standard window manager which could work in a variety of environments.

Communications

Project UNISON

UNISON is one of two high-speed networking projects funded as part of the Alvey Programme. It is a sequel to the UNIVERSE project which ended in September 1984. The UNISON collaborators currently comprise Acorn Computers Ltd, University of Cambridge Computer Laboratory, Logica UK Ltd, Loughborough University of Technology, and RAL. Generally, the objectives of the project are to investigate the provision of an integrated services high-speed digital network suitable for use in the interconnection of the next generation of information technology products. Considerable emphasis is being placed on developing a

basic network service and higher level value-added services within a unified architecture, capable of supplying integrated voice, image, and more conventional distributed computing services. The research elements of the project are concentrated in two areas, novel methods for constructing the network services over the Integrated Services Digital Network (ISDN) and investigations into particular advanced applications, of interest in their own right and for test use of the network. An important decision was to base the whole network design upon use of the emerging international standards for ISDNs. An incipient version of this will be provided for the project by the Alvey High-Speed Network, itself based upon 2 Mbps terrestrial links to be supplied by British Telecom and Mercury. This basic network will provide configurable circuit switched high speed links between the participating sites. Project funding was approved during the latter part of the year. The major activities since then have been in specifying the network architecture and initiating the development of specific pieces of hardware needed to interface British Telecom's Megastream to the Cambridge Fast Ring. Preliminary work on the software systems which will be used to provide the common infrastructure for the project has begun and the installation of Megastream links to participants' sites is progressing.

Alvey Infrastructure

The multi-user interactive facilities supported for Alvey consist of 11 GEC Series 63 systems and 5 Systime 8750s (VAX 11/750 equivalents) with a UNIX service (UTS) on the IBM-compatible Atlas 10 mainframe. Support for the Series 63 systems is provided by Edinburgh Regional Computing Centre under contract, while the VAX systems and the UTS service are supported by RAL using local development systems. The infrastructure also supports SUN single-user systems (see Single-User Systems below).

GEC Series 63

The major activity this year has been establishing a UNIX service on the Series 63 systems. The standard AT&T System V version of UNIX is now installed on all systems. The connection to the wide area network was initially based on the York box front-end but upgrades from 63/30s to 63/40s have greatly improved the network access to these machines.

Systime 8750

The VAX systems are provided to allow import to and export from the Series 63 systems of software required or produced by the user base. In addition, the VAX systems provide a UNIX service based on the Berkeley 4.2 version. The intention is to move to System V UNIX when the version on the VAX stabilises and is fully supported.

UTS

During the year, the UNIX service UTS on the Atlas 10 has been established and very encouraging results have been obtained in running large programs on the system. PROLOG, FRANZLISP and ML/LCF have all been mounted. Cambridge University has run in a few minutes on the Atlas 10 proofs written in ML/LCF which would have taken all night on a VAX. The 4250 erosion printer has been used extensively from UNIX utilities such as Ditroff and Pic to produce slides, technical reports and books. The combination of UNIX with the power and peripherals of an IBM mainframe service provides a facility unique in the UK.

Interactive Computing

RAL supports the Board's computing community via the Single-User Systems programme and the Interactive Computing Facility (ICF). Both are funded through the Board's Computing Facilities Committee. The ICF service continues to be based on PRIME and GEC 4000 systems distributed around the country. Support is provided for 12 PRIME systems and six GEC 4000 systems in universities and polytechnics. In addition, nine PRIME and GEC systems are supported at RAL.

GEC 4000

Support for the GEC 4000 systems is to cease. A new version of the operating system (4.15) is in preparation, for release in mid-1986. Systems at Cranfield and Bradford closed during the year and parts of these systems were used to enhance other systems.

PRIME

All PRIME systems have been upgraded during the year with additional memory, disk capacity and processor upgrades. As a result, 40% power and 20% disk space has been added to the facility. The current plan is to continue running the PRIME system for at least the next five years with a move to running the PRIME UNIX operating system (PRIMIX) alongside the PRIMOS operating system. Benchmarking of the Beta test version of PRIMIX has taken place in conjunction with Surrey University. The major addition to PRIME software this year has been the mounting of the RAL/ICL portable GKS in conjunction with Salford University. The service continues to receive good support from site managers who provide some systems development effort as well as managing the local facility. In addition, the contract with UMIST provides a large part of the PRIME support.

Pyramid

A Pyramid Reduced Instruction Set Computer (RISC) has been purchased as a multi-user system running System V and Berkeley 4.2 UNIX together. This is being used to move existing packages from the PRIME systems in order to assess the performance of such packages under a comparable UNIX system and to ascertain how such packages are restructured to use UNIX facilities. A joint activity with Pyramid will replace the X25 connection currently based on the York box by an in-board solution based on an X25 board.

DEC10

This year saw the closure of the ICF DEC10 KL at Edinburgh. Over the nine-year life of the installation, it was the major ICF facility providing an excellent service for, in particular, Artificial Intelligence and Computer-Aided Design workers, and the Science Board's Crystal Structure Search and Retrieval Database. The DEC10 system delivered a total of 75,000 Allocation Units to interactive users (about 375,000 terminal connect hours). In a typical year, the machine supported some 60 to 70 SERC grants, corresponding to between 350 and 400 active users. Over the last two years, existing users of the DEC10 have moved to other facilities. One of the last groups to move was the ABACUS design group at Strathclyde University. This group was one of the largest user groups on the DEC10, accounting for some 15 to 20% of machine usage, and has been provided with a Systime 8750 running UNIX, the first external UNIX facility supported by ICF.

Single-User Systems

The Single-User System programme continues to provide support for high-powered workstations with an agreed set of Common Base software centrally supported. This includes FORTRAN 77 and PASCAL compilers, and NAG and GKS libraries running on top of the UNIX operating system. Wide Area Network communication is provided by the JNT Coloured Book protocols for mail, file transfer and remote log-in.

Hardware

The original hardware in the Common Base was the ICL PERQ1 machine, of which about 130 systems were installed. This was followed by an architecturally similar system, the PERQ2. Much time during the year

was spent assessing various systems in an attempt to find an alternative to add to the Common Base. About 120 manufacturers were contacted initially, ten being selected as able to supply equipment of the correct power. These suppliers received a more detailed Operational Requirement and Apollo, SUN and Whitechapel were chosen for further assessment. Systems were installed and quantitative and qualitative tests were carried out, including the porting of some large applications programs. After detailed assessment of these systems, it was decided to add the SUN2 system to the Common Base. About 50 PERQ2 and 50 SUN2 second-generation systems have been installed (Plate IX). SUN has recently introduced the SUN3 and ICL is due to release the PERQ3. Major activities this year have been a final upgrade of the PERQ1s with a larger writable control store to run the most recent version of the operating system.

Communications

Local Area Network communications on the PERQ1 have been provided by the Cambridge Ring running the Basic Block protocol. These have been less than satisfactory owing to the General Purpose Interface Bus on the PERQ1 allowing only low speed communications. With the introduction of the PERQ2 and SUN2, the preferred local area network technology is Ethernet. Currently, the SUN2 systems run proprietary protocols (TCP/IP) on the Ethernet hardware while the PERQ2 systems run standard ISO protocols. Work is proceeding to integrate the two systems to allow interworking.

Software

The ICL PERQ2 has a complete range of Common Base software available and a major activity has been to ensure it was available on the SUN2. The major omission was GKS and an assessment of the GKS system provided by SUN is under way. The SPY screen editor developed by RAL has been ported to the SUN2 so that users have the same editing environment on both systems. In addition, a set of utilities forming a graphical toolkit has been developed for the PERQ2 and is being implemented on the SUN2. These provide portable standard ways of accessing input from the mouse, performing raster operations, using pop-up menus etc. Interfaces to these utilities have been provided for FORTRAN, PASCAL and C. A number of software contracts have been let to universities to augment the basic software on the PERQ2. The University of Kent has completed a set of FORTRAN utilities including a source level debugger and an implementation of the NAG TOOLPACK, which provides facilities for documenting and tuning FORTRAN programs. Other work includes on-line documentation and specialist window environments. A contract with Edinburgh University has nearly completed a LISP implementation on the PERQ2.

Central Computing

Mainframe Support

While the year was a period of stability regarding the hardware of the Central Computing Service, it saw major changes in other areas. In April, direct charging was introduced, as recommended by the Macfarlane Working Party, and the IBM MVT operating system was replaced by the more modern MVS. Despite this major upheaval, the Service continued to run large amounts of work for users (Table 5.1).

Table 5.1 Use of Central Computer Facility 1985, Account Units (AU)

Funding Source	Batch	CMS
ASR Board	16685	1140
Engineering Board	76818	2729
Nuclear Physics Board	657793	9824
Science Board	103206	2608
External	21581	645
Total	876083	16946

Note: Batch AUs are calculated as MVS AUs + MVT use converted at 1 hour = 100 AUs.

Direct charging is intended to make the Central Computing Service more responsive to the needs of the Council's research programmes. Each Board is required to pay directly for its use of computing resources and is offered a generous discount for making firm financial commitments at the beginning of each year. Rates are set to recover operating costs and to fund a capital replacement programme but initial indications are that revenue, while covering running costs, will be insufficient to cover the replacement programme.

The long-heralded change to MVS was the culmination of two years preparation. MVT had not been supported by IBM for many years and was incapable of taking advantage of modern hardware. The RAL MVT system had been heavily modified over its 14-year life to cater for the needs of the specialised user community and corresponding changes had to be made to MVS and its spooling sub-system JES3. Basic system modifications and a complete re-write of the accounting and batch graphics systems were required.

VM/CMS

Release 3 of the Control Program (CP) part of the VM operating system was installed in January. This allowed the introduction of the IBM database system SQL/DS to enable CMS users to query information relating to the tape and disk management system TDMS. SQL/DS is also available for CMS users to set up and query their own databases.

As part of a collaboration with CERN and other high energy physics centres, much work has been done on unifying the RAL and CERN VM/CMS systems. This has included an exchange of CP and CMS modifications, the production of a set of 'common fund' EXECs and macros which can run at each site and the installation of RAL facilities at CERN and vice versa. Tests have been carried out on an improved batch system for CMS which originated at SLAC. SLAC Batch has been interfaced to the CMS accounting system and will be a replacement for the existing Batch Monitor on which it is based. Further work is needed to interface it to TDMS before it can be utilised fully as a batch system with access to tapes.

An important change was made to Atlas 10 software. The VM operating system runs under the control of a hypervisor whose main function is to simulate in microcode the action of several privileged machine instructions. It was discovered that the Atlas 10 was spending too much time in the hypervisor and it was realised that the hypervisor functions could be carried out much more efficiently if they were performed by CP. The hypervisor was replaced by the modified CP resulting in 20–30% more CPU power available to user jobs in the MVS virtual machine.

Many other enhancements and additions to CMS commands and facilities were made, including installation of the IBM Document Composition Facility (DCF/SCRIPT). Initially, this was used by the office automation system, PROFS, but was later made available to all users as a text processing system with interfaces to the Xerox 8700 laser and IBM 4250 electro-erosion printers.

MVS/JES3

Because most effort during the two-year conversion

programme had been directed at implementing local requirements in MVS, such as the tape management system TDMS, the accounting/resource control system and the dataset protection system ACF2, the initial production version was several releases out of date. Subsequent effort has been directed to bringing the system up to the latest IBM release. Further development was required to run a local MVS system on the IBM 3081 so that this machine could be utilised outside prime shift when there is very little CMS activity. This went into production at the beginning of December.

Another development brought the Masstor M860 storage device into service under the control of the data management system ASM2. It was used for taking back-up copies of the MVS disks and, from 28 October, for the migration of datasets which had not been used for a specified period. Datasets in the M860 are retrieved automatically within a few seconds when referenced by a job without the user having to take any specific action. This migration applies only to complete datasets. To allow archiving of individual members of user libraries, the program PDSMAN was installed. It provides user-controlled archiving to and retrieval from magnetic tape, a clean-up and space re-use system, and facilities for listing library and archive members.

Performance Analysis

The performance monitoring and analysis systems were modified to reflect the move to MVS and the subsequent introduction of a local MVS system on the 3081. A new version of the statistical analysis package SAS was installed. This is used to analyse results from the CMS and MVS monitoring tools and to produce reports and graphs which are used to spot performance problems and help with decisions on corrective action.

User Support

The Program Advisory Office handles queries from users via electronic mail, telephone and visits from users. Under normal circumstances, the Office handles about 35 queries a day. The move to MVS saw this rise to 80 per day, many of which were of a novel character. This required a new system for handling user queries which allows a team of experts to work independently on separate queries. In addition to dealing with specific problems, there has been a need for user training on MVS. User Support staff have written a primer and run several conversion courses. User turnover is high and there is a continuous training requirement. This year saw the introduction of a new course covering CMS and MVS. The course gave attendees a chance to practise their newly gained knowledge with supervised tutorial sessions accounting for a considerable percentage of the course. The course was acclaimed as a success and has been run four times for a total of over 60 students. The material developed for the course has been made available to existing users.

Office Automation

Once again, there has been a large increase in the use of office automation based on the IBM PROFS (PRofessional OFfice System) product installed at RAL. In the 1984 Annual Report, the number of users was noted as having grown from 40 to 250; the number has now passed 400. There have been significant developments in the provision of access to and from PROFS over various networks accomplished by the use of PROFSNET. There has also been development work on the use of IBM PCs for office automation and considerable effort has been expended on training. A new user-friendly front-end system has been provided between PROFS and the information retrieval system containing SERC Financial Memoranda and Conditions of Employment, Laboratory Notices and Circulars etc. PROFS has been used extensively for Laboratory administration, particularly for document preparation, transmission and filing. Much material for this Report has been prepared using PROFS.

Decision Support Systems

Following a decision that administrative database systems using INFO (a relational database package) should not reside on the PRIME B computer, they were transferred to the IBM environment under VM/CMS where INFO can also run. This involved extensive re-writing of control procedures. The RAL Library STATUS/INFO system has continued production and SPEED software has been installed to aid data input. Records are being added to the RGO Library database using the RAL data input system. A system to handle dosimetry records in the Laboratory has been completed. A system, FDS, has been set up, linked to PROFS but also available under VM/CMS, which maintains a database of financial information. The major software development project concerned the STATUS information retrieval system developed by AERE Harwell, which is being adapted to the VM/CMS environment. It is a particularly ambitious project involving use of modern techniques of inter-virtual machine communication which can lead to distributed database handling. The work also involves interfaces to the IBM product ISPF and, of course, PROFS. Having STATUS available on the IBM system will allow databases currently mounted on RAL PRIMEs to be moved to the central computing system and made available to a wider community.

Scientific Databases

Participation in the database programme of the World Data Centre for Solar Terrestrial Physics was extended to the embryonic Geophysical Data Facility, initially with a catalogue and database for the NIMBUS satellites tape archive. The major development during the year has been a database for the recent successful

AMPTE mission. This used generalised data management software (R-EXEC) developed by RAL computing staff. The move to unified software and user interfaces for all geophysical data services is already proving beneficial.

Graphics

Migration from MVT to MVS and the demise of the FR80

Hardcopy output previously destined for the FR80 is now produced on the Xerox 8700 laser printer. A system has also been developed for hardcopy output to be directed to the IBM 4250 electro-erosion printer giving a resolution of 600 dots/inch. Facilities for producing user titles on microfiche have been added to the service provided on the NCR 5330 microfiche recorder. A system has been developed which accepts metafiles in the format given in GKS annex E and produces output on the 8700 printer. Extra fonts and software have been installed in VM which provide for the typesetting of mathematical formulae on the 4250 and the RAL software which processes files to this device has been enhanced to allow output from the UNIX 'troff' system to be printed.

High-Level Graphics Routines

It was decided during the year to provide the NAG Graphical Supplement as a cohesive package of high-level graphics routines. These routines make obsolete those developed by RAL which cover some, but not all, of the functions available in the NAG system. Faults in the RAL routines as installed on the IBM systems have been cured during the year and a revised version of parts B and D of the RAL Graphics User's Guide has been prepared. A program which simplifies the plotting of experimental data (EZIPLOT) has been written; this allows casual users to produce any of the forms of data display provided by the high-level routines without detailed knowledge of the graphics system.

Graphical Kernel System (GKS), Development and Distribution

During the year, installation of GKS (the international standard graphics system, implemented jointly by RAL and ICL) has taken place on PRIME (under PRIMOS) and IBM (under CMS) computers. Initial releases of the PRIME and CMS systems were made in June and were accompanied by full user documentation. Extra device handlers have been developed and support for the Tektronix 4014, full Sigmex range and Benson plotter were under test at the end of the year. Throughout the year, a collaborative effort has been maintained with the Computer Board for Universities and Research Councils which is developing and distributing the RAL/ICL GKS system to its computers. System interfaces and device handlers developed by the Computer Board will add to the range developed by RAL.

Administrative Computing

The IBM 3032 system at RAL, which had been used as a development machine for SERC-wide administrative computing, was closed in July after systems running on that computer had been transferred to the new Joint Administrative Computing Service IBM computer at Swindon, a shared SERC/NERC machine.

European Academic Research Network (EARN)

EARN, together with its companion networks BITNET and NETNORTH, is a computer network between academic institutes and research centres for world-wide communications. It consists of a set of independent host nodes connected by leased telecommunication lines in an open, unmeshed topology. A central computer in each country provides international connectivity and some central information services. There are currently some 600 computers in the network. The Laboratory has recently developed a gateway between EARN and JANET, the Joint Academic Network. This allows the UK academic community to take advantage of the network with no additional equipment or software being required on site. EARN provides only file transfer and mail plus some messaging facilities which are provided by IBM computers. The gateway allows file transfer and mail facilities between the two networks with only minor restrictions. There is a continuous programme of development within EARN and, in particular, the European part of the network will migrate to internationally agreed standard protocols for data transmission. These standards will also be used within JANET and most other European countries within the next few years. In the meantime, EARN will provide a very valuable service allowing UK researchers to communicate with colleagues overseas.

VAX Systems

A VAX 11/750 was upgraded by the addition of an extra megabyte of main storage, doubling its capacity, and a 414 megabyte fixed disk. This allowed the latest release of the VMS operating system and equivalent levels of networking software to be installed. With the increasing popularity of VAXs as local multi-user systems, RAL computing staff are now providing central support for nearly 50 machines. This support covers Digital's networking software as well as the 'coloured book' software produced by UWIST and St Andrews.

General International File Transfer (GIFT)

The GIFT project is a collaboration aimed at producing a package of gateway software to run on a VAX computer which will allow file transfers between

different but intersecting computer networks. It was originated by the European Committee for Future Accelerators in 1982 and is intended to link networks in Italy (INFNET), Switzerland (CERNET) and the UK (JANET). UK development has been undertaken by RAL in collaboration with Oxford University. This has involved the production of an interface between the file transfer software used to communicate with JANET and a network-independent file transfer system which runs in the gateway computer. The first stage of this development, which allows JANET users to initiate file transfers from their own computers to and from computers on CERNET and DECNET at CERN, was completed by the middle of the year. A production service was begun on 1 August on the JANET/CERNET gateway VAX at CERN. Further development and testing has continued on the second stage which allows similar file transfers to be initiated by CERNET and CERN DECNET users.

National Networking

Joint Network Team (JNT)

JNT is responsible for the establishment and introduction of common communications standards in the UK academic community. Its remit covers the activities funded by the Computer Board and the activities of the Research Councils themselves with the aim of creating a unified networking infrastructure. The programme of development and installation in support of the UK interim Coloured Book protocols has continued. Basic facilities for network access, file transfer and terminal communication are available on most commonly used machines, and support for electronic mail and job transfer exists for many systems. As an indication of scale, more than 350 electronic mail systems have now been registered with the Name Registration Scheme. Work has been completed this year on the definition of a further protocol, called the Simple Screen Management Protocol, which provides for improved full screen terminal working across the network. Some initial implementations of this protocol have been produced, and more are under way.

The growing interest in ETHERNET networks has led to the creation of recommendations for the set of protocols to be used with this technology. The JNT recommendations, which have been adopted by the Computer Board for use in university procurements, show the pattern expected in future years by adopting International Standards. The recommendations are Functional Standards; they list published international standards and state which of the options in these standards should be selected. They also define a mapping from the previously defined interim protocols. This is but one facet of a more general activity concerned with the move from the current interim protocols to the use of International Standards. A working group, drawn from university and Research Council networking experts, has been active throughout the year planning the transition to the new standards and determining the conversion facilities needed to prevent disruption of the service seen by network users. This group is due to publish its proposed strategy for comment.

This year has also seen a significant growth in JNT European involvement. It has taken a leading role in the initiative to establish the European Association of Academic Networks (RARE) to coordinate and encourage communication between institutions in Europe, and it has been involved in the CEN/CENELEC work aimed at the creation of a single set of functional standards for communication to open up a genuinely European market.

Network Executive

The Network Executive is responsible for the operation of the JANET network. Network rationalisation has continued throughout the year; all university and SERC sites and most NERC sites are now connected. Development has focused on consolidation, although significant increases in capacity have been made in the more heavily loaded trunk links. A programme of hardware upgrades has brought network switches to a common level capable of supporting the manufacturer's current control software. A phased transition to this software has taken place during the summer and early autumn and is now complete. This puts the network in a stronger position to adopt new products, allowing further enhancements. The major benefit so far of the move from SERC-produced software to manufacturer-supported software has been the availability of much more complete network management facilities. The logging of statistics allows much more information to be collected on the use of the network, and work has been in progress throughout the year on the processing, archiving and analysis of this data. The information available allows the Network Executive to monitor loading in different parts of the network, and trend analysis will allow links in need of upgrade to be identified before overload occurs. In the latter part of the year, planning for a major upgrade of the network began, to allow the support of more demanding applications. This work will continue throughout 1986, as will the existing rolling programme of rationalisation and enhancement.

Publications and Reports

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K M Crennell, I D Brown
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J Molecular Graphics 3 (June 1985)

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C D Osland
Using the IBM 4250 from SCRIPT and TROFF
SEAS annual meeting Zurich (Sept 1985)

K G Jeffery
Databases and office automation
IVth British Nat Conf on Databases, Keele (Jul 1985)

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SERC Britain has IT Conf Southampton (Oct 1985)

B J Read
AMPTE-UKS Database Catalogue
AMPTE Joint Science Working Group Meeting Bakewell (June 1985)

K M Crennell et al
The Identification of Fringe Minima in Electronic Speckle Pattern Images
3rd Int Conf British Pattern Recognition Association, Scotland (Sept 1985)

Lectures and Meetings

External Lectures by RAL Staff

A J J Dick, Oxford (January)
The Knuth-Bendix algorithm and its application to program transformation

A J J Dick, European conference on computer algebra (March)
ERIL Presentation

A J J Dick, Manchester (June)
The Knuth-Bendix algorithm as implemented in an interactive laboratory for equational reasoning

D A Duce, Leicester (16 January)
Formal Specification and GKS

D A Duce, Cambridge (27 February)
Formal Specification of Graphics Software

D A Duce, Oxford (7 March)
Formal Specification of Graphics Software

D A Duce, Imperial College (14 March)
The Graphical Kernel System (GKS)

D A Duce, Imperial College (14 March)
Computer Graphics and Kernel Specification

D A Duce, Salford (21 March)
Graphics Standards

D A Duce, Bath (27 March)
The Graphical Kernel System (GKS)

D A Duce, IEE, London (12 April)
Standards for Computer Graphics

D A Duce, Lancaster (15 May)
Formal Specification of Graphics Software

D A Duce, IBM Yorktown Heights (5 August)
Standards for Computer Graphics

D A Duce, Hewlett Packard, Bristol (1 October)
Formal Specification of Graphics Software

D A Duce, RSC Microprocessor Group, Imperial College (23 October)
Standardisation and Computer Graphics

D A Duce, CWI, Amsterdam (12 November)
Specification of the Graphical Kernel System

D A Duce, CERN (5/6 December)
The Graphical Kernel System (GKS)

F R A Hopgood, COMMUNIX, London (13 June)

F R A Hopgood, UNICOM, London (25 June)
GKS Tutorial

F R A Hopgood, UNICOM, London (27 June)
Extending GKS to 3D

F R A Hopgood, A S Williams, Nice, France (12 September)
Panel Session on Window Management, EG85

F R A Hopgood, D A Duce, CERN (5/6 December)
The Graphical Kernel System (GKS)

Computing Seminars

M Diaz, NERC (15 January)
Spatial databases using Tesseral methods

J Welsh, Queensland (30 January)
An adaptive editor for Pascal programs

E Polak, California (1 April)
DELIGHT.MIMO: An interactive environment for optimisation based design of control systems

C Adams, RAL (2 April)
The UNISON project and the ALVEY high speed network

J M Brady, Oxford (26 April)
Describing surfaces

C D Osland, RAL (16 May)
Progress in graphics standards

D E Broadbent, Oxford (23 May)
Some contacts between psychology and computers

J Clark, Silicon Graphics (30 May)
The IRIS Workstation: why and how it was developed

P Henderson, Stirling (4 June)
Functional programming, formal specification and rapid prototyping

J R Gurd, Manchester (11 June)
The Manchester Dataflow Project

D O'Shea, Amdahl Corporation, (17 June)
UTS: UNIX on the IBM mainframe computers

J E Ranelletti, USA (24 June)
Supercomputers and the future

J Baldwin, Cardiff (3 September)
Running a university computing centre

R Avant, C Plunkett, Amdahl (8 October)
The Amdahl vector processor range

R Bell, IBM (UK) Ltd (15 October)
The IBM 3090 vector facility

C Henfrey, C McGregor, Cray Research (3 December)
CRAY Presentation