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Atmospheric Re-entry: a multifaceted problem demanding multidisciplinary solutions

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The atmospheric re-entry problem is one of the most difficult problems to attack from a G&C perspective. It is characterized by a wide operation envelope, from high hypersonic to low subsonic speeds and altitudes of 120 Km to sometime TAEM, with fast and drastic dynamic changes encompassing thermal / structural / human constrains while at the same time the stability and controllability sets of the vehicle are dramatically small. Furthermore, the re-entry problem is a truly collaborative work between the two big letters in G&C as guidance and control schemes are intertwined to a level not seen in aircraft control (from where most techniques are developed and tested prior to Space flight).

In our presentation we will present the main challenges and solutions for each of the blocks in G&C architectures based on a review of the tried-and-true systems flown in Space vehicles (Space Shuttle, Apollo, ARD, Soyuz). A summary that can be taken as a future roadmap from Deimos perspective will conclude our talk.

Some of the challenges ahead involve:

- Simplicity of design: especially for the control/guidance design.
- Digital & analog/manual interactions in the design.
- Fault detection & isolation and associated fault tolerant control schemes.
- Inclusion of safe margins & robustness objectives from the analysis to the design process.