μTCA for physicists?

A project to evaluate platforms for uTCA based systems at CERN and in the HEP community

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1. Background

In 2006, as a spin-off from the ATCA and AMC standards the PICMG consortium has published the uTCA standard. Since then uTCA systems have found a certain level of adoption not only in the telecom market but also in industrial control systems. For a few years now they have also triggered the interest of a number of independent groups in the HEP community and a small number of projects have been started [Reference 1].

As several independent groups both in the CERN experiments and the accelerator recently have started to develop modules for uTCA systems the question arises to how these modules should eventually be housed. The uTCA market provides a very large number of different solutions ranging from 2 to 12 slot systems with horizontal or vertical card orientation, different air flow schemes, different card sizes and so on. In addition to the many mechanical alternatives, uTCA systems also can be ordered with different types of standard backplanes or even backplanes with a specific, user defied routing of the signal lines. In order to have access to all relevant information CERN has become an Associate Member of the PICMG organization and has joined the "xTCA for Physics" group. Information from these sources is available to all people at CERN via special (partially protected) Web sites [Reference 1, Reference 2]. During the TWEPP 2010 Workshop in Aachen the "xTCA Interest Group" was founded and will serve as a platform for the exchange of information across projects and institutes [Reference 1, Reference 3]. The interest group will use the "xtca_news@cern.ch" mailing list for internal communication. The same mailing list will also be used for announcements of xTCA events at CERN. Both the interest group and the mailing list are open and new members are welcome to subscribe.

2. Motivation

The PH-ESE group has recently started its first uTCA project: the development of a Gigabit Link Interface AMC (the GLIB, [Reference 4]). In parallel to this development, it is very natural to evaluate certain technical aspects (see below) of the uTCA standard and its sub-standards. As a first step the group has purchased two MCH modules, a processor AMC, an I/O AMC, an AMC load card, as well as two different

uTCA shelves. The procedures and tools used for these evaluations and their results could be of benefit to a much wider community than the PH-ESE group alone, and this project addresses this concern.

At this point in time we propose to focus our effort on uTCA systems and AMCs. Because the available resources do not allow for the parallel evaluation of both uTCA and ATCA we have decided to start with the simpler one of the two standards. We are convinced that in the uTCA environment many lessons can be learnt that will also be relevant to ATCA based systems. We will be trying to synchronize our efforts with current xTCA projects such as the µTCA projects in CMS and BE as well as the ATCA projects of ATLAS and LHCb.

Beyond the simple reporting tasks envisaged above, the question arises whether it would be in the interest of CERN and of the HEP community if certain recommendations were made for the configuration of uTCA shelves which, if adopted, could help reducing the number of incompatible systems and facilitate purchase procedures, system support and management of spare components. This question will only be addressed once the project is well underway and has delivered first evaluation results and lessons learnt.

3. µTCA and MTCA.4

In 2001 the PICMG group has released the ATCA standard. Initially ATCA boards were meant to host PMC/XMC mezzanines but soon a dedicated mezzanine standard has been developed for ATCA and published under the name Advanced Mezzanine Card (AMC). It was soon realized that one could build another standard around these AMCs which would allow using them in shelves with direct connection to a backplane. This standard was published in 2006 under the name µTCA (Micro TCA). A µTCA system consists of a number of standardized components which by now are all available from several vendors. The main components are:

- Shelves
- Backplanes
- Power supplies
- Ventilation units
- MCH boards. The MCH is the component that manages all other elements and provides the switching matrix for the various communication channels
- AMC modules

During the last years µTCA systems have become relatively popular, especially in Europe, and the number of H/W and S/W products is growing steadily. As ATCA, the µTCA standard has been designed with full redundancy in mind and a lot of effort has gone into the definition of how the components of a µTCA system communicate with each other in order to guarantee a smooth operation of all units. Nevertheless early adopters have observed interoperability issues in systems made from components of

several vendors. In addition the standard contains a large number of optional features or alternative solutions that have to be managed carefully by the system integrators.

From 2008 onwards a group of representatives from several HEP institutes as well as members of industrial companies have worked on a "physics profile" for the µTCA standard, initially known as "µTCA for physics", now called MTCA.4. In the xTCA world the creation of a "profile" is a common procedure. Profiles fix some of the areas that are left undefined or optional by the base standards and may contain features that go beyond these standards in other areas. The latest version of MTCA.4 can be downloaded from:

https://xtca-for-physics.web.cern.ch/xtca-for-physics/MTCA.4.pdf (CERN login required)

Even though the MTCA.4 standard has not been finalized yet it is already possible to buy prototype shelves and backplanes that were built to a draft version of it. It is yet unknown when exactly the MTCA.4 draft standard will be submitted to PICMG for ballot but most likely it will happen very soon.

The main features of MTCA.4 with respect to µTCA are:

- AMC card format
  - Vertical: Double width (single width possible)
  - Horizontal: Mid size (18 mm). Compact possible. Full-size possible but not recommended because the backplane connectors are spaced by 18mm. Therefore a full-size AMC covers two slots
- Possible addition of rear transition modules (RTMs). These RTMs approximately double the PCB space and allow for cables entering from the back of the crate. The power limit stays at 80 W (recommended power distribution: AMC: 50W + RTM: 30W)
- Standard backplane. The routing of the signals on the backplane is fixed. Both high speed slot to slot and low speed bussed clock lines are available
- Down-selection of transfer protocols. Only the PCIe protocol should be used in the fat-pipe region

The MTCA.4 standard has been designed such that it will be compatible with most commercially available MCH and AMC cards. It is therefore possible to use MTCA.4 compliant shelves also for many systems that do not require the additional features of this standard as long as the higher price of the shelf (due to the more complex mechanics and lower production volume) is accepted.

4. Project scope

The current activities around uTCA and the availability of several (partially incompatible) platforms with different merits prompt us to evaluate some of the candidate implementations and eventually attempt to define a preferred platform for the development and deployment of uTCA systems at CERN and in the HEP community . We propose to break down the project in three phases:

A) We propose to first carry out **technical evaluations** of systems built to both the basic uTCA standard and the MTCA.4 sub-standard and to assess the respective advantages and disadvantages of the two alternatives. System features that will be covered by the evaluation include:

- Mechanics
- Power supplies
- Cooling
- Backplane properties
    - IPMI connectivity
    - intra-crate connectivity
    - clock distribution
- MCH control
- Redundancy
- Scalability to large systems
- Etc.

The objective of this phase is to better understand and discuss with the community the issues related to this new technology. The discussion forum will be the newly formed interest group on xTCA systems. At least two AMC boards will be developed as tools for the evaluation phase:

a. An AMC load board with RTM [Reference 5]

b. An evaluation board for the MMC designed by J.P. Cachemiche (Marseille) [Reference 6, Reference 7]. This board is already available in prototype form and in use.

B) In addition to the evaluations described above we are planning to carry out informal market **surveys** and user surveys, and to make the results of this work available to the community through regular oral and written reports.

C) Eventually the **support** of a selected set of components of uTCA systems, if consensus is reached, could become part of the PH-ESE service activities. For instance, discussions around a common MMC module have already started in the xTCA interest group.

5. Project duration

We propose to launch the project on a trial basis until mid-2012, and discuss its continuation in early 2012 based on the results obtained in the first year.

6. Project team

The project will be led by Markus Joos in collaboration with Vincent Bobillier, Stefan Haas, Francois Vasey and Paschalis Vichoudis.

7. References

Reference 1: https://twiki.cern.ch/twiki/bin/view/XTCA/WebHome#Project_repository

Reference 2: https://xtca-for-physics.web.cern.ch/xtca-for-physics/

Reference 3: http://indico.cern.ch/contributionDisplay.py?sessionId=26&contribId=176&confId=83060

Reference 4: https://espace.cern.ch/project-GBLIB/default.aspx

Reference 5: https://espace.cern.ch/project-GBLIB/Shared%20Documents/Load%20board/ALB%20v0.1.docx

Reference 6: https://edms.cern.ch/nav/P:EDA-02203:V0/I:EDA-02203-V1-0:V0/TAB4

Reference 7: https://espace.cern.ch/project-GBLIB/Shared%20Documents/GLIB_MMC_test.PNG