18 Workplan and schedule

This chapter outlines the short-term (6–12 months) post-TDR workplan for the major activities in the HLT and DAQ systems (including DCS). The global HLT/DAQ development schedule is presented in Section 18.1 as the basis for the definition and context of the workplan. The detailed workplan, which is still in preparation, is introduced and a number of issues which will have to be addressed are indicated (Section 18.2). The strategy that has been developed for the detector integration and commissioning is described in Section 18.3.

18.1 Schedule

This section presents the overall schedule for the HLT/DAQ system up to LHC turn-on in 2007. The development and deployment of the HLT/DAQ system, both hardware and software, has been mapped onto the ATLAS detectors installation plan [18-1].

18.1.1 System hardware

For the system hardware, the planning is driven by the production schedule for the two custom read-out components:

- the S-LINK Link Source Card (LSC), to be installed on the RODs;
- the ROBin, the receiver part of the ROS (S_LINK receiver and ROL multiplexer).

An analysis of the detector installation schedules points to the first quarter of 2004 as the moment for the Final Design Review of the LSC and the ROBin. The review of the ROBin requires the I/O optimization studies (see Section 18.2.1) to have been completed beforehand. (The third custom component of the HLT/DAQ, the RoI Builder, is not on the critical path for the detector installation schedule).

The global HLT/DAQ production schedule is shown in Figure 18-1. It identifies the principal milestones concerning the detector needs for TDAQ installation, the TDAQ component production (in the case of custom components), the component purchasing and associated tendering (in the case of commercial components), as well as testing and commissioning.

Figure 18.1 is a gantt chart with the pricipal milestones of detector installation, such as combined test beam run, commissioning, cosmic run, etc., and the TDAQ components production and purchasing schedule.

18.1.2 System software

Six major releases of the system software have been identified (dates are indicative at this stage and will be adapted if necessary). The release strategy is driven by detector operations (e.g. test beams and cosmic-ray run) and commissioning (see Section 18.3).

Figure 18-1 Schedule of the overall HLT/DAQ project

1. Current DAQ release, integrating Online Software and DataFlow. It is targeted at the needs of the ATLAS H8 test-beam operations in 2003 and to the I/O optimization and system-performance measurements. This release has been operational since May 2003.
2. ‘Combined test-beam’ release for the combined run in 2004.
3. ‘Sub-detector read-out’ release for initial detector commissioning with single ROD Crate DAQ (RCD) for single crates.
4. ‘HLT/DAQ installation’ release for commissioning of the HLT/DAQ components and global detector commissioning in autumn 2005.
5. ‘Cosmic-ray run’ release for global HLT/DAQ and global detector commissioning, as well as for the ATLAS cosmic-ray run in autumn 2006.
6. ‘LHC start-up’ release for the start of LHC operation in April 2007.

The software-development schedule is shown in Table 18-1 for the software of the three sub-systems, Online Software, DataFlow, and High-Level Trigger. For the HLT, only the LVL2 and EF infrastructure part of the software (required for detector monitoring during detector commissioning phases) is considered here. The development schedule of the other components of the HLT software, namely the selection core software and the physics algorithms, is not linked to the DAQ releases and is not reported in the table. It will only be fully defined later this year.

Table 18-1 Software development schedule for the software of Online Software, DF and HLT

RELEASE	Online Software	DataFlow	High Level Trigger
TDR release (Jun 03)	As described in TDR - Mar 03	As described in TDR, first full DataFlow - May 03	Current EF release - Summer 03
Combined test beam (Summer 04)	Prototype versions of control, configuration, and monitoring services - Feb 04	Consolidation of TDR release, evolution of ROD Crate DAQ - Apr 04	EF infrastructure (version from PDR) - May 04 (LVL2 infrastructure - late summer 04)
Sub-detector read-out (Autumn 04)	Full support of final ROD Crate DAQ - Jun 04	First release of final Dataflow, including ROD Crate DAQ - Dec 04	
HLT/DAQ installation (Autumn 05)	Full functionality of control, configuration, and monitoring services, including I/F to conditions DB - Apr 05	Consolidation of previous release, completion of DataFlow functionality - Jun 05	Completion of HLT functionality for cosmic-ray run - Summer 05
Cosmic-ray run (Autumn 06)	Final large-scale performance and support for partitioning - Mar 06	Final large-scale release - Jun 06	Ready for cosmic-ray run - Summer 06
LHC start-up (Apr 07)	Final implementation ready for tuning - Dec 06	Consolidation of previous release - Dec 06	Ready for initial physics run - Dec 06

18.2 Post-TDR workplan

The detailed workplan to meet the objectives described in the schedule of the previous section is in preparation and will be finalized soon after the TDR publication. Its description goes beyond the scope of this document, which specifically addresses the workplan of the short-term post-TDR phase, characterised by the completion of the studies for the optimization of the HLT/DAQ baseline, both in the DataFlow (Section 18.2.1) and in the HLT (Section 18.2.2). The Detector Control System workplan is outlined in Section 18.2.3, while Section 18.2.4 lists some of the other issues that will be addressed.

18.2.1 DataFlow workplan

In the baseline design, the flow of data and of control messages between the ROS and the HLT can be implemented using bus-based or switch-based data collection, for the aggregation of data from a number of Read Out Links into each port of the main DataFlow network. Work up to the Final Design Review (FDR) of the custom hardware in the DataFlow (first quarter of 2004) will address, with high priority, the optimization of the data flow at the ROS level.

As described in Chapter 8, a full-system prototype has been developed supporting simultaneously the two data-aggregation techniques, by means of a ROBin prototype with two Read Out Links at the input, and output to both PCI-bus and GEth (see Section 8.1.3.2). Performance measurements done on a prototype of the full HLT/DAQ architecture with a size of order 10% of the final system, as reported in Chapter 8 and Chapter 14, demonstrate the overall viability of the baseline architecture. The measurement programme is continuing with the deployment of a number of ROBin modules in the 10% prototype system, allowing a direct comparison of functional and performance aspects. This will lead to the choice of the optimal Input/Output path before the FDR of the ROBin, currently planned for the first quarter of 2004.

The results of the measurements will continue to be used in the discrete event modelling aimed at providing a description of the behaviour of the system scaled to the final size.

18.2.2 High-Level Trigger workplan

The work on the HLT system up to the end of 2003 will be focused on several principal areas which are discussed below.

The LVL2 and EF testbeds, discussed in Section 14.2, will be exploitated during the summer period in order to arrive at a complete set of measurements concerning the functionality and performance of the HLT event-selection software. This information, together with the initial results of physics-performance studies using the selection algorithms running in the selection-software framework, will be analysed in an internal review currently planned for late October. The review will identify areas in the software which may require optimisation, partial re-implementation, or re-design. The review will define the end of the initial cycle — requirements analysis, design, implementation, testing, and exploitation — which characterises modern software projects. The second, shorter, cycle will be launched immediately following the review with a view to completing it a year later. During this time, the system-exploitation phase will include its use in the combined ATLAS test-beam during the summer of 2004.

In parallel with the testbed exploitation, further optimization studies of the selection-software design and implementation will be done, as discussed in Section 14.2.1. The results of these studies will provide important input to the review.

Data are available from the production of large samples of simulated physics channels with noise and pile-up included. Exploitation of these data using the LVL2 and EF algorithms is now underway in order to optimize the implementation and tune the performance of the selection algorithms in terms of signal efficiency, background-rate reduction, and execution time. This will lead to an update of the numbers presented in Refs. [18-2], [18-3] and [18-4]. Initial results are presented in this TDR. This work will continue for the rest of this year and beyond.

The HLT system software (used to control the flow of data to and from the HLT algorithms, and for the control and supervision of the HLT) is being tested in the testbeds and also, currently (in the case of the EF), in testbeam. The design and implementation of these software systems will also be reviewed towards the end of 2003 with a view to having an updated design and implementation by the middle of 2004.

The purchase of the bulk of the HLT computing and network hardware will take place at as late a date as possible compatible with ATLAS installation and commissioning requirements as well as the LHC start-up schedule. This is done to benefit from the best possible price / performance ratio of the equipment. The standard sub-farm racks, discussed in Section 5.5.11, will need to be prototyped. This work will begin later this year with a view to having a first rack prototype in 2004.

As mentioned notably in Sections 1.5 and 5.2.3.1.4, aspects of access to and use of the conditions database, and connection of the TDAQ system to the offline prompt reconstruction and to CERN mass storage system are not yet sufficiently defined. These issues have already begun to be addressed with the offline computing group, and this will continue into next year.

18.2.3 Detector Control System workplan

The DCS schedule is summarised in Figure 18-1.

18.2.3.1 Front-End

The process of producing the ELMBs has started. At the beginning of the third quarter of 2003 the radiation qualification of the components will be done, and fully-tested modules should be ready at the end the last quarter of 2003. The software for the ELMB is being finalized and will be tested in the third quarter of 2003 before being loaded into the ELMB as part of the production process.

18.2.3.2 Back-End

The Framework Software that is built on top of the SCADA software PVSS is being reviewed and the implementation of a re-designed version will start at the beginning of the third quarter of 2003 in the framework of the JCOP project. The core libraries and tools are expected by end November 2003. This final software will be used for the test-beam operation in 2004, at the ATLAS pit for controlling the sub-detectors, and the experimental infrastructure from mid-2004 onwards. In the beginning, each system will operate stand-alone. Integrated operation will be needed from the end of 2005 onwards. On this timescale, the overall supervisory system for coherent operation of the whole ATLAS experiment from the main control room will be set up. Communication with external systems will be needed in 2006 in order to allow global commissioning of ATLAS, and for the cosmic-ray run in the third quarter of 2006.

18.2.4 Other issues to be addressed

During the deployment of the full-system HLT/DAQ prototypes for measurements and optimization of performance, a number of other issues will be addressed which are important for the system functionality and the definition of certain services. Amongst these issues, the following have so far been identified:

- processor and process management in the HLT farms;
- flow of data in databases (for production, conditions, configuration);
- fault tolerance;
- TDAQ output and computing model viz., offline prompt reconstruction and mass storage;
- use of remote EF sub-farms;
- system scalability and robustness against variation of parameters, eg LVL2 rejection power.

As an illustration, the last of the these points is developed briefly here. The feasibility of the architecture depends on a number of assumptions regarding both external conditions (such as the data volume of a region of interest) and extrapolations of measurements performed today. Further study of the robustness of the baseline architecture with respect to reasonable, and maybe foreseeable, variations of these assumptions will be an item for the short-term post-TDR workplan.

Table 18-2 lists some of the key parameters for the architecture. For each parameter, the currently assumed value is given, and consequences of the variations are discussed.

Table 18-2 Variations of baseline parameters.

Parameter	Current value	Remarks
RoI data volume	~2%	Implications on ROL–ROB aggregation factor, ROB–ROS aggregation factor, and LVL2 switch size.
RoI request rate/ROB	Uniform distribution	This will not be the case. Non-uniform distributions have been studied extensively in Paper Models. Their implications on the traffic pattern through the level-2 network need further studies.
LVL2 acceptance	30:1	A more pessimistic figure implies a higher rate into the EB or a reduction in the maximum LVL1 rate that can be accepted, hence an effect on the ROL and ROB aggregation factors and the number of SFIs. Thus a large EB network, as well as a related impact (higher EB rate) on the EF farm size.
HLT Decision time/event	10 ms @ Level-2 1 s @ EF	Variations of O(10%) have a corresponding effect on the size of the farms and the related central (Level-2 or EB) networks.
SFI Input/Output capability	70 Mbyte/s In 70 Mbyte/s Out	Impact the size of the EB network (because of additional SFIs) Impact the organization of the EF farm. Less events output by the SFI will mean smaller sub-farms (or more SFIs per sub-farm)

18.3 Commissioning

During the detector installation, the corresponding read-out elements will have to be tested and commissioned. This section presents the strategy developed so that the detector commissioning requirements can be met in parallel with the commissioning of the TDAQ elements themselves.

An outline of the most relevant aspects and issues of the HLT/DAQ commissioning can be added here.

The detector commissioning will be done in three phases, namely the readout of a single ROD crate, the readout of multiple ROD crates, and the readout of multiple sub-detectors. The necessary tools for the implementation of such a strategy are briefly described here. Some of these tools are already available today and used at the test beam, in test beds, and at test sites.

A more detailed description of the commissioning plan can be found in the relevant documentation of the ATLAS Technical Coordination [18-5].

18.3.1 Tools for detector commissioning

18.3.1.1 ROD-Crate DAQ

The first need of a sub-detector will be to check the functionality of the front-end electronics via the readout FELs into ROD modules. For this first functionality check, the ROD-Crate DAQ (RCD) will be used. The RCD software is being completed now and its exploitation on test beam operations is starting. For the initial phase of detector commissioning, it will be a mature and stable product.

The RCD is the minimal infrastructure to read-out the sub-detectors' RODs. The readout will be done initially via VMEbus, by the ROD Crate Controller (RCC), as shown in Figure 18-2. Data processing can be done at the level of the RCC or in an external workstation (conected via Ethernet to the RCC) running the ROS application. Data in the workstation can then be stored to disk. The necessary infrastructure will be in place in the underground counting room, including the DCS, the TTC, the Local Trigger Processors, and the Conditions Database for the storage of calibration data.

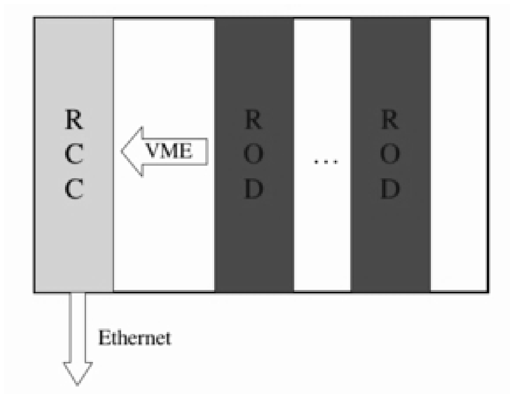

Figure 18-2 Readout of ROD modules via VMEbus by the ROD Crate Controller

The second step will implement the ROD readout via the standard Read Out Link (ROL) into a stand-alone ROS, as in Figure 18-3. This setup will enable the data integrity over the ROLs to be checked simultaneously for a number of RODs and is the first major step in the detector — DAQ integration. The setup mentioned above is very similar to the one already in use and well tested at the H8 ATLAS test beam.

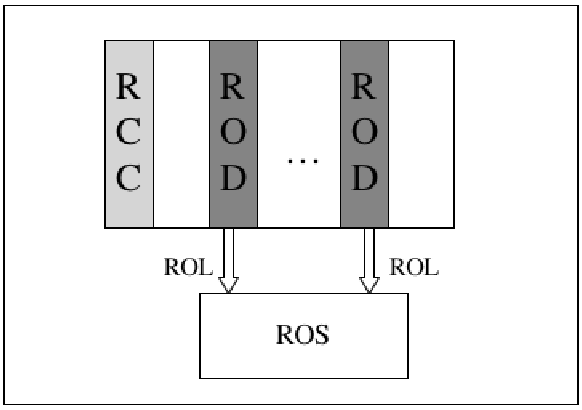

Figure 18-3 Readout of ROD Modules via ROLs connected to a minimal ROS system

18.3.1.2 Readout of multiple ROD crates

In the second phase, data taking from multiple ROD crates will be implemented. This will allow the complete readout of one or more TTC partitions, requiring multiple ROS units and a minimal Event Builder. In all cases the storage of the data to disk or to the Conditions Database will be allowed (Figure 18-4).

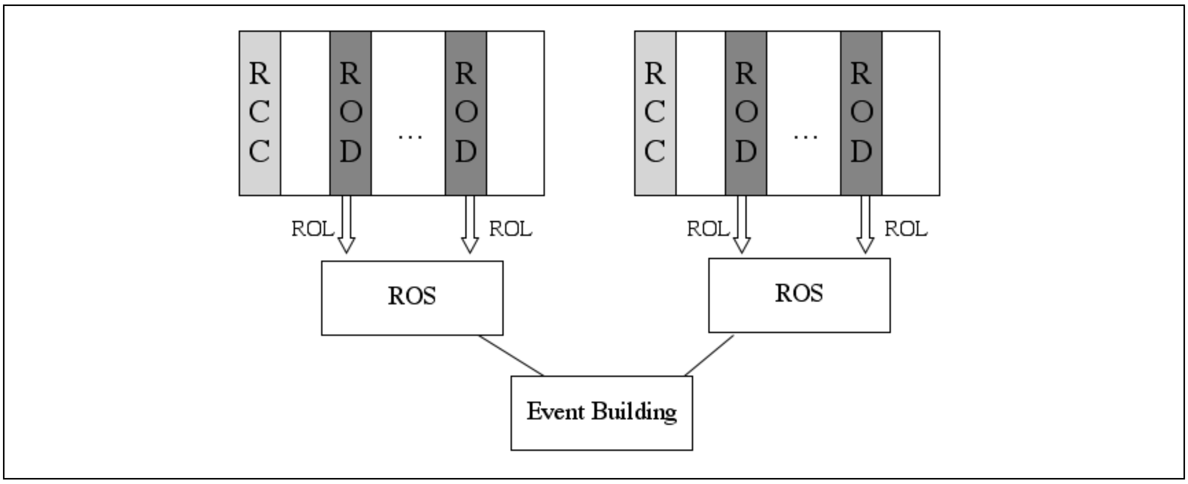

Figure 18-4 Readout of multiple ROD crates via ROLs with a minimal Event Building infrastructure

18.3.1.3 Readout of multiple sub-detectors

In preparation for the cosmic-ray run and during the final phase of the ATLAS Commissioning, there will be the need for reading out several sub-detectors simultaneously. The time scale for these operations matches the time scale for the completion of installation of the final TDAQ elements. A possible configuration for the readout of more than one sub-detector is very similar to the one presented in Figure 18-4. The number of hardware elements involved may vary significantly, however the major change will be the addition of Event Filter sub-farms (only needing minimal processing power) to complete the dataflow chain. In the case of multiple sub-detector readout, the CTP infrastructure and the DCS supervisor will also be needed.

Add reference to (and some text from) the recent session at Athens on commissioning with cosmics...

18.4 References

18-1 ATLAS installation schedule

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