The FSM of the ATLAS MDT-DCS

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1. Requirements, Scope and Definitions

- The FSM of the MDT shall behave – in terms of look and feel - as any other ATLAS FSM. It should comply with the guidelines as described in the document: "*ATLAS DCS Integration Guidelines"*.
- Control procedures, where damage to the detector may occur, should not be part of the FSM (or software in general). These interlocks have to be implemented in hardware. Some control actions will be done via software but fast action has to be assured; an example is turning off HV when machine background becomes very high.
- The FSM topology of the MDT is of type *geographical*. Although, the status of the sub-systems (the logical type), has to be available on the top level (i.e. control room). This state is obtained ~~(besides)~~ separately from the FSM.
- The DDC is not part of the FSM, nor has it influence on its design.
- The DAQ is responsible of the partitioning and hence it maintains a list of 'active' chambers. The FSM only makes partitioning possible. There may be a need for DCS partitions as some chambers may have HV on but not be in the readout.
- According to the guidelines, the CU's get their information only from their children and not from any other source or external system.
- There are around 1200 chambers, roughly divided among the 4 main parts: EA, BA, BC and EC.

2. MDT Sub-systems

The following sub-systems can be distinguished inside the MDS-DCS system.

1. **Temperature**: all chambers have several T-sensors. The range is in the order of 6 to 20 sensors.
2. **B-field**: a majority of chambers is equipped with 1 to 4 sensors.
3. **CSM-ADC**: The FE (front-end electronics) of a chamber are monitored by the so-called CSM-ADC. It reads the voltages, currents and temperatures of the CSM itself and the mezzanine-cards.
4. **JTAG**: the FE is initialized/loaded by JTAG strings. It sets the FE with thresholds and various parameters, necessary for a proper readout.
5. **LV (**Low-Voltage): the FE gets their power from the LV system.

6. **HV (**High-Voltage): the tubes will get their high-voltage from this system.

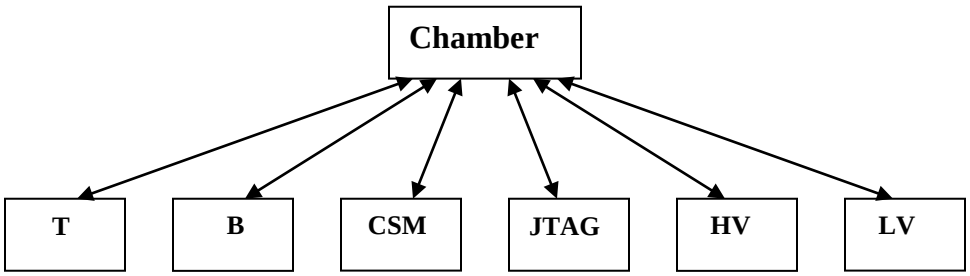
The sub-systems are completely independent and not related to each other.
In some cases information from one subsystem will be needed by another. (an example Is LV status needed by CSM/JTAG)

3. Status Generator

All the sub-systems should reflect a status in terms of the FSM. ~~A single T-sensor may be regarded in the terminology of the FSM as a DU (Device Unit).~~ Considering the number of sensors, ~~this is a not an effective way to organize the FSM~~. the sensors have to be grouped, and such a group can be regarded as a single DU. The logical choice for a group is of course a **chamber**.
Main question is how to define the status of a group of identical sensors. The mechanism is rather easy. A PVSS script loops along the sensors and on each round it determines and writes the status to the belonging FSM data-point. It is recommended to keep the status algorithm simple and flexible. ~~Combining several – but equal - devices into a single DU is also known as 'Status Generator'.~~
The process which decides the status of low level components and Device Units is called A Status Generator. The status which it determines in sent to the higher level FSM.

4. Low-level FSM

Based on the premises mentioned in the previous chapters, we might think of the following layout for the lowest part of the FSM-schema:



The chamber in this schema is the CU (control unit). It collects the status of the 6 sub-systems and derives a common status. A couple of remarks using this schema may seem appropriate:
(Later you call this a Logical Unit – should say so here rather than changing name later).

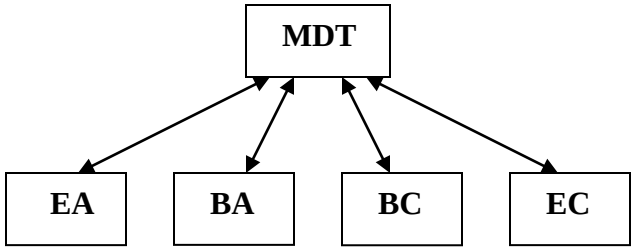
- There are around 1200 chambers, what implies 7200 DU's.
- The T, B and CSM sub-systems are passive. They only yield a status and do not accept commands, whereas JTAG, HV and LV do. The status of HV or LV is far

more important for the overall status, than for instance the status of the temperature.

- There is a use case where the temperature of a mezzanine card exceeds a limit. This will be detected by the CSM DU and its state NOT_OK is sent to the chamber CU, on which the CU decides to switch off the LV and the general state of the CU goes to NOT_OK as well.

5. Top-level FSM

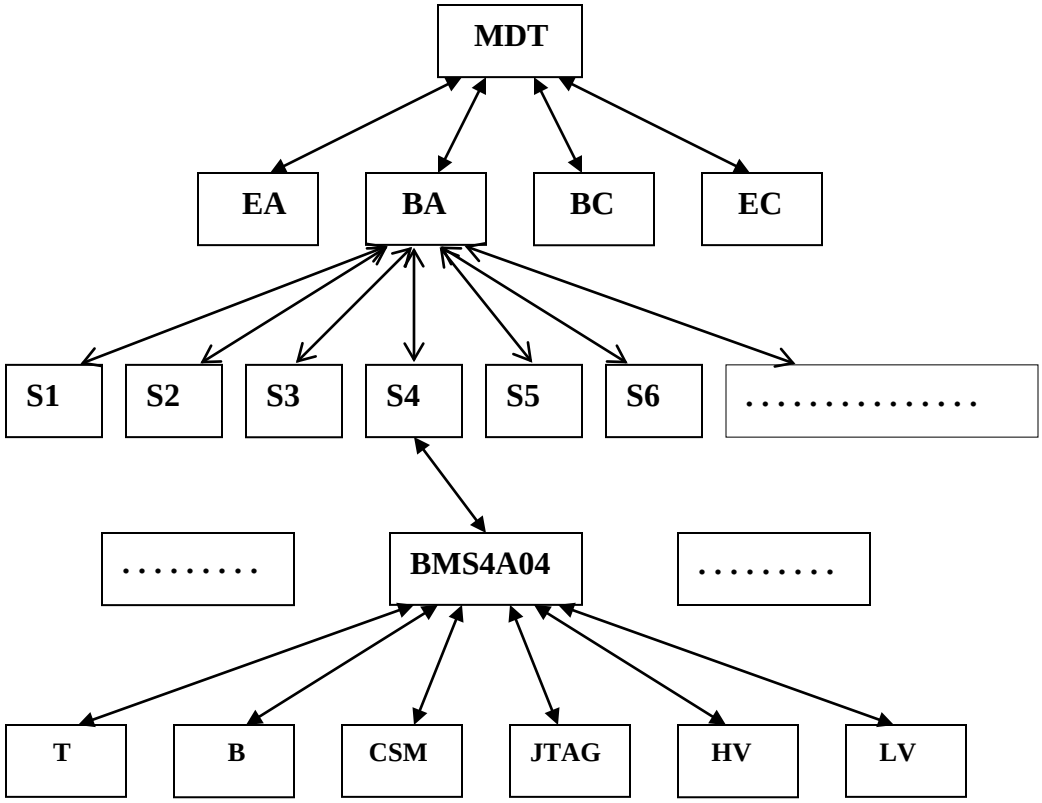
The MDT is part of the MUON sub-detector and is on the same level as the RPC, TGC and CSC. All of them being a CU. The first sub-division is already decided and has the following layout:



Thus, the MDT is divided into 4 logical CU's, one for the Endcap A-side, one for the Endcap C-side and the same for the Barrel.

6. The Middle Layer

The lowest-level and top-level need to be connected by an additional geographical division (layer). Both Endcap and Barrel have 16 sectors, thus the obvious choice is to sub-divide by **sector**. It implies that the number of CU's increases with 4 * 16 = 48. Compared with the number of CU's of the chambers (~1200), this is marginal. The total hierarchy of the MDT-FSM now looks as follows:



7. Implementation

There are around 1200 chambers and hence 1200 CU's. Recent versions of the FSM have the concept of LU (logical unit), a kind of light-weight CU. The chamber CU should be a LU, because of the ~~amount~~ number of them and because it is right above the DU's, which makes it ideal to be an LU.

For the CANbus control (T, B, CSM and JTAG) 8 PC's are utilized (with PVSS), thus the DU's for them are equally distributed among these PC's. (around 4*1200/8 = 600/PC) The LV and HV have each 2 PC's for their 1200 DU's respectively. The first obvious question is of course, where do the 1200 chamber-LU's reside? What can an average PC handle?

The 4 top CU's (EA, BA, BC, EC) will run on the SCS-PC in the control room, but what about the intermediate 48 CU's? It certainly means that for the FSM more PC's are needed.

How many? Please suggest.