GNC application cases needing multi-core processors

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Modern advanced space Guidance, Navigation, and Control (GNC) systems are now common ground for current space vehicle systems. Large satellites with flexible appendages, flight dynamics and precise control of ascent vehicles, control of a tight satellite formation, precision landing on a rocky surface, or rendezvous with a space station are some of the nowadays common examples of space missions that need and utilize extensively advanced GNC systems.

This presentation explains and provides evidence of the needs of the GNC systems design in terms of computational power (CPU load) showing that the current on-board processors are un-able to fulfil those needs properly. The presentation shows also that multi-core architectures are able to cope with the CPU demand requested and claims for a roadmap to establish a proper investment in this line.

The presentation covers 3 example areas in which multi-core computer architectures could alleviate the CPU demands requested by the GNC engineer.

The areas are as follows:

Case 1, intelligent Entry, Descent, and Landing (iEDL): this case is about the computation of optimal trajectories and optimal control command in real-time. Safe landing on a rocky surface (planet, moon, asteroid) requires the planning and execution of many actions is real time. The acquisition of the sensors is continuous, leading to complex filtering navigation algorithms (e.g. data fusion). The navigation function is followed by the exertion of commands that are calculated optimally (e.g. model-based predictive control) and finally those two lead to a recalculation of the entire left trajectory all in real-time (e.g. dynamic optimal inversion).

Case 2, large satellite with large flexible appendages: large antennae or large solar arrays have arrived to the markets of telecommunication satellites or observation of the Earth satellite missions. The control of the compound platform plus appendages is very complex. The matrix of inertia of such satellites creates problems in the control of the attitude slew manoeuvres and the control of the attitude pointing stability. New control paradigms have been developed as to cope with this problem but the proposed solutions by the GNC engineer do not fit on the current CPU architectures.

Case 3, tight formation flying: the challenging problem in this case is to keep a tight formation between several spacecraft with millimetre accuracy. Only advanced control techniques are able to establish the correct computation of actions on the formation to keep the geometry.

The presentation will show pictorial examples and comparison between the current delivered CPU load and the required one.