Recent Activity in Satellite Technology and Applications

Satellite and space technology may not be as glamorous as it was during the Space Race and Apollo Program, but it remains an essential part of the technology base. Research, communications, remote sensing, navigation, defense and other applications all rely heavily on satellites to enable key portions of their work.

The recent series of natural disasters highlighted the role of satellite technology, particularly for communications and remote sensing. Even in the U.S., local telecom infrastructure was disabled, requiring a combination of temporary terrestrial systems, volunteer amateur radio communications and satellite communications. The most visible satellite systems were the satellite phones and the television news media satellite links.

Sensing and Imaging satellites were at the forefront, providing weather-related data in the case of hurricanes and floods, and delivering images for damage assessment, rescue and cleanup operations. The need was so great that the Department of Defense permitted distribution of images from its classified high-resolution "spy satellites" to emergency agencies.

On the everyday front, the use of GPS location technology continues to grow rapidly. GPS receivers have reached extremely low cost levels, enabling location capability to be included in many consumer applications when it previously would never be considered. Of course, satellite television delivery systems—direct-to-home or as part of networks—have become ubiquitous.

The report looks at some of the key technologies and recent activities in satellite systems.

Commander Sergei Krikalev unloads supplies onto the International Space Station. On August 16, 2005, Krikalev became the human with the most cumulative time in space and now has spent more than 800 days in space.

NASA Programs

There are many active NASA programs, so we selected a few that represent a range of applications:

International Space Station—The interruption of the Space Shuttle flights has significantly reduced the research operations of the ISS, mainly due to the smaller lift capability of the Russian space fleet. ISS mission emphasis remains largely two-fold: developing and maintaining the ISS facility itself, and doing research that is mainly biological and materials oriented.

Gravity Probe B—This is the relativity gyroscope experiment being developed by NASA and Stanford University to test two unverified predictions of Albert Einstein's general theory of relativity.

The experiment will check, very precisely, tiny changes in the direction of spin of four gyroscopes contained in an Earth satellite orbiting at 400-mile altitude directly over the poles. So free are the gyroscopes from disturbance that they will provide an almost perfect space-time reference system. They will measure how space and time are warped by the presence of the Earth, and, more profoundly, how the Earth's rotation drags space-time around with it. These effects, though small for the Earth, have far-reaching implications for the nature of matter and the structure of the Universe.

Advanced Composition Explorer (ACE)—An Explorer mission that was managed by the Office of Space Science Mission and Payload Development Division of the National Aeronautics and Space Administration (NASA).

The Earth is constantly bombarded with a stream of accelerated particles arriving not only from the Sun, but also from interstellar and galactic sources. Study of these energetic particles will contribute to our understanding of the formation and evolution of the solar system as well as the astrophysical processes involved. The Advanced Composition Explorer (ACE) spacecraft carrying six high-

resolution sensors and three monitoring instruments samples low-energy particles of solar origin and high-energy galactic particles with a collecting power 10 to 1000 times greater than past or planned experiments.

ACE orbits the L1 libration point which is a point of Earth-Sun gravitational equilibrium about 1.5 million km from Earth and 148.5 million km from the Sun. With a semi-major axis of approximately 200,000 km the elliptical orbit affords ACE a prime view of the Sun and the galactic regions beyond. The spacecraft has enough propellant on board to maintain an orbit at L1 until ~2019.

CloudSat and *Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (Calipso)*—These satellites are undergoing final preparations for launch from Vandenberg Air Force Base, Calif. They will provide a new, 3-D perspective on Earth's clouds and airborne particles called aerosols. The satellites will answer questions about how clouds and aerosols form, evolve and affect water supply, climate, weather and air quality.

CloudSat's cloud-profiling radar is more than 1,000 times more sensitive than typical weather radar. It can detect clouds and distinguish between cloud particles and precipitation. "The new information from CloudSat will answer basic questions about how rain and snow are produced by clouds, how rain and snow are distributed worldwide and how clouds affect the Earth's climate," said Dr. Graeme Stephens, CloudSat principal investigator at Colorado State University, Fort Collins, Colo.

Cluster II—These satellites are determining the physical processes involved in the interaction between the solar wind and the magnetosphere by visiting key regions like the polar cusps and the magnetotail. The four Cluster spacecraft are mapping in three dimensions the plasma structures contained in these regions. The simultaneous four-point measurements also allow differential plasma quantities to be derived for the first time. For example, the density of current flowing around the spacecraft is derived from the magnetic field measurements using Ampere's law.

Aqua—A NASA Earth Science remote sensing satellite mission named for the large amount of information that the mission will be collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice, and snow cover on the land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans, and air, land, and water temperatures.

Our thanks to NASA for providing excellent information on its web site (www.nasa.gov) and those of its partner agencies and institutions.

Satellite-Related News

A report from **Frost & Sullivan** states that the global commercial satellite market is improving after an all time low in 2002. The over-supply of transponders is being gradually absorbed, and high definition TV (HDTV) has begun to generate interest. However, the capacity of individual commercial satellites has risen above the demand for services, and with long design lives, the number of orders for the replacements is yet to see growth.

Boeing has announced the on-orbit delivery of the Spaceway F1 satellite to **DirecTV**. The most complex commercial satellite ever manufactured, Spaceway F1 will enable DirecTV to broadcast local high definition television (HDTV) channels into several of the nation's largest markets. The satellite includes an on-board digital processor and a flexible payload with a fully steerable downlink antenna that can be reconfigured on orbit to seamlessly address market conditions.

Space Imaging has announced that it will soon offer satellite ground station access and sell imagery from the **Indian Space Research Organization's** (ISRO) newest satellite CARTOSAT-1 (P-5). Space Imaging has a sales and marketing agreement through 2010 with Antrix Corp., a division of the ISRO, which covers worldwide rights to sell imagery outside of India. The agreement covers sale of imagery and direct ground station access to the CARTOSAT-1, RESOURCESAT-1 and the Indian Remote Sensing (IRS) 1-C and 1-D satellites.

CARTOSAT-1 has two state-of-the-art panchromatic cameras that take black-and-white stereoscopic images in the visible light spectrum at a resolution of 2.5 meters. The cameras cover a swath of about 30 km and take images of the same area during the same pass from two different angles. The stereo images can be used to create accurate elevation data of the Earth and create three-dimensional image maps. Since the cameras are steerable, CARTOSAT-1 has a revisit time over any part of the Earth every five days.

Northrop Grumman and **Boeing CEV** have unveiled plans to design and build NASA's proposed Crew Exploration Vehicle (CEV), a modular space system intended to carry humans to the International Space Station by 2012 and back to the moon by 2018. The CEV comprises a crew module that builds on NASA's Apollo spacecraft, a service module and a launch-abort system. It is designed to be carried into space aboard a shuttle-derived launch vehicle.

The **Spaceward Foundation**, in partnership with **NASA**, has announced the first Beam Power competition. The event will be held at the NASA Ames Research Center in Mountain View, Calif., on Oct. 21-23, 2005, with prize money furnished by the NASA Centennial Challenges program.

The Beam Power challenge focuses on the development of wireless power technologies for a wide range of exploration purposes, such as human lunar exploration and long-duration Mars reconnaissance. In this challenge, teams will develop wireless power transmission systems, including transmitters and receivers, to power robotic climbers to lift the greatest weight possible to the top of a 50-meter cable in under three minutes.

The prizes for the event will total $400,000 for four prize competitions over two years, the first under NASA's Centennial Challenges program. The winners of each initial 2005 challenge will receive $50,000. A second challenge in 2006 will award purses of $100,000, $40,000, and $10,000 for first, second, and third place.