Software: The underestimated component in space missions

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Software plays a central role in each space mission, it decides between mission success and failure and it is one of the most complex components in each space mission. Despite of this, its importance and the effort of the software construction are (almost) *always* underestimated.

Many micro, pico and nano satellite projects do not have software specialists; the software is the last item in the project plan, often some thing like "and then comes the software to the board computer and we can fly". Many satellite specifications contain some sentences like: "The functions of the board computer are navigation, attitude control, telemetry, command interpretation etc". If you look at the block diagram of the board computer you will not find any module named "Navigation" or "Command Interpreter". The effort is associated to the board computer but performed by software.

No wonder that most projects are delayed because of the software, many missions failure can be tracked back to software and specification errors (examples are part of the presentation), many satellites fly with a preliminary software version and the "final" version is planed to be uploaded in orbit some months later, and the software costs are (almost) *always* at least twice as high as planed. All this is not because the software developers are specially dummy or lacy. It is because the software effort is (almost) *always* underestimated by orders of magnitude, in best case by factors but not by percent (graphical statistics are part of the presentation).

The software complexity in space missions grows very fast, twice as big every 10 months (statistics are part of the presentation). The expectations to the software grow even faster. The tendencies are: more autonomy (definition and examples in the presentation) and more data reduction (methods are part or the presentation). Instead of storing and downloading Giga-Bytes of data the software shall extract the required information, so only a few Kilo-Bytes of information need to be stored and downloaded instead of Giga-Bytes. New missions attempt to have automatic operations. For this purpose the onboard software has to be able to plan autonomously the actions for the next hours, day or even weeks. (Graphics are part or the presentation).

An important aspect of each space mission is its fault tolerance, especially in the data management segment. Fault tolerance can not be added just by replicating hardware (examples are part of the presentation). An intelligent resource and redundancy management plays a central role for the fault tolerance, and this is a software function (examples are part of the presentation). This important aspect is very often forgotten when planning the robustness of the system. (The presentation contains some basic/general principles for fault tolerance).