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Discussion on the Requirement Analysis and Preliminary Design of the New AGS Controls

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I. Introduction

A number of in-depth discussions have been held and more thinking work done on a number of essential topics of the new AGS controls. The following topics have been covered: Operational Aspects,[1] Power supplies and RF,[2] Instrumentation,[3,4] Timing,[5] System Architecture, Data Base,[6–8] Function generators. Though appearing on a previous list[9] Vacuum and motor drive have not been discussed.

Most discussions were based on written documents (see list of references) except for Function generator, which was merely touched upon, and for System Architecture where information is to be found in documents concerning Data Base and Device controllers.

II. Comments

Mostresearch topics as recommended by the preliminary study[9] have progressed significantly. In particular OAS has produced a significant input for the design of the HITL-part of the AGS controls which does not require pulse-to-pulse modulation (PPM), and hence forth that aspect has not been considered in detail.

Progress has also been made towards standardization of the interface though, so far, standardization of command protocols for various categories of devices seems not quite available yet.

Finally, the system architecture is coming into shape and despite the lack of an explicit design document, there seems to be a good understanding of its structure among the various participants.[6]

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1. Operational Aspects

OAS has specified the user aspects in most areas of the control system with a particular emphasis on HITL. Aspects of diagnostic and maintenance, general system display, timing and trigger selection still remain to be covered before this task is completed. However, we feel that a pre-study should be undertaken involving some key people from operation, machine physics and controls to investigate the impact of PPM. Though the central structure has built-in provision for PPM, there may still be some pitfalls depending on how the different beams will be operated. It is understood that PPM will be mandatory for the Booster. Since the Booster project is likely to be started by October 1985, it would in our opinion be too late to wait until then to review the controls from the PPM point of view.

2. Hardware Standardization

a. Power Supplies and RF

The power supply and radio frequency group have carried out a systems approach. The border line between controls and power supply or RF specialists still remains to be fully defined for all cases. In particular the control protocol for power supplies has to be written down. Some constraints such as galvanic isolation or physical length of the IEEE 488 bus have to be taken into account in the design of the hardware interface modules.

The implementation of the HITL controls will not benefit from the proposed universal functional controller; however, the interface modules used for this early implementation should emulate the power supply control protocol.

The implementation of PID is aimed at solving a regulation function specific to a particular device. Hence it should be under the sole responsibility of the hardware specialist and should not be confused with a control function. The incentive for doing so is the reliability of the low level control (i.e. device controller, since the device is interfaced to the device controller). The stability of the beam essentially depends on the quality of this control. This situation becomes even more critical as soon as PPM is introduced.

b. Timing

The working group have carried out an investigation on the timing of the machines with the specialists. Some new concepts are proposed which are based on a single computer controlled generator distributing coded time event over the whole site. Hardware from other laboratories can be used.

The time resolution of this system is in the range of one microsecond which is acceptable for any event originating from the Gauss Clock or from some low frequency (about 1 kHz) real time clock. However, the timing events linked to the bunch structure of the beam have to be generated by dedicated computer controlled hardware dealing with the radiofrequency clock. Time resolution as critical as a few 10 nanoseconds is required which cannot be satisfied by the central generator.

Should the need arise, the PPM of timing will have to be studied carefully.

Timing simulation and timing monitoring functions should be viewed with a systems approach.

However careful one may be in designing a new timing system, one will never be able to guarantee that all timing events are delivered correctly, hence devices should be internally protected against all possible timing faults. Each device should trace timing faults.

c. Instrumentation

The topics specified in the mission statement of the study group has been reviewed and it was agreed that it should be completed as follows:

- Specification of the use of instrumentation by the operations crew, physicists and specialists from the various consoles (main console, local terminal, ...). It should be investigated whether there is any need for shared access to these instruments by different users (e.g. at different instants within the same machine cycle).
- Definition of the initial state the instrument should return to after, e.g., a power failure or through a remote reset procedure. Thereset procedure needs also detailed definition (cf crash-panic button on main console).
- Study of a possible character generator for remote local display, i.e. near the device proper.
- Study of the impact of PPM both on the controls aspect and the instrument hardware.

Here again, the responsibilities between controls and instrumention specialist seems not very well defined (see higher).

d. System Architecture (Figure 1)

The system architecture hardware is defined in detail and so is the communication software. (Communications protocol between host/station/device controller.)

The functionality of the low level software, i.e., at the level of device controller and station is defined. The concept of logical devices, the basic building block of the control software, provides flexibility for later extension to PPM.

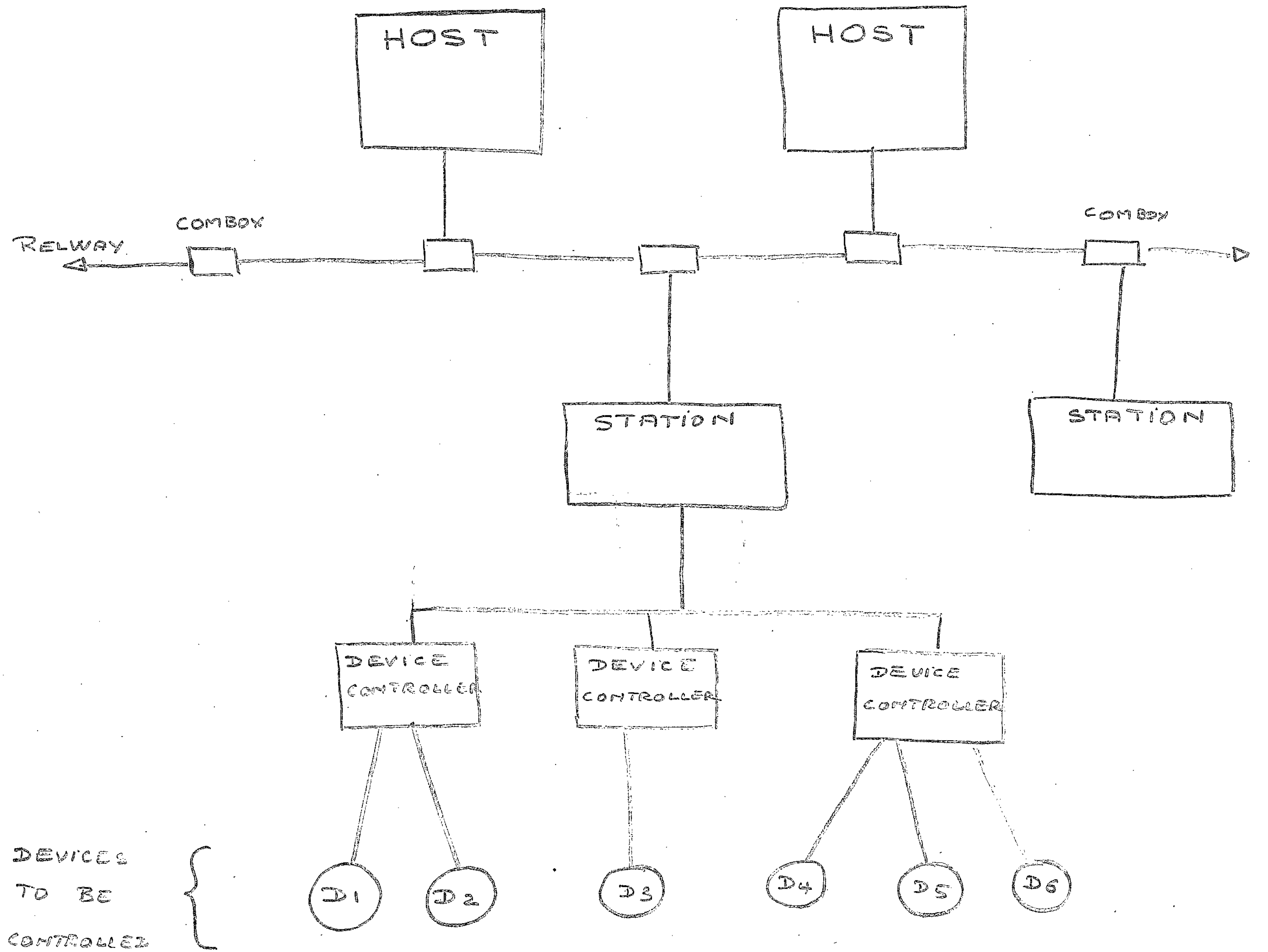


Fig. 1. LOGICAL REPRESENTATION OF SYSTEM ARCHITECTURE.

The functionality of the high level module, i.e., in the host needs to be studied further. In general, it deals with device specific functions as conversion from physical units into counts including limit checks: this would be more efficiently performed in the device controller. This would enhance the reliability of the system since errors may appear during the transmission of "count values" between the host and the device controller. An additional advantage is that data in physical units would be available to the device or controls specialist working locally in stand-alone (i.e., independent of the network). Local display of device controller data would also be available in physical units (e.g., chapter on instrumentation).

e. Data Base (Figure 2)

There seems to be general agreement that for the purpose of on-line controls only a simple data base [Data Description File (DDF)] consisting of flat files may be sufficient. For on-line controls, speed of access is of prime importance.

Other applications of a more clerical type (e.g., magnet characteristics, process archives) require more flexibility as can be provided by commercially available type data bases. So, in general, one agrees that a compound of simple data base, a DDF, and commercial one should be able to cope with "all" problems.

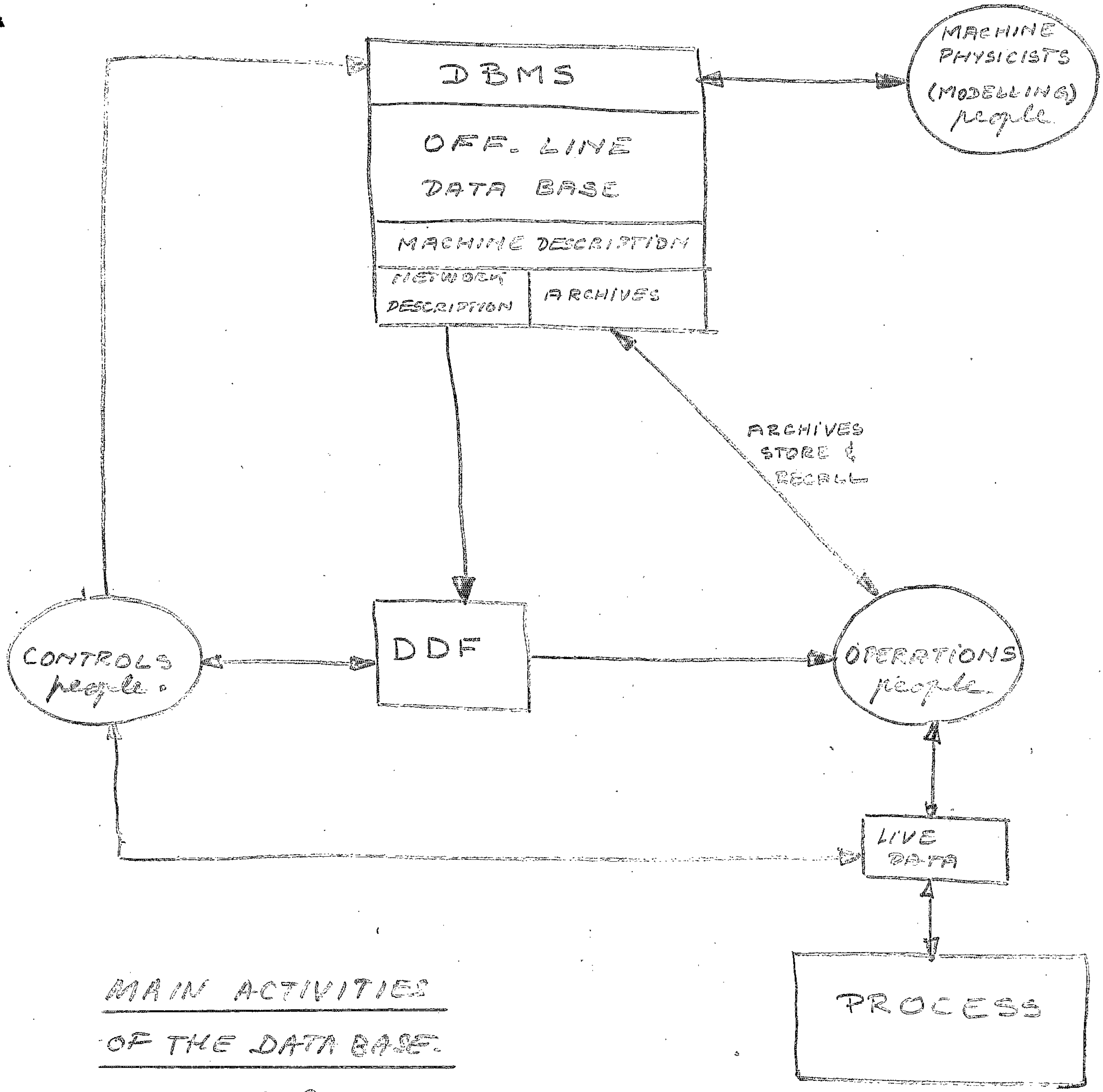
There are still some discussions as to whether one could start from a simple homemade data base and later add a commercial one from which the simple on-line data base could be generated. This strategy is a pragmatic one which copes with the rather tight HITL schedule. Moreover it ensures the availability of fast access to data as required by most control applications. It was suggested to invest some limited effort investigating commercial data bases available on the site to ensure ourselves that they can generate the requested DDF.

For the sake of completeness, a formal document should be produced giving the user requirements and specification for such data bases.

III. Suggestions and Next Steps

1. We restate our concern about PPM and would therefore encourage a prestudy involving OASG, controls and hardware specialists on this matter. OASG should clearly state how they envisage operating the various beams. Hardware specialists, in particular the magnet and power supply specialists, have to take into account that their devices will be pulsed not only because of PPM, but also because of beam physics aspects. CO specialists could cross check whether they can cope with these operating conditions. An early study could avoid possible pitfalls which would be far more expensive to fix later.

   In addition, one should study how to return the machine into proper operating conditions after power failure. This raises the problem of safeguarding set points and commands.



MAIN ACTIVITIES OF THE DATA BASE.

Fig 2.

2. At this stage of the design process of the controls project one should start a number of subprojects:
   - Application software layout (in particular, HOST)
   - Data base
   - Alarms

   These subjects are sufficiently important to be under the full time responsibility of one person each.

3. The standardization effort should be pursued including the vacuum and motordrive.

4. A large number of papers have been written so far on OAS, standards, architecture, data bases, etc. We would suggest a general synthesis document covering all requirements, constraints and specifications. This document could include paper models of the various logical entities of the control system: architecture, application software layout, data base, alarm, etc.

   Each model would describe the functionality of the various modules, their data structure, data flow, interfaces, ...; hence reaching general understanding of all parties involved in the project, including potential subcontractor (e.g., for commercial data bases).

5. Control systems involve contributions of many people belonging to different administrative groups. It is therefore of paramount importance to have clearly defined responsibilities. Mixing responsibilities as seems to be the case in the device controller, an item which needs to be most reliable, can only lead to reduced performance, reliablity, and demotivation of the implementers. We would therefore suggest that the CO keeps the entire responsibility in the device controller. If device specialists have to develop any device specific algorithms (e.g., PID loops) they should be implemented within the device itself. (Figure 3.)

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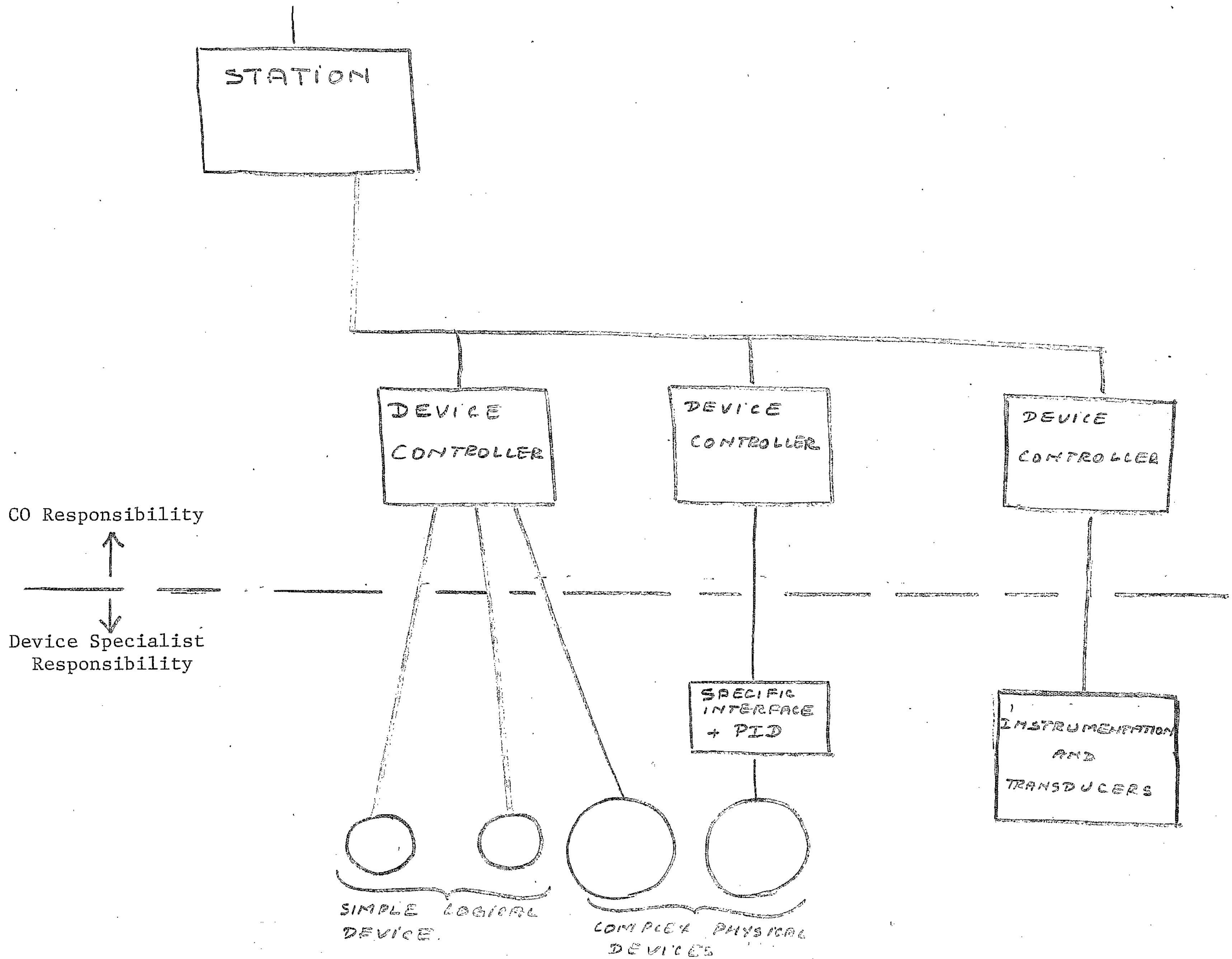

Fig. 3. Limit of Responsibilities