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To: "Mary O'Brien" <Marysue.Obrien@jpl.nasa.gov>
From: "Douglas J. Clark" <douglas.j.clark@jpl.nasa.gov>
Subject: Approval for Release of Co-op Report

Mary Sue:

Per our phone conversation yesterday, contained below is the text of the co-op report t-hat Martin Klipp wrote and will be submitting to his school (Univ. of Ill.). I filled out and submitted the 1330 form at http://techreports/jpl/ecomm/forms.html. The report has also been submitted to Section Manager (Kim Reh), Program Manager (Ken Russ), and Project Manager (Torn Sorensen). They may have suggestions for minor changes, but I expect that the overall tone of the report will be unchanged.

Thanks!

-Doug

While on assignment at the Jet Propulsion Laboratory, I participated in the development of the X- 33 Avionics Flight Experiment (AFE) This idea] opportunity not only gave me an insider's look at the design ancl operation of modern aerospace avionics, but also allowed me to interact with others in the industry in an effort to stay on the cutting edge of the new technologies being incorporated into existing avionics architectures.

Before presenting my contributions to the project in particular, some background information on the project is in order. In an effort to replace the aging Space Shuttle, the National Aeronautics and Space Administration (NASA) has contracted Lockheed-Martin Corporation to build the VentureStar Reusable Launch Vehicle (RLV). This Single Stage- to-Orbit (SS1'0) craft will incorporate several new technologies, including completely autonomous flight control, lifting body aerodynamics, and a Linear Aeros pike propulsion system, being built by Rocketdyne. To test all of these features before they are used on the commercial flight vehicle, the Lockheed-Martin Skunkworks is building the X-33, a prototype technology demonstrator roughly half the size of eventual RLV. JPL, also wanting to test several of its technical achievements in avionics, wi 1 1 deliver a smal 1 avionics bus monitoring system to be flown on board the x-33. The purpose of this unit is to demonstrate the capability of new flight software, written for real-time operating systems, and miniaturization of certain components of avionics hardware. It will monitor traffic on the vehicle's avionics bus, and from it the software will perform state estimation (where the vehicle is and how it is flying) and checking of flight rules (determining whether given variables stay within certain ranges, or whether a necessary message is sent before another) . These tasks will be facilitated by the use of a miniaturized sensor stack consisting of a micro- gyroscope, micro-accelerometer, ancl Global Positioning System (GPS) receiver. The hardware and software will be installed on small circuit boards stacked on top of each other, connected by elastomeric interconnects, a conductive bonding material that will hold the slices together while allowing them to communicate with each other without wires or plug-in boards. The entire unit should fit inside of a shoebox, with a proportional reduction in weight , making flights with it more cost-effective since the vehicle could now support a larger payload. The reduction of wire connections, since the different units are all on one interconnected stack, also reduces the chance of failure due to fire, damage, or electrical malfunction.

When I arrived on the project, my first responsibility was to learn how the x-33 would fly by reading through the documentation describing the flight software being developed by Lockheed-Martin. From this information, I gained a reasonable understanding of the vehicle's flight dynamics, which would
aid me later when it was necessary to find bus messages that would indicate