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ACTS Shut Down: April 28, 2004

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The Advanced Communications Technology Satellite (ACTS) was shut down on Wednesday April 28 after more than ten years in orbit. The satellite, still fully operational and in the hardware configuration set at launch, was shut down due a funding shortfall, in spite of repeated efforts by NASA and the Ohio Consortium for Advanced Communications to find new sources of support.

The ACTS satellite, launched on Sept 12, 1993, started a revolution in satellite communications with its onboard technology, which opened the Ka frequency Band for commercial use. The satellite used very small spot beams for effective frequency re-use; provided on board circuit switching for service directly to the users; contained broadband TDMA channel switching using transponders with 900 MHz bandwidth; provided contiguous coverage across the Northeast, isolated beams covering selected areas in the entire country and a steerable antenna covering the hemisphere and capable of tracking the Shuttle in flight.

ACTS was conceived by NASA in the mid seventies to provide additional capacity for communications by satellite, since surveys indicated a saturation of the existing C and Ku Bands then in use. The expected saturation did not materialize due to then unforeseeable advances in communications technologies such as fiber optics, digital transmission and compression techniques.

The ACTS program was also designed to maintain US preeminence in satellite communications, in view of expected technology advances taking place in Europe and Japan. The program was started in late 1984 and was marred by controversy from the beginning, with the US Congress supporting it and the Administration opposing it.

Industry was in favor of the program, but wanted it to be experimental and short lived, with established carriers fearing competition from a government asset that would be offered free to experimenters. As a result, the satellite was specified for a payload life of two years and a bus life of four years.

The program faced cancellation six times because of the diverging views of the Administration and Congress, causing major re-plans and increased costs. As if that were not enough, the loss of the Shuttle, which was to launch ACTS, continued to add to the program problems.

These setbacks, coupled with technical challenges in developing the new technologies listed above, made the program longer and more costly than originally intended, but the determination of NASA and the industrial contractors team carried the program to completion and placed the satellite in the desired orbit.

The on-orbit checkout proceeded per plan, with performance well beyond expectations, with the Baseband Processor network operating as expected the first time it was turned on, an especially rewarding result given the stringent timing requirements imposed on the entire system, something that had never been done before in a space application.

The performance success did not, however, create the demand for experimentation that had been hoped for. To that effect, NASA continued its experiment recruiting campaign by increasing contacts, exhibiting at trade shows, and providing public demonstrations of the system capabilities. One demonstration using the ACTS Baseband Processor network was staged at the 1994 ICSSC Conference in San Diego, where attendees could make telephone calls to anywhere in the States using a T1 VSAT at the show. The calls were routed through ACTS to a T1 VSAT in Cleveland and from there automatically to the final destination using terrestrial lines, in a fine example of seamless interoperability with the terrestrial telephone network.

Many old time experts, who believed that geo-stationary satellites could not be used for voice telephony because of the time delay, were surprised at the lack of echo, and impressed by the clarity of the signal.

As the experiment campaign raised interest, the demand for experiment time increased to the point that many experimenters were on the waiting list when the two year payload operation period was drawing to a close, so NASA decided to keep operating the satellite, since there were no objections from the common carriers, many of which were experimenters waiting to get time on the satellite.

Additional demand for experiment time was created by the filers of Ka Band commercial systems, following the FCC decision to award Ka Band slots for commercial services as a result of the demonstrated success of the ACTS system. NASA was then faced with the dilemma of how to extend the life of the satellite beyond the four year life of the bus. Lockheed Martin proposed to NASA a study to use the momentum wheel pivot to offset the inclination angle and maintain accurate pointing after the termination of the North-South maneuvers.

This was feasible for ACTS since it was the first LM spacecraft equipped with a ground re-programmable Attitude System Processor (ASP). The study confirmed the feasibility and NASA authorized the development of the autonomous on-board ASP software, which was tested and in place before the fuel was exhausted in July 1998, well after the four year contract life. NASA in the meantime had modified the ground stations to track the spacecraft, and inclined orbit operation began without any interruption of service or degradation of performance. This continued until November of 2002, at which time the range of the pivot motion was reached. The control algorithm was further refined to use the magnetic torquers to assist the pivot, and operation continued in this fashion until the shutdown, although with degraded yaw pointing. A ground algorithm to help

maintain good yaw control was developed, but not implemented due to lack of funding in the last year of the spacecraft life.

During its lifetime, the ACTS system proved the effectiveness of all the technologies on board and far exceeded all the goals that had been set for the program.

The ACTS experiments established the usefulness of satellites in providing integrated digital services ranging from thin route single voice lines to 622 MBps; to fixed and mobile services on land, at sea and in the air; not just in the US, but as far as Antarctica and the Amazon jungle.

In addition to demonstrating the above-mentioned communication capabilities, the Propagation Beacons on the ACTS spacecraft provided stable signals at both transmit and receive frequencies and enabled the ACTS Propagation Campaign, in which seven identical receiving stations were deployed in various rain zones for a period of up to five years. The propagation campaign generated a reliable and accurate data set, used by NASA to produce the Ka Band Propagation Handbook available to designers in developing systems with predictable service availability.

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