Satellite Times®

Volume 2, Number 6
July/August 1996

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NEAR & Dear

A report on the incredible satellite rendezvous with an asteroid

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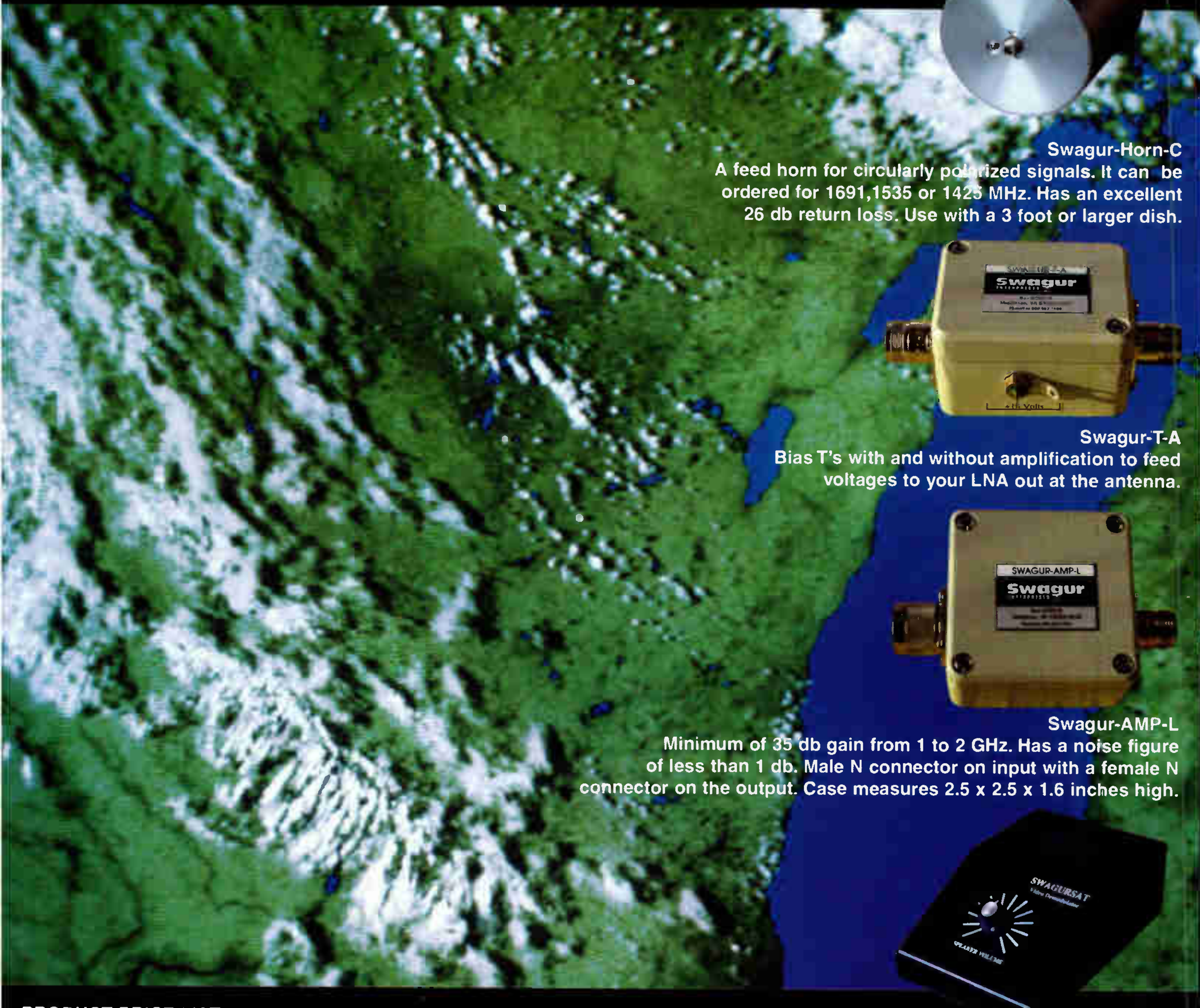

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Satellite Times

Cover Story

Cover: The cover photo for this issue of Satellite Times is an artist's rendition of the NEAR spacecraft maneuvering around EROS 433 in December of 1999.

Exploring Asteroids — NEAR and Dear

By Len Losik

A new breed of NASA satellites has quietly emerged to the forefront of scientific research. These satellites will explore our galaxy as never before. One of the first ones launched is headed for a big rock. Story starts on page 10.

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July/August 1996

Ariane 5 — A Bid for the Future

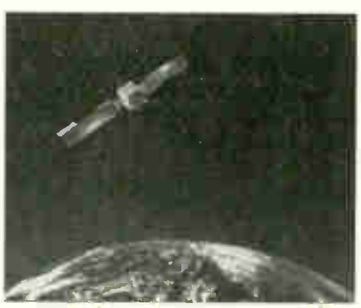
By Philip Chien

Even though the first test launch was a failure, ESA and Arianespace will be back with the Ariane 5 rocket very soon. *ST* staffer Philip Chien takes a look at the rocket and the program that is Europe's future in space. Story starts on page 14.

Onward Christian Broadcasters — Delivering the Gospel from on High

By Donna M. Vincent, PhD.

Throughout history, religious leaders have used a variety of means to deliver their message. But times have changed and present-day Christian broadcasters use satellites to deliver the gospel from on high. Story starts on page 18.



Monitoring U.S. Navy Ships via INMARSAT

By John Wilson, W4UVV

One of the new satellite bands that has become a favorite with monitors is the L-band. This is the home of INMARSAT and transmissions from U.S.Navy ships. You can monitor these broadcasts; we help you get started. See page 24.

DEPARTMENTS

ST Test: the New APT Receiver from Hamtronics

One question we hear a lot at the *ST* offices is, "What type of receiver should I use for NOAA and Meteor APT transmissions." In the View From Above column in this issue, *ST* staffer Jeff Wallach and the Dallas Remote Imaging Group review this new and exciting entrant in the competitive weather satellite receiver marketplace.

ST

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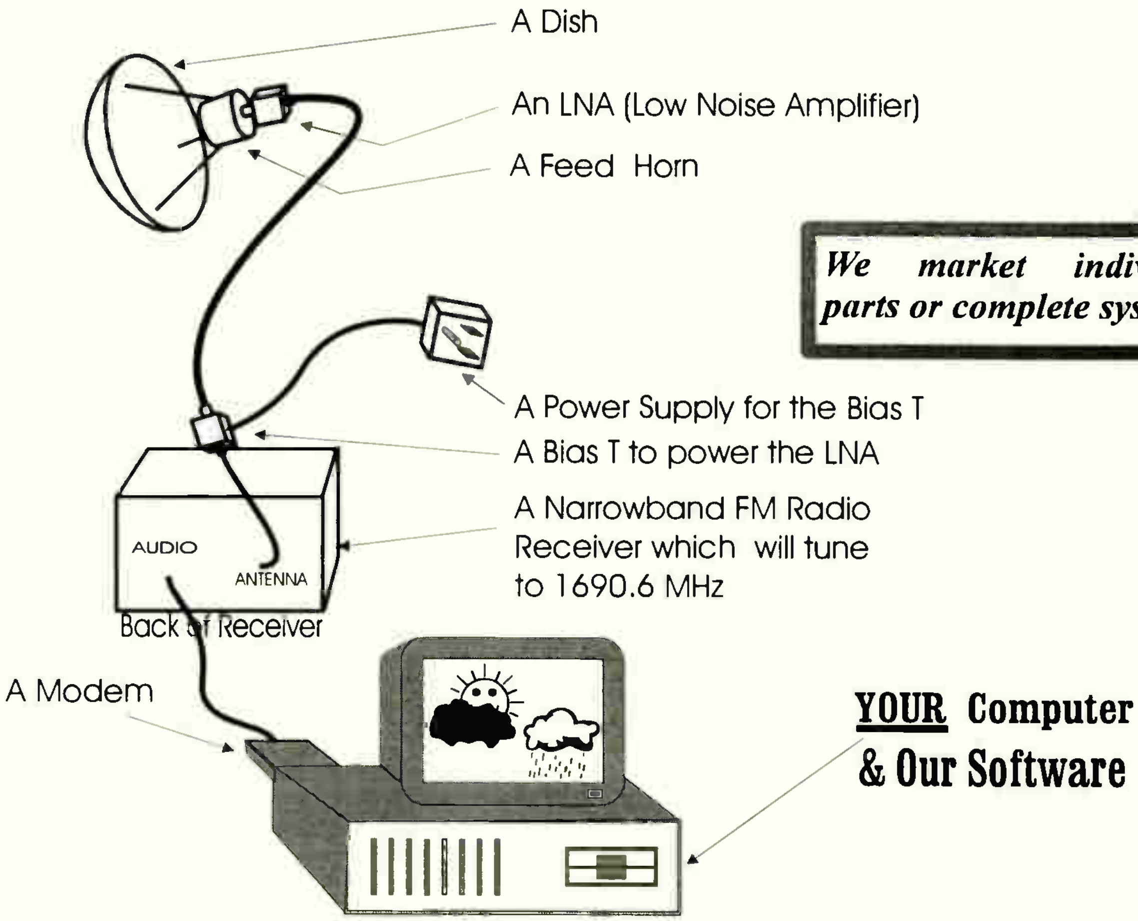

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DOWNLINK

By Larry Van Horn
Managing Editor

A Hard Pill to Swallow

As this issue of *Satellite Times* goes to press, the probe into the Ariane 501 accident is focusing on the rocket's on-board computer system. As you will read in the *Satellite Monitor* column and our Ariane 5 launch vehicle profile in this issue, the 501 vehicle failed just 30 seconds into its inaugural flight.

Cause of the mishap from the investigation team centers around the on-board computer receiving wrong information on the rocket's attitude and ordering a suicidal turn. The system was trying to compensate for a condition that did not exist.

Once the computer sensed the wrong attitude, it ordered the solid rocket booster nozzles to make a sharp turn. After the on-board command was issued to the hardware, the system believed that the maneuver still wasn't enough and ordered the main stage engine nozzles to follow suit.

As the rocket veered to its side, aerodynamic pressures began to break it apart. The fairing protecting the payload of four Cluster science satellites was destroyed under the stress and this triggered the rocket's self destruct system.

While the loss of the first Ariane 5 is a difficult pill to swallow for the people at the European Space Agency, the loss of the Cluster scientific satellites can not be measured. Those important research satellites cannot be replaced.

The satellites were to have studied, in three dimensions, the Earth's magnetic field and its complex relationship with the Sun. These observations were going to be done in conjunction with other spacecraft from the U.S., Russia, and other European spacecraft. Research performed by these satellites could have unlocked some of the mysteries regarding radio wave propagation that affects HF radio transmissions — a loss to radio hobbyists worldwide.

More than 250 scientists in several countries were to participate in the project. The entire team saw their work on the project (over thirteen years), go up in smoke and fire on June 4. On behalf of the *ST* family, our deepest sympathy is extended to the Cluster satellite development team.

Another issue of concern to *ST* readers is the proposal by the World Administrative Radio Conference 97 IWG-2A committee to share the amateur radio 2 meter and 70 centimeter ham bands with the second round, little LEO companies. Complete details can be found in publisher Bob Grove's *Uplink* column in this issue.

Registrations for the fall Grove Communications Expo 96 continue at a brisk pace. If you are going to attend this year's extravaganza and are planning to stay at the Atlanta Airport Hilton (the convention hotel), please call the toll free registration number and make your reservations now. Rooms are limited and we are filling up fast. Complete details can be found in the Grove Expo ad in this issue of *ST*.

The same applies for the banquet/ keynote address on Saturday night. We are expecting a large crowd to hear the Expo keynote speech by NASA astronaut Ron Parise, so make those banquet reservations today. Seating at the banquet is limited.

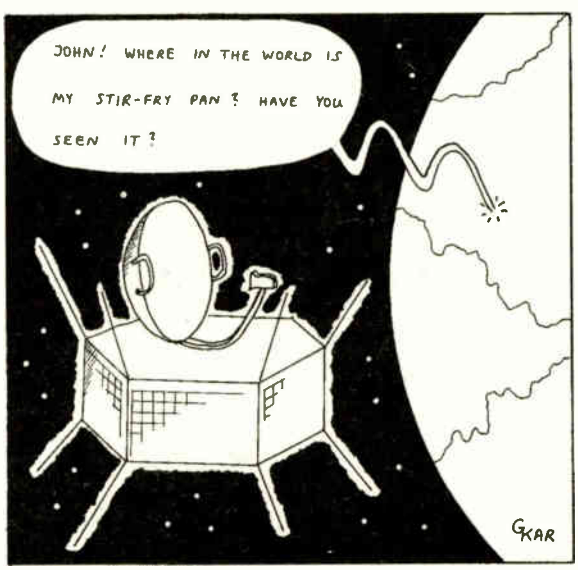
If you are a radio hobbyist and interested in space communications, visually tracking satellites, or radio astronomy, do not miss the Grove Communications Expo in October.

I would like to bid farewell to Bill Grove from the pages of *ST*. While only on the *ST* staff for a short time, Bill's *Internet and Space* column had a large following. Bill has moved on to other pursuits and we wish him well. *Satellite Times* will continue to cover developments on the Internet through the individual columns in the magazine.

Finally, I would like to take this opportunity to welcome Philip Chien to the staff of *Satellite Times*. Phil should not be a stranger to *ST* readers. He has written several features and satellite profiles for the magazine over the last two years.

We have had quite a few requests for a regular column to cover the activities surrounding the manned space program, and Philip will be covering this beat in his new *Final Frontier* column. Phil is a veteran reporter of space activities at the Cape and is part of the media pool that regularly covers space launches from our east coast Spaceport.

Welcome aboard, Phil; we look forward to your valuable contributions in the pages of *Satellite Times*— your space magazine of record.



The early Hamsats were built by volunteers, in basements and garages.

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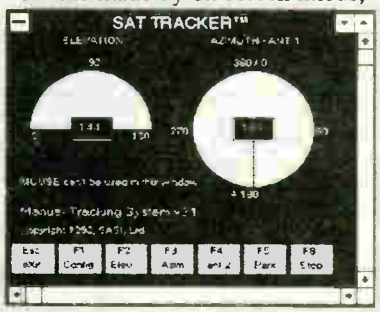

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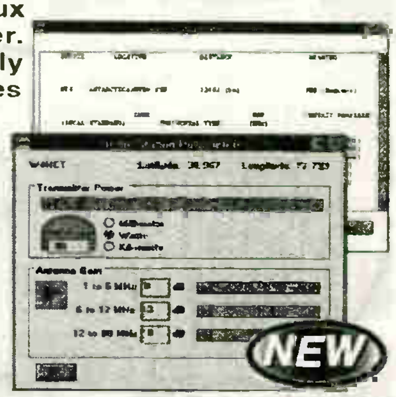

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Satellite Monitor

By Wayne Mishler, KG5BI
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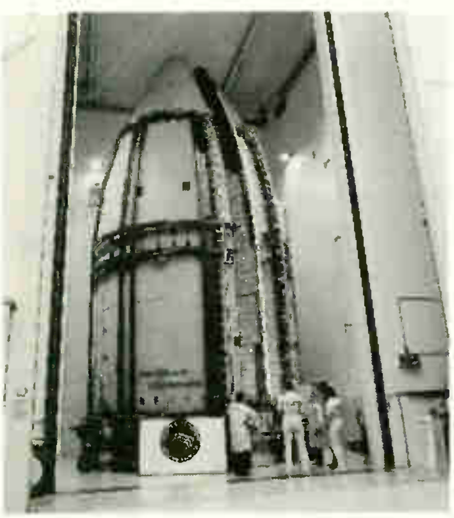
Loss of Ariane 5 slows European space program

The June 4 loss of the sleek Ariane 5 rocket was a major setback for Europe as a competitor in the worldwide satellite launch market. The flagship of the European Space Agency, carrying four Cluster satellites which were to study the Sun's affect on the Earth's atmosphere, veered off course just 40 seconds into its maiden flight and was blown up by ground control. The rocket's trajectory had been planned so that any debris would fall into the sea, but instead the flaming remnants of Ariane fell on land near the Kourou launch facility in French Guiana, South America. No injuries were reported, but about 100 guests watching the launch were evacuated, and the half-billion dollar payload, of course, was lost.

First reports suggest that the exhaust nozzles which pivot to steer the rocket rotated abnormally and threw the rocket off course.

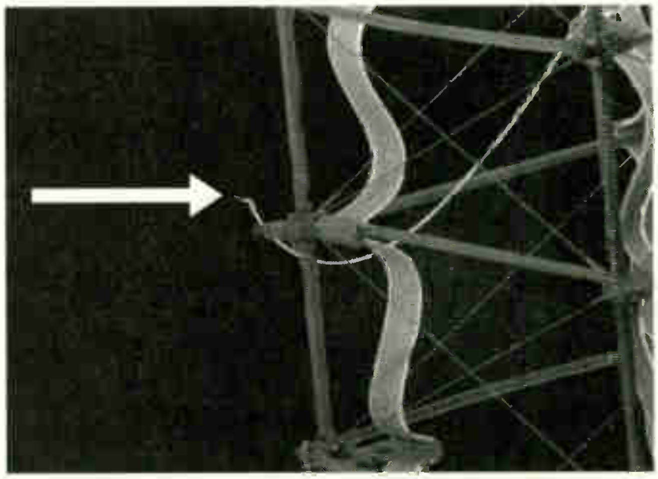
The Cluster satellites were to study the violent interactions of Earth and Sun. They were to orbit Earth in tetrahedral formation taking precise three-dimensional measurements of the phenomena that occurs where solar winds strike the magnetosphere (our outer atmosphere) at speeds of 3 million kilometers per hour. They were not insured, and there is no word on if or when that experiment will be continued.


Accoustic test of Ariane 5 rocket

Another Ariane 5 launch scheduled for September will probably be delayed until 1997 while a board of inquiry investigates the failure and proposes corrective action.

Meanwhile the eyes of the worldwide space industry remain focused on the future of the Ariane series. Arianespace, builders of the rocket, vow to correct the failure and continue development of the Ariane series which has failed seven times in 86 launches. Ariane 4 was the last previous failure. It exploded in mid-flight in 1994. Despite the loss of Ariane 5, two major ESA clients, Intelsat and Eutelsat, have expressed continuing confidence in Ariane.

Arianespace downplayed the incident as merely a setback and not the kiss of death.


The frayed end of the tether portion of the Tethered Satellite System (TSS) is seen at the end of the supportive boom. On February 25, 1996, the STS 75 crew deployed the TSS, which later broke free.

NASA says satellite tether was burned

The recent tethered satellite experiment failed because the tether was weakened by internal arcing and burning which caused it to break, according to NASA and the Italian Space Agency.

A significant portion of the tether had burned away, leading to tensile failure. The break occurred when about 12.2 miles (19.7 km) of tether was unreeled. At the time, the tether was feeling a tug of about 15 pounds (65 newtons).

The arcing could have been caused either by foreign objects penetrating the tether, or by a breach in the insulation surrounding the tether conductor, scientists say. A breach in the insulation could have provided a path for electric current to arc from the copper wire in the tether to a nearby electrical ground.

The system was generating 3,500 volts DC and up to 0.5 amps of current as the satellite was being deployed. That high voltage was produced by the tether cutting through the Earth's magnetic field at 17,500 miles per hour.

Hubble reveals innards of collapsed star

If the star had exploded within 50 light years of Earth, scientists say it would have ended life on this planet.

Chinese called it the "guest star." It appeared mysteriously one day about a thousand years ago and loomed in the sky day and night. Astronomers described it as reddish-white with long pointed rays shining in four directions.

Actually what they were seeing was a star ten times bigger than our Sun going supernova 7,000 light years away from Earth. In its violent death, the star blazed with the light of 400 million suns. It remained visible in daylight for nearly a month, and at night for a year.

Afterwards, the event was forgotten for more than 600 years. But in 1731, English physicist and amateur astronomer John Bevis, using a telescope, rediscovered the strings of gas and dust of the star's nebula (remains) – a diffuse mass of interstellar dust and gas. With renewed interest, other astronomers began to study the phenomenon. Lord Rosse named the nebula "Crab" in 1844, because its tentacle-like structure resembled the legs of the earthly crustacean.

The observations continue, with vastly improved telescopes. But even the most significant of observations from earth was dwarfed by a recent discovery of NASA's Hubble telescope in space. "I don't think that any of us were prepared for what we saw," says Jeff Hester of Arizona State University. He led a team of astronomers in assembling a cosmic "movie" from a series of Hubble observations taken several weeks apart.

As opposed to ground-based images of the Crab which show subtle changes in the nebula over months or years, the Hubble movie shows sharp wisp-like features streaming away from the center of the nebula at half the speed of light. They are emanating from the compact core of the exploded star spinning at 30 revolutions per minute at the center of the nebula. It's what scientists call a neutron star – a cinder composed of the original star's dense, collapsed neutron core.

Shooting outward from the cinder are two powerful beams of light. As it spins on its axis, the beams sweep over the Earth, giving the appearance of blinking on and off. Because of this flickering effect, the neutron star is also called a pulsar.

Its rapid rotation and intense magnetic field act as a slingshot, flinging off subatomic particles at nearly the speed of light. Electrons and positrons (anti-matter) react with the dust and gas of the nebula to create glowing, eerie shifting patterns of light. They illuminate the interior of the nebula, which is more than 10 light-years across.

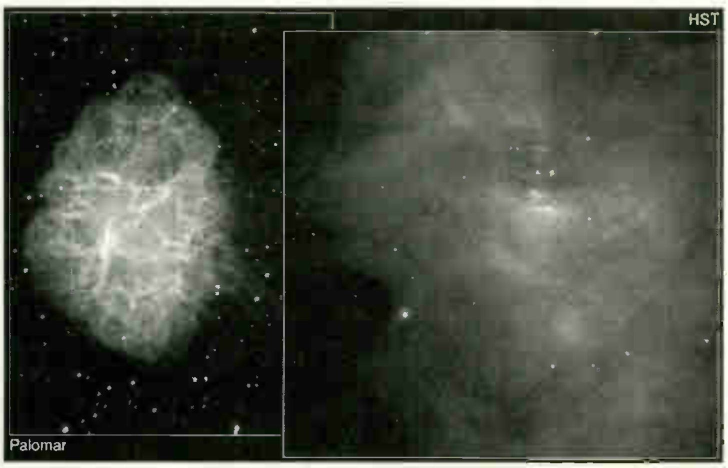
"Watching the wisps move outward through the nebula is a lot like watching waves crashing on the beach – except that in Crab the waves are a light-year long and are moving through space at half the speed of light," says Hester.

"You don't learn about ocean waves by staring at a snapshot. By their nature, waves on the ocean are ever-changing. You learn about ocean waves by sitting on the beach and watching as they roll ashore. This Hubble movie of the Crab is so significant because for the first time we are watching as these 'waves' from the Crab come rolling in."

This move isn't apt to be a box office hit. At least not in its present form. But it is giving astronomers a remarkable look at the dynamic relationship between the tiny Crab pulsar and the vast nebula that it powers.

Comet Hyakutake reveals secrets

In space, ten million miles is a nat's whisker. That's how close the comet Hyakutake came to Earth this spring. If scientists were nervous about the near miss, they didn't show it. Instead they examined it like a specimen, using the National Science Foundation's powerful radio telescope.



The Crab Nebula as seen by the telescope at Mt Palomar (left) and its center as viewed by the Hubble Space Telescope.

It is interesting that the word "comet" derives from a Greek word describing human features. Aristotle used the word "kome" (hair of the head) to describe the tail of a comet. The word "kometes" (wearing long hair) was adopted into Latin as cometes, and later appeared in old English as cometa.

Hyakutake, like a human model, was a willing subject for scientists who say it is among the brightest of comets. "Much of the progress in cometary research comes from the study of the relatively bright comets," says Patrick Palmer of the University of Chicago. Several comets pass close enough to Earth each year to be studied, but few are bright enough to be studied in detail. Bright comets produce higher quality data. And because of this more research groups study them.

Four teams of scientists examined Hyakutake using the VLA (very large array) radio telescope at the National Radio Astronomy Observatory in Socorro, N.M. They did three principal types of studies.


Comet Hyakutake

Three of the groups worked together to detect thermal radio emission from the comet, and to look for the characteristic radio emission in the comet's coma (or head—remember your Greek.) The remaining group used the VLA as a receiver to monitor radar signals bounced off the comet from another ground station at Goldstone, Calif.

Numerous telescopes of all types were trained on Hyakutake as it passed Earth, but only the VLA was capable of detecting long-wave thermal emissions and carrying out the radar experiment.

Thermally generated radio emissions reveal much about a comet. Scientists can use them to learn about the sizes of particles that make up the coma. They can contain information about the heat balance of comets, and about their molecular composition. For example, a comet can be examined with a radio telescope at specific wavelengths to determine the presence of specific molecules, such as formaldehyde, methanol and ammonia.

Comets are thought to be dirty snowballs of ices and dust – materials left over from the formation of planets and moons, such as ammonia, methane, carbon dioxide, and water. In this sense they are like natural samples which can tell scientists about the pre-solar nebula from which our solar system was formed.

The radar signals will help scientists learn about the halo of particles around the nucleus of Hyakutake. These particles are believed to be about one centimeter in diameter. Such a halo "has never been directly seen before," says Imke de Pater of the University of California.

It was a rare opportunity. The comet's won't be visible from Earth again for 10,000 years.

Asian digital broadcast facility debuts

Asia's largest independent television broadcast facility, Asia Broadcast Centre, with 85,000 square feet of floor space and four 11-meter satellite dishes, went into operation this May in Singapore.

The $30 million facility is one of a few fully digital broadcast facilities in the world, and already several major programmers are knocking at the door. The Centre has commitments from The Discovery Channel, Sony Entertainment Television, Liberty Sports Communications and Dow Jones.

The project is a joint venture of Group W Network Services of Westinghouse Electric Corporation, and The Yellow River Network, of Singapore.

"Asia Broadcast Centre is a gateway for television programmers in the rapidly expanding Asia marketplace, where today there are more than 400 million television viewing households," says James Crow, a 13-year veteran of Westinghouse and managing director of the Centre.

"We are well-positioned to provide one-stop shop service to large international programmers who want to localize and broadcast programs to the vibrant Asian region," he says.

The new facility, with a staff of 100, offers digital production including editing, dubbing, graphics, and program origination, compression, and satellite delivery. It is the only independent broadcast distributor with a license for satellite uplink from the Telecommunications Authority of Singapore.

The spacious Centre houses ten fully-equipped playback suites and eight digital on-line suites, a secure climate-controlled 3,000 square-foot video library with room for 150,000 tapes, and two studios. The larger of the studios has 4,000 square feet of floor space, and the other has 800 square feet.

The Centre's satellite antennas link it with satellites covering the Pacific Ocean region. These include PanAmSat PAS2 and PAS 4, APSTAR 1 and PALAPA-C1. Their combined footprint reaches from Africa across India and includes Australia, New Zealand and Southeast Asia. Five additional antennas are planned.

EchoStar unveils new digital broadcasting center.

The EchoStar Communications Corporation unveiled its DISH Network worldwide satellite digital broadcasting center at Cheyenne, Wyo., with a May 3 ribbon-cutting ceremony and announcements of more expansion.

"Our worldwide digital broadcast center houses an extensive array of highly technical, state-of-the-art satellite communications equipment from the world's leading manufacturers," says EchoStar chairman and CEO Charlie Ergen.

The 60,000 square-foot center comprises editing and production facilities, studios and transmission services available to other companies for a fee.

ECHOSTAR®

"Our expansion plans will produce more jobs at the broadcast center, which will benefit the local economy," says EchoStar president Carl Vogel.

Currently, the center transmits digital MPEG-2 television programming to EchoStar I – the first direct broadcast satellite of the DISH Network. There are plans to expand the facility to support two additional satellites. EchoStar II will offer niche and sports programming this fall, and will require two additional antennas to be installed at the center this summer. EchoStar III is planned for launch late next year.

The grand opening of the broadcast center coincides with the national launch of the DISH Network" programming packages. Advertisement of the new DISH services began running on May 1.

Programming packages range from about $20 to $30 per month and include the usual popular channels. A total of more than 200 channels of digital video, audio and data services are expected to be delivered to homes throughout the continental United States with the launch of EchoStar II later this year.

Steer clear of that space junk, matey

It's not a serious problem yet, but it could be in the future. The problem of space debris, that is. The hazard to spacecraft posed by man-made debris floating around up there is growing and deserves international action now, says a report from a committee of the National Research Council.

The report urges space faring nations of the world to approach the problem with a cooperative approach. Data must be collected on the damage that could arise from collisions between spacecraft and debris. Builders of spacecraft must begin shielding critical components in the event of collisions. And there must be backups in key systems.

And finally

Now there's *proof* that TV ad writers are "spaced out."

Pepsi is now filming ads in space. Coca-Cola of course can't be far behind. And that's not all.

Remember the ad with the Pepsi and Coca-Cola truck drivers sitting down together in a café, sharing each other's product, and getting into a fight?

Well, in space there are no truck drivers. Only astronauts and cosmonauts. Talk about your average everyday international incident just waiting to happen. This could start the cold war all over again. Actually it probably would be called a cola war.

Reuter news service reports that PepsiCo, Inc., paid a seven-figure sum for Russian cosmonauts to film the new commercial during a space walk, in May, at the Mir space station.

When NASA mission operations director Jeff Bantle heard about it, he wouldn't speculate on how NASA might react to such an offer. "The shuttle is looking at ways to involve commercial enterprise," he said. "But I haven't seen any proposals."

There's no question that NASA could use the money. Space ships don't fly on fumes, you know. Not that our government would let them take the money. Who needs industry when you've got taxpayers.

Of course it didn't take a rocket scientist to see all of this coming.

Pepsi planted the seed in 1985 by sending one of their cola dispensers into space with Challenger. They said it was to give our astronauts their first sample of carbonated beverages in zero gravity. Rrrright.

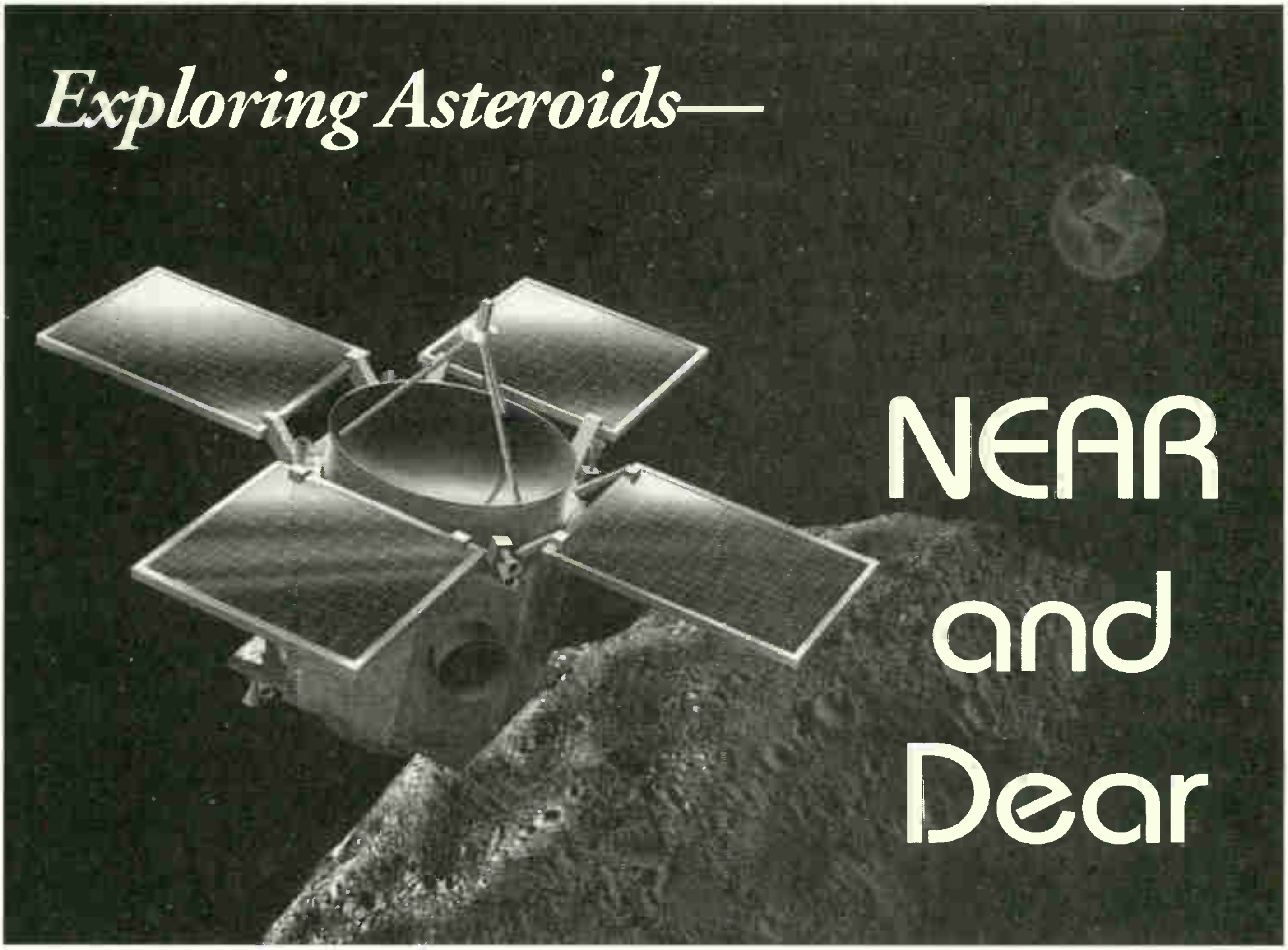
And Coca-Cola must've liked the idea. While the cosmonauts were filming the Pepsi commercial our astronauts were trying out a Coca-Cola dispenser aboard the space shuttle.

Of course Pepsi has been producing commercials with a space theme since the mid-80's. There was the one where the occupants of a space ship chose Pepsi over Coke, in 1984. And another in 1985 showing an astronaut craving a Pepsi while waiting for lift-off. And of course the one in 1986 showing two astronauts drifting off into space in pursuit of their last bottle of Pepsi. That one was produced in English *and* Russian.

Get ready for a vending machine on Mir.

Sources:
EchoStar Communications Corporation, European Space Agency, Group W Network Services, McDonnell Douglas, National Research Council, National Science Foundation, PR Newswire, Reuter News Service

Exploring Asteroids— NEAR and Dear



By Len Losik

A new breed of NASA satellites has quietly emerged to the forefront of scientific research. These satellites will explore our galaxy as never before. This series new series of explorers is called Discovery.

NASA's satellites have been sent to the moon, planets and other planet's moons since the 1960's. These voyagers have helped to confirm theories of planetary composition, and, search for telltale signs of life. The more we look for life, the more indications we find that remind us of life on our Earth.

The NEAR satellite, short for Near-Earth Asteroid Rendezvous, is a NASA Discovery satellite designed to collect close-up scientific data on asteroids for the very first time. Scientists have been studying asteroids for centuries. Wanting to know where they come from, where they have been, when were they formed, how many are there and how many more will be coming.

As our understanding of asteroids and what part they may play in man's evolution increases, knowledge of asteroids is becoming more significant. Paleontologists that study fossil remains began looking to space for answers for understanding Earths history. Their study continues to lend support to the theory that man's past and future is strongly influenced, if not directly guided, by large and small bodies from space that impact the Earth. With this in mind, NASA is looking at exploring asteroids for scientific questions and for potential commercial applications.

The Near Earth Rendezvous Satellite

NEAR was created to explore near-earth bodies. John Hopkins University Applied Physics Laboratory (APL) is responsible for its design, development, manufacture, launch, operations and scientific data collection. APL has been responsible for over 50 satellites in the last 35 years. Because of their many successes, NASA turned to APL to prove faster, better, and cheaper can be the new NASA way.

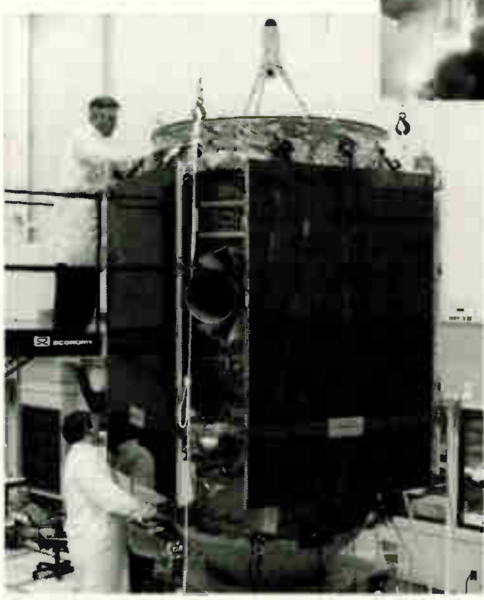
NASA conceived a visionary mission that would satisfy many areas of space exploration. NEAR provides for true space exploration. Determining the composition of a nearby asteroid, NEAR will lay the ground work for future commercial mining of near Earth bodies. NEAR will demonstrate the feasibility of a low cost, low energy journey suitable for any satellite to nearby bodies in space. Future mining of asteroids is certainly feasible depending on the composition of the asteroid and the amounts of elements and minerals in its make-up. The low cost and low energy method to reach an asteroid used on NEAR is suitable for future commercial enterprises seeking to reach them as well.

The development phase for NEAR lasted only 27 months. NEAR project costs is well under US$115 million. NEAR is a Discovery mission by NASA that included a US$150 million funding cap. Another interstellar pioneering program from APL is the now-famous Clementine. Clementine turned into a lunar mapping mission and deep-space explorer. The cost and schedule for Clementine was 22 months and US$75 million.

NEAR Mission

NEAR was first planned to visit asteroid 4660 Nereus, a small 0.6 mile object with only a few points of interest. Mission planners looked for larger asteroid within the energy window of the McDonnell Douglas Delta II launch rocket that could provide more interesting results. Mission planners decided to incorporate a 2 year fly by of the Earth in January 1998, to add velocity (a "delta V") to NEAR. The delta-V from the Earth fly-by, when added to that provided by the Delta II rocket, gave a 4 week fly-by of a larger asteroid named 433 Eros in January, 1999. The asteroid Eros, was named after the Greek god for love, son of Mercury and Venus.

NEAR was launched into an 28.5 degree inclined trajectory by the Delta II from Cape Canaveral, Florida, so that the total Earth rotation velocity would not be added to the Delta II launch velocity. The February 17 launch also means that maximum velocity will not be achieved due to the trajectory at an incline to desired plane for rendezvous. An even a larger efficiency loss would have occurred if NEAR was launched just 3 days earlier on Valentines day, February 14.



The NEAR satellite under construction and the Delta II rocket that put it in space.

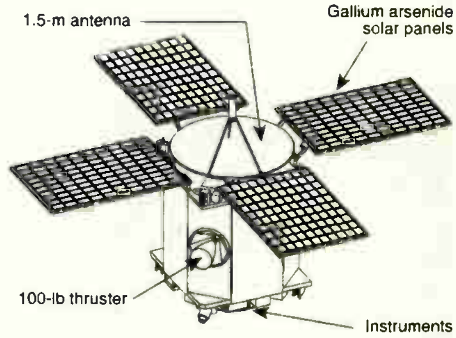
On the way to 433 Eros, NEAR will pass another asteroid named 253 Mathilde in June of 1997. NEAR could get as close as 750 miles to Mathilde for imaging with NEAR's instruments. Mathilde is part of the large main asteroid belt and will yield even more information about these near earth bodies. Mathilde was discovered in 1885, but its composition wasn't well known until last year. Mathilde rotates once in 17 days and has a diameter of 38 miles.

433 Eros is an asteroid in the inner asteroid belt. Scientists believe that information from Eros will confirm that it contains several precious metals and silicates like iron, magnesium, and nickel. It is hoped that Eros' composition will be similar to some meteors that have fallen to earth that contained water.

The 433 Eros asteroid was discovered on August 13, 1898. It's an elongated body about 25 miles long and 13 mile sides. It's in an orbit around the sun very similar to Earths, just slightly more eccentric. Eros is thought to be 4.6 billion years old. It was formed about the same time as the planets. 433 Eros rotates once in 5 hours and 15 minutes and orbits the sun in a 10 degree inclined orbit. As NEAR leaves these asteroids, an intensive search will be completed looking for asteroid-orbiting moons like the one found by NASA's Galileo satellite.

NEAR Satellite

Designed to operate at more than twice the distance from the sun as the earth is, NEAR will be the first man-made satellite to orbit an asteroid. NEAR looks like a box with its flaps hanging out. It's the same size as a sauna. Its solar arrays were held down along the sides until the cable holding them down was cut right after trajectory injection when it left the Delta rocket. The solar arrays then deployed to their extended position and they looked like a flat blue



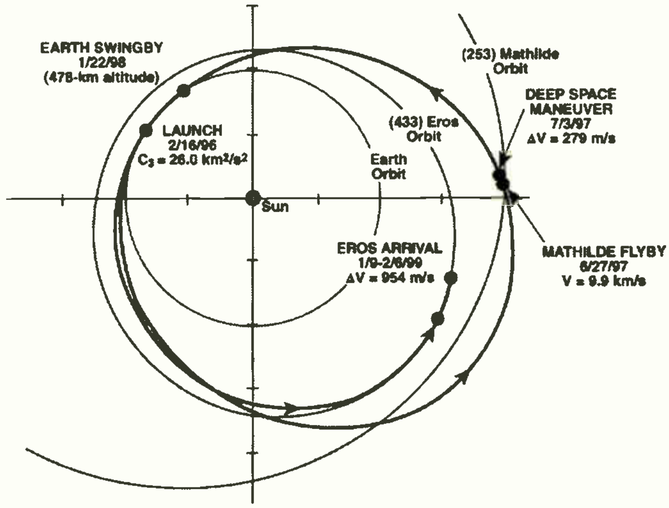
NEAR Spacecraft Attributes

propeller at one end of a gold box.

The solar arrays generated over 1800 watts right after deployment from its launch vehicle (1 AU or Astronomical Unit). As NEAR approaches its target asteroids, the solar array output will decrease to as low as 350 watts, since NEAR will be much farther away the sun (2.2 AU). As NEAR comes close to the Earth later (and closer to the sun), the solar arrays will again be generating maximum electric power, but less than at launch since solar cells will be older and their performance degrades in space.

NEAR contains discrete space flight hardware that's been used for decades.

NEAR Trajectory Profile



An attitude control system used for pointing the box towards the sun, and for measuring body rates and orientation/position knowledge, reaction wheel/momentum wheels. A propulsion system consisting of bi-propellant tanks, tetrahydrazine and nitrogen tetraoxide as an oxidizer (oxygen supplier), propellant lines, valves and thrusters for orbit energy changes and orbit inclination control. This combination of oxidizer and fuel has been used since the 1950's.

A thruster that will provide 100 pound-force will use both fuel and oxidizer while smaller thrusters will use only the hydrazine for stabilization when the larger thruster is fired. Seven small, 1-pound-force thrusters are modulated to keep the larger 100-pound force thruster pointed exactly when it is fired. Large tanks are needed to carry the liquid propellants for several orbital energy changes and contingency reserves to correct unplanned problems.

The communications link uses a 1.5 meter parabolic dish that sits at the same end as the solar arrays sun-facing with the solar arrays. Three low-gain and high-gain antennas are for larger area coverage. All will work with NASA's Deep-Space Network groundstations. Solid-state storage units are sized for 1.7 X 10e9 digital data bits. Solid state units are replacing the more common tape-and-reel systems on NASA's science missions. Costs were kept low on NEAR significantly when generic equipment that had many years of previous use, few problems, and much in-house experience at APL.

NEAR and Earth Orbiting Satellites

Two design items differentiate NEAR from Earth orbiting satellites. NEAR must use oversized solar arrays for power generation. The farther away NEAR gets from the sun, the light intensity decreases, and the power output of the solar array goes down. Although all the equipment on NEAR needs only about 300 watts, it must generate 350 (300+margin) watts when NEAR is farthest away from the sun. NEAR can generate 1800 watts at 1 AU, but the same solar arrays can only generate 350 watts at 2.2 AU.

Interplanetary satellites also experience a tremendously different radiation environment than Earth-orbiting ones. Radiation shielding for low voltage operating equipment is done for each mission based on a predicted radiation environment the satellite will experience. Higher operating voltage of the equipment, generally means, less susceptibility to radiation caused upsets and degradation. However, low voltage parts (TTL, ECL and CMOS) and circuits are the mainstay of todays satellites and will probable remains so unless higher-voltage components become economical in the future.

NEAR's Science Instruments

Over 30 years of study has not answered some fundamental questions about asteroids. When asteroids are made of the same material, why don't they look the same spectroscopically? What impact do the physical features have on understanding their make-up and origin? These questions continue to go unanswered.

NASA's Galileo interplanetary satellite recorded spectroscopic data on two asteroids, but these questions were left unanswered. NEAR's instruments are more sensitive and designed to collect contiguous data on asteroids, rather than merely passing by as Galileo's and other planetary fly by missions' instruments has done.

Conclusion

NEAR faces many obstacles for a successful mission. Many failures can still occur and cause a total loss of mission. Even so, NASA and APL have won a major cost-to-produce breakthrough for space exploration. Among the breakthroughs from APL and NEAR will be many firsts: the first man-made satellite to orbit a small body; the first satellite to provide in-depth exploration of a near-Earth asteroid; the first interplanetary mission to be launch by the Delta II rocket and the first satellite to be powered by solar arrays outside Mars orbit. NASA-APL's Near and Discovery satellites are leading NASA to quicker and inexpensive space exploration yielding inexpensive and more plentiful science.

NASA is looking to NEAR to provide scientist the information for answering questions about the creation, age and evolutionary process of asteroids. NEAR has already demonstrated NASA's "faster, better, cheaper" goals. Although still costing over $100 million, NEAR's extremely short schedule, and low price, is bringing space exploration costs down.

NEAR and others like it will provide national and international mining companies with exactly the information and services they need to determine the financial advantages that space mining will yield. Its time for them to expand their roles so that more resources can be made available. NEAR is now one of NASA's low cost satellites for exploring planets, moons, asteroids and comets. Other satellites based on NEAR can provide even lower costs for exploring other near Earth bodies in space.

NEAR Features

Cost:	$112 million
Launch Date:	February 17, 1996
End of Mission:	December 31, 1999
Size:	5 1/2 x 5 1/2 x 5 1/2 feet
Weight:	1782 pounds
Total Power:	350 watts at 2.2 AU
Instrument Power:	81 watts
Supporting Equipment Power:	310 watts
Redundancy:	Critical/high risk units only
Downlink Telemetry Frequency:	X-band 8.40-8.44 GHz
Number of Science Instruments:	6

- Multispectral Imager,weight 17.6 lbs, power 13 watts
- X and Gamma Ray Spectrometerweight 59.4 lbs, power 31 watts
- IR Spectrograph, weight 130.6 lbs.,power 15 watts
- Magnetometer, weight 4.4 lb, power 1 watt
- Laser Altimeter, weight 11.0 lbs, power 21 watts

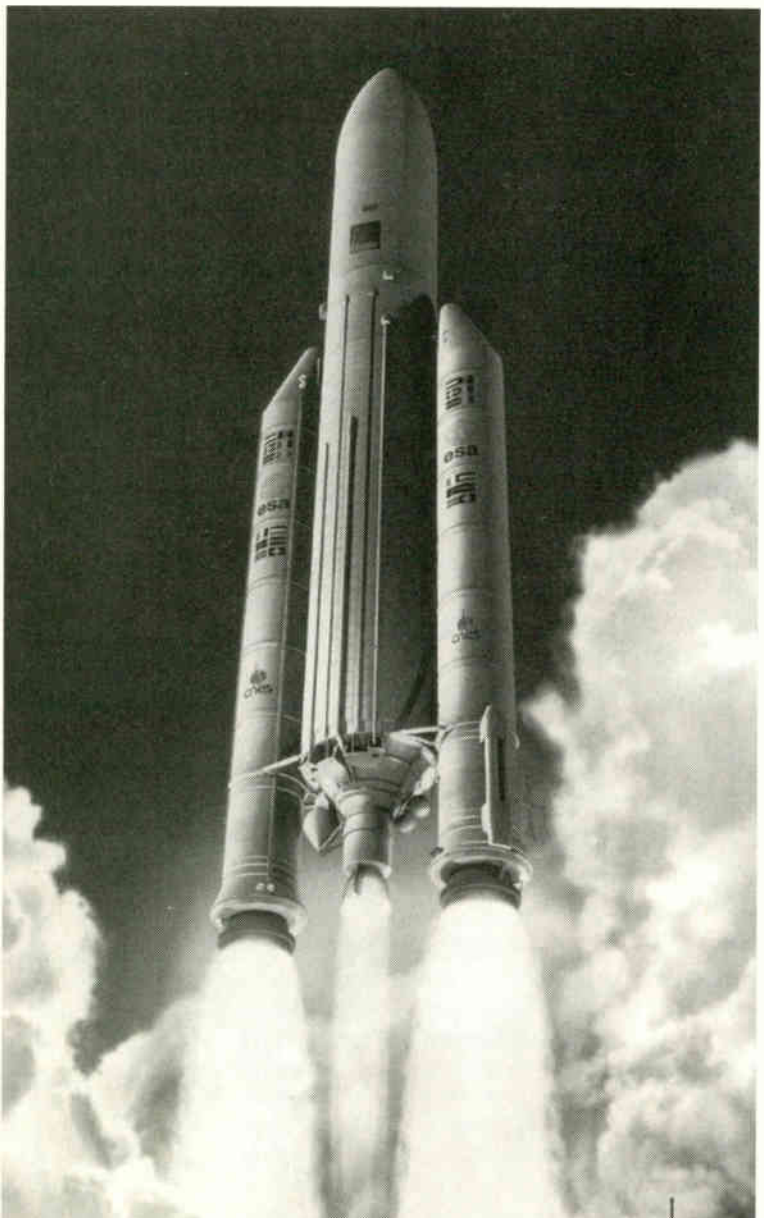
Technology Breakthroughs:

- Solid State Data Recorders
- Earth Added Delta-v
- Drbiting an Asteroid

Internet Home Page: http://sd-www.jhuapl.edu/NEAR/

Ariane 5

A Bid for the Future



arianespace

ST Launch Vehicle Profile
By Philip Chien, Earth News

European space ministers realized at their meeting in Rome in January 1985 that there was a lucrative market within Europe's reach with a large, reliable launch vehicle in their arsenal. At their next meeting in November 1987 at The Hague, a major decision was made. Europe would develop a successor to the Ariane 4 roacket, to consolidate its gains and secure its future share in the aerospace market.

Europe's hopes to develop that new commercial launch vehicle were set back when the Ariane 501 test flight resulted in a vehicle failure — just 40 seconds into the mission. The launch was conducted on June 4, 1996, from the ELA 3 launch pad at the Centre Spatial Guyanais near Kourou, French Guyana. Preliminary data indicated that the gyros gave incorrect information to the flight computers. The computers instructed the solid rocket boosters's hydraulic actuators to move the booster's nozzle over to one side, sending the vehicle out of control. As the vehicle broke up under aerodynamic stress the internal safety system activated the explosive destruct package, which was followed by a range safety command from the ground. It was an unauspicious debut for the new launch vehicle.

Lost in the accident were four identical scientific satellites, the European-built Cluster geophysics satellites. Cluster was to have been the key European part of the International Solar Terrestrial Physics (ISTP) project, complementing the U.S.-built Polar and Wind spacecraft, the joint U.S.-Japanese Geotail mission, and the joint U.S.-European SOHO mission. The failure marked the first loss of a major scientific satellite due to a launch vehicle failure since 1986. The most recent loss of a scientific satellite due to a launch vehicle failure was the Spartan-Halley spacecraft, lost in the STS-51L Challenger accident.

Ariane 5 is one of the largest launch vehicles ever designed and it is the largest vehicle in commercial production for placing commercial satellites into orbit. Performance of the Ariane 5 is only surpassed by the U.S. Saturn launch vehicles, and Soviet N-1 and Energia giants — no longer in production. Until another heavy lift launch vehicle permutation is created, Ariane 5 will hold the record for the maximum amount of useful payload to placed orbit.

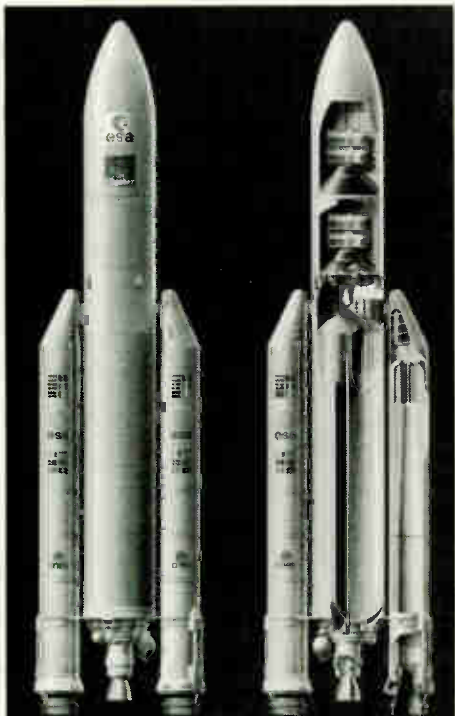
The specifications call for up to 6,800 kg to geosynchronous transfer orbit or 10,000 kg to a sun-synchronous polar orbit. Ariane 5 can also be configured for escape velocity (planetary) missions, or to deliver payloads to the International Space Station. 13 European countries spent 6.58 billion ESA units (US$8.68 billion) to develop the launch vehicle. The largest share is owned by France, with 46% of the contracts. CNES, the French space agency, is responsible for the Ariane 5 project management.

The European Space Agency funds the development and test flights of Ariane launch vehicles. Once they're declared operational the normal operations are turned over to the commercial Arianespace company. Arianespace is responsible for marketing the launch services and procuring vehicles for the commercial launch market. Arianespace has successful bid for 60% of the launches of commercial and international satellites. Since the launch vehicle development is funded by ESA and much of the operations in French Guiana are underwritten by the French government, U.S. launch vehicle providers have complained that Arianespace is unfairly subsidized.

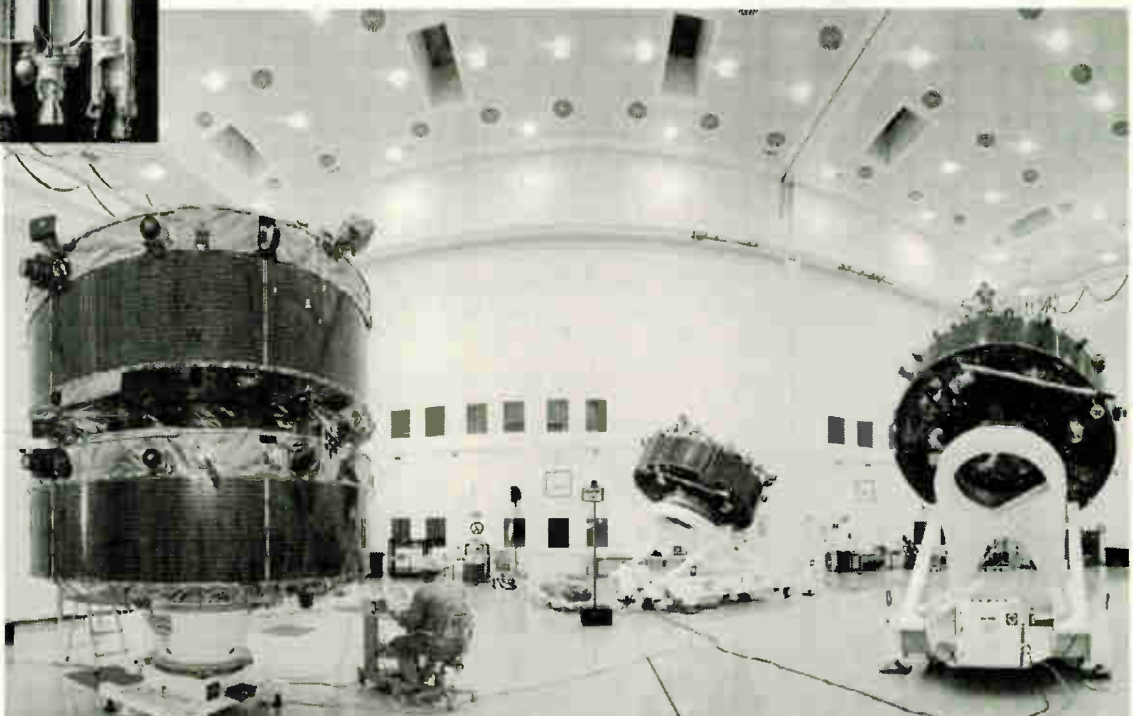
Arianespace counters that U.S. launch vehicles benefit by government infrastructure at the Cape Canaveral Air Station and some launch vehicle development costs which are indirectly supported by government contracts. Both sides agree that non-market economy launch vehicles (e.g. Russia and China) have an unfair economic advantage when it comes to competition for commercial launch services contracts.

The second Ariane 5 test flight, which was scheduled for late this year, includes the European Atmospheric Reentry Device (ARD) and AMSAT's Phase 3-D spacecraft. In a joint statement AMSAT-DL President Karl Meinzer DJ4ZC and AMSAT-NA President Bill Tynan W3XO said, "We, at AMSAT are, quite naturally, distressed to hear of this unfortunate occurrence." On behalf of the amateur radio satellite community, they extended sincere condolences to ESA, Arianespace, CNES and the Cluster Project. Both AMSAT officials expressed confidence, however, that the ESA team will overcome this setback and develop a successful launch vehicle.

Originally, Ariane 5 had several intended purposes. Besides launching commercial satellites it was intended to launch the French-led Hermes spaceplane.



Above, cross-sectional view of the the Ariane-5 launcher reveals the rocket's internal configuration for its doomed maiden flight with the four indentical CLUSTER satellites.



At right, the four CLUSTER spacecraft as they were being assembled by IABG in Germany.

Sequence at left shows the intended launch and deployment stages of the Ariane-5 from lift-off (bottom) to release of its four CLUSTER geophysics satellites.

Hermes died a quiet death when the rest of Europe balked at the high development cost and questioned why Europe needed its own space plane.

When Hermes was canceled France scrambled to find spaceflights for their 'spationauts' on U.S. shuttle flights and Russian Mir missions. French spationaut Jean-Jaques Favier was originally selected as a Hermes experimenter. Favier was the principal investigator for the MEPHISTO furnace which has flown on three shuttle missions, the backup payload specialist for the STS-65 IML-2 mission, and the primary payload specialist for the STS-78 Life and Microgravity Sciences Spacelab flight. After the Ariane 501 failure he commented, "Of course it's sad when a test fails, however it was a qualification test only, so this thing can happen. I'm sure the program is not over and we'll see other Ariane 5 flying pretty soon."

There are proposals on the drawing board (CAD station?) for a European Crew Transfer Vehicle (CTV) to carry astronauts to and from space station. If that ever does become a reality the CTV may become the space station's 'lifeboat' in case astronauts ever have to abandon space station. CTV would be used if there's an injury or illness, if there's a problem with the station, or if the shuttle became grounded for too long a period or couldn't return the astronauts to Earth.

Since a manned spacecraft was one of the intended Ariane 5 payloads the vehicle was designed with a projected 98.5% reliability factor for its operational missions. The manned proposals included some form of escape system, possibly a copy of the Apollo Launch Escape System, in case there is a vehicle failure. Clearly the first flight was not the way to instill confidence in Ariane's customers, but it must be remembered that it was a test flight.

One of the key methods to insure reliability is simplicity. There are only four propulsion components — a two-stage core vehicle and two solid boosters. In comparison, the Ariane 44L booster has three stages plus four strap-on boosters with a total of ten engines. With less parts there are less things to go wrong.

The Ariane 5 first stage measures 5.4 meters in diameter, and a length of 30.5 meters. Its total mass fully fueled is 170 tons, of which, 155 tons are the liquid hydrogen and liquid oxygen propellants. The liftoff thrust is 830 kN, which gradually increases to 1130 kN as the Vulcain engine goes from sea level to vacuum. The burn time is 600 seconds.

When the countdown reaches zero, the Vulcain engine ignites and builds up thrust. The computers check the engine's performance and if there are any problems the engine can be shut down automatically. The vehicle is not committed to flight until the ignition command is sent to the solid boosters.

The two large solid boosters are 3 meters in diameter and 31.2 meters high. By comparison, the shuttle's solid rocket boosters are 3.6 meters diameter and 45.5 meters high. The Ariane 5 boosters are the largest solid rocket motors ever made by European manufacturers, and only surpassed in size by the space shuttle SRBs and the Titan III/IV solids. The Ariane boosters each hold 235 tons of propellant and weigh 265 tone at launch. The boosters have movable nozzles, similar to the shuttle SRBs and MX ICBM.

The solid booster cases are manufacturered in Europe and shipped to French Guiana where they're loaded with propellant. Some of the Ariane 5 boosters will be equipped with parachutes to slow their splashdown speed. Arianespace and ESA plan to recover those boosters for analysis.

The core vehicle the Ariane 5 upper stage looks tiny when compared to the solid rocket boosters. It's used to perform the orbital injection, and any maneuvering required to deploy the various satellites launched by the Ariane 5.

The upper stage uses a bipropellant engine. It burns storable monomethyl hydrazine fuel and nitrogen tetroxide — the same propellants used by the Ariane 4 second stage, Delta second stage, and shuttle Orbiting Maneuvering System engines. The upper stage generates 29 kN thrust, with a specific impulse (efficiency) of 324 seconds. At liftoff it weighs 10,900 kg, with its load of 9.700 kg of propellant. The upper stage puts the vehicle in orbit and controls all of the satellite deployments. It aims the vehicle in the proper deployment attitude, can be spun if the satellite requires it, and after ejecting each satellite performs a backaway maneuver to prevent accidental recontact. After the mission is complete the upper stage burns off its remaining propellants to minimize the chances for an explosion.

The Ariane 5 vehicle is assembled in an enclosed building, permitting a controlled environment with few weather constraints. Payloads are prepared in separate facilities and mated to the launch vehicle in the assembly building. The entire vehicle is rolled out to the launch pad just nine hours before launch.

The final hours at the launch pad consist of checking out connections to the launch pad, RF checks for the satellite and launch vehicle, and loading the supercold liquid oxygen and hydrogen propellants into the first stage.

Arianespace has always prided itself on flexibility. Launch vehicles can carry several different payloads to different orbital destinations. Ariane 5 can carry up to three separate satellites. The original vehicle specifications called for the capability to launch two large satellites (e.g. Hughes HS-601) to geosynchronous orbit. Since satellite mass has been increasing, ESA decided to fund an Ariane 5 improvement program in October 1995. It will increase the Ariane 5 geosynchronous performance to 7400 kg.

The planned Ariane 502 mission will use even broader capabilities. After the first stage has completed its burn the ARD research vehicle will be ejected — before the vehicle has reached orbital velocity. ARD is a sub-scale prototype crew vehicle, similar in design to the Apollo Command Module. ARD will continue on a ballistic trajectory, three quarters of the way around the world, and eventually parachute in to the Pacific Ocean south of Hawaii.

After ejecting ARD, the upper stage will fire to place the rest of the payloads in to a geosynchronous transfer orbit. From there the satellites use their own onboard propellant systems to guide themselves to their final destinations.

Due to changing international money markets, Ariane 5 has to cut costs to remain competitive against U.S., Russian, and Chinese-built launch vehicles. One key factor that is aiding cost cutting is the size of the launch team — just 80 people.

Finally, as we go to press with this issue of Satellite Times, the exact cause of the Ariane 501 failure has not been determined, and a launch date for Ariane 502 has not been announced.

Philip Chien of Earth News is space writer and consultant. His email address is PCHIEN@IDS.NET.

Ariane 5 launch vehicle frequencies

The launch vehicle has two antennae for its telemetry beacons — one in the vehicle equipment bay and one in the forward skirt of the first stage. The transmission frequency is in the 2200-2290 MHz band with a transmitting power of 8 watts. The allocated frequencies are 2203 MHz, 2218 MHz, and 2227 MHz. The range destruct receiver has two antenna on the first stage, receiving signals in the 440-460 MHz. range.

The vehicle also has a C-Band radar transponder to aid tracking stations. It receives signals at 5690 MHz. and transmits in the 5400-5900 MHz. band. The specifications call for a .8 microsecond pulse at 400 watts peak.

Onward Christian Broadcasters

Delivering the Gospel from on High

By Donna M. Vincent, Ph D.

Throughout history, communicators have used a variety of means to deliver their messages — clay tablets, papyrus rolls, medieval vellum, parchment, palm leaves, and gold plates to name a few. Impact and reach were limited.

Times have changed. Present-day communicators use satellites to support message delivery to millions of people around the world. Religious evangelists rely on state-of-the-art transmission technologies to expand their preaching presence and support their missionary efforts. From high-powered satellites, they beam religious programs, expansive live crusades, and media blitzes. All of the organizations interviewed for this article count this high-tech means of message delivery as critical to the success of their ministries.

Some religious organizations that use satellite technology to spread their message are Billy Graham's "Global Mission," The Christian Broadcasting Network, The Church of Jesus Christ of Latter Day Saints, the United Methodist Church, the ALAS Network, Trinity Broadcasting Network, World Harvest Television, The Faith and Values Channel, Eternal Word Television Network, and the Vatican.

Billy Graham's "Global Mission"

Evangelist Billy Graham, master of the electronic church, and leader of the Global Mission, an outreach which used approximately 30 satellites to link over 2,000 sites for a recent worldwide crusade, believes that the church should make use of the available technology to disseminate its messages. "The technology revolution has shrunk the world to a global village, with instant access to world news networks in even the most remote area. It is time for the church to utilize this technology to make a worldwide statement that in the midst of chaos, emptiness, and despair, there is hope in the person of Jesus Christ," he explains.

Substantial decrease in the cost of satellite technologies have made the equipment more affordable for religious organizations. "Today we are able to enter countries with the Gospel that would have been closed to us five years ago. Advances in technology have made it possible to outfit some locations with $5,000 worth of equipment. Five years ago, the equipment would have cost us $50,000," explains Robert Williams, Director of Global Mission and International Ministries for the Billy Graham Evangelistic Association, the religious organization which pioneered the "live link" technique. "Live link" means that all the sites are linked to the live crusade.

Rev. Billy Graham

Described as the largest event of its kind in broadcast history, the Global Mission broadcast — the "made-for-satellite evangelistic crusade" — was transmitted to over one billion people in 185 countries, across 29 time zones, and in 116 different languages.

"Industry experts tell us that this was probably the biggest thing ever done by satellite. It was likened to a project like the Olympics. But in a way, it was more complicated than the Olympics because, we created more specific pathways to reach many smaller reception centers," notes Mike Southworth, Manager, Satellite Services for the Global Mission.

Eight mobile uplink units on-site in Puerto Rico transmitted a beam to each of 16 groups of countries. Up to four audio tracks per feed were available for simultaneous language translation. A 35-person team at the transmission site in Puerto Rico and countless technicians around the world made the event a reality, says Dick King, senior vice president of operations and engineering for Global Access, a leading full-service provider of telecommunications transmission and networking services, which provided the primary satellite feeds via Orion 1 and Hughes' Galaxy 3 for Graham's undertaking.

Global Access coordinated the space segment for the originating feeds, the schedule, and the uplink requirements and assignments. "Using Global Access's internal inventory and acquired space segments, 10 transponders were utilized over a period of six days to provide pathways for the 16 daily feeds. The feeds, originating in Puerto Rico, were turned around to approximately 20 other satellites serving regional and global footprints around the world," King says.

"This level of planning and coordination is similar to what is required for major events such as the Olympics or World Cup Soccer, except that the Global Mission originated from only one venue rather than several. Global Access is proud to have been a part of the Global Mission team, and will provide international and domestic transmission services on an even greater scale as it continues to expand its staff and product offerings in the international marketplace," King adds.

The transmissions, which began at 9:00 a.m. each day and continued until 7:00 a.m. the following morning, utilized 10 antennas and hopped two or three times between satellites and earth stations before reaching Mission sites with more than 300 hours of programming.

Global Access also provides transponder time for a number of religious broadcasters including TBN, Sonlight Broadcasting, Adventist Media Center, The Radio & Television Commission of the Baptist Convention, The United Methodist Commission, and the Christian Broadcasting Network.

Host of* The 700 Club*, Ben Kinchlow, is shown with Terry Meewsen, and Pat Robertson.* The 700 Club *is the network's flagship program.

Christian Broadcasting Network

A pioneer in the use of satellite technology, the Christian Broadcasting Network (CBN) was the first Christian ministry in the world to own its own earth station and to have its own satellite transponder (RCA SATCOM-1). Pat Robertson, religious broadcaster, and founder of CBN, the world's largest religious television ministry, with programs airing across the U.S. and in 70 countries explains that "CBN was the third broadcaster in America, after HBO and Turner, to begin a satellite-to-home-service. As a matter of fact, The Family Channel was the first direct-to-home satellite network in America."

Robertson adds that "without satellite technology, the job of taking the Gospel message worldwide would be impossible. Satellite technology is the critical link to the world. With the advancing technology, there is a whole new generation of technology opening up which one day will probably bypass the broadcast stations or even the cable systems and open up satellite-to-home television delivery and information delivery in the new digital age."

Was the move to use satellite technology an easy sell? "It was to CBN," explains Patty Richardson, CBN's Media Relations Manager. "Getting stations to install downlinks was difficult until Merv Griffin began syndicating Entertainment Tonight and other programs by satellite only. Keystone and Bonneville Satellite's syndication services went a long way toward breaking the ice with TV stations. Home Box Office (HBO) broke the ice with CATV systems," she notes.

CBN began uplinking programming in 1977 to provide coverage of a telethon to several cities. Following this event, satellite technology gradually replaced the antiquated system of 'bicycling' videotapes from station to station across the United States, according to Richardson.

The organization's earth station farm is located in Virginia Beach, Virgina, and consists of 16 satellite dishes — four which are 30 to 35 feet and 12 smaller dishes which are 18 inches to 23 feet in diameter, receive signals for CBN news. The larger dishes transmit signals to one of 38 satellites, and the smaller ones receive signals for CNN news.

CBN's flagship program, *The 700 Club*, a 90-minute live television program that has aired weekdays since 1966 uses three satellites to reach its viewers. Transponder 11 on Hughes Galaxy 5 carries signals to the East Coast via The Family Channel's east coast feed. Transponder 1 on GE's Satcom 3 carries the program to the West Coast. FamilyNet (Galaxy 4) and Trinity Broadcasting Network (Galaxy 5, transponder 3) also carry The 700 Club.

Richardson says the organization also has a digital audio uplink on Hughes Galaxy 4 Ku and uses a large quantity of occasional service on several other satellites on an as-needed basis. "We use Intelsat on occasion for backhauls. It's still too expensive for us to use for routine downstream transmissions, she notes. "We also have the capacity to transmit by Vyvx digital video fiber as needed."

The network uses Scientific Atlanta exciters and receivers, MCL and Varian High Power Amplifiers and Scientific Atlanta and Vertex uplink antennas for video uplinks. For its Ku-band digital audio uplink, CAN uses Comstream exciters and receivers, an SSE Transmitter and a Prodelin antenna. SNG trucks on-site are used to augment the network's uplink capacity.

At one time, CAN provided dishes to stations. "We did have an agreement to supply antennas to cable systems during

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

the Hughes Galaxy 1 days, but that program ended with the demise of Galaxy 1, Richardson adds.

CAN International's global efforts began about 20 years ago with the broadcast of *The International 700 Club* in the Philippines. Today, the international edition airs in 60 countries worldwide including the Far East, Canada, South America, Mexico, Africa, and Europe. CAN International has produced original programs for broadcast via satellite to China, the Philippines, and Romania, and is also known for opening the door for evangelization in Cuba.

The Church of Jesus Christ of Latter Day Saints

Established in April 1980 with approximately 10 downlink locations, the Church of Jesus Christ of Latter Day Saints Church Satellite Network covers all of the US and Canada, including Alaska and Hawaii and parts of the Caribbean. The church uplinks its satellite broadcasts from Bonneville International Headquarters in Salt Lake City, Utah to approximately 3,000 downlinks located in church-owned buildings and over 100 downlinks in Western Europe.

"The leadership of the Church saw the value of satellite broadcasts years ago and positioned itself so that it could use this technology as it became available," notes Thomas E. Brown, Audiovisual, Church of Jesus Christ of Latter-Day Saints. "The Church has the responsibility to keep members informed and to spread the gospel of Jesus Christ to all those desiring to hear. The satellite system is a key part of the Church's mission."

The Church of Jesus Christ of Latter-Day Saints provides programming for families and for the training of leaders, officers, and teachers in the Church. This training includes two semi-annual General Conferences of the Church which are available to cable, television, and radio stations on a public service basis. These two semi-annual conference sessions are sent via satellite to the British Isles, Ireland, Denmark, Finland, Norway, Sweden, Austria, Germany, The Netherlands, Switzerland, Belgium, France, Italy, Portugal, and Spain.

"We also provide 'firesides' with inspirational talks given by Church leaders. These may be focused on youth groups, adults, parents, or some other group within the Church," Brown says. "All of the programming on the network is produced by the Church or on contract with other production facilities for the Church."

In addition to these religious programs, Brown says that the network broadcasts Brigham Young University football and basketball games.

The organization conducts surveys to assess its satellite evangelism efforts and thus far, has found that its membership is very receptive to satellite broadcasts. "These broadcasts provide members in remote areas with the same opportunity to participate in conferences and firesides as those members in Salt Lake City," he adds.

The United Methodist Church

The United Methodist Church has used satellite technology for teleconferencing for about ten years. United Methodist Teleconference Connection (UMTC), a part of United Methodist Communications (UMCCom) Department of Communication Education, has harnessed the instantaneous exchange of information made possible by satellite technology, offers video teleconference via satellite to local church representatives nationwide. The unit plans, coordinates, produces, and uplinks satellite teleconferences on subjects ranging from congressional newsletters and public relations planning to media and crisis management.

Shirley Whipple Struchen, director of UMTC's church-wide teleconferencing effort, predicts that the teleconferences will change the way the church does mission and ministry and give new meaning and credibility to United Methodism as a "connectional" church.

UMTC
UNITED METHODIST TELECONFERENCE CONNECTION

Tom McAnally, director of United Methodist News Service says that these teleconferences are "beginning to change the ways United Methodists relate to one another." Last April, UTMC set up a nationwide satellite broadcast for United Methodist Women's Assembly. The Saturday-Night-From the Assembly program, which marked a celebration of the first 20 plus years of United Methodist Women, was received by more than 100 downlink sites. UMW officials estimate that the program was seen by more than 15,000 women. In Spring 1994, the United Methodist Board of Higher Education and Ministry (BHEM) used satellite technology to facilitate a free teleconference celebrating the official opening of Africa University, the first Methodist University in Africa. The teleconference included scenes of the inaugural ceremonies from the Zimbabwe campus, participation in an authentic African worship service, live interviews, and the latest footage of Africa University campus.

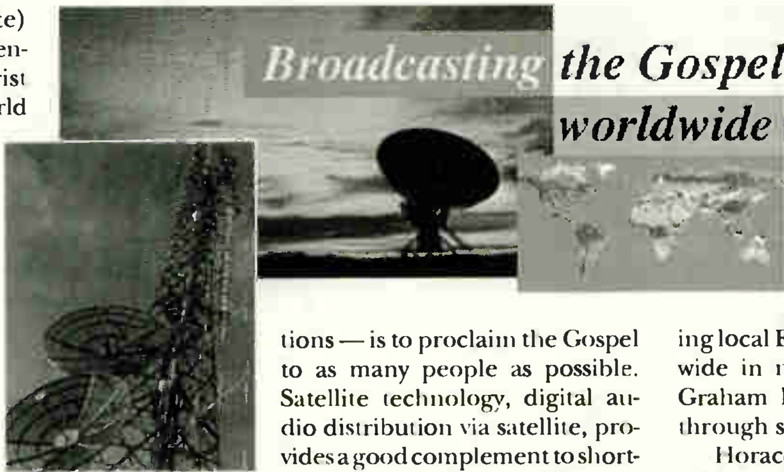
Though the organization's satellite uplink capabilities via Galaxy 7, a new breed of satellite that has both C-band and Ku-band channels, it currently transmits only on the C-band. It broadcasts to satellite dishes at conference sites, local churches, retirement homes, businesses, camping areas, colleges and seminaries, throughout the US.

The ALAS Network

Trans World Radio (TWR), an international missionary broadcasting organization, whose first broadcast was aired over a 2,500-watt transmitter in Tangier, Morocco in 1954, transmits nearly 1,000 hours of Gospel programs each week in over 100 languages from 10 primary transmitting stations on five continents. TWR staff of over 1000 in more than 30 nations, provides German, Polish, and Slovak programming via Astra, one of Europe's most popular direct broadcast satellite network. TWR targets a potential 15 million households in Europe via a non-preemptable audio channel subcarrier on the satellite. TWR's international headquarters are located in Cary, NC.

In addition to broadcasting via satellite, TWR broadcasts on AM and shortwave from transmitters located in Albania, The Netherlands Antilles, Cyprus, Guam, South Africa, Monte Carlo, Russia, Sri Lanka, Swaziland, and Uruguay,

TWR is also involved in the ALAS



(America Latina via Satellite) network, a non-profit joint venture with Heralding Christ Jesus Blessing (HCJB) World Radio. HCJB is based in Quito, Ecuador, and provides 24-hour-a-day Christian programming to local AM and FM stations in Latin American cities in Argentina, Bolivia, The Netherlands Antilles, Chile, the Dominican Republic, Ecuador, Panama, Paraguay, Peru, and Venezuela.

"The partnership relationship permits ALAS, which presents no "on-air" identity, to operate as a separate entity, overseen by both organizations. The network is merely a delivery system. Local stations may choose to air ALAS-delivered programs either in real time or digitally recorded for delayed broadcast," explains TWR's Bill Damick, assistant director, broadcaster relations. The ALAS corporation manages the network which has its technical planning and maintenance functions headquartered at the HCJB facilities in Quito. The TWR station provides engineering assistance from Bonaire, The Netherlands Antilles.

Trans World manages the relationships with North American-based broadcasters who place their programs for ALAS delivery, and HCJB overseas equipment installation, training, and servicing. According to Damick, "the arrangement has worked very well, and has been a great encouragement to the Evangelical community in both North and South America as they have watched the two organizations cooperate so closely for a common goal instead of each doing their own thing."

"The partnership that TWR has with HCJB in the ALAS satellite project developed out of the conviction by both organizations that SW broadcasting as a primary means of sharing the Gospel with Latin America would yield increasingly fewer results in the coming years," Damick says. "This is due to the rapid urbanization of most of the South American nations and the fact that SW reception in urban areas, particular with simpler receivers is problematic at best."

Like many international radio broadcasters, the network was faced with the problem of how to deliver relevant, up-to-the-minute programming to affiliate stations broadcasting to city-based populations — is to proclaim the Gospel to as many people as possible. Satellite technology, digital audio distribution via satellite, provides a good complement to shortwave, AM, and FM capabilities of the two international radio stations.

Company officials say that although they see shortwave as a better way of penetrating closed countries than satellites, satellite can enhance the other methods they use to reach their target audiences. According to Damick, both TWR and HCJB have long histories of shortwave broadcasting to the region.

In addition, both organizations have provided high-quality programs by mail to large numbers of small, community-oriented Christian stations throughout South America. In the past, these stations often suffered from inadequate postal service, resulting in late or lost tapes.

Now they can receive reliable, high-quality sound, and access to a variety of programs with satellite access. "ALAS provides a means for these broadcast ministries as well as for TWR and HCJB to bring programs directly to the stations on an encoded channel," Damick explains. He hopes that the ALAS network "will provide a vehicle for expanding local radio ministries in Latin America to other parts of the Spanish-speaking world, as well as provide a link for sharing local Evangelistic crusades continent-wide in much the same way that Billy Graham has so successfully ministered through satellite television."

Horace Easterling, director of ALAS Affiliate Relations, agrees that satellite technology supports the organization?s mission: "It is a perfect match. There are many Christian radio stations throughout Latin America reaching a ready-made audience. They are doing a great job of ministering to the Evangelical Church and are now depending upon us for the delivery of high-quality teaching programming. Selling the technology was probably the easiest thing I?ve been involved in. Most people were saying, "What took you so long?"

The network uses a uplinks in Quito and Bonaire supported by the Intelsat 603 global beam (325.5 degrees east), which covers the North-East coast of Brazil, all of South and Central America, most of the USA, and large parts of Africa and Europe. The affiliate control system was designed in-house by HCJB engineers to provide station affiliates with the ability to select programming according to a preprogrammed schedule.

According to Easterling, the ALAS network has a fully redundant system at both sites which uses SSE Technologies' 20-watt C-band amplifiers. The distribution network consists of three uplinks linked by dedicated 19.2 kbps auxiliary SCPC channels which provide station-to-station telephony, fax, data, and e-mail for network coordination purposes. A 7.6-meter Standard G hub station located in Quito delivers two or three high power 192 kbps, MPEG digital audio channels to affiliate stations.

The island of Bonaire houses the 4.6 meter uplink which transmit a single, lower power 192 kbps MPEG signal to Quito, where it is integrated into the broadcast uplinks by the Quito Program Automation and Control Systems (PACS). In the event of a "catastrophic" failure of the Quito Hub, the Bonaire uplink can support a single broadcast-power carrier.

The network plans to install a third, 3.7 meter uplink in the US to provide a gateway for broadcasters to send material to the uplink via pre-recorded DAT tape, dial-up line or dedicated ISDN.

The basic system at the Quito uplink station, which is supported by a proprietary system from Comstream, can deliver a selection of fixed channels which can be selected by remote receivers, according to Comstream's Bruce Rowe, manager, marketing communications.

The Comstream coder/receiver combination (ABR200/CM701) offers ALAS the flexibility it needed when it started modifying its operating parameters for more efficient operation. "The audio quality is entirely acceptable although it is necessary to carefully select the modulation scheme and data rates due to variable performance of the ABR 200 receiver under different modulation rates and schemes," according to P. Ritchie, systems and development engineer at the engineer research and development department of HCJB.

The ALAS network has 31 affiliated Christian AM and FM stations in seven countries and plans to place downlinks in Peru, Colombia, and Venezuela. The focus of the network has been primarily Latin America, but plans are in place to move to other parts of the world.

TWR maintains cooperative arrangements with other organizations. Evangeliums Rundfunk (ERF) in Wetzlar, Germany is one of a large number of autonomous evangelical broadcast organizations which cooperate with TWR to share the Christian gospel message.

"Our cooperative efforts come where TWR airs ERF-produced programs for Germany and to a number of other countries, in German and several other languages. TWR counts it a great privilege to be part of what ERF is doing," Damick says.

Trinity Broadcasting Network

Trinity Broadcasting Network's (TBN) corporate brochure describes TB as the world's largest religious network and the oldest Christian television network in America. According to Nielsen research, TBN, which was launched in May 1973, is the most-viewed religious network in America.

TBN uplinks religious, inspirational, educational, and family-oriented programming via GE's GStar birds to affiliates in the United States, including cable systems, wireless cable providers, SMATV providers, and individual consumers with backyard dishes. TBN uses PanAmSat for distribution of its international signal. Although the organization has the capacity to go digital and often uses a subcarrier to carry a compressed digital signal, the video signal they currently send to affiliates throughout the United States is analog.

At the network's international production facilities in Irving, TX, TBN does the "equivalent of United Nations translations of Trinity's programs into Spanish, Italian, Russian, and Chinese for distribution throughout the globe," explains Colby May, communications counsel for TBN. "Scores of foreign countries receive the programming, including every Central American country, most Latin American countries, [countries] throughout Africa, Italy, and Switzerland," he says. "Programmers and cable channels throughout Europe also receive our programming."

Praise the Lord

Dish types used by TBN include Scientific-Atlanta dishes for both its fixed earth stations (5-15 meter) and its remote satellite trucks (3-5 meter). TBN also provides dishes to institutions (e.g., prisons), and to individuals and organizations who plan to distribute its programming more widely.

In 1977, TBN incorporated satellite technology into its media mix. "Satellite was an easy sell because it facilitated timely distribution of quality programming at a very reasonable price and 'interaction' with believers without regard for distance," May explains. "Our management regards satellite technology and supporting services as an essential part of the operation of the Trinity Network."

World Harvest Telesvision

LeSea Broadcasting's World Harvest Television (WHT) programming, which is funded primarily from the sale of air-time, is available to affiliate stations located throughout the United States, parts of Canada and Mexico, Hawaii and beyond via Galaxy 4. Broadcasting since August 1992, WHT provides a mix of Christian and family programs.

"LeSea feels satellite technology fits the mission of reaching lost souls for Christ," explains Craig Wallin, National Sales Manager. "Overall, the importance of satellite for LeSea's evangelization efforts cannot be underestimated."

WHT uses a 9-meter Harris dish, Varian transmitter and Aydin stand-by transmitter at their operations in South Bend, Indiana. Programs are transmitted either live, by tape, or satellite rebroadcasts. Wallin says that LeSea uses six audio subcarriers to deliver shortwave radio programming to transmitters in central Indiana and Hawaii.

WHRI, one of LeSea's international shortwave station broadcasts 24 hours in English and native languages to overseas audiences in South America and Europe. KWHR, which broadcasts from Hawaii, is the organization shortwave radio station which serves South East Asia and China.

The Faith and Values Channel

In a 1991 article America magazine article, Reverend Bernard R. Bonnot, director of communications for the Faith and Values Channel (previously VISN), described the network as a "major instrument of interfaith achievement in the 21st century" and the "PBS of religious broadcasting."

The network, which is based in New York, is an interfaith cable services which went on the air in 1988 and had already reached 7.5 million cable homes by March 1991. The Faith and Values Channel is a non-profit, religious cable-television programming service was founded and run by the National Interfaith Cable Coalition (NICC) and consists of more than 64 Protestant, Jewish, Roman Catholic and Eastern Orthodox faith groups and evangelical traditions.

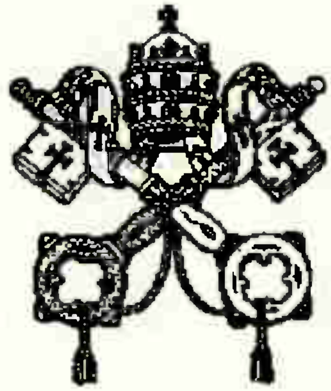
The network programs 16 hours of the Faith and Values Channel, a 24-hour national religious channel carried by cable systems around the country, reaches more than 23.4 million cable households on approximately 1,475 cable systems serving over 4,600 communities nationwide.

According to Portia Badham, media and public relations for the Faith and Values Channel, the other eight hours are provided by ACTS, a network which is owned and operated by the Radio and Television Commission of the Southern Baptist Convention.

The Faith and Values Channel provides programs ranging from the one-hour specials, dramas, and documentaries to multiple program series. Recently the network aired the ecumenical worship service celebrating the 50th anniversary of the founding of the United Nations. The service was attended by U.N. Secretary General Boutrous Boutrous-Ghali, Princess Margaret of Great Britain and Archbishop Desmond Tutu of Capetown, South Africa.

Eternal Word Television Network

One of the nation's largest religious cable television network, the Eternal World Television Network (EWTN, Catholic Cable Network) recently expanded its international coverage to include Europe, Africa, Central, and South America. The organization reached an agreement with Intelsat, the leading international provider of Spanish-language cable programming in Latin America, to provide 24-hour coverage on Intelsat 601 at 152.5 degrees west.



This move will increase EWTN coverage to more than 42 countries in three continents and will supplement the network's North American Feed on Galaxy 1R. EWTN will use General Instrument DigiCipher technology and plans to share a compressed transponder with another broadcasting organization.

Mother Angelica, foundress of EWTN, says this expansion is important for EWTN. "Conditions around the world are so serious — wars, earthquakes, floods — that we need to reach people everywhere. In the coming years, their faith is going to be tested — they are going to need hope. EWTN offers great hope and teaching."

Launched in 1981, EWTN currently operates 24-hours-per-day from a state-of-the-art complex in Irondale, Alabama, reaches 38 million homes in more than 20 foreign countries. The network produces nearly 75 percent of its programming and acquires the other 25 percent from sources in the U.S., Europe, and Asia. The network's schedule includes documentaries, talk shows, series hosted by leading scholars, children's shows, and music specials. Two hours per day is devoted to Spanish-language programming.

The Vatican

The Vatican, the world center of Catholicism has established a digital audio satellite network to reach its followers throughout the world with important Catholic news and events. ComStream, a major international provider of resilient digital networks for voice, audio, data, imaging, and video applications and one of the companies that pioneered the development of digital compression transmission technologies, configured the network and provided supporting technologies.

The Vatican's network uses a 128 kbps channel that provides CD-quality sound and an uplink with a primary transmission channel and a backup channel. To connect to the network, which includes a portable satellite uplink, each church must be equipped with an ABR200 digital audio receiver.

The Final Judgement

From all indications, religious organizations will continue to include high-tech delivery services in their media mix. Those that use satellites to disseminate information agree that without them, taking the Gospel message worldwide would be virtually impossible. ST

Donna M. Vincent, Ph.D. writes frequently on communications technology, international communications, and issue management. This article originally appeared in the December 1995 issue of VIA Satellite.

Monitoring U.S. Navy Ships via INMARSAT

By John Wilson (W4UVV)

For readers of *Satellite Times* who are fortunate enough to have set up their own INMARSAT satellite receive system, it is now possible to monitor U.S. Navy ships via these L-band space communications platforms.

INMARSAT communications systems have been commonplace aboard a variety of commercial ships for several years now. Recently the Department of the Navy recognized the advantage of having a commercial, 24 hour, dependable, two way telephone/facsimile capability. This has resulted in a large number of INMARSAT communications suites being installed onboard naval vessels.

Gone are the days when sailors had to depend upon the high frequency (HF) Military Radio Affiliate System (MARS) for a phone patch home or for passing health and welfare message traffic to loved ones. During the 'cold war,' most naval vessels were not permitted to run MARS HF traffic due to tight communications regulations. Today however, an INMARSAT telephone/fax system has become a 'must have' communications package aboard U.S. Navy ships.

Where are the satellites?

Four INMARSAT satellites provide continuous worldwide telephone/data service (see figure 1).

The AOR-E satellite provides coverage from north of Scandinavia south through eastern and western Europe to Africa. The AOR-W satellite overlaps some of the AOR-E "footprint" signal beginning west of Africa westward through North America and South America to the Hawaiian Islands. As you might expect the Indian and Pacific Ocean satellites provide extensive coverage to their respective geographical locations. The two Atlantic Ocean Relay INMARSAT satellites can be received by monitors who live on the eastern United States seaboard westward to near the Mississippi River. For midwest monitors, the AOR-W INMARSAT transmits a strong signal into the continental United States. Monitors on the west coast have both the AOR-W and the POR satellites within range of their listening post. The IOR satellite cannot be monitored in the United States due to physical line of sight curvature prohibitions of the earth geometry.

FIGURE 1: Inmarsat locations

Atlantic Ocean Relay-East (AOR-E)	15 degrees West
Atlantic Ocean Relay-West (AOR-W)	55 degrees West
Indian Ocean Relay (IOR)	295 degrees West
Pacific Ocean Relay (POR)	192 degrees West

Who's Who?

In the clear identifications are not used on INMARSAT for naval vessel telephone communications. Table 1 is a list of known U.S. Navy vessels monitored on INMARSAT with the vessel's hull number designations and first and/or subsequent code names in use, where known.

How Can I Monitor INMARSAT?

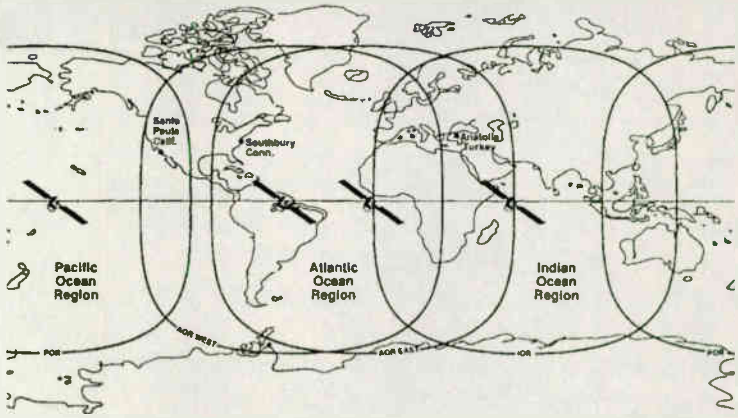
For about the price of a mid-range scanner you can monitor one or more of these interesting satellites with receivers that tune the 1500 MHz. range. Each INMARSAT provides a maximum capacity of 125 voice/data channels simultaneously. Based on monitoring, actual utilization tends to average between 25-50 channels simultaneously. The Armed Forces Radio TV Service (AFRTS) can be monitored 24 hours-a-day on 1537.000 MHz. on each of the INMARSAT spacecraft. Most INMARSAT monitors use these broadcast as a beacon to fine tune antenna pointing angles.

Voice signals are transmitted using the FM Single Channel Per Carrier (FM SCPC) mode and can be monitored on a VHF/UHF communications receiver in the Wide or Narrow Band FM mode, depending upon the bandwidth design of the receiver.

For a reprint of the two part *Monitoring Times* INMARSAT articles (February/March 1994) on assembling your own receiving system, a geostationary satellite look angle chart for your geographical location, and an INMARSAT system component's price list, send $10 (USA), $15 (Foreign) to: John Wilson, 6413 Bull Hill Road, Prince George, Virginia, 23875 or telephone (804) 862-1262.

TABLE 1: Known U.S. Naval Vessels with INMARSAT Installations

Vessel Name (Hull Number)	Code Name(s)
USS Abraham Lincoln (CVN-72)	Eclipse/Eclipse II/III/IV
USS America (CV-66)	Bright Star/Bright Star II
USS Antrim (FFG-20)	Belfast
USS Anzio (CG-68)	Tower
USS Arctic (AOE-8)	Polar Bear
USS Ardent (MCM-12)	Passion
USS Arleigh Burke (DDG-51)	War Hero
USS Arthur W. Radford (DD-968)	Chairman
USS Ashland (LSD-48)	Fire Storm
USS Aubrey Fitch (FFG-34)	Moresy Defender
USS Austin (LPD-4)	Texan
USS Barry (DDG-52)	Father Navy
USNS Big Horn (T-AO 198)	Unknown
USS Boone (FFG-28)	Frontiersman
USS Briscoe (DD-977)	Whetstone
USS Butte (AE-27)	Big Sky
USS Cape St. George (CG-71)	Peninsula
USS Carl Vinson (CVN-70)	Sunrise/Sunrise II/Sunrise III
USS Carney (DDG-64)	Mick
USS Caron (DD-970)	Cue Ball
USS Carr (FFG-52)	Carlos
USS Carter Hall (LSD-50)	Hope Foundation
USS Clark (FFG-11)	Oregon Trail
USS Comte de Grasse (DD-974)	Pasture
USNS Comfort (T-AH 20)	Hospital
USS Connolly (DD-979)	Governor
USNS Concord (T-AFS 5)	Jelly
USS Detroit (AOE-4)	Motorman
USS Dexterous (MCM-13)	Handy
USS De Wert (FFG-45)	Authentic
USS Deyo (DD-989)	Bellafonte
USS Doyle (FFG-39)	Pineapple
USS Dwight D. Eisenhower (CVN-69)	White Wolf
USS Elrod (FFG-55)	Hammering Hank
USS Estocin (FFG-15)	Swords Edge
USS Fahrion (FFG-22)	Dragon
USS Flatley (FFG-21)	Decisive
USS Gallery (FFG-26)	Gun Platform
USS George Washington (CVN-73)	Cherry Tree
USS Gettysburg (CG-64)	Four Score
USS Grapple (ARS-53)	Firm Grip
USS Grasp (ARS-51)	Iron Grip
USS Guam (LPH-9)	Sugar Cane
USS Gunston Hall (LSD-44)	Musclemen
USS Haleyburton (FFG-40)	Tar Heel
USS Hawes (FFG-53)	Left
USS Hayler (DD-997)	Semaphore
USNS Henry J. Kaiser (T-AO 187)	Unknown
USS Hue City (CG-66)	Colorful
USS Jack Williams (FFG-24)	Double Shot
USS John F. Kennedy (CV-67)	Serein I/II
USS John Hancock (DD-981)	Big Name
USNS John Lenthall (T-AO 189)	Unknown
USS John L. Hall (FFG-32)	Monty's Deal
USS John Rogers (DD-983)	Father & Son
USNS Joshua Humphreys (T-AO 188)	Unknown
USS Kalamazoo (AOR-6)	Cheerios
USNS Kanawha (T-AO 196)	Unknown
USS Kauffman (FFG-59)	McIntosh
USS Kearsarge (LHD-3)	Mountaineer
USS Kidd (DDG-993)	Youngster
USS Klakring (FFG-42)	Big Ben
USS Laboon (DDG-58)	Steel Halo
USS La Moure County (LST-1194)	Hauler
USS LaSalle (AGF-3)	Leprechaun
USNS Leroy Grumman (T-AO 195)	Unknown
USS Leyte Gulf (CG-55)	Swimming Pool
USS McInerney (FFG-8)	Ireland's Own
USS Merrimack (AO-179)	Iron Clad
USS Mississippi (CGN-40)	Long River
USS Mitscher (DDG-57)	Aviation Specialist
USS Monongahela (AO-178)	Three Rivers
USS Monterey (CG-61)	Intrepid



Vessel Name (Hull Number)	Code Name(s)
USS Moosbrugger (DD-980)	Bull Winkle
USS Mount Baker (AE-34)	Border Peak
USS Mount Whitney (LCC-20)	Pierside
USS Mount Whitney-Staff (LCC-20)	Satcom III
USS Nashville (LPD-13)	Keelboat
USS Nassau (LHA-4)	Resort
USS Nicholas (FFG-47)	Yuletide
USS Nicholson (DD-982)	Joker
USS Nimitz (CVN-68)	Twilight I/II
USS Normandy (CG-60)	Beach
USS O'Bannon (DD-987)	Cocktail Onion
USS Oliver Hazard Perry (FFG-7)	Olive Garden
USS Pensacola (LSD-38)	Five Flags
USS Peterson (DD-969)	Cheers
USS Philippine Sea (CG-68)	Seminole
USS Platte (AO-186)	Plateau
USS Ponce (LPD-15)	Seaport
USS Portland (LSD-37)	Rose Festival
USS Puget Sound (AD-38)	Pier Scrapper
USS Rampage (DDG-61)	Soaring Hero
USS Robert G. Bradley (FFG-49)	Bristle
USS Saipan (LHA-2)	White Sand
USS Samuel B. Roberts (FFG-58)	Hebrew
USS Samuel E. Morison (FFG-13)	Historian
USNS San Diego (T-AFS 6)	Friar
USS San Jacinto (CG-56)	Brilliance
USS Santa Barbara (AE-28)	Mary Lou
USNS Saturn (T-AFS 10)	Unknown
USS Scott (DDG-995)	Terrier
USS Seattle (AOE-3)	Big Tree
USS Shenandoah (AD-44)	Magnificent Tree
USS Shreveport (LSD-13)	Magnolia
USS Simpson (FFG-56)	Bartman
USNS Sirius (T-AFS 6)	Unknown
USS South Carolina (CGN-37)	Hugo
USS Spruance (DD-963)	Quiet Warrior
USS Stark (FFG-31)	Strong Man
USS Stephen W. Groves (FFG-29)	Timber Stand
USS Stout (DDG-55)	Solomon Hero
USS Stump (DD-978)	Puzzle
USS Supply (AOE-6)	Eagle
USS Taylor (FFG-50)	Admiral's Elite
USS Ticonderoga (CG-47)	Empire
USS Theodore Roosevelt (CVN-71)	Super Natant/Super Natant II
USS Thomas S. Gates (CG-51)	Hinge
USS Thorn (DD-988)	Thicket
USS Tortuga (LSD-46)	Pirates
USS Trenton (LPD-14)	Garden Staff
USS Underwood (FFG-36)	Briar Patch
USS Vella Gulf (CG-72)	Velarium
USS Vicksburg (CG-69)	River Siege
USS Wasp (LHD-1)	Stinger/Stinger II
USS Whidbey Island (LSD-41)	Northwest
USS Yellowstone (AD-41)	Yogi Bear
USS Yorktown (CG-48)	White Knuckle

By Doug Jessop

The V-Chip and Other Developments

The passage of the new federal Telecommunications Reform Bill, mandating a V-chip in every new television set, is producing some heavy duty public sentiment. In fact, President Clinton, who has endorsed the V-chip technology, invited representatives from the National Association of Broadcasters, the National Cable Television Association., and the Motion Picture Association of America among others, to a meeting at the White House on this issue. The major issues to be hammered out at this meeting were how ratings will be done and exactly who will determine ratings categories.

First, let's define what a V-Chip is. V-Chip stands for Violence Chip. It is suppose to put a blue screen on your TV if you have the chip programmed to block out a certain rated show.

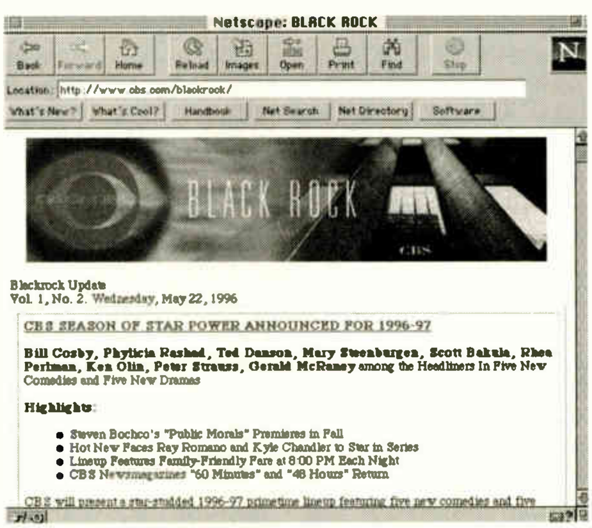
This all sounds fine and good except for a few minor details. First, there isn't even a working V-Chip. They are talking about is using one of the TV signal interval blanking lines, similar to where close captioned text is carried on the transmission signal, to send info on the rating of the show.

Second, how many people do you know are going to chuck their current TV (which doesn't have the chip) in the trash and buy one of these new sets? We are talking about a transition that will take years.

Third, the movie ratings folks look at a couple dozen movies a week. Television is generally broadcasting anywhere from 18 to 24 hours of programming a day. Presuming that the average show is 30 minutes in length, we are now up to anywhere from 36 to 48 shows, for one broadcast station every day. If we add in all the various networks, we are talking 252 to 336 shows in a single day. Now add in the cable stations and various other satellite network channels and you can see that the idea of rating every single show on the airways anytime soon is crazy.

In a statement released recently, Fox Chairman Rupert Murdoch said, "We have decided to implement the MPAA-like (Motion Picture Association of America) rating system for the TV programs on Fox. We are prepared to act unilaterally if necessary." Fox caught the other networks off guard, causing some executives to accuse Fox of grandstanding. With the squeaky clean programming that Fox airs (sic), having them say they were going to be first to implement the ratings system is like a fox running the hen house (sorry, I couldn't resist the pun).

Finally, the last time I checked, if it weren't for the 12 year old and younger kids, most of America's VCRs would still be blinking 12:00. If it takes someone to program what level of shows are seen in a home, you can bet a paycheck that someone else will find a way to deprogram it.



Fifty television producers, writers, industry guild, and network executives, including Steven Bochco, John Wells and Marcy Carsey met with Motion Picture Association president Jack Valenti recently to discuss the proposed ratings system for television. According to Valenti, the meeting was "freewheeling and passionate," with almost everyone in attendance opposing the ratings system, which will be modeled after that of the MPAA.

The producers voiced fears that the proposed system will endanger creative expression and stigmatize some dramas among advertisers. The producers finally agreed to help develop a system with "integrity" that will help parents decide what is acceptable for their small children to watch.

Bottom line, television is not just about pretty pictures telling a nice story, it's about money plain and simple. The reality is that a show only survives if enough people watch that show to make it viable to the advertising community. The best way to get the garbage off the airways is to vote with your remote control.

If you would like more information on this bill and you have an Internet account go to the Piper and Marbury site for the legalese at: **http://www.cix.org/Reports/telecomm96.html**.

Industry Shorts

The FCC recently issue a final order that allows international satellite carriers to provide domestic services. The same bill will also allow domestic satellite carriers to provide international services. In the past, domestic and international satellite services have been totally distinct areas of turf.

Primestar must be sighing with relief, at least until the successful launch of GE-2 sometime in fourth quarter of this year. Primestar has reached an agreement with GE American Communications securing long term capacity on the new bird. As mentioned in the last issue of *Satellite Times*, Primestar is currently using the aging K1 satellite. This new agreement is a four year contract with an option to extend 15 years.

By the time you read this, we should hopefully have a new communications satellite operating at 123 degrees West — Hughes Galaxy 9. Check out the *Satellite Services Guide* center video grid in this issue of *ST* for a preliminary transponder linup.

According to a report in *USA Today*, ABC will provide American Airlines with programming for its new in-flight viewing service on domestic and interna-

Bottom line, television is ... about money plain and simple. The reality is that a show only survives if enough people watch that show to make it viable to the advertising community. The best way to get the garbage off the airways is to vote with your remote control.

tional flights. Programming will include sports, news, and full-length episodes of prime-time shows, such as *Home Improvement* and *Ellen*. The American Airlines show feed has been sending its programming via satellite to a central taping facility and then physically getting them on the planes. I haven't heard if this procedure will be any different with the new contract.

TeleNoticias is on the verge of being sold to Westinghouse Electric Corp. If completed, the acquisition of TeleNoticias would be the company's first major expansion into the international television market. The transaction would also provide a new outlet for the CBS network, which would most likely take over the channel's programming. The Miami-based Spanish language network reaches 14 million homes in 21 countries.

In a recent press release, Viacom Inc. said that its Nickelodeon children's television unit is planning to launch a 24-hour channel in Latin America via satellite. The channel would use Spanish and Portuguese-language programs acquired form Toronto-based Nelvana Enterprises Inc. The shows would be transmitted via PanAmSat global satellite system from Miami.

San Francisco companies C/NET: The Computer Network (Galaxy 9) and television syndicator Golden Gate Productions, announced recently that they have formed a partnership to distribute *TV.COM*, a weekly television series on the Internet. The program is scheduled to premiere this fall.

Capital Cities/ABC has indefinitely postponed its plans for a 24-hour cable news channel. The move immediately improved the probability of success for rival cable prospectors NBC and Fox, which in recent months have announced plans to go up against the Cable News Network.

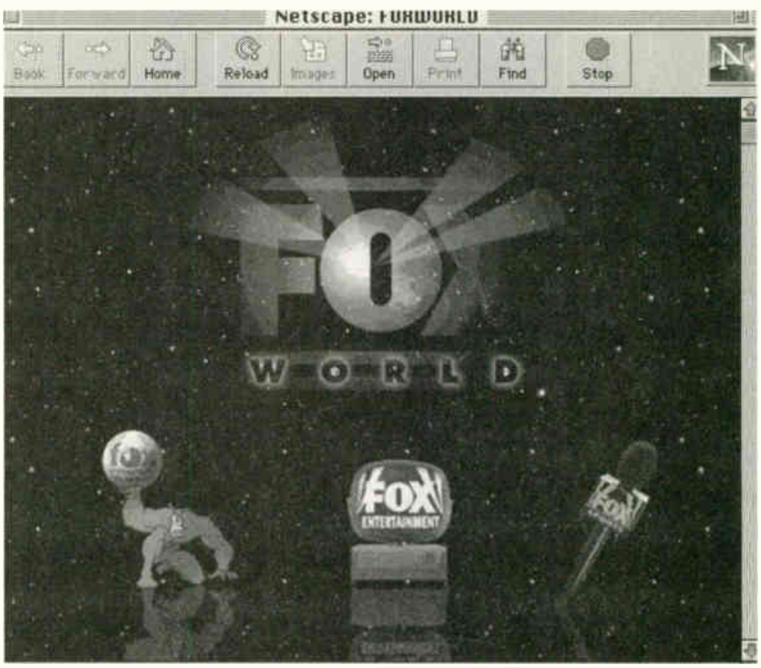
According to network executives, the final blow to ABC's plans was News Corp's recent offer to pay cable systems $10 or more per subscriber if they agreed to carry the new Fox cable channel. Despite ABC's offer to cable operators, albeit a lesser amount, the News Corp offer "really changed the environment," said ABC News president Roone Arledge. Arledge said ABC will look at doing a more limited cable news service, possible teaming up with someone else. News Corp, meanwhile, has still not confirmed its offer to cable systems.

In other transponder news, Liberty Media Corp., a unit of Tele-Communication Inc., has agreed to purchase a controlling stake in Video Jukebox Network Inc. for US$11.2 million. Video Jukebox, controls The Box, a digital satellite channel which allows viewers to request music videos by dialing a 900 number. The company, only reaches about four million cable homes and is not considered a threat to MTV which is carried via an analog channel on satellite.

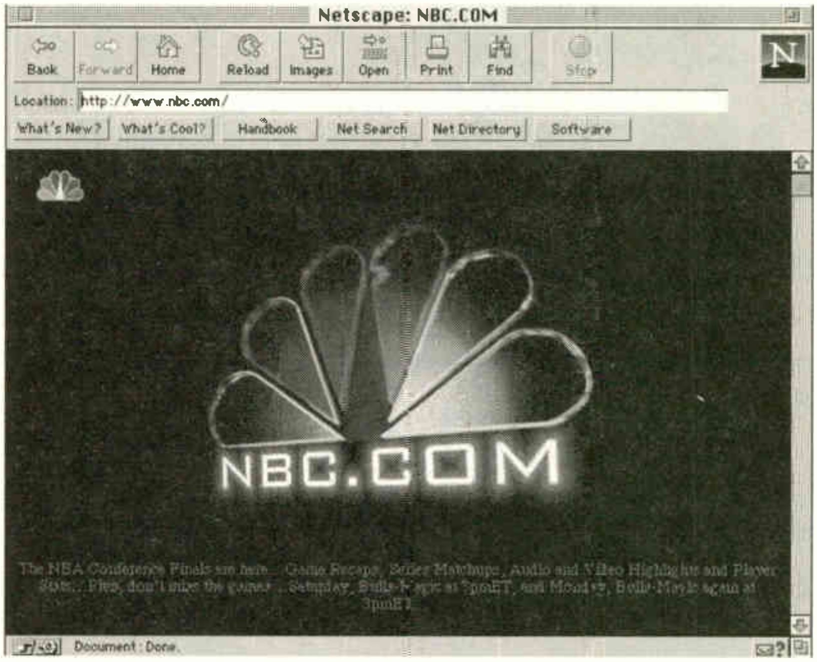
MTV Networks unofficially announced plans for MTV2, a spin-off music video channel that will consist almost entirely of music videos and will most likely be commercial free according to industry sources. MTV2 may also eventually contain custom-programmed play lists that target different musical tastes. "MTV2 will serve as a companion to our existing MTV, but at this point, there are no specific details that we can get into about it," said Andy Schuon, executive vice president of programming at MTV. The launch of MTV2, which could be as soon as late summer, comes five years after MTV announced plans to splinter the channel into three signals.

Programming News

The Fox network recentl announced that its new morning show, *Fox After Breakfast*, will premiere August 12. The show, based on the fX cable network's *Breakfast Time*, will air weekdays from 9-10 a.m. and will be hosted from New York by Tom Bergeron and Laurie Hibberd.



America's Most Wanted, the Fox program which helped capture 422 criminals and reunite 16 missing children with their families, has been canceled after nine years, to make room for two new comedies. While the network plans on airing Most Wanted specials and movies, the show's 40 full-time staffers will be let go in this month.



The interesting part of this story is not what is airing, but what isn't — cartoons. It should be interesting to see what happens to the lucrative children's television advertising money, especially since the show is starting so close to the all important Christmas holiday advertising period.

Through some miracle, daytime talk show *Tempestt*, has managed to escape the fate of cancellation experienced by all the other rookie talk shows this season. But now, it looks like Cosby Show alumnus Tempestt Bledsoe, might be down for the count.

According to a report in *Daily Variety*, although the cancellation is not yet official, the prospects of the show in the future is slim. Columbia TriStar TV Distribution, the show's syndicator, has already closed the low rated program's office in New York, after it concluded its production schedule in early May. According to a spokesperson for Columbia TriStar Television, "the show is still on the air and no decision has been made on its fate."

Fox has ordered 25 new episodes of its Saturday-night sketch comedy show *Mad TV* for next season. The show, which has been absent from Fox's schedule recently, returned May 25 with a new episode. Repeats of the show will air during the summer in the 11:00 p.m. to midnight time slot. While this is not exactly what I would call award winning and definitely not family fare, *Mad TV* does seem to capture some of the feel of the magazine *MAD* from my childhood. Too bad that the best stuff, Spy vs. Spy, doesn't feature any living breathing actors.

Best known as *The Mommies*, from their now canceled sitcom of the same name, the duo of Caryl Kristensen and Marilyn Kentz are now trying their hands at a daytime talk show. Called *Caryl and Marilyn: Real Friends*, the new one hour program started June 10th on ABC.

Their new show replaced *Mike and Maty*, which has struggled in the ratings since its debut in April, 1994. As housewives and mothers, Kristensen and Kentz say they felt something was missing from typical daytime talk shows. The two say they will offer everyday topics ranging from parenting, relationships and sex, to fashion, fads and food. But what will make their show different is the added element of humor. The program will be taped in Los Angeles. Can you say mid-mid-season replacement.

America's Most Wanted, the Fox program which helped capture 422 criminals and reunite 16 missing children with their families, has been canceled after nine years, to make room for two new comedies. While the network plans on airing *Most Wanted* specials and movies, the show's 40 full-time staffers will be let go in this month.

FBI spokesman Rex Tomb said this week that the cancellation of the show dealt "a serious blow to the cause of modern law enforcement." The show, he said, "successfully empowered millions of Americans to safely and constructively combat crime."

In my recent Internet surfing here is an interesting find, *TV Guide Online*. They began offering the complete editorial section of *TV Guide* magazine at their web site, marking one of the first times that a magazine's virtually entire editorial content will be available online at no cost. *TV Guide Online* is available at: **http://www.tvguide.com**. *TV Guide's* official program listings and grids were made available to *TV Guide Online* earlier this year. Additionally, *TV Guide Online* features celebrity bulletin board guests, a gallery of original *TV Guide* covers, and the latest celebrity gossip.

Courtroom Television Network's (Court TV) Law Center, the network's online reference, resource and discussion area, will provide extensive up to date news, discussions, and source material as well as an audio feed of Court TV's coverage of the Oklahoma City bombing trial on the Internet and America Online. Coverage will commence when the case, scheduled to begin in late fall, goes to trial. Court TV's comprehensive coverage of the trial and collection resource materials will include: Next day availability of audio from the trial using Real Audio technology; daily transcripts and court documents from the trial as it progresses; downloadable courtroom sketches of the trial and additional graphics; online updates to be posted throughout the day by an on-site Court TV reporter; reports from Court TV and American Lawyer Media; an extensive collection of links to related Oklahoma City material and documents; and frequent America Online discussions with Court TV's on-site reporter.

In Closing

As mentioned in the last issue of *Satellite Times*, I have set up a comments form on the Internet for readers of this column. The site is now on a new, faster server at: **http://www.searcher.com/**STcomments.html. Your comments are warmly invited and may even show up in a future issue of *Domestic TVRO*. We'll soon see how closely you really read this column in each issue of *Satellite Times*! ST

By George Wood

A Really Big TVRO Show

The annual Cable and Satellite Show is certainly the biggest TVRO event in Britain every year, and one of the most important in Europe. It's also expanding, and this year's show, held April 15-17, moved from its former location at London's Olympia hall to the relatively new and large second hall at Earl's Court, to make room for the 225 plus exhibitors.

During the three days there were just over 7,400 visitors, a very large number considering the show is trade only, and NOT open to the public.

As I wrote last time, digital satellite television is just getting underway here in Europe. The first generation of digital satellites have gone into orbit, but what broadcasters and viewers alike have been waiting for have been consumer receivers. These were on display for the first time at Cable and Satellite.

Looking down at the hall from the press room above, the two largest stands, from arch-rivals Eutelsat and Astra, were facing off right next to each other on the floor below. Eutelsat was the first in Europe with regular digital broadcasts, from its Hot Bird satellite at 13 degrees East. Viacom uses a single transponder there at 11.283 GHz to transmit the European version of the Sci-Fi Channel using MPEG-2 and the European digital implementation called DVB.

While more MPEG transmissions from coming Hot Birds to be co-located at the same position can be expected, Astra is far ahead of Eutelsat, with its first two all-digital Astra 1E and 1F satellites already in place alongside the earlier analog Astra satellites at 19 degrees East.

Yves Feltes, head of Corporate Public Relations for Astra's owners, Luxembourg's Societe Europeene des Satellites (SES), told me that the 40 digital transponders on the two satellites will provide Astra with the "critical mass" necessary for the introduction of digital satellite packages for the various markets in Europe.

"The big advantage of going digital is clearly that using digital compression technologies, you're going to be able to fit between six and ten channels on a transponder that in analog could only carry one single TV service. So the 40 transponders that are in orbit now are going to provide us with capacity to distribute up to 400 television channels all across Europe," he says.

Broadcasters

Astra's first digital customers include France's Canal Plus (who launched their initially 24 channel digital package on April 23), to be followed by programmers like Nethold, Luxembourg's CLT, the Kirch Group, German public broadcasters ARD/ZDF, and Pro 7. Promised services include more general entertainment channels, Europe's first regular pay-per-view services, and video-near-on-demand, where viewers can access the start of a hit movie every 15 or 30 minutes.

"What digital is going to offer to the consumer," Yves Feltes waxed enthusiastically, "is a considerable multiplication of the programs on offer. There's going to be tailor-made programming, practically allowed the consumer to become his own program director, deciding what he wants to see at what time he wants to see it."

The Canal Plus digital service, called Canal Satellite, and stretching across four Astra transponders, won't be complete until September. Services will include pay-per-view soccer, pay movies, and a computer channel called C:Direct. According to *What Satellite* magazine, the 20 channels will be "staggercasted" with Canal Plus Jaune (Yellow) and Canal Plus Bleu (Blue) broadcasting the same programs but in different time slots. Film channels will be available in both ordinary 4:3 and widescreen 16:9 formats.

Germany's Kirch will be using three Astra transponders for a variety of services, including DF1 to 5 and Cinedom 0 to 4, presumeably for staggered video-nearly-on-demand films. Kirch has signed a five year agreement with Viacom for German-rights to MTV, VH-1, Nickelodeon, and programming from Paramount.

Nethold will be devoting one Astra transponder to Scandinavia, and another to the Benelux. (Nethold is using other satellites for services to Italy, Southern Africa, and the Middle East.)

Cable and Satellite 96 was more international than ever before. Since it's a trade-only show, all the participants wore name tags, and you could see that people came from all over Europe and even parts of the Middle East. The BBC was on hand, for the first time

Digital satellite television is just getting underway here in Europe. The first generation of digital satellites have gone into orbit, but what broadcasters and viewers alike have been waiting for have been consumer receivers. These were on display for the first time at Cable and Satellite.

showcasing its international channels BBC World and BBC Prime, rather than the domestic product.

Many other broadcasters were there was well, from the new European Weather Channel and the Sci-Fi Channel, to several of the rather tame "Adult" channels that are now competing over European satellites, which all featured models showing a bit of flesh.

But the broadcaster that was overwhelmingly conspicuous in its absence was Britain's near satellite monopoly, Rupert Murdoch's British Sky Broadcasting. Apparently BSkyB saved itself a few pounds and decided to let Astra represent it. It was a remarkable absence, but as this year's theme was undoubtedly the arrival of digital satellite broadcasting, Sky's non-appearance was a fair reflection of Sky's fuzzy digital plans.

Having dominated the British satellite scene, both through it's own channels and its distribution/subscription monopoly that takes in other broadcasters, Sky seems in no hurry to spend money doing pioneering work. The message seems to be: Let the Netholds and Canal Pluses do the work, and Mr Murdoch is prepared to follow suit.

Sky's plans really do seem unfocused. Murdoch has allied himself with the Canal Plus-Bertelsmann block in choosing digital standards. It has announced a project with Britain's former independent terrestrial broadcaster Granada to launch an uninspired digital package called Granada Sky Broadcasting. A month after the Cable and Satellite Show, BSkyB announced first that it would be booking half the transponders on an upcoming Astra satellite, to be located somewhere other than 19 degrees East, and then said it and Hughes are considering launching a satellite at the British DBS position of 31 degrees West (formally occupied by British Satellite Broadcasting, which Murdoch bought out) to offer digital channels throughout Europe.

Which, if any, of these plans actually happen, is open to conjecture. Murdoch's newly launched digital services over Asiasat-2 (part of his Star-TV service) or his ambitious American DBS plans with MCI, may affect the European offerings as well.

Receivers

Just about every satellite receiver manufacturer was displaying some kind of DVB receiver at Cable and Satellite 96, although the only company that is actually producing consumer units available in stores so far is the British manufacturer Pace. Nokia and others showed impressive models, but they seem to be largely prototypes that will be appearing on store shelves in a few months.

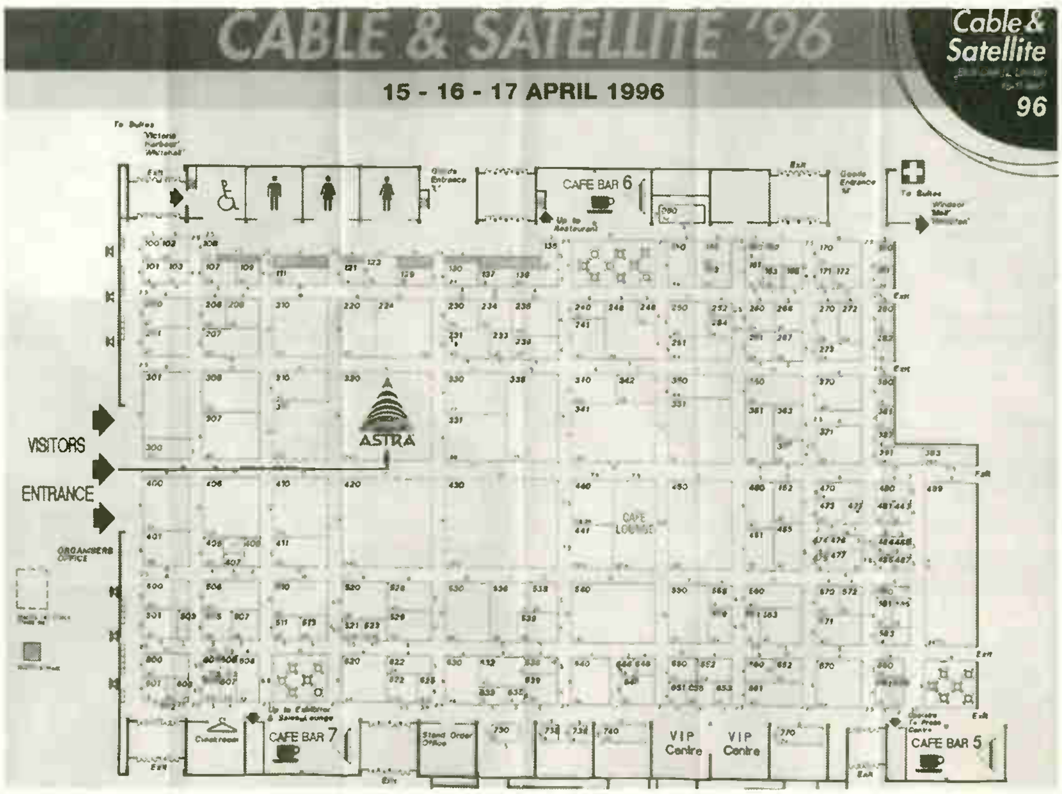
Pace presented its DVS200 MPEG-2 DVB receiver, which includes support for Europe's analog PAL and SECAM standards as well as NTSC, Musicam audio for services like DMX, and an RS232 serial link for interaction with personal computers.

Indeed, as Pace's Jim Beverage told me: "Basically the digital satellite receiver really is quite a complex computer. Because it is a computer, it runs on software, and that software can be configured for a number of different applications."

For example, the DVS200 includes a software download feature that allows easy upgrading of the receiver functions. Even more intriguing is the coming DVS600 model, which was also displayed at Cable and Satellite. This includes an internal V22 bis modem, for pay-per-view and other interactive services. At the Pace demonstration, this receiver was used to access the Worldwide Web on the Internet.

"One of the applications we're looking at," Jim Beverage told me, "is actually utilizing the processors in the memory to run Internet-like applications from the broadcaster. Not just getting into the Internet and surfing the Web, but it's going to be services like those available on the Internet to enhance and augment the broadcasting experience for the viewer."

Whatever that may actually mean, cable has always had the edge in potential interactivity over satellite. Digital systems should



One of the great hopes for digital televison was that one standard, MPEG-2, would replace the incompatible NTSC-PAL-SECAM world of analog television. Unfortunately, Europe is failing poorly in this regard.

bridge that gap, with the built-in modems providing a route back to the broadcaster or the Internet. According the Jim Beverage, while initial receivers carry 14.4 kbps modems, these can be easily upgraded for much faster ISDN return paths.

One of the great hopes for digital televison was that one standard, MPEG-2, would replace the incompatible NTSC-PAL-SECAM world of analog television. Unfortunately, Europe is failing poorly in this regard. Many European broadcasters, such as Canal Plus, BSkyB, and Germany's Bertelsmann, have agreed on a single MPEG decoder system. But maverick German media baron Leo Kirch, having first rejected, then accepted, the joint standard, seems to have once again gone his own way. Nethold, which is launching the first digital services to Italy, Scandinavia, the Benelux, Southern Africa, and the Middle East, seems to have taken the Kirch route as well.

When I asked Pace if they could manufacture a receiver that could accomodate several different decoder systems, I got a rather evasive answer. The bottom line seems to be in the negative, but Pace's Jim Beverage did observe that if broadcasters choose to put their signals over a satellite using multiple systems, then these would be available to people with different boxes.

The chance of this actually happening seems slight, but Viacom, which is working with Kirch in Germany, is working with BSkyB in Britain. So MTV and VH-1 in English may be encoded in one system, while the German versions may use another.

This is one of the reasons why potential buyers of new digital receivers should wait until they see what services are actually being marketed in their areas. Besides, the receivers will probably cost so much that broadcasters will have to subsidize them for subscribers, just as providers of mobile GSM telephone services here in Europe have subsidized cellular telephones to the near give-away point.

Radio

Radio is another reason to hold off. DMX has launched here in Europe, as part of what is called Astra Digital Radio (ADR). In order to create the system, Astra cleared as many of its analog subcarriers as it could. This even included forcing broadcasters to abandon the powerful mono 6.5 MHz subcarriers in favor of the weaker stereo pair at 7.02 and 7.20 MHz (not available to older satellite receivers), in order to provide lots of bandwidth for ADR. The first ADR receivers have had to be programmed for these signals scattered around the transponders, and now with ADR/DMX being marketed in Germany and Britain, you can buy stand-alone receivers from a couple of manufacturers, that cost considerably more than entry-level analog satellite TV receivers.

Most of the free ADR signals are in German, so there's really little interest outside of Germany, Austria, and Switzerland. Why would anyone want to spend several hundred dollars (or pounds) on an ADR receiver, when they will be able to buy a less expensive MPEG-2/DVB TV receiver within a few months? The DVB receivers won't be able to tune into the various ADR channels scattered here and there. But, as DMX's Richard Hurst-Wood told me, they are signing agreements with Nethold and other broadcasters to provide DMX along with the digital TV stream. The independent ADR/DMX channels may just be a temporary phase, replaced by the broader MPEG multi-channel streams.

So, while Cable and Satellite was a great showcase for the Dawn of the Digital Age in European TVRO, the apparent message was to wait and see.

Meanwhile, moving away from Europe, there are new digital radio services to Asia and Africa, thanks to the World Radio Network, which has added newservices to its previous analog relays of some 20 international broadcasters to Europe via Astra and to North America via Galaxy 5.

The African relays are on the new Intelsat 707 satellite at 1 degree West, on 3.915 GHz, in MPEG-2 on the audio 8 channel. The Asian-Pacific service is part of a European radio package on Asiasat-2 at 100.5 degrees East, transponder 10B at 4 GHz, also in MPEG-2 as part of the DVB audio stream.

Meanwhile, I can't write about the Dawn of the Digital Age in satellite radio, without mentioning Radio Sweden's bold new digital venture that began on May 20th. After months of preparations, weeks of construction, and far too few days of training, Radio Sweden tossed out the analog tape recorders, closed the analog studios, and said goodbye to all the studio engineers, as the entire broadcast chain went digital.

Nowadays, reporters either record their telephone interviews directly into one of the special computer workstations, or copy in their DAT interviews. They record their own continuity in the computer, then edit their stories, finally saving them to the main datebase.

Each day's presenter/producer

There are new digital radio services to Asia and Africa, thanks to the World Radio Network, which has added new services to its previous analog relays of some 20 international broadcasters to Europe via Astra and to North America via Galaxy 5.

then calls up desired stories, jingles, and music from the database, composing that day's program in a similiar workstation. When it's time for the broadcast, the computer plays the recorded sound automatically, with the presenter adding continuity between the stories in a special broadcast computer booth. The computer records the entire program, and, with some editing, and provision for the inclusion of live news, plays it back automatically when called for in the schedule.

The system Radio Sweden uses is called RadioMan. It was originally developed by a Finnish company called Jutel for use by small commercial stations, and was totally revamped for the needs of a news-oriented public service broadcaster. While the listener may not notice much beyond the occasional missing program when the system crashes, for the broadcasters it's a whole new world, with the comfortable and familiar control room/studio combination of engineer and presenter, tapes and music players (turntables or CDs) replaced by a more lonely existance in front of a computer screen.

Ironically, with the switch to RadioMan, sound has disappeared from Radio Sweden's Worldwide Web pages, as the two systems are initially still incompatible.

In other Web news, Eutelsat and Astra finally launched their sites just before the Cable and Satellite Show:

http://www.eutelsat.org and http://www.astra.lu

Despite owning his own Internet provider (Delphi) Rupert Murdoch has been slow in putting British Sky Broadcasting on the Web. It's finally appeared at: **http://www.sky.co.uk**

And what may ultimately replace this column someday (although I hope not) can be found in the excellent SATCO DX listing of the Clarke Belt at:

http://www.satcodx.com

But in the meantime, Radio Sweden's MediaScan is at:

http://www.sr.se/rs/english/media/media.htm

Thanks to Frank Oestergren, James Robinson, and Curt Swinehart for their many contributions. Don't forget the e-mail address is: **wood@rs.sr.se** ST

LIST OF DIGITAL TELEVISION ON ASTRA 1E

Transponder 66
Canal Satellite, Canal Plus, Canal Plus Janune, Canal Plus Bleu, Mosa, Monte Carlo, Eurosport, Canal J, and Planete

Transponder 68
Canal Satellite, Voyage, Meteo, LCI, CNN, Canal Jimmy, MCM, and Premiere

Transponder 69
Kirch, Comedy, Junior, Star Kino, CMT, and DF 1

Transponder 70
Canal Satellite and Kiosque 1 till 6

Transponder 71
ARD/ZDF, VH-1, MTV, ZDF, and ARD

Transponder 72
Canal Satellite, Cine Cinefil, Cine Cineams 1, Cine Cinemas 2, Cine Cinemas 3, Muzik, Canal Plus, and Cine Cinemas

Transponder 74
SES (Astra)

Transponder 77
Nethold-Nordic:- Filmnet 1 Nordic, Filmnet 2 Nordic, Supersport Nordic, Hallmark, TV Norge, and Kanal 5

Transponder 79
Kirch:- DF1 till 5

Transponder 80
Nethold-Benelux:- Filmnet Benelux, Supersport Belgien, Supersport Holland, Hallmark, SBS 6, and VT4

The following channels are also reported to be in the Nethold packages:

Video: BET On Jazz, Travel Channel, Weather Channel, Performance Art Channel, Bloomberg Information, CNBC, European Business News, Giva TV, MS NBC (Microsoft-NBC computer channel), Discovery, NBC Super Channel, and TCC (The Children's Channel)

DMX audio: Symphonic, Country, Techno, Reggae, Great Singers, European Hits, Opera, Love Songs, Contemporary, New Age, Jazz Classic, Rock Classic, Latin, Norwegian, Danois, Classic och Soul.

Transponder 81
Kirch:- Cinedom 0 till 4

Transponder 83
Sky Sports, Sky Movie, Sky One, Sky News

Thanks to Frank Oestergren of Aftobladet:

ON THE AIR

By Steve Handler

Viewing Ariane/NASA Space Launches

With a slight tropical breeze and the Atlantic ocean on its door, the Ariane 42P booster stood tall and erect on the pad at Kourou, ready for launch. Mission 85 would take the MSAT-1 satellite owned by Canada's TMI into orbit. Thanks to the AT&T Galaxy 4 satellite, I watched the live broadcast of the launch. Only people assembled at the launch site had a better view.

Arianespace missions are launched from the European Space Agency's Guyana Space Center, located in Kourou, Guyana, South America. Kourou's equatorial location permits launches to take advantage of the "slingshot effect" of the earth's rotation. This reduces fuel burning maneuvers geostationary satellites require to place them into their proper orbit.

The hour-plus broadcast of the launch, covered both pre and post-launch activities. The English language narration provided by Mesui Ciceker and Joshua Jampol was both entertaining and educational. Numerous explanations of terms and procedures were included. Even a layman would understand the events as they transpired.

To fill some of the pre-launch "dead" time, taped video was aired in-between the live coverage. These video films were well produced. One video explained the assembly of the three booster stages of the Ariane 4. Another film gave a short company retrospective about Arianespace.

Two different videos covered the MSAT-1 satellite, including one about its transportation and preparation at the launch site. MSAT-1 was built for TMI International of Canada and is located in a geostationary orbit, at 106.5 degrees West. Designed and built by Spar Aerospace in Ottawa, Canada, it uses a platform supplied by Hughes Space and Communications. It provides mobile communications services in North America, including Canada and Central America.

A video-taped guided tour of the telemetry and tracking center provided a birds eye view of the facility. An explanation and film of the gantry withdrawal was the subject of another video.

In-between the videos, abundant live shots of the launch vehicle and control center provided the viewer with a sense of "being there." During the live coverage, a countdown clock was shown on the lower left portion of the screen.

As the cameras panned the Jupiter 2 control center, the narrators pointed out members of Arianespace's staff, such as the Director of Operations as well as VIPs attending the launch, and provided brief bits of background on their careers.

The new Jupiter 2 control center was inaugurated and put into service during flight 82. It contains an operations room, press center, digital video control room, and large guest room. The workstations and counsels in the operations room are staffed by launch personal, including the mission manager, flight manager, operations manager, and ground facilities managers. Additionally, the payload customers also have representation in the operations room.

A large video screen in Jupiter 2 provided video from cameras at the launch site. During pre-launch, it also displayed information about the launch vehicle's status, as well as the countdown. Duiring post-launch, the right side of the video screen provided flight details, including elapsed mission time, booster altitude, and velocity. For a successful launch the satellite needed to achieve a velocity of roughly 10 km/sec.

The torch-like flames of the Ariane 4 Viking engines graced the video screens at launch, and the roar of the engines filled the control room. As the booster moved upward in the nighttime sky, video shot from an infrared camera allowed for extended viewing.

The trajectory of the launch vehicle was tracked and displayed on another large video screen. An explanation of the booster separation of stage 1 was provided by the narrators. Separation of "COIF" was also explained.

The COIF is a protective covering (called a fairing) that surrounded the

The Jupiter 2 Control Room at the Guyana Space Center is the heart of the Arianelaunch facility. (Arianespace)

The torch-like flames of the Ariane 4 Viking engines graced the video screens at launch, and the roar of the engines filled the control room. As the booster moved upward in the nighttime sky, video shot from an infrared camera allowed for extended viewing.

MSAT-1 payload, which separates from the launch vehicle when it is outside of the atmosphere and protection is not needed. A video animation showed the separation of stage two.

Tracking station information showing the handoff in tracking coverage from Kourou to Natel, Brazil, then to Ascension Island, and finally to Libreville, Gabon, also was provided on-screen.

Following the post-launch coverage, speeches from officials of Arianespace as well as TMI were aired.

Mission 85 (V85) lifted off at 6:36 p.m. EDT on Saturday, April 20, 1996, following a string of 15 successful Arianespace launches within a 13 month period. The 55 meter tall Ariane 42 P which was used for the launch, is a version of the three stage Ariane 4 booster with two solid strap-on boosters attached.

Arianespace launches a satellite about once a month. Coverage of these launches on C-band is not limited to a specific domestic satellite or transponder. It appears that those Ariane missions where either the satellite was manufactured by an American company or where the satellite is owned by an American company have domestic coverage available for US and Canadian viewers. Mission 85 was televised using channel 7 on the Galaxy 4 satellite.

Ariane doesn't have a monopoly on satellite launches from expendable launch vehicles. Each year a number of Delta, Altas, and Titan launch vehicles carry satellites aloft from both Cape Canaveral and Vandenberg Air Force base. These rockets, as well as the Ariane 4 and 5 boosters are known as expendable launch vehicles (ELV). An ELV is used only once and not recovered or recycled.

There are a number of sources that provide information about upcoming launches, sometimes including the specific satellite and channel that will carry the event.

The Ariane 42P awaiting launch to place the MSAT-1 satellite into orbit. (Arianespace)

NASA's Kennedy Space Center — Expendable Launch Vehicles Directorate — maintains an ELV launch information site on the Internet's World Wide Web. It contains detailed information about upcoming ELV launches from the Cape, as well as other NASA launch facilities at Vandenberg AFB and Wallops Island. The web site provides links for more detailed information about unclassified launches.

Information about which satellite and transponder will be providing live coverage of the launch is often available several days prior to a scheduled launch. By clicking on "Full uplink information is available here," you are transported to another web page with detailed information about the launch time, launch windows and satellite uplink. Try **http://www.ksc.nasa.gov/elv/lau_info.htm** for NASA's ELV world wide web site.

Launch information is also available from the U.S. Air Force's 45th Space Wing located at Patrick Air Force Base. They also have a web site. It lists the Cape Canaveral Air Station launch schedule and links you to additional sites for more detailed information about specific unclassified launches. Their WWW site is located at **http://www.pafb.af.mil/launches/mainlnch.htm**.

Another site of interest to those with Internet web access is Hughes Communications, Inc's located at: **http://www.hcisat.com**. It contains interesting information about the company and their satellite fleet. This web site has their quarterly magazine online, a What's New section, current and past press releases about upcoming launches, a page called Satellite 101 that provides a detailed glossary of satellite terminology and buzzwords, and detailed information about the fleet of satellites HCI owns and operates.

Postings on several newsgroups available via the Internet also

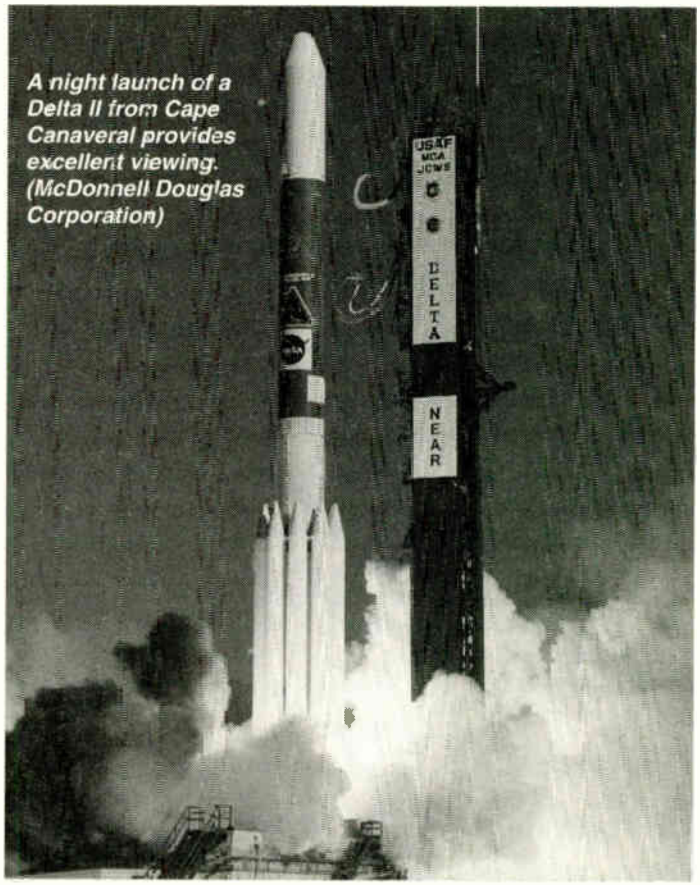
If do not have access to the Internet, a telephone call to (407) 494-6397 will provide you with recorded information on Cape Canaveral ELV launches. For space shuttle launch information, contact NASA at (407) 867-4636.

include launch information and occasional uplink information. The newsgroup **rec.video.satellite.tvro** has postings that includes general information about C-band and Ku-band TVRO satellite viewing. The newsgroup **sci.space.shuttle** is primarily devoted to information about the space shuttle, NASA press releases, and information about shuttle launches. Finally, the newsgroup **sci.space.news** carries announcements of space-related news items including NASA mission status and launch updates, and announcements of astronomical events of widespread interest.

If you do not have access to the Internet, a telephone call to (407) 494-6397 will provide you with recorded information on Cape Canaveral ELV launches. For space shuttle launch information, contact NASA at (407) 867-4636.

If you know the launch time, but do not know on which satellite and channel it will be broadcast, you can still try to hunt for the broadcast. I would suggest beginning about an hour and a half before the scheduled launch, and searching all of the probable satellites that may be carrying the feed.

Possible satellites to check include Hughes Communication's Galaxy 3/4/7 and AT&T's Telstar T-401/T-402R. During a recent Ariane broadcast, I noticed the pre-launch broadcast being set up using an ID slate with the words "France Telecom" at the bottom of the screen and a rolling picture. Shortly after the picture stabilized the broadcast began.



A night launch of a Delta II from Cape Canaveral provides excellent viewing. (McDonnell Douglas Corporation)

NASA TV — Two for One

Speaking of space launches, NASA TV is located on GE Americom's Spacenet SN-2 (also called S2), channel 9. It carries all space shuttle launches live from pre-launch coverage through post touchdown coverage. This includes live TV from mission control, mission press briefings, and TV/audio from the shuttle. In addition to channel 9, NASA also has a scrambled channel in use during shuttle flights on Spacenet 2, channel 5.

The landing of Columbia for Mission STS-75 was broadcast live on NASA TV. (NASA)

During the March flight of STS-76, channel 5 was observed operating in the clear. At times, the video on both channels 5 and 9 carrying the same broadcasts. If for some reason you are unable to receive Spacenet 2, you should also check Galaxy 4, channel 24. CBS Newspath, which operates on this channel, often carries the launch and landing of the shuttle.

For general information about NASA TV as well as programming details, visit their web site at: **http://www.hq.nasa.gov/office/pao/Television/ntvtext3.html**. ST

LISTENING POST

By Keith Stein
kstein@erols.com

The VHF High Band

Before you start reading this issue of the Listening Post, this is what I want you to do. Close your windows, pull down the shades, draw the drapes, and lock your doors. We're going to be talking about military surveillance from space.

For those readers who are tired of seeing the same old beginners columns on monitoring amateur, weather, and Russian navigation satellites; this column will cover a portion of the spectrum that will be challenging to the listener. In this edition of the *ST Listening Post*, we are going to cover the 150.1 to 225 MHz or VHF high band. In this area of the radio spectrum, you will find satellites that perform geodetic research, electronic intelligence gathering, communications, and earth imaging. We have a lot to cover, so lets get right into it.

Geodesy and Mapping

Since 1962, Russian and U.S. geodesy and mapping satellites have helped establish the coordinates of any point on Earth, accurately determine the shape of Earth, and assisted in producing accurate topographic maps. These measurements are produced by simultaneous ground based observations of earth orbiting satellites from around the world. Parameters recorded during these observations are:

- Distance to the satellite
- Change in speed
- Orientation

A series of Russian satellites, named GEO-IK, are launched by SL-14 Tsyklon boosters into a orbit around 1,500 km that is inclined between 73.6-82.6 degrees. The on board transmitter operates for up to 12 hours daily.

The U.S. also orbits geodetic missions. These have been primary military flights launched by DoD. Frequency tables in Larry Van Horn's out of print book *Communications Satellites*, indicate that Russian and U.S. Geodetic satellites have monitored on the following frequencies:

150.300	Russia	PCM	Cosmos geodetic research satellites
216.000	US Navy	Carrier	Military geodetic sats/(SURCAL)

ELINT

The best way to describe an electronic intelligence (ELINT) satellite is think of it as a communications receiver in orbit. ELINT's are used to pinpoint the location of enemy defense radars, and determine their range and signal characteristics. These satellites are also used to locate military transmitters and intercept communications. Russia started launching ELINT birds in 1970.

Since then, a second and now a third generation ELINT satellite variant have been flown by the Russians. The second generation Tselina ELINTs have been monitored on six frequencies in the VHF high band. Frequencies for the new third generation heavy ELINTS have not been discovered. Searching through the following frequencies may still provide some sporadic activity for the older ELINTs:

153.000	Russia	CW	Cosmos Tselina second generation ELINT — third harmonic of 51.000 MHz
153.420	Russia	CW	Cosmos Tselina second generation ELINT — third harmonic of 51.140 MHz
153.480	Russia	CW	Cosmos Tselina second generation ELINT — third harmonic of 51.160 MHz
204.000	Russia	CW	Cosmos Tselina second generation ELINT — fourth harmonic of 51.000 MHz
204.560	Russia	CW	Cosmos Tselina second generation ELINT — fourth harmonic of 51.140 MHz
204.640	Russia	CW	Cosmos Tselina second generation ELINT — fourth harmonic of 51.160 MHz

Store-Dump Communication Satellites

These satellites are launched from Russia's Plesetsk Cosmodrome in northern Russia by a SL-8 Cosmos booster. These systems are placed in a 785-810 km orbit inclined 74 degrees. These 875 kg spacecraft receive information from low power transmitters around the world and store the data until they are positioned over a ground station to downlink. Over 48 of these satellites have been launched since 1970, used mainly by Russian Defense Forces.

153.600	Russia	CW	Cosmos Store-Dump communications satellite — third harmonic of 51.200 MHz
153.660	Russia	CW	Cosmos Store-Dump communications satellite — third harmonic of 51.220 MHz
153.720	Russia	CW	Cosmos Store-Dump communications satellite — third harmonic of 51.240 MHz
204.800	Russia	CW	Cosmos Store-Dump communications satellite — fourth harmonic of 51.200 MHz
204.880	Ruusia	CW	Cosmos Store-Dump communications satellite — fourth harmonic of 51.220 MHz
204.960	Russia	CW	Cosmos Store-Dump communications satellite — fourth harmonic of 51.290 MHz

Chinese Imaging Satellites

Various Chinese imaging satellites have also been reported in the high band VHF range. A couple of the frequencies to watch include: 179.985 and 180.000 MHz

Russian Manned Spacecraft

Among all these surveillance and intelligence frequencies noted above, you can even monitor some manned spacecraft data transmissions. The next time a crew is launched to Russia's Mir space station, check out 166.000 MHz in wideband FM when the

The best way to describe an electronic intelligence (ELINT) satellite is think of it as a communications receiver in orbit. ELINT's are used to pinpoint the location of enemy defense radars, and determine their range and signal characteristics.

Soyuz TM vehicle passes over your area. Not a very easy signal to catch, but give it a try and let us know what you get.

NAVSPASUR Space Surveillance System

Known as the electric fence and part of the Space Surveillance Network, the Naval Space Command operates several 216.980 Mhz transmitters and receivers which cover the whole southern United States. What do these transmitters and receiver do? They track everything and anything in earth orbit as objects penetrate the electric fence.

Transmitters are positioned at Lake Kickapoo, Tex; Gila River, Ariz.; and Jordan Lake, Ala. Receive sites for the fence are located in San Diego,Calif; Elephant Butte, N.M.; Silver Lake, Miss; Red River, Ark; Tattnall, Ga; and Hawkinsville, Ga. The Hawkinsville and Elephant Butte are for high altitude satellites while the rest handle low altitude orbital intercepts. All data from these sites is then processed at Naval Space Command Headquarters in Dahlgren, Va. This system provides major input to the famous two-line orbital elements we all have come to know and love.

Launch Sites, Space Centers and Aircraft

We have mentioned this several times in LP, but this column isn't going to just stick to orbiting satellites frequencies. A look into some of the frequencies used at launch sites, space centers and space agency aircraft is always welcomed—anything space related. Even listings for security and maintenance frequencies used by ground personnel will be covered. My trip in August 1995, to NASA's Wallops Flight Facility, Va. revealed the following active frequencies:

156.600	NASA Control and Coast Guard support vessels
164.700	NASA Range Safety Net
170.350	NASA Wallops Island Security
170.400	NASA Wallops Flight Facility Paging System
171.000	NASA Wallops Island Security

Listening Post Intercepts

All times in UTC. All voice transmissions in English unless otherwise noted. Abbreviations used in this column:

AFB	Air Force Base	LSB	Lower Sideband
AMSAT	Radio Amateur Satellite Corporation	MHz	MegaHertz
		N	North
ARIA	Advanced Range Instrumentation Aircraft	NASA	National Aeronautics and Space Administration
APT	Automatic Picture Transmission	NFM	Narrow FM
		NOAA	National Oceanic and atmospheric Administration
DoD	Department of Defense	RTB	Return to Base
E	East	STS	Space Transportation System
FLTSATCOM	Fleet Satellite Communications	USB	Upper Sideband
G	Gigahertz	USCGC	U.S. Coast Guard Cutter
H	Horizontal Polarization	UTC	Coordinated Universal Time
HF	High Frequency		
K	kiloHertz	W	West
LoS	Loss of Signal	WBFM	Wideband FM

K3840	AMSAT North America East Coast Net heard at 0208. LSB with net control station located in Philadelphia, PA. (Keith Stein-Woodbridge, VA)
K5711	A simulated space shuttle launch bailout operation was performed for mission STS-77. The "crew" bailed out around 1315 with "rescue ops" starting immediately. They picked up the crew from the water around 1400 with some "injured" and flew them to Holmes Regional Medical Center in Melbourne, FL. Stations heard included: Cape Radio, DoD Cape, AIRBOSS, MOONSHINE, USS Taylor, USCGC Dauntless, KINGs 1-3, CLEARANCE 1, HAWKEYE 1. Also mentioned were JOLLY 1 through 4, but not heard on this net. (David E. Crawford-Gainesville, FL)
K9043	Space Shuttle Countdown Demonstration Test (mission STS-77) was monitored at 1500 using USB and included a simulated orbiter-ditching (Mode 8 bailout) in the Atlantic (at 27N33 79W46). (Crawford-FL)
K13218	Abnormal (Vandenberg AFB), ARIA 2 (EC-18 or EC-135 aircraft), ARIA Control, and others heard at 1750 in USB. Other frequencies used: 10352, 13900, 14987, 11110, 15793 and 17560 all USB. (Jeff Jones-San Francisco, CA) *Probably tracking Titan 4 launch carrying classified satellite-Keith.*
M119.100	Aircraft heard at Washington National Airport, VA: NASA 8 (Beech 200) landing at 1125. NASA 1 (Gulfstream-1159A) departing at 1212. NASA 948 (Gulfstream-1159) departing at 2036, all using AM mode. (Stein-Washington DC)
M126.500	NASA 426 (P-3B aircraft) heard conducting instrument checkout flights of Global Tropospheric Experiment at 0010 in AM. (Stein-VA)
M137.500	APT imagery was received from NOAA 12 at 0800 using NFM. (Tromso Satellite Station-Norway)
M137.620	APT imagery was received from NOAA 14 at 0214 using NFM. (Tromso Satellite Station-Norway)
M139.205	Radio traffic from U.S. space shuttle was monitored just before docking with the Russian space station Mir in NFM. Docking occurred about 0233. (Christian Mass-The Netherlands) *The center frequency is actually 139.208 MHz and is only used by the shuttle when docking with Mir-Keith*
M142.600	Russian and German language heard from Mir space station crew at 1152 using NFM. (Eric Brandon-Roswell, GA)
M143.625	Mir radio traffic was monitored at 0230 during the docking maneuver with the U.S. space shuttle. The docking took place about three minutes after LoS of the signal. (Jose EA6IC-Mallorca Island, Spain)
M145.550	U.S. astronaut/cosmonaut Shannon Lucid was heard at 1400 using NFM with a "very strong signal" using the callsign R0MIR. (Jeff Brower-Western U.S.)
M147.450	Amateur radio station WA3NAN providing retransmission of space shuttle air-to-ground communications (mission STS-76) at 0234 in NFM. (Stein-VA)
M170.305	Wireless mike being used during a management assessment meeting at NASA Headquarters. 1504 using NFM. (Stein-DC)
M171.045	Wireless mike being used during internal Reduction In Force (RIF) briefing at NASA Headquarters auditorium at 1322 using NFM. (Stein- DC)
M171.905	Wireless mike being used during internal Reduction In Force (RIF) briefing at NASA Headquarters auditorium at 1230 using NFM. (Stein-DC)
M261.850	FLTSATCOM 4 (172 degrees East) between 0100-0240, EAGLE talking with EAGLE-4 and Barracuda regarding a HF antenna (inverted V) and problems receiving HF at some other location. Instructions were given to line the antenna up on 78 degree azimuth and to conduct tests on HF. EAGLE-4 and BARRACUDA conducted tests on 9.750 MHz for nearly an hour, but could barely copy the CW ident they were sending each other (Phil Pittard-Mount Gambier, Australia)
M261.925	FLTSATCOM 4 (172 deg. E) at 0232. Unknown station calling what sounded like MIKE 4 CHARLIE, no response. Activity ceased after 4 calls. (Pittard-Australia)
M408.400	NASA Headquarters security units Alpha 5, Alpha 7, Alpha 11, Central and Dispatch conducting routine surveillance of building at 1143 in NFM. (Stein-Washington, DC)
M463.725	NASA Headquarters building maintenance channel heard at 1410 using NFM. (Stein-Washington, DC)
G5.800	The Lois and Clark wildfeed, which has been gone for some time returned to its regular spot on Galaxy 4 (99.0 degrees West), transponder 18 at 0830, audio on 5.8L/6.2R/6.8M (David Stager)
G10.862	Astra 1D (19.1 degrees East) providing live video of Astra 1F launch aboard Russian Proton booster at 2225. (Stefan Hagedorn-Germany)
G11.499	Intelsat K (21.5 degrees West) providing live video of Astra 1F launch aboard Russian Proton booster at 2225. (Hagedorn-Germany)
G11.525	Intelsat K (21.5 degrees West) providing live video of U.S. space shuttle docking with Russian space station Mir at 0200. (Ivan Artner-Budapest, Hungry)

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INTRODUCTION

The Satellite Services Guide (SSG) is designed to keep the satellite listening enthusiasts up to date with the latest information available on a wide variety of hard-to-obtain space and satellite information. Many hours of personal observations and contributor reports have been compiled into this section. Errors are bound to happen, especially since services and elements sets change often, and geostationary satellites constantly change orbital positions. Care has been taken to check the accuracy of the information presented and it does represent the most current information available at press deadline.

How to Use the Satellite Service Guide

The various sections of the SSG include:

1. **Satellite Radio Guide** — This is a listing of audio subcarrier services that can be heard with a standard C-band (3.7 - 4.2 GHz) and in some cases a Ku-band (11.7-12.2 GHz) TVRO satellite system (no additional equipment is required). Services are broken down into various categories and provide the user with the satellite/transponder number and frequencies in megahertz of the various audio channels. These audio subcarriers are broadcasting on active TV channels that are either scrambled or not scrambled. You do not need a subscription for any of the radio services listed. Tuning in to an audio subcarrier will disrupt the TV sound, but not the TV picture. Listings with a 'N' are narrow bandwidth, 'DS' indicates discrete stereo.

2. **Single Channel Per Carrier (SCPC) Services Guide** — A SCPC transmitted signal is transmitted with its own carrier, thus eliminating the need for a video carrier to be present. Dozens of SCPC signals can be transmitted on a single transponder. In addition to a standard TVRO satellite system, an additional receiver is required to receive SCPC signals. Most SCPC signals will be found in the C-band.

3. **International Shortwave Broadcasters via Satellite** — This section of the SSG list all the various shortwave radio broadcasters currently being heard via satellite audio channels. Most of the channels listed are audio subcarriers and only require a C-band TVRO satellite system to monitor these broadcasts.

4. **DSS/USSB/Primestar Channel Listings** — This is a complete channel guide at press deadline of the channels and services found on the various direct broadcast satellite systems transmitting in the Ku-band (12.2-12.7 GHz). Addresses and telephone numbers are provided so that the reader can obtain additional information direct from the providers. We would be grateful if you would mention to these providers that you heard about their service from *Satellite Times* magazine.

5. **Satellite Transponder Guide** — This guide list video services recently seen from satellites transmitting in C-band located in the U.S. domestic geostationary satellite arc. A standard TVRO satellite system is required to view these services. White boxes indicated video services in the clear or non-video services. Gray shaded boxes indicated video services that are scrambled using the VideoCipher 2+ encryption system and are only available via subscription. Black boxes are video services that are scrambled using various other types of encryption schemes and are not available in the U.S. Transponders that are encrypted have the type of encryption in use listed between the brackets (i.e. - [Leitch]). O/V indicates that wild feeds, network feeds and other random video events have been monitored on that transponder. (none) means that no activity of any kind has been observed on the transponder indicated.

6. **Ku-band Satellite Transponder Services Guide** — This section of the SSG performs the same service as the C-band Satellite Transponder Guide listed above, but covers signals found in the Ku-band from 11.7 to 12. 2 GHz.

7. **Amateur and Weather Satellite Two Line Orbital Element Sets** — This section of the guide presents the current (as of press deadline) two line orbital element sets for all of the active amateur and weather satellites. These element sets are be used by computerized orbital tracking programs to track the various satellites listed.

8. **Geostationary Satellite Locator Guide** — This guide shows the space catalog object number, International payload designator, common name, location in degrees east/west and type of satellite/frequency bands of downlinks for all active geostationary satellites in geostationary orbit at publication deadline.

9. **Amateur Satellite Frequency Guide** — This guide list the various amateur radio satellites (hamsats) and their frequency bandplans. Most of the communications you will hear on these satellites will utilize narrow bandwidth modes of operation (i.e- upper and lower sideband, packet, RTTY, morse code). *Satellite Times* would like to thank the officers and staff of AMSAT for this use of this chart in the magazine.

10. **Satellite Launch Schedules** — This section presents the launch schedules and proposed operating frequencies of satellites that will be launched during the cover date of this issue of the magazine.

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

AUDIO SUBCARRIERS

An audio sub-carrier requires the presence of a video carrier to exist. If you take away the video carrier, the audio sub-carrier disappears as well. Most TVRO satellite receivers can tune in audio subcarriers and they can be found in the range from 5.0 to 9.0 MHz in the video carrier.

Audio frequencies in MHz, All satellites/transponders are C-band unless otherwise indicated. DS=Discrete Stereo, N=Narrowband, W=Wideband

Classical Music

KUCV-FM (90.9) Lincoln, Neb. (Nebraska Public Radio)	S3, 2/4	5.76/5.94 (DS)
SuperAudio — Classical Collections	G5, 21	6.30/6.48 (DS)
WFMT-FM (98.7) Chicago, Ill.	G5, 7	6.30/6.48 (DS)
WQXR-FM (96.3) New York, N.Y., ID-*96.3 FM*	C4, 15	6.30/6.48 (DS)

Satellite Computer Services

Planet Connect, Planet Systems, Inc 19.2 kbps srvc.	G4, 6	7.398
	T402R, 4	7.398
Planet Connect, Planet Systems, Inc 100 kbps srvc.	G1, 9	7.80
	T402R, 4	7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
	T402R, 4	7.264
	G4, 6	7.264
Storyvision	G5, 3	7.30
Superguide	G5, 7	5.48

Contemporary Music

Radio Romance (from Philippines)	G4, 24 (Ku-band)	6.20
Safeway In-Store Radio — contemporary	S3, 18	5.96, 6.48
SuperAudio — *Light and Lively Rock*	G5, 21	5.96, 6.12 (DS)

Country Music

CINC-FM (96.3) Thompson, Manitoba	E2, 2	6.40
Safeway In-Store Radio — country	S3, 18	6.12
SuperAudio — *American Country Favorites*	G5, 21	5.04/7.74 (DS)
Transtar III radio network	S3, 9	5.76/5.94 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, Tenn., ID-*The Hit Kicker*	E2, 18	6.20
WSM-AM (650) Nashville, Tenn.	C4, 24	7.38, 7.56

Easy Listening Music

Easy listening music, unidentified station	G4, 6	7.69
Safeway In-Store Radio — easy listening	S3, 18	6.32
SuperAudio — *Soft Sounds*	G5, 21	5.58/5.76 (DS)
United Video — easy listening	C4, 8	5.895 (N)

Foreign Language Programming

Antenna TV (Greece)	T3, 22	5.85
Arab Network of America radio network	G6, 10	5.80
CBC Radio-East (French)	E2, 1	5.38/5.58 (DS)
E2, 1	7.36	
CHIN-AM/FM (1540/100.7) Toronto, Ontario Canada, ID-*CHIN* — multilingual	E2, 2	7.89
DZMM-Radyo Patrol (from Philippines)	G4, 24 (Ku-band)	6.80
French language audio service	E2, 11	6.12
India ethnic radio	E2, 2	7.61
Indian Sangeet Sager	E2, 16 (Ku-band)	6.12
Irish music (Sat 1430-0000 UTC)	S3, 3	6.20
KAZN-AM (1300) Pasadena, CA — Asian Radio	K2, 8 (Ku-band)	6.20
Northern Native Radio (Ethnic)	E2, 26 (Ku-band)	6.43/6.53 (DS)
RAI Satelradio (Italian)	G7, 14	7.38
Radio Canada (French)	E2, 11	5.40/5.58 (DS), 5.76
Radio Dubai (Arabic)	G7, 10	7.48
Radio Maria (Italian-Religious programming)	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Sedeye Iran (Farsi)	S3, 15	6.20 (N)
Radio Tropical (Haitian Creole)	S2, 11	7.60
Radio Otto (Italian)	T402R,18	5.80
	T3, 22	6.2, 6.8 (occ use on this satellite/ transponder)
Russian-American radio network	SBS5, 14 (Ku-band)	6.20
Trinity Broadcasting radio service (Spanish) SAP — religious	G5, 3	5.96
WCMQ-FM (92.3) Hialeah, Fla. (Spanish), ID-*Mega 92* — contemporary hit radio	S2, 4	7.74, 7.92
WCRP-FM (88.1) Guyama, P.R. (Spanish) — religious	G4, 6	6.53
WLIR-AM (1300) Spring Valley, N.Y. (Ethnic)	S2, 1	7.60
XEW-AM (900) Mexico City, Mexico (Spanish), ID-*LV de la America Latina*	M2, 8	6.80
XEW-FM (96.9) Mexico City, Mexico (Spanish), ID-*W-FM 96.9*	SD1, 7	7.38
XEWA-AM (540) Monterrey, Mexico (Spanish), ID-*Super Estelar* — contemporary music	M2, 8	7.38
XEX-AM (730) Mexico City, Mexico (Spanish), ID-*Frecuencia Libre*	M2, 14	7.38

Jazz Music

KLON-FM (88.1) Long Beach, Calif., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio — *New Age of Jazz*	G5, 21	7.38/7.56 (DS)
WQCD-FM (101.9) New York City, N.Y., ID-*CD 101.9, Cool FM*	C4, 6	6.20

News and Information Programming

Arkansas Radio Network	G4, 6	6.20
Business Radio Network	C4, 10	8.06 (N)
E2, 2	7.43 (N)	
Cable Radio Network	C3, 23	7.24 (N)
CNN Headline News	G5, 22	7.58
CNN Radio News	S3, 9	5.62
G5, 5	7.58	
Standard News	S3, 17	5.20
USA Radio Network — news, talk and information	S3, 13	5.01 (Ch 1), 5.20 (Ch 2)
WCBS-AM (880) New York, N.Y. — news	G7, 19	7.38
WCCO-AM (830) Minneapolis, Minn.	G6, 15	6.20
WGN-AM (720) Chicago, Ill./Interstate Radio Network (overnight) — talk	E2, 2	5.22

Religious Programming

Ambassasor Inspirational Radio	S3, 15	5.96, 6.48 (DS)
American Spirit Network/KYND-AM (1520) Houston, Tex. — Religious/variety (weekends)	S3, 24	7.40
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5, 11	6.12
C3, 1	6.20	
Christian Music Network Lakeland, Fla	S2, 21	6.20, 7.60
Eternal Word Radio Network	G1, 11	5.40
Heaven Radio Network	G1, 17	7.92
Inspirational Music (no ID)	G5, 6	7.38
KHCB-FM (105.7) Houston, Tex.	C1, 10	7.28
Salem Radio Network	S3, 17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WHME-FM (103.1) South Bend, Ind, ID-*Harvest FM*	G4, 15	5.58/5.78
WROL-AM (950) Boston, Mass. (occasional Spanish)	S3, 3	6.20
Z-music — Christian rock	G1, 6	7.38/7.56

Rock Music

CILQ-FM (107.1) Toronto, Ontario Canada, ID-*Q-107*	E2, 2	5.76/5.94 (DS)

Satellite Radio Guide

Safeway In-Store — oldies	S3, 18	5.20, 5.40
Seltech Radio Syndicated service — classic rock	E2, 2	5.40/5.58 (DS)
SuperAudio — *Classic Hits* - oldies	G5, 21	8.10/8.30 (DS)
SuperAudio — *Prime Demo* - mellow rock	G5, 21	5.22/5.40 (DS)
WCNJ-FM (89.3) Hazlet, N.J./Skylark Radio network — Oldies	G4,22	5.80

Speciality Formats

Aries In Touch Reading Service	C5, 24	6.48
	C4,10	7.87
Colorado Talking Book Network	C1, 2	5.58
C-SPAN I ASAP (program schedule)	C3, 7	5.58
C-SPAN II ASAP (program schedule)	C4, 19	5.58
Nebraska Talking Book Network	S3, 4	6.48
SuperAudio — Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
The Weather Channel-USA — occasional audio	C3, 13	6.80
The Weather Channel-USA — classical music	C3, 13	7.78
Voice Print Reading Service	E2, 6	7.44 (N)
Yesterday USA — nostalgia radio	G5, 7	6.80
	T402R, 11	5.80

Talk Programming

American Freedom Radio network	G6, 14	5.80
For the People radio network (Chuck Harder) — talk and information	C1, 2	7.50
KTRT-AM (1270) Claremore, OK	T3, 7	5.60
Marinet Broadcasting	G6, 23	8.10
Omega Radio Network	G6, 14	7.56
One on One Sports radio network — sports talk	E2, 2	7.51
Practical Radio Communications (audio distribution circuit)	T3, 7	7.90
Prime Sports Radio — sports talk and information	S3, 24	5.80
Talk America — talk programs	S3, 9	6.80
Talk Radio Network — talk programs	C1, 5	5.80
WOKIE Network (tech talk)	SBS6, 13B (Ku)	6.20 (occasional network on when Megabingo is present)
WWTN-FM (99.7) Manchester, TN — news and talk	G15,18	7.38,7.56

Variety Programming

American Urban Radio — news/features/sports	S3, 9	6.30/6.48 (DS)
CBC Radio (English)	E2, 6	5.40/7.58, 5.58
CBC Radio (occasional audio)	E2, 1	5.78
CBC-FM Atlantic (English)	E2, 6	6.12/6.30 (DS)
CBC-FM Eastern (English) 5.76/5.94 (DS)		E2, 6
CBM-AM (940) Montreal, Quebec Canada — variety/fine arts	E2, 1	6.12
CFR-FM	E2, 19 (Ku-band)	6.12/6.30
CJRT-FM (91.1) Toronto, Ontario Canada — fine arts/jazz-nights	E2, 26 (Ku-band)	5.76/5.94 (DS)
KBVA-FM (106.5) Bella Vista, Ark., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSKA-FM (91.1) Anchorage, Alaska — variety/fine arts	C5, 24	7.38/7.56 (DS)
KSL-AM (1160) Salt Lake City, Utah — news/talk/country-overnight	C1, 6	5.58
WAXY-AM (790) Miami, Fla. — variety	S2, 4	7.38
WUSF-FM (89.7) Tampa-St. Petersburg, Fl. (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

FM SQUARED (FM²) AUDIO SERVICES

Another type of satellite audio is known as FM Squared. FM Squared signals require a video carrier to exist. These signals are similar to audio subcarriers as we know it except for the fact that they are located below the 5.00 MHz audio subcarrier frequency that a normal satellite receiver can tune to.

Spacenet 3 Transponder 13

Ambassador Inspirational Radio: 1.420, 4.470, and 4.650 MHz
Blank Audio carrier: 2.500 and 3.390 MHz
Hot Tub Radio Party Networ: 1.050 MHz
International Broadcasting Network: 4.830 MHz
Religious Backhauls (various): 1.235 MHz
Satellite Music Network — *Country Coast-to-Coast*: 3.570 and 3.750 MHz
Satellite Music Network — *Good Time Rock and Roll Oldies*: 2.670 MHz
Satellite Music Network — *Pure Gold*: 2.860 and 3.030 MHz
Satellite Music Network — *Starstation*: 3.930 and 4.110 MHz
"Unforgetable Music of All Time" music service: 2.130 and 2.310 MHz
USA Radio Network: .330 MHz
VCY America: .540 and .780 MHz
WJSO-FM (90.1) Pikeville, KY (Moody Broadcasting Network): 1.770 and 4.290 MHz

Spacenet 3 Transponder 17

Childrens Sunshine Network: 1.275 MHz
Data Transmission: .840 and 1.225 MHz
In-Touch — religious: 4.470 MHz
Salem Satellite Network: 4.650 and 5.010 Mhz
Satellite Music Network — *Traditional Country*: 3.570 and 3.750 MHz
Skylight — religious: 1.770 and 4.260 MHz
UPI Radio Network: .330 MHz

Spacenet 3 Transponder 18

Data Transmissions: 4.800 MHz

Galaxy 4 Transponder 3 (Ku-band)

Blank Audio Carriers: 1.065, 1.155, 1.245, 2.070, 2.430, 2.550, 2.670, 2.790, 2.950, 3.040, 3.160, 3.960, and 4.080 MHz
Data Transmissions: 3.090 MHz
Generic News: 3.510 MHz (occasional audio)
In-Store audio network ads: .710, .795, .880, 3.420, 3.600, 3.690, 3.780, and 3.860 MHz
MuZAK ‡ Services: .275, .390, .510, .975, 1.355, 1.470, 1.590, 1.710, 1.830, 1.945, 2.190, 2.310, and 3.330 MHz

Galaxy 4 Transponder 4 (Ku-band)

Blank Audio Carriers: .180, .350, and 1.250 MHz
Data Transmissions: .110, .255, .300, .350, .470, .575, .675, .710, .740, .765, .845, .890, .930, 1.180, and 1.225 MHz

Galaxy 4 Transponder 16 (Ku-band)

Blank Audio Carriers: 1.230, 1.470, 1.965, 2.070, 2.280, 2.730, and 3.280 MHz
Data Transmissions: .645, 2.140, 2.350, 2.470, 2.820, 2.870, 2.970, 3.000, 3.060, 3.115, 3.205, 3.245, 3.265, 3.345, 3.620, 3.735, 4.145, and 4.150 MHz
In-Store audio networks: .150, .270, .390, .755, .870, .990, 1.110, 1.350, 1.590, 1.710, and 1.800 MHz

Anik E1 Transponder 7 (Ku-band)

Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

This audio is digital in nature and home dish owners have not been able to receive it by normal decoding methods yet. The only satellite that FM Cubed transmissions have been discovered on so far is Galaxy 4, transponder 1. WEFAX transmissions and Accu-Weather (for subscribing stations) are transmitted on this transponder.

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

The frequency in the first column is the 1st IF or LNB frequency and the second column frequency (in parentheses) is the 2nd IF for the SCPC listing. Both frequencies are in MHz.

Spacenet 2 Transponder 12-Vertical (C-band)

1202.30 (77.7) U.S.Information Agency *Radio Marti* (ISWBC), Spanish language broadcast service to Cuba

Galaxy 6 Transponder 3-Horizontal (C-band)

1405.60 (54.4) KIRO-AM (710) Seattle, Wash — news, talk, and sports talk radio/Seattle Mariners MLB radio network
1405.40 (54.6) Sports Byline USA/Sports Byline Weekend
1404.60 (55.4) Talk America Radio Network
1404.00 (56.0) Occasional audio
1403.80 (56.2) Occasional audio/Free Enterprise Radio Network
1403.20 (56.8) Motor Racing Network (MRN)
1400.80 (59.2) WBAL-AM (1090) Baltimore, Md — news/talk/Baltimore Orioles MLB radio network
1397.20 (62.8) WTMJ-AM (620) Milwaukee, Wis — talk radio/Milwaukee Brewers MLB radio network
1393.40 (66.6) WGN-AM (720) Chicago, Ill — talk radio/ Interstate Radio Network (IRN)/Chicago Cubs MLB radio network
1393.20 (66.8) Wisconsin Radio Network/Illinois Radio Network/Tribune Radio Networks
1393.00 (67.0) USA Radio Network
1392.70 (67.3) WGN-AM (720) Chicago, Ill — talk radio/ Interstate Radio Network (IRN)/Chicago Cubs MLB radio network
1391.60 (68.4) XEPRS-AM (1090) Tijuana, Mexico — Spanish language programming, ID - *Radio Express*
1390.60 (69.4) Los Angeles Dodgers MLB radio network (English)
1390.40 (69.6) Los Angeles Dodgers MLB radio network (Spanish)
1389.70 (70.3) Occasional audio/data transmissions (burst)
1389.50 (70.5) Data transmissions (burst)
1387.10 (72.9) Michigan News Network (MNN)
1386.70 (73.3) Michigan News Network (MNN)
1386.50 (73.5) WJR-AM (760) Detroit, Mich — talk radio/Detroit Tigers MLB radio network
1386.30 (73.7) Illinois News Network
1385.80 (74.2) Illinois News Network
1385.10 (74.9) For the People Radio Network
1384.20 (75.8) California Angels MLB radio network
1384.00 (76.0) Chicago White Sox MLB radio network
1383.80 (76.2) KJR-AM (950) Seattle, Wash — sports talk radio
1383.40 (76.6) Oakland A's MLB radio network
1377.90 (82.1) Occasional audio
1375.40 (84.6) USA Radio Network/Grow-wise Gardner Network
1374.10 (85.9) Northwest Direct — news and talk

Satcom K2 Transponder 2-Vertical (Ku-band)

1010.60 Foreign language audio service identifying as *Radio Tejan*

Spacenet 3 Transponder-Horizontal 13 (C-band)

1207.90 (52.1) Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious
1207.20 (52.8) Good News Radio Network — christian radio
1207.00 (53.0) Good News Radio Network — christian radio
1206.70 (53.3) Data Transmission
1206.55 (53.45) ABC Satellite Music Network — adult contemporary *Starstation*
1206.30 (53.7) ABC Satellite Music Network — adult contemporary *Starstation*
1206.00 (54.0) ABC Satellite Music Network — modern country *Country Coast-to-Coast*
1205.85 (54.15) ABC Satellite Music Network — modern country *Country Coast-to-Coast*
1205.65 (54.35) "Unforgetable Music of All Time" music service
1205.40 (54.6) "Unforgetable Music of All Time" music service
1204.45 (55.55) KJAV-FM (104.9) Alamo, Tex — spanish language religious, Nuevo Radio Christiana Network
1204.25 (55.75) Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious
1202.25 (57.75) ABC Satellite Music Network — golden oldies format *Pure Gold*
1202.10 (57.9) ABC Satellite Music Network — golden oldies format *Pure Gold*
1201.90 (58.1) Occasional audio
1201.70 (58.3) Hot Tub Radio Party Network
1201.50 (58.5) Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious
1201.30 (58.7) Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious

Spacenet 3 Transponder 17-Horizontal (C-band)

1123.50 (56.5) Salem Radio Network — religious
1123.30 (56.7) Salem Radio Network — religious
1123.10 (56.9) Salem Radio Network — religious

Galaxy 4 Transponder 1-Horizontal (C-band)

1444.45 (55.55) Data transmissions
1443.80 (56.2) Voice of Free China (ISWBC) Taipei, Taiwan
1443.60 (56.4) KBLA-AM (1580) Santa Monica, Calif. — *Radio Korea*
1443.40 (56.6) Voice of Free China (ISWBC) Taipei, Taiwan
1438.30 (61.7) WWRV-AM (1330) New York, N.Y. — Spanish religious programming and music, ID - *Radio Vision Christiana de Internacional*
1436.30 (63.7) KOJY-AM (540) Costa Mesa, Calif/KJQI-AM (1260) Beverly Hills, Calif — all news
1436.00 (64.0) KUSC-FM (91.5) Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1435.70 (64.3) KUSC-FM (91.5) Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1429.00 (71.0) Occasional audio

Galaxy 4 Transponder 2-Vertical (C-band)

1402.60 (77.4) WVAQ-FM (101.9) Morgantown, W Va — West Virginia Metro News
1402.00 (78.0) WVAQ-FM (101.9) Morgantown, W Va — West Virginia Metro News
1399.00 (81.0) Oklahoma News Network
1398.80 (81.2) Progressive Farmers Network
1398.00 (82.0) Oklahoma News Network
1397.20 (82.8) Oklahoma News Network

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0) WGST-AM (640) Atlanta, Ga. — news/ talk
1404.80 (55.2) KOA-AM (850)/KTLK-AM (760) Denver, Colo — news and talk/Colorado Rockies MLB radio network
1404.40 (55.6) Tennessee Radio Network (TRN)
1404.00 (56.0) South Carolina Radio Network
1403.00 (57.0) Minnesota Public Radio
1402.40 (57.6) Minnesota Public Radio
1402.10 (57.9) KNOW-FM (95.3) St. Paul, Minn — fine arts, Minnesota Public Radio
1398.50 (61.5) KKFN-AM (950) Denver, Colo. — sports talk
1398.30 (61.7) WSB-AM (750) Atlanta, GA — news/ talk/Atlanta Braves MLB radio network
1397.80 (62.2) Occasional audio
1397.50 (62.5) Minnesota Talking Book network
1397.30 (62.7) WSB-AM (750) Atlanta, GA — news/ talk/Atlanta Braves MLB radio network
1396.90 (63.1) Occasional audio
1396.40 (63.4) Georgia Network News (GNN)
1396.20 (63.8) WCNN-AM (680) Atlanta, GA — all sports talk radio
1396.00 (64.0) WHO-AM (1040) Des Moines, Iowa — talk/Iowa News Network
1395.80 (64.2) Kentucky News Network
1395.10 (64.9) Occasional audio
1394.70 (65.3) WHAS-AM (840) Louisville, Ky — adult contemporary music
1394.40 (65.6) Minnesota Public Radio
1394.00 (66.0) Minnesota Public Radio
1389.00 (71.0) Occasional audio
1388.90 (71.1) Data transmissions (burst)
1387.80 (72.2) Data transmissions (constant)
1384.40 (75.6) KOA-AM (850)/KTLK-AM (760) Denver, Colo — news and talk/Colorado Rockies MLB radio network
1384.20 (75.8) WSB-AM (750) Atlanta, Ga. — news and talk/Atlanta Braves MLB radio network
1383.10 (76.9) VSA Radio Network — Ag news
1382.60 (77.4) Soldiers Radio Satellite (SRS) network — U.S. Army information and entertainment
1382.30 (77.7) Motor Racing Network (occasional audio)
1382.00 (78.0) WFAE-FM (90.7) Charlotte, N.C. — NPR affiliate
1381.80 (78.2) WHO-AM (1040) Des Moines, Iowa — talk radio/Iowa News Network
1377.40 (82.6) Data transmission (packet burst/tones)
1377.10 (82.9) In-Touch — reading service for blind
1376.00 (84.0) Kansas Audio Reader Network

Galaxy 4 Transponder 4-Vertical (C-band)

1387.50 (52.5) Dakota Sports network/Dakota News network
1381.80 (58.2) Data transmissions

Single Channel Per Carrier (SCPC) Services Guide

1379.00 (61.0) Louisiana Network/Louisiana Ag Network

1378.80 (61.2) WLAC-AM (1510) Nashville, Tenn. — news and talk/Road Gang truck driver radio network (overnight)

1377.50 (62.5) Mid-America News Network/Mid-America Ag Network

1377.30 (62.7) WLAC-AM (1510) Nashville, Tenn. — news and talk/Road Gang truck driver radio network (overnight)

1376.00 (64.0) Data transmissions

1375.60 (64.4) KISN-AM (570) Salt Lake City, Utah — sports talk/Buzz AAA minor league baseball radio network

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1) WCRP-FM (88.1) Guayama, P.R. — religous/educational (Spanish)

Galaxy 4 Transponder 1-Horizontal (Ku-band)

959.20 ABC Satellite Music Network — country and western *Real Country*

959.00 ABC Satellite Music Network — country and western *Real Country*

Anik E2 Transponder 11-Horizontal (C-band)

1246.00 (54.0) Radio Canada International (ISWBC)

1245.50 (54.5) Canadian Broadcasting Company (CBC) Radio — Yukon service

Anik E2 Transponder 13-Horizontal (C-band)

1206.00 (54.0) Canadian Broadcasting Company (CBC) Radio — southwestern Northwest Territories service

Anik E2 Transponder 15-Horizontal (C-band)

1166.00 (54.0) Canadian Broadcasting Company (CBC) Radio — eastern Northwest Territories service

Anik E1 Transponder 17-Horizontal (C-band)

1126.00 (54.0) Canadian Broadcasting Company (CBC) Radio — northern Northwest Territories service

1125.50 (54.5) Canadian Broadcasting Company (CBC) Radio — Newfoundland and Labrador service

Anik E2 Transponder 19-Horizontal (C-band)

1086.00 (54.0) Canadian Broadcasting Company (CBC) Radio — Quebec and Labrador service

Anik E1 Transponder 21-Horizontal (C-band)

1024.30 (75.7) Canadian weather conditions and warnings

1036.70 (63.3) In-store music

1037.00 (63.0) In-store music

1037.50 (62.5) In-store music

SBS5 Transponder 2-Horizontal (Ku-band)

1010.60 (83.4) Wal-Mart in-store network (English)

1010.20 (83.8) Wal-Mart in-store network (English)

1009.80 (84.2) Sam's Wholesale Club in-store network (English)

1001.40 (92.6) Wal-Mart in-store network (English)

1001.00 (93.0) Wal-Mart in-store network (English and Spanish ads)

1000.60 (93.4) Wal-Mart in-store network (English)

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2) RFD Radio Service

1404.60 (55.4) WGN-AM (720) Chicago, Ill — news/talk/ Chicago Cubs MLB radio network
KOA-AM (850) Denver, Colo. — news/ talk/Colorado Rockies MLB radio network (occasional audio)

1400.60 (59.4) Learfield Communications

1400.40 (59.6) Learfield Communications/Missouri Net

1400.20 (59.8) Occasional audio/Data transmissions

1400.00 (60.0) Learfield Communications

1396.60 (63.4) Kansas Information Network/Kansas Agnet

1396.40 (63.6) Nebraska Ag Network

1396.20 (63.8) Missouri Network/St. Louis Cardinals MLB radio network

1396.00 (64.0) Occasional audio

1395.70 (64.3) Missouri Net/WIBW-AM (580) Topeka, Kan — news and talk/Kansas City Royals MLB radio network

1387.30 (72.7) WPTF-AM (680) Raleigh, N.C. — news and talk/North Carolina News Network

1386.40 (73.6) Learfield Communications

1386.20 (73.8) Radio Iowa

1385.00 (74.0) People's Radio Network

1384.60 (75.4) North Carolina News Network/Capitol Sports Network

1384.40 (75.6) Capitol Sports Network

1384.20 (75.8) Capitol Sports Network

1384.00 (76.0) Occasional audio/ABC Direction Network

1383.80 (76.2) Occasional audio

1383.60 (76.4) Occasional audio

1383.40 (76.6) Capitol Sports Network

1382.90 (77.1) Missouri Net

1382.60 (77.4) North Carolina News Network

1382.30 (77.7) Virginia News Network

1382.10 (77.9) Learfield Communications/Missouri Net

1381.40 (78.6) Learfield Communications

1378.70 (81.3) Radio Pennsylvania Network

1378.50 (81.5) Radio Pennsylvania Network

1378.30 (81.7) Radio Pennsylvania Network/Philadelphia Phillies MLB radio network

1378.10 (81.9) Radio Pennsylvania Network

RCA C5 Transponder 21-Vertical (C-band)

1045.00 (55.0) Los Angeles Dodgers MLB radio network (English)

1043.60 (56.4) Unistar Music Radio — *Today's Hits, Yesterday's Favorites*

1043.40 (56.6) CNN Radio Network

1043.20 (56.8) Unistar Music Radio — *Today's Hits, Yesterday's Favorites*

1042.80 (57.2) Unistar Music Radio — *Original Hits*

1042.60 (57.4) Unistar Music Radio — *Original Hits*

1042.40 (57.6) Unistar Music Radio — *Good Times and Great Oldies*

1042.20 (57.8) Data transmissions

1042.00 (58.0) Unistar Music Radio — *Good Times and Great Oldies*

1041.80 (58.2) CNN Radio Network

1034.80 (65.2) Unistar Music Radio — *Country and Western*

1034.60 (65.4) Unistar Music Radio — *Country and Western*

1034.40 (65.6) Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*

1034.20 (65.8) Data transmissions

1034.00 (66.0) Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*

1033.70 (66.3) Occasional audio

1033.20 (66.8) Unistar Music Radio — *Country and Western*

1032.80 (67.2) Data transmissions

1032.40 (67.6) Unistar Music Radio — *Country and Western*

International Shortwave Broadcasters via Satellite

By Larry Van Horn and Robert Smathers

AFRICA NO. 1
B.P. 1, Libreville, Gabon. Telephone +241 760001 (voice), +241 742133. Intelsat 601 (27.5 west) Tr 23B (3915 MHz RHCP). 8.20 MHz audio (French).

ARAB REPUBLIC OF EGYPT RADIO
(Arabic ID: Idha'at Jumhuriyat Misr al-Arabiyah min al-Qahirah) P.O. Box 1186, Cairo, Egypt. Eutelsat II F3 (16.0 east) Tr 27 (11176 Mhz V) 7.02 MHz audio.

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)
AFTRS-BC, 10888 La Tuna Canyon Road, Sun Valley, CA 91352-2098. AFRTS radio service carries a variety of radio network news and sports programming for servicemen overseas aboard Navy ships. Satellites carrying AFTRS transmissions include: Spacenet 2 (69.0 west) Tr 20 (4100 MHz V) 7.41 MHz audio and Intelsat 703 (177.0 east) Tr 38 (4177 MHz LHCP) 7.41 MHz audio

BRITISH BROADCASTING CORPORATION (BBC)
Bush House, The Strand, London, WC2B 4PH. Telephone: +44 171 240 3456 (voice), +44 171 240 8760 (fax)
English BBC World Service transmissions can be found on the following satellites: Astra 1B (19.2 east) Tr 23 (11552 MHz H) 7.38 MHz audio, Eutelsat II F1 (13.0 east) Tr 25 (10987 MHz V) 7.38 MHz audio, Intelsat 601 (27.5 west) Tr 73 (11155 MHz V east spot) 7.56 MHz audio, Asiasat 1 (105.0 east) Tr 5 (3900 MHz V south beam) 7.20 MHz audio, and Satcom C3/F3 (131.0 west) Tr 7 (3840 MHz V) 5.41 MHz audio

C-SPAN AUDIO SERVICES
C-SPAN Audio Networks, 400 North Capitol Street, NW, Suite 650, Washington, D.C. 20001 Attn: Tom Patton. Telephone: (202) 626-4649 (voice)

C-SPAN Audio 1
Satcom C3/F3 (131.0 west) Tr 7 (3840 MHz.V) 5.20 MHz audio. A complete schedule of C-SPAN 1 audio services can be found in the November-December, 1995 issue of *Satellite Times*.

C-SPAN Audio 2
Satcom C3/F3 (131.0 west) Tr 7 (3840 MHz.V) 5.40 MHz audio. The BBC World Service in English is broadcast continuously 24-hours a day on this audio subcarrier.

DEUTSCHE WELLE (DW)
P.O.Box 100 444, 50968 Cologne, Germany. Telephone: +49 221 389 4563 (voice), +49 221 389 3000 (fax)
Deutsche Welle services are available on the following satellites: Satcom C4/F4 (135 west) Tr 5 (3800 MHz V) 7.38/7.56 MHz audio, Astra 1A (19.2 east) on Tr 2 (11229 MHz V) 7.38/7.56 MHz audio, Eutelsat (13.0 east) Tr 27 (11163 MHz V) 7.02/7.20 MHz. audio, Intelsat K (21.5 west) Tr H7 (11605 MHz H), 7.38/7.56 MHz audio, and Intelsat 702 (1.0 west) Tr 23B (3.911 MHz RHCP) digital MPEG-2 subcarrier.

ISLAMIC REPUBLIC OF IRAN BROADCASTING (IRIB)
External Service, P.O. Box 3333, Tehran, Iran. Telephone: +98 21 291095 (fax). Intelsat 602 (63.0 east) Tr 71 (11002 MHz V) for IRIB Radio 2 Farsi service using 5.60/6.20 MHz. audio. IRIB Radio 1 in various languages uses 5.95 MHz and Tr 73 (11155 MHz V) 6.20 MHz audio..

ISRAEL RADIO
P.O. Box 1082, Jerusalem 91010, Israel. Intelsat 702 (1.0 west) Tr 73 (11178 MHz V) 7.20 MHz audio.

LA VOIX DU ZAIRE
Station Nationale, B.P. 3164. Kinshasa-Gombe, Zaire. Telephone +243 12 23171-5. Intelsat 510 (66.0 east) Tr 12 (3790 MHz RHCP) 7.38/7.56 MHz audio with French.

RADIO ALGIERS INTERNATIONAL
21 Blvd des Martyrs, Alger, Algeria. Eutelsat II F3 (16.0 east) Tr 34 (11678 MHz H) 7.38 MHz audio with Spanish at 1900-2000 UTC and English 2000-2100 UTC.

RADIO AUSTRALIA
GPO Box 428G, Melbourne, Vic. 3001, Australia. Telephone: +61 3 616 1800 (voice), +61 3 626 1899 (fax)
Palapa B2P (133.0 east) Tr 9 (3880 MHz H) 7.20 MHz audio

RADIO BELGRADE
Hilandarska 2, 11000 Beograd, Serbia. Telephone: +381 11 344 455 (voice), +381 11 332014 (fax)
Eutelsat II F4 (7.0 east) Tr 22 (11181 MHz H) 7.02 MHz audio with Serb/English.

RADIO BUDAPEST
Body Sandor u. 5-7, 1800 Budapest, Hungary. Telephone: +36 1 138 7224 (voice), +36 1 138 8517 (fax) E-mail: *h9563mes@ella.hu*. Eutelsat II F3 (16.0 east) Tr 33 (11596 MHz H) 7.02 MHz audio from 2300-0500 UTC

RADIO CANADA INTERNATIONAL
P.O. Box 6000, Montreal, Canada H3C 3A8. Telephone: (514) 597-7555 (voice), (514) 284-0891 (fax). Eutelsat II F6 (Hot Bird 1 at 13 east) 11265 MHz H 7.20 MHz audio for Canadian troops in Bosnia.

RADIO EXTERIOR DE ESPANA (REE)
Apartado 156202, Madrid 28080, Spain. Telephone +34 13461083/1080/1079/1121 (voice); 34 13461097 (fax).
Eutelsat II F6 (Hot Bird 1 at 13.0 east) (11220 MHz H) 7.56 MHz audio and Hispasat 1A/B (31.0 west) Tr 6 (12149 MHz RHCP) 7.92 MHz audio.

RADIO FRANCE INTERNATIONAL (RFI)
B.P. 9516, Paris F-75016, France. Telephone: +33 1 42 30 30 62 (voice), +33 1 42 30 40 37 (fax)
RFI broadcast can be heard in French, 24-hours a day.on the following satellites: Intelsat 601 (27.5 west) Tr 23B (3915 MHz RHCP) 6.40 MHz audio to Africa/Middle east, and Palapa B2P (113 east) Tr 8 (3860 MHz V) 6.15 MHz audio to Asia.

RADIO MEDITERRANEE INTERNATIONALE
3 et 5, rue Emisaliah (B.P. 2055), Tanger, Morocco. Intelsat 513 (53.0 west) Tr 14 (3990 MHz RHCP) 7.20/8.20 MHz audio in Arabic/French.

RADIO NETHERLANDS
P.O..Box 222, 1200JG Hilversum, The Netherlands. Telephone +31 35 724222 (voice), +31-35-724252 (fax) E-mail: *letters@rnw.nl*. Various languages are relayed via Astra 1C (19.2 east) Tr 64 (10935 MHz V) 7.74 and 7.92 audio.

RADIOSTANTSIYA MAYAK
The Mayak radio service consists of light music, sports, news and weather on the hour and half hour in Russian. On the air continuously. The service can be found on Tr 6 (3675 MHz RHCP) 7.50 MHz audio on the following satellites: Gorizont 27 (53.0 east), Gorizont 22 (40.0 east), Gorizont 26 (11.0 west), Gorizont 18 (140.0 east), Gorizont 19 (96.5 east), Gorizont 28 (90.0 east), and Gorizont 24 (80.0 east).

RADIO SWEDEN
S-10510 Stockholm, Sweden.. Telephone: +46 8 784 7281 (voice), +46 8 667 6283 (fax). E-mail: *wood@stab.sr.se* Tele-X (5.0 east) Tr 40 (12475 MHz) 7.38 MHz audio and Astra 1B (19.2 east) Tr 33 (10964 MHz H) 7.38 or 7.56 MHz audio.

RADIOTELEVISIONE ITALIANA (RAI)
Viale Mazzini 14, 00195 Roma, Italy. Telephone: +39 6 5919076. Selected programs of RAI's external service are carried on Eutelsat II F6 (Hot Bird 1 @ 13.0 east) (11446 MHz V) 7.56 MHz audio. This is a feed to the BBC Atlantic relay station on Ascension Island. Satcom C1 (137.0 west) Tr 15 (4000 MHz V) 7.38 MHz audio.

RADIO VLAANDEREN INTERNATIONAL
P.O. Box 26, B-1000, Brussels, Belgium. Telephone: +32 2 741 3802 (voice), +32 2 734 7804 (fax) E-mail: *rvi@brtn.be* Astra 1C (19.2 east) Tr 63 (10921 MHz H) 7.38 MHz audio.

RDP INTERNATIONAL
Av. 5 de Outubro 197, 1000 Lisbon, Portugal. Telephone: +351 1 535151 (voice), +351 1 793 1809 (fax).
RDP International uses the following satellites for various broadcast to the indicate coverage areas:
Asiasat 2 (service due to start on this satellite in September 1995), Eutelsat II F2 (10.0 east) Tr 39 (11658 MHz V) 7.02/7.20 MHz audio to Europe. Express 2 - Russian Statsionar 4 (14.0 west) on 4025 MHz (RHCP) 7.0 MHz audio to South America, Africa, the US east coast and southern Europe, Gorizont 22 - Russian Statsionar 12 (40 east) Tr 11 (3925 MHz RHCP) 7.02 MHz audio to Africa, southern Europe, and the Indian Ocean region.

SWISS RADIO INTERNATIONAL
Giacomettstrasse 1, CH-3000 Bern 15, Switzerland. Telephone: +41 31 350 9222 (voice), +41 31 350 9569 (fax). SRI uses the following satellites for its external services: Astra 1A (19.2 east) Tr 9 (11332 MHz H) 7.38 MHz audio Multilingual/7.56 MHz English 24-hours, Eutelsat II (13.0 east) (11321 MHz V) 7.74 MHz. audio, Intelsat K (21.5 west) Tr 7 (11605 MHz H) 8.10 MHz audio multilingual 24 hours, and Satcom C4 (135 west) Tr 5 (3800 MHz V) 8.10 MHz.

TRANS WORLD RADIO (TWR)
Astra 1A (19.2 east) Tr 16 (11436 MHz V) 7.38/7.56 MHz audio with German language

International Shortwave Broadcasters via Satellite

programming from Evangeliums Rundfunk and TWR-UK. Astra 1C (19.2 east) Tr 38 (11038 MHz V) 7.38 MHz audio Multilingual from TWR-Europe.

TUNIS INTERNATIONAL RADIO

71 ave de la Liberte, Tunis, Tunisia. Eutelsat II F2 (16.0 east) Tr 39 (11658 MHz V) 7.20 MHz audio.

VATICAN RADIO

I-00120, Vatican City State, Italy. Telephone: +396 6988 3551 (voice), +396 6988 3237 (fax) Eutelsat II F1 (13.0 east) Tr 32 (11554 MHz H) 7.74 MHz audio. Reports at presstime indicate that Vatican Radio will be downlinking on two Intelsat C-band birds (34.5 wesr and 66 east) by the fourth quarter of 1995.

VOICE OF AMERICA (United States Information Agency)

Washington, D.C. 20547. The Voice of America (VOA) transmits a variety of audio programs in various languages on the following satellites and audio subcarriers:.

Eutelsat II F1	13.0 east	Tr 27	11163 MHz.	PAL system
Intelsat 510 PAL system	66.0 east	Tr 38	4177.5 MHz.	
Intelsat 601	27.5 west	Tr 14	3995 MHz.	PAL system
Intelsat 601	27.5 west	Tr 81	3742 MHz.	PAL system
Spacenet 2	69.0 west	Tr 2H	3760 MHz.	NTSC system
Intelsat 511	180.0 west	Tr 14	3974 MHz.	PAL system

NTSC system baseband subcarrier frequencies

Primary Television Audio (USIA Worldnet)		6.80 MHz
Channel 1	5.94 MHz	
Channel 2	6.12 MHz	
Channel 3	7.335 MHz	
Channel 4	7.425 MHz	
Channel 5	7.515 MHz	
Channel 6	7.605 MHz	
Wireless File (data)	6.2325 MHz	
E-mail (data)		6.2775 MHz

PAL system baseband subcarrier frequencies

Primary Television Audio (USIA Worldnet)		6.60 MHz
Channel 1	7.02 MHz	
Channel 2	7.20 MHz	
Channel 3	7.335 MHz	
Channel 4	7.425 MHz	
Channel 5	7.515 MHz	
Channel 6	7.605 Mhz	
Wireless File (data)	6.2325 MHz	
E-mail (data)	6.2775 MHz	

VOICE OF THE ARABS

P.O. Box 566, Cairo 11511, Egypt. Transmissions from this external radio service have been heard on Arabsab 1C at 31 east on 3882 MHz (LHCP) FDM at 1440 MHz. Broadcast have also been noted on Eutelsat II-F3 at 16 east, Tr 27 (11176 MHz V) 7.20 MHz audio.

VOICE OF SAHEL

Niger Radio and Television Service. Transmissions of the domestic radio shortwave service have been reported on Intelsat 702 at 1.0 west. No other details are available at this time.

VOICE OF THE IRAQI PEOPLE (CLANDESTINE)

Programming has been reported on Arabsat 1C at 31.0 east on a FDM tranmission centered at 3940 MHz RHCP. Transmissions have been noted from 24.5 kHz to 2700 kHz in USB between 1300-0100 UTC.

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

P.O. Box 12, South Bend, IN 46624. Religious broadcaster WHRI/KHWR uses audio subcarriers to feed their three shortwave broadcast transmitters as follows: Galaxy 4 (99.0 west) Tr 15 (4000 MHz.H) 7.46/7.55 MHz audio with WHRI programming relayed to their broadcast transmitters in Indianapolis, Ind. for shortwave transmissions beamed to Europe and Americas and 7.64 MHz audio for KHWR programming relayed to their broadcast transmitter in Naahlehu, Hawaii for shortwave transmissions beamed to the Pacific and Asia.

WORLD RADIO NETWORK

Wyvil Court, 10 Wyvil Road, London, SW8 2TG, England, Telephone: +44 171 896 9000 (voice), +44 171 896 9007 (fax). In North America, call at local rates on (202) 414-3185. E-mail via Internet: *online@wrn.org.* WRN can also be heard live on the World Wide Web to users with high speed connections at: http//town.hall.org/radio/wrn.html. WRN schedules are subject to change. Complete schedules for North America (WRN2), Europe (WRN1 and WRN2), and the new Africa/Asia-Pacific (WRN1) services are listed in page 92 of this issue of *Satellite Times.*

North American Service Schedule

WRN1 — Galaxy 5 (125.0 west) Tr 6 (3820 MHz V) 6.80 MHz audio.

UTC/EDT/PDT	SERVICE/PROGRAM
0000/2000/1700	ABC Radio Australia - Melbourne
0100/2100/1800	YLE Radio Finland - Helsinki
0130/2130/1830	Radio Sweden - Stockholm
0200/2200/1900	Radio Prague (Slovakia)
0230/2230/1930	Radio Austria International - Vienna
0300/2300/2000	Polish Radio - Warsaw
0330/2330/2030	Radio Budapest (Hungary)
0400/0000/2100	Radio Telefis Eireann (RTE) - Dublin, Ireland
0500/0100/2200	Channel Africa - Johannesburg, South Africa (Mon-Sat)
0530/0130/2230	BBC Europe Today (Mon-Fri)
	Glen Hauser's World of Radio (Sat)
	UN Radio from New York (Sun)
0600/0200/2300	Swiss Radio International - Berne
0630/0230/2330	Radio Canada International - Montreal
0700/0300/0000	ABC Radio Australia - Melbourne
0800/0400/0100	KBS Radio Korea International - Seoul
0900/0500/0200	Voice of Russia - Moscow
0930/0530/0230	Radio Netherlands - Hilversum
1030/0630/0330	Channel Africa - Johannesburg, South Africa (Mon-Sat)
	Radio Romania International - Bucuresti (Sun)
1100/0700/0400	Radio Australia - Melbourne
1200/0800/0500	Radio Telefis Eireann (RTE) - Dublin, Ireland
1300/0900/0600	Radio Prague (Slovakia)
1330/0930/0630	RTHK - News from Hong Kong (Mon-Fri)
	Radio Romania International - Bucuresti (Sat)
	UN Radio from New York (Sun)
1400/1000/0700	YLE Radio Finland - Helsinki
1430/1030/0730	Radio Vlaanderen International - Brussels Calling
1500/1100/0800	Radio France International - Paris
1600/1200/0900	Voice of Russia - Moscow
1630/1230/0930	Radio Netherlands - Hilversum
1730/1330/1030	Radio Telefis Eireann (RTE) - Dublin, Ireland
1800/1400/1100	ABC Radio Australia - Melbourne
1900/1500/1200	Blue Danube Radio - Vienna (Mon-Fri)
	Glen Hauser's World of Radio (Sat)
	SABC Network Africa (Sun)
1930/1530/1230	Radio Vlaanderen International - Brussels Calling
2000/1600/1300	BBC Europe Today (Sun-Fri)
	UN Radio from New York (Sat)
2030/1630/1330	Polish Radio - Warsaw
2100/1700/1400	Radio Telefis Eireann (RTE) - Dublin, Ireland/News and Both Sides
2300/1900/1600	Radio Netherlands - Hilversum

WRN2 — Galaxy 5 (125.0 west) Tr 6 (3820 MHz V) 6.20 MHz audio. New 24 hour multi-lingual channel for North America designed for the re-broadcasting of programs in a variety of languages for domestic FM/AM relays and cable distribution. WRN program information can be heard daily on North American WRN1 service at 1025 and 1725 UTC.

European Service

WRN1 - Astra 1B (19.2 east) Tr 22 (11538 MHz V) 7.38 MHz audio. All broadcasts are in English. Program information is available on Astra 1B VH-1 text page 222, 223 and 224. WRN network information can be heard on the European service daily at 0125, 1025 and 2050 BST.

WRN2 - Eutelsat II F-1 (13 east) Tr 25 (10987 MHz V) 7.38 MHz. Multi-lingual programming.

Africa/Asia-Pacific Service

WRN1 - Intelsat 702 (1 west) Tr 23B (3911.5 MHz Circular-Polarization) MPEG2 Audio Stream and Asiasat 2 (100.5 east) Tr 10B (4000 MHz H) MPEG2 Audio Stream.

WORLDWIDE CATHOLIC RADIO - WEWN

P.O. Box 176, Vandiver, AL 35176 USA. Telephone: (205) 672-7200 (voice), (205) 672-9988 (fax). WWW URL: http://www.ewtn.com. WEWN broadcasts are available on: Galaxy 1R (133 west) Tr 11 (3920 MHz H) 5.40 MHz (English) and 5.58 MHz (Spanish). WEWN is also available internationally on Intelsat 601 (27.5 west) Tr 22.7, 5.59 MHz (English) and 5.68 MHz (Spanish).

YLE RADIO FINLAND

Box 10, SF-00241 Helsinki, Finland. Telephone: +358 0 1480 4320 (voice), +358 0 1481 169 (fax) E-mail: *rfinland@yle,mailnet.fi* Most of YLE's broadcasts to Europe are available on Eutelsat II F1 (13.0 east) Tr 27 (11163 MHz V) 8.10 MHz. audio, and Asiasat 2 (100.5 east) Tr 10B (4000 MHz H) early this year.

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

Alphastar (United States)

Alphastar is a new medium power Direct-to-Home satellite service for the United States. The service will use some of the Telstar 402R (Ku-band 11.7-12.2 GHz) segment. The satellite is located at 89º West. Channel assignments and programming where not available at presstime.

Alphastar Digital Television, 208 Harbor Drive, Building One, First Floor, Stamford, CT 06904. Telephone: (203) 359-8077. Web site: **http://www.teecomm.com**

DirecTV and USSB (United States)

These two DBS services are carried on the Hughes high power DBS-1/2/3 satellites located at 101º West (Ku-band 12.2-12.7 GHz).

DirecTV, 2230 East Imperial Highway, El Segundo, Calif. 90245, 1-800-DIRECTV (347-3288), Web site: **http://www.directv.com**

100	Direct Ticket Previews (DTV)	Previews
101-199	Direct Ticket Pay Per View (DTV)	PPV
121	Letterbox (LTBX)	
140-141	Unknown service (LAST)	
200	Direct Ticket Previews (DTV)	Previews
201	DirecTV Information Updates (DTV)	Promo
202	Cable Network News (CNN)	News
203	Court TV (CRT)	Speciality
204	CNN Headline News (HLN)	News
205	DirecTV Special Events Calendar (DTV)	Promo
206	ESPN 1 (ESPN)	Sports
207	ESPN Alternate (ESNA)	Sports
208	ESPN 2 (ESN2)	Sports
210	DirecTV Sports Schedule (DTV)	Promo
211	Tell a Friend (DTV)	Contest
212	Turner Network Television (TNT)	TV programming
213	Home Shopping Network (HSN)	Home Shopping
214	Home and Garden TV (HGTV)	Home Improvement
215	E! Entertainment TV (E!)	Speciality
216	MuchMusic (MUCH)	Music Videos
217	Black Entertainment TV (BET)	Entertainment
219	American Movie Classics (AMC)	Movies
220	Turner Classic Movies (TCM)	Movies
221	Arts and Entertainment (A&E)	TV
222	The History Channel (HIST)	History
223	The Disney Channel East (DIS1)	Movies/Kids
224	The Disney Channel West (DIS2)	Movies/Kids
225	The Discovery Channel (DISC)	Science/TV documentary
226	The Learning Channel (TLC)	Science/TV documentary
227	Cartoon Network (TOON)	Cartoons
229	USA Network (USA)	TV
230	Trio (TRIO)	TV
232	The Family Channel (FAM)	TV
233	WTBS-Ind Atlanta, Ga.(TBS)	Superstation
235	The Nashville Network (TNN)	Country/Outdoors
236	Country Music TV (CMT)	Country Music Videos
240	The Sci-Fi Channel (SCFI)	Science Fiction
242	C-SPAN 1 (CSP1)	Congress-House of Representatives
243	C-SPAN 2 (CSP2)	Congress-U.S. Senate
245	Bloomberg Information Television (BIT)	News
246	CNBC (CNBC)	Financial/Talk
247	America's Talking (AT)	Talk
248	The Weather Channel (TWC)	Weather
250	Newsworld International (NWI)	News
252	CNN International (CNNI)/CNN fN	News/Financial
254	The Travel Channel (TRAV)	Travel Shows
258	Bravo (BRAV)	Arts
268	Direct Ticket Previews (DTV)	Previews
269	STARZ! - West (STZW)	Movies
270	STARZ! (STZE)	Movies
271	Encore (ENCR)	Movies
273	Encore-Westerns (WSTN)	Movies
274	Encore-Mystery (MYST)	Movies
275	Encore-Action (ACTN)	Movies
276	Encore-True Stories (TRUE)	Movies
277	Encore-WAM! (WAM!)	Movies
278	Encore (ENC)	Movies
282	WRAL Raleigh, N.C. (CBS)	Network TV
283	KPIX San Francisco, Calif (CBSW)	Network TV
284	WNBC New York, N.Y. (NBC)	Network TV
285	KNBC Los Angeles, Calif. (NBCW)	Network TV
286	KRMA Denver, Colo. (PBS)	Network TV
287	WJLA Washington, D.C. (ABC)	Network TV
288	KOMO Seattle, Wash. (ABCW)	Network TV
289	FoxNet. (FOX)	Network TV
298	TV Asia (TVA)	Ethnic Programming
299	In-store dealer info channel (DTV)	Retailers only
300-399	Regional and PPV Sports	Sports
300	DirecTV Sports Offers (DTV)	Promo
302	MLB Extra Innings Daily Prog. Lineup (DTV)	Sports
303	Newsport (NWSP)	Sports
304	The Golf Channel (GOLF)	Sports
305	Classic Sports Network (CSN)	Sports
306	Speedvision (SV)	Sports
307	Outdoor Life Channel (OL)	Sports
309	SportsChannel New England (SCNE)	Sports
310	Madison Square Garden (MSG)	Sports
311	New England Sports Network (NESN)	Sports
312	SportsChannel New York (SCNY)	Sports
313	Empire Network (EMP)	Sports
314	SportsChannel Philadelphia (SCPH)	Sports
315	Prime Sports KBL (PKBL)	Sports
316	Home Team Sports (HTS)	Sports
317	SportsSouth (SPTS)	Sports
318	Sunshine (SUN)	Sports
320	Pro AM Sports (PASS)	Sports
321	SportsChannel Ohio (SCOH)	Sports
322	SportsChannel Cincinnati (SCCN)	Sports
323	SportsChannel Chicago (SCCH)	Sports
324	Midwest SportsChannel (MSC)	Sports
325	Prime Sports Southwest (PSSW)	Sports
326	Prime Sports Midwest/Rocky Mountain/ Intermountain West (PS)	Sports
331	Prime Sports West (PSW)	Sports
332	SportsChannel Pacific (SCP)	Sports
336	MLB Extra Innings Daily Progr. Lineup (DTV)	Sports
380	MLB Extra Innings Daily Prog. Lineup (DTV)	Sports
401	Spice (SPCE)	Adult
402	Playboy (PBTV)	Adult
501	Music Choice — Hit List (MC1)	Audio
502	Music Choice — Dance (MC2)	Audio
503	Music Choice — Hip Hop (MC3)	Audio
504	Music Choice — Urban Beat (MC4)	Audio
505	Music Choice — Reggae (MC5)	Audio
506	Music Choice — Blues (MC6)	Audio
507	Music Choice — Jazz (MC7)	Audio
508	Music Choice — Singers and Stnds (MC8)	Audio
509	Music Choice — Contemporary Jazz (MC9)	Audio
510	Music Choice — New Age (MC10)	Audio
511	Music Choice — Electric Rock (MC11)	Audio
512	Music Choice — Modern Rock (MC12)	Audio
513	Music Choice — Classic Rock (MC13)	Audio
514	Music Choice — 80's Retro (MC14)	Audio
515	Music Choice — Metal (MC15)	Audio
516	Music Choice — Solid Gold Oldies (MC16)	Audio
517	Music Choice — Soft Rock (MC17)	Audio
518	Music Choice — Love Songs (MC18)	Audio
519	Music Choice — Progressive Country (MC19)	Audio
520	Music Choice — Contemporary Country (MC20)	Audio
521	Music Choice — Cntry Gold/Cl. Cntry (MC21)	Audio
522	Music Choice — Big Bands Nostalgia (MC22)	Audio
523	Music Choice — Easy Listening (MC23)	Audio
524	Music Choice — Classic Favorites (MC24)	Audio
525	Music Choice — Classics in Concerts (MC25)	Audio
526	Music Choice — Contemp. Christian (MC26)	Audio
527	Music Choice — Gospel (MC27)	Audio

Direct Broadcast Satellite (DBS) Systems

528	Music Choice — Big Kids Music (MC28)	Audio
529	Music Choice — Sounds of the Seasons (MC29)	Audio
530	Music Choice — Bluegrass (MC30)	Audio
531	Music Choice — Rock New Release Show (MC31)	Audio
599	NRTC Radio Service (NRTC) For private use only	
790	RealNet — Real Estate Channel (REAL)	

USSB

USSB, 3415 University Avenue, St. Paul, Minn. 55114, 1-800-204-USSB (8772)

899	USSB Programming Higlights	Promo
900	Special Event programming (BIG 1)	Special Events
910	Special Event Programming (BIG2)	Special Events
963	All New Channel (ANC)	News
965	Video Hits One (VH1)	Rock Music Videos
967	Lifetime (LIFE)	TV
968	Nickelodeon (NICK)	TV/Kids
970	Flix (FLIX)	Movies
973	Cinemax East (MAX)	Movies
974	Cinemax 2 (MAX2)	Movies
975	Cinemax West (MAXW)	Movies
977	The Movie Channel East (TMC)	Movies
978	The Movie Channel West (TMCW)	Movies
980	HBO East (HBO)	Movies
981	HBO 2 East (HBO2)	Movies
982	HBO 3 (HBO3)	Movies
983	HBO West (HBOW)	Movies
984	HBO 2 West (HB2W)	Movies
985	Showtime East (SHO)	Movies
986	Showtime 2 (SHO2)	Movies
987	Showtime West (SHOW)	Movies
989	MusicTV (MTV)	Rock Music Videos
990	Comedy Central (COM)	Comedy
995	Sundance Channel (SUND)	Movies
999	USSB Programming Highlights	Promo

EchoStar (United States)

ECHOSTAR

The new Echostar 1 high power DBS (Ku-band 12.2-12.7 GHz) satellite is now operational at 119º West. Echostar's service is called "TheDISH (Digital Satellite Network) Television Network.

Echostar, 90 Inverness Circle East, Englewood, CO 80112, Telephone: (303) 799-8222, Fax: (303) 799-3632. Web Site: **http://www.echostar.com**

100	DISH Network Channel	Promo
102	USA Network	TV
104	Comedy Central	Comedy
108	Lifetime	TV
110	TV Food Network	Food
112	Home and Garden Network	Speciality
114	E! Entertainment TV	TV
118	Arts and Entertainment	TV
120	History Channel	History
122	Sci-Fi Channel	Science Fiction
132	Turner Classic Movies	Movies
138	Turner Network Television	TV
140	ESPN	Sports
142	ESPN2	Sports
160	MTV	Music Videos
162	VH-1	Music Videos
166	Country Music Television	Music Videos
168	The Nashville Network	Country
170	Nickelodeon	Kids
172	The Disney Channel	Movies/Kids
176	The Cartoon Network	Cartoons
178	The Learning Channel	Science/TV Documentary
180	The Family Channel	TV
182	The Discovery Channel	Science/TV Documentary
200	Cable News Network	News
202	Headline News	News
204	Court TV	Speciality
206	CNN International/CNNfn	News/Financial
208	CNBC	Financial/Talk
210	C-SPAN	Government
214	The Weather Channel	Weather
220	The Travel Channel	Travel Shows
226	QVC Shopping Network	Home Shopping
230	WTBS Atlanta, Ga.	Superstation
232	KTLA Los Angeles, Calif.	Superstation
234	WPIX New York, N.Y.	Superstation
240	WGN Chicago, Ill.	Superstation
241	WNBC-NBC New York, N.Y.	Network TV
242	KNBC-NBC Los Angeles, Calif.	Network TV
243	WRAL-CBS Raleigh, N.C.	Network TV
244	KPIX-CBS San Francisco, Calif.	Network TV
245	WJAL-ABC Washington, D.C.	Network TV
246	KOMO-ABC Seattle, Wash.	Network TV
247	FOXNet	Network TV
249	PBS	Network TV
260	Trinity Broadcasting Network	Religious
261	Eternal Word TV Network	Religious
300	HBO East	Movies
301	HBO2 East	Movies
302	HBO3 East	Movies
303	HBO West	Movies
304	HBO2 West	Movies
310	Showtime East	Movies
311	Showtime West	Movies
312	Showtime East 2	Movies
320	Cinemax East	Movies
321	Cinemax East 2	Movies
322	Cinemax West	Movies
401	The Golf Channel	Sports
500	PPV 1 DISH-on-Demand (events)	Pay per view
501	PPV 2	DISH-on-Demand Pay per view
502	PPV 3	DISH-on-Demand Pay per view
503	PPV 4	DISH-on-Demand Pay per view
504	PPV 5	DISH-on-Demand Pay per view
505	PPV 6 DISH-on-Demand	Pay per view
600	RAI (Italy)	International
602	ART	International
700	DISH 2 (Showroom Promo Channel)	Promo
900	Business TV	Financial
901	Business TV	Financial
DISH CD ™		
950	Young Country	Audio
951	Country Gold	Audio
952	Country Currents	Audio
953	Jukebox Gold	Audio
954	70's Song Book	Audio
955	Adult Favorites	Audio
956	Adult Contemporary	Audio
957	Album Adult Alternative	Audio
958	HitLine	Audio
959	Classic Rock	Audio
960	Modern Rock	Audio
961	Hard Rock	Audio
962	Hip Hop	Audio
963	Urban Beat	Audio
964	Latin Styles	Audio
965	Fiesta Mexicana	Audio
966	Eurostyle	Audio
967	Mainstream Jazz	Audio
968	Contemporary Jazz Flavors	Audio
969	Expressions	Audio
970	Contemporary Instrumentals	Audio
971	Symphonic Classical	Audio
972	Light Classical	Audio
973	Beautiful Music	Audio
974	Mature Vocals	Audio
975	Contemporary Christian	Audio
976	Children's	Audio

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

ExpressVu (Canada)

This is Canada's first digital medium power Direct-to-Home satellite TV service. The service will provide Canadian, American, and international video and audio programs. 110 channels will be offered using Canada's Anik E1 (Ku-band 11-.7-12.2 GHz) satellite at 111º West. Channel assignments and programming where not available at presstime.

ExpressVu Inc, 1290 Central Parkway West, Suite 1008, Mississauga, ON L5C 4R3, Telephone 1-800-339-6908 in Canada. Web Site: **http://www.expressvu.com**

Galaxy Latin America (Mexico, Central and South America)

Ft. Lauderdale, FL
Web site: **http://www.sattv.com**
New Latin American DBS service carried on Galaxy 3R at 95º West (Ku-band, 11.7-12.2GHz). Medium power Direct-to-Home service for Mexico, Central and South America. Galaxy Latin America will have 144 channels of video (72 channels in Spanish/72 channels in Portuguese). 60-CD quality channels of music as well as pay-per-view movies and events will also be provided. A .6-1.1 meter dish will be needed to utilize the service. Channel assignments and programming where not available at presstime.

Primestar (United States)

Primestar is a medium power Direct-to-Home satellites service carried on Satcom K1 at 85º West (Ku-band 11.7-12.2 GHz). Primestar uses K1 transponders 2-13 and 15-16 19 transponders).

Primestar Partners, 3 Bala Plaza West, Suite 700, Bala Cynwyd, PA 19004, 1-800-966-9615

1	HBO (East)	Movies
2	HBO 2 (East)	Movies
3	HBO 3	Movies
7	Cinemax (East)	Movies
8	Cinemax 2	Movies
13	TV Japan (English)	Not included in $50 a month package
14	TV Japan (Japanese)	Not included in $50 a month package
15	Future service	
17	Future service	
19	Future service	
27	Starz!	Movies
31	Encore 3 — Westerns	Movies
32	Encore 4 — Mystery	Movies
33	Encore	Movies
34	The Disney Channel (East)	Movies/Kids
35	The Disney Channel (West)	Movies/Kids
40	The Golf Channel	Sports
47	C-SPAN	Congress
48	CNBC — occasional service	Financial/Talk
49	The Weather Channel (TWC)	Weather
50	CNN International (CNNI)/CNN fN	News/Financial
51	Cable Network News (CNN)	News
52	CNN Headline News	News
	Ingenius News Service	Data Wire Services
55	PreVue Channel	Program Guide
56	Future service	
58	Turner Network Television (TNT)	TV
59	Turner Classic Movies (TCM)	Movies
63	WTBS-Ind Atlanta, Ga. (TBS)	Superstation
65	The Discovery Channel (TDC)	Science/TV documentary
66	The Learning Channel (TLC)	Science/TV documentary
68	Arts & Entertainment (A&E)	TV
70	USA Network	TV
71	The Sci-Fi Channel	Science Fiction
72	The Family Channel	TV
73	The Cartoon Channel	Cartoons
74	Nickelodeon/Nick at Nite	Kids
75	E! Entertainment Network	Speciality
76	Lifetime	TV
77	The Nashville Network (TNN)	Country/Outdoors
78	Country Music TV (CMT)	Country music videos
80	MTV	Music Videos
83	Faith and Values Network	Religious
84	[illegible]VC — occasional service	Home Shopping
111	[illegible]DH-NBC Boston, Mass.	Network TV
112	WSB-[illegible] Atlanta, Ga.	Network TV
117	WUSA-CBS Washington, D.C.	Network TV
120	KTVU-FOX Oakland/San Francisco, Calif	Network TV
124	WHYY-PBS Philadelphia, Penn.	Network TV
131	[illegible]PN	Sports
133	[illegible]N2	Sports
137	Classic Sports Network (occ)	Sports
138	Mega+1	Sports
141	New England Sports Network (NESN)	Sports
142	Madison Square Garden Network (MSG)	Sports
143	Empire Sports Network	Sports
144	Prime Sports KBL	Sports
145	Home Team Sports (HTS)	Sports
146	SportSouth	Sports
147	Sunshine	Sports
148	Pro American Sports (PASS)	Sports
149	Future service	
152	Prime Sports Midwest	Sports
153	Prime Sports Rocky Mountain	Sports
154	Prime Sports Southwest	Sports
155	Prime Sports Inter-Mountain West	Sports
156	Prime Sports Northwest	Sports
157	Future service	
158	Prime Sports West	Sports
159	Midwest SportsChannel	Sports
181	HBO en Espanol	Movies
182	HBO2 en Espanol	Movies
183	HBO3 en Espanol	Movies
187	Cinemax Selecciones	Movies
188	Cinemax2 Selecciones	Movies
190	Univision	Spanish language
201	Viewer's Choice	PPV
202	Request 1	PPV
203	Request 5	PPV
204	Hot Choice	PPV
205	Continuous Hits 1	PPV
206	Continuous Hits 2 — occasional service	PPV
207	Continuous Hits 3	PPV
208	Request 2	PPV
209	Request 3	PPV
210	Request 4	PPV
221	Playboy — occasional service	Adult
301	Superadio — Classical Hits	Audio
302	Superadio — America's Country Favorites	Audio
303	Superadio — Lite 'n' Lively Rock	Audio
304	Superadio — Soft Sounds	Audio
305	Superadio — Classic Collections	Audio
306	Superadio — New Age of Jazz	Audio
311	DMX Audio — Lite Jazz	Audio
312	DMX Audio — Classic Rock	Audio
313	DMX Audio — 70's Oldies	Audio
314	DMX Audio — Adult Contemporary	Audio
315	DMX Audio — Hottest Hits	Audio
316	DMX Audio — Modern Country	Audio
317	DMX Audio — Traditional Blues	Audio
318	DMX Audio — Salsa	Audio
527	Testing Channel	Tests

Added in May: TVLand (channel unknown)

Ku-band Satellite Transponder Services Guide

By Robert Smathers

H = Horizontal polarization, V = Vertical polarization, Occ video = Occasional Video,
[ ] = Type of encryption or video compression

Spacenet 2 (S2) 69° West

19	11740-H	Data transmissions
21	11900-H	TV ASAHI [Leitch]
22	11980-H	Empire Sports Network [video compression]
23	12060-H	Kentucky Educational TV (occ) - uses half transponders
24	12140-H	Occ video

SBS 6 (SBS6) 74° West

1	11717-H	Data transmissions
2	11749.5-V	Occ video
3	11774-H	Occ video
4	11798.5-V	Occ video
5	11823-H	Occ video
6	11847.5-V	Occ video
7	11872-H	Occ video
8	11896.5-V	Occ video
9	11921-H	Occ video
10	11945.5-V	Occ video
11	11963-H	CONUS Communications (half transponders)
12	11994.5-V	CONUS Communications (half-transponders)
13	12019-H	CONUS Communications (half transponders)
14	12043.5-V	Global Access occ video
15	12075-H	Global Access occ video
16	12092.5-V	Occ video
17	12110-H	Global Access occ video
18	12141.5-V	Occ video
19	12174-H	CNN Newsbeam (occ)

SBS 4 (SBS4) 77° West (Inclined orbit)

1	11725-H	NBC feeds
2	11780-H	NBC feeds
3	11823-H	NBC feeds
4	11872-H	NBC feeds
5	11921-H	NBC feeds
6	11970-H	NBC feeds
7	12019-H	NBC feeds
8	12068-H	NBC feeds
9	12117-H	NBC feeds
10	12166-H	NBC feeds

GE K2 (K2) 81° West

1	11729-H	NBC-East
2	11758.5-V	Pagesat computer service/Data transmissions
3	11788-H	NBC-Pacific (West spot beam)
4	11817.5-V	Cyclesat/occ video
5	11847-H	NBC contract channel
6	11876.5-V	Occ video
7	11906-H	NBC contract channel (network feeds)
8	11935.5-V	Chinese Communications Channel [Oak]
9	11965-H	NBC-Mountain
10	11994.5-V	[Compressed video]
11	12024-H	NBC contract channel (network feeds)
12	12053.5-V	Occ video
13	12083-H	NBC NewsChannel
14	12112.5-V	Occ video
15	12142-H	Data transmissions
16	12171.5-V	[Compressed video]

GE K1 (K1) 85° West

1	11729-H	Data transmissions
14	12112.5-V	(None)

Transponders 2-13 and 15-16 consists of Primestar programming encrypted and compressed using the Digicipher system. GE K1 uses the same frequency plan as GE K2. A complete Primestar channel guide is presented in the DBS section of *Satellites Times* Satellite Service Guide.

Spacenet 3R (S3) 87° West

19	11740-H	Data transmissions
20	11820-H	Data transmissions
23	12060-H	Oregon Educational Network (West spot beam)
24	12140-H	NYNET (SUNY) Ed Net/NY Lottery feeds (East spot beam)

Telstar 402R (T402) 89°West

Alphastar DBS uses many of this satellite's Ku-band transponders

1	11730-V	AT&T Tridom [digital]
2	11743-H	AT&T Tridom [digital]
3	11790-V	AT&T Tridom [digital]
4	11803-H	AT&T Tridom [digital]
7	11910-V	Occ video
15	12157-V	DMX for Business [digital data]

Galaxy 7 (K7) 91° West

1	11720-V	Occ video
2	11750-H	Data transmissions
3	11750-V	Indiana Higher Education [Compressed video]
4	11780-V	Occ video
6	11810-V	TCI Headend in the Sky?
7	11840-V	National Digital Television Center (slate)
8	11870-H	Data transmissions
9	11870-V	TCI Headend in the Sky?
10	11900-V	Occ video
11U	11945-H	[Compressed video]
12	11930-V	TCI Headend in the Sky?
13	11960-V	Occ video
14	11990-H	Occ video
15	11990-V	Occ video
16	12020-V	Occ video/The People's Network (TPN)
17	12050-H	Westcott Communications ASTN [B-MAC]/National Weather Networks (occasional)
18	12050-V	TCI Headend in the Sky?
19	12080-V	The Asia Network/Real Estate TV Network/Occ video
20	12110-H	Data transmissions
21	12110-V	TCI TV [B-MAC]
22	12140-V	TCI Headend in the Sky?
23	12170-H	Data transmissions
24	12170-V	TCI Headend in the Sky?

GSTAR-3 (GST3) 93° West (Inclined Orbit)

1	11730-H	Data transmissions
2	11791-H	Data transmissions
3	11852-H	Occ video
4	11913-H	Occ video
5	11974-H	Occ video
6	12035-H	Occ video
7	12096-H	Occ video
8	12157-H	Occ video
9	11744-V	Occ video
11	11866-V	Occ video
12	11927-V	Occ video/Mayo Clinic teleconference [B-MAC]
13	11988-V	Occ video/Mayo Clinic teleconference [B-MAC]
14	12049-V	Occ video/Mayo Clinic teleconference [B-MAC]
15	12110-V	Gstar 3 ID Channel
16	12171-V	Occ video

Galaxy 3R (G3R) 95° West

Ku-band side of this satellite is used entirely for the Galaxy Latin American DBS System.

Telstar 401 (T401) 97° West

1	11730-V	SCPC transmissions
2	11743-H	AT&T Skynet TV [compressed video]
3	11790-V	South Carolina Educational TV State Network [Digicipher]
4	11798-H	National Tech University [compressed video]
5	11845-V	PBS [Digicipher]
6	11855-H	SERC/PBS regionals/stations (half-transponders)
7	11902-V	PBS educational services (half-transponders)
8	11915-H	PBS stations/regionals and backhauls
9U	11986-V	PBS digital video [Digicipher]/ VSAT traffic
9L	11957-V	Egyptian TV
10	11962.5-H	Louisiana Public TV State Network [Digicipher]
11	12040-V	Occ video
12	12046-H	Occ video/Data transmissions (half-transponders)
13	12095-V	Spectradyne Hotel Hotel In-room movies [compressed video]
14L	12093-H	Peachstar Educational Network (Distance Leaming)
14U	12123-H	Georgia Public TV State Network (GPTV)
15	12147-V	ABC network and affiliate feeds (half-transponders)
16	12167-H	ABC network and affiliate feeds (half-transponders)

Galaxy 4 (K4) 99° West

1	11720-H	SCPC services/Data transmissions
2	11750-V	Data transmissions
3	11750-H	FM² services/MUZAK/Data transmissions
4	11780-H	FM² services/Planet Connect computer service (19.2 kbps)/ Data transmissions
5	11810-V	Data transmissions
6	11810-H	Occ video
7	11840-H	Chinese Television Network *Jong Ten* - Chinese/Taiwan all-news service
8	11870-V	Occ video
9	11870-H	Occ video
10	11900-H	CNN Airport Network [SA MPEG]
11	11930-V	Occ video (half-transponders common)
12	11930-H	Occ video/Channel One (occ)/ Microsoft TV (occ)
13	11960-H	Occ video/FDX SNG (occ)
14	11990-V	Occ video (half-transponders common)
16	12020-H	FM² services/Data transmissions
17	12050-V	CBS Newsnet and affiliate feeds (half-transponders)
18	12050-H	Honk Kong TVB Jade Channel (Chinese) [scrambled unknown system]
19	12080-H	Data transmissions
20	12110-V	Occ video (half-transponders common)
21	12110-H	Asian-American TV Network (occ)
22	12140-H	Family Net [Digicipher]
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

24	12140-H	E.M.G. courses [digicipher]

DBS-1 101.2° West/DBS-2 & DBS-3 100.8° W

A complete DIRECTV‡ and USSB channel guide is presented in the DBS section of *Satellites Times* Satellite Service Guide. These satellites operate in the 12.2-12.7 GHz range.

GSTAR-1 (GST1) 103° West

1	11730-H	Data transmissions
2	11791-H	Data transmissions
3	11852-H	Fed-X - occ video [B-MAC] /Occ video
4	11913-H	Data transmissions
5	11974-H	Occ video
6	12035-H	Data transmissions
7	12096-H	Healthcare Satellite [video compression]/Occ video
8	12157-H	Data transmissions
9	11744-V	Data transmissions
10	11805-V	Data transmissions
11	11866-V	Data transmissions
12	11927-V	Data transmissions
13	11988-V	Occ video
14	12049-V	Data transmissions
15	12110-V	Data transmissions
16	12171-V	Data transmissions

GSTAR-4 (GST4) 105° West

1	11730-H	Data transmissions
2	11791-H	Data transmissions
3	11852-H	CNN Newsource (Primary) [Leitch] some feeds in clear
4	11913-H	Occ video
5	11974-H	Occ video
6	12035-H	Occ video
7	12096-H	CNN Newsbeam/Occ video
8	12157-H	CNN Newsource International/ Occ video
9	11744-V	Data transmissions
11	11866-V	Occ video
12	11927-V	Occ video
13	11988-V	CNN Newsbeam/occ video
15	12110-V	CNN Newsbeam/occ video
16	12171-V	Occ video

Anik E2 (A1) 107.3° West

1	11717-V	Telesat Canada DVC: MovieMax!, Family Channel E&W, SuperChannel [digital video compression]
2	11743-V	DirectPC Canada [digital]
3	11778-V	Data transmissions
4	11804-V	Much Music
5	11839-V	Canadian Parliamentary Access Channel, Youth TV E&W, Vision TV, CHSC Shopping [digital video compression]
6	11865-V	Moviepix!; The Movie Network [digital video compression]
7	11900-V	Rogers Network [digital video compression]
8	11926-V	Rogers Network [digital video compression]
9	11961-V	Occ video
10	11987-V	Occ video
11	12022-V	Showcase TV (West)
12	12048-V	Saskarchewan CommunicaNetwork
13	12083-V	Data transmissions
14	12109-V	Data transmissions
15	12144-V	Telesat Canada stationkeeping (GLACS)
16	12170-V	Knowledge Network
17	11730-H	Discovery Channel Canada [Oak]
18	11756-H	Occ video
19	11791-H	Bravo! Canada
20	11817-H	Life Network
21	11852-H	Data transmissions
22	11878-H	Data transmissions
23	11913-H	Showcase TV (East)
24	11939-H	Ontario Legislature
25	11974-H	La Chaine (TV Ontario's French lanaguage service)
26	12000-H	TV Ontario (English)
27	12035-H	Occ video
28	12061-H	Occ video
29	12096-H	Atlantic Satellite Network (ASN)
30	12122-H	Telesat Canada stationkeeping (GLACS)
31	12157-H	CBC Newsworld feeds
32	12183-H	RDI feeds

Solidaridad 1 SD1 109.2° West

(No video has been seen on any Ku-band transponder)

Anik E1 (A2) 111° West

Note: Due to loss of power from the satellite south solar panel on March 26, 1996, Anik E1 Ku-band transponders 7-16 and 21-32 are off indefinitely according to Telesat officials.

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Data transmissions
5	11839-V	Business TV [digital]
6	11865-V	NovaNet FM² Services
17	11730-H	Woman's Television Network E&W [digital video compression]
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	SCPC/Data transmissions/New Country Network, Access Network of Alberta [Shaw digital video compression]

Anik C3 (C3) 114.9° West (Inclined Orbit)

(This satellite rarely has video transmissions)

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

(No video has been seen on any Ku-band transponder)

EchoStar 1 119°West

Satellite is still testing at presstime. A complete channel guide for TheDISH Television Network is presented in the DBS section of *Satellites Times* Satellite Service Guide. This satellite (and the soon to be launched Echostar 2) operate in the 12.2-12.7 GHz range.

SBS 5 (SBS5) 123° West

1	11725-H	Comsat Video in-room programming [B-MAC] (half transponders) — Satellite Cinema 1/3
2	11780-H	SCPC services
4	11872-H	Comsat Video in-room programming [B-MAC] (half transponders) — Satellite Cinema 4/2
5	11921-H	Data transmissions
6	11970-H	Data transmissions
7	12019-H	Data transmissions
8	12068-H	Comsat Video in-room programming [B-MAC] (half transponders) — ESPN/ Showtime
9	12117-H	Comsat Video in-room programming [B-MAC] (half transponders) — CNN Headline News/WTBS
10	12166-H	WalMart [V2+]/Occ video
11	11748-V	Data transmissions
12	11898-V	Occ video
13	11994-V	Occ video
14	12141-V	WMNB Russian-American TV [inverted video]

GSTAR-2 (GST2) 125° West

6	12035-H	Occ video
8	12157-H	Occ video
9	11744-V	Data transmissions
11	11866-V	GSTAR-2 ID slate
13	11988-V	Occ video
14	12049-V	Occ video
15	12110-V	Occ video
16	12171-V	Occ video

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69°	Galaxy 6 (G6) 74°	Telstar 302 (T2) 85°	Spacenet 3 (S3) 87°	Telstar 402R (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 401 (T1) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	Anik 1
1	SC New York [V2+]	Tokyo BS New York feeds	(none)	(none)	The Babe Channel/o/v	Sega Channel Interactive [Digital]	TVN Theatre 1 [V2+]	Exxxtasy (Adult) Promo/VTC	SCPC services	Data Transmissions	CBC- E
2	(none)	Global Access o/v/Canadian Horse Racing	(none)	Nebraska Educational TV [digicipher]	Data Transmissions	CBS West [VC1]	TVN Theatre 2 [V2+]	Data Transmissions	SCPC services	STARZ! 2 [V2+]	The Spe
3	USIA Worldnet TV	SCPC services	(none)	WSBK-Ind Boston [V2+]	Dragnet/Horse Racing [B-MAC]/o/v	Action PPV [V2+]	TVN Theatre 3 [V2+]	Keystone/Parmount feeds/o/v	SCPC services	Data Transmissions	Telesat [C
4	H.TV (Spanish) [V2+]	Canadian Horse Racing/o/v	(none)	Nebraska Educational TV (NETV)	Shop at Home	fX East	TVN Theatre 4 [V2+]	Group W Videoservices/o/v	SCPC services	Encore-Westerns [V2+]	Canc Compr M
5	NASA Contract Channel-o/v [Leitch]	NHK New York feeds	(none)	Univision [V2+]	FOX feeds East	fX West	TVN Theatre 5 [V2+]	Keystone o/v/MLB Backhauls	Global Access o/v	Data Transmissions	Telesa [Com
6	Data Transmissions	NHK (TV Japan) feeds	(none)	(none)	o/v	Game Show Network [V2+]	TVN Theatre 6 - Letterbox [V2+]/TVN Promos (occ)	Buena Vista TV feeds	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	CBC N [
7	o/v	National Empowerment TV	(none)	Data Transmissions	Cable Video Store [V2+]	The Golf Channel [V2+]	America's Choicemall (infomercials)	Global Access o/v	Global Access o/v/NC Open Net	Basil Bassett Bingo	CBC-N
8	Data Transmissions	(none)	(none)	Data Transmissions	MLB Backhauls/o/v	o/v	Gospel Music TV	PBS X	Telemundo [SA MPEG]	KOMO-ABC Seattle (PT24W) [V2+]	Glo [Leitch]
9	NASA TV	MuchMusic U.S. [V2+]	(none)	WPIX-Ind New York [V2+]	Horse Racing [Digital]	o/v	TVN Theatre 9 - adulTVision (adult) [V2+]	FOX feeds East	Global Access o/v/Book TV	Data Transmissions	CBC-I At
10	Data Transmissions	Arab Network of America (ANA)	ABC West [Leitch]	Data Transmissions	Exxxtreme TV/The Cupid Network (adult) [V2+]	United Arab Emirates TV Dubai	Showtime East 2 [V2+]	FOX feeds East	WJLA-ABC Washington, DC (PT24E) [V2+]	FOXNet (PT24E) [V2+]	Canc Compre M
11	SC Philadelphia [V2+]	Keystone o/v/MLB Backhauls	(none)	CNN feeds/o/v	Outdoor Channel	Estacion Montellano (Spanish Rel)/o/v	o/v	ABC feeds	Global Access o/v/BBC Breakfast News	STARZ! East [V2+]	CBC-A
12	Data Transmissions	TV Asia [digicipher]	(none)	Data Transmissions	o/v	(none)	MCI Andover o/v/RAI TV o/v	ABC NewsOne channel	Keystone o/v/MLB Backhauls	Keystone o/v/MLB Backhauls	Canc Compre [M
13	Data Transmissions	RTPi	(none)	SCPC/FM2 services	FOX feeds West	CSN/Kaleidoscope/P-SS/The Box [Digicipher]	o/v	FOX feeds East	Informercials/o/v	Data Transmissions	CBC-C P
14	Data Transmissions	Cornerstone TV WPCB-TV (Rel)	(none)	CNN [B-MAC]	TVLand	Independent Film Channel [V2+]	o/v	FOX News Service	WRAL-CBS Raleigh (PT24E) [V2+]	Goodwin Comm o/v	Canc Compr M
15	HERO Teleport [Digicipher]	Midwest Sports Channel [V2+]	(none)	KTLA-Ind Los Angeles [V2+]	Spice (adult) [V2+]	Intro Television [V2+]	o/v	Exxxtasy 2 (adult) [V2+]	World Harvest TV (Rel)	Data Transmissions	
16	Data Transmissions	Horse Racing [Digital]	(none)	CNN International [B-MAC]	Adam and Eve (adult) [V2+]	(none)	HBO 2 East [V2+]	MLB Backauls/o/v	CBS West [VC1]	NPS Promo Channel	CTV
17	Data Transmissions	Keystone o/v/MSG II-o/v/MLB Backhauls	(none)	FM2/SCPC services	FOX feeds	ESPN Intl [B-MAC]	Cinemax 2 East [V2+]	MLB Backhauls/o/v	CBS East/o/v [VC1]	Data Transmissions	CBC-
18	(none)	Global Access o/v	(none)	US Sat.Corp (infomercials)/ In-store audio	Kelly Broadcast Systems contract channel/o/v	Teleport Minnesota/CBS feeds/o/v	Global Access o/v/Informercials	Keystone o/v/MLB Backhauls	CBS feeds/o/v [VC1]	STARZ! West [V2+]	Video Ch
19	Data Transmissions	University Network/Dr. Gene Scott (Rel)	(none)	SSN Sportsouth [V2+]	Channel America	CBS East [VC1]	HBO 3 [V2+]	Keystone o/v/UPN/MLB Backhauls	CBS East/o/v [VC1]	Data Transmissions	TV North (T
20	Armed Forces Radio & Television Service [B-MAC]	CNN Headline News Clean Feed [V2+]	ABC East [Leitch]	(none)	Global Access/o/v	Prime Sports Showcase	HBO 2 West [V2+]	ABC East [Leitch]	CBS East [VC1]	Data Transmissions	Canc Compre [SA
21	SC New England [V2+]	XXXplore-XXXpose Promo Ch/o/v	(none)	SSN Pro Am Sports (Pass) [V2+]	MLB Backhauls/o/v	BET on Jazz	Univision/Univision feeds [Digital]	ABC East [Leitch]	WB Syndication-Network/CBS feeds/o/v	Data Transmissions	Telesat Comp
22	SC New York Plus [V2+]	Horse Racing [Digital]	(none)	Data Transmissions	ABC feeds - L.A. Bureau	NewsTalk Television	Horse Racing [Digital]	ABC West [Leitch]	WNBC-NBC New York (PT24E) [V2+]	Data Transmissions	[illegible]
23	NHK TV Japan secondary feeds	Worship TV (Rel)	(none)	SSN Home Teams Sports (HTS) [V2+]	La Cadena de Milagro (Spanish Rel)	fX Movies [V2+]	3 Angels Broadcasting	ABC East [Leitch]	SCOLA [Wegener]	Data Transmissions	CBC-E
24	(none)	Horse Racing [Digital]/o/v	(none)	America One	PandaAmerica (Home Shopping)	International Channel [V2+]	FLIX [V2+]	Exxxtasy Premier (adult) [V2+]	CBS Newspath feeds	KPIX-CBS San Francisco (PT24W) [V2+]	Inactiv Trans

Unscrambled/non-video — Subscription — Not available in U.S. — o/v = occasional video

Satellite Transponder Guide

By Robert Smathers

2 (A1) .3°	Solidaridad 1 (SD1) 109.2°	Telesat E1 (A2) 111°	Morelos 2 (M2) 116.8°	Telstar 303 (T3) 123°	Galaxy 9 (G9) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133	Satcom C4 (F4) 135	Satcom C1 (F1) 137°	
English tern	(none)	Data Transmissions	Data Transmissions	(none)	Global Access o/v	Disney East [V2+]	Family Channel West [V2+]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Prime Network [V2+]	1
s Network k]	(none)	(Inactive)	Data Transmissions	(none)	Global Access o/v	Playboy (Adult) [V2+]	The Learning Channel	Spanish language networks [SA MPEG]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
gital Video ssion]	SCPC services	Data Transmissions	Data Transmissions	(none)	NHK TV Japan	Trinity Broadcasting (Rel)	Viewer's Choice PPV [V2+]	Encore [V2+]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
Video sion [SA-EG]	(none)	Data Transmissions	Data Transmissions	(none)	General Communications [Digital]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food Network [Digicipher]	Lifetime East [V2+]	SC Pacific [V2+]	4
gital Video ssion]	o/v	Data Transmissions	Data Transmissions	(none)	Global Access o/v	CNN [V2+]	Faith and Values Channel/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	5
[illegible] k]	(none)	(Inactive)	Data Transmissions	XXXplore (adult) [V2+]	General Communications [Digital]	WTBS-Ind Atlanta [V2+]	Court TV [Digicipher]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
English	XEQ-TV canal 9	Data Transmissions	Data Transmissions	American Independent Network (AIN)	TVN Video Compression [Digital]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN Prime Sports West [V2+]	7
TV al feeds	(none)	Climaxxx (adult) [V2+]	XHGC canal 5	XXXpose (adult) [V2+]	General Communications [Digital]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
English ntic	o/v	(Inactive)	(none)	XXXplore/XXXpose (adult) Promo Channel	TVN Video Compression [Digital]	ESPN [V2+]	Music Choice [Digital]	ESPN2 Blackout [V2+]/SAH	QVC Network	Syndicated Entertainment TV (SET)	9
Video sion [SA-EG]	Mexican Parliament	(Inactive)	(none)	XXtreme/ClimaXXX (adult) Promo Channel	TVN Video Compression [Digital]	MOR Music	Home Shopping Club Spree	America's Talking [V2+]	Home Shopping Network (HSN)	SSN Prime Sports SW [V2+]	10
French	(none)	(Inactive)	XEIPN canal 11	(none)	TVN Video Compression [Digital]	Family Channel East [V2+]	Newsport [V2+]	Eternal Word TV Network (Rel)	(none)	Network One N1 [V2+]	11
Video sion [SA-EG]	Data Transmissions	(Inactive)	Data Transmissions	(none)	General Communications [Digital]	Discovery West [V2+]	History Channel [V2+]	Valuevision	Nustar (Promo Channel)	Data Transmissions	12
English ific	(none)	(Inactive)	(none)	(none)	TVN Video Compression [Digital]	CNBC [V2+]	The Weather Channel [V2+]	Encore [Digicipher]	Travel Channel [V2+]	SC Chicago [V2+]	13
Video sion [SA-G]	Data Transmissions	(Inactive)	XEW canal 2	(none)	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Blackout [V2+]/SAH	Fit TV	KUSA-NBC Denver [V2+]	14
	Multivision [Digicipher]	(Inactive)	Data Transmissions	(none)	Showtime West [V2+]	HBO East [V2+]	Showtime East [V2+]	CNN International/CNNfN [V2+]	WWOR-Ind New York [V2+]	SC Cincinnati/Ohio/Florida [V2+]	15
Green)	Data Transmission	CTV (Red)	Canal 22	(none)	General Communications [Digital]	Cinemax West [V2+]	MTV West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Prime Sports West/ Prime Deportiva [Digicipher]	16
Feeds	(none)	(Inactive)	o/v	(none)	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN Prime Sports (various) [V2+]	17
Catalog nnel	(none)	(Inactive)	Clara Vision (Rel)	(none)	The Movie Channel West [V2+]	TNN [V2+]	Nickelodeon West [V2+]	HBO Multiplex [Digicipher]	Viewer's Choice [Digicipher]	Prime/Sunshine Alt/Cal-Span	18
rn Canada NC)	Multivision [Digicipher]	Canadian Horse Racing/o/v	(none)	(none)	MTV West [V2+]	USA East [V2+]	Showtime/MTV [Digicipher]	Cinemax East [V2+]	C-SPAN 2	FOXNet [V2+]	19
Video sion/NTV PEG]	(none)	Canadian Horse Racing/o/v	Data Transmissions	(none)	General Communications [Digital]	BET [V2+]	Jones Intercable [Digicipher]	Home and Garden Network	Showtime West [V2+]	o/v	20
ital Video ssion]	(none)	SCPC services/ Data Transmissions	(none)	(none)	Global Access o/v	MEU [V2+]	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Sportchannel alt/SportsChannel Fla.	21
[illegible]]	(none)	(Inactive)	XHIMT canal 7/TeleCasa	Antenna TV [V2+]/HRT Croatia/o/v	Global Access o/v	CNN/HN [V2+]	Your Choice TV [Digicipher]	Nostalgia Channel	Movie Channel West [V2+]	SSN PSNW [V2+]/Step Stair Ed Net	22
English	(none)	(Inactive)	(none)	(none)	The Computer Network	A&E [V2+]	E! Entertainment TV [V2+]	(none)	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
(Failed onder)	(none)	(Inactive)	HDF canal 13	(none)	General Communications [Digital]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio (DMX) [Digital]	Global Shopping Network	CMT [V2+]	SSN Sunshine [V2+]	24

Unscrambled/non-video Subscription Not available in U.S. o/v = occasional video

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 246 active geostationary/synchronous satellites at publication deadline. Synchronous satellite location information is supplied to *Satellite Times* by NASA's Goddard Space Flight Center-Orbital Information Group (Mr. Adam Johnson). We are particularly grateful to the following individuals for providing payload information and analysis: Earth News: Philip Chien; Molniya Space Consultancy: Mr. Phillip Clark; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; U.S. Space Command/Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

'd' indicates that satellite is drifting — moving into a new orbital slot or at end of life. 'i' indicates an orbital inclination greater than 2 degrees and '#' indicates that the satellite is drifting.

Radio Frequency Band Key

VHF	136-138 MHz
P band	225-1,000 MHz
L band	1.4-1.8 GHz
S band	1.8-2.7 GHz
C band	3.4-7.1 GHz
X band	7.25-8.4 GHz
Ku band	10.7-15.4 GHz
K band	15.4 -27.5 GHz
Ka band	27.5-50 GHz
Millimeter	> 50 GHz

Satellite Service Key

BSS	Broadcast Satellite Service
Dom	Domestic
DTH	Direct to Home
FSS	Fixed Satellite Service
Gov	Government
Int	International
Mar	Maritime
Met	Meteorology
Mil	Military
Mob	Mobile
Reg	Regional

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
23730	1995-067A Telecom 2C (France)	3.0E	Dom FSS/Gov-Mil (X/C/Ku)
20929	1990-095A DSP F-15 (USA)	3.8E#	Mil-Early Warning (S/X)
23712	1995-060A USA 115 (DFS-2/Milstar-2)	4.0E	Mil-Comm (P/S/K)
19919	1989-027A Tele X (Sweden)	5.0E	Reg DTH/FSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.1E	Reg DTH (Ku)
22921	1993-076A USA 98 (NATO 4B)	6.0E/i	Mil-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	6.9E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg FSS (Ku)
19596	1988-095A Raduga 22 (Russia)	12.0E/i	Dom FSS/Gov-Mil (X/C)
22269	1992-088A Cosmos 2224 (Russia)	12.1E#	Mil-Earl Warning (X)
22557	1993-013A Raduga 29 (Russia)	12.2E#	Dom FSS/Gov-Mil (X/C)
20777	1990-079B Eutelsat II F1	13.0E	Reg FSS (Ku)
21055	1991-003A Italsat 1 (Italy)	13.0E	Dom-Telephone (S/K/Ka)
23537	1995-016B Hot Bird 1 (Eutelsat II F6)	13.3E	DTH (Ku)
21803	1991-083A Eutelsat II F3	15.9E	Reg FSS (Ku)
23686	1995-055A Astra 1E	19.1E	Reg DTH (Ku)
23331	1994-070A Astra 1D	19.2E	Reg DTH (Ku)
21139	1991-015A Astra 1B	19.2E	Reg DTH (Ku)
19688	1988-109B Astra 1A	19.2E	Reg DTH (Ku)
22653	1993-031A Astra 1C	19.4E	Reg DTH (Ku)
14234	1983-077A Telstar 3A (301) (USA)	20.1Ei	Dom FSS-Saudi Arabia (C)
19331	1988-063B Eutelsat 1 F5	21.5E#	Reg FSS (VHF/Ku)
13010	1981-122A Marecs 1 (ESA)	22.4E/i	Int Mar-EUR (L/C)
22175	1992-066A DFS 3 (Germany)	23.5E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.5E/i	Reg FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (Russia)	25.9E/i	Dom/Gov FSS (C/Ku)
23842	1996-021A Astra 1F	26.9E	Reg DTH (Ku)
20706	1990-063B DFS 2 (Germany)	28.5E	Dom BSS (S/Ku/K)
21894	1992-010B Arabsat 1C	31.0E	Reg FSS/BSS (S/C)
19765	1989-004A Gorizont 17 (Russia)	33.8E/i	Dom/Gov FSS (C/Ku)
14128	1983-058A Eutelsat 1 F1 (ECS 1)	35.9/i	Reg FSS (Ku)
21821	1991-087A Raduga 28 (Russia)	35.9E/i	Dom FSS/Gov-Mil (X/C)
23775	1996-005A Gorizont 31 (Russia)	39.9E#	Dom/Gov FSS (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	42.0E	Reg FSS (Ku)
23839	1996-020A Inmarsat 3 F-1	42.5E/i	Int Mar (L/C)
19928	1989-030A Raduga 23 (Russia)	44.6E/i	Dom FSS/Gov-Mil (X/C)
14421	1983-105A Intelsat 507	47.1E/i	Int FSS/Mar (L/C/Ku)
22981	1994-008A Raduga 1-3 (Russia)	48.8E#	Dom FSS/Gov-Mil (X/C)
21038	1990-116A Raduga 1-2 (Russia)	49.4E/i	Dom FSS/Gov-Mil (X/C)
22245	1992-082A Gorizont 27 (Russia)	52.7E#	Dom/Gov FSS (C/Ku)
19687	1988-109A Skynet 4B (UK)	52.9E/i	Mil-Comm (P/S/X/Ka)
13636	1982-006A DSCS II E15 (USA)	57.0E/i	Mil-IOR reserve operational (S/X)
14675	1989-069B DSCS III A2 (USA 44)	57.0E/i	Mil-IOR primary operational (P/S/X)
15629	1985-025A Intelsat 510	56.9E/i	Int FSS (C/Ku)
22913	1993-074A DSCS III B10 (USA 97)	60.E/i	Mil-IOR primary operational (P/S/X)
20667	1990-056A Intelsat 604	60.0E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	63.0E	Int FSS (C/Ku)
13636	1982-106A DSCS II F16 (USA 43)	64.5E/i	Mil-IOR reserve operational (S/X)
13595	1982-097A Intelsat 505	64.6E/i	Int FSS/Mar (L/C/Ku)
20918	1990-093A Inmarsat 2 F1	64.7E#	Int Mar-IOR (L/C)
23461	1995-001A Intelsat 704	65.9E	Int FSS (C/Ku)
23636	1995-040A PanAmSat 4 (PAS 4)	68.4E	Int FSS (C/Ku)
20083	1989-048A Raduga 1-1 (Russia)	69.6E/i	Dom FSS/Gov-Mil (X/C)
23448	1994-087A Raduga 32 (Russia)	70.6E#	Dom FSS/Gov-Mil (X/C)
22963	1993-002A Gals 1 (Russia)	71.0E	Dom BSS (Ku)
23717	1995-063A Gals 2 (Russia)	71.0E	Dom BSS (Ku)
20410	1990-002B Leasat 5 (USA)	71.6E/i	Mil-IOR reserve (P/S/X)
12474	1981-050A Intelsat 501	71.7E/i	Int FSS (C/Ku)
23589	1995-027A USA 111 (UFO-5)	71.9E/i	Mil-IOR reserve (P/S/K)
08882	1976-053A Marisat 2	72.2E/i	Int Mar-IOR (P/L/C)
22787	1993-056A USA 95 (UFO-2)	72.7E/i	Mil-IOR primary (P/S)
22027	1992-041A Insat 2A (India)	74.0E	Dom FSS/BSS/Met (S/C)
23327	1994-069A Elektro 1 (Russia)	75.9E#	Met (L)
23680	1995-054A Luch 1-1 (Russia)	76.7E/i	Tracking & Relay SDRN-2 (Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.4E	Reg FSS (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.4E	Reg FSS (C/Ku)
23653	1995-045A Cosmos 2319 (Russia)	79.6E#	Data Relay (C)
21759	1991-074A Gorizont 24 (Russia)	80.0E/i	Dom/Gov FSS (C/Ku)
23010	1994-012A Raduga 31 (Russia)	83.0E	Dom FSS/Gov-Mil (X/C)
20643	1990-051A Insat 1D (India)	83.1E	Dom FSS/BSS/Met (S/C)
22836	1993-062A Raduga 30 (Russia)	84.5E#	Dom FSS/Gov-Mil (X/C)
19548	1988-091B TDRS F3 (USA)	85.4E/i	Gov (C/S/Ku)
18922	1988-014A PRC 22 (China)	87.2E/i	Dom FSS (C)
22880	1993-069A Gorizont 28 (Russia)	90.1E#	Dom/Gov FSS (C/Ku)
23765	1995-003A Measat 1 (Malaysia)	91.4E	Dom FSS/DTH (C/Ku)
23731	1995-067B Insat 2C (India)	93.1E	Dom FSS/BSS/Met (S/C)
22724	1993-048B Insat 2B (India)	93.4E	Dom FSS/BSS/Met (S/C)
23426	1994-082A Luch 1 (Russia)	95.1E#	Tracking & Relay CSDRN (Ku)
20263	1989-081A Gorizont 19 (Russia)	96.2E/i	Dom/Gov FSS (C/Ku)
20473	1990-011A PRC 26 (China)	97.8E#	Dom FSS (C)
19683	1988-108A Ekran 19 (Russia)	99.0E/i	Dom BSS (P)
22210	1992-074A Ekran 20 (Russia)	99.2E#	Dom BSS (P)
23723	1995-064A AsiaSat 2	100.7E	DTH (C/Ku)
21922	1992-017A Gorizont 25 (Russia)	103.2E#	Dom/Gov FSS (C/Ku)
20558	1990-030A Asiasat 1	105.2E	DTH (C/Ku)
23176	1994-040B BS-3N (Japan)	107.3E	Dom BSS (Ku)
20570	1990-034A Palapa B2R	107.7E	Reg FSS (C)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	108.8E#	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.9E	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.2E#	Dom FSS (C)
23779	1996-006A Palapa C-1	112.8E	Reg FSS (C/Ku)
17706	1987-029A Palapa B-2P	113.0E	Reg FSS (C)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	113.9E	Dom FSS (Ku)
23768	1996-003A Koreasat 2 (Mugunghwa 2)	115.3E	Dom FSS (Ku)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.6E	Dom FSS (C/Ku)
21964	1992-027A Palapa B4	118.2E	Reg FSS (C)
20217	1989-070A GMS-4 (Himawari 4)	120.1E#	Met (P/L)
21132	1991-014A Raduga 27 (Russia)	127.4E/i	Dom FSS/Gov-Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.8E	Dom FSS (Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	129.6E#	Reg FSS (C/Ku)
23651	1995-044A N-Star A (Japan)	131.4E	Dom/Mob FSS (S/C/Ku/Ka)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.9E	Dom FSS (C/K)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	135.8E	Dom FSS (C/K)
23781	1996-007A N-Star B (Japan)	136.1E	Dom/Mob FSS (S/C/Ku/Ka)
23185	1994-043A Apstar A1 (China)	137.9E	DTH (C)
20107	1989-052A Gorizont 18 (Russia)	139.8E/i	Dom/Gov FSS (C/Ku)
23522	1995-011B GMS-5 (Himawari 5)	140.0E#	Met (P/L)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
20953	1990-102A Gorizont 22 (Russia)	140.1E/i/d	Dom/Gov FSS (C/Ku)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.0E#	Reg FSS (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	144.9E/i	Dom/Gov FSS (C/Ku)
20066	1989-046A DSP F-14 (USA)	145.5E/i	Mil-Early Warning (S/X)
19874	1989-020A JCSAT 1 (Japan)	149.7E	Dom FSS (Ku)
18316	1987-070A ETS V (Japan)	150.2E/i	Experimental (L/C)
18350	1987-078A Optus A3 (Aussat K3)	152.0E#	DTH (Ku)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.8E	DTH/Mob (L/Ku)
22253	1992-084A Superbird A1 (Japan)	158.0E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	160.0E	DTH/Mob (L/Ku)
21893	1992-010A Superbird B1 (Japan)	162.0E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	163.9E/i	DTH (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	169.0E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(USA)	172.1E/i	Mil-POR reserve (P-Bravo/S/X)
22871	1993-066A Intelsat 701	173.9E	Int FSS (C/Ku)
22719	1993-046A DSCS III B9 (USA 93)	175.0E/i	Mil-WPAC primary operational (P/S/X)
23305	1994-064A Intelsat 703	176.9E	Int FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	178.0E#	Int Mar-POR (L/C)
16117	1985-092C DSCS III B5 (USA 12)	180.0E/i	Mil-WPAC reserve operational (P/S/X)
15873	1985-055A Intelsat 511	179.8W/i	Int FSS (C/Ku)
23467	1995-003A USA 108 (UFO-4) (USA)	177.7W/i	Mil-POR (P/S/K)
15236	1984-093C Leasat 2 (USA)	177.2W/i	Mil-POR primary (P/S/X)
19121	1988-040A Intelsat 513	176.9W#	Int FSS (C/Ku)
09478	1976-101A Marisat 3	176.7W/i	Int Mar-POR (P/L/C)
21639	1991-054B TDRS F5 (USA)	174.4W	Int FSS/Gov (C/S/Ku)
18631	1987-100A Raduga 21 (Russia)	170.8W/i	Dom FSS/Gov-Mil (X/C)
20499	1990-016A Raduga 25 (Russia)	170.5W/i	Dom FSS/Gov-Mil (X/C)
23613	1995-035B TDRS F7 (USA)	150.1W#	Int FSS/Gov (C/S/Ku)
21392	1991-037A Satcom C5 (Aurora II)(USA)	138.9W	Dom FSS (C)
20945	1990-100A Satcom C1 (USA)	137.0W	Dom FSS (C)
23581	1995-025A GOES 9 (USA)	135.3W	Met (P/L/S)
22096	1992-057A Satcom C4 (USA)	134.8W	Dom FSS (C)
21873	1992-006A DSCS III B14 (USA 78)	135.0W/i	Mil-EPAC primary operational (P/S/X)
23016	1994-013A Galaxy 1R (USA)	133.1W	Dom FSS (C)
22117	1992-060B Satcom C3 (USA)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (USA)	130.1W/i	Mil-EPAC reserve operational (P/S/X)
21906	1992-013A Galaxy 5 (USA)	125.0W	Dom FSS (C)
16649	1986-026A Gstar 2 (USA)	125.0W#	Dom FSS (Ku)
15826	1985-048D Telestar 3D (USA)	123.0W#	Dom FSS (C)
19484	1988-081B SBS 5 (USA)	123.0W	Dom FSS (Ku)
22988	1994-009A USA 99 (DFS-1/Milstar 1)	120.0W	Mil-Comm (P/S/K)
23754	1995-073A EchoStar 1 (USA)	119.1W	DTH (Ku)
16274	1985-109B Morelos B (Mexico)	116.8W	Dom FSS (C/Ku)
13652	1982-110C Anik C3 (Canada)	115.0W/i	Dom FSS (Ku)
23313	1994-065A Solidaridad 2 (Mexico)	113.0W	Dom FSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.1W	Dom FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.2W	Dom FSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom FSS (C/Ku)
08746	1976-023A LES 8 (USA)	106.5W/i	Mil-Exp comm (P/Ka)
23846	1996-022A MSAT M1 (Canada)	106.1W	Mobile (L/C)
08697	1976-017A Marisat 1	105.9W/i	Int Mar-AOR (P/L/C)
15643	1985-028C Leasat 3 (USA)	105.9W/i	Mil-CONUS reserve (P/S/X)
23696	1995-057A USA 114 (UFO-6)	105.4W/i	Mil-CONUS (P/S/K)
08747	1976-023B LES 9 (USA)	105.3W/i	Mil-Exp comm (P/Ka)
20946	1990-100B Gstar 4 (USA)	105.0W	Dom FSS (Ku)
03029	1967-111A ATS 3 (USA)	104.8W/i	Exp comm (VHF/C)
15677	1985-035A Gstar 1 (USA)	103.0W	Dom FSS (Ku)
23435	1994-084A DSP F-17 (USA)	103.6W#	Mil-Early Warning (S/X)
22930	1993-078A DBS 1 (USA)	101.3W	DTH (Ku)
21227	1991-028A Spacenet 4 (USA)	101.1W	Dom FSS (C/Ku)
23553	1995-019A AMSC 1 (USA)	101.0W	Mobile (L/X)
23598	1995-029A DBS 3 (USA)	100.9W	DTH (Ku)
23192	1994-047A DBS 2 (USA)	100.9W	DTH (Ku)
22796	1993-058B ACTS (USA)	100.0W	Exp Comm (C/K/Ka)
17181	1986-096A USA 20 (FltSatCom F7)(USA)	99.2W/i	Mil-CONUS primary (P/S/X/K)
22694	1993-039A Galaxy 4 (USA)	99.0W	Dom FSS (C/Ku)
22927	1993-077A Telstar 401 (USA)	97.0W	Dom FSS (C/Ku)
23741	1995-069A Galaxy 3R (USA)	95.0W	Dom/DTH (C/Ku)
19483	1988-081A Gstar 3 (USA)	93.2W/i	Dom FSS/Mob (L/Ku)
16650	1986-026B SBTS 2 (Brazil)	92.1W	Dom FSS (C)
22205	1992-072A Galaxy 7 (USA)	91.0W	Dom FSS (C/Ku)
23670	1995-049A Telstar 402R (USA)	89.0W	Dom FSS (C/Ku)
18951	1988-018A Spacenet 3R (USA)	87.2W	Dom FSS (L/C/Ku)
15237	1984-093D Telestar 3C (302) (USA)	85.1W#	Dom FSS (C)
16482	1986-003B Satcom K-1 (USA)	85.0W	Dom FSS (Ku)
16276	1985-109D Satcom K-2 (USA)	81.0W	Dom FSS (Ku)
15235	1984-093B SBS 4 (USA)	77.2W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (USA)	76.0W/i	Dom FSS (C)
14133	1983-059B Anik C2 (Argentina)	75.9W/i	Dom FSS (Ku)
23051	1994-022A GOES 8 (USA)	75.5W#	Met (P/L/S)
14050	1983-041A GOES 6 (USA)	74.9/i	Met (P/L/S)
20873	1990-091B Galaxy 6 (USA)	74.1W	Dom FSS (C)
20872	1990-091A SBS 6 (USA)	74.1W	Dom FSS (Ku)
23124	1994-034A Intelsat 702	73.1W/d	Int FSS (C/Ku)
15642	1985-028B Anik C1 (Argentina)	71.9W	Dom FSS (Ku)
12855	1981-096A SBS 2 (USA)	70.9W/i	Dom FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.0W	Dom FSS (C)
15385	1984-114A Spacenet 2 (USA)	70.0W	Dom FSS (C/Ku)
23536	1995-016A Brasilsat B2 (Brazil)	65.1W	Dom FSS (C/X)
15561	1985-015B SBTS 1 (Brazil)	63.0W#	Dom FSS (C)
21940	1992-021B Inmarsat 2 F4	54.4W/i	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	52.7W	Int FSS (C/Ku)
23628	1995-038A DSCS III B7 (USA)	52.5W/i	Mil-WLANT primary operational (P/S/X)
23528	1995-013A Intelsat 705	50.0W	Int FSS (C/Ku)
22314	1993-003B TDRS F6 (USA)	45.7W/i	Gov (C/S/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Int FSS (C/Ku)
23764	1996-002A PanAmSat 3R (PAS 3R)	43.1W	Int FSS (C/Ku)
16116	1985-092B DSCS III B4 (USA 11)	42.5W/i	Mil-ATL reserve operational (P/S/X)
19883	1989-021B TDRS F4 (USA)	41.1W	Int FSS/Gov (C/S/Ku)
12089	1980-098A Intelsat 502	40.2W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (USA)	37.7W	Int FSS (Ku)
23168	1994-038A Cosmos 2282 (Russia)	34.8W#/d	Mil-Early Warning (X)
20523	1990-021A Intelsat 603	34.5W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.1W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.3W/i	Int FSS/Mar (L/C/Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	Dom BSS/FSS (Ku)
22116	1992-060A Hispasat 1A (Spain)	30.0W	Dom BSS/FSS (Ku)
21765	1991-075A Intelsat 601	27.6W	Int FSS (C/Ku)
21653	1991-055A Intelsat 605	24.6W	Int FSS (C/Ku)
22112	1002-059A Cosmos 2209 (Russia)	23.6W#	Mil-Early Warning (X)
20253	1989-077A USA 46 (FltSatCom 8)	23.3W/i	Mil-AOR primary (P-Charlie/S/X/K)
21989	1992-032A Intelsat K	21.7W	Int FSS (Ku)
16101	1985-087A Intelsat 512	21.5W#	Int FSS (C/Ku)
15391	1984-115A NATO III D	21.1W/i	Mil-Comm (P/S/X)
20705	1990-063A TDF 2 (France)	19.0W	DTH (Ku)
19621	1988-098A TDF 1 (France)	18.8W	DTH (Ku)
19772	1989-006A Intelsat 515	18.1W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.8W/i	Mil-Comm (P/S/X)
20391	1989-101A Cosmos 2054 (Russia)	16.4W/i	Tracking & Relay WSDRN (Ku)
21149	1991-018A Inmarsat 2 F2	15.5W/i	Int Mar-AOR-E (L/C)
23132	1994-035A USA-104 (UFO-3)(USA)	15.2W/i	Mil-AOR primary (P/S)
21789	1991-079A Cosmos 2172 (Russia)	15.1W/i	Data Relay (C)
15386	1984-114B Marecs B2	14.9W/i	Int Mar-AOR (L)
10669	1978-016A Ops 6391 (FltSatCom 1) (USA)	14.6W/i	Mil-AOR reserve (P-Alpha/S/X)
23319	1994-067A Express 1 (Russia)	14.0W	Int FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	13.5 W#	Data Relay (C)
22009	1992-037A DSCS III B12 (USA 82)	12.0W/i	Mil-ELANT primary operational (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	11.5W#	Dom/Gov FSS (C/Ku)
22912	1993-073B Meteosat 6 (ESA)	10.4W#	Met (L)
21813	1991-084A Telecom 2A (France)	8.1W	Dom FSS/Gov-Mil (X/C/Ku)
21805	1991-080B DSP F-16 (USA)	6.9W#	Mil-Early Warning (S/X)
21939	1992-021A Telecom 2B (France)	5.0W	Dom FSS/Gov-Mil (X/C/Ku)
23816	1996-015A Intelsat 707	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.1W#	Mil (P/S/X/Ka)
20168	1989-062A TV Sat 2 (Germany)	0.8W	Dom BSS (Ku)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.6W	Reg BSS (Ku)
21140	1991-015B Meteosat 5 (MOP 2)	0.2W	Met (L)

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Satellite	Mode		Frequencies															
OSCAR 13 (AO-13) (Notes 1 & 13)	B (u/V)	Dn	145.828	838	848	858	868	878	888	898	908	918	928	938	948	958	968	145.978
		Up	435.570	560	550	540	530	520	510	500	490	480	470	460	450	440	430	435.420
	Bcns		145.812 (RTTY, CW, PSK)															145.985
	S (u/S)	Dn	2400.711	720	730	740	2400.747											
		Up	435.601	610	620	630	435.637											
	Bcn		2400.650 (RTTY, CW, PSK)															
OSCAR 10 (AO-10) (Notes 2 & 13)	B (u/V)	Dn	145.825	835	845	855	865	875	885	895	905	915	925	935	945	955	965	145.975
		Up	435.179	169	159	149	139	129	119	109	099	089	079	069	059	049	039	435.029
	Bcn		145.810 (Steady unmodulated carrier)															145.987
RS 10/11 (Notes 3, 4, 5 and 13)	A (v/A)	Dn	29.360	370	380	390	29.400				Robot	29.403						
		Up	145.860	870	880	890	145.900				(CW)	145.820						
	Bcn		29.357 (CW)															
RS-12/13 (Notes 3, 6 & 7)	K (h/A)	Dn	29.410	420	430	440	29.450				Robot	29.454						
		Up	21.210	220	230	240	21.250				(CW)	21.129						
	Bcn		29.408															
RS-15 (Note 13)	A (v/a)	Dn	29.354	29.364	29.374	28.384	29.394											
		Up	145.858	145.868	145.878	145.888	145.898											
UoSat 11 (UO-II) (Note 14)	Bcns	Dn	145.826	435.025	2401.500													
		Up	None															
PACSAT (AO-16) (Notes 8, 9 & 11)	[a]	Dn	437.025 (Sec) 437.050															
		Up	145.900	145.920	145.940	145.960												
DOVE (DO-17) (Notes 10 & 11)	[b,c]	Dn	145.825	2401.220														
		Up	None															
WEBERSAT (WO-18) (Note 11)	[a]	Dn	437.075	437.100 (Sec)														
		Up	None															
LUSAT (LO-19) (Notes 8 & 11)	[a]	Dn	437.125	437.150 (Sec)														
		Up	145.840	145.860	145.880	145.900												

NOTES

1. AO-13 carries a 70 cm trammitter for Modes J and L. However, this transmitter failed in mid-1993 and has been inoperative since.
2. The AO-10 beacon is an unmodulated carrier. This satellite has suffered computer damage making it impossible to orient the satellite for optimum service or solar illumination. In order to preserve it as long an possible, do not transmit to it when you hear the beacon FMing.
3. RS-10/11 and RS-12/13 are each mounted on common spaceframes, along with comunication and navagation packages.
4. RS-10 has been in Mods A for some months, but also has capability for Mode T (21.160-21.200 Uplink, 145.860-145.900 Downlink), Mode K (21.160-21.200 Uplink, 29.360-29.400 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.
5. RS-11 is currently turned off. If activated, it has capability for Mods A (145.910-145.950 Uplink, 29.410-29.450 Downink), Mode T (21.210-21.250 Uplink, 145.910-145.950 Downlink), Mode K (21.210-21.250 Uplink, 29.410-29,450 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.
6. RS-12 has been in Mode K for some months, but also has capability for Mode A (145.910-145.950 Uplink, 29.410-29.450 Downlink), Mode T (21.210-21.250 Uplink, 145.910-145.950 Downlink) an well as combined Modes K/A and K/T using these same frequency combinations.
7. RS-13 is currently turned off. If activated, it has capability for Mode A (145.960-146.000 Uplink, 29.460-29.500 Downlink), Mode K (21.260-21.300 Uplink, 29.460-29.500 Downlink), Mode T (21.210-21.250 Uplink, 145.960-146.000 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.
8. Transmitters on both AO-16 & LU-19 are currently using Raised Cosine Mode.
9. AO-16 users are encouraged to select 145.900, 145.920 and 145.940 for uploading and 145.960 for directory and/or file requests.
10. DOVE is designed to transmit digital voice messages, but due to hardware and software difficulties, it has not yet met this objective except for a few short tests. Recently, it has been transmitting telemetry in normal AX-25 AFSK packet.
11. Letters in [ ] represent digital formats, as follows:
    [a] 1200 bps PSK AX-25
    [b] 1200 bps AFSK AX-25
    [c] 9600 bps FSK
    [d] Digitized voice (Notes 8 & 9)
12. PO-28 is available to amateurs on an intermittent, unscheduled basis.
13. Modes of operation used include: CW./USB/FAX/Packet/RTTY
14. Modes of operation used include: FM (AFSK) & PSK Data.
15. Modes of operation used include: Packet & FM Voice.

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Satellite	Mode		Frequencies
JAS-Ib (FO-20) (Notes 11 & 13)	JA Linear	Dn	435.800 810 820 830 840 850 860 870 880 890 435.900
		Up	146.000 990 980 970 960 950 940 930 920 910 145.900
	Bcn		435.795 (CW)
	JD [a] Dgtl	Dn	435.910
		Up	145.850 145.890 145.910
OSCAR 22 (UO-22) (Note 11)	[c]	Dn	435.120
		Up	145.900 145.975
KITSAT A (KO-23) (Note 11)	[c]	Dn	435.173
		Up	145.850 145.900
KITSAT B (KO-25) (Note 11)	[c]	Dn	435.175 436.500
		Up	145.870 145.980
IT-AMSAT (IO-26) (Note 11)	[a,c]	Dn	435.820 (Sec.) 435.867
		Up	145.875 145.900 145.925 145.950
EYESAT /AMRAD (AO-27) (Note 11)	[b,a]	Dn	436.800
		Up	145.850
POSAT (PO-28) (Notes 11 & 13)	[c]	Dn	435.250 435.280
		Up	145.925 145.975
MIR (Note 15)	[b]	Up & Dn & FM voice	145.550
SHUTTLE (SAREX) (Note 15)	[b]	Dn	145.840
		Up	144.450 144.470

Compiled by
AMSAT
The Radio Amateur Satellite Corp.
PO Box 27 Washington, DC 20044

Amateur and Weather Satellite Two-Line Orbital Element Sets

Below is an example of the format for the elements sets presented in this section of the Satellite Service Guide. The spacecraft is named in the first line of each entry. Illustration below shows meaning of data in the next two lines.

OSCAR 10
1 14129U 83058B 94254.05030619 -.00000192 00000-0 10000-3 0 3080
2 14129 26.8972 308.5366 6028238 209.9975 94.5175 2.05881264 56585

	Catalog #	Intl. Desig.	Epoch Year	Epoch Day .Fraction	Period Decay Rate	Not used		
1	14129U	83058B	94	254.05030619	- .0000192	00000-0	100000-30	3080

	Catalog #	Inclination	Right Asc. of Node	Eccentricity	Argument of Perigee	Mean Anomaly	Mean Motion	Revolution # at Epoch	
2	14129	26.8972	308.5366	6028238	209.9975	94.5175	2.05881264	5658	5

Notice that there is no decimal point printed for eccentricity. The decimal point goes in front of the number. For example, the number shown above for eccentricity would be entered into your computer tracking program as .6028238.

AMATEUR RADIO SATELLITES
OSCAR 10 (AMSAT OSCAR 10, AO-10)
1 14129U 83058B 96162.15584581 -.00000004 00000-0 10000-3 0 4299
2 14129 26.1735 205.3932 6006571 22.5500 355.5374 2.05880304 69722
UOSAT 2 (UoSAT 2, UoSAT 11, UO-11)
1 14781U 84021B 96160.48499956 .00000071 00000-0 19762-4 0 8897
2 14781 97.7992 151.5956 0012323 113.8513 246.3989 14.69457506656376
RS-10/11 (Radio Sputnik 10/11, Cosmos 1861)
1 18129U 87054A 96161.46830125 .00000035 00000-0 21669-4 0 2255
2 18129 82.9260 154.2454 0011229 168.0646 192.0776 13.72366454449113
OSCAR 13 (AMSAT OSCAR 13, AO-13)
1 19216U 88051B 96162.03840914 .00002245 00000-0 57810-3 0 2185
2 19216 57.2504 111.8235 7424153 41.7519 355.3387 2.09816994 29696
OSCAR 16 (PACSAT, AMSAT-OSCAR 16, AO-16)
1 20439U 90005D 96160.75108292 .00000028 00000-0 27866-4 0 9867
2 20439 98.5556 246.1284 0010465 227.9883 132.0406 14.29977030332860
OSCAR 17 (DOVE, DO-17)
1 20440U 90005E 96160.28441319 .00000013 00000-0 21766-4 0 9864
2 20440 98.5608 246.3064 0010422 227.9199 132.1098 14.30118455332825
OSCAR 18 (WEBERSAT, WO-18)
1 20441U 90005F 96158.24506347 .00000033 00000-0 29709-4 0 9903
2 20441 98.5609 244.2429 0011123 235.4747 124.5381 14.30088138332533
OSCAR 19 (LUSAT, LO-19)
1 20442U 90005G 96160.27056059 .00000011 00000-0 21142-4 0 9864
2 20442 98.5623 246.7227 0011465 228.6022 131.4174 14.30196651332843
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 96161.58838163 .00000014 00000-0 96327-4 0 8830
2 20480 99.0261 187.8912 0540824 141.6761 222.4081 12.83233970296912
RS-12/13 (Cosmos 2123, Radio Sputnik-12/13)
1 21089U 91007A 96160.15681737 .00000071 00000-0 59957-4 0 8948
2 21089 82.9233 196.0366 0027711 259.7246 100.0781 13.74070761267797
OSCAR 22 (UOSAT-F, UOSAT 5, UO-22)
1 21575U 91050B 96160.34680693 .00000020 00000-0 20996-4 0 6928
2 21575 98.3491 226.9922 0006991 297.8150 62.2326 14.37026046256798
OSCAR 23 (KITSAT-A. KITSAT 1, KO-23)
1 22077U 92052B 96158.59986485 -.00000037 00000-0 10000-3 0 5822
2 22077 66.0782 211.6231 0012778 301.8956 58.0814 12.86297478179447
OSCAR 25 (KITSAT-B, AMSAT OSCAR 25, KO-25)
1 22830U 93061H 96160.72489501 -.00000017 00000-0 10154-4 0 4890
2 22830 98.4712 225.6759 0010780 212.8491 147.2021 14.28109605140825
OSCAR 26 (ITAMSAT-1, ITALY-OSCAR 26, IO-26)
1 22826U 93061D 96158.91151436 -.00000062 00000-0 -76871-5 0 4773
2 22826 98.5819 234.8122 0008377 262.4721 97.5513 14.27804103140536
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT-OSCAR 27, AO-27)
1 22825U 93061C 96160.73657166 .00000053 00000-0 39189-4 0 4796
2 22825 98.5814 236.4392 0007826 258.7783 101.2518 14.27697043140789
OSCAR 28 (POSAT-1, PO-28)
1 22829U 93061G 96158.77145055 .00000028 00000-0 28701-4 0 4701
2 22829 98.5782 234.7893 0009294 249.7059 110.3123 14.28123523140546
HEATHSAT
1 22827U 93061E 96160.23169412 .00000023 00000-0 26989-4 0 5393
2 22827 98.5799 236.0119 0008338 249.1493 110.8789 14.27939552140732
ITAMSAT
1 22828U 93061F 96160.71665904 .00000040 00000-0 33407-4 0 4564
2 22828 98.5771 236.6397 0009309 241.5750 118.4491 14.28143098108908
RS-15 (Radio Rostok, Radio Sputnik 15)
1 23439U 94085A 96158.81017050 -.00000039 00000-0 10000-3 0 1380
2 23439 64.8216 39.8678 0161666 200.9673 158.4571 11.27525417 59611

WEATHER SATELLITES
Geostationary Spacecraft
GOES 8 (Operational East-USA)
1 23051U 94022A 96159.28782156 -.00000268 00000-0 00000+0 0 5371
2 23051 0.0281 282.8271 0003590 205.0366 157.1704 1.00273158 15269
GOES 9 (Operational West-USA)
1 23581U 95025A 96160.40364809 .00000071 00000-0 00000+0 0 1973
2 23581 0.1909 83.5083 0000916 256.8447 286.7995 1.00279245 3828
ELEKTRO (Russia)
1 23327U 94069A 96160.70299409 -.00000118 00000-0 00000+0 0 1629
2 23327 0.1098 188.1566 0004333 243.6700 154.9976 1.00274117 5916
METEOSAT 5 (MOP-2 Operational-ESA)
1 21140U 91015B 96161.70120370 -.00000021 00000-0 00000+0 0 2050
2 21140 0.5259 75.7729 0000834 355.2293 79.6264 1.00275289 21531
METEOSAT 6 (Operational-ESA)
1 22912U 93073B 96161.26885995 -.00000101 00000-0 10000-3 0 4760
2 22912 0.1257 317.1540 0000540 82.7049 304.4978 1.00272087 7776
HIMAWARI 4 (GMS 4 Standby-Japan)
1 20217U 89070A 96158.79131519 -.00000379 00000-0 10000-3 0 3854
2 20217 1.7701 75.2770 0001808 139.1265 85.5877 1.00258807 25314
HIMAWARI 5 (GMS 5 Operational-Japan)
1 23522U 95011B 96134.54990383 -.00000305 00000-0 10000-3 0 1225
2 23522 0.4001 332.1090 0002081 155.5536 81.5508 1.00260683 4108

Near Polar/Polar Orbiting Spacecraft
NOAA 12 (Operational morning spacecraft-USA)
1 21263U 91032A 96161.75386843 .00000127 00000-0 75753-4 0 9650
2 21263 98.5596 181.0769 0012218 301.1853 58.8128 14.22627543263408
NOAA 14 (Operational afternoon spacecraft-USA)
1 23455U 94089A 96161.77099131 .00000029 00000-0 40599-4 0 6336
2 23455 98.9456 107.2717 0008505 266.6781 93.3416 14.11591785 74404
METEOR 2-21 (Operational-Russia)
1 22782U 93055A 96161.17228540 .00000050 00000-0 32274-4 0 4896
2 22782 82.5474 353.4951 0023007 4.1866 355.9484 13.83055721140020
METEOR 3-5 (Operational-Russia)
1 21655U 91056A 96162.06555045 .00000051 00000-0 10000-3 0 8948
2 21655 82.5499 325.4906 0013081 185.6559 174.4396 13.16847377231736
METEOR 3-6 (Operational-Russia)
1 22969U 94003A 96160.93857236 .00000051 00000-0 10000-3 0 2600
2 22969 82.5617 266.3117 0014494 261.9291 98.0190 13.16737053113960
DMSP B5D2-7 (Operational USAF)
1 23233U 94057A 96161.78532280 .00000112 00000-0 83862-4 0 8079
2 23233 98.8286 220.6660 0011811 197.7913 162.2843 14.12711421 91782
DMSP B5D2-8 (Operational USAF)
1 23533U 95015A 96161.64567755 -.00000040 00000-0 20228-5 0 5444
2 23533 98.8418 164.2078 0008487 76.1278 284.0832 14.12740577 62566

Satellite Launch Schedules

By Keith Stein

Space Transportation System (STS-NASA)

Space Shuttles are launched from the Kennedy Space Center, Florida.

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-79	August 1996/ Atlantis*	51.6/213	10 days	S/MM-04

*Crew Assignment: CDR-William Readdy, PLT-Terry Wilcutt, MS1-Tom Akers, MS2-John Blaha, MS3-Jay Apt, MS4-Carl Walz.

STS	Downlink Frequency Assignments:
VHF/UHF Voice	139.208, 145.840, 243.0 (AM), 259.7 (AM), 279.0 (AM) and 296.8 MHz (AM)
UHF Data	416.500 MHz
S-band TLM	2217.5, 2250.0 and 2287.5 MHz
C-band TRK	5400-5900.0 MHz

Mir	Downlink Frequency Assignments:
VHF Voice	130.165, 130.625, 143.618, 143.625, 145.550, 145.800 MHz

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1996	Soyuz	Baikonur	Progress M-33
July 1996	Soyuz		Baikonur Soyuz TM-24
July 1996	Molniya	???????	???????
August 1996	Proton	Baikonur	INMARSAT 3 F2
September 1996	???????	???????	Bion 11
September 1996	Start	???????	Worldview-1

Progress M-33	Downlink Frequency Assignments:
VHF	166.000 Mhz (WBFM)

Soyuz TM-24	Downlink Frequency Assignments:
VHF Voice	121.750 MHz (WBFM)
VHF TLM	166.0 Mhz (WBFM)
L-band TLM	922.750 and 926.100 Mhz

INMARSAT 3 F2	Downlink Frequency Assignments:
L-band	1530.0 Mhz, 1537.0 Mhz
C-band	3600.0 Mhz

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1996	Atlas	CCAS	EHF-7
July 1996	Titan 4	???????	Classified
August 1996	Pegasus XL	VAFB	FAST
August 1996	Delta II	CCAS	NAVSTAR GPS
August 1996	Atlas IIA	CCAS	GE-1
August 1996	Delta II	CCAS	Iridium #1
September 1996	Pegasus	Torrejon	MINISAT
September 1996	Atlas 2A	CCAS	EUTELSAT HOT BIRD 2
September 1996	Atlas IIA	CCAS	Tempo (DBS/Loral)
September 1996	Titan II	VAFB	NOAA-K

Atlas	Downlink Frequency Assignments:
S-band TLM	2202.5, 2206.5 2210.5, 2211.0, 2215.5 Mhz
C-band	5765.0 MHz

Titan 4	Downlink Frequency Assignments:
UHF Data	416.5 Mhz
S-band	2217.5, 2255.5, 2272.5 and 2287.5 Mhz

Pegasus XL	Downlink Frequency Assignments:
UHF-band	416.5 MHz
S-band TLM	2288.5 MHz
C-band TRK	5765.0 MHz

L-1011 A/C	Downlink Frequency Assignments:
L-band	1480.5 MHz telemetry
L-band	1727.5 MHz Chase video
S-band	2250.5 MHz video downlink
C-band	4583.5 MHz video downlink
C-band	5765.0 MHz transponder downlink

FAST	Downlink Frequency Assignments:
S-band TLM	2215.0 MHz

Delta II	Downlink Frequency Assignments:
S-band TLM	2244.5, 2241.5 and 2252.5 MHz
C-band TRK	5765.0 MHz.

Navstar GPS	Downlink Frequency Assignments:
L-band	1227.5 Mhz
S-band	2227.5 MHz

GE-1	Downlink Frequency Assignments:
C-band	3.7 - 4.2 GHz
Ku-band	11.73 - 12.17 Ghz

NDAA-K	Downlink Frequency Assignments:
VHF-band	137.35, 137.5, 137.62, 137.77 Mhz
L-band	1544.5, 1698.0, 1702.5, 1707.0 Mhz
S-band	2247.5 MHz

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1996	Ariane 4	Guiana	ARABSAT and TURKSAT
September 1996	Ariane 44P	Guiana	INTELSAT 7
September 1996	Ariane 5	Guiana	ARD and AMSAT OSCAR PHASE 3D

Satellite Launch Schedules

Ariane 4	**Downlink Frequency Assignments:**
S-band	2203.0, 2206.0 and 2218.0 Mhz

ARABSAT	**Downlink Frequency Assignments**
C-band	3.70-4.20 Ghz
Ku-band	12.5-12.7 Ghz

PHASE-3D	**Downlink Frequency Assignments**
Analog	145.805-145.955 Mhz
	435.475-435.725 Mhz
	2400.225-2400.475 Mhz
	10451.025-10451.275 Mhz
	24048.025-24048.275 Mhz
Digital	29.325-29.335 Mhz
	145.955-145.990 Mhz
	435.900-436.200 Mhz
	2400.650-2400.950 Ghz
	10451.450-10451.750 Ghz
	24048.450-24048.750 Ghz

Japanese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
August 1996	H-II	Osaki	ADEOS & JAS-2
September 1996	M-5	Kagoshima	MUSES-B

ADEOS	**Downlink Frequency Assignments:**
S-band	2220.0 Mhz
X-band	8150.0, 8250.0 and 8350.0 Mhz

MUSES-B	**Downlink Frequency Assignments:**
K-band	14.20 Ghz

Chinese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1996	Long March	Xichang	Apstar

List of Abbreviations and Acronyms

A/C	Aircraft.
ADEOS	The Advanced Earth Observing Satellite is developed with the aim of establishment of platform technology for future spacecraft and interorbit communication technology for the transmission of Earth observation data.
ARABSAT	Communications satellite for the Arab Satellite Communications Orgnization (ASCO) for providing regional TV, telephony, data and fax relay.
ARD	European Space Agency (ESA) Atmospheric Reentry Demonstrator.
Bion 11	Carrying two Rhesus monkeys for a joint life sciences mission between NASA and Moscow's Institute of Biomedical Problems (IBMP).
CCAS	Cape Canaveral Air Station.
CDR	Commander.
Clark	This high resolution satellite will locate utility pipelines & cables, and help town planners at construction sites.
EHF F7	U.S. Navy communications satellite replacing Fleet Satellite Communications Network.
EUTELSAT	European commercial communications satellite.
FAST	Fast Auroral Snapshot Explorer. Spacecraft to investigate the processes operating within the auroral region.
GE-1	General Electric telecommunications satellite that will cover the continental United States including Alaska and Hawaii.
GHz	Gigahertz.
Inmarsat	Commercial satellite series providing global maritime and aviation communications.
Intelsat	The International Telecommunications Satellite Organization is a non-profit commercial co-operative of 133 member nations.
Iridium	The Iridium system is a planned commercial communications network comprised 66 low earth orbiting satellites. The system will use L-band to provide global communications services through portable handsets.
JAS-2	Japanese amateur radio satellite.
K-band	10.90 to 17.15 Ghz
MHz	Megahertz.
Minisat	Program under the Interministerial Commission for Science & Technology (INTA). The spacecraft will carry a Extreme Ultraviolet Radiation Detector and Low Energy Gamma Ray Imager.
MS	Mission Specialist.
MUSES-B	Radio astronomy research satellite from Japan.
Navstar	U.S. Air Force Global Positioning Satellite for military and civilian navigation services.
NOAA	Conducts research and gathers data about the global oceans, atmosphere, space, and sun, and applies this knowledge to science and service that touch the lives of all Americans.
PHASE 3D	Amateur radio satellite.
PLT	Pilot.
Progress	Unmanned supply ship launched to the Russian Mir space station.
RNG	Ranging.
S-band	2000 to 2300 Mhz
S/MM-04	Shuttle mission to the Russian Space Station MIR to support design and assembly of the international space station.
Soyuz TM	Manned mission to carry replacement crews to the Russian space station Mir.
Tempo	A high power DTH satellite owned by Tempo, a subsidiary of Tele-Communications Inc.
TLM	Telemetry.
TRK	Tracking.
TURKSAT	Turksat carries 16 active Ku-band transponders providing TV, radio, data & voice services.
UHF	Ultra High Frequency (390 to 499 MHz)
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
WBFM	Wide Band FM
Worldview	The 3 m resolution satellite of WorldView Imaging Corp of Livermore, CA. Systems aims at the GIS and geographically-oriented multimedia uses.

Keith Stein is a space analyst/freelance writer based in Woodbridge, Virginia.

Satellite Launch Report

By ***Phillip Clark****, Molniya Space Consultancy*

How to Use the Satellite Launch Report

The "Satellite Launch Report" is a complete list of satellite launches which took place during March and April 1996. The format of the listing is as follows:

First line: launch date and time (UTC), international designation of the satellite, satellite name and satellite mass.

Second line: date and time (in decimals of a day, UTC) of the orbital determination, orbital inclination, period, perigee and apogee. In some cases where a satellite has manoeuvred, more than one set of orbital data will be listed.

This data is followed by a brief description of the satellite's planned mission, the launch vehicle, launch site, etc. '*' next to satellite's mass indicates that the mass has been estimated, and that no official information has been published.

The *Satellite Times* "Satellite Launch Report" is extracted from more detailed monthly listings, "Worldwide Satellite Launches", compiled by Phillip S. Clark and published by Molniya Space Consultancy, 30 Sonia Gardens, Heston Middx TW5 0LZ United Kingdom.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1996 Mar 9/0133	1996-014A	Rex 2		113 kg
1996 Mar 9.46	89.95 deg	101.25 min	804 km	832 km

First successful launch of a Pegasus-XL vehicle (first two launches failed to reach orbit). Rex 2 (P94-2) is a follow-on to Rex 1 launched in 1991: satellite is built by CTA Space Systems. Carries experiments to study ionospheric electron density irregularities that affect radio communications. A secondary experiment uses GPS for on-orbit attitude determination and control. L-1011 carrier aircraft took off from Vandenberg AFB March 9 at 0035 UTC and went to the drop zone 100 km west of Monterey, California at an altitude of 12 km: Pegasus was dropped from the aircraft at 0133 UTC. Pegasus third stage in an orbit similar to the payload.

1996 Mar 14/0711	1996-015A	INTELSAT 707		4,175 kg
1996 Mar 14.537	.04 deg	630.70 min	184 km	35,783 km
1996 Mar 21.100	.04 deg	1,436.54 min	35,776 km	35,815 km

INTELSAT 707 is an international telephone and broadcasting (domestic and regional services) satellite, launched for INTELSAT. Mass quoted above is at launch: on-station it is 3,650 kg and the dry mass of 1,760 kg. Satellite initially located close to 0 deg E: manoeuvred off-station April 6 and was relocated over 358-359 deg E approximately April 10. Launched from Kourou by an Ariane-44LP: H-10-3 third stage is in an orbit similar to the first one listed for the satellite.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1996 Mar 14/1740	1996-016A	Cosmos 2331		6,500 kg?
1996 Mar 14.85	67.14 deg	89.73 min	164 km	358 km

"Yantar" fourth generation, close look photoreconnaissance satellite, expected to remain in orbit for about 60-70 days. Data capsules are returned during the flight and it is believed that the main descent module is recovered at the end of the mission. Launched from Plesetsk using a Soyuz-U vehicle: third stage (Block I) initially in an orbit similar to the satellite, decayed March 20.

1996 Mar 21/0453	1996-017A	IRS P3		922 kg
1996 Mar 21.31	98.80 deg	101.41 min	802 km	848 km
1996 Apr 23.47	98.80 deg	101.29 min	819 km	821 km

"Indian Remote Sensing" satellite built by ISRO. Launched from Sriharikota using Polar Satellite Launch Vehicle (PSLV): fourth stage in an orbit similar to the first one listed for the satellite.

1996 Mar 22/0813	1996-018A	Atlantis (STS-76)		111,737 kg
1996 Mar 22.37	51.65 deg	89.00 min	158 km	293 km
1996 Mar 24.11	51.65 deg	92.44 min	390 km	398 km

SMM-3 ("Shuttle-Mir Mission"), carrying 6 astronauts at launch: K R Chilton (commander), R A Searfoss (pilot), R M Sega (payload commander and mission specialist, MS-1), M R Clifford (MS-2), L M Goodwin (MS-3) and S W Lucid (MS-4). Orbiter's payload bay carried SPACEHAB module which can be used for carrying supplies and equipment to the Mir Complex. Mass quoted above is that projected for landing. Launched from Kennedy Space Center 0813 UTC. Orbiter docked with the Mir Complex (using the docking Module left on the Kristall module during the STS-74 mission) Mar 24 at 0234 UTC with the astronauts performing experiments with the Mir crew during their stay. Lucid remained on board Mir when Atlantis undocked from the Mir Complex March 29 at 0108 UTC and landed at Edwards Air Force Base at 1329 UTC. Lucid will remain on board Mir until the STS-79 mission in August 1996.

1996 Mar 28/0021	1996-019A	Navstar 25 (USA 117)		1,881 kg
1996 Mar 27.87	34.90 deg	356.86 min	193 km	20,383 km
1996 Apr 8.09	54.70 deg	717.97 min	20,083 km	20,281 km

Navigation satellite to be operated in plane C, slot 2 of the Global Positioning System (GPS). Mass quoted above includes propellant: the dry mass is 930 kg. Launched from Cape Canaveral using a Delta-2 (7925) vehicle: second stage left in a 35.07 deg, 94.64 min, 450-552 km orbit, third stage (PAM-D) in an orbit similar to the first one shown for the satellite.

1996 Apr 3/2301	1996-020A	INMARSAT-3 F-1		2,064 kg
1996 Apr 4.21	23.26 deg	639.62 min	868 km	35,558 km
1996 Apr 14.13	2.67 deg	1,436.01 min	35,758 km	35,811 km

Maritime communications satellite, operated by INMARSAT, London (UK). Mass quoted above is at launch: mass on-station is approximately 1,100 kg at the beginning of its life, dry mass is 860 kg. Initially located over 27-28 deg E but during Apr 25-29 was relocated to 38-39 deg E: to be operational over 64 deg E. Launched by an Atlas-2A from Cape Canaveral: second stage (Centaur) left in an orbit with the parameters 21.95 deg, 642.32 min, 1,028-35,536 km.

Launch Date/Time	Int Des	Satellite		Mass
Epoch	Incl	Period	Perigee	Apogee
1996 Apr 8/2309	1996-021A	Astra-1F		3,010 kg
1996 Apr 9.55	6.96 deg	880.46 min	12,127 km	35,976 km
1996 Apr 19.34	0.06 deg	1,435.82 min	35,772 km	35,790 km

Astra 1F is the first commercial payload to be launched using a Proton vehicle. Direct broadcast television satellite operated by the Societe Europeenne des Satellites in Luxembourg. Mass quoted above is at launch: on-station at the beginning operations the mass is approximately 1,900 kg. Initially located over 26-27 deg E, but the planned operational location is 19.2 deg E. Launched from Tyuratam using a four-stage Proton-K: third stage left in a 51.61 deg, 88.64 min, 193-222 km orbit (decayed April 14), fourth stage (Block DM-2) in an orbit similar to the first one listed for the satellite.

1996 Apr 20/2236	1996-022A	MSAT 1		2,855 kg
1996 Apr 20.72	7.76 deg	634.86 min	350 km	35,831 km
1996 Apr 26.75	0.04 deg	1,436.16 min	35,707 km	35,869 km

MSAT 1 is a mobile communications satellite operated by TMI Communications (Ottawa, Canada). Mass quoted above is that at launch: in geosynchronous orbit it is 1,710 kg at the beginning of operations and the dry mass is 1,330 kg. Satellite located over 253.5 deg E. Launched from Kourou using an Ariane-42P: third stage (H-10-3) in an orbit similar to the first one shown for the satellite.

1996 Apr 23/1148	1996-023A	Priroda		19,700 kg?
1996 Apr 23.79	51.65 deg	89.94 min	214 km	328 km
1996 Apr 26.57	51.65 deg	92.43 min	391 km	396 km

Fourth large module (designated 77KSI) to be launched to the Mir Complex. Carries an array of remote sensing and microgravity experiments. During April 25 one of the two battery systems on Priroda failed, but this did not prevent the module docking at the front longitudinal axis (+X) of the Mir Complex April 26 at 1243 UTC. Relocated to +Z port on the Mir core module April 27 using Lyappa support arm: this completes the planned compliment of modules which form the Mir Complex: Kvant 2 (1989-093A, 77KSD) is located at the +Y port, Kristall (1990-048A, 77KST) at -Z and Spektr (1995-024A, 77KSO) at -Y: the small Kvant 1 module (1987-030A, 37KZ) is at -X. Launched by a three-stage Proton-K from Tyuratam: third stage in an orbit similar to the first one listed for the satellite.

1996 Apr 24/1227	1996-024A	MSX		2,680 kg
1996 Apr 24.70	99.38 deg	103.02 min	897 km	906 km

MSX ("Midcourse Space Experiment") is a Ballistic Missile Defense Organization satellite. Satellite is intended to study the infra-red, visible and ultra-violet signatures of missiles during the mid-course phase. Launched by a Delta-2 (7920) from Vandenburg AFB: second stage in a 96.58 deg, 95.56 min, 224-867 km orbit after performing a manoeuvre following the satellite's deployment.

1996 Apr 24/1300	1996-025A	Cosmos 2332		500 kg?
1996 Apr 24.67	82.96 deg	103.62 min	295 km	1,565 km

Spherical satellite, approximately 2 metres diameter, flown for the passive monitoring of the Earth's atmospheric density. Launched from Plesetsk using a Cosmos-3M: second stage in an orbit similar to that of the satellite.

1996 Apr 24/2337	1996-026A	USA 118		8,000 kg?
Geosynchronous orbit?				

Classified payload, launched for the Department of Defence: payload is believed to be a SIGINT satellite in geosynchronous orbit, but no orbital data have ben issued. Launched from Cape Canaveral using a Titan-4/Centaur: third stage (Centaur) could be in either a geosynchronous transfer orbit or a geosynchronous orbit.

Launch Date/Time	Int Des	Satellite		Mass
Epoch	Incl	Period	Perigee	Apogee
1996 Apr 30/0431	1996-027A	SAX		1,400 kg?
1996 Apr 30.37	3.96 deg	96.54 min	583 km	603 km

SAX ("Satellite Astronomia raggi-X") is a joint Italian-Dutch X-ray satellite: mass of experiment payload is 490 kg. Launched from Cape Canaveral using an Atlas-1: second stage (Centaur) in an orbit similar to that for the satellite.

Updates for Previous Launches

International Designation	Comment
1982-017A	INTELSAT 504 was retired after being boosted off-station at the end of November 1995.
1983-058A	EUTELSAT-1 F-1 re-stabilised its location over 36 deg E approximately 1996 Mar 12.
1988-018B	Telecom 1C has been manoeuvred off-station over 2-3 deg E and appears to be in a retirement orbit. Orbital data from USSPACECOM have been sparse in recent months and therefore the date that the satellite was manoeuvred off-station can only be roughly estimated as March 25. The following is the presumed retirement orbit:- 1996 Apr 11.39, 0.66 deg, 1,472.26 min, 36,090 km, 36,894 km
1989-041B	DFS 1 was retired in January 1996 after being boosted off-station in mid-December 1995.
1990-102A	Gorizont 22 was re-located over 139-140 deg E approximately 1996 Apr 5.
1991-010A	The last orbital correction by Cosmos 2133 was 1995 Apr 18-23 and the satellite has drifted off-station over 80 deg E. The satellite is presumably no longer operating.
1993-063H	The FSW-1 5 re-entry module decayed from orbit 1996 Mar 12. USSPACECOM data indicates that orbital decay was at 0405 UTC over 23.2 deg S, 340 deg E, over the South Atlantic Ocean.
1994-034A	INTELSAT 702 was manoeuvred off-station over 358-359 deg E approximately 1996 Apr 15-16.
1995-004C	ODERACS 2A decayed from orbit 1996 Mar 13.
1995-004H	Originally USSPACECOM reserved the catalogue number 23476 for ODERACS 2F but this object was never given either an international designator or a catalogue number: therefore the international designator "1995-004H" for this object should be considered to be unofficial.
1995-040	The launch time for PAS 4 should be 1995 Aug 3 at 2258 UTC.
1995-072B	The on-board battery for Skipper had been incorrectly connected and as a result the satellite "died" through lack of power about a day after launch.
1996-006A	Palapa-C 1 was manoeuvred off-station over 123 deg E approximately 1996 Mar 3 and was re-located over 112-113 deg E approximately 1996 Mar 16.
1996-012B	TSS-1R decayed from orbit 1996 Mar 20.
1996-013A	Add the following orbital data for Polar:-1996 Mar 9.70, 85.93 deg, 1,051.42 min, 5,141 km, 50,605 km

American Named Official Airlines of Expo '96

By Larry Van Horn
Expo '96 Publicity Chairman

American Airlines has been named the official airlines of the 1996 Grove Communications Expo. Expo attendees will be able to get special round trip rates from American by using a special registration number and toll free telephone number.

The airline is offering a five percent discount off American's lowest discount rate to Expo goers. This rate is subject to availability and all fare rules and restrictions apply. This discount may not be used in conjunction with other discounted type fares (i.e.-Senior, Child, Military/Government, Companion, etc.)

Attendees desiring to travel coach will get a 10 percent savings on their round trip ticket purchase and those traveling first class can get a five percent discount.

Some restrictions do apply to get the special rate. Travel is to and from Atlanta (round trip only). Travel must originate and end in the continental United States, Hawaii, San Juan, St. Thomas, St. Croix, Bermuda, or the Bahamas. Coach tickets must be purchased seven days in advance. A $50.00 administrative charge applies for reissue or refund.

To make reservations and receive the special rates mentioned above, attendees must use the American meetings services desk toll free number — **1-800-433-1790.** Make sure you use the special American Star Number **S2406MC** when confirming your reservations for the Expo.

The Grove Expo has also selected Avis as the official Rent A Car for the 1996 Expo. Special rental rates are available to attendees one week before and after the Expo.

Should a lower qualifying rate become available, Avis will honor a five percent discount on that rate. You must return the vehicle to the same renting location or additional charges will apply. Weekend daily rates are available from noon Thursday through Monday at 11:59 p.m. Rates do not include tax, optional coverages, or gas refueling charges. Renter must meet Avis minimum age, driver, and credit requirements. State imposed surcharges are additional.

If you want the special Expo 96 rate from Avis, you must use the assigned Meeting Discount Number — **J627344** — by calling the special toll-free 800 number: **1-800-331-1600.**

Specialty Topics

New to this year's Expo is a series of talks loosely defined as the computer/technology track. At 9:00 a.m. Saturday morning, *Monitoring Time's* John Fulford will kick it off with a *Beginners Guide to Bug Hunts*. Regular attenders know that the two bug hunts conducted during the Expo have become a very popular part of the program each year. John's forum (which will also address direction-finding techniques in general) will help anyone who might be hesitant to join in on the fun.

When do you say "good buy" or "good-bye" to used equipment? Old timers hold old equipment in high esteem. But are there really bargains in the flea market? Find out at 10:15 a.m. Saturday morning during Bob Grove's *Used Equipment — Bargain, Bust, or Investment* forum.

People in the radio hobby have an overriding interest in communicating. The Internet has gotten rid of the static and distance problems of radio, and has enormously increased the number of people communicating and sharing information. During Larry Van Horn's *Internet and the Radio Hobbyist* forum on Saturday at 1:00 p.m., learn how the two hobbies cross over and how you can benefit from adding this new capability to your skills.

What is available for the radio enthusiast on the software market? *MT*'s John Catalano will review and demonstrate the latest logging database, radio control, and data decoding programs at 2:15 p.m. on Saturday afternoon.

Anything we do in space with satellites requires knowing how to track them, and most applications today require fast, accurate predictions. Dr. TS Kelso of the *Satellite Times* staff will cover the basics of satellite tracking and review various software programs available to make this task easy and fun during his forum Saturday afternoon.

Sunday morning will feature three more specialty/computer/technology forums. *ST* managing editor Larry Van Horn will return to the podium at 9:00 a.m. to explore the world of space and cyberspace.

FM/TV DXing is a specialty area a lot of hobbyists are interested in exploring. What equipment and what antenna do you need? What are E-skip, tropo, and the more exotic modes of propagation like aurora and meteor scatter? Find out as *MT* columnist Doug Smith challenges you with *FM/TV: 1000 Mile TV Reception - You Can Do It.*

You know they are up there, but just what do you need to know to be able to watch the U.S. Space Shuttle or Russian Mir space station track across the sky? Dr. TS Kelso's *Visually Observing Earth Satellites* forum will close out the specialty forums at 11:30 a.m. Sunday. This seminar will go beyond knowing where the satellites are, to knowing when they will be visible and discussing some simple projects to test your skills.

Complete details on the Expo 96 are available at the Grove Internet home page on the Internet. Point your web browser to URL address: ***http://www.grove.net/hmpgexpo.html*** for the latest information and Expo updates. You can also register for the Expo and get additional information by sending e-mail to the following address: **expo96@grove.net**. An automatic Expo information service is available by sending e-mail to:**expo96-info@grove.net.**

To register by phone, call the Grove order line at 1-800-438-8155 or by fax at 1-704-837-2216.

The Grove booth is always a popular browing location for Expo participants, and this year should be no different. You can expect great bargains from all of our exhibitors!

GROVE COMMUNICATIONS EXPO

Come to Grove Communications EXPO '96!

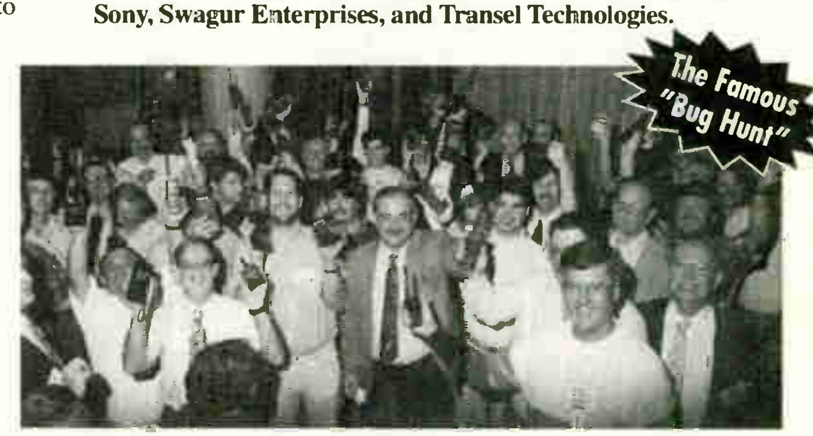
If you are interested in **electronic communications**, the **Grove Communications Expo** is your event of the year! Expo '96 in Atlanta, to be held **Oct. 18-20**, unites you with hundreds of like-minded communications enthusiasts who assemble to **exchange information, introduce new products, and offer technical help**. This is an outstanding opportunity for you to move into the information age! This year's expanded program includes over **50 seminars, forums, demonstrations and events** in the following areas:

- **Computers and the Internet**
- **Shortwave and scanner monitoring**
- **Satellite communications**
- **Radio astronomy**

As in recent years, the Expo will feature exhibits by top-name vendors, a hands-on listening post, club booths and prizes. Tours will be conducted to the **Delta Communications Center, Atlanta Fire Communi-cations, Atlanta/Fulton County Communications Center** and more.

Keynote speaker at this year's banquet will be **Ron Parise, NASA astronaut** and astronomer. Parise, WA4SIR, has made two trips into space aboard the shuttle and operated the shuttle's amateur radio experiments **(SAREX)**. Several special workshops, forums and exhibits will be sponsored this year by the Society of Radio Astronomers **(SARA)**, which will be conducting their fall conference in conjunction with the Expo!

This year's scheduled exhibitors include **AMSAT, Bearcat Radio Club, Cellular Security Group, Computer Aided Technology, Dallas Remote Imaging Group, Electronic Distributors (EDCO), Grove Enterprises, ICOM, OptoElectronics, Radio Astronomy Supplies, Radio Progressive, Satscan Electronics, Scan Master, Signal Intelligence, Sony, Swagur Enterprises, and Transel Technologies.**



Atlanta Airport Hilton
October 18-20, 1996

Registration is $55 per person (take $10 off if you bring a first-time registrant with you). Rooms at the Airport Hilton available at the convention rate of $76 per night, single or double occupancy. Call 1-800-Hiltons.

For more information and schedules, set your web browser to **http://www.grove.net/hmpgexpo.html**, e-mail us at **expo96-info@grove.net**, phone us at **1-800-438-8155**, or fax us at **1-704-837-2216**.

Amateur Radio Satellites

By John A. Magliacane, KD2BD

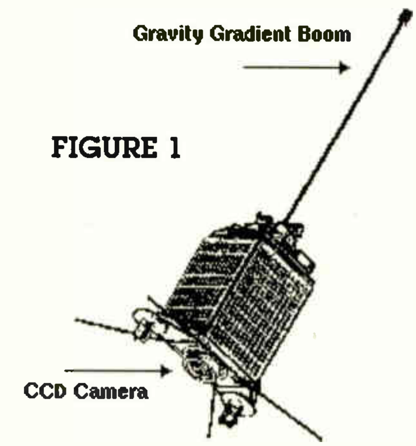
The View From Above, Amateur-Style

OSCAR (Orbiting Satellites Carrying Amateur Radio) satellites, in addition to providing a valuable communications resource for amateur radio operators, yield useful data about the near earth environment. This data is free for the asking, and is made available through telemetry transmissions that require no licensing of any kind to receive. In addition to scientific experiments, a growing number of OSCAR satellites are being designed around charge coupled device (CCD) earth imaging video cameras that provide exciting views of the earth from their vantage points in space.

Video Flies On UoSAT-OSCAR-9

UoSAT-OSCAR-9, launched on October 6, 1981, was the first amateur satellite to carry a video camera. OSCAR-9's camera provided views of the earth from an altitude of approximately 540 kilometers using an MA357 two-dimensional CCD array manufactured by GEC. The camera had an imaging area of 385 x 288 pixels, and its response was optimized to enhance land features and coastal lines. A 60 degree field of view was digitized by the CCD imager into a 256 x 256 pixel image containing 16 shades of grey. The images taken by the camera were stored in 32 kilobytes of RAM and transmitted to groundstations digitally on a VHF downlink frequency of 145.825 MHz using a synchronous data transmission at a rate of 1200 bits per second. The data transmission method used unique line sync and frame header codes to identify the top of each image and the start of each video line for proper representation at the groundstation. Images taken by UoSAT-OSCAR-9 provided 500 km x 500 km coverage with a resolution down to 2 km. A complete image could be received by groundstations in under four minutes.

FIGURE 1



Drawing of the UoSAT-OSCAR-11 spacecraft. Notice the CCD imaging camera at the base of the satellite. A gravity gradient boom at the top of the spacecraft is used to keep the camera pointing toward the earth.

UoSAT-OSCAR-11, launched on March 1, 1984, followed in the tradition of UoSAT-OSCAR-9 and carried an identical CCD imaging camera. However, OSCAR-11's on-board electronics digitized images taken by the camera to 128 shades of grey rather than 16, and the spacecraft's higher orbital altitude of approximately 660 kilometers provided a wider field of view of the earth. To ensure a complete image could be received in a single pass, OSCAR-11 used a 4800 bit per second data transmission rate on the 70-cm band.

UoSAT-OSCAR-11's camera was, and is still, seldom used. Greater time is devoted to other experiments carried on the spacecraft. In past years, the Digital Communications Experiment (DCE) was given quite a lot of use. The experience gained with the DCE lead to the development of the present day constellation of "Pacsat" digital store-and-forward communication satellites. UoSAT-OSCAR-11 is still alive and well, while it's older brother, UoSAT-OSCAR-9, decayed in the earth's atmosphere in the late 1980s.

High resolution CCD cameras are also carried on the UoSAT-OSCAR-22 and KITSAT-OSCAR-23 satellites. These satellites primarily act as packet radio store-and-forward file servers (Pacsats), and the pictures they take are available for download as image files. These files can be converted to popular image formats such as GIF and JPG, and enhanced to reveal subtle detail using simple utility programs.

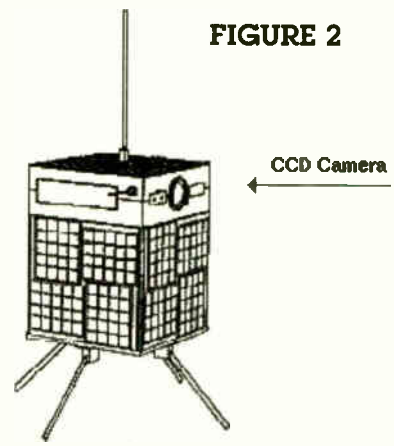
The Dimension of Living Color

The image transmissions made by the UoSAT satellites and KITSAT-OSCAR-23 were a refreshing change of pace from traditional OSCAR satellite communications, but their low resolution and limited scheduled operations restricted their use. Low earth orbiting weather satellites were (and still are) available that provided much higher image resolution than was possible through the eyes of an OSCAR satellite. However, a new dimension in earth imaging, the dimension of color, was added to OSCAR images shortly after the successful of WEBERSAT-OSCAR-18 on January 22, 1990.

WEBERSAT-OSCAR-18

WEBERSAT-OSCAR-18 is a microsatellite whose primary mission objective is to register, store, and downlink earth images taken by a color CCD video camera, similar to what may be found in a

FIGURE 2



The WEBERSAT-OSCAR-18 microsat satellite. A color CCD video camera is mounted towards the top of the spacecraft. Passive attitude control (a simple bar magnet) aligns the satellite with the earth's magnetic field, allowing the camera to point toward the surface of the earth.

typical camcorder. Images taken by the camera are digitized, stored in memory, and downlinked to groundstations on the 70-cm band using packet radio communication techniques at a rate of 1200 bits per second. Groundstation software specifically developed for use with WEBERSAT, called WeberWare, is used to collect and compile image transmissions copied by the groundstation receiver into a picture viewable on a personal computer. Henry, ZL1AAN of Devonport, New Zealand is well known for his efforts in receiving and processing WEBERSAT images. Many of the WEBERSAT images he has received and processed have also been converted to the popular JPG image format, and uploaded to the AMSAT-OSCAR-16 Pacsat satellite so they could be easily downloaded by any Pacsat groundstation. Some of the more recent images taken by WEBERSAT may be retrieved via the Internet from **ftp.njin.net** (165.230.224.140) using the anonymous file transfer protocol (FTP). WEBERSAT images are located in the pub/SpaceNews/webersat subdirectory.


FIGURE 3

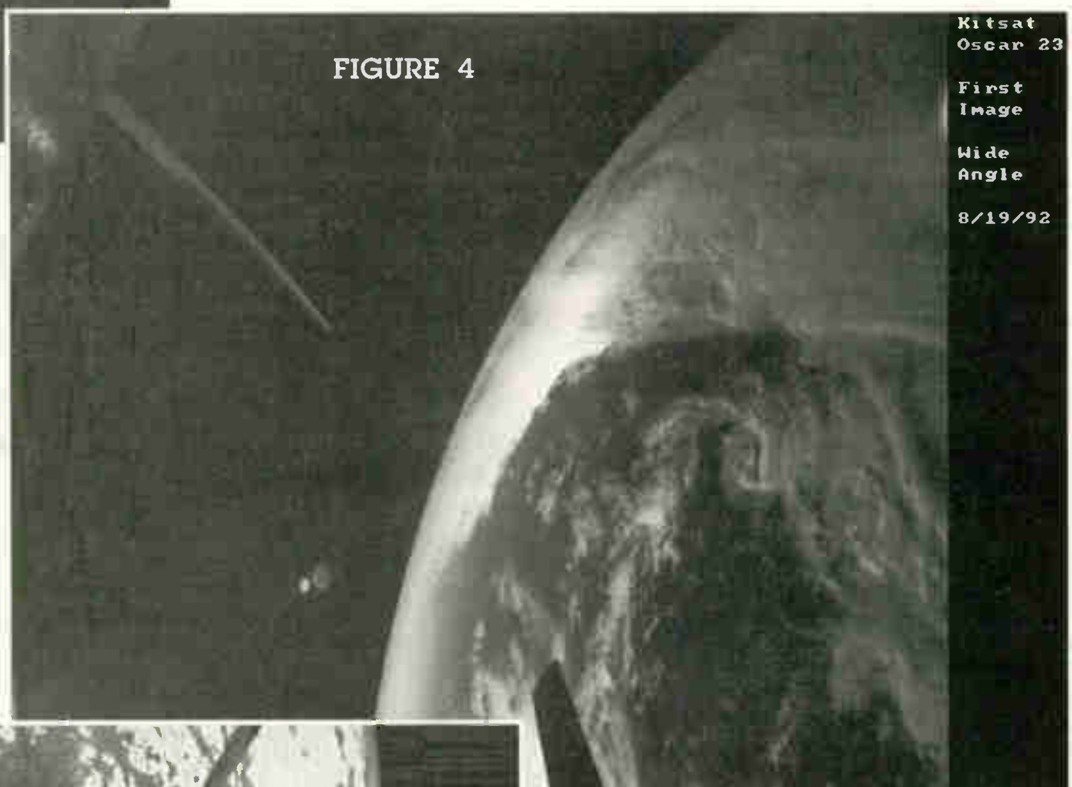


FIGURE 4

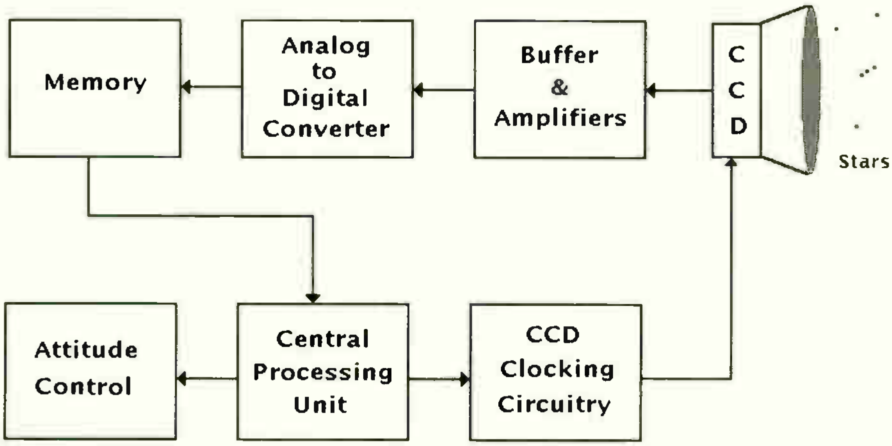
Above: This WEBERSAT image taken over Yemen is probably the best ever taken by the spacecraft. This image was received and processed by ZL1AAN.

Right: the first image taken by the KITSAT-OSCAR-23 satellite. (Photo by NK6K)

Below: Image of Italy taken by the UoSAT-OSCAR-22 satellite. (Photo by NK6K)

FIGURE 5

FIGURE 6 **Sunsat Star Camera Block Diagram**

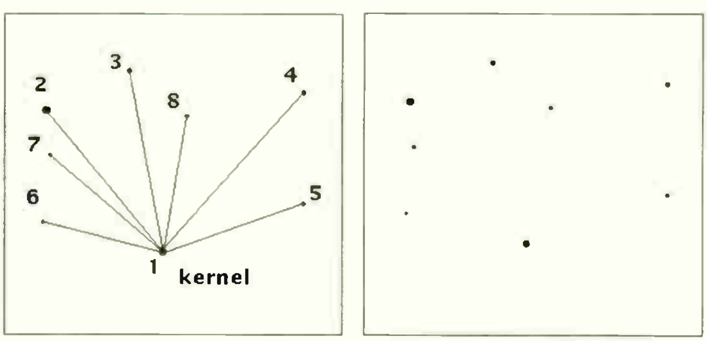


WEBERSAT-OSCAR-18 transmits image data on a downlink frequency of 437.102 MHz using raised cosine binary phase shift keying (BPSK) and an antenna exhibiting right-hand circular polarization. Groundstations typically receive WEBERSAT downlink signals using an SSB receiver, a 1200 baud Pacsat Modem, a packet radio terminal node controller (TNC), a small 437 MHz yagi antenna ,and a personal computer. Reception is also possible with an omni-directional antenna if a low-noise preamplifier is installed at the antenna's feedpoint, but this method is seldom as good as when a gain antenna such as a yagi is used. Image data is "broadcast" by the satellite by its beacon transmitter using packet radio techniques, and it is the job of WeberWare groundstation software to collect and compile the image data collected over several orbital passes and produce a complete and viewable image. Image processing software can fill in lines of video that may have been missed during reception of the image transmission.

Other Uses of CCD Imagers

Sunsat, South Africa's first amateur satellite is currently scheduled for launch some time next year. Sunsat will contain two CCD imaging cameras. The first will be used to provide full color, high resolution images of the earth. The second will be used to photograph known stars in the universe and compare their observed positions against a star catalog located in memory to determine the satellite's attitude relative to the earth. The star camera will yield a very accurate attitude determination of the Sunsat satellite. Recognition software based on a combination of the Baldini and van Bezooijen algorithms are planned allowing successful recognition with as few as three stars within the star camera's 10 degree field of view.

Sunsat Star Camera



Observed Stars **Guide Stars**

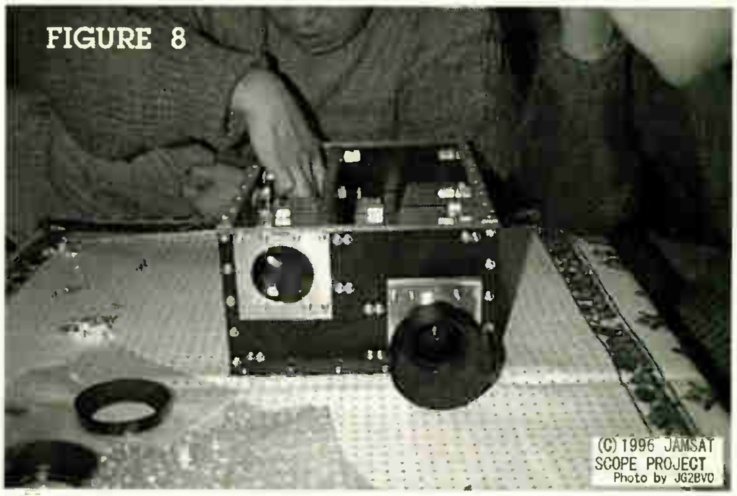
Observed constellation and a possible guide constellation

Sunsat will employ a recognition algorithm to find a constellation from the star catalog that best matches the observed constellation.

Looking Beyond The Earth

A Spacecraft Camera experiment for Observation of Planets and the Earth (SCOPE) will fly on the Phase 3D satellite. SCOPE is a product of JAMSAT (AMSAT-Japan), and will include two high-resolution CCD imaging cameras. Wide angle and zoom lenses that are part of SCOPE will be used for taking images of objects in outer space as well as the earth. SCOPE will be microprocessor controlled and interfaced with the RUDAK-U experiment. Some of the camera's functional commands may be handed over to general users of the satellite to allow them control over the images taken by the SCOPE camera. Satellite users will be able to retrieve images taken by the SCOPE experiment directly from the spacecraft using packet radio techniques.

FIGURE 8



The Spacecraft Camera experiment for Observation of Planets and the Earth (SCOPE) will fly on the Phase 3D satellite.

Conclusion

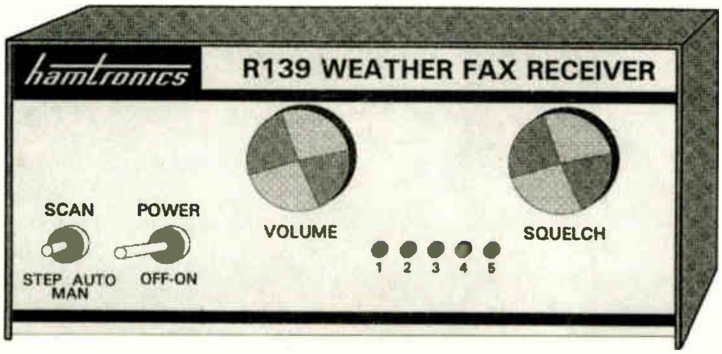
The use of charge coupled device video cameras has come a long way since the days of UoSAT-OSCAR-9. Their use is a clear reminder that there is more to the Amateur Satellite program than just two-way analog and digital communications. The reception and processing of images taken by OSCAR spacecraft will continue to be a fascinating activity for amateur radio operators and satellite monitors alike, and the relatively simple transmission methods will ensure easy reception in the years to come. ST

THE VIEW FROM ABOVE

By Jeff Wallach, Ph.D.
Dallas Remote Imaging Group

New APT Receiver from Hamtronics

A very popular question asked by *ST* weather satellite enthusiasts is often "what type of radio receiver should I use for NOAA and Meteor Automatic Picture Transmission (APT) image reception, and how much money should I plan to spend?". Well, there are several factors that one needs to consider in purchasing a weather satellite receiver, including:



- Assembled or kit form
- Internal PC card or external package
- Frequency range
- Overall receiver sensitivity
- Frequency stability and selectivity
- Intermediate Frequency (IF) bandwidth
- Audio output linearity (for image clarity)

While there is generally a direct correlation between the quality, features, and functions of a receiver and its cost, there are weather satellite receivers in the marketplace that are a good comprise of both cost and function. Fred Piering, the Director of Engineering for the Dallas Remote Imaging Group (DRIG), has recently had the opportunity to evaluate a new, low-cost receiver by Hamtronics.

Hamtronics has been a leading supplier of narrow-band FM receiver and transmitter modules for both amateur radio and weather satellite reception. Hamtronics has recently added to their portfolio of fine products the new R139 Weather Satellite Receiver.

This receiver comes in either fully assembled or kit form, and is an improved, 3rd generation receiver designed from the ground up for NOAA APT and Russian Meteor weather satellite reception in the 137 MHz frequency band. It incorporates several improvements over the former R137 and R138 units. Jerry Vogt, president of Hamtronics, has been very responsive to the suggestions of the *ST* readership and weather satellite community for providing modifications to the circuitry to improve the overall reception of APT imagery.

The R139 is a commercial-grade, five-channel, crystal controlled VHF FM receiver for operation in the 137 MHz band. It includes the following crystals for NOAA and Meteor APT reception:

137.300 MHz	Russian Meteor APT
137.400 MHz	Russian Meteor, OKEAN, and SICH APT
137.500 MHz	NOAA APT
137.620 MHz	NOAA APT
137.850 MHz	Russian Meteor APT

This range of frequencies covers all the active U.S. and Russian weather satellites that have been transmitting over the past few years.

Frequency selection for a particular satellite is accomplished by stepping the scan switch on the front panel. Bright LED's indicate which channel is active. For automatic scanning, the R139 continually scans all five channels until it locks onto a transmitting weather satellite. Each channel is turned on for a 500 msec period, which is enough for the receiver squelch circuit to respond if it hears a signal for that satellite frequency. If the signal drops or disappears, the receiver will resume scanning for another active signal. Separate volume and squelch controls allow setting the audio volume and signal threshold sensitivity.

The R139 also has a tape recorder output that can be used to activate a tape recorder automatically whenever the APT downlink is present, even while you are away from your ground station! This allows you to play back the recorded signal into the demodulator and display the weather satellite image at a more convenient time.

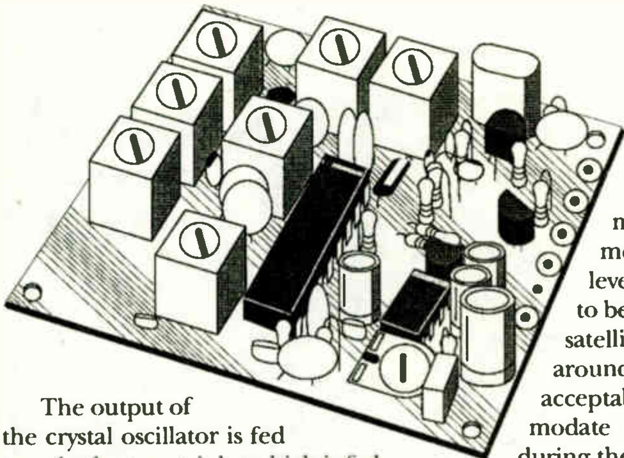
Physically, the assembled R139 receiver is enclosed in an attractive and professionally prepared external cabinet measuring 5 inches wide, 4 3/4 inches deep and 2 1/4 inches high. The unit's compact size and shape make it a welcome addition to an already crowded ground station desktop!

The front panel consists of the manual/automatic scan switch, on/off power switch, volume control, squelch control, and five LED's for indicating which frequency the receiver is locked on to. The rear panel consists of the BNC antenna connector, and a 9-pin DB connector for connecting the +12 to +18 volt power, tape recorder input, APT demodulator audio input, and an external speaker to monitor the satellite transmissions. Power is provided by an external 12 volt wall adapter, which is provided.

Receiver Design

Inside, the receiver circuitry is interconnected by a double sided glass epoxy printed circuit board. (see above, right.). The conductors are tin/lead coated for easy soldering, and the board layout is very clean.

The architecture of the receiver is quite straight forward and conventional. The antenna BNC connector is coupled to a 3SK122 dual gate MOSFET RF amplifier stage, with a single tuned circuit and followed by a double tuned narrow bandpass filter. The output of the filter is fed into a second 3SK122 transistor that is configured as the mixer. The five crystal local oscillator actually consists of an individual transistor oscillator for each crystal. The five crystals also have their own trimmer capacitor to allow setting each individual crystal exactly on frequency.



The output of the crystal oscillator is fed to a single stage tripler which is fed by a double tuned narrow band filter. This is subsequently narrow band filtered on the output of the tripler circuit, prior to being routed to the mixer transistor. The mixer transistor output is filtered with a ceramic filter at 10.7 MHz and supplied to a complex, single conversion FM-IF integrated circuit. Within this integrated circuit the signal goes through a down-conversion process to 455 kHz passing through another ceramic filter and converted to the audio signal. The audio signal is amplified by the popular LM380 audio amplifier, and provides excellent gain for driving the demodulator board and tape recorder.

Excellent construction, receiver alignment, tuning, and operating instructions are provided in both the kit and assembled units.

Performance

DRIG 'bench tested ' the Hamtronics R139 receiver with actual on-the-air reception of NOAA and Meteor APT imagery. Testing was accomplished using a 20 element crossed Yagi antenna, a preamplifier and azimuth/elevation tracking system. The RF signal was fed into the R139 and the receiver audio output fed into a home-brew APT demodulator card, and imagery captured using the Multi-FAX MF-7 software program. The ground station was located in Maitland, Florida and was at an elevation of 5 meters above sea level!

Measurements were made of the receiver for modulation acceptance (IF bandwidth), sensitivity, selectivity, frequency accuracy, and audio output linearity. In general, the R139 receiver performed very well and the receiver usually exceeded the published specifications. The receiver was very easy to use and worked perfectly right out of the shipping box.

Measurements were made of the intermediate frequency bandwidth and modulation acceptance. This is a critical measurement that will determine the contrast dynamic range and overall quality of the imagery received. The modulation acceptance was measured with an input signal level of -110 dBm and was found to be +/- 19 kHz. Since the NOAA satellites have a signal deviation of around +/- 17 kHz, this value is very acceptable and will generally accommodate the 2 kHz of Doppler shift during the orbital pass.

It should be noted that standard 'scanner' receivers on the market usually either have too narrow and IF bandwidth (+/- 8 kHz) or too wide an IF bandwidth (+/- 50 kHz). A total bandwidth of approximately 40 kHz is acceptable for NOAA APT reception and the R139 performed very well in this respect.

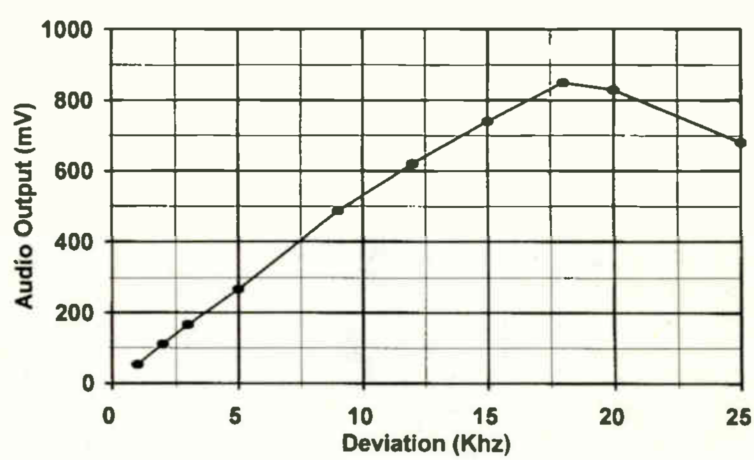
The sensitivity was measured for SINAD (Signal Including Noise and Distortion) and for the degree of FM 'quieting'. The SINAD measurements were performed with an artificial modulation of +/- 17 kHz and 1 kHz tone frequency. The measured sensitivity values are shown in below and expressed in microvolts of sensitivity.

12 dB SINAD	-120 dBm 0.22 uV
20 dB SINAD	-115.8 dBm0.36 uV
-12 dB Quieting	-122 dBm 0.18 uV
-20 dB Quieting	-118 dBm 0.28 uV

The maximum amount of 'quieting' is important for receiving noise-free pictures, clear of any 'sparklies' or other video noise. The maximum degree of quieting as measured on this particular receiver was - 43 dBm. If you use an 8-bit A/D converter for the demodulator card, the least significant bit equates to -48 dBm. This can usually be enhanced on most receivers by the addition of post filtering to the audio signal. Many demodulator boards employ audio input low pass filtering for this very reason.

The frequency of each of the oscillators was also measured. The results are shown above.

FIGURE 1 **Audio Linearity**
R139



Channel (MHz)	Measured (MHz)	Error (Hz)
137.300	137.299825	-175
137.400	137.399930	-70
137.500	137.498930	-1070*
137.620	137.620050	+50
137.850	137.849443	-557*

*-These channels were adjusted prior to all measurements, and probably reflect individual crystal tolerances rather than receiver design).

The audio linearity was also measured. This is another critical measurement for good quality weather satellite images. Since the video information in the downlink datastream is amplitude modulated (AM) on the frequency modulation (FM) carrier signal, the audio linearity provides the proper grey scale from black to white. Poor audio linearity will result in poor contrast in the APT imagery.

Linearity is most important in the infrared (IR) imagery where the temperature gradations are desired with good accuracy. Most of the newer APT software use the 'wedges' in the greyscale to actually measure temperatures in the cloud tops and sea-surface temperatures. The audio linearity for the R139 receiver tested is shown in Figure 1. The audio linearity proved to be very acceptable over the measured deviation range.

Figures 2, 3, and 4 are examples of the APT visible and IR imagery ingested with the Hamtronics R139 weather satellite receiver. Note the excellent dynamic range and greyscale in the imagery. Figure 2 is a NOAA 12 visible image of the Mississippi River and sorrounding areas. Figure 3 is another visible image of the east coast of the United States. Figure 4 is a combined visible and IR image of the eastern half of the United States from the NOAA 14 spacecraft.

In summary, the Hamtronics R139 receiver would be an excellent addition to your weather satellite ground station. This moderately priced kit (or assembled) unit provides advanced scanning functions, covers the most used satellite frequencies, and allows unattended operations by automatic scanning and recording of the APT signal. Jerry Vogt and his management team offer outstanding customer service and are attentive to the needs of the weather satellite enthusiast. For more information and pricing, write to:

Hamtronics, Dept. 65-G,
65 Moul Road, Hilton, New York 14468-9535
Phone 716-392-9430, Fax: 716-392-9420

I would like to thank Fred Piering for his reveiw and evaluation of the R139 receiver.

Future columns of the *View from Above* will review other weather satellite receivers and demodulator equipment produced by a variety of fine vendors specializing in the APT/WEFAX and HRPT/GVAR marketplace.

GOES 8 and GOES 9 WEFAX Transmission Schedules Updated

NOAA/NESDIS has updated the transmission schedules for both GOES-8 (EAST) and GOES-9 (WEST). These new schedules are presented elsewhere in this issue of Satellite Times, or you may FTP the files from the Dallas Remote Imaging Group server at: ftp.drig.com /pub/GOES, The files names are: wefaxg8.asc and wefaxg9.asc

And now for some active satellites to listen to with your weather satellite receiver. Here is an update of the active U.S. NOAA and Russian polar orbiting APT imaging satellites: ST

Active NOAA and Russian APT Orbiters

NOAA 12	137.500 MHz
NOAA 14	137.620 MHz
Meteor 3-5	137.850 MHz
OKEAN 1-7	137.400 MHz (Over Europe)
SICH-1	137.400 MHz (over Europe)

Active GOES Geostationary Satellites

GOES-8 (East)	1691 MHz
GOES-9 (West)	1691 MHz

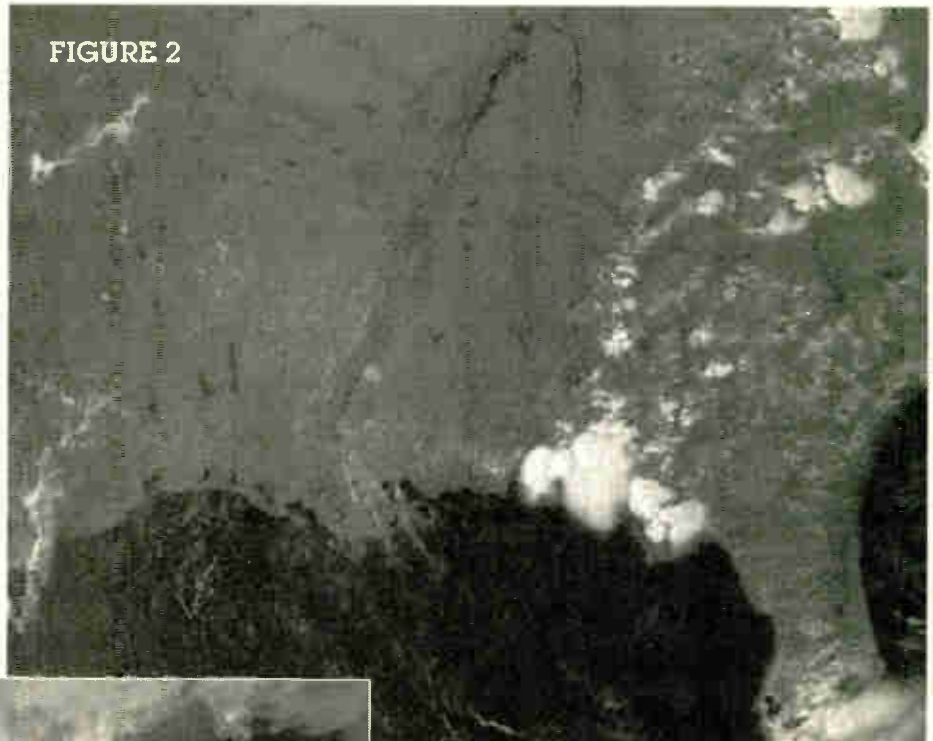


FIGURE 2


FIGURE 3

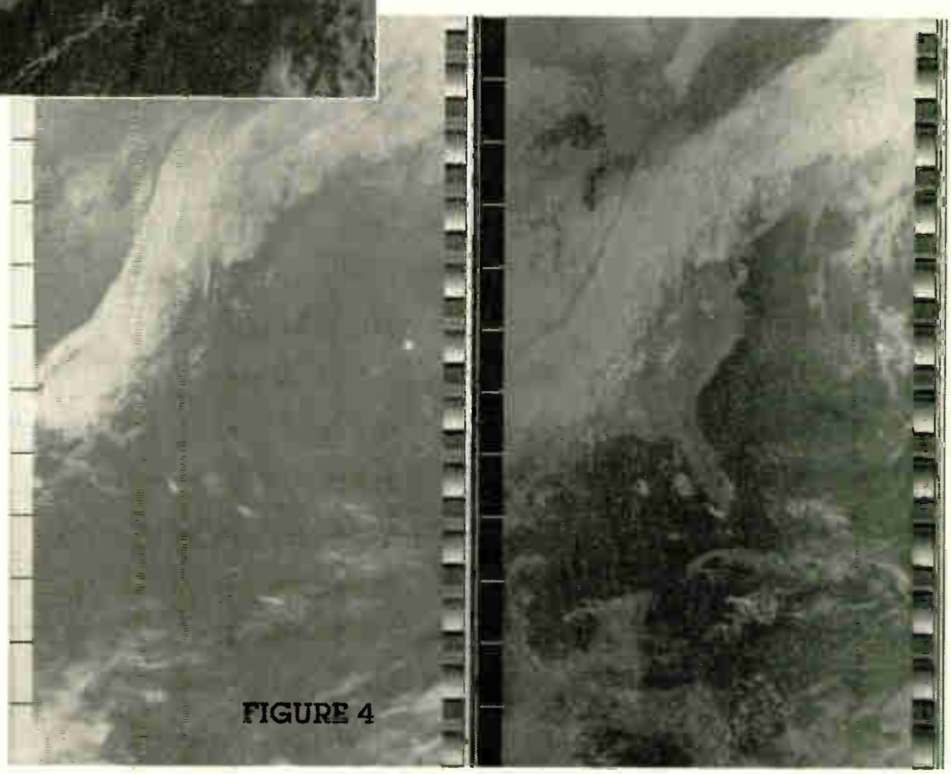


FIGURE 4

Donald E. Dickerson, N9CUE

PCS Update

Change is a word that most of us are not too comfortable with. We tend not to like too much change in our lives, even though change can be good. We must, however, learn to live in a sea of constant change because that is a large part of what our lives consist of, thanks in part, to technology.

The speed of change in every area of telecommunications, data and satellite technology is difficult to keep pace with. In this edition of *Personal Communications Satellites* we will take a look at some of the changes, developments and possible future outcomes of our current satellite technology, and how it is being used to bring about that brave new world of Personal Communications.

What is this new world of personal communications you say? Its main goal is to provide voice, and data services on a worldwide basis from small handheld transceivers, something like your basic *Star Trek* communicator. These new communications mediums will be a satellite based system, using Little Earth orbit (LEO) satellite networks to begin with. They will interface with conventional telephone and cellular services.

The 1995 Telecommunications Act has opened the doors for phone companies and others to enter the research and development stage of the personal communications markets. Satellites technology, not surprisingly, is an important part of the infrastructure.

Skycell

Satellite technology is already being used to support a technology we take for granted — the cellular telephone. There are still vast areas of this country and the world that do not have cell coverage. You can not roam if you wanted to in many locations. This snag in the advancement of technology has been over come by Skycell. That is the name of American Mobile Satellite Corporation's (AMSC) new cellular roaming service.

Westinghouse Series 1000 Mobile Satellite Telephone System. Handset below is the Mitsubishi AST112 Dual Mode Satellite/Cellular Telephone.

Skycell's satellite roaming service will compliment normal cellular service, not replace it. Voice, data, and fax will be sent digitally and seamlessly. You will never notice when your phone switches from terrestrial to satellite operation. This service is available now through your local cellular dealer or you can call 1-800-474-6543 for the nearest dealer in your area.

Two companies, Westinghouse and Mitsubishi, are producing the mobile satellite equipment required for satellite service. The Mitsubishi transceiver even allows you to plug in a handheld analog cell phone.

Skycell satellite roaming services will be particularly attractive to pleasure boats, commercial shipping, and private aviation A variety of transportation and public safety applications are possible and the system is user friendly too. You dial your number like you would on any phone then simply hit the send button and you have satellite access. Skycell can also provide a wide-area voice paging service. You can run, but you can't hide from the ultimate beeper.

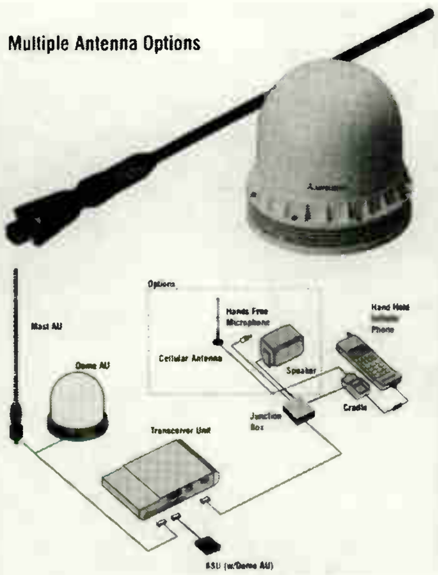
AMSC's Skycell uses a geostationary satellite to support this system. It's foot print covers all of North, Central and the northern part of South America, the Caribbean and Hawaii. The satellite, AMSC-1, measures 62 feet across its two deployed antennas and 68 feet across its solar panels. It can carry up to 2,000 simultaneous voice channels. Communications with the users takes place in the L-band while communications with ground stations takes place in the Ku-band.

The satellite was launched in April of last year, from the Kennedy Space Center, on an Atlas II launch vehicle and placed in a geostationary orbit at 101 degrees west. The satellite is based on the Hughes HS-601 satellite bus and carries six spotbeams. And it is just the beginning of the info revolution.

Qualcomm

Qualcomm Inc. of San Diego provides a geostationary satellite based mobile communication service. The service, called OmniTRACS (see the *ST* March/April issue) is being used in Bosnia by the Army. "For the first time, Army truck drivers will have two-way communications and command control over log distances," according to Army logistics analyst John Waddick."We expect that the satellite based system will be particularly useful in the rugged terrain of southern Europe, where traditional radio communications are often impossible". OmniTRACS provides reliable two-way data communications even when radio communications are disrupted by distance or terrain. This system is being installed in many vehicles throughout Europe. EUTELTRACS is the European distributor for the system.

Korea, Brazil and Australia are three other countries where you can get or will soon be able to get OmniTRACS service. OmniTRACS main user is the trucking/transportation industries and trucking companies all over the world are signing up for this service. In Brazil, though , the Police depart-



Antenna options for the Mitsubishi system.

ments are the most interested parties. Squad cars carry a data/radiolocation package so that headquarters can keep track of their cars and officers. Korea is ready to start selling and installing equipment and Australia transportation companies have requested demonstrations of the systems capabilities.

Qualcomm is also developing CDMA technology to secure Sprint's next generation digital cellular telephone in the Personal Communication Service (PCS). At last years FCC auction of new radio spectrum for PCS, Sprint Telecommunications Venture (STV) came out the biggest winner. They have contracted Nortel to provide networks and equipment based on Qualcomms Code Division Multiple Access (CDMA) technology, the first of its kind. Nortel will build CDMA PCS networks in 17 major market areas of the United States

Qualcomm is also working with Globalstar on a LEO /CDMA based satellite phone system and has awarded Orbital Mobile Communications, Ltd. the contract to build the handset. But that's another story.

One final note on Qualcomm. J.B. Hunt trucking has just ordered 6,000 OmniTRACS units for their trucks. Next time you are driving down the highway take a close look at that J.B. Hunt semi that passes you. You may find a satellite antenna on top of the cab.

ACTS

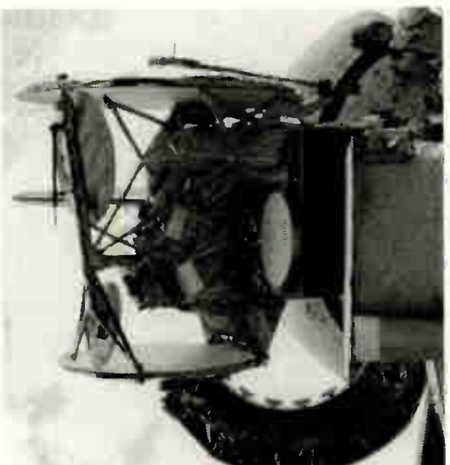
The Advanced Communications Technology Satellite (ACTS) was NASA's test bed for the technology that is now being used to develop the PCS and mobile satellite systems. This satellite is making worldwide, cellular phone, fax and data services possible.

ACTS was launched in 1993 bt the space shuttle and is located at 100 degrees West. The spacecraft is unique in many ways, but its real magic is the fact that it can send data at rates 20 times faster than any other method or system. It is this ability and its unique switching system that is making the Iridium system possible. Iridium is Motorola's network of LEO satellites that will use the ACTS technology.

When phone calls are made through ACTS they are rousted to ground stations or electronically switched using one of two methods. The first is called a baseband processor switch. The second is called an intermediate (IF) matrix switch.

The Baseband Processor is used with a technique called Onboard Stored Baseband Switched TDMA (Time Division Multiple Access). In this process calls are grouped together regardless of their final destination and packaged or put into one large package or packet. The process of putting this large packet together is called multiplexing. The signals are then sent to the satellite in a single burst transmission. When the signals arrive at the satellite each 64 Kbps phone call is demultiplexed and stored in memory. From there they are remultiplexed according to their destination nation. This process is known as OSBS/TDMA.

In the IF Matrix switch, calls are sorted by destination on the ground, multiplexed into multiple groups according to destination then uplinked to the satellite in smaller multiple bursts. This is called SS/TDMA.



ACTS satellite launched from the Space Shuttle.

OSBS/TDMA has one clear advantage. Since the signal or calls are packaged in a large single group. The signal-to-noise ratio can be improved as much as 3 db by central processing. The OSBS/TDMA is best suited for carrying relatively low volume traffic from hundreds of VSAT type stations. The SS/TDMA is a less efficient method that is better utilized by a small number of high volume stations — less than 100 — using high volume, trunked traffic.

ACTS has demonstrated high speed data rates — 622 Mbps and 696 Mbps — for short burst transmissions. This also means that digital voice, data, and fax can be sent over terrestrial fiber optic networks, like the Advanced Research Project Agency (ARPA) Synchronous Optical Network (SONET). This will help standardize the speeds on the Global Information Super Highway now under construction. SONET uses 696 Mbps Quadriphase (QQPSK) or Biphase (BPSK) with Forward-Error-Correction (FEC).

The Army Space Command used ACTS to provide communications for the Gulf War at data rates of 1.544 Mega bits per second. Intelligence, weather and command information was sent to 1.2 meter ACTS earth stations to elements of 1st Cavalry.

The ACTS system is also the test bed for the Integrated Services Digital Network (ISDN). It will support simultaneous delivery of voice, data, and video over single links to various elements of the Armed Forces at 64 Kbps. The Army Research Lab and NTIA are working with NASA to standardize the ISDN network. Oh, yes. For those of you so equipped, ACTS has beacons at 20.185 and 27.505 GHz.

There are hundreds of experiments and continuous research being conducted through ACTS by several universities, the military and numerous commercial interest. These projects include preparation for disaster preparedness and recovery, aeronautical communications/air traffic control, medical research and systems, airborne astronomical observations, and propagation studies to name but a few. ACTS is undoubtedly one of the most important satellite launched during the last quarter of this century. And it's impact on information systems, consumer electronics, and services will forever change the way we live and communicate. ..till next time around. ST

By Steve Dye, sdeye99@aol.com

More GPS Applications

As mentioned in the last column, we will be looking at the technology and applications of satellite navigation primarily through the Global Positioning System (GPS). One application in which I myself am involved concerns mapping out the signal strength, interference levels, and other parameters of cellular and Personal Communications Systems (PCS). This task employs a GPS receiver, a scanning receiver or a test mobile, and a laptop loaded with the appropriate software for reading the GPS and test mobile receivers' data output.

In the design and optimization phases of a wireless communications system's buildout — and particularly of cellular systems — it is essential that the coverage area of a serving cell is quantified, as well as the extent of any interference it may cause and/or experience. The practices outlined below are used by nearly all operators worldwide and is one of the most important tools an operator could use, relying on GPS for a cost effective, reliable solution.

Figure 1 shows a typical setup as used by system operators today. The GPS receiver output is fed to the laptop computer through the serial port. Information such as real time, latitude and longitude is processed and displayed via the user interface and stored in a file. The test mobile or scanning receiver will output data on such parameters as signal strength, interference, and system messaging, to one of the laptop's other serial ports. The software processes both inputs and enables an aggregate data stream combining the GPS and test data into a data file. A typical data file can be seen Table 1.

This kind of measurement is known as a "drive test," and is performed on a daily basis as a means of continually assessing system performance. Typically, new transmitters, power levels, and frequencies are introduced to the system quite regularly, and drive tests are required to maintain system quality. Figure 2 illustrates a typical plot derived from processing the drive test data. This example shows the results one would expect to see following a drive test in a downtown area. The typical grid pattern shows that the test vehicle drove up and down the streets in the town center, and on highways leading to and from the city. The software that plots these results can interface with a database loaded with highway and base station position data to provide a readable plot.

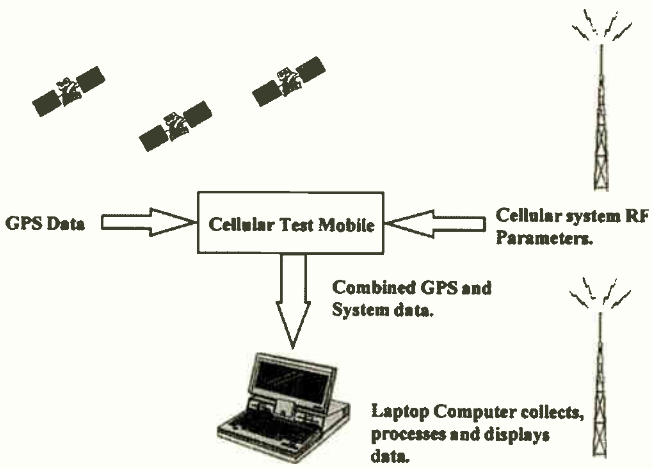


FIGURE 1: Typical Cellular System Signal Measurements

During the drive test, the test mobile is continually communicating with the system it is being served, yielding a host of information for the laptop computer to process. All relevant parameters are processed and displayed on the laptop. Once the drive test is complete, the collected data is processed further by another program that produces the plot seen in Figure 2.

The design engineers now have the ability to choose what parameter they want featured on the drive test plot. In the example shown in Figure 2, the signal strength is displayed with the location of the cell hand-offs as determined by global position.

A cell hand-off occurs when the signal strength or quality of a mobile call deteriorates, generally as a result of the mobile's distance from the serving cell. When a cell that can offer better conditions is reached, the call is handed off to the new cell.

GPS is very useful here, as the exact spot this occurs may need to be optimized, and GPS allows for constant feedback on a system's performance. A range of signal strengths are chosen and are represented on the plot by colors to indicate exactly where this occurred.

Other equally important parameters that can be plotted are noise (C/I+N), messaging such as hand-off occurrences, server, and neighboring server's information and carrier identities. The analysis allows really unlimited flexibility for the designers in assessing the quality of their system.

By plotting these parameters against GPS locations, cellular engineers can optimize their systems since they are able to pinpoint the exact position of a defect or system anomality and work backwards to alleviate the problem.

Performing this important measurment is a major role for GPS, which calls for easily available, cost effective GPS receivers. Just consider the number of licensed wireless systems in this world today, coupled with the hundreds more that are planned, and you can see how this single application comprises a large market for GPS receivers and third party software development.

This type of application goes beyond cellular radio engineering. Radio and TV stations, to whom range and pattern of coverage are critical, can now perform a drive test and plot precisely who can and cannot receive their signals.

One difficulty in using GPS for this application was encountered in heavily built-up areas such as those in downtown New York or Chicago, in which buildings blocked visibility to a sufficient number of satellites. And, of course, when passing through tunnels or under an overpass system, GPS is no longer received until the test vehicle appears in the open again.

Recently, new antennas capable of receiving GPS in high rise areas have been made available. Though reception in tunnels is still not possible, an antenna manu-

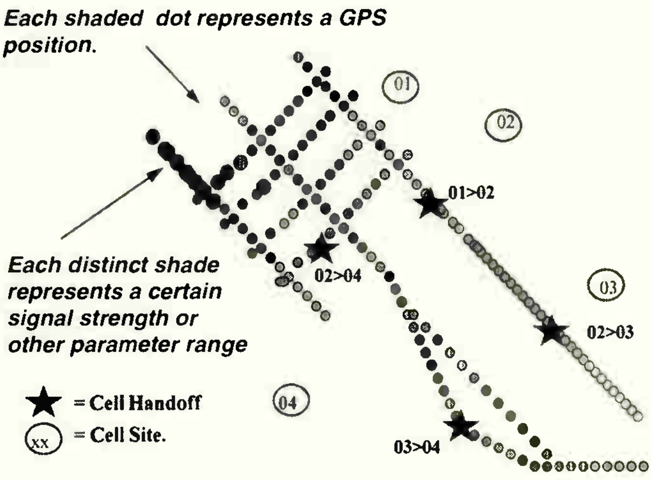


FIGURE 2: Example of Signal Strength, System Event and GPS Position Plot

factured by Trimble Navigation Ltd. offers a 25 dB gain with multipath filtering. This means that the direct signal can be received, or has a greater chance of being received, due to the high gain, and any multipath signals encountered in this type of environment will be filtered out.

One rather interesting application for GPS that recently caught my attention was used by country clubs. Have you ever been out there on the green and suddenly broken out in a sweat, wondering where you are relative to the club house and what your global position is? Well, me neither, but neither do I play golf. However, a company called ProShot manufacturers a patented OmniGolf system, which provides the clubhouse and golfers all the information they need to prevent such an episode and more. The cart, equipped with an LCD display and communications link, will indicate the distance from the clubhouse, plus tips and hazards for the area they are entering. The clubhouse, on the other end of the communications link, is able to track the location of each cart on the course and keep tabs on all players' whereabouts.

This rather abstract application of GPS only goes to show the extremely broad market acceptability of GPS. GPS is becoming a familiar term for many consumers, who have never heard of the technology before. Goffing is only one of many innovative applications that will help to achieve this.

The recent air disaster, involving the tragic death of Commerce Secretary Ron Brown and 34 other unfortunate victims could have been avoided if the aircraft had been equipped with GPS. Hindsight has 20-20 vision, but industry leaders and politicians agree that GPS could have saved valuable lives. The tragedy apparently occurred as a result of extremely poor weather conditions, offering zero visibility and a cloud base of 400 feet. The aircraft crashed because it was off course. GPS in even its simplest form would have indicated a bearing, a heading, and an altitude with sufficient accuracy to get them out of the mountains and onto the correct heading. It has now been mandated by Congress that all U.S. Air Force VIP jets will be equipped with GPS navigation capability by the year 2000.

The other tragedy is that it took such an event to learn what was an expensive lesson: That the same technology that allows golf course club houses to locate a golf cart with pin-point accuracy is the same technology that can — *if implemented* — contribute immensely in averting such disasters.

A Place in Time

In the feature article I wrote for the March /April issue of *Satellite Times*, mention was made of the atomic clocks on board each satellite. These provide the extremely accurate timing signals required for ranging purposes. In modern digital communications, timing is of the essence. Multiplexers, de-multiplexers, oscillators, and circuit switches most all synchronized to one single time source to ensure correct time slot allocation and synchronization between various interconnecting elements in the system.

This can be achieved by utilizing a rack-mounted rubidium clock in the system from which all timing and frequency signaling is derived. An alternate means is to use a GPS receiver that processes the GPS timing signals and provides a variety of frequency outputs for a multitude of uses, including digital communication systems.

Trimble Navigation Ltd. of Sunnyvale California — forever at the forefront of GPS technology — has a new product that was designed especially for timing wireless networks. The Palisade is a device that integrates a GPS receiver, an antenna, a power unit, and the all-important interface. The unit can be mounted on a tower or building and is small and light enough to prevent wind loading on the structure to which it's mounted.

Latitude	Longitude	Rel Dist (M)	Time	C/I+N (dB)	RSSI (dBm)
33°54'52"	84°17'11"	0	09:52:35	29	-81
33°54'52"	84°17'12"	0.008	09:52:36	29	-81
33°54'52"	84°17'12"	0.017	09:52:37	29	-82
33°54'52"	84°17'13"	0.027	09:52:38	29	-82
33°54'52"	84°17'14"	0.037	09:52:39	29	-81
33°54'52"	84°17'14"	0.047	09:52:40	29	-81
33°54'53"	84°17'15"	0.059	09:52:41	31	-75
33°54'53"	84°17'16"	0.069	09:52:42	31	-75
33°54'53"	84°17'17"	0.088	09:52:45	31	-71

Table 1. Typical Drive Test Data File Contents.

GPS A-Z

Continuing from our last column, here is an explanation of more acronyms, abbreviations, and phrases:

C/A code: The coarse or clear acquisition code is also sometimes referred to as the civilian code. It is modulated on the GPS L1 signal. The L-band ranges from 350 to 1550 MHz. The L1 signal is transmitted by each GPS satellite on 1572.42 MHz. It is a sequence of 1023 pseudorandom, binary, biphase modulations at a chip rate of 1023 kHz.

Carrier Aided Tracking: This is a signal processing strategy that uses the GPS carrier signal to achieve an exact lock on the pseudorandom code.

CDMA: Code Division Multiple Access is a method that broadcasts a multitude of digitally encoded signals, each with a unique code, but all on the same frequency. The receiver with the correct code will be able to read what all others will see as noise.

Chip: A chip is the transition time for individual bits in the pseudo-random sequence, i.e., the time taken to transit from a '1' to a '0'.

Clock Bias: This is the difference between the clock's indicated time and true universal time.

Control Segment: A world wide network of GPS monitoring stations that assures the quality and corrects the GPS timing and orbit.

Cycle Slip: The phase offset produced by an out-of-lock situation during the carrier aided tracking process.

That concludes this edition of Navigation Satellites. If you have any questions or input, you may email me at: *gpsyes@aol.com.* ST

RADIO ASTRONOMY

Jeff Lichtman

Radio Astronomy Amateur Project

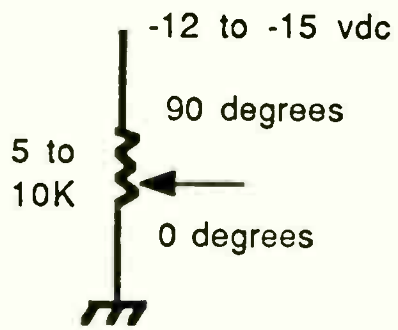
Since the conception of SARA (Society of Amateur Radio Astronomers) back in 1981, many interesting projects have been presented by its members. These have been reported in the SARA newsletter *Radio Astronomy*, and also presented at yearly meetings at NRAO (National Radio Astronomy Observatory) in Green Bank, West Virginia.

Some of these projects have been of tremendous help to me and other SARA members. In this issue, I'm going to present one of these projects to the readers of *Satellite Times*.

When doing research in any subject, you must have the most accurate data possible in order to validate your research records.One of the most important items within the radio telescope block diagram is the antenna. Without it, you might as well pack up and go home! The antenna collects the signals and routes them to the RF amplifier etc. In the study of radio astronomy it is important that we use our antenna properly.

The antenna is usually stationary in most amateur radio observatories (meridian transit). If you are ambitious, you may want to motorize the antenna. This of course allows you to sit in the comfort of a nice warm or air conditioned observatory, while moving the antenna in right ascension or declination.

FIGURE 1: Potentiometer at the Antenna



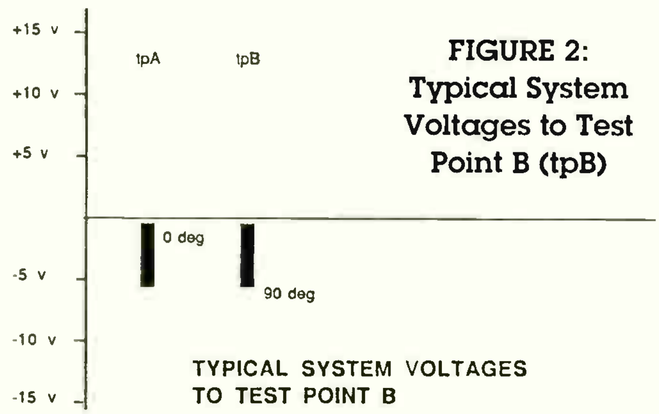


FIGURE 2: Typical System Voltages to Test Point B (tpB)

A few years ago, one of our past SARA presidents motorized his antenna installation. Mr. Chuck Forster, WA9ACI, of Oregon, Wisconsin, presented a paper on his antenna positioner at a SARA meeting at NRAO. I recently asked Chuck if he would let me share this with the amateur community, and he graciously granted permission.

The requirements for an antenna position indicator are:

- Unit must be inexpensive.
- Non-critical, easy to obtain components.
- Easy to duplicate.
- Accuracy within one degree or less.

To generate a feedback signal at the antenna, a single turn pot with a weighted arm hanging from the pot shaft, is adequate for providing a voltage output proportional to the antenna position.

For azimuth or hour angle rotary movement, use a ten turn pot with a threaded screw on the shaft of the pot. Wrap stainless steel fish leader wire on the screw threads so that as the pot shaft rotates, the wire is pulled out.

Wrap the pull wire around the antenna mast. As the mast rotates, it will wind or unwind the steel wire around the screw on the pot shaft, thereby rotating the pot shaft and generating a voltage output relative to the antenna position. A spring or counter weight is required to force the pot to rewind the wire when the mast rotates in the opposite direction.

The method of getting the signal back to operating position, is done by a single pot, The single and ten turn pots will produce a voltage of approximately three or four volts, proportional to the movement of the antenna. The exact range depends upon the total movement of the sensor pot, size of shaft, etc., but not very critical.

The minimum and maximum voltage obtained is not critical. Adjust the shaft on the sensor pot so the voltage output from the center slider of the sensor pot is approximately -0.5 volts, with the antenna at minimum position. As the antenna rotates to a higher elevation or azimuth position, the sensor pot output voltage should rise to a negative voltage. See Figure 1.

Use a linear pot of 5 to 10K ohms at the antenna. The old carbon pots found in old military gear will work fine for elevation indication. Any good quality ten turn pot will work for the azimuth or hour angle sensor pot.

FIGURE 3. 8-Bit A/D Readout

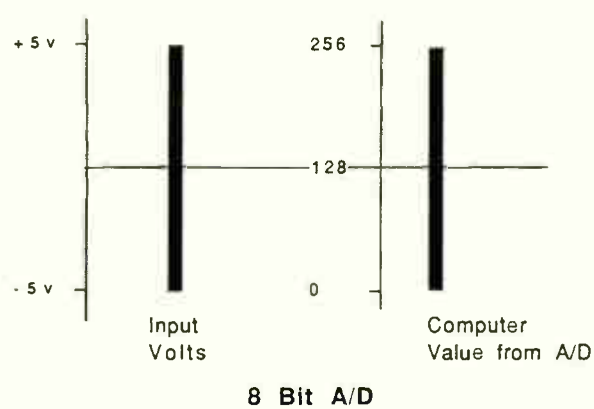
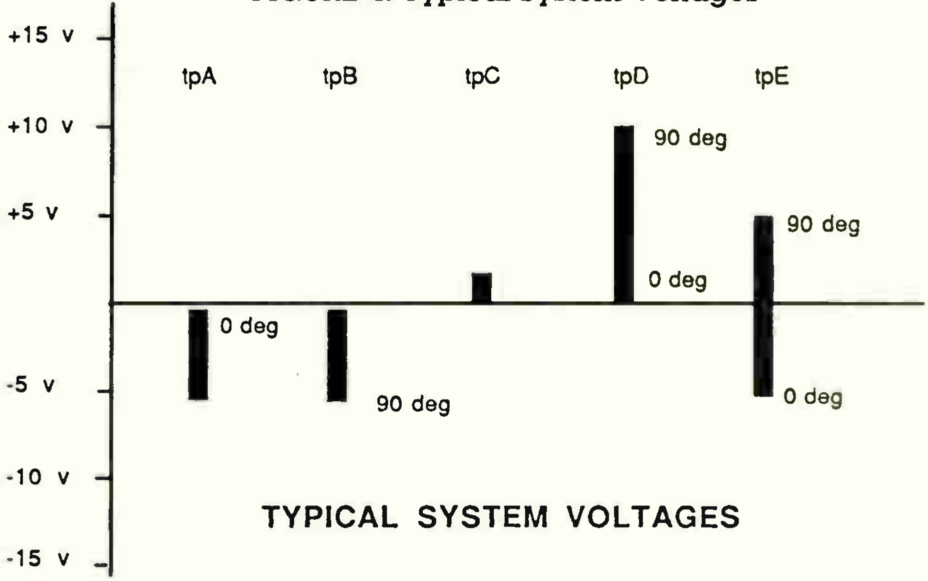


FIGURE 4. Typical System Voltages



If the distance from the pot to the position indicator is more than 50 feet, induced voltages may interfere with the output reading from the high impedance position sensor pot. The antenna position sensing output voltage must be "stiffened" by the use of the op-amp circuit shown in figure 5 (U1A).

The output from the position sensor is not usable as received. Referring to figure 5, U2A and U2B, we can move the antenna to the minimum position, say eight degrees, and adjust pot R16, so that the voltage at test point C (tpC) equals +0.08 volts. Moving the antenna to the maximum position, say 88 degrees, adjust pot R12 so that the voltage at tpC is equal to +0.88 volts. By connecting a digital voltmeter to tpC, you will then have a digital readout of antenna position.

For developing voltages for computer input, the tpC voltages will be useful. If you are using an 8-bit A/D (analog to digital) converter that has an input of -5 to +5 volts or 0 to +5 volts the 0 to 0.9 volt output range of tpC limits your precision.

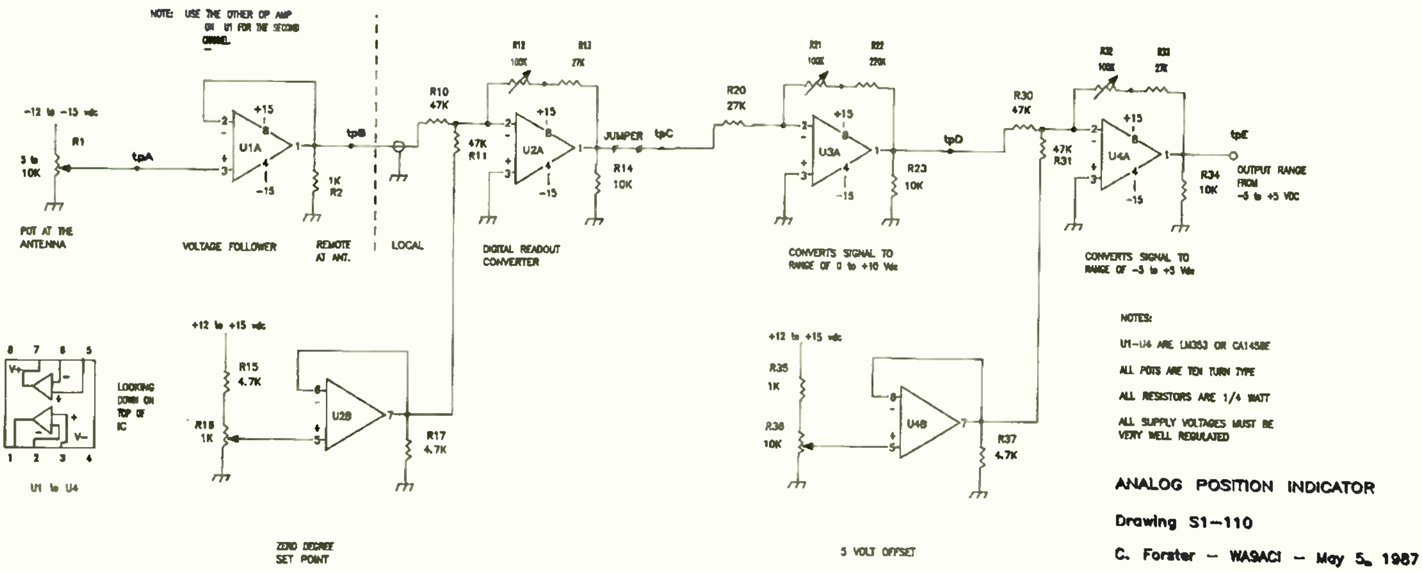
Assume you have an 8-bit A/D converter with an input of -5 to +5 volts this will produce a value of 0 to 255 in your computer. If you read 0 to 0.9 volts, you will get computer values of 0 to 23. The maximum precision of your computer will be 1/23 or 4.3 %. If you are trying to read 0 to 90 degrees, the error caused by your computer will be 4 degrees, this is not very accurate. In the case where you are reading 0 to 3.6 volts in azimuth, the computer error will also be 4 degrees.

One way to reduce the computer error is to convert the 0 to 0.9 volt signal to a -5 to +5 volt signal. -5 volts equaling 0 degrees elevation, and a +5 volt signal equaling 90 degrees. Referring to figure 5, circuits U3, U4A and U4B perform this function.

Earlier, we adjusted the output on tpC using whatever extreme elevation settings the antenna was capable of. For the remainder of the circuit, we must have the antenna move 0 to 90 degrees to complete the alignment. If it is not possible to move the antenna, simply open the jumper at tpC and apply 0 to +0.9 volts to the input of U3A.

To adjust circuit U3A, open the jumper at tpC, apply 0 volts at tpC and verify 0 volts at test point D (tpD). Apply +0.9 volts at tpC and adjust pot R21 to obtain +10 volts at tpD. If your A/D accepted 0 to +5 volts, you

FIGURE 5



could adjust R21 for +5.0 volts and quit here.

To adjust circuit U4A, open the jumper at tpC, apply 0 volts at tpC and adjust R36 for 0 volts at test point E (tpE). Apply +0.9 volts at tpC and adjust R32 to obtain +10 volts at tpE. Leaving +0.9 volts at tpC, adjust R36 to obtain +5.0 volts at tpE. At this point, the alignment is complete, close the jumper at tpC.

Figure 4 Note: *The figures are typical for an elevation or azimuth circuit. The voltages at tpA will vary from installation to installation.*

If you are only interested in computer control, you may by-pass the U2A circuit. However, this is not recommended since the digital readout available at tpC is very helpful in checking out or verifying the calibration of the entire system.

The circuitry described in this column will provide a high degree of accuracy in determining the position of your remote antenna. The circuit will optimize the precision of the 8-bit A/D converter. The converter converts all input voltages to the computer with values from 0 to 255 producing a precision of 1 part in 256.

Assuming the circuitry is without error, the best that an 8-bit A/D converter will be able to read is within 0.4 % or 0.35 degrees for a 0 to 90 degree elevation drive. This is acceptable, but when reading a 0 to 360 degree azimuth drive, the precision is limited to 1.4 degrees, which is an excessive additional error to add to the system. A 9-bit A/D would be just right, reducing the computer error to 0.20 % or 0.7 degrees for a 360 degree drive.

You can obtain a ninth bit with your 8-bit A/D converter. Instead of simply reading the A/D one time, read it 10 times, sum all the values and divide by 10. Below are some typical values obtained by applying a constant DC voltage to the computer A/D and noting the benefits of averaging the readings.

Test data was obtained by reading the 8-bit ten times, noting the highest and lowest single A/D value read each time a batch of ten reads were completed. Any one of the single values could become the data used if only a single read to the A/D were made.

Typical A/D Values

Highest value *	Lowest value *	Average value*	Maximum Deviation (%) *
189	184	185.76	1.95
187	184	186.07	1.17
188	184	186.46	1.56
188	184	185.68	1.56
187	184	185.33	1.17
189	184	187.21	1.17
187	184	185.66	1.17
187	184	186.06	1.17
189	184	186.82	1.56
189	184	186.89	1.56

* out of 10 reads

Highest Average Value: 187.21
Lowest Average Value: 185.33
Maximum Deviation of average values (%): 0.73

As shown in the tabulation below, a single A/D read could result in almost 2% error added to the 0.4 % precision A/D. Averaging the readings reduces the A/D reading error to 1.13 % versus 2.4 %. The above A/D readings included a slight amount of induced AC ripple on the input voltage, this reading error is also reduced by averaging the 8-bit data.

Again, I would like to thank Mr. Chuck Forster, past president of SARA for allowing me to present this fine example of an amateur radio astronomy project.

If you have built and tested a project in the area of radio astronomy, send me the details. Let me remind our readers of my previous challenge. Submit a radio astronomy project and we will judge it. We will award a first, second, and third prizes for the best projects submitted.

For those of you interested in SARA, we will be holding our annual conference at NRAO, July 14-17, 1996. For more information, contact the SARA treasurer — Mr. Hal Brashwitz, 3623 West 139th St., Cleveland, Ohio, 44111 (216) 252-8177. A registration fee and food fee is charged along with room costs. If you are interested in amateur radio astronomy, you might even consider joining SARA — US$26.00 buys alot!

ST WHAT'S NEW

by Wayne Mishler, KG5BI
email: mishler@aol.com

Computer creates rare view of planet Earth

The December 1995 edition of Earth magazine includes several great ARC-created earth images in its cover story.

It's an eerie feeling you get the first time you see mother Earth in her birthday suit.

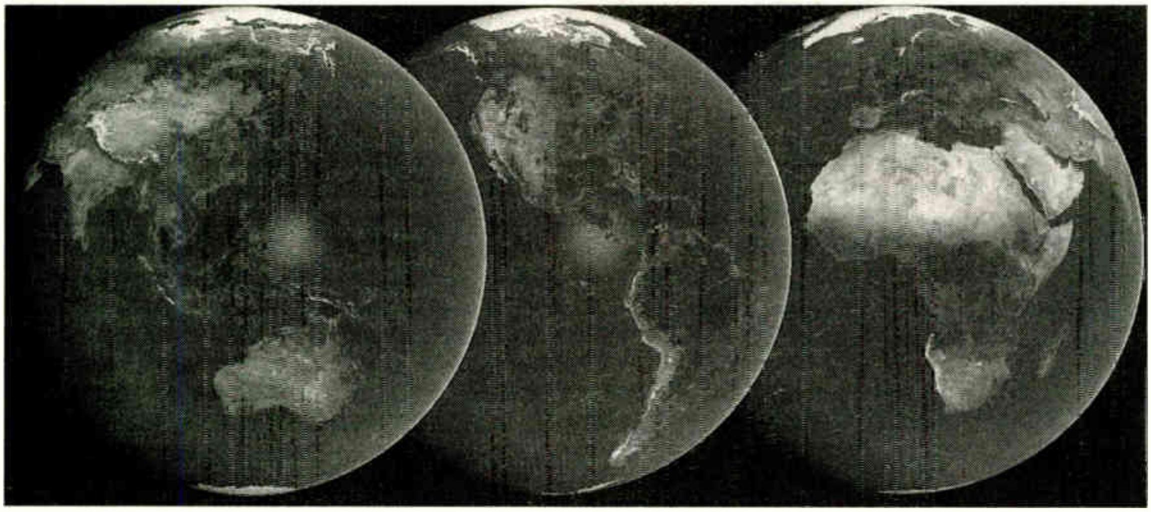
Oh sure, you've seen pictures taken by astronauts. You've seen maps of the world. You've seen drawings and the work of cartographers. But you've never seen anything like the image of Earth created by ARC Science Simulations, of Loveland, Colo.

They've produced cloud-free computer image which, if printed with magazine-quality resolution, would cover a 20-foot-wide billboard. The image shows cities, mountains, lakes, deserts and even cultivation areas. If you look closely you can see the clear-cut forests in Siberia, the blast area of Mount St. Helens, and even the Nile's Aswan Dam. You'll catch yourself trying to find where you live. You'll see the Earth without those funny little man-made lines called boundaries. You'll feel kinship with people of neighboring countries.

Probably the first question you'll ask when you see this rare portrait of Earth will be: "Okay, how'd they get a picture without clouds?"

The answer is both simple and complex. Over a four-month period in the spring and summer of 1992, ARC collected digital images from weather satellites and photographs from the space shuttle. These images showed Earth from every angle and under various states of cloud cover. At some point in time nearly every kilometer of Earth's surface was photographed at least once without clouds. While no single picture showed the entire planet without clouds, the collective data was entered into a powerful computer which built a composite view using only cloud-free images of each kilometer of the planet's surface. The result was a virtual image of Earth as it would appear from space with no clouds or haze.

The image was 16 months in



the making. It occupies about two gigabytes of computer storage. That's more than most personal computers can put on their hard drives, much less load into RAM. Using this massive collection of data, ARC's computer can project images of Earth as it would appear at any time of day from any angle or altitude down to a few hundred kilometers.

The image can also be printed on paper. In fact you can own a 40-inch-wide limited edition print showing the Asian, American, and African hemispheres along with a close-up of the United States as viewed from the west coast. An unlaminated copy is only $45. A laminated copy is $65. Both versions are printed with 300 line-per-inch quality in superb color on heavy paper.

Order by calling 1-800-759-1642. But don't wait too long. Remember this is a limited edition.

Astronomers can tap into satellite data, aid research project on new web site

A new site on the World Wide Web offers professional and amateur astronomers direct access to near real-time data from ALEXIS, a Los Alamos National Laboratory satellite. All astronomers, including students and amateurs, are invited to participate in the project. The site (http://nis-www.lanl.gov/nis-projects/alexis/) provides basic information about the spacecraft, photographs, and a menu of options.

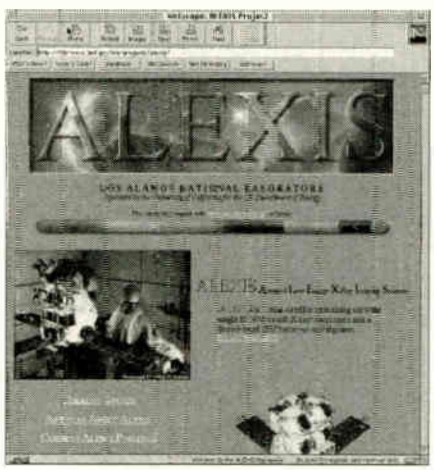
The Los Alamos National Laboratory is operated by the University of California for the U. S. Department of Energy (DoE.)

Visitors can gain access to the site's data by registering online. Registration is free. A verification number will be provided via email. You will need this number to get access to the data viewer. Once you are connected with the viewer, go to the primer on EUV transients. This will describe the ALEXIS project in more detail and explain how to interpret the tables of data.

The $17 million ALEXIS, funded by the DoE Office of Nonproliferation and National Security, was launched about three years ago to detect bursts of extreme ultraviolet photons (EUV transients.) Scientists want to identify the sources of these bursts and learn more about them. But they need your help.

ALEXIS is a relatively small satellite carrying EUV telescopes, but ground-based optical astronomers are needed to look for visual confirmation of transients detected by the satellite's telescopes.

One way to do this is to access the web site to get coordinates of a likely upcoming transient, and then train your telescope on that spot. If you see a star brighten or fade, you can call up the web page to see if ALEXIS saw anything unusual in the extreme ultraviolet range at the same place and time. Consult the web site for information on how to report your findings.



How to find meteorites

There are two ways to find meteorites. You can go dig in the dirt at the point of impact. Or you can order one out of the Catalog and Handbook of Meteorites from Bethany Sciences.

This amazing booklet is more than just a source of meteorite samples. It is a virtual library on the samples that the sell. A typical description of a sample reads like this:

"On February 18, 1948, many Midwest residents saw a fireball explode and send meteorite material across a 20-mile-long field. Over 100 stones have been recovered, including one of the largest stone meteorites ever found. This meteorite, which is a friable (easily crumbled), lime-poor enstatite achondrite with some nickel-iron inclusions, appears almost white." You can buy fragments for $45 a gram.

The catalog includes many interesting articles on well known and lesser known meteorites that have struck the Earth over the years. Browsing between its glossy covers is like delving into an encyclopedia – the more you browse, the harder it is to put down.

This is one catalog you'll enjoy. You can get a copy by writing Bethany Sciences, P. O. Box 3726, Amity Station, New Haven CT 06525. In case you'd rather call than write, their phone number is 1-203-393-3395.

New catalog offers astronomy books and software

Ever think of building your own astronomy telescope. You'll find a book on it and a lot more in the new 31-page catalog from Sky Publishing Company.

"Lately the number of books, star atlases, computer programs, and other products for astronomy enthusiasts seems to be expanding faster than the universe itself,"

says Sky Publishing president and publisher Richard Fienberg.

"The 1996 Sky Publishing Catalog is your guide to the best of what's available today. Here you'll find more than 200 carefully selected books and products, including 50 that are new to our catalog this year."

To find out about their product line, or to ask about getting your own copy of the catalog, you can call them toll free. The number is 1-800-253-0245.

Digital television to be launched in Mid-East

NetHold, an international pay-TV group, has announced plans to launch a direct to home (DTH) digital satellite television service for customers in the Middle East.

A subsidiary called MultiChoice has been granted exclusive DTH rights to distribute the services of ART (Arabic Radio and Television) in the region.

The services are to be broadcast via two Ku-band transponders on the PAS-4 satellite, and uplinked from a ground station near Rome.

The programming package from MultiChoice will be the first in the region to comply with MPEG-2/DVB, which is rapidly becoming the international standard for digital television.

EWTN Global Catholic Network now broadcasts on AM/FM radio via satellite

EWTN this Spring began delivering AM/FM service free via satellite to radio stations around the world. Using the reach of their satellite system, the network is now broadcasting audio in North America on Galaxy IR, transponder 11, frequency 5.40 MHz (English) and 5.58 MHz (Spanish.) They are broadcasting internationally on Intelsat 332.5 degrees, channel 22.7, frequency 5.59 MHz (English) and 5.68 MHz (Spanish.)

The new service complements the network's short-wave radio station, WEWN, which has been beaming 24-hour broadcasts worldwide for the past three years.

Check the World Wide Web for satellite needs

Looking for a hard-to-find for your satellite receiving system? Check the KVH Industries home page on the World Wide Web. You'll find them at http://www.kvh.com. You can browse their products, download brochures, and even ask questions by email.

"If someone has a question or comment, they will quickly get a response," says marketing coordinator Sandy Oxx.

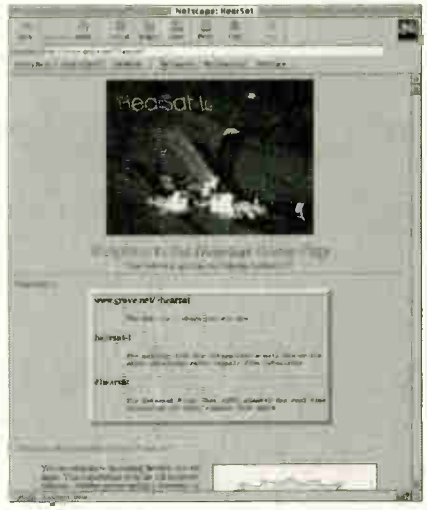
KVH Industries designs and manufactures several lines of navigational products for marine, military and commercial markets. You've seen some of their products described in this column in the past, including the TracVision marine satellite tracking antenna system.

HearSat-L space buffs move to Grove web site

In case you've been looking for the HearSat-L group world wide web site, they've moved to a new web server: http://www.grove.net/~hearsat.

Everyone is invited to participate in their regular Internet relay chats. "We've been covering major space events in these sessions," says moderator John Corby. Topics vary but focus on space events such as the docking between Atlantis and Mir. "The docking was relayed by one of our founding subscribers, Ivan Artner, from his station in Hungary. Ivan kindly translated the Russian language into English for us," Corby adds.

Since its beginning in November, 1995, HearSat-L has grown to 77 subscribers from



13 countries. Their chats can be exciting for space enthusiasts. If you are interested in listening to satellites and space communications, then the Hearsat-L newsgroup is just for you.

If you'd like more information about the group and/or about subscribing to the newsgroup, you can reach John via email at jcorby@headwaters.com. ST

Final Frontier

By Philip Chien

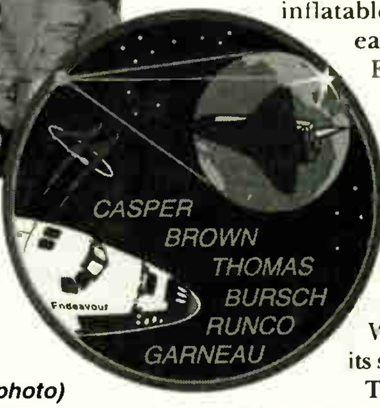
STS-77: More than a Cola Break

STS-77 featured the first shuttle flight with three new Block I main engines, the first ascent controlled by the new mission control center, and a record number of rendezvous. But this is the mission which most people will remember as the one where the Coke machine failed to work.

The payloads featured the fourth Spacehab flight, the Inflatable Antenna Experiment (IAE), and Technology Experiment Advancing Missions in Space (TEAMS).

The commercially-built Spacehab doubles the shuttle crew cabin's volume. Spacehab Inc. originally projected a market for thousands of 57 liter (2 cu. ft.) lockers, at US$1 million each. But their only customer was NASA, who agreed to pay US$184,237,000 for 200 lockers. Spacehab hoped to sell additional lockers to commercial and foreign concerns, but only made one sale. So most Spacehab lockers were NASA experiments, or lockers which NASA gave away to commercial companies. Spacehab's planned six missions were cut back to four.

NASA Crew photo of the STS-77 members. On the front row are astronauts John H. Casper (right), mission commander; and Curtis L. Brown Jr., pilot. In the rear, from the left, are astronauts Daniel W. Bursch, Mario Runco Jr., Marc Garneau and Andrew S. W. Thomas, all mission specialists. Garneau represents the Canadian Space Agency (CSA). (Official NASA photo)



Spacehab 4 featured a dozen experiments, most notably the Commercial Float Zone Furnace. Hours of video showing the crystal growth progress were transmitted - not the most exciting images from space! Experimenters wanted 12 samples and got two bonus samples because everything worked properly. A membrane experiment processed gas permeable polymers. Paragon Vision Systems is studying the material and plans to make prototype contact lenses from the flight material. The ultimate goal is long-wear contact lenses manufacturered in space. Other Spacehab experiments featured biology and materials processing.

The most publicized experiment on this mission was the Fluid Generic Bioprocessing Apparatus. According to NASA's technical documents FGBA studied:

"...multi-phase fluid handling in microgravity. It also investigated physiological modeling in space, and show associated life sciences system impacts."

Sounds like a serious scientific experiment to manipulate a fancy liquid or something to do with the body's functions - right? Well - another description could read:

"The FGBA will study how carbonated beverages, specifically Coca Cola and Diet Coke, can be dispensed in space and whether or not astronauts burp afterwards."

Was FGBA a legitimate experiment or a publicity stunt? NASA points to the experiment's capabilities to pump two-phase fluids in microgravity and potential spacecraft applications. NASA funded FGBA's US$1.75 million portion of Spacehab.

Coca Cola Inc. wanted to use the experiment to investigate future markets, and invested US$750,000 in the hardware. Coca Cola also got plenty of publicity - even the flight hardware's design. Unlike most experiments with a plain faceplate and a discrete logo FGBA looks like a Coke machine and dispenses Coke into bottles which look like Coke bottles!

The most visually exciting payload was the Inflatable Antenna. Inflatable components have many advantages over mechanical structures. Proponents have suggested inflatable antennas, solar arrays, and sunshields. NASA's only large inflatables were the early 1960s Echo satellites so many questions remain unanswered. Could a large structure inflate properly? Would it hold its shape?

The inflatable antenna was packaged in a box the size of a kitchen table. Inflated it would occupy one hundred times that volume. In space only 2.8 grams (.1 oz.) of nitrogen was required to pressurise the 14 meter (50 foot) diameter antenna. IAE flew on Spartan, a relatively inexpensive platform which provides power, attitude control, and data storage.

TEAMS featured four independent payloads. The Global Positioning System (GPS) Attitude and Navigation Experiment (GANE) used four GPS antennas in the same configuration planned for space station. The Vented Tank Resupply Experiment (VTRE) evaluated fluid handling. The Liquid Metal Thermal Experiment (LMTE) examined heat pipes. PAMS, the Passive Aerodynamically Stabilized Magnetically Damped Satellite, tested satellite stabilization.

Brilliant Eyes Ten Kelvin Sorption Cryocooler Experiment (BETSCE - pronounced 'Betsy') was a mechanical refrigerator which may be used to cool detectors on future spacecraft.

The Aquatic Research Facility (ARF) flew Sea Urchin, Starfish, and blue mussels. U.S. and Canadian marine biologists are studying early development.

Endeavour also carried twelve Get Away Specials — inexpensive self-contained experiments. These included a Utah State University payload which held experiments for every grade level from kindergarten through graduate studies, and a Cal Tech gamma ray burst detector which may solve one of astronomy's most perplexing problems.

The six man crew was assigned a year before the flight — commander John Casper, pilot Curt Brown, Canadian mission specialist Marc Garneau, American mission specialists Mario Runco and Dan Bursch, and rookie Andy Thomas, a native Australian who had emigrated to the United States.

In 1983, NASA invited Canada to fly shuttle payload specialists and in 1984 Marc Garneau became the first Canadian to fly in space. Canadian officials claim that he was first because of his military background which was considered desirable due to the rapid training period, but his French-Canadian Quebec background was certainly another factor. In 1992 NASA offered to train two Canadians as mission specialists with shuttle responsibilities. Chris Hadfield and Marc Garneau were selected, making Marc the first astronaut candidate with spaceflight experience! His 11.5 years between his spaceflights sets a record which no astronaut wants to break.

Another crewmember with an unenviable record is Dan Bursch. When the shuttle prepares for launch its three engines are started in sequence. Normally Main Engine Cutoff (MECO) occurs eight and a half minutes later when the shuttle has enough velocity. If the computers detect any potential problems during the startup sequence an automatic shutoff is commanded and the system prevents the solid rocket boosters from igniting.

The RSLS (Redundant Set Launch Sequencer) abort is incredibly exciting, scary, and eerie to watch in person, but actually a safe process where the astronauts and launch team safe the shuttle's systems. Shuttle crews practice a simulated engine cutoff and escape procedures a couple of weeks before launch.

There have been five RSLS aborts in the

The $750,000 Coke machine didn't work at first, but astronauts were able to fix it.

shuttle program — including both of Dan's previous missions — STS-51 and STS-68. He quickly received the nickname the "MECO kid", and unending ribbing from his fellow astronauts. Certainly the rest of the crew had to be admired for their courage accepting a flight assignment with him!

STS-77 was especially challenging for the pilots. The shuttle includes two sets of propellant tanks — forward and aft. The shape of the shuttle's nose limits the size of the forward tanks, and it's the limiting factor for missions which require a lot of maneuvering. The flight plan called for four rendezvous — one to retrieve Spartan and three with PAMS. NASA is conservative when it calculates the forward propellant figures, but the numbers were pessimistic — Endeavour had 100 kg (220 lbs) less propellant than what was required.

The mission was also power-limited. Endeavour has five sets of cryogenic tanks — technically not enough power for the shuttle and its experiments.

The normal 'cryo consumption' numbers allow for possible launch delays. As the shuttle sits cryos evaporate, reducing the margins. STS-77 was scheduled for nine planned days plus one energy-dependent day which would be added if enough power was available. For a nine day flight BETSCE would not even be turned on! So the goal was to launch Endeavour on the first try — if at all possible.

Launch was scheduled for May 19. Dan Bursch's previous aborts were on everybody's mind. One unconcerned person was fellow astronaut Mario Runco — he had a perfect launch record — two launches in two attempts. So he thought his good karma would outpower Dan's bad karma. Karma, a good launch team, a good set of engines, and good weather resulted in launch at the opening of the window.

On flight day 2 the crew deployed Spartan. After giving Endeavour enough time to move away Spartan's onboard timer commanded the inflation sequence. Spartan/IAE went in to an unexpected end-over-end tumble, causing the astronauts to use additional propellant for stationkeeping at a safe distance. After one orbit the timer commanded IAE to eject from Spartan. Many viewers on the ground were able to see the shuttle and antenna flying in formation, and some lucky viewers were able to view the shuttle, Spartan, and antenna as three separate objects in the sky. A day later Endeavour rendezvoused with Spartan and put it back in to the cargo bay for return to Earth.

PAMS was ejected on flight day four. The trashcan-size satellite was aimed towards Earth, with a slight wobble. PAMS is a simple structure — a can with a heavy weight at one end, and magnetic torquer rods to align the satellite with the Earth's magnetic field. The objective was to evaluate a satellite stabilization system which doesn't require any moving parts or propellant.

Experimenters anticipated PAMS would rotate itself 90 degrees so the heavy end would face the flight direction instead of pointing down towards the Earth. The magnetic rods would hopefully align with the Earth's magnetic field and dampen out any wobbling or other motions.

There were problems with the laser, which was used to determine the spacecraft's attitude, but overall the experimenters were extremely satisfied with the results. All of the rendezvous were completed — with 170 kg (374 lbs) excess propellant — almost enough for another.

The only significant problem was the Coke machine. Ground controllers sent up five pages of troubleshooting instructions. It was determined that a thermal switch was probably at fault and engineers developed a six page procedure for the astronauts to open up the hardware and bypass the thermal switch with a jumper. The repair was successful and the astronauts were able to enjoy a cold coke.

Reentry sighting information was available on Internet and many ground based obersevers reported viewing Endeavour as it streaked across the United States towards Florida. Endeavour landed on May 29 completing its ten day mission and setting new records for the number of rendezvous and time stationkeeping with another object in space. ST

ST THE BEGINNER'S COLUMN

By Ken Reitz, KC4GQA

Betting on the Future

If you're like many other *Satellite Times* readers, this may be your first exposure to the world of satellites. And, you're more than likely asking yourself fundamental questions about this whole concept like: "If High Definition TV (HDTV) becomes a reality in my lifetime, does this mean that TV personalities such as Barbara Walters, Dan Rather and Alphons D'mato will have to wear even more make-up when they're on the air?"

By now you've been bombarded by countless TV commercials showing small dish satellite TV and how great the advantages are, for instance, in having a little dish and a big monthly bill as opposed to having a big dish and a much smaller bill. Anyway, doesn't that go against the laws of pysics? The short answer is no. In Turner's theorem the size of the dish is disproportionally equal to the size of your checking account.

DBS v "Full View" Round One

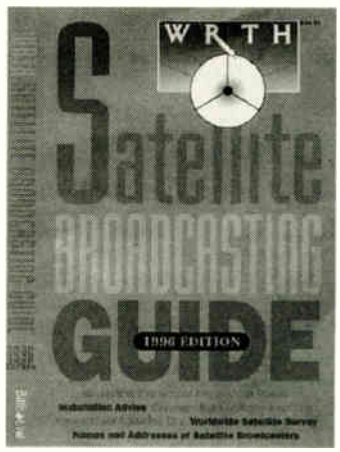
That brings us squarely to the point of answering your questions regarding satellites and the strain they put on all of us. It's clear *ST* reader Vaclav Pesek of Michigan is feeling the strain as he ponders how to receive Deutsche Welle TV. He's done his homework too and writes:

"...after we read several columns about the C-band future...one might speculate that the C-band broadcasts are a shakedown cruise for the technology..."

I know exactly how he feels. It's like buying an expensive cassette player just as CD players are being introduced.

To properly answer Vaclav's question, let's go shopping for cars. When we start thinking about where we'd like to sink all of our disposable income, our first thought is to buy a car. But, first we have to ask questions: What do we need this car for? Commuting? Touring? Carrying around a bunch of kids? How much do we want to spend? Do we even have to ask? Are we on a tight budget?

If all a person wants is to watch Deutsche Welle TV, the solution is simple: Buy a nice six or seven foot dish (about US$200); a nice, bottom of the line satellite receiver (about US$150); a simple LNBF (about US$125); throw in another US$50 for a feed line and voila! For a little over US$500 you've got a complete system for receiving Deutsche Welle TV all day, every day, all year long. With a little careful shopping and haggling you can get that price down to about US$150. Now, you can hardly buy a decent shortwave radio for that and here is a complete satellite TV system. So, what do you want, a Cadillac? OK! But, you'll have to pay for one.



DBS Vs "Full View" Round Two

Similarly, Bill from New Orleans wants to see a comparison between the DBS field of satellite systems and the so-called "Full View" systems. A "Full View" system is one as I've just described except, it has an actuator motor which drives the dish across the Clarke Belt from one horizon to the other allowing one to view all of the satellites (add another US$80). Suppose you want to watch cable-style programming on your "Full View" dish, better add another US$300 for the VideoCipher II RS module. Total cost of the "Full View" system: US$905.

Now, let's allow for programming. The DBS services want us to spend a minimum of US$30 per month for their services (they get to pick the services). That works out to US$360 per year so that after your DSS dish celebrates its first birthday you've put US$1,000 into it.

With a "Full View" system you can buy as much programming as you want or need. Let's say you want The Weather Channel, TBS, American Movie Classics, Turner Classic Movies, Bravo, and Independent Film Channel, that would cost about US$6.50 per month. Oh, by the way, you also get CSPAN I and II, Deutsche Welle TV, NASA Select, PBS, every shopping/religious channel you can name, NBC, FOX, CBS, FX, and dozens more networks in the clear for free. That works out to US$78 per year so that after your "Full View" dish celebrates its first birthday you've put US$983 into it.

Looming On The Horizon

Now, let's look down the road a bit. The current crop of C-band satellites have between 10 and 15 years left on them, so let's take the expenses out to five years and see what we've spent. After five years of subscriptions on the DSS system: US$1,800. After five years on the "Full View" system: US$390. You could actually afford to throw away your "Full View" system, buy a new one every five years and still come out ahead.

Hey, let's get paranoid! Suppose one of the DBS birds was to suffer the same problem that has bedeviled Anik E2. What would all those DBS subscribers do? On C-band they just shuffle the various channels around and squeeze programmers into every available transponder, no big deal.

Bill also wanted to know what it would take to get international reception from his location using a ten foot dish, C- and Ku-band feeds and LNBs, and a GI 2720R IRD?

As for the entertainment value of trying to watch anything on the Intelsat birds strung out across the Atlantic, it's a big disappointment. Here I'll refer you to the *1996 WRTH Satellite Broadcasting Guide* (available at Grove Enterprises 800-438-8155) which lists all of the satellites and their transponders. A quick glance shows that most programming is spot beamed to Europe, and/or encrypted. Those that aren't are possibly circularly polarized (you'll lose precious dB of gain using a linear polarizer to receive them) and, finally, they're so far away from New Orleans that you'll need a larger dish than your ten footer to get anything other than a very noisy signal.

Try Hispasat, a Ku-band bird at 31 degrees west. It will be quite a ways down on your eastern horizon and all the programming, if you see any at all, will be in Spanish using the PAL transmission format favored by Europeans.

Satellite Receiver Resurrection

ST reader James Kakalec writes:

"...I found a C. Itoh Citation 900 receiver the other day, but it needs a DSB-300. Are these receivers useful anymore and, if so, what might I pay for a well used one and what is the DSB-300?...are they necessary?"

It's always fun to find antique satellite gear and put it to use. James, I asked Brian Hoopsik of Professional Satellite Repair (814) 342-5635, about your receiver and he told me that the 900 was a block receiver and that the 300 was the power supply to the dish drive. The 900, if it still works, could be used as a stand-alone receiver for a fixed position dish. In addition, a new stand-alone dish mover can be purchased from Skyvision, Inc. (800) 334-6455 This will not work in conjunction with the 900, but beside it. Brian also noted that there is a switch inside the receiver which changes the input from the LNB to 930-1430 MHz. You want the switch in the 950-1450 MHz position. As to price, I wouldn't pay more than US$25 for it.

And you see folks, this is what I was talking about earlier in being able to get the price down on a "Full View" system. Go to a hamfest, do a little dumpster diving, offer to take the junk off the back shelves of your local dealer. Put an ad in the local classifieds. Watch more TV!

SCPC, Data and Other Curiosities

Dwight Talley of Richmond, Virginia, likes to tinker with satellite gear and notes that it would be helpful to have some sort of indicator at the dish when the satellite signal is the strongest to facilitate peaking a system whether it's a TVRO, DSS, or GOES (*The new Sony DSS systems do have signal stength indicators on the dish-editor*).

Professionals use several different types of peaking devices. The simplest and cheapest is a small relative strength peaking meter. The meter is put in-line between the feedhorn and the receiver feed line via a six or eight foot piece of properly sized coax. These meters are for the C through Ku-band frequencies and would not be useful in the S-band or DBS Ku-band frequencies. I don't know of any such peaking aide for those bands, but it sounds like a great idea for the dealer trade.

Dwight also wants to be able to use his ICOM R7000 for Single Channel Per Carrier (SCPC) reception and his AEA PK-232 Terminal Node Controller for satellite data reception. The R7000 receives from 25 MHz to 2 GHz, and is easily used as an SCPC receiver, but it's really overkill. And I can't recommend dedicating a radio whose price tag is around the two grand mark for SCPC recpetion. I would opt instead for the one of the many consumer SCPC receivers on the market from Avcomm, SatScan or Universal Electronics.

As far as copying commercial data transmissions on satellite, my understanding is that they are addressable and that non-subscribers will not have access. Years ago, before the advent of digital encryption and tiers of access, simple hobby data receivers could copy data streams all around the Clarke Belt.

Ku-band Reception Questions

F Sing Kwan of Dallas, Texas, is trying to pick up Ku-band signals from the Anik satellites using a three foot offset dish, a Pansat 3500 receiver, and a Pro Brand LNBF. At the time he wrote his letter, there was plenty of Ku-band activity on Anik E1. Now that one of E1's solar panels has stopped working, the reduced power availability has decreased transponder activity.

Information from Telesat has it that as many as 10 of its 32 Ku-band channels will continue to function at normal levels in the future. Still, the reason you can't receive any signal in Big D has to do with the size of your dish. A well built, ten foot, Ku-band capable dish will work fine for Anik reception that far out in the footprint. The ten foot dish will also be perfect for C-band reception of Morelos in your area.

Public Radio and SCPC Reception

Nikki Terranova of San Diego, California, can't get enough variety in the public radio offerings of the San Diego area and wants to know how to receive the programming offered by NPR, PRI, and MPR via satellite, specifically on SCPC.

The bad news is that NPR and PRI have opted to switch from analog SCPC transmissions to digital. They've also switched from Galaxy 4 C-band to Telstar 401 Ku-band. Continuing with the bad news, there is no consumer grade digital SCPC receiver on the market.

There are a few public radio signals available in analog form (KSJN-Minneapolis-St. Paul and KUSC-Los Angeles), but not enough to warrant the investment if all you're interested in is SCPC radio. Instead, I would direct you to the myriad audio subcarriers on C-band, which give not only the great variety you're seeking, but excellent audio fidelity as well (a thing always lacking in home SCPC reception).

On C-band subcarriers you'll find KLON-FM Long Beach (Jazz), CJRT-FM Toronto, Ontario (Fine Arts-Days, Jazz-Nights) and WUSF-FM Tampa, Florida (Same programming as CJRT). *ST*'s *Satellite Services Guide* — Audio Subcarrier chart found in the center of this issue lists over one hundred such music and news sources. It's tough to ask for more. ST

GOES 8 and 9 WEFAX Broadcasts Schedules

The following WEFAX broadcasts schedule was provided by *Satellite Times View from Above* columnist Jeff Wallach and the Dallas Remote Imaging Group.

GOES-8 East WEFAX Schedule
Valid as of May 21, 1996

TIME (UTC)	WEFAX PRODUCT
0002	GOES-9 2100Z NH IR
0006	MET-5 0000Z D3 IR
0010	MET-5 0000Z D4 IR
0014	MET-5 0000Z D5 IR
0018	GOES-9 2100Z FD IR
0022	MET-5 0000Z D7 IR
0026	MET-5 0000Z D8 IR
0030	MET-5 0030Z D2 IR
0034	MET-5 0030Z D9 IR
0038	MET-5 0030Z D1 IR
0042	MET-5 0030Z D3 IR
0046	GOES-8 2345Z NH IR
0050	W500 48 HR 250MB HT/TEMP/ WND
0100	W501 72 HR SLP/1000-500TK
0105	W502 72 HR 500MB HT/TEM/WND
0110	GOES-8 2345Z NE IR
0114	GOES-8 2345Z SE IR
0118	GOES-8 2345Z NW IR
0122	GOES-8 2345Z SW IR
0126	GOES-8 2345Z 4KM US IR
0130	GOES-8 2345Z 16KM FD IR
0134	GOES-8 2345Z NH WV
0138	GOES-8 2345Z NE WV
0142	GOES-8 2345Z SE WV
0146	GOES-8 2345Z NW WV
0150	GOES-8 2345Z SW WV
0154	GOES-8 0045Z NH IR
0158	GOES-8 2345Z 16KM FD WV
0202	GOES-9 0000Z NH IR
0206	GOES-9 0000Z FD IR
0210	NOAA-14 POLAR VIS NH 010E-080W W026
0214	NOAA-14 POLAR NIR SH 010E-080W W027
0218	NOAA-14 POLAR DIR NH 010E-080W W028
0222	NOAA-14 POLAR DIR SH 010E-080W W029
0226	NOAA-14 POLAR DIR MER 010E-060W W030
0230	GOES-9 0000Z FD WV
0235	GOES-8 0145Z NH IR
0240	ICE CHART
0245	ICE CHART
0250	ICE CHART
0255	ICE CHART
0300	W064 SIG WX PROG FL250-600
0305	SIG WX PROG FL250-600
0310	MET-5 0300Z D4 IR
0314	MET-5 0300Z D5 IR
0318	NOAA-14 POLAR VIS MER 040W-110W W031
0322	MET-5 0300Z D7 IR
0326	MET-5 0300Z D8 IR
0330	MET-5 0330Z D2 IR
0334	MET-5 0330Z D9 IR
0338	MET-5 0330Z D1 IR
0342	GOES-8 0245Z NH IR
0346	GOES-8 0245Z NE IR
0350	GOES-8 0245Z SE IR
0354	GOES-8 0245Z NW IR
0358	GOES-8 0245Z SW IR
0402	GOES-8 0245Z 4KM US IR
0406	GOES-8 0245Z 16KM FD IR
0410	MET-5 0400Z E1 MOIST
0414	MET-5 0400Z E2 MOIST
0418	MET-5 0400Z E3 MOIST
0422	MET-5 0400Z E4 MOIST
0426	MET-5 0400Z E5 MOIST
0430	MET-5 0430Z D2 IR
0434	MET-5 0430Z D1 IR
0438	GOES-9 0300Z NH IR
0442	MET-5 0430Z E6 MOIST
0446	MET-5 0430Z E7 MOIST
0450	MET-5 0430Z E8 MOIST
0454	MET-5 0430Z E9 MOIST
0458	GOES-8 0345Z NH IR
0506	GOES-9 0300Z FD IR
0514	NOAA-14 POLAR VIS NH 080W-170W W034
0518	NOAA-14 POLAR VIS SH 080W-170W W035
0522	NOAA-14 POLAR NIR NH 080E-010E W036
0526	NOAA-14 POLAR NIR SH 080E-010E W037
0530	NOAA-14 POLAR VIS MER 100W-170W W038
0534	NOAA-14 POLAR NIR MER 080E-010E W039
0538	NOAA-14 POLAR DIR NH 080W-170W W040
0542	NOAA-14 POLAR DIR SH 080W-170W W041
0546	NOAA-14 POLAR NIR MER 140E-070E W032
0550	NOAA-14 POLAR DIR MER 040W-110W W033
0558	GOES-8 0445Z NH IR
0606	MET-5 0600Z C03 VS
0610	MET-5 0600Z D1 IR
0614	MET-5 0600Z D3 IR
0618	MET-5 0600Z D4 IR
0622	MET-5 0600Z D5 IR
0626	MET-5 0600Z D6 IR
0630	MET-5 0630Z D2 IR
0634	MET-5 0630Z C02 VS
0638	MET-5 0630Z C03 VS
0642	MET-5 0630Z C3D VS
0646	MET-5 0630Z C2D VS
0650	MET-5 0630Z D3 IR
0654	MET-5 0630Z D1 IR
0658	GOES-8 0545Z NH IR
0702	GOES-8 0545Z NE IR
0706	GOES-8 0545Z SE IR
0710	GOES-8 0545Z NW IR
0714	GOES-8 0545Z SW IR
0718	GOES-8 0545Z 4KM US IR
0722	GOES-8 0545Z 16KM FD IR
0726	GOES-8 0545Z FD WV
0730	GOES-9 0600Z NH IR
0734	GOES-9 0600Z FD IR
0738	GOES-8 0645Z NH IR
0742	GOES-9 0600Z FD WV
0746	NOAA-14 POLAR DIR MER 100W-170W W042
0750	W006 24 HR PRECIP ACCUM VT00Z
0755	W007 24 HR SFC/1000-500THK
0800	W008 24 HR 500MB HT/WD/TMP
0805	W009 24 HR 250MB HT/WD/TMP
0810	W014 24 HR 250 MB PROG.
0815	W015 24 HR 250 HT ISOTACHS
0820	W016 24 HR TROP PRESS/VWS
0825	W017 24 HR TROP PRESS/VWS
0830	W018 24 HR 300 STM/ISOTACHS
0835	W019 24 HR 300 STM ISOTACHS
0840	W020 24 HR 200 STM ISOTACHS
0845	W021 24 HR 200 STM ISOTACHS
0850	W022 24 HR 500 STM ISOTACHS
0855	W023 24 HR 500 STM ISOTACHS
0900	W010 24 HR 850 STM ISOTACHS
0905	W011 24 HR 850 STM ISOTACHS
0910	MET-5 0900Z D1 IR
0914	NOAA-14 POLAR DIR NORTH POLE W043
0918	MET-5 0900Z D4 IR
0922	MET-5 0900Z D5 IR
0926	NOAA-14 POLAR DIR SOUTH POLE W044
0930	MET-5 0930Z D2 IR
0934	MET-5 0930Z C02 VS
0938	GOES-8 0745Z NH IR
0945	W012 24 HR 700 STM/ISOTACHS
0950	W013 24 HR 700 STM ISOTACHS
0955	W100 00Z MSL PRES/1000-500TK
1000	W101 00Z MSL PRES/1000-500TK
1005	W102 24HR MSL PRES/1000-500TK
1010	W103 24HR MSL PRES/1000-500TK
1015	W104 48HR MSL PRES/1000-500TK
1020	W105 48HR MSL PRES/1000-500TK
1026	GOES-8 0845Z NH IR
1030	GOES-8 0845Z NE IR
1034	GOES-8 0845Z SE IR
1038	GOES-8 0845Z NW IR
1042	GOES-8 0845Z SW IR
1046	GOES-8 0845Z 4KM US IR
1050	GOES-8 0845Z 16KM FD IR
1054	SCHEDULE FILE PART-1
1058	SCHEDULE FILE PART-2
1102	WEFAX MESSAGE FILE
1106	GOES-8 0945Z NH IR
1110	W503 48 HR SLP/1000-500TK
1115	W504 48 HR 500MB HT/TMP/ WND
1122	NOAA-14 POLAR VIS NH 170W-100E W001
1126	NOAA-14 POLAR VIS SH 170W-100E W002
1130	NOAA-14 POLAR NIR NH 010E-080W W003
1134	NOAA-14 POLAR NIR SH 010E-080W W004
1138	NOAA-14 POLAR VIS MER 170W-120E W005
1142	NOAA-14 POLAR NIR MER 020E-050W W006
1146	NOAA-14 POLAR DIR NH 170W-100E W007
1150	NOAA-14 POLAR DIR SH 170W-100E W008
1154	NOAA-14 POLAR DIR MER 170W-120E W009
1158	GOES-8 1045Z NH IR
1202	GOES-9 0900Z NH IR
1206	MET-5 1200Z C03 VS
1210	MET-5 1200Z D1 IR
1214	MET-5 1200Z D3 IR
1218	MET-5 1200Z D4 IR
1222	MET-5 1200Z D5 IR
1226	GOES-9 0900Z FD IR
1230	MET-5 1230Z D2 IR
1234	MET-5 1230Z C02 VS
1238	MET-5 1230Z C03 VS
1242	MET-5 1230Z C3D VS
1246	MET-5 1230Z C2D VS
1250	MET-5 1230Z C1D VS
1254	MET-5 1230Z D1 IR
1258	GOES-8 1145Z NH IR
1302	GOES-8 1145Z NE IR
1306	GOES-8 1145Z SE IR
1310	GOES-8 1145Z NW IR
1314	GOES-8 1145Z SW IR
1318	GOES-8 1145Z 4KM US IR
1322	GOES-8 1145Z 16KM FD IR
1326	GOES-8 1145Z NH VS
1330	GOES-8 1145Z NH WV
1334	GOES-8 1145Z NE WV
1338	GOES-8 1145Z SE WV
1342	GOES-8 1145Z NW WV
1346	GOES-8 1145Z SW WV
1350	GOES-8 1245Z NH IR
1354	GOES-8 1245Z NH VS
1358	GOES-8 1145Z FD WV
1402	GOES-9 1200Z NH IR
1406	GOES-9 1200Z FD IR
1410	TBUS NOAA-9
1415	TBUS NOAA-10
1420	TBUS NOAA-11
1425	TBUS NOAA-12
1430	W505 48 HR 250MB HT/TMP/ WND
1435	GOES-8 1345Z NH IR
1440	GOES-8 1345Z NH VS
1445	W506 72 HR SLP/1000-500TK
1450	W507 72 HR 500MB HT/TMP/ WND
1455	W508 72 HR 250MB HT/TMP/ WND
1500	W066 SIG WX PROG FL250-600
1505	SIG WX PROG FL250-600
1510	MET-5 1500Z D1 IR
1514	GOES-9 1200Z FD WV
1518	MET-5 1500Z D4 IR
1522	MET-5 1500Z D5 IR
1526	MET-5 1500Z D6 IR
1530	MET-5 1530Z D2 IR
1534	MET-5 1530Z C02 VS
1538	GOES-8 1445Z NH IR
1542	GOES-8 1445Z NE IR
1546	GOES-8 1445Z SE IR
1550	GOES-8 1445Z NW IR
1554	GOES-8 1445Z SW IR
1558	GOES-8 1445Z 4KM US IR
1602	GOES-8 1445Z 16KM FD IR
1606	GOES-8 1445Z NH VS
1610	GOES-8 1445Z NE VS
1614	GOES-8 1445Z SE VS
1618	GOES-8 1445Z NW VS
1622	GOES-8 1445Z SW VS
1626	GOES-8 1545Z NH IR
1630	GOES-8 1545Z NH VS
1638	GOES-9 1500Z NH IR
1642	GOES-9 1500Z FD IR
1706	NOAA-14 POLAR VIS MER 130E-060E W010
1710	NOAA-14 POLAR NIR MER 040W-110W W011
1714	NOAA-14 POLAR DIR MER 130E-060E W012
1718	NOAA-14 POLAR VIS NH 100E-010E W013
1722	NOAA-14 POLAR VIS SH 100E-010E W014
1726	NOAA-14 POLAR NIR NH 080W-170W W015
1730	NOAA-14 POLAR NIR SH 080W-170W W016
1734	NOAA-14 POLAR VIS MER 070E-000E W017
1738	NOAA-14 POLAR NIR MER 100W-170W W018
1742	GOES-8 1645Z NH IR
1746	GOES-8 1645Z NH VS
1758	MET-5 1800Z D2 IR
1802	MET-5 1800Z D1 IR
1806	MET-5 1800Z D3 IR
1810	MET-5 1800Z D4 IR
1814	MET-5 1800Z D5 IR
1818	MET-5 1800Z D6 IR
1822	MET-5 1800Z D7 IR
1826	MET-5 1800Z D8 IR
1830	MET-5 1830Z D2 IR
1834	MET-5 1830Z D9 IR
1838	GOES-8 1745Z NH IR
1842	GOES-8 1745Z NE IR
1846	GOES-8 1745Z SE IR
1850	GOES-8 1745Z NW IR
1854	GOES-8 1745Z SW IR
1858	GOES-8 1745Z 4KM US IR
1902	GOES-8 1745Z 16KM FD IR
1906	GOES-8 1745Z NH VS
1910	GOES-8 1745Z NE VS
1914	GOES-8 1745Z SE VS
1918	GOES-8 1745Z NW VS
1922	GOES-8 1745Z SW VS
1926	GOES-8 1845Z NH IR
1930	GOES-8 1845Z NH VS
1934	GOES-8 1745Z FD WV
1938	GOES-9 1800Z NH IR
1942	GOES-9 1800Z FD IR
1950	GOES-9 1800Z FD WV
1954	NOAA-14 POLAR DIR NH P 100E-010E W019
1958	NOAA-14 POLAR DIR SH P 100E-010E W020
2005	W047 24 HR SFC/1000/500THK
2010	W048 24 HR 500MB HT/WD/TMP
2015	W049 24 HR 250MB HT/WD/TMP
2020	W054 250 HT ISOTACHS
2025	W055 250 HT ISOTACHS
2030	W056 24HR TROP PRES/VWS
2035	W057 24HR TROP PRES/VWS
2040	W058 24HR 300 STM/ISOTACHS

2045	W059 24HR 300 STM/ISOTACHS
2050	W060 24HR 200 STM/ISOTACHS
2055	W061 24HR 200 STM/ISOTACHS
2100	W062 24HR 500 STM/ISOTACHS
2105	W063 24HR 500 STM/ISOTACHS
2110	GOES-8 1945Z NH IR
2114	GOES-8 1945Z NH VS
2118	NOAA-14 POLAR DIR MER 070E-000E W021
2122	MET-5 2100Z D7 IR
2126	MET-5 2100Z D8 IR
2130	MET-5 2130Z D2 IR
2135	W050 24HR 850 HT ISOTACHS
2140	W051 24HR 850 HT ISOTACHS
2145	W052 24HR 700 HT ISOTACHS
2150	W053 24HR 700 HT ISOTACHS
2155	W150 00Z MSL PRES/1000-500TK
2200	W151 00Z MSL PRES/1000-500TK
2205	W152 24HR MSL PRES/1000-500TK
2210	W153 24HR MSL PRES/1000-500TK
2215	W154 48HR MSL PRES/1000-500TK
2220	W155 48HR MSL PRES/1000-500TK
2225	W156 24HR PRECIP ACCUM VT 12Z
2230	GOES-8 2045Z NH IR
2234	GOES-8 2045Z NE IR
2238	GOES-8 2045Z SE IR
2242	GOES-8 2045Z NW IR
2246	GOES-8 2045Z SW IR
2250	GOES-8 2045Z 4KM US IR
2254	GOES-8 2045Z 16KM FD IR
2258	GOES-8 2045Z NH VS
2302	GOES-8 2045Z NE VS
2306	GOES-8 2045Z SE VS
2310	GOES-8 2045Z NW VS
2314	GOES-8 2045Z SW VS
2320	W509 48 HR SLP/1000-500TK
2325	W510 48 HR 500MB HT/TMP/WND
2330	NOAA-14 POLAR VIS NH 010E-080W W022
2334	NOAA-14 POLAR VIS SH 010E-080W W023
2338	NOAA-14 POLAR NIR NH 170W-100E W024
2342	NOAA-14 POLAR NIR SH 170W-100E W025
2346	GOES-8 2145Z NH IR
2350	GOES-8 2145Z NH VS
2354	GOES-8 2245Z NH IR

GOES 9 West WEFAX Schedule
Valid as of May 28, 1996

TIME (UTC)	WEFAX PRODUCT
0000	H 0000Z IR NW PS GMS
0005	I 0000Z VS NW PS GMS
0010	A 0000Z IR NW GMS
0015	B 0000Z IR NE GMS
0020	C 0000Z IR SW GMS
0025	D 0000Z IR SE GMS
0030	GOES-9 2300Z NH IR
0035	GOES-9 2300Z NH VS
0040	W484 PG-WDS & TEMP FL50
0045	W486 48HR 1000 STM/ISOTACHS
0050	W487 48HR 1000 STM/ISOTACHS
0055	W482 SIG WX PROG 400-70MB
0100	W483 SIG WX PROG 400-70MB
0105	W273 PG-WDS & TEMP FL100
0110	W473 PG-WDS & TEMP FL50
0118	GOES-9 0000Z NH IR
0122	GOES-9 0000Z NW IR
0126	GOES-9 0000Z SW IR
0130	GOES-9 0000Z NE IR
0134	GOES-9 0000Z SE IR
0138	GOES-9 0000Z FD IR
0142	GOES-9 0000Z NH VIS
0146	GOES-9 0000Z US IR
0150	GOES-9 0000Z NH WV
0154	GOES-9 0000Z NW WV
0158	GOES-9 0000Z SW WV
0202	GOES-9 0100Z NH IR
0206	GOES-9 0000Z NE WV
0210	GOES-9 0000Z SE WV
0214	GOES-9 0000Z FD WV
0218	GOES-8 2345Z NH IR
0222	GOES-8 2345Z FD IR
0226	GOES-8 2345Z FD WV
0230	POLAR DIR NH 010E-080W W028
0240	ICE CHART
0245	ICE CHART
0250	ICE CHART
0255	ICE CHART
0300	H 0300Z IR NW PS GMS
0305	I 0300Z VS NW PS GMS
0310	A 0300Z IR NW GMS
0315	B 0300Z IR NE GMS
0320	C 0300Z IR SW GMS
0325	D 0300Z IR SE GMS
0330	GOES-9 0200Z NH IR
0334	POLAR DIR SH 010E-080W W029
0338	POLAR DIR MER 010E-060W W030
0342	POLAR VIS MER 040W-110W W031
0346	POLAR NIR MER 140E-070E W032
0350	POLAR DIR MER 040W-110E W033
0354	GOES-8 0245Z NH IR
0358	GOES-8 0245Z FD IR
0402	GOES-9 0300Z NH IR
0406	GOES-9 0300Z NW IR
0410	GOES-9 0300Z SW IR
0414	GOES-9 0300Z NE IR
0418	GOES-9 0300Z SE IR
0422	GOES-9 0300Z FD IR
0426	GOES-9 0300Z US IR
0430	D2 0430Z IR METEOSAT
0434	D1 0430Z IR METEOSAT
0438	D3 0430Z IR METEOSAT
0442	E6 0430Z MOIST METEOSAT
0446	E7 0430Z MOIST METEOSAT
0450	E8 0430Z MOIST METEOSAT
0454	E9 0430Z MOIST METEOSAT
0458	GOES-9 0400Z NH IR
0502	POLAR VIS NH 080W-170W W034
0506	POLAR VIS SH 080W-170W W035
0522	POLAR NIR NH 080E-010E W036
0526	POLAR NIR SH 080E-010E W037
0530	POLAR VIS MER 100W-170W W038
0534	POLAR NIR MER 080E-010E W039
0538	POLAR DIR NH 080W-170W W040
0542	POLAR DIR SH 080W-170W W041
0554	GOES-9 0500Z NH IR
0600	H 0600Z IR NW PS GMS
0605	I 0600Z VS NW PS GMS
0610	A 0600Z IR NW GMS
0615	B 0600Z IR NE GMS
0620	C 0600Z IR SW GMS
0625	D 0600Z IR SE GMS
0630	D2 0630Z IR METEOSAT
0634	C02 0630Z VS METEOSAT
0638	C03 0630Z VS METEOSAT
0642	C3D 0630Z VS METEOSAT
0646	GOES-8 0545Z NH IR
0650	GOES-8 0545Z FD IR
0654	GOES-8 0545Z FD WV
0702	GOES-9 0600Z NH IR
0706	GOES-9 0600Z NW IR
0710	GOES-9 0600Z SW IR
0715	W301 ANAL 1000 STM/WDS
0720	W302 ANAL 1000 STM/WDS
0725	W303 ANAL 1000 STM/WDS
0730	W304 ANAL 1000 STM/WDS
0735	W305 ANAL 1000 STM/WDS
0740	W306 ANAL 1000 STM/WDS
0745	W307 ANAL 1000 STM/WDS
0750	W308 ANAL 1000 STM/WDS
0755	W309 PG-WDS & TEMP FL340
0800	GOES-9 0700Z NH IR
0805	W311 PG-WDS & TEMP FL240
0810	W210 PG-WDS & TEMP FL240
0818	GOES-9 0600Z NE IR
0822	GOES-9 0600Z SE IR
0826	GOES-9 0600Z FD IR
0830	GOES-9 0600Z US IR
0834	GOES-9 0600Z FD WV
0850	POLAR DIR MER 100W-170W W042
0854	GOES-9 0800Z NH IR
0900	H 0900Z IR NW PS GMS
0905	I 0900Z VS NW PS GMS
0910	A 0900Z IR NW GMS
0915	B 0900Z IR NE GMS
0920	C 0900Z IR SW GMS
0925	D 0900Z IR SE GMS
0930	POLAR DIR NORTH POLE W043
0934	POLAR DIR SOUTH POLE W044
0950	GOES-8 0845Z NH IR
0954	GOES-8 0845Z FD IR
0958	GOES-9 0900Z NH IR
1002	GOES-9 0900Z NW IR
1006	GOES-9 0900Z SW IR
1010	GOES-9 0900Z NE IR
1014	GOES-9 0900Z SE IR
1018	GOES-9 0900Z FD IR
1022	GOES-9 0900Z US IR
1030	W214 PG-WDS & TEMP FL100
1035	W215 PG-WDS & TEMP FL50
1040	W216 PG-WDS & TEMP FL50
1045	W217 PG-WDS & TEMP FL340
1050	W218 PG WDS & TEMP FL340
1055	W219 PG WDS & TEMP FL340
1100	GOES-9 1000Z NH IR
1105	W420 PG WDS & TEMP FL240
1110	W221 PG WDS & TEMP FL240
1115	W421 PG WDS & TEMP FL180
1120	W222 PG WDS & TEMP FL180
1125	W422 PG WDS & TEMP FL100
1130	W223 PG WDS & TEMP FL100
1135	W423 PG WDS & TEMP FL50
1140	W430 24HR 1000 STM/ISOTACHS
1145	W431 24HR 1000 STM/ISOTACHS
1150	W432 PG-WDS & TEMP FL50
1155	W440 SIG WX 400-70MB
1200	GOES-9 1100Z NH IR
1205	J 1200Z IR NW PS GMS
1210	A 1200Z IR NW GMS
1215	B 1200Z IR NE GMS
1220	C 1200Z IR SW GMS
1225	D 1200Z IR SE GMS
1230	POLAR VIS NH 170W-100E W001
1234	POLAR VIS SH 170W-100E W002
1238	POLAR NIR NH 010E-080W W003
1242	POLAR NIR SH 010E-080W W004
1246	POLAR VIS MER 170W-120E W005
1250	GOES-8 1145Z NH IR
1254	GOES-8 1145Z FD IR
1258	GOES-8 1145Z FD WV
1302	GOES-9 1200Z NH IR
1306	GOES-9 1200Z NW IR
1310	GOES-9 1200Z SW IR
1314	GOES-9 1200Z NE IR
1322	GOES-9 1200Z SE IR
1326	GOES-9 1200Z FD IR
1330	GOES-9 1200Z US IR
1334	GOES-9 1200Z NH WV
1338	GOES-9 1200Z NW WV
1342	GOES-9 1200Z SW WV
1346	GOES-9 1200Z NE WV
1350	GOES-9 1200Z SE WV
1354	GOES-9 1200Z FD WV
1358	POLAR NIR MER 020E-050W W006
1402	GOES-9 1300Z NH IR
1410	TBUS NOAA-9
1415	TBUS NOAA-10
1420	TBUS NOAA-11
1425	TBUS NOAA-12
1430	SCHEDULE FILE PART-1
1434	SCHEDULE FILE PART-2
1438	WEFAX MESSAGE FILE
1442	POLAR DIR NH 170W-100E W007
1446	POLAR DIR SH 170W-100E W008
1450	POLAR DIR MER 170W-120E W009
1454	GOES-9 1400Z NH IR
1500	H 1500Z IR NW PS GMS
1505	J 1500Z VS NW PS GMS
1510	A 1500Z NW IR GMS
1515	B 1500Z NE IR GMS
1520	C 1500Z SW IR GMS
1525	D 1500Z SE IR GMS
1530	POLAR VIS MER 130E-060E W010
1534	POLAR NIR MER 040W-110W W011
1538	POLAR DIR MER 130E-060E W012
1550	GOES-8 1445Z NH IR
1554	GOES-8 1445Z FD IR
1602	GOES-9 1500Z NH IR
1606	GOES-9 1500Z NW IR
1610	GOES-9 1500Z SW IR
1614	GOES-9 1500Z NE IR
1618	GOES-9 1500Z SE IR
1622	GOES-9 1500Z FD IR
1626	GOES-9 1500Z US IR
1634	GOES-9 1500Z NH VS
1646	GOES-9 1500Z NE VS
1650	GOES-9 1500Z SE VS
1702	GOES-9 1600Z NH IR
1706	GOES-9 1600Z NH VS
1715	W263 SIG WX 400-70MB
1720	W463 SIG WX 400-70MB
1730	W350 ANAL 1000 STM/WDS
1735	W351 ANAL 1000 STM/WDS
1740	W352 ANAL 1000 STM/WDS
1745	W353 ANAL 1000 STM/WDS
1750	W354 ANAL 1000 STM/WDS
1755	W355 ANAL 1000 STM/WDS
1800	H 1800Z IR NW PS GMS
1805	J 1800Z VS NW PS GMS
1810	A 1800Z IR GMS
1815	B 1800Z IR GMS
1820	C 1800Z IR GMS
1825	D 1800Z IR GMS
1830	GOES-9 1700Z NH IR
1835	GOES-9 1700Z NH VS
1840	W358 ANAL 1000 STM/WDS
1845	W359 PG WDS & TEMP FL340
1850	W360 PG WDS & TEMP FL340
1855	W361 PG WDS & TEMP FL340
1902	GOES-9 1800Z NH IR
1906	GOES-9 1800Z NW IR
1910	GOES-9 1800Z SW IR
1914	GOES-9 1800Z NE IR
1918	GOES-9 1800Z SE IR
1922	GOES-9 1800Z FD IR
1926	GOES-9 1800Z US IR
1930	GOES-9 1800Z NH VS
1934	GOES-9 1800Z NW VS
1938	GOES-9 1800Z SW VS
1942	GOES-9 1800Z NE VS
1946	GOES-9 1800Z SE VS
1950	GOES-8 1745Z NH IR
1954	GOES-8 1745Z FD IR
1958	GOES-8 1745Z FD WV
2002	GOES-9 1800Z FD WV
2006	GOES-9 1900Z NH IR
2010	GOES-9 1900Z NH VS
2014	POLAR VIS NH 100E-010E W013
2018	POLAR VIS SH 100E-010E W014
2022	POLAR NIR NH 080W-170W W015
2026	POLAR NIR SH 080W-170W W016
2030	POLAR VIS MER 070E-000E W017
2034	POLAR NIR MER 100W-170W W018
2038	POLAR DIR NH 100E-010E W019
2042	POLAR DIR SH 100E-010E W020
2046	POLAR DIR MER 070E-000E W021
2050	POLAR VIS NH 010E-080W W022
2054	POLAR VIS SH 010E-080W W023
2058	POLAR NIR NH 170W-100E W024
2100	H 2100Z IR NW PS GMS
2105	I 2100Z VS NW PS GMS
2110	A 2100Z IR NW GMS
2115	B 2100Z IR NE GMS
2120	C 2100Z IR SW GMS
2125	D 2100Z IR SE GMS
2130	GOES-9 2000Z NH IR
2134	GOES-9 2000Z NH VS
2150	POLAR NIR SH 170W-100E W025
2154	GOES-8 2045Z NH IR
2158	GOES-8 2045Z FD IR
2205	W268 PG-WDS & TEMP FL340
2210	W269 PG-WDS & TEMP FL340
2215	W270 PG WDS & TEMP FL240
2220	W470 PG WDS & TEMP FL240
2225	W271 PG WDS & TEMP FL240
2230	W471 PG WDS & TEMP FL180
2235	W272 PG WDS & TEMP FL180
2240	W474 PG WDS & TEMP FL100
2246	GOES-9 2100Z NH IR
2250	GOES-9 2100Z NW IR
2254	GOES-9 2100Z SW IR
2258	GOES-9 2100Z NE IR
2302	GOES-9 2200Z NH IR
2306	GOES-9 2100Z SE IR
2310	GOES-9 2100Z FD IR
2314	GOES-9 2100Z US IR
2318	GOES-9 2100Z NH VS
2322	GOES-9 2100Z NW VS
2326	GOES-9 2100Z SW VS
2330	GOES-9 2100Z NE VS
2334	GOES-9 2100Z SE VS
2338	GOES-9 2200Z NH VS
2354	POLAR DIR NH 010E-080W W026
2358	POLAR DIR SH 010E-080W W027

SATELLITE PROFILE

By Philip Chien, Earth News

Mir-ely Russia's Best Space Effort

It's been in space for over a decade, well beyond its planned five year lifetime. It's the largest object in orbit and has been the home to scores of cosmonauts, visitors from other countries, and even a couple of NASA astronauts. It's Mir — the pride of the Russian Space Agency.

Many western space observers don't feel the same way about Mir, calling it a piece of space junk, held together with bubble gum and rubber bands. Frank Culbertson, the U.S. head of the joint shuttle-Mir activities commented, "Mir is a lot like owning an old car. It may not have all of the bells and whistles of a new car, but it's reliable, and each morning when it starts up you're glad that you have it." The analogy with an old car is pretty good. Mir's core module has been in space for over ten years, traveling around the Earth 58,500 times — a distance of 2.35 billion kilometers., or one and a half times the distance from Earth to Saturn.

The word 'Mir' is usually translated in to English as 'peace,' but also means 'world' or 'an autonomous community,' A popular Russian greeting is 'Mir o Mir' — Peace on Earth.

Mir is the successor to the Soviet Salyut space stations. From 1971 to 1985, the USSR operated eight Salyut-class space stations. The early Salyuts had many problems, including the death of the three Soyuz 11 cosmonauts. But later Salyuts, including the Salyut 3 and 5 military manned-Almaz series, were extremely successful.

The early Salyut 1 through 5 stations were temporary structures, filled with most of their supplies at launch. The manned Soyuz spacecraft could only carry two or three cosmonauts and a very small amount of fresh supplies, similar to the U.S. Skylab program. Salyut 6 introduced the second generation station with two docking ports. Cosmonauts could be swapped out, keeping the station crewed for longer periods. In addition automated Progress cargo craft could bring up to 2,500 kg of supplies, keeping the station in operation almost indefinitely.

Even before Salyut 7 completed its useful lifetime plans were underway to launch Mir, a third-generation Soviet space station. When Mir's core module was launched on February 20, 1986, the plan was to gradually increase its capabilities with specialized expansion modules over its planned five year lifetime. Eventually a Mir-2 station would be built, building upon the experience gained from the original Mir station. The fall of the Soviet Union, Russia's economy, and Mir's components lasting much longer than originally anticipated changed that plan.

The first Mir crew consisted of Leonid Kizim and Vladimir Solovyov. They docked their Soyuz T-15 spacecraft with Mir on March 21, 1986. After a 52 day stay they left Mir temporarily. They became the first crew in history to visit two separate space stations, traveling 2500 km to Salyut 7. They spent 51 days aboard Salyut 7, salvaging anything which was still usable — including an acoustic guitar. These items were loaded aboard their Soyuz for the trip back to Mir. On June 25, Soyuz T-15 undocked from Salyut 7 and began the 29 hour trip back to Mir. The crew spent an additional 21 days aboard Mir before returning to Earth.

At first glance the Mir core module isn't that much different from Salyut 7. The key difference is a multi-axis docking module which can accommodate up to five spacecraft. In addition, Mir has an aft docking port, like Salyut 7.

The Kvant 1 module had originally been intended for Salyut 7, but got delayed beyond the station's useful lifetime. It was launched on March 31, 1987. Kvant didn't have any onboard propulsion system so the Functional Service Module was used to rendezvous and dock Kvant to Mir's aft port.

Kvant added attitude (pointing) control to Mir. Mir can point itself by firing thrusters, burning fuel which has to be brought up from the ground. Kvant has six rapidly spinning gyrodynes. By applying electricity the gyros can be spun faster or slower to point the spacecraft different directions. The gyros use a lot of electricity, but power is easily generated in space by solar panels.

Kvant's scientific payload is the Roentgen X-ray telescope. It was developed by high energy astronomers from the Soviet Union, Netherlands, the U.K., Germany, and the European Space Agency and launched just in time. A month before

Kvant's launch a Supernova exploded in the nearby Large Magellanic Cloud, the closest Supernova in over 400 years. Kvant's instruments made the first X-ray observations of the Supernova.

Mir received its first ham radio equipment in 1988 via a Progress resupply ship, five years after the shuttle first tested ham radio aboard a crewed spacecraft. Vladimir Titov had the honor of the first cosmonaut amateur license — U1MIR and his flight engineer Musa Manarov received U2MIR.

Unlike the short-term shuttle missions where astronauts try to make as many contacts with as many people as possible, the cosmonauts aboard Mir are more interested in taking the time to talk to people and get to know them. An astronaut aboard the shuttle is only away from family, friends, and outside human contact for a couple of weeks. A Mir crew can be isolated for several months — or even a year. Quite often the cosmonauts find out about world events and the status of upcoming launches via ham radio before they find out through normal channels. Unfortunately the cosmonauts also hear many rumors, often from realistic sounding sources. When there were rumors that cash-poor Russia was going to sell Mir to either Japan or the United States, the cosmonauts were worried about whether or not they were going to lose their jobs!

Until 1989, Mir operations were similar to Salyut 7. Salyut 7 also had crew swapouts for continuous presence and expansion modules docked to its aft port. But Mir's plan called for additional large expansion modules, starting with the Kvant 2.

Kvant 2 was delayed and the Russians decided it was more prudent to mothball Mir than waste a crew which was specifically trained to activate the new Kvant 2 module. On April 26, 1989, the three person Mir 4 long duration crew left the station operating in an automatic mode until Kvant 2 was ready for launch.

September 5, 1989 marked an important milestone in the Soviet space program, and an important date in history. The two person crew of Alexandr Viktorenko and Alexandr Serebrov were launched on Soyuz TM-8, to begin the fifth long duration mission aboard Mir. It also marked the start of continuous human presence in space. Since that date there have always been at least two cosmonauts in space, a goal the United States didn't achieve until STS 76 delivered American astronaut Shannon Lucid to Mir. While there is always the possibility than an emergency could cause Mir to be abandoned, the Russian Space Agency and NASA intend to keep humans in space continuously for the foreseeable future.

Kvant 2 was launched on November 26, 1989. It featured an expanded airlock, and a 'flying armchair', the Soviet version of the Manned Maneuvering Unit. Kvant 2 also included a shower, and an electrolysis system which generates breathing oxygen from the crew's waste water and urine.

The Krystall module was launched on May 31, 1990. Krystall features the APAS-89 docking port which was intended for use with the Soviet shuttle. Krystall's other capabilities included materials processing furnaces, an Earth resources camera, a hothouse for growing plants, and additional astrophysics telescopes.

The only Soyuz spacecraft to dock with Krystall was TM-16, crewed by Gennadiy Manakov and Alexandr Poleshchuk. NASA insisted that the Russians prove that the port actually worked before its first use by a space shuttle. The normal Soyuz docking probe was replaced by APAS and TM-16 docked with Krystall in January 1993.

In August 1991 cosmonauts Anatoly Artsebarsky and Sergei Krikalev had the unenviable situation of hearing about a coup which threatened to crush Boris Yeltsin's government from space. Flight controllers sent up reports from the Soviet Central TV (pro-coup) and Russian Radio (anti-coup). A couple of months later the Soviet Union separated into its independent republics. Sergei later commented "There wasn't anything we could do about it, so we just concentrated on our work."

With the changing world situation President Bush and Yeltsin signed a space agreement in June 1992, calling for the exchange of astronauts and cosmonauts. One U.S. astronaut would fly a long duration Mir mission and two Russian cosmonauts would fly shorter duration shuttle missions. Astronauts Norm Thagard and Bonnie Dunbar went to Russia to train with the Russian Space Agency and cosmonauts Vladimir Titov and Sergei Krikalev came to the United States to train with NASA.

In June 1993, the agreement was expanded. The U.S. agreed to pay Russia $400 million for U.S. astronauts to spend a total of two years aboard Mir. The $400 million can be thought of as rent for two years, or as a form of foreign aid. The price is certainly a bargain — it gives NASA a test bed for experiments leading up to space station.

By 1992, Mir's systems had become complicated enough, and old enough to require continuous monitoring. Russian officials have acknowledged that if Mir was abandoned for any long period it would lose control and could not be recovered.

Solar panels gradually lose efficiency over time. At first, it isn't a problem, but by 1994, Mir found itself in a severe energy crisis. The solar arrays were not generating enough power for all of Mir's systems and experiments, and the batteries weren't holding enough of a charge for the darkness cycles in each orbit. So all non-essential equipment had to be shut off. Cosmonauts were limited to experiments which didn't require a high power load, and the materials processing furnaces were shut off. What most people don't realize is space travelers rarely know exactly where they are over the Earth, they use laptop computers with the same satellite tracking programs used by amateur satellite users and satellite observers. During Mir's power crisis even those computers had to be shut off to conserve power.

The last two expansion modules, Spektr and Priroda, were both delayed due to the Russian economy. Spektr arrived on May 31, 1995, over a year behind schedule. Originally, Priroda was supposed to be in place by December 1994, which got delayed to December 1995, and slipped again to April 1996.

When Spektr finally entered operation, its solar panels provided badly needed power, bringing the Mir complex up to its nominal power level.

The Docking Module was the only Mir component to be delivered by the shuttle. It serves as a standoff to permit the shuttle to dock with Mir's Krystall module without reconfiguring Mir each time. The four meter long structure keeps the shuttle an adequate distance from Mir's solar arrays.

Since it was launched within the shuttle's cargo bay it didn't need any propulsion system, rendezvous radar or avionics, power, or many other spacecraft subsystems. The Docking Module includes two hard points for externally mounted payloads. It was used to carry two solar arrays, one with Russian solar cells, the other with U.S. solar cells. By the time you read this article, the Mir 21 crew should have transferred the joint U.S/Russian array from the Docking Module to Kvant 1. The Russian array will be kept for future use when it's needed.

Priroda was launched on Apr 23, 1996, and arrived on Mir on April 26th, finishing the planned assembly of the Mir complex.

With the combined Mir core module, Kvant 1, Kvant 2, Krystall, Spektr, and Priroda modules the Mir complex's usable crew volume is 396 cubic meters. (14,000 cubic feet), finally exceeding Skylab's 354 cubic meters (12,500 cubic feet).

The Shuttle-Mir flights have added significant capabilities to Mir. Most importantly the shuttle can bring back large amounts of cargo. The small Soyuz spacecraft can only hold three cosmonauts, plus a very small amount of experiments — about the size of a large book. The shuttle can also fly a freezer for returning medical samples.

On the STS 74 mission there was no requirement to carry any refrigerated samples up to Mir, so the shuttle crew decided to carry a special surprise. Commander Ken Cameron convinced shuttle managers that it would make more sense to operate the freezer with a full load to help keep the temperature stable, and it was filled with 4 kg (9 lbs) of ice cream (minus the samples the NASA crew used for 'quality control').

The shuttle's high cargo capacity also means failed components can be returned from Mir. Until the STS 71 mission there was no way to bring back Mir's failed components for analysis. So Russian spacecraft designers had little data to tell them how well their equipment worked or didn't work. The shuttle has brought back failed batteries, gyrodynes, and other components, and even unneeded components for reuse on future spacecraft. For example, Spektr's TORU avionics and docking equipment were brought back to Earth by STS 71, recycled and reused for the Priroda module.

The Shuttle-Mir missions have a lot of symbolic value and each flight include several carefully orchestrated public affairs ceremonies. According to NASA Public Affairs, "The astronauts and cosmonauts are expected to share their personal views of this unique experience." Many symbolic gifts which the astronauts give to their Russian colleagues actually make two-way trips on the shuttle. They're given to the cosmonauts aboard Mir and then handed back to the astronauts (off camera) for return via the shuttle and safe keeping until the cosmonauts finish their missions. One exception was a United Nations flag which was launched aboard Soyuz and returned by the STS 74 mission. The flights overlapped the 50th anniversary of the founding of the U.N. and the two crews had a reunion on April 22nd, 1996, to present the flag to U.N. Secretary General Boutros Boutros-Ghali.

Much more important than the official gifts is personal items which have been taken to Mir. The STS 74 mission carried many personal supplies for Shannon Lucid, including several books chosen by her children for her to read during her five month stay in space. The crew also brought shampoo, note paper, and other little items to the Mir 20 crew, including personal letters from their families. During their four days together the cosmonauts took time out to read those letters and compose replies. STS 74 commander Ken Cameron commented that those personal letters were — to him — the most important things he returned from Mir.

Each of the five shuttle missions to Mir has encountered a slightly different configuration:

STS 63	Mir module with Kvant, Kvant 2, and Krystall (Note — STS 63 made a close rendezvous and approach, but did not dock with Mir)
STS 71	Spektr in place, Krystall on the long axis (temporary location)
STS 74	Krystall on the side location
STS 76	Docking Module in place
STS 79	Priroda in place

The remaining shuttle missions to Mir will encounter the same configuration as the STS 79 mission, with the only difference being whether or not a second Soyuz or Progress is also docked to Mir.

In the glory-days of the Soviet Union, cosmonauts aboard Mir were able to communicate with ground controllers through dozens of tracking stations, ships, and aircraft around the world. With the fall of the Soviet Union, the international stations were decommissioned, leaving Mir with only a handful of Russian tracking sites. There are many times where very little communications can take place because Mir's passes over the ground stations take place while the crew's asleep. Russia does have two geosynchronous Altair relay satellites, but they're rarely used due to the cost and requirements to point Mir's antenna at the satellites.

Valeri Ryumin, the chief Russian for the joint Shuttle-Mir activities, willingly acknowledges that while the U.S. might have an occasional budget impasse, Russia was dealing with constant economic problems. "For you it's an occasional thing. For us it's something we have to worry about every day."

Recently NASA has agreed to use U.S. tracking stations to supplement the Russian tracking network and tests have been performed with Mir communicating directly through NASA's ground stations. When the shuttle is docked to Mir the shuttle's VHF radio is often used to give Mir almost constant communications with its control center — via the shuttle's tracking and communications network.

Last year, Russia approached NASA with an unusual problem. It turned out that Mir's anticipated lifetime was longer than anybody expected since components were outliving their planned lifetimes. Russia wanted to use Mir as long as possible, and could not afford to operate both Mir and its pledged portion of the international space station. Russia offered a couple of proposals, including building the international space station around Mir's existing components or reusing Mir's more recent modules on the international space station. Building the space station around Mir was not politically acceptable to the U.S., even if the technical problems could be solved, since it would be perceived that the space station was originally a Russian-only effort.

NASA produced a counter-offer where three additional shuttle flights would go to Mir with an additional 6000 kg of supplies, offsetting the cost of the Progress resupply ships. In addition, NASA agreed to launch most of the Russian Solar Power Platform, reducing the requirement for Russia to purchase Ukrainian-built Zenit launchers. Since the Solar Power Platform components will ride in the shuttle's cargo bay, they won't need any propulsion system, avionics, or other hardware for the rendezvous and docking with space station. At first, Russia wanted NASA to pay for additional time aboard Mir. But NASA made it quite clear that since these additional flights were to help Russia meet its goals, there would be no payment for any additional astronaut stays aboard Mir.

By the year 2000, Russia plans to shut down Mir and concentrate on the international space station. By this time, the Mir core module will have spent over 14 years in space and have traveled 3.28 billion kilometers. Ground controllers will instruct the larger expansion modules (Spektr, Priroda, Krystall, and Kvant 2) to separate from the core module, and each separate spacecraft will be commanded to fire its thrusters one last time — on a destructive reentry over an unpopulated area, ending the first reusable, long term space station. ST

Mir Myths and Trivia

There are many rumors, tall tales, and rather outlandish lies about Mir. Many events on Mir have gotten so distorted that it's hard to recall the original reasons for the myth.

Certainly the biggest myth about Mir is that cosmonaut Sergei Krikalev got 'stranded' aboard the space station. According to many news media he had no way of returning to Earth, was alone in space, was running out of food and water, etc. The May/June 1996 issue of *Satellite Times* (*Changes and Challenges*, page 19) has a more accurate description of the events.

When STS 74 docked with Mir in November 1995, many people called it the first time people from four countries were in space at the same time. Well, it was actually the first time people representing four countries were aboard the same spacecraft simultaneously.

On the U.S. side Atlantis's crew included U.S. astronauts Ken Cameron, Jim Halsell, Jerry Ross, and Bill McArthur, and Canadian astronaut Chris Hadfield. On the Russian side were Russian cosmonauts Yuri Gidzenko and Sergei Avdeev, and Thomas Reiter, a German representing the European Space Agency. However, the STS 51G shuttle mission in July 1985 had space travelers who were born in four countries. On that mission American-born astronauts Dan Brandenstein, J.O. Creighton, Steve Nagel, and John Fabian were joined by American astronaut Shannon Lucid (who was born in Shanghai, China), and foreign passengers Patrick Baudry and Salaman Al Saud, representing France and Saudi Arabia. It's also interesting to note that the STS 46 mission featured Americans Loren Shriver, Andy Allen, Marsha Ivins, Jeff Hoffman, and Costa Rican-born Franklin Chang-Diaz, the European Space Agency's Swiss astronaut Claude Nicollier, and Italy's Franco Malebra. STS 46 overlapped the Mir 11/12 mission with Soviet cosmonauts Alexandr Viktorenko, Alexandr Kaleri, Anatoly Soloviev, and Sergei Avdeev, plus French researcher Michel Tognini for a total of six different countries who had given birth to space travelers.

Many NASA documents claimed that Shannon Lucid was the first American woman aboard Mir, which should come as a great surprise to astronauts Bonnie Dunbar and Ellen Baker. They visited Mir during the STS 71 mission. Lucid is actually the first American woman to have a long duration stay on board Mir.

When Atlantis docks with Mir on the STS 79 mission this month (August, 1996), the combined spacecraft will have a total mass of 218,490 kg (481,681 lbs). Spacecraft launched on ten separate rockets will be connected to each other.

Module	Launch Date	Docking Date	Catalog Number	International Designator
Mir Core Module	Feb 20, 1986	N/A	16609	1986-017A
Kvant 1 (Quantum)	Mar 31, 1987	Apr 12, 1987	17845	1987-30A
Kvant 2 (Quantum)	Nov 26, 1989	Dec 6, 1989	20335	1989- 93A
Krystall (Crystal)	May 31, 1990	Jun 10, 1990	20635	1990-48A
Spektr (Spectrum)	May 20, 1995	May 31, 1995	23579	1995- 24A
Docking Module	Nov 12, 1995	Nov 15, 1995	N/A	1995-61B
Soyuz TM-23	Feb 21, 1996	Feb 23, 1996	23798	1996-11A
Priroda (Nature)	Apr 23, 1996	Apr 26, 1996	23848	1996-23A
Progress M-33	Jul 27, 1996	Jul 30, 1996	TBD	TBD
Atlantis STS 79	Jul 31, 1996	Aug 2, 1996	TBD	TBD

Note: The Kvant 1 module was delivered to Mir via a tug. The Docking Module was delivered via the shuttle on the STS 74 mission. While they've been given international IDs they never flew as independent spacecraft. All of Mir's components were launched on Proton (SL-13) rockets with the exception of the Docking Module, Soyuz, and Progress. Progress M-33 and Atlantis's launch dates are subject to change.

Mir Trivia

Vladimir Titov got to see Mir from the inside (Mir 3), and from the outside (STS 63)

Anatoly Soloviev was aboard Mir when Krystall arrived, and went through Krystall's APAS hatch to enter Mir from Atlantis.

Nikolai Budarin is the only Russian cosmonaut to never experience a Soyuz launch. Vladimir Dezhurov is the only one to never land aboard a Soyuz.

Valery Polyakov, MD, is the ultimate long duration space record holder, with an eight month stay plus an additional 14 month stay for a total of 22 months aboard Mir.

Besides Soviet and Russian cosmonauts Mir has been visited by space travelers representing eleven countries and international organizations - Bulgaria, Afghanistan, France (3), Japan, Great Britain, Austria, Kazakhstan (2), Germany, ESA (2 - Germany), US (2 long term + 14 on the STS 71, 74, and 76 missions), Canada (via shuttle on STS 74). ST

World Radio Network Schedules

WRN1 - European English Service
Astra 1B (19 degrees east) Transponder 22, (VH-1),11.538 GHz, V-Polarization, Audio Subcarrier 7.38 MHz, All programmes in English. WRN program information can be heard daily at 0125, 1025 and 2050 BST. Program information is also available on VH-1 Text page 222, 223, and 224.

All times BST (For Central European Time add one hour)
0000 - Radio Budapest
0030 - Radio Netherlands
0127 - Earth & Sky (Daily Science Series)
0130 - Radio Prague
0200 - NPR All Things Considered (rpt)
0300 - CBC As It Happens (Mon-Fri)
0300 - CBC tba (Sat)
0300 - CBC tba (Sun)
0400 - Polish Radio Warsaw
0430 - BBC Europe Today (Mon-Fri)
0430 - Glen Hauser's World of Radio (Sat)
0430 - UN Radio From New York (Sun)
0500 - YLE Radio Finland
0530 - Radio Austria International
0600 - NPR All Things Considered (rpt)
0730 - PRI Market Place (Tuesday-Saturday)
0730 - PRI Sound Print (Sunday)
0730 - PRI Dialogue (Monday)
0800 - ABC Radio Australia
0900 - Radio Swiss Int'l (Mon-Sat)
0900 - C-Span Weekly Radio Journal (Sunday)
0930 - Radio Canada Int'l (Mon-Fri)
0930 - UN Radio (Sat)
1000 - Radio Prague
1030 - Radio Netherlands
1127 - Earth & Sky (Daily Science Series)
1130 - Channel Africa, Johannesburg (Mon-Sat)
1130 - Glen Hauser's World of Radio (Sun)
1200 - NPR Morning Edition (Monday-Friday)
1200 - NPR Press Club (Sat)
1200 - NPR Weekly Edition (Sun)
1300 - NPR Morning Edition (Monday-Friday)
1300 - NPR Weekend Edition (Saturday & Sunday)
1400 - Radio France International
1500 - Voice of Russia (Mon-Sat)
1500 - VOA Communications World (Sun)
1530 - Radio Vlaanderen International
1600 - ABC Radio Australia
1700 - ORF Blue Danube Radio (Monday-Friday)
1700 - Glen Hauser's World of Radio (Sat)
1700 - SABC Network Africa (Sun)
1730 - Radio Netherlands
1825 - News in Esparanto from Polish Radio Warsaw
1830 - RTE News at Six
1900 - Radio Austria International
1930 - YLE Radio Finland
2000 - RTHK - News from Hong Kong (Mon-Fri)
2000 - UN Radio from New York (Sat)
2015 - Health Watch (Sat)
2000 - Radio Romania International (Sun)
2030 - KBS Radio Korea International
2100 - Radio Sweden
2130 - Polish Radio Warsaw
2200 - NPR All Things Considered
2300 - PRI The World (Mon-Fri)
2300 - NPR All Things Considered (Sat & Sun)

WRN2 - European Multi-lingual Service
Eutelsat II F-1 (13 degrees East) Tr 25 (NBC), 10.987 GHz, V-Polarization, Audio Subcarrier 7.38 MHz. Please note that at all other times the schedule for WRN1 - Europe is broadcasts.

All times BST (Subtract five hours for Eastern Time)
0309 - Vatican
0745 - Vatican end
0830 - Vatican start (Sunday only)
0930 - Vatican start (Mon-Sat only)
1130 - Vatican end (not Wednesday)
1200 - Vatican end (Wednesday only)
1200 - Radio Studio Delta start (Mon-Fri only)
1300 - Delta end (Mon-Fri only)
1300 - Vatican start
1530 - Vatican end
1530 - Radio Studio Delta start (Mon-Fri only)
1630 - Delta end
1630 - Vatican start
2230 - Vatican end
2230 - Radio Studio Delta start (Mon-Fri only)
2330 - Delta end (Mon-Fri only)

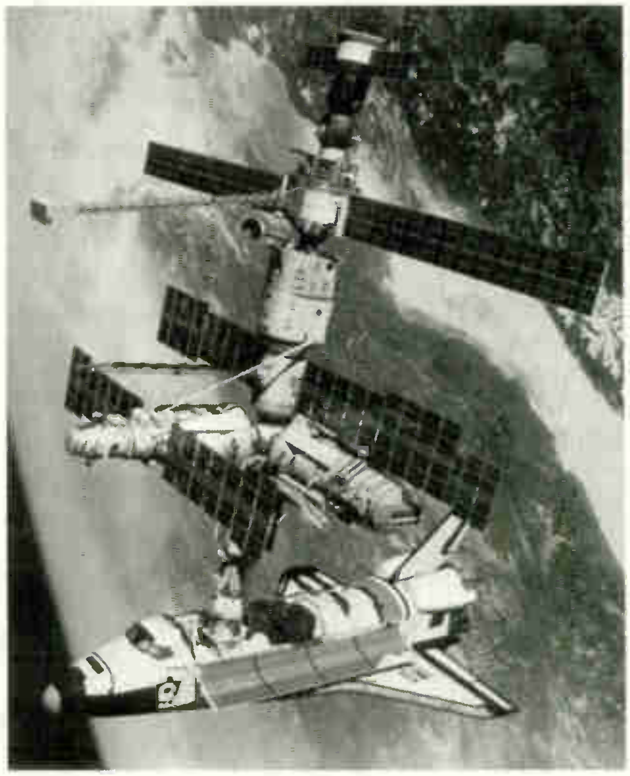
WRN 2 - N. American Multi-lingual Service
Galaxy 5 (125 degrees West) Tr 6 (TBS) 3.820 GHz, V-Polarization, Audio Subcarrier 6.2 MHz. Please note that programmes listed below with an asterisk (*) are subject to pre-emption without notice. WRN programme information is available on TBS Text page 204.

All times Eastern (For UTC add five hours)
0030 - *Radio Netherlands in Dutch
0125 - *WRN Announcements, until....
0600 - YLE Radio Finland, News in Finnish
0625 - YLE, News in Swedish
0630 - YLE, News in English
0700 - *WRN Announcements, until....
0800 - RTE News in Irish
0900 - Radio Prague in Czech
0927 - *WRN Announcements, until....
1000 - YLE Radio Finland, Regional broadcasts in Finnish
1030 - YLE, News in Finnish
1100 - YLE, Features in Finnish
1120 - YLE, Slow speed Finnish
1130 - YLE, News in English
1200 - *WRN Announcements, until....
1400 - *Radio Sweden, News in Swedish
1430 - *WRN Announcements, until....
1500 - *Radio Vlaanderen International in Dutch
1530 - *Radio Netherlands in Dutch
1625 - *WRN Announcements, until....
1645 - YLE, News in French
1700 - *Polish Radio Warsaw in Polish
1800 - Radio Budapest in Hungarian
1830 - YLE Radio Finland, Rock Music & Talk in Finnish (Mon-Fri)
1830 - YLE, Phone-in for children in Finnish (Sat&Sun)
1900 - YLE, News in Swedish
1930 - YLE, News in English
2000 - YLE, Light music in Finnish
2100 - YLE, Documentaries in Finnish (Mon-Thu)
2100 - YLE, Chuch Bells & Concert in Finnish (Sat)
2100 - YLE, New Classical releases in Finnish (Sun)
2130 - YLE, Light Music in Finnish (Fri only)
2200 - YLE, News in English
2230 - YLE, News in Finnish
2300 - YLE, News in Finnish
2310 - YLE, Religious programme in Finnish (Sun-Fri)
2320 - YLE, News in Swedish
2323 - YLE, Programme Preview in Finnish
2330 - Radio Austria International in German

WRN 1 - Africa/Asia-Pacific Service
Intelsat 702 (1 degree West) Tr 23B, 3.9115 GHz, Circular-Polarization, MPEG2 Audio Stream and AsiaSat-2 (100.5 degrees East) Tr 10B, 4.000 GHz, H-Polarization, MPEG2 Audio Stream.

All times UTC. For South African Standard Time add two hours and for Australian Eastern Time add eleven hours.
0030 - Radio Netherlands
0127 - Earth & Sky (Daily Science Series)
0130 - Radio Prague
0200 - Voice of Russia
0230 - Radio Sweden
0300 - NPR All Things Considered (rpt)
0430 - BBC Europe Today (Mon-Fri)
0430 - Glen Hausers' World of Radio (Sat)
0430 - BBC Int'l Call (Sun)
0500 - YLE Radio Finland
0530 - Radio Austria International
0600 - NPR All Things Considered (rpt)
0730 - RTE Dublin
0930 - Radio Canada Int'l (Mon-Fri)
0930 - UN Radio (Sat)
1000 - Radio Prague
1030 - Radio Netherlands
1127 - Earth & Sky (Daily Science Series)
1130 - Channel Africa, Johannesburg (Mon-Fri)
1130 - BBC Science Magazine (Saturday)
1130 - Glen Hausers' World of Radio(Sunday)
1200 - NPR Morning Edition (Monday-Friday)
1200 - NPR Press Club (Sat)
1200 - NPR Weekly Edition (Sun)
1300 - RTE Dublin
1400 - Radio France International
1500 - Voice of Russia (Mon-Sat)
1500 - VOA Communications World (Sun)
1530 - Radio Vlaanderen International
1600 - ABC Radio Australia
1700 - ORF Blue Danube Radio (Monday-Friday)
1700 - Glen Hausers' World of Radio (Sat)
1700 - BBC Int'l Money Prog & Sports Zone (Sun)
1730 - Radio Netherlands
1830 - RTE Dublin
1900 - Voice of America - World News & Mission Bosnia
1930 - YLE Radio Finland
2000 - Radio Deutsche Welle - News from Germany
2050 - Esperanto from Polish Radio
2100 - Radio Sweden
2130 - Polish Radio Warsaw
2200 - RTE Dublin

Hear the Mir, and more ...



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SATELLITE TIMES ADVERTISERS' INDEX

Space Glossary

NAVSTAR GPS Related Acronyms and Abbreviations (Courtesy of the U.S. Coast Guard Navigation Center)

AE	Antenna Electronics
A/D	Analog to Digital
AFB	Air Force Base
AFI	Automatic Fault Indication
AFS	Air Force Station
AHRS	Attitude and Heading Reference System
AIMS	Airspace Traffic Control Radar Beacon System IFF Mark XII System
A/J	Anti-Jamming
AOC	Auxilliary Output Chip
A-S	Anti-Spoofing
ASIC	Application Specific Integrated Circuit
ATE	Automatic Test Equipment
BCD	Binary Code Decimal
BIH	Bureau International de L'Heure
BIPM	International Bureau of Weights and Measures
BIT	Built-In-Test
BPSK	Bi Phase Shift Keying
C/A-code	Coarse/Acquisition-Code
CADC	Central Air Data Computer
CDMA	Code Division Multiplex Access
CDU	Control Display Unit
CEP	Circular Error Probable
CMOS	Complementary Metal Oxide Semiconductor
C/No	Carrier to Noise Ratio
CRPA	Controlled Radiation Pattern Antenna
CSOC	Consolidated Space Operations Center
CW	Continuous Wave
DAC	Digital to Analog Converter
dB	Decibel (X = 10 Log X dB) 10
DGPS	Differential GPS
D-Level	Depot Level
DLM	Data Loader Module
DLR	Data Loader Receptable
DLS	Data Loader System
DMA	Defense Mapping Agency
DoD	Department of Defense
DOP	Dilution of Precision
dRMS	Distance Root Mean Square
DRS	Dead Reckoning System
DT&E	Development Test and Evaluation
ECEF	Earth-Centered-Earth-Fixed
ECP	Engineering Change Proposal
EDM	Electronic Distance Measurement
EFIS	Electronic Flight Instrument System
EM	Electro Magnetic
EMCON	Emission Control
ESGN	Electrically Suspended Gyro Navigator
FAA	Federal Aviation Administration
FMS	Foreign Military Sales
FOM	Figure Of Merit
FRPA	Fixed Radiation Pattern Antenna
FRPA-GP	FRPA Ground Plane
GaAs	Gallium Arsenide
GDOP	Geometric Dilution of Precision
GPS	Global Positioning System
HDOP	Horizontal Dilution of Precision
HOW	Hand Over Word
HSI	Horizontal Situation Indicator
HV	Host Vehicle
HQ USAF	Headquarters US Air Force
ICD	Interface Control Document
ICS	Initial Control System
IF	Intermediate Frequency
IFF	Identification Friend or Foe
I-Level	Intermediate Level
ILS	Instrument Landing System
INS	Inertial Navigation System
ION	Institute of Navigation
IOT&E	Initial Operational Test and Evaluation
IP	Instrumentation Port
ITS	Intermediate Level Test Set
JPO	Joint Program Office
J/S	Jamming to Signal Ration
JTIDS	Joint Tactical Information Distribution System
L1	GPS primary frequency, 1575.42 MHz
L2	GPS secondary frequency, 1227.6 MHz
LEP	Linear Error Probable
LRIP	Low Rate Initial Production
LRU	Line Replaceable Unit
LO	Local Oscillator
mB	Millibar
MCS	Master Control Station
MCT	Mean Corrective Maintenance Time
MHz	Megahertz
MLV	Medium Launch Vehicle
MmaxCT	Maximum Corrective Maintenance Time
MOU	Memorandum of Understanding
M/S	Metres per Second
MSL	Mean Sea Level
MTBF	Mean Time Between Failure
MTBM	Mean Time Between Maintenance
N/A	Not Applicable
NAV-msg	Navigation Message
NOSC	Naval Ocean Systems Center
NRL	Naval Research Labratory
NS	Nanosecond
NSA	National Security Agency
NTDS	Navy Tactical Data System
NTS	Navigation Technology Satellite
OBS	Omni Bearing Select
OCS	Operational Control System
O-Level	Organization Level
OTHT	Over The Horizon Targeting
PC	Personal Computer
P-Code	Precise Code
PDOP	Position Dilution of Precision
PLSS	Precision Location Strike System
P I	Pre Planned Product Improvement
PPM	Parts Per Million
PPS	Precise Positioning Service
PPS-SM	PPS Security Module
PRN	Pseudo Random Noise
PTTI	Precise Time and Time Interval
PVT	Position Velocity and Time
RAM	Reliability and Maintainability
RCVR	Receiver
RF	Radio Frequency
RMS	Root Mean Square
RNAV	Area Navigation
RSS	Root Sum Square
RT	Remote Terminal
RTCA	Radio Technical Commission for Aeronautics
RTCM	Ratio Technical Commission for Maritime Services
S/A	Selective Availability
SAMSO	Space and Missile Systems Organization
SBB	Smart Buffer Box
SC	Special Committee
SEP	Spherical Error Probable
SI	International System of Units
SIL	System Integration Labratory
SINS	Shipborne INS
SPS	Standard Positioning Service
SRU	Shop Replacable Unit
STDCDU	Standard CDU
TACAN	Tactical Air Navigation
TAI	International Atomic Time
TBD	To Be Determined
TDOP	Time Dilution of Precision
TFOM	Time Figure Of Merit
TTFF	Time to First Fix
UE	User Equipment
UERE	User Equivalent Range Error
UHF	Ultra High Frequency
USA	United States of America
USNO	US Naval Observatory
UT	Universal Time
UTC	Universal Time Coordinated
VDOP	Vertical Dilution of Precision
VHSIC	Very High Speed Integrated Circuit
VLSIC	Very Large Scale Integrated Circuit
VOR	Very High Frequency (VHF) Omnidirectional Range
WGS-84	World Geodetic System - 1984
YPG	Yuma Proving Ground
1 PPM	1 Pulse Per Minute
1 PPS	1 Pulse Per Second

UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

Hams Face Loss of VHF/UHF Bands!

A proposal by the low-earth-orbiting (LEO) satellite community would deal a crippling blow to amateur radio if implemented. A consortium of little LEO proponents is preparing to petition the upcoming World Administrative Radio Conference (WARC 97) for up to 20 megahertz of additional spectrum to accommodate their speculative Personal Communications Services (PCS) growth. Although they had been granted spectrum previously, their stunning proposal was made to the Informal Working Group 2A (IWG-2A).

Alarmingly, among their targeted frequency ranges are the two most heavily populated VHF/UHF amateur radio bands, 144-148 MHz and 420-450 MHz, which they are seeking to wrest from the hams and reallocate to their service. A stroke of the pen would virtually wipe out VHF/UHF amateur radio, a contemptuous act of ill-conceived self service.

The two meter band, along with thousands of repeaters and associated 70 centimeter links, is the primary band used for Skywarn weather networks, public safety assistance during disasters and power outages, satellite communications for both the OSCAR/AMSAT program as well as the worldwide NASA Shuttle/MIR Satellite Amateur Radio Experiment (SAREX), crowd control at civic events, moonbounce experiments, cutting-edge communications research and development, and many other applications.

Assets in place for these two bands may well be in the hundreds of millions of dollars, with major manufacturing industries pivotally committed to this service. Arbitrarily reallocating these bands to a commercial service calls into question the collective competence and judgment of those who would request or enact such capricious rulemaking.

Although the military resists this alternative, there is plenty of available space in the 225-400 MHz spectrum. Just listen sometime; the sound you will hear is that of the vacuum of disuse. While there are discrete spots of tactical satellite activity, and occasional air-to-ground communications during exercises, that vast 175 megahertz expanse is shamefully underutilized. Since the aerospace industry is already manufacturing hardware for this part of the spectrum, equipment is readily available for the little LEOs.

I would propose this one-minute test of available spectrum in any metropolitan area: Equip the IWG-2A members with a scanner and have them search the narrow, 4-megahertz-wide, two meter band, then the enormous, 175-megahertz-wide, UHF military aircraft band to see which is more active. One sweep should do it.

The clamor for more spectrum extends to other services as well: 138-144 MHz (military), 216-218 MHz (inland waterways/interactive TV), 401-406 MHz (meteorological data), 450-460 MHz (UHF land mobile), 790-862/890-902 MHz (TV broadcasting/land mobile/cellular telephone), and 1390-1400/1427-1432 MHz (aerodefense). There is no reason for empathy for the little LEO industrialists; all the allocations were in place when they developed their system architecture.

If you would like to share your well-considered thoughts with these rulemakers, write to them or email them direct. Submit your comments in writing to Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554, or by e-mail at **wrc97@fcc.gov**. Commenters are requested to file an original plus one copy.

The comment should reference the Advisory Committee public record number, "Reference No. ISP-96-005" and the Informal Working Group 2A. The FCC staff will ensure that your comments will be forwarded to the IWG-2A committee.

These individuals would benefit by hearing your thoughtful, non-intimidating thoughts to help them make a more logical choice than the one which has been presented. ST

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