A VERSATILE MULTI PROCESSED CONTROL SYSTEM FOR MIMAS

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The synchrotron injector MIMAS is operated by a fully distributed control system based upon a network of identical microcomputers integrated in a serial branch CAMAC interface system. Each subset of the machine can be accessed either from touch panel operator consoles or locally. Each computer is equipped with an autonomous peripheral environment wich allows an automatic start. These features combined with a dedicated software insure a safe and flexible operation as well as an excellent reliability of the whole system.

Network organization

The network has a star topology. Each branch of the star is a serial CAMAC branch. At the center of the star, a communication system, named "SAMU", provides transmission and CAMAC handling. It enables to drive up to 256 CAMAC crates organized in 16 branches of 16 crates.

The dedicated serial crate controllers use coaxial lines for transmissions, allowing a maximum distance of 300 meters between two crates and a transmission rate of 30000 CAMAC cycles per second.

The "SAMU" system is a multiprocessor system built in a VME crate: eight MOTOROLA 68000 processors (12 MHz clock) are divided in two groups:

- four main processors, each of them driving four CAMAC branches.
- four secondary processors for service routines dealing with the whole system.

The use of adequate I/O adress segments on the VME bus allows each of the eight processors to communicate to each other and to access any CAMAC branch.

A VME memory module (1 Mbyte RAM battery backed) is used by the software as a RAM disk.

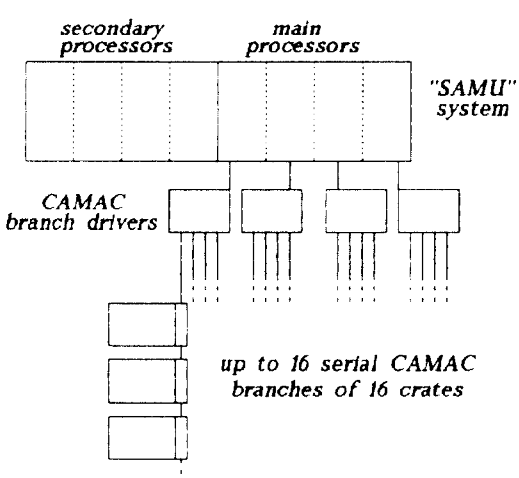
Local intelligence and distributed control

To perform a distributed control, the system to be controlled must be divided into subsystems, each of them being operated by a local computer. All these computers must communicate to each other for the whole system consistency.

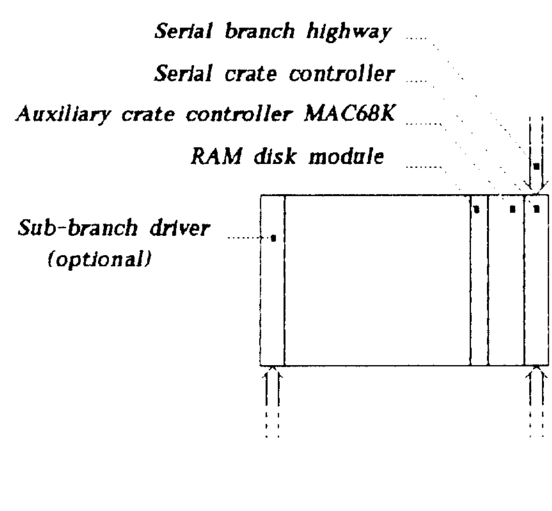
In the present case, the local computers are located into auxiliary home made CAMAC crate controllers, named "MAC68K", based upon MOTOROLA 68000 microprocessors (8 MHz clock).

A MAC68K can access modules in its own CAMAC crate and, if necessary, in a CAMAC sub-branch of up to 15 crates. A shared segment of its memory is accessible both by the CPU and the CAMAC, allowing communications through the network.

As for the SAMU system, a CAMAC memory module (1 Mbyte battery backed) is associated with each MAC68K for RAM disk use.



The CAMAC network



CAMAC crate with a MAC68K system

Basic software

The operating system "N68KDOS" used in both the SAMU processors and the MAC68K is a fast multitasking real time system with the main following features:

- up to 6 tasks (commutation time 30 μs).
- software priority and interrupt handling.
- time sharing (time slicing of 10 ms).
- date, time and delays handling.
- file management for local or nonlocal files and remote process control.
- autostart of the system and the application program when powered up, or after a failure. This feature uses the RAM disk storing programs and data files.
- support for MOTOROLA FORTRAN and PASCAL language (VERSADOS compatible), including standard I/O statements.

Application software

The application software in a MAC68K is based upon an outer layer of the system software named "MONIX68" which allows handling of numerous devices by a polling method.

To operate the system, the user has only to give a table describing devices to be controlled and write associated routines.

General organization of the control system

The main equipments linked to MIMAS are:

- one heavy ion source (DIONE).
- one polarized ion preinjector (HYPERION).
- one radio frequency quadrupole (RFQ).
- the synchrotron MIMAS itself.
- various beam lines.
- ultra vacuum system.

Various parameters of the synchrotron, including the control console, have been gathered in logical subsets, corresponding to a beam line section, each of them driven by a MAC68K. When necessary an external signal connected to the machine timing and distributed to all MAC68K allows precise synchronism of processes; this is typically the case for displaying and monitoring some parameters at each cycle.

Moreover, a task named "MAILING" running on one SAMU auxiliary processor sends a given number of general parameters, e.g. particule type, source, repetition time..., to all MAC68K at each cycle.

Each MAC68K can be controlled either locally through a mobile terminal or by one of the command sets described here below.

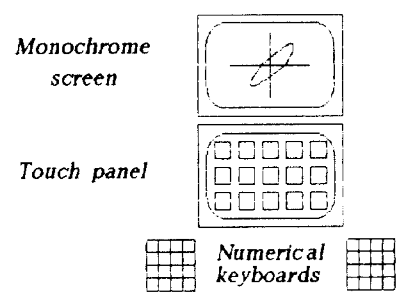
Operator consoles

An operator console consists of one or many sets of I/O devices providing communication between operators and the system.

Two types of sets are used:

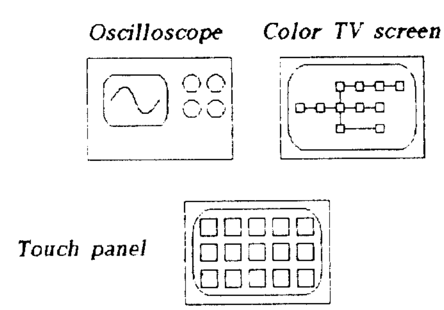
- Command sets:
  - 1 touch panel to dialog with a remote subsystem.
  - 2 numeric keyboards to send numerical values.
  - 1 monochrome screen to display parameters of the subsystem in operation.

- Observation sets:
  - 1 touch panel to select synoptic boards or analogical signals.
  - 1 to 10 color screens for synoptic boards.
  - 1 to 2 oscilloscopes for analogical signals display.



Command set

When using the command set, the operator can ask for logical connection to a subset of the machine, and then command this subset.



Observation set

The observation set allows selection of synoptic boards on color TV screens, and commutation of signals towards oscilloscopes.

From the software point of view, console handling is considered as an ordinary process of the system.

Two MAC68K are dedicated to console control:

- one for all the command sets.
- one for all the observation sets.

Moreover the latter includes a spooling system allowing any other subsystem to send alphanumerical or graphic files to a printer.

Various application MAC68K

The way the parameters have been logically divided into the 12 MAC68K in use for the control of MIMAS and its two associated preinjectors is the following:

Hyperion: control of the polarized particles preinjector and the first part of the beam injection line.
Specific routines: emittance measurement.

Dione: control of the heavy ion source.
Specific routines: emittance measurement.

R.F.Q.: control of the 200 MHz Radio Frequency Quadrupole cavity used to boost the Dione particles.

Beam Injection Line: control of the second part of the line down to the inflector.
Specific routines: automatic alignment, emittance measurement and deduced envelops plotting.

Injection: definition of timings of sources, R.F.Q. and betatron.

Focusing and cycle: supervising of the main dipoles and quadrupoles power supplies. MIMAS timing, according to the type of particle.
Specific routines: command of the quadrupoles by definition of either wave numbers or currents.

Radio frequency: control of the capture and acceleration of the injected beam and radius tracking.
Specific routines: theoretical determination of R.F. parameters.

Closed orbit: correction of closed orbit defects, chromaticity and resonances. Distorsion of closed orbit for extraction.
Specific routines: closed orbit reconstruction and correction.

Kickers: control of the kicker magnets used to eject from Mimas and inject into Saturne. Synchronizing of kickers with respect to R.F.

Beam Transfer Line: beam transfer from Mimas to Saturne.
Specific routines: same as those for the beam injection line.

Main Power supplies and Cooling: monitoring of main power supplies and cooling systems.

Vacuum: monitoring of vacuum in Mimas and its beam transfer lines and heating of the machine.
Specific routines: plotting of parameters' evolution.

Conclusion

This versatile control system has been operational since the very start of Mimas and gives since then full satisfaction to its users.

Acknowledgements

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