

# Steps toward new Millennium: A Unified Approach to Three Satellite Projects

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The New Millennium (NM) program announced by NASA calls for ambitions "smaller, better, faster" spacecrafts. The basic idea is that truly low-cost operations require a paradigm shift to "justified operations". The NM baseline is zero operator between the payload user and the instrument. Each and every operator allowed into the mission must be JUSTIFIED. Several large institutions are making plans to "demonstrate" NM capabilities on testbeds in a matter of years. The Computational Sciences Division (IC) at the NASA Ames Research Center, together with several partners, is actively working towards implementing autonomous capabilities on three missions: EUVE, TERRIERS, and WEBSAT. This paper describes the three efforts in a unified framework (Figure 1). The NM goals can be stated as populating the autonomous operations functional diagram with automated re-usable software/hardware modules.

In close collaboration with the University of California at Berkeley's Center for UV Astrophysics (CEA), technology developed in IC is now operational on the EUVE satellite ground station. The system reduced the ground station personnel from three to one shift. The system automatically screens the satellite data stream and pages on-call operators in case of malfunction. Enhancement of the system will include more sophisticated health management in the form of automated fault diagnosis and possible recovery, as well as scientific scheduling.

Boston University's (BU) Center for Space Research is heading a consortium of private and public partners to build and operate a small tomography satellite. The effort will be performed under a contract with USRA over the next three years. The Tomographic Experiment uses Radiative Recombinative Ionospheric Extreme Ultraviolet and Radio Sources, hence its name TERRIERS. Another consortium has formed to provide a semi-autonomous ground station for TERRIERS. The four partners involved are BU, IC, CEA, and the Jet Propulsion Laboratory (JPL).

Stanford University's Satellite System Development Laboratory (SSDL) offers a graduate spacecraft design program. The objective is for students to build a small satellite in a year. With a Hardware budget of \$50,000 or so, these satellites definitely qualify for part of the NM

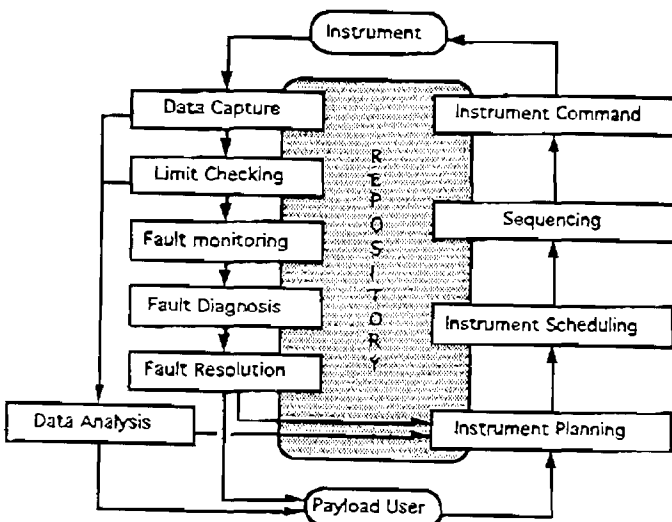


Figure 1: Autonomous operations functional diagram.

motto. WEBERSAT was successfully launched in January 1990 and is a 27 pound satellite containing several space experiments including a color video camera. The WEBSAT project will allow direct control of the WEBERSAT satellite and reception of the earth images collected via a World Wide Web interface. The loop between the payload user and the instrument will be completely and automatically closed.

The choice of the three project briefly mentioned above is not accidental. EUVE is a complex satellite which has been in operation for several years and is being "refurbished" for autonomy. WEBERSAT is a very simple satellite and its complete automation will be accomplished at the cost of eliminating some functionality. TERRIERS is being designed with autonomy in mind and will provide a flying testbed for advanced concepts. The three projects allows IC to attack the NM objectives from different perspectives (Figure 2), implementing autonomous functionality in ground software. Possibilities are being explored for on-board software for TERRIERS and a future SSDL satellite.

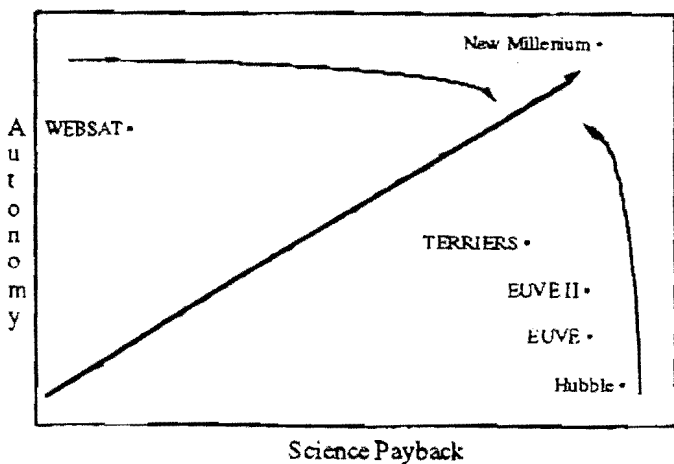


Figure 2: Approaching New Millennium objectives from several directions.