Deliverables, Cost, Manpower, Maintenance and Schedule for CSC Readout Replacement

DELIVERABLES

The muon CSC readout replacement for the 2013-2014 shutdown is envisaged to be accomplished with the Reconfigurable Cluster Element (RCE) generic high bandwidth DAQ concept implemented on the ATCA platform. This New ROD Complex (NRC) is expected to replace the existing CSC ROD crates with compatible interfaces to the rest of ATLAS. The NRC is implemented on a set of ATCA modules, Cluster On Board (COB), which contains four (4) processing COB Mezzanine Boards (CMB) or Data Processing Module (DPM) each, while each CMB has two RCEs each hosted on a Virtex-5 FPGA. Each COB also has a Fulcrum switch on the motherboard in conjunction with another CMB, the Data Transmission Module (DTM), with a single RCE managing the dataflow to/from and within the board, and interfacing to the ATLAS TTC system. The whole NRC is hosted in one ATCA shelf, with four (4) COBs performing the role of direct communication with the frontend, in particular to sparsify the data with Feature Extraction (FEX). Another COB gathers output data from the four FEX COBs and format the data for transmission on S-Links to the ROSes. The hardware configurations of the FEX COBs and the Formatter COB are identical, but each type of COB has its own distinctive Rear Transition Module (RTM). The CSC RTM at the back of each FEX COB has 12 SNAP-12 MPO transceivers, while the SFP RTM at the back of the Formatter COB has 16 SFP transceivers. The 4+4 spare COB+RTM(FEX) are needed during the system test stage as a data injectors emulating the CSC front-end. Finally, a computing node running LINUX will serve the role similar to the SBCs in the current VME system, as the TDAQ control interface communicating with the formatter COB via Ethernet.

The list of hardware deliverables for the production system is then:

Components	In System	Spares
COB (FEX + formatter)	5	4
RTM (FEX)	4	4
RTM (Formatter)	1	2
ATCA shelf	1	1
TDAQ control server node	1	1

Table 1: Deliberable list of the production system.

HARDWARE COST

With the prototyping of the COB, RTMs and CMBs all well advanced, there is already some experience in pricing the hardware construction. All components estimates are based on prototype purchases, which typically have rather small dependence on quantity purchased. PCB fabrications are also based on actual prototype pricing for all types of PCBs, but the unit cost here does depend on the number of PCBs produced together in one order. Shared production with other projects in ATLAS or beyond lowers the unit cost for production. The only CSC special component on the deliverable list above is the RTM for the FEX COB. The general design principle to make the RTM a very simple board is exactly to allow specific application dependent variations at limited extra cost for each new type of RTM.

For the more costly COBs, we will base the unit PCB cost on a quote for 10 COB PCB boards during prototyping. The CMB PCB cost is an extrapolation based on a unit cost of $475 for an order of 8 boards. It is highly likely that the CSC NRC production will be shared with at least some small additions from other projects, while a pooled production of >>10 COBs together with other projects can potentially reduce the costs further. The cost estimate for each COB is shown in Table 2.

Components	Multiplicity	Unit cost ($)	Summed cost ($)
COB PCB and loading	1	1800	1800
COB motherboard components	1	700	700
CMB PCB and loading	5	350	1750
CMB components	5	1050	5250
Total cost per COB			**9760**

Table 2: Per COB cost estimate.

We approximated the single RCE DTM to be the same cost as the dual-RCE DPM for a uniform CMB cost. The higher cost for lower multiplicity of DTM production should be safely compensated by one RCE less on the DTM.

For the RTMs, we will assume dedicated small volume CSC production. The cost estimate for each RTM is shown in Table 3.

Components	Multiplicity	Unit cost ($)	Summed cost ($)
CSC RTM PCB and loading	1	350	350
CSC RTM MPO transceivers	12	240	2880
CSC RTM other components		100	100
Total cost per CSC RTM			**3330**
SFP RTM PCB and loading	1	350	350
SFP transceivers	16	50	800
SFP RTM other components		50	50
Total cost per SFP RTM			**1200**

Table 3: Per RTM cost estimate.

Combining the individual board cost estimates for the full production system is shown in Table 4.

Components	System +spare	Unit cost ($)	Summed cost ($)
COB	9	9,760	87,840
CSC RTM	8	3,330	26,640
SFP RTM	3	1,200	3,600
ATCA shelf	2	5,500	11,000
TDAQ server node	2	4,000	8,000
Miscellaneous cables			1,000
Total production system cost			**138,080**
Total production system cost (including 9% overhead)			**150,510**

Table 4: Production system overall cost estimate.

The above table is for the production system, with majority of the cost to be committed during Jan/2014 production. For prototypes and test stand, an additional $35K is needed for a dedicated CSC test stand at CERN with two sets of COB+RTM prototype boards, one ATCA shelf and a test stand server, during FY13. These cost estimates do not include contingency.

MANPOWER

This CSC readout replacement is taking advantage of a significant integral of effort on the RCE concept R&D in the last five years at SLAC to mature the new technology so that the application towards an upgrade system like the CSC readout becomes a more manageable final step. The remaining engineering effort to deliver production quality COB and Gen-II RCE hardware is regarded as part of the core effort of the generic R&D that will continue to leverage the SLAC KA15 generic R&D funds to complete and not charged to the CSC readout replacement project. The RCE core firmware and some of the generic protocol plug-in (such as S-Link, TTC interface) firmware and software are also regarded as generic R&D, not costing against CSC readout replacement project, but need to be tracked together for schedule concerns. The manpower cost for the CSC readout replacement project is therefore mainly on the design and implementation of CSC specific applications. Physicist manpower associated with the project is also not included in the manpower costing, but will factor in the overall task responsibilities and schedule. In particular, Nicoletta Garelli (project scientist, SLAC) supported by SLAC research budget and Andy Nelson (postdoc, UCI) and Anthony DiFranzo (grad student, UCI) supported by the UCI research budget are expected to contribute significantly to the project. The estimated manpower needs, integrated FTE*time over full FY, to be costed as CSC specific M&O effort:

Personnel	FY12	FY13	FY14
Mike Huffer	0.10	0.40	0.30
Ric Claus	0.20	0.80	0.60
Jim Russell		0.30	0.15
Engineer	0.05	0.10	
SLAC Tech support			
Raul Murillo Garcia	0.20	1.00	1.00
Total	**0.65**	**2.80**	**2.05**

Table 5: Manpower cost in FTE*year for CSC specific application charged to the project.

The manpower costs are only listed up to end of FY14 when the CSC is expected to be joining ATLAS for combined commissioning. There is expected to be some additional manpower cost for FY15 during the commissioning phase and early data taking that is more than the steady-state maintenance, which is regarded as additional maintenance beyond the construction phase.

MAINTENANCE

Both SLAC and UCI are committed to maintain and operate the NRC throughout its operational lifetime, foreseen as 2015 until 2018/LS2. Operational support at CERN will be provided by a resident SLAC project scientist, taking direct responsibilities for hardware maintenance and major updates, and by the UCI CSC operations team. In addition, the design team based at SLAC will supply operational support. Although extensive hardware maintenance is not foreseen, any necessary hardware maintenance will be greatly facilitated by the expertise maintained at SLAC for development and support of the RCE applications for other projects. Adequate spare hardware is included in the production plans.

SCHEDULE

A preliminary schedule for the design and construction phase of the project is included in a separate file. Some of the key dates and milestones for the project follow:

- Oct/8/2012: Conceptual Design Review.
- Mar/8/2013: Fully functional COB+CMB+RTM prototype hardware and RCE Gen-II core firmware ready for design testing.
- Jun/14/2013: Final Design review. Prototype firmware and software designs are validated with prototype hardware.
- Feb/5/2014: Completion of full set of hardware production.
- Apr/9/2014: Readiness Review. Full system DAQ operations demonstrated with data injector input emulation.
- Aug/1/2014: Join ATLAS for combined commissioning.

This preliminary schedule provides some schedule contingency between tasks. Moreover, to mitigate schedule risk, most of the responsible personnel, as well as co-workers, are available at a larger fraction of their time, if needed. The schedule chart is mainly for task tracking purpose while incomplete for personnel resource tracking, as some tasks such as integration tests and reviews will involve majority of the people on the project while only the main responsible person is listed in the schedule.

The early phase of NRC system testing will be performed using the data injector, thus eliminating at that stage dependence on availability of real small wheel hardware. With thorough testing prior to full integration with ATLAS, NRC deployment should not require global ATLAS resources earlier than the schedule of IBL (+pixel nSQP) commissioning needs.