nAos
UNOS

Proposal for a VXI digitized signal observation system for the PS Complex

B. Frammery

1 - Introduction

The CERN PS Complex machines basically run on a 1.2 second frame, which means that the same event might occur with this 1.2 second repetition rate. It may also happen with a slower repetition rate of a multiple of 1.2 second, practically up to something like 28 sec. To monitor these events a very large analog mutiplexing system was developped 12 years ago to bring 8 analog signals to every control console in the Main Control Room (MCR) and in some local control rooms out of of total of about 1600 signals.

2 - Current system

This system is called SOS (Signal Observation System); it is structured in 3 layers (**Fig 1**) :

- local multiplexors, called "villages" gathering about 100 signals and producing 8 to 12 outputs,
- intermediate multiplexors so called "towns" processing the village outputs plus a certain amount of direct signals called "essential signals",
- a top layer located under the MCR and called "central SOS" which distributes the 80 incoming signals to 8 consoles.

These signals are fed to digital oscilloscopes and observed according to triggers related to the key moments of the beam processing in the machines (elaborated from 40 pulses and 10 pulse trains)

Through this multiplexing network, signals produced by beam monitors or local equipments sneak their way over hundreds of meters. This brings severe limitations on the bandwidth and the signal-to-noise ratio.(20 MHz bandwidth and 10mV noise level).

The software driving the SOS is running on each console computer which will be shortly no more maintained.

Besides these technical aspects, the SOS system suffers from a poor maintenability linked to the departure of its conceptors and a total unexpandability.

2 - Proposed system

To overcome the SOS limitations a local digitization of the signals is obviously a way to go provided high sampling rates, compactness and low enough prices may be achieved. This upgrade proposal is to be considered as part of the joint PS-SL Controls rejuvenation project aiming at replacing dedicated consoles and CAMAC by mutiwindow workstations and VME local crates linked together through an Ethernet (or Token Ring) fiber.

This system (called **N**ew **A**nalog **O**bservation **S**ystem), is based on the new VXI technology launched by a consortium of all the largest instrumentation companies; its structure is the following (**Fig 2**) :

- locally (at the location of the current SOS "villages"), VXI crates containing all the equipment to multiplex and digitize between 90 and 108 signals per crate : a slot0-controler running under a RT-UNIX system, 2 to 4 digitizers and 6 to 7 "200 MHz" bandwidth multiplexers **(Fig 3)**

- triggers locally produced in VME controls crates using the new TG8 modules produced by SL,

- a virtual multi-trace oscilloscope implemented in workstations at the other end **(Fig 4)**

All the crates and the related workstations are distributed along an Ethernet cable, probably specific for the system because of the expected heavy traffic that it will have to face (up to 80 data blocks of up to 8kbytes per 1.2 s emitted mostly around precise timings corresponding to injections, or extractions).

The standard settings of the local digitizers used to observe each analog signals will be stored in a database along with reference signals. Another part of the database will contain the digitizer characteristics so that the user will not have to care about specificities.

3 - Schedule and budget

3 - 1 Hardware cost of ONE signal

As an example the LPI case(208 signals) was studied in detail, leading to the following figures :

- Crates VXI	3	30kF
- HP 4-channel digitizer modules	5	60kF
- Hp 2-channel fast digitizer modules	2	32kF
- 18-to-12 mutiplexer modules	16	40 kF
- Slot-0 controller	3	45kF
	Total =	**207kF**

This comes to a hardware cost of **1kF per signal.**

(this price is likely to decrease since all the commercial modules are very new products)

3 - 2 Common costs

The dedicated Ethernet network, the dedicated workstations and software patents costs have to be considered as a an investment commonto the whole project. Some items can be discussed since the first slice does not probably request the full extension of the network. Nevertherless, at some point all of the following will have to purchased :

- DECstation 3100	8	128kF
- LAN server (common to all machines)	1	30 kF
- LAN extension (Ethernet)	1	50kF
- RT- Unix patents	1	30kF
- VXI subroutine library	1	20kF
	Total =	**258kF**

An extra software cost is also to be planned since, most likely, the manpower for the dedicated software production will have to come from outside CERN in a proportion that can be roughly estimated to 50% ; this includes :

- RT-Unix drivers for the VXI modules,
- Integration of the LYnxOS system on the Slot0-controler
  (if the real-time Unix sold by the manufacturer (VxWorks) cannot be used),
- general management software for the multiplexing,
- database related programs

Another rough estimation of the total manpower needed comes to **about 2 man-year**

3 - 3 Planning and cost evaluation

The numbers of analog signals for the other machines connected to the current multiplexing system are :

- PSB : 606 + 64
- PS : 514 + 115
- AAC : 41
- LI : 68
- LEAR : 50
- Pb Linac : 120 (new machine to be commissioned in 1993)

Addition of extra signals will probably be requested, since the enlarged bandwidth allows for signals that were formerly out of the field of the SOS. On the other hand, one expects that also some signals connected to the SOS and very seldom used will be removed. The total number of signals eventually connected could then be considered as constant.

If one expects a "filling factor" of the crates of 80% (figure of the current SOS), one gets :

- LI + Pb Linac:	1992 (to be operational in 1993)	>>3 crates	= 210 kF
- PS + LPI :	1993 (" 1994)	>> 8 + 3 crates	= 770 kF
- Booster :	1994 (" 1995)	>> 8 crates	= 560 kF
- AA + LEAR:	1995(" 1996)	>> 2 crates	= 140 kF

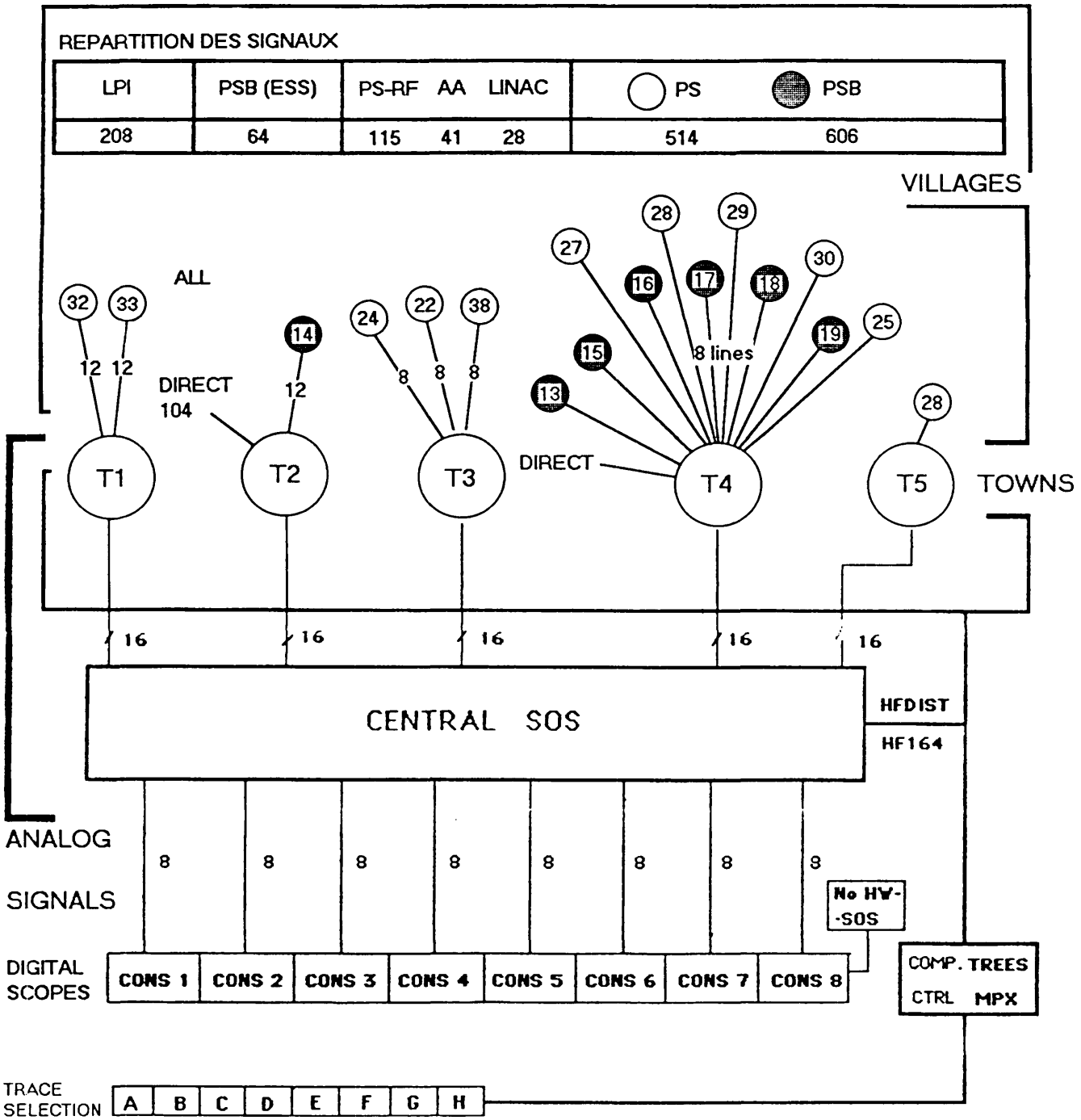
The global enveloppe of the project cost can be estimated to **about 2 MF** plus the external manpower cost.

4 - The SL case

The project received the full support of the SL controls group to which it was presented and the use of such a system for the SPS and the LEP machines was discussed : these machines do not have a general multiplexing system, but the number of crates requested will probably be rather small, since the slow cycling rate of their machines allows for a monitoring which can rely on numeric figures and can do with few analog signals.

- Fig 1 -

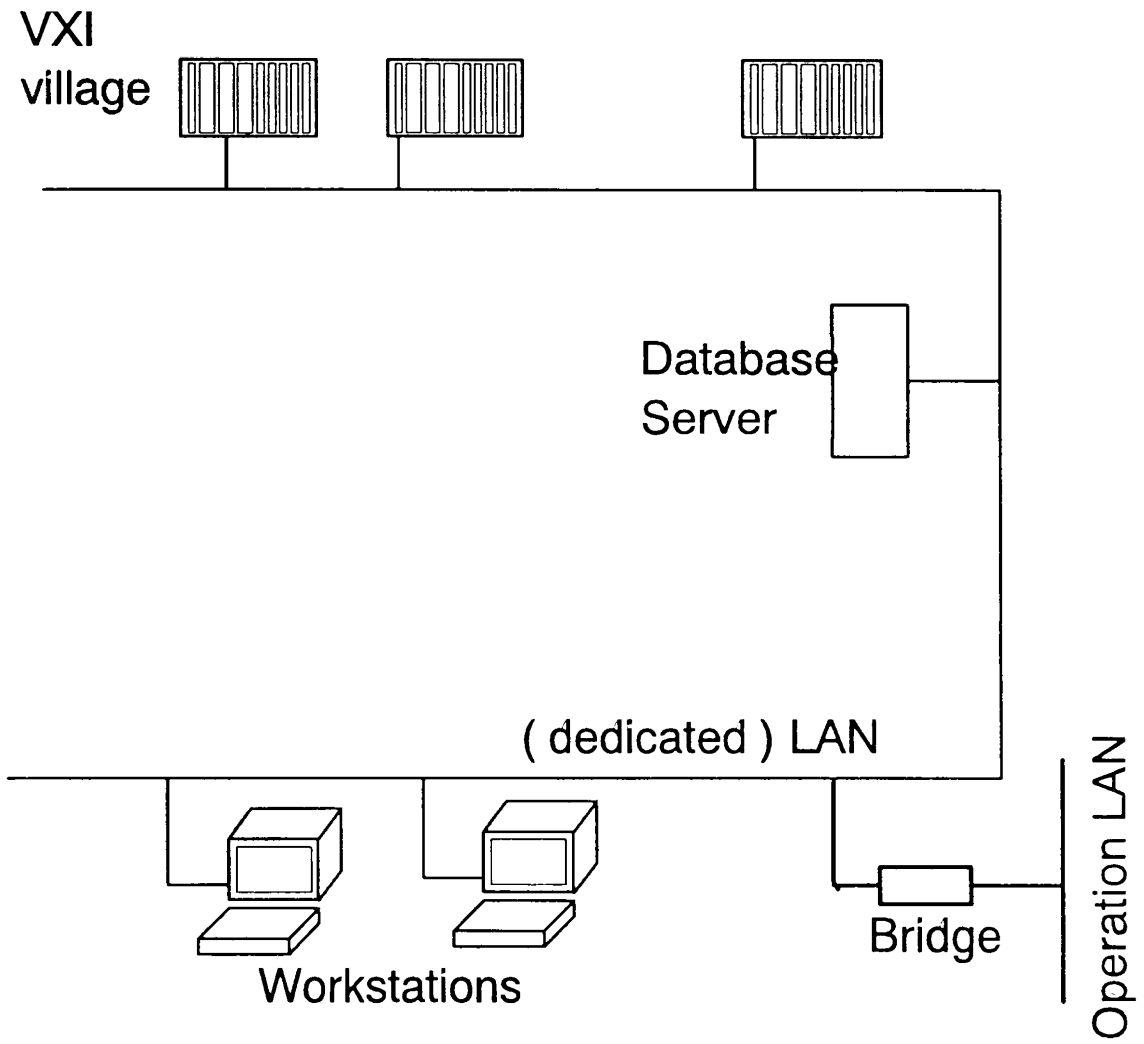
Current SOS system



28-02-1990

- Fig 2 -

nAos
UPOS



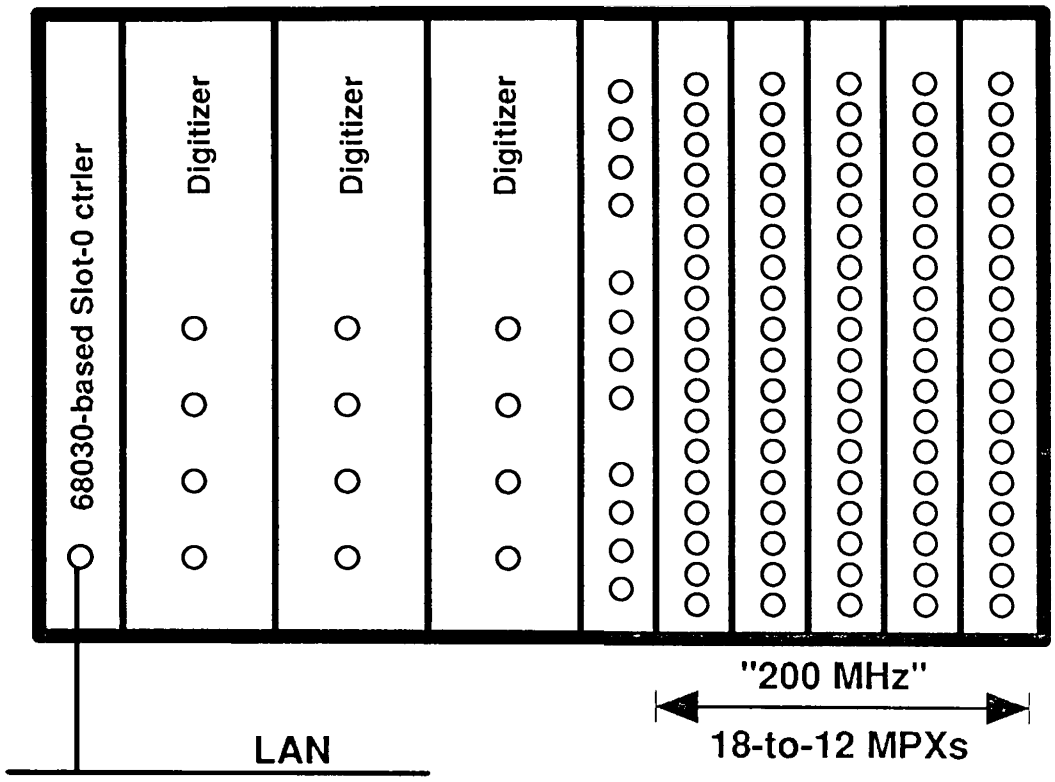
Expected traffic :

- 10 stations using up to 12 signals
- raw data blocks from 1/2 k to 8 kbytes
- normal repetition rate : 1.2 sec
+ 12 signals at 10 Hz rep. rate

===> up to 400 kbytes / sec ! !

Recognition using either the multicast technique or the time marking using an extra TG8 at the Wkst level.

- Fig 3 -



nAos VXI crate

(new version of a SOS "village")

- up to 90 input signals
- up to 200MHz bandwidth MPXs
- 500MHz or 1GHz sampling rates
- 8 (12) output channels (1k to 8kbytes/signal)
- 10 mV to 10V full-scale input range
- RT-UNIX operating system

nAos
UFOS

- Fig 4 -

Virtual oscilloscope (B. Mangeot)