by
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Here are some recollections of the computing support for the experiments at the SRF and SRS. The NINA and SRS control systems are not described – we hope that these can be covered elsewhere in the SRS History pages at some future time.

Data Acquisition at the SRF, 1972-1977

At the time the SRF was established on the NINA electron synchrotron, there was already a well-established computing and electronics infrastructure supporting the particle physics experiments on NINA.

Data acquisition systems for the SRF were based from the same building blocks as the ones used for Particle Physics. Vasily ('Basil') Zacharov had been recruited from CERN at the start of Daresbury Laboratory as Head of the Computing and Electronics Division, and he introduced a strong philosophy for data acquisition systems in which minicomputers controlled data collection and sent data though fast data links to a central computer [1]. 'Horses for courses': the local data acquisition and control computer was dedicated to that (though including a basic graphical display of raw data so the experimenter could have immediate sight of the data being collected), and any data analysis was performed on a powerful mainframe computer.

The first three experimental stations on the SRF were all controlled by one Honeywell 316 (16-bit words) minicomputer (possibly replacing a Honeywell 112, which had 12-bit words), interfaced to the experimental equipment (e.g. stepping motors for monochromator control, photomultipliers for photon counting) through NIM (Nuclear Instrument Modules, for high voltage power supplies, amplifiers and other analogue electronics) and the CAMAC system (see below) [2]. A serial data link transferred data to the Laboratory's central mainframe computer (initially an IBM 360/65, replaced in 1973 by an IBM 370/165) via an IBM 1800 communications 'front-end', where it was recorded on magnetic tape [3].

The minicomputer was programmed in low-level assembler language (DAP-16). Programs were written using visual display units connected to the mainframe computer, first passing through a home-grown macro pre-processor (CAMACRO), which expanded embedded CAMAC control commands into assembler language. The programme was output on paper tape for loading into the minicomputer (via a CAMAC-interfaced paper tape reader, naturally).

Later (1976) a new data acquisition system [4] was provided for the EXAFS experimental station developed by Warwick University (Robert Pettifer). This used a Digital Equipment Company (DEC) PDP-11/05 minicomputer with as much as 24KB of memory (yes, kilobytes, not gigabytes or even megabytes!), CAMAC, a multi-tasking operating system executive MFT-11, and a new high-level language for process control, RTL/2, which had been developed by the (then) big UK chemicals company, ICI. In keeping with the times, system software was written in-house: Daresbury system programmers wrote MFT-11 (initially for use in wide-area networking front-ends) and the RTL/2 cross-compiler (run on the IBM mainframe) for the PDP-11. RTL/2 was also used on the control systems for the SRS and the Daresbury Nuclear Structure Facility.

The Laboratory was one of the pioneers in the development of the CAMAC international standard for modular interfacing electronics [5, 6] and computer networking in the UK (in particular, JANET, the nationwide Joint Academic Network) through its membership of international standards organisations. CAMAC made it possible for most of the interfacing electronics to be independent of any particular computer. It has a 24-bit data bus – at the time its specification was first being developed, 12-bit minicomputers were current, and double this seemed a likely evolution! The Laboratory also commissioned an extended version of the Basic interpreted language (CATY on PDP-11, CATHY on Honeywell 316 and 516 computers) to drive CAMAC for testing and small-scale control systems. CATY was taken up also by EMBL in Hamburg. (This continued the tradition of giving female names to our machines and systems – NINA, DESY [pronounced “Daisy”], DORIS, CATY, CATHY.)

As an early developer of the standard, Daresbury designed and built many modules to meet its requirements; for instance CAMAC crate controllers (connecting minicomputers to CAMAC), stepping motor controllers, scalers (for pulse counting) and serial data links. CAMAC was later used in connecting the Laboratory to the wide-area network, JANET (reference [3] has a number of photographs of PDP-11’s with CAMAC interfacing). Many of these designs were taken up by commercial companies in the UK and abroad, selling to research laboratories and industry around the world, helping them to develop their product lines and find new markets. Somewhat incredibly, CAMAC is still in use today, more than 40 years after its inception.

These developments covered a wide range of applications far beyond the confines of SR and deserve an account of their own. SR experiments at Daresbury and elsewhere benefited greatly from the overall framework, as well as those components developed specifically for the SRF and SRS.

Data Acquisition and Analysis Systems for the SRS, 1981-1987

Plans for data acquisition systems for the world’s first dedicated X-ray synchrotron radiation source, the SRS, [7] leaned heavily on the experience gained on the SRF, while recognising that were would be a number of experimental stations that would be much more demanding of data acquisition and run-time analysis than had been the case for the SRF. Each station would have a dedicated minicomputer, with a capacity matched to the station’s individual needs, connected by serial data links to another machine (the ‘data concentrator’) that would provide the interface to the Laboratory’s local area network and mainframe computer.

The plan to use CAMAC sparked controversy in some quarters, since microprocessors were emerging as the potential basis for much cheaper hardware. However, in the end the Laboratory’s investment in CAMAC was recognised, as were the manpower implications for hardware development for any alternatives.

SRS data from the relatively undemanding stations was stored on magnetic tape on the central computer (local storage was needed for Protein Crystallography data, however), as before. A lightweight relational database system (Rapport, from the software house Logica) was implemented on the central computer for cataloguing the incoming data.

SRF users had been left to their own devices as far as data analysis was concerned. For the SRS, the Laboratory established a suite of software on the central computer, the SRS Program Library [8], to meet common needs. The Laboratory, in collaboration with the Rutherford Appleton Laboratory, had established a system of workstations in UK universities, connected to the SRCnet (later JANET). These could be used from the users' home bases to access and process SRS data held on the central computer.

The first few stations had small PDP-11s controlling CAMAC crates, with floppy disks replacing paper tape readers and punches. It was planned that they would run an extension of CATY (CATEX), to include floating-point arithmetic, under the MFT-11 operating system executive. However it soon became clear that the software envisaged would entail a heavy burden of development and maintenance of home-grown software. MFT-11 was abandoned in favour of using manufacturer-supplied RT-11 operating system. CATEX continued to be used for some years, and FORTRAN was introduced. FORTRAN is well-known as a language for scientific calculation rather than for real-time control and data acquisition, but it proved to be successful for these purposes also. One immediate benefit was that SRS users were familiar with it and could take part in developing the applications. Later (*when?*), C++ and Java, running on UNIX-based systems, became the chosen vehicles for control and data acquisition software.

Daresbury continued to attract attention for large-scale computing resources. A Cray-1 supercomputer was installed in 1979. This was actually serial number 1 and the first in the UK, on loan from Cray. It was much-travelled, coming to DL via the European Centre for Medium Range Weather Forecasting (ECWMF) at Reading and the MOD at Aldermaston and was soon bought by and transferred to the University of London, but helped to establish Daresbury as a centre for high-performance computing (see reference [3] for the history of this area).

It soon became apparent that the mainframe on which data analysis was to be performed did not offer the reliability and real-time response needed for SRS experiments. For a period, the time-sharing system on the IBM mainframe, TSO, failed every 20 minutes of so – users learned to save their work rather frequently! The 370/165 was replaced by an IBM lookalike, the AS/7000 from National Advanced Systems, in 1981. However, the real-time data analysis issue remained and the data concentrator (a small PDP-11, used exclusively as a communications front-end) was replaced in March 1982 by a Systime 8750 'midi-computer' (basically a DEC VAX-11/750, but assembled by the Leeds-based British OEM [Original Equipment Manufacturer], Systime, under licence from DEC). This offered sufficient power for near real-time interactive data reduction and feedback, and sufficient local storage to insulate the experiments from reliability and response problems of the central computer. Image processing was an emerging requirement on the SRS, for example for X-Ray Topography, and an ARGS graphics system was installed on the 8750. This borrowed from developments for the STARLINK astronomy network established by SERC's Rutherford Appleton Laboratory.

At about this time, the Ethernet standard for local area networks (LANs) was emerging. The SRS soon adopted it to replace the serial data links, and the needed network protocols and software were developed in-house [10]. A local electronics company, Sension, was commissioned to develop and supply the repeaters connecting systems to the LAN.

The 1980s and 1990s saw a steady evolution of the computer systems used at the SRS, riding the technological waves of large-scale integrated circuits (LSI) and the widely-adopted UNIX operating system. Station computing diversified to provide more tailored solutions to the differing demand of the experiments. The introduction of electronic area detectors (e.g. Multi-Wire Proportional Chambers and CCD-based systems) greatly increased the data handling requirements of some stations. An implementation of the PDP-11 in chip form, the LSI-11, was incorporated directly into CAMAC crate controllers. Local hard disk drives (‘Winchester disks’) started to appear. DEC Microvaxes and Sun and Silicon Graphics graphics workstations were used as the station control computers. A portable, modular suite of data acquisition and control software, the Generic Data Acquisition System (GDA), was developed and exported to some other laboratories.

Acknowledgements

The first data acquisition system for the SRF was developed by Les Naylor, and then Peter Clout.

CAMACRO and CATY (and its several derivatives, e.g. CATHY for Honeywell 16-bit machines) were developed by Francis Golding (FG Associates).

The SRF EXAFS data acquisition system was developed by Pat Ridley.

Harald Kirkman wrote the MFT-11 Executive System and Bill Purvis wrote the RTL/2

cross-compiler.

CAMAC and network developments were led by Tony Peatfield until his move to the University of London Computer Centre around 1980. He was succeeded as group leader by Ted Owen.

Manolis Pantos established the SRS Program Library of data analysis software.

Software for the Ethernet-based local area network was provided by Robin Tasker, France Rake, Paul Kummer and David Hines.

See also the references below for others contributing to the work described above.

Thanks to Mark Enderby, Samar Hasnain, John Helliwell, Manolis Pantos and John West for reading and making helpful suggestions for this article.

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