Demonstration of Autonomous Rendezvous Technology (DART)

Case Study Transcript

Jim Lomas **The Failure Chain**

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As I mentioned earlier there is a SURI GPS receiver as part of the GN&C system. The SURI GPS receiver when it got on orbit for the first time in the DART mission it saw more satellites than it had ever seen before in any terrestrial application or any testing. The software inside the SURI didn't really know how to handle this very well and it caused a slight hiccup in the navigation state that the SURI was putting out. This caused a navigation state error which was the original cause for the filter, the GN&C navigation filter to reset. When that happens we take the solution from the SURI and use it as a starting point and then start trying to navigate. The second problem that the SURI had was an embedded velocity bias which was documented by the company, but not very well communicated between the various design teams.

The navigation filter inside the flight computer that GN&C system was getting bad information from the SURI, this caused the navigation state to constantly be drifting outside of an acceptable bound that was determined by the gains. This constantly made the nav state reset and slowly drift off and reset, this constantly happened from the minute we got on orbit until the retirement of the mission.

The failure of the DART mission, the error or problem that came up was caused by this constant resetting of the navigation state. This is similar to your speedometer in your car being wrong and you're constantly accelerating up to what you think is the right speed, shooting past it, braking and slowing back down, shoot past it, constantly accelerating, braking. A vehicle on orbit uses its thrusters to accelerate and brake. In the mission we expected to fire our thrusters occasionally, but what really happened because of this bad nav state was we were constantly firing our thrusters to accelerate and slow down. This used up all the fuel or used up the fuel much earlier than we had planned in the beginning of the mission.

Another sensor in the GN&C system was the proximity sensor, the AVGS. This sensor would have provided us very accurate range as with elevation to the target. In the mission we would use GPS up to a certain point and then we'd switch over to our proximity sensor. Because the nav state was incorrect we never thought we actually acquired the point which we were aiming for so we never switched over to full proximity sensor information. We did use some of that information which gives us sight to the target as with in elevation, which allowed us to line up very accurately with the target, it got rid of all of our side to side and up and down error, but we didn't, still didn't know how far away we were or how fast we were moving to the target.

The stage was now set at this point in the mission with the poor nav state and its not actually switching over to the full proximity sensor information that we were lined up with the target, we were trying to get to a point where we could switch to full nav state from that proximity sensor, yet we were actually headed towards it when we thought we were backing away. We, at this time, actually touched, bumped into collided with the target and shortly after our fuel estimator told us we were out of fuel, we had to go retire the vehicle, which the vehicle did do at that point.