Project name

Machine Serviceable Electronics Standards

Classification (accelerator/detector: subsystem)

Accelerator

Institution(s) and personnel

University of Illinois at Urbana-Champaign, Department of Physics:
Michael J. Haney (electrical engineer)

Lawrence Berkeley National Laboratory:
Lawrence R. Doolittle (electrical engineer)

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Others, to join

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Project Overview

This project will examine the feasibility of a machine serviceable alternative to VME. A successful result would be extremely advantageous to NLC or TESLA, as well as other accelerator physics projects, and embedded applications beyond.

There are many applications for an electronics packaging standard that lends itself to machine (robotic) serviceability. In the linear collider context, there may be many electronic modules that will not be readily accessible for human service, either due to short-term limitations (e.g. radiation), or due to perpetuating limitations (e.g. located in a small diameter tunnel). If these modules can be readily removed and replaced by an automated or tele-operated machine functioning in the hostile environment, then the actual repair of the module can be performed in a convenient and human-friendly shop environment.

And while VME is currently very popular in the particle physics community, its typical implementation has many shortcomings, such as large heavy boards that are difficult to insert (for 9Ux400mm), or uncomfortable levels of noise that limits analog applications (for 3-row 6U).

Beyond the linear collider context, there are countless embedded applications for a standard that supports high performance electronics while aggressively addressing electromagnetic compatibility (EMC), in a packaging format suitable for remote manipulation. From seabed electronics, to orbital satellites - if it can be made easier to service, then more performance will be delivered.

Independent of application, the key elements include:

- low insertion force, because it is expensive to make strong robots; this may imply high-speed serial communication protocols, and high-voltage distribution with DC-DC conversion, to reduce pin-count.
- self-alignment of modules, or strong registration of the service unit, or tactile feedback; one or more of these are required to deal with the 3 rotational axes of the module, and the 3 additional axes of the insertion force vector.
- well designed and tested grounding and shielding approaches, to aggressively address EMC concerns.
- intelligent “backplanes” (or perhaps switch fabrics), to relax the constraint of getting each module into a dedicated “slot”; long-term delivered performance will be improved if modules can be readily moved from defective positions to “spare” positions.
- compatibility solutions that address existing VME and/or CPCI designs; one example is a parallel-to-serial conversion adapter, which converts parallel VME bus access (to/from an existing VME board) into serialized packets to be routed across a switch fabric (see VITA 34, below).
- hot-swap, plug+play, and related high-availability concerns, to reduce the impact of service on the remaining electronics in the subsystem.

These features would be of considerable value in human-serviceable contexts as well. As such, this project could have profound impact on electronics for high energy physics in general.

Description of first year project activities

The first objective of this project is to form a study group, and to identify the primary features required. The elements listed above are simply a starting point. Participants will be solicited from universities, laboratories, and industry, with the understanding that this is primarily a voluntary effort.

The second objective is to examine existing candidate solutions, as well as works in progress. One specific work in progress is VITA 34, “A Framework for an Embedded Architecture” (see www.vita.com/vso/draft_stds.html). Many of the elements listed above (low pin count, DC-DC conversion, strong EMC packaging, VME-serialization) are also being considered by VITA 34; we have much to learn from them, and others.

The final objective for the first year is to draft a feasibility report, and preliminary specification.

Future work would begin with a prototype. As considerable mechanical engineering may be involved with respect to packaging, shielding, and cooling, it may be educational to offer the prototype development as an undergraduate design challenge. The University of Illinois has “senior design” projects, and many schools offer design “contests” to promote creativity. The actual solution of the registration/self-alignment problem may well be addressed by student competition.

Budget

The budget assumes modest but regular telecommunications; group meetings will be coordinated with other regular activities, to minimize expenses.

Institution	Item	Cost
Illinois	Travel, telecommunication	$1,500
LBL	Travel, telecommunication	$1,500
other	Travel, telecommunication	$1,500
other	Travel, telecommunication	$1,500
	Indirect costs	$3,240
	Grand total	$9,240