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Satellite Times®

Volume 4, Number 1 September/October 1997

Same Sun, Different Planet.

Pathfinder Sets "Six Wheels on [Martian] Soil" and Revolutionizes Space Exploration Forever

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Satellite Times

Cover Story

Cover Photo: *The first photo of a sunset from another planet. This image was taken by the imager for Mars Pathfinder (IMP) on Sol 21. The image was taken as part of a twilight study which indicates how the brightness of the sky fades with time after sunset. Scientists found that the sky stays bright for up to two hours after sunset, indicating that Martian dust extends very high into the atmosphere.*

"Six Wheels on Soil"

By Philip Chien, ST Staff

On July 4th, NASA had a special fireworks display of its own when the Mars Pathfinder mission successfully landed on the red planet. Within hours of the safe landing, the lander opened up and deployed a six wheel, mini-rover named Sojourner. Get the complete story and the exciting photographs in our cover story starting on page 10.

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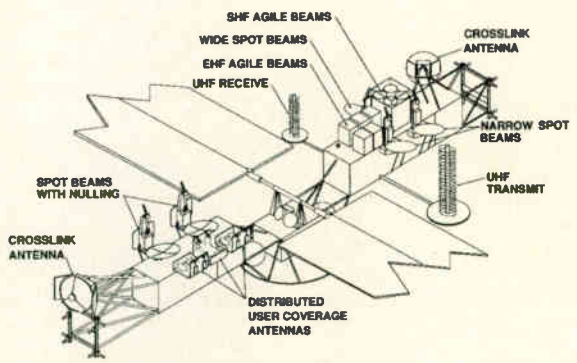
September/October 1997

The Darker Side of Deep Black

Conclusion of our three-part series on the U.S. military space program

By Philip Chien, ST Staff

Disappearing satellites, stealth spacecraft, UFOs, NATO, Milstar, and much more are discussed in the conclusion of Philip Chien's extensive look into the U.S. military space program. Story includes a detailed summary of every military spacecraft launched since 1984. Uncover the secrets starting on page 18.



"It was widely reported that the launched satellite [designated USA 53] had accidentally exploded or had broken into several pieces, and that additional items from the launch were tracked in the NORAD catalog. Several months later, observers found the satellite in a stable 800 km (497 mile) high, 65 degree inclination orbit, indicating that the satellite had made several maneuvers but certainly hadn't failed or exploded ...

In the summer of 1990 the payload disappeared from view..."

Marking an important new milestone in radio astronomy history, scientists at the National Radio Astronomy Observatory (NRAO) Socorro, New Mexico, have made the first images which use a radio telescope antenna in space. Story on page 93.

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ST

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DOWNLINK

By Larry Van Horn
Managing Editor
steditor@grove.net

Conspiracy Theories

You would have had to be in a coma the last couple of months not to know about the successful Mars Pathfinder mission to the red planet. The major media covered the initial landing and first few pictures, but there is more of the story that wasn't covered.

Your space magazine of record—*Satellite Times*—has the rest of the story and pictures that the national media didn't show you. We hope you enjoy the special coverage on Mars in this issue of *ST*.

But in fairness to all viewpoints and in the interest of providing *ST* readers with complete coverage of the Mars Pathfinder mission, here are a few of the side show stories that have not made it to the mainstream press.

Absolute proof that our government is hiding the truth from us resides here, in the famous "Face on Mars." Speak to us of these crimes, O Great One!

One of the most bizarre, no-holds-barred UseNet newsgroups on the internet is **alt.conspiracy**. One can truthfully find evil lurking behind anything by visiting this little corner of cyberspace. Just about anything that appears in the national press is refuted by someone in this newsgroup. The Mel Gibson movie *Conspiracy Theory* can't hold a candle to some of the material you will see posted here.

After the Mars Pathfinder landing I decided to cruise over to **alt.conspiracy** and check out what the gang thought about the mission. I wasn't disappointed; posters to the newsgroup were doing their best to help the UseNet group live up to its name.

The conspiracy that seemed to get the most attention was the belief that Mars Pathfinder had not landed on Mars at all. In fact, it was all an elaborate ruse by NASA. Pathfinder had actually landed just off of U.S. Interstate Highway 5 between Albuquerque and Farmington, New Mexico. Another theory placed touchdown at Sedona, Arizona.

Other conspiracy theories discussed in the newsgroup about the mission included:

- Alien spacecraft have been discovered hovering on the Martian horizon (the government is withholding the pictures, of course)
- Mars is populated by beer-drinking litterbugs; and
- Evian water bottles have been found on the Martian surface under the rock Barnacle Bill by the Sojourner rover.

One of my favorite Pathfinder conspiracies was posted to the group on July 5.

"The probe in fact has landed on Mars and will continue to send back photos and data ... until life is found there. Then the transmissions will cease and the U.S. government will say it was a malfunction in the equipment, when in fact, NASA is still receiving messages and signals."

In typical soap opera fashion there are even skeptics in the group who don't trust the other skeptics. In an Associated Press wire story, a poster to the conspiracy group told a reporter that he was convinced the government had manufactured some kooks and planted them on the newsgroup to divide the legitimate skeptics.

On July 25, 1997, another AP wire story contained a report from San'a, Yemen, that three Yemeni men claiming ownership of Mars had filed a lawsuit against NASA for landing on the red planet.

The weekly *Al-Thawri* newspaper reported that the three filed their suit in a Yemeni court.

The Arabic newspaper quoted the men as saying,

"We inherited the planet from our ancestors 3,000 years ago. Sojourner and Pathfinder ... began exploring it without informing us or seeking our approval."

The plaintiffs demanded the immediate suspension of all operations on Mars until the Yemeni court delivers a verdict. They also asked that the court order NASA to refrain from disclosing any information pertaining to Mars' atmosphere, surface, or gravity before receiving approval from them or until a verdict is reached.

But, I saved the best for last. One of the more interesting radio talk shows here in the United States is the Art Bell show. This show airs during the very early hours of the morning here in the U.S. There is no shortage of interesting callers to Art's show each morning.

A couple of days ago, I was up early and heard one of Art's callers give a definitive answer to one of mankind's greatest mysteries—the disappearance of the city of Atlantis.

According to Art's caller, the Pathfinder had set down in an ancient Martin flood plain and the new photos indicate conclusively that the missing city of Atlantis was on Mars, not Earth. The caller also explained that the legend of Atlantis had migrated over the centuries to Earth. Of course, he didn't bother to tell us how the legend got here to Earth. So now you know where Atlantis truly is and the rest of the story.

It is fun to toy with the conspiracy theories, but I think I will stick to the real story in Phil Chien's feature that starts on page 10. We hope you enjoy our special Pathfinder mission coverage.

And on a final note. A news story was just passed to me here in the *ST* editorial office. The bad news is that aliens have just landed on Earth. The good news is that they eat politicians.

ST

I would like to take this opportunity to wish the Satellite Times staff a happy third birthday. As we start our fourth year, I hope each of you, our faithful readers, will find something useful in the pages of Satellite Times in the coming year.

SATELLITE MONITOR

By Wayne Mishler, KG5BI

Scientists look back in time at formation of Universe

While the world gawks and marvels at recent images of Mars, other eyes are peering farther into space at a subtle spectacle that may unlock profound secrets of the past.

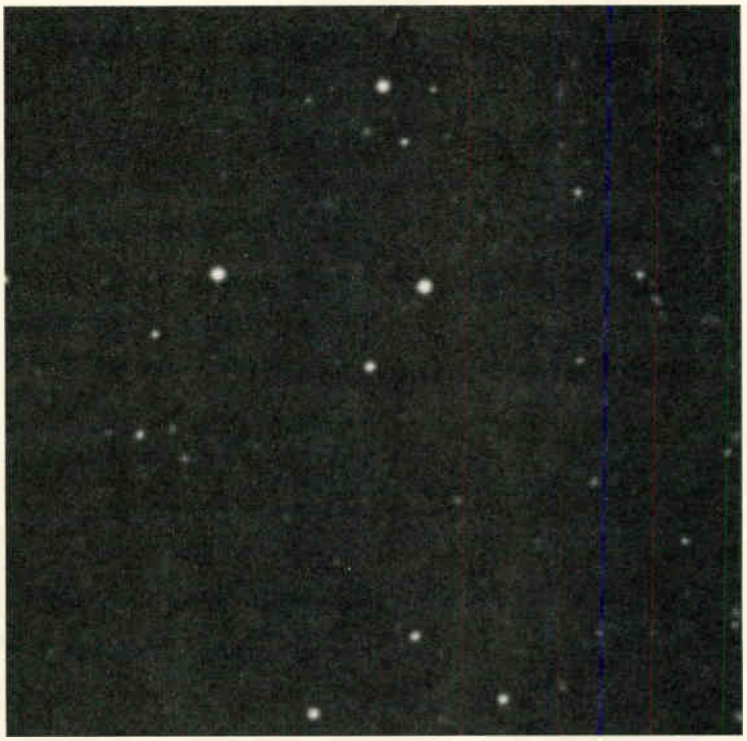
Scientific eyes, squinting through telescopes, are studying light that is billions of years old.

As insects trapped in tree resin tell us about the era of dinosaurs, ancient light from distant galaxies may tell us about the origin of the Universe. Imagine seeing ancient light and the information it carries from many billions of years ago.

Of course, we can't see such light with the naked eye, because its source is too distant. It is many thousands of times too faint for human eyes to see. But the Hubble Space Telescope and other powerful telescopes and instruments at the European Space Agency (ESA) have been detecting and analyzing ancient light for some time now.

On August 1, the ESA announced startling new observations of a relatively bright southern quasar called HE 2347-4342. While studying this quasar, scientists were treated to a glimpse backward in time. They saw what the Universe may have looked like soon after the so-called Big Bang. They were able to look back through 80 percent of the life span of the Universe. Or to put it another way, if the Universe was 100 years old, they may have actually seen the Universe in its prime at age 20.

The discovery, say ESA astronomers, adds credence to the standard Big Bang cosmology. "It is an important step forward in our understanding of the thermal history of the Universe," says an ESA spokesman. "Theoretical modeling based on such data should allow us to identify the still unknown epoch when the first galaxies and quasars began to light up and thereby ionize the intergalactic gas left over from the Big Bang."



ESA recently announced startling new observations of a relatively bright southern quasar called HE 2347-4342.

The ionized state of intergalactic gases changed as the Universe evolved. And this is a key that could unlock ancient secrets.

According to scientists, enormous clouds of hydrogen and helium were left over from the Big Bang. Production of the protons and neutrons of these gases stopped. The Universe was extremely hot, and photons were scattered everywhere. The Universe was one big light. After some 100,000 years, the Universe cooled to a few thousand degrees, and free electrons, from which photons radiate, combined with gaseous nuclei to form atoms. The photons were no longer free, and the Universe became transparent. Cosmologists refer to this as the re-combination epoch.

As the Universe continued to cool, and as atoms formed, they moved together in huge clouds from which galaxies and stars emerged.

When the first generation of stars and, later, quasars formed, their intensive ultraviolet radiation removed electrons from the hydrogen and helium atoms, causing them to become ions. This is known as the re-ionization epoch.

Scientists believe that the first quasars were formed during that epoch. So by studying the state of ionization of gases in beams of ancient light from quasars, scientists believe they are actually seeing the Universe in its early stages of development.

Quasars are believed to be very bright centers of distant galaxies, where energetic action is occurring, possibly caused by a massive black hole at the center of that galaxy.

The study of quasars is not new. In the 1950s, astronomers scanned the heavens with a radio telescope in search of objects radiating radio waves. They discovered several such objects which appeared to be similar to stars. They studied one of the objects for a decade, observing that it radiated both radio waves and ultraviolet radiation with much greater intensity than an ordinary star. Such radiation had only been observed coming from the Sun and a few so-called flare stars.

Over the years, several other radio

emitting objects were discovered but not understood.

In 1963, American astronomer Maarten Schmidt, working at the Palomar observatory, photographed the light spectrum of a radio emitting star. The spectral lines did not match any known atoms. The mystery was solved when Schmidt realized that the lines were those of a hydrogen atom, extremely shifted from their normal positions toward the red end of the spectrum. This told him the object was not a star, because stars do not exhibit redshifts.

Astronomers discovered that it is possible to calculate the distance from Earth to a quasar by studying the magnitude of the redshift in the quasar's spectrum. The greater the redshift, the greater the distance from Earth. The distances for quasars typically measure several billion light years.

In 1989 a man named Dieter Reimers and colleagues at the University of Hamburg, Germany, initiated a spectral survey of the southern sky in search of bright quasars. They were especially interested in finding quasars with clear lines of sight to the Earth; that is, transparent for ultraviolet light. With a clear view, they would be able to study the quasars and intergalactic gas in unprecedented detail with large telescopes.

The greater the distance to a quasar, the longer its light has been en route, the longer the look back into time, and the earlier the epoch of Universe development.

More than 650 quasars have been discovered in this work.

The very brightest of these is the quasar HE 2347-4342, with a tremendous redshift, located in the Phoenix constellation. It was discovered in October 1995 by Lutz Wisotzki, at the University of Hamburg. The "HE" stands for Hamburg-ESO. It is 10,000 times fainter than light that can be detected by the naked eye, but more than 1,000 times more luminous than our Sun.

Its redshift of 2.885 places it so far away that it has a look-back time of more than 80 percent of the age of the Universe.

In turning their telescopes on quasars, scientists are really studying gases. It is not unlike looking at a street light at night to see if it is raining.

Because of the nature of chemistry and physics, it took primeval helium longer to ionize than hydrogen. Scientists wondered: Would we be able to detect pockets of primeval helium in the same epoch at which we observe remote quasars? In the latest observations, scientists indeed saw for the first time a patchy presence of intergalactic matter coinciding with a major transition phase of the Universe.

This discovery puts in place one more piece of the puzzle of how our Universe was formed. And it takes us another step closer to future revelations.

New data shows 'disk' of doomed matter circling black hole

For years theorists have guessed that gravity pulls doomed matter into the flat disk that revolves around a black hole. The satellite *International Ultraviolet Explorer* has proved them right. A gassy mass known as an accretion disk is indeed rotating around the black hole in galaxy 3C390.3. Scientists have calculated the disk to be one-fifth a light-year wide, according to a June 3 announcement by the European Space Agency.

When this black hole, more than a billion light-years from Earth, swallows a larger morsel than usual, galaxy 3C390.3 flares up, and energy radiates outward from its center. As expected energy of the event takes longer to reach the Earth from the far side of the disk than from the near side. The interval is about one-fifth of a light-year.

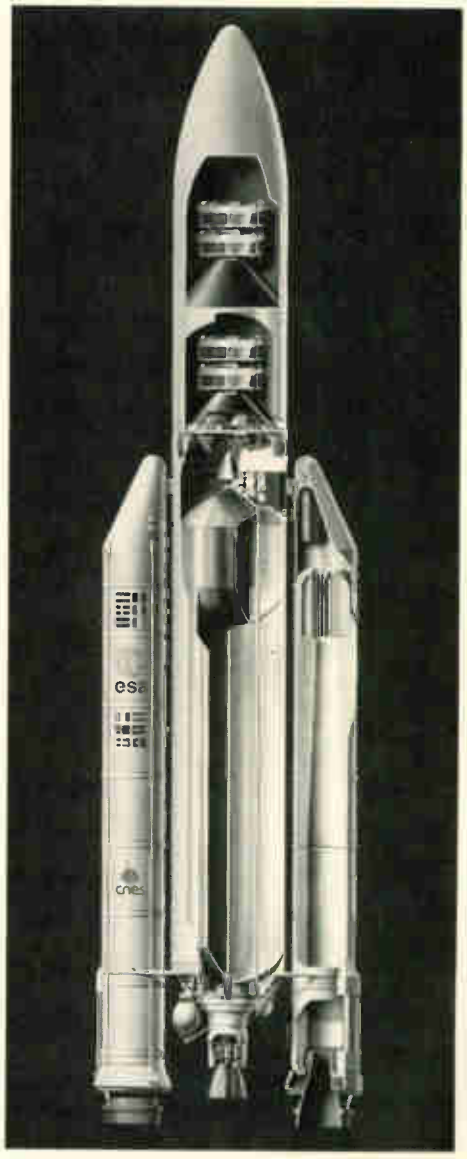
The black hole has a mass of about 200 million suns. By Einstein's theory of gravity, the horizon of the black hole, where infalling matter disappears, is about 600 million kilometers from the center. This is slightly less than the distance from our Sun to Jupiter. This means the black hole's radius is about 1 light-hour, and the disk is about 2,000 times wider than that.

"Our insight into the accretion disk of 3C390.3 shows that the ghost of *Explorer* will haunt astronomy for decades to come," says ESA's Willem Wamsteker, who drew these conclusions.

"This is only one of many new results to be expected as we sift through the monumental set of data from the *Explorer*," he says. "The world's astronomers can look back at our 18 years of observations with fresh ideas, novel questions, and improved techniques."

Cluster will fly again!

ESA's science program committee has agreed on the reflight of a full Cluster



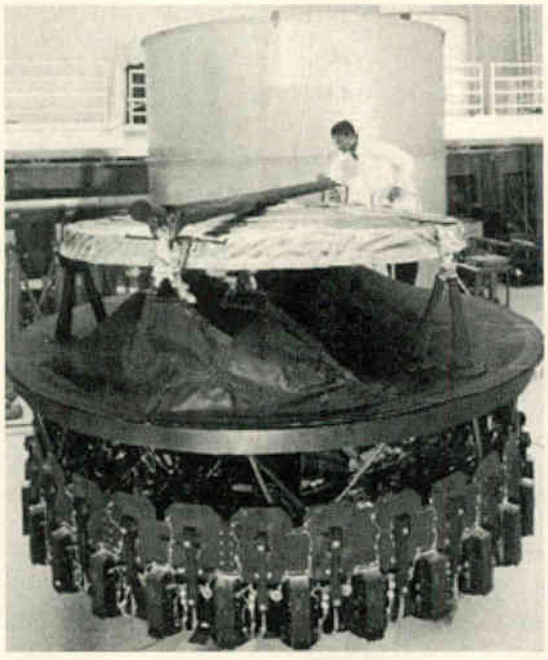
mission by mid-2,000. The original Cluster mission was lost in the June 4, 1996, explosion of Ariane Five. The new flight will continue the original mission to investigate the physical interaction between Sun and Earth.

Cluster II satellites are to be launched in pairs by two Russian Soyuz launchers in mid-2,000. ESA says it will work jointly with the industrial consortium and science communities of Europe and the U.S. to minimize costs of the launch.

As previously planned, the four Cluster spacecraft will carry out three-dimensional measurements in the Earth's magnetosphere, working with the spacecraft *SOHO.*

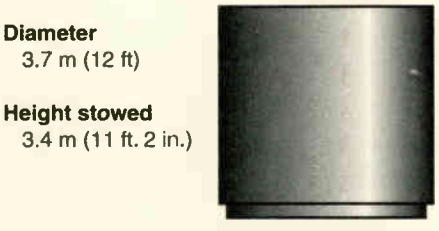
The fundamental design of the four identical Cluster spacecraft remains unchanged; however, some minor changes are likely because of the different launch vehicle and obsolescence of some components.

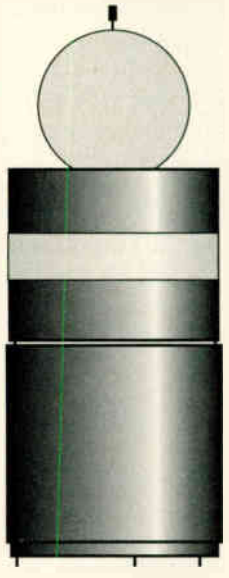
The Cluster II scientific goals are to measure with very high accuracy small-scale plasma structures in space and time in the near-Earth environment. Each spacecraft will carry an identical set of 11 experiments.



At left, technicians work on the HS-393 spaceframe.

Diagram below depicts the stowed and deployed sizes and weights of the PanAmSat SBS-6 satellite.





Aviation gets new satellite communications system

The U. S. Federal Aviation Administration (FAA) has ordered a new satellite-based communications system for use by the nation's airports and pilots, the PanAmSat Corporation announced in June.

The contract was awarded last year to MCI, who will build and deploy the system on three Ku-band transponders on two PanAmSat domestic satellites.

When completed and fully operational, the new system will include a satellite-based communications network for transmitting radar, computer, navigational and weather data, and tower-to-pilot communications throughout the nation.

"PanAmSat satellites will form the hub of a communications system that is vital to the airline industry in the United States," says Carl Brown, PanAmSat executive vice president.

Initially MCI will use one transponder on PanAmSat's SBS 6 Ku-band satellite to start operation of the system in August. The system will be moved to PanAmSat's Galaxy X satellite when launched in mid-1998. This will expand the system's capacity to two Ku-band transponders, with option for a third.

Galaxy X is an HS 601 satellite with 24 C-band and 24 Ku-band transponders, offering coverage of the U. S. including Alaska.

Air Force eyes next generation of military satellites

The U. S. Air Force Space and Missile Center at Los Angeles has let a contract to develop a prototype for a digital processor that will be the heart of a new generation of military communications satellites.

The $65 million contract went to Hughes Space and Communications Company. Under provisions of the contract, they have three years to develop an engineering model of the advanced digital signal processor with anti-jamming protection. This processor is the core of the satellite payload. Operating in the extremely high-frequency range, the processor is to thwart jamming while receiving signals, routing them, and preparing them for transmission back to Earth.

If the prototype is successful, the processor is scheduled to go into production in the year 2,001.

Movie idealizes search for alien life...

Dr. H. Paul Shuch hopes that the film *Contact*, which was to debut in box offices in July, will generate some interest and some new members for the now privately funded Search for Extra-Terrestrial Intelligence (SETI) League.

Shuch is executive director of the non-profit League which went private after Congress forced NASA to discontinue government funding for the program in 1993.

The mission of the League has not changed. They continue to determine through microwave monitoring whether humankind is alone in the Universe.

The movie, based on Carl Sagan's 1985 novel, describes how the research search might have gone if Congress had allowed NASA to continue the program.

"The real SETI League is very different from the movie version," says Shuch. "Ours is a grass-roots effort by ham radio operators and amateur astronomers. But we are hopeful that the popularity of the movie will help to fuel public interest in our program."

Since Congress terminated NASA's SETI funding, the SETI League and other scientific groups have been working to raise money to continue the research program. It is now a non-profit organization entirely funded by members and donations.

The movie was made on a $95 million budget. "That would be enough to finance the SETI League's operations for about 600 years," Shuch says, adding that the money will be well-spent if it raises public interest in the project.

Shuch invites anyone interested in participating in the research, or wishing to help support it, to send an e-mail to **join@setileague.org/**. Include a postal address to receive information by mail. The League also has a Web site at: **http://www.setileague.org/**.

For information about joining you can call the League's membership hotline at 800-TAU-SETI.

Scenes from the new movie, "Contact," along with the message actually sent into space in 1974 by the Arecibo Observatory (above) and a capture of the SETI web page.

And finally . . .

Just when I thought network TV programming couldn't get any worse, along comes Ted Turner, of Time Warner, challenging Rupert Murdoch, of News Corp, to a slugfest boxing match.

The *Atlanta Journal-Consttitution* reports that Turner wants to fight Murdoch in a $4.95 pay-per-view event and give $5 million in proceeds to charity.

Would a million people actually pay $4.95 to see that?

After I read the story, I got sick. Turned green. Maybe it was coincidence. Or maybe it was the thought of two hairy-legged old men in boxing shorts chasing each other around a sweaty ring.

I can see the headlines now: Turner-Murdoch fight ends in coronary. Can you imagine a million pay-per view fans demanding their money back? Now there's a pay-per-view event.

But as I sat down to write an editorial for the *Journal* questioning the sanity of everyone in network programming, I had to back-peddle. Whoa. There, hidden between the lines of that unassuming little press report, was a brilliant idea.

Instead of amassing huge armies and sending our young men and women to war, why not just let heads of state slug it out in a boxing ring. The winner would take over the loser's country. No shots need be fired.

Think of the tax dollars that would save. The entire military budget would be up for grabs. Hey, we could start a new tax, like social security, except we could call it something like the IMW (Impoverished Magazine Writers) tax to support the truly brilliant arm of the Fourth Estate.

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ST

Sources: *Atlanta Journal-Constitution*, European Space Agency, Hughes Space and Communications Company, PanAmSat, and the SETI League

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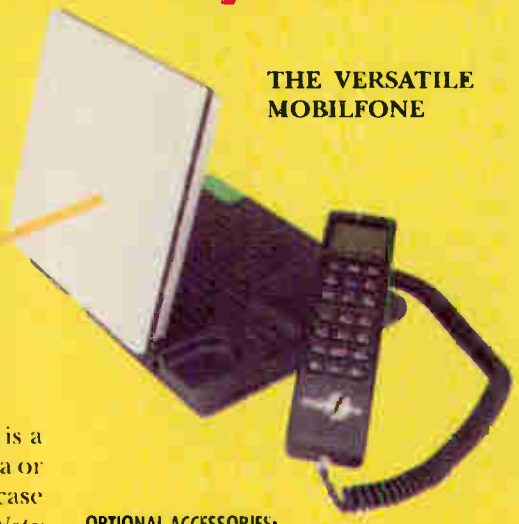

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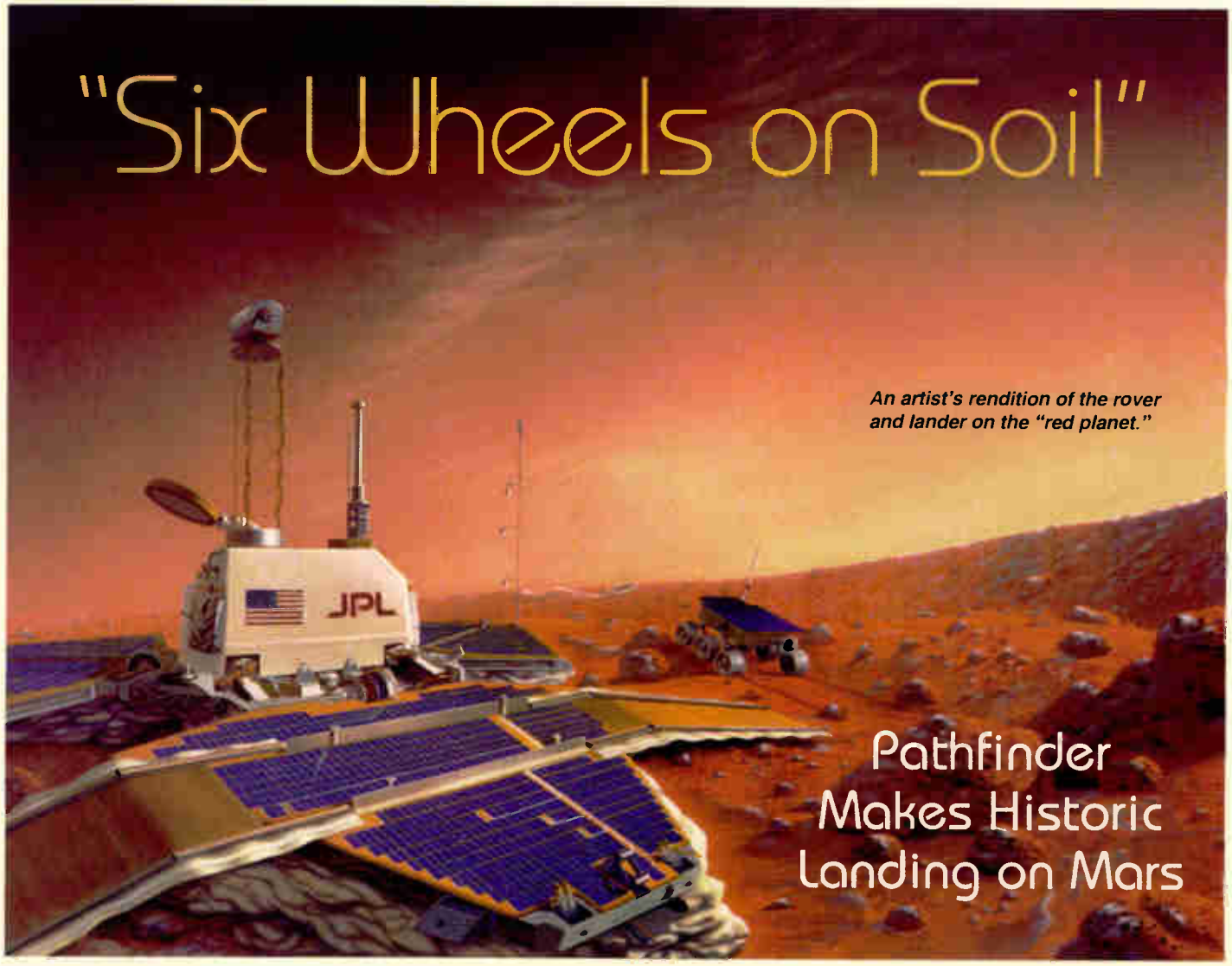


An artist's rendition of the rover and lander on the "red planet."

Pathfinder Makes Historic Landing on Mars

By Philip Chien, ST Staff

The mood at NASA's Jet Propulsion Laboratory is nervous anticipation. For the first time in over 20 years humans are attempting to land a spacecraft on Mars. But unlike Viking Mars Pathfinder's going directly in—using an unproven inflatable airbag system to slow the spacecraft as it descends to the surface.

The July 4 landing date was chosen to honor Independence Day; orbital mechanics demanded an early July landing and the 4th was as good as any other date. The landing site was chosen for both engineering and science reasons.

Engineers asked for a low altitude location at a latitude with acceptable sun angles. Scientists were interested in a region with many different features. Ares Vallis fulfilled both of those requirements. It's the mouth of an ancient flood channel, formed by a gigantic flood, similar to the ancient one which created the Mediterranean Sea. In two weeks the landing area flood plain received as much water as if all of the Great Lakes drained into the Gulf of Mexico. Scientists hoped the mouth of a river channel would be an excellent place to examine rocks which had been carried downstream by the flood.

The airbags were inherited from a previously proposed program for a series of inexpensive Martian probes. At first it was hoped that the airbags would save money and weight. But it turns out that the additional layers which were added to make the system more robust eliminated any weight savings. However, airbags many prove to be useful for future missions which want to land in rough terrains where the precise landing location isn't important.

The cruise stage separated from Pathfinder on July 4 at 9:32 a.m. (all times are Pacific Daylight Time/UTC-7 as received on Earth). Light speed time from Mars to Earth is approximately 10 minutes 30 seconds.

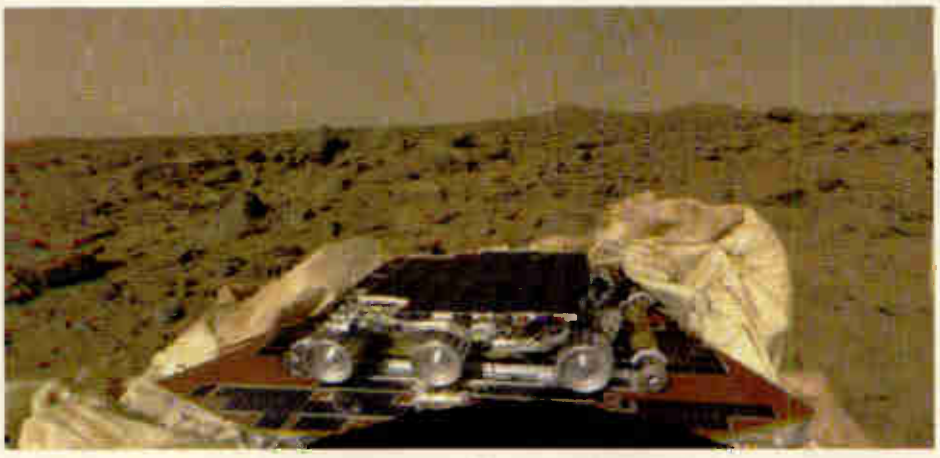
It took just five minutes from the entry to landing. At 10:02 a.m. Pathfinder encountered the upper atmosphere—the equivalent of hitting a brick wall at 26,460 km/hr (16,600 mph). The aeroshell absorbed 100 megawatts of thermal energy to slow Pathfinder's descent to 1,440 km/hr (900 mph). A 7.3 meter (24 ft) parachute deployed, slowing the descent rate to 234 km/hr (147 mph). The used heatshield was released and crashed on the Martian surface.

The lander was lowered from its backshell on a 20 meter (66 ft) tether. When the radar altimeter indicated that it was 1.5 km (.95 mi) above the surface the four airbags inflated, encapsulating the lander. At an altitude of about 100 meters (330 ft) three solid rockets in the backshell were fired to halt the descent and the tether was cut. The encapsulated lander then dropped to the surface (the equivalent of a six story building) and bounced 15 times before coming to a halt. Forty two separate ordnance devices, ranging from braking rockets to pyrotechnic bolt cutters had to work properly to ensure the landing's success.

Landing occurred at 10:07:25 a.m., about 20 seconds earlier than anticipated. To the engineers' astonishment Pathfinder landed right side up—a one in four chance. It was followed by the automatic airbag deflation, their retraction using a fishing reel-like system, and the opening of the three petals. At that point Pathfinder shut off its radio and waited for the Martian sunrise at 12:45 p.m.

Pathfinder Phones Home

After landing, the IMP (imaging camera for Mars Pathfinder) rotated until it found the Sun. Based on that orientation and the predicted location, the high gain antenna (HGA) rotated towards where it thought the Earth was located. It turned out it was pointed within one percent—better than anticipated. The HGA can send back X-band data at 2.5 kilobits per second—ten times the rate of the omnidirectional low gain antenna (LGA).



Before embarking on its first journey on Martian soil, the lander is photographed on its "petal" by the lander's camera. Interesting rocks and terrain greeted scientists as each new photo was received. The formation of two hills in the background—named Twin Peaks—are of extreme geological interest. The left hill has a smooth apron which may have been caused by gravitational processes or water. The hill on the right seems to have horizontal bands running through it. As of yet unidentified, the bands may be deposits, sedimentary layers, or terraces cut by erosion.

The first downlink session started at 2:07 p.m. sending engineering data. At 4:32 p.m. the first highly compressed black and white images were returned showing Pathfinder's view of Mars. These engineering images showed the lander's orientation, and whether or not the airbags were blocking the rover's exit ramps. Within several hours the first color photos, carefully patched together from the individual frames, were released.

The images showed both rover exit routes blocked by airbags. The engineers made the decision to raise the petal to pull in the bags a bit further, which worked successfully.

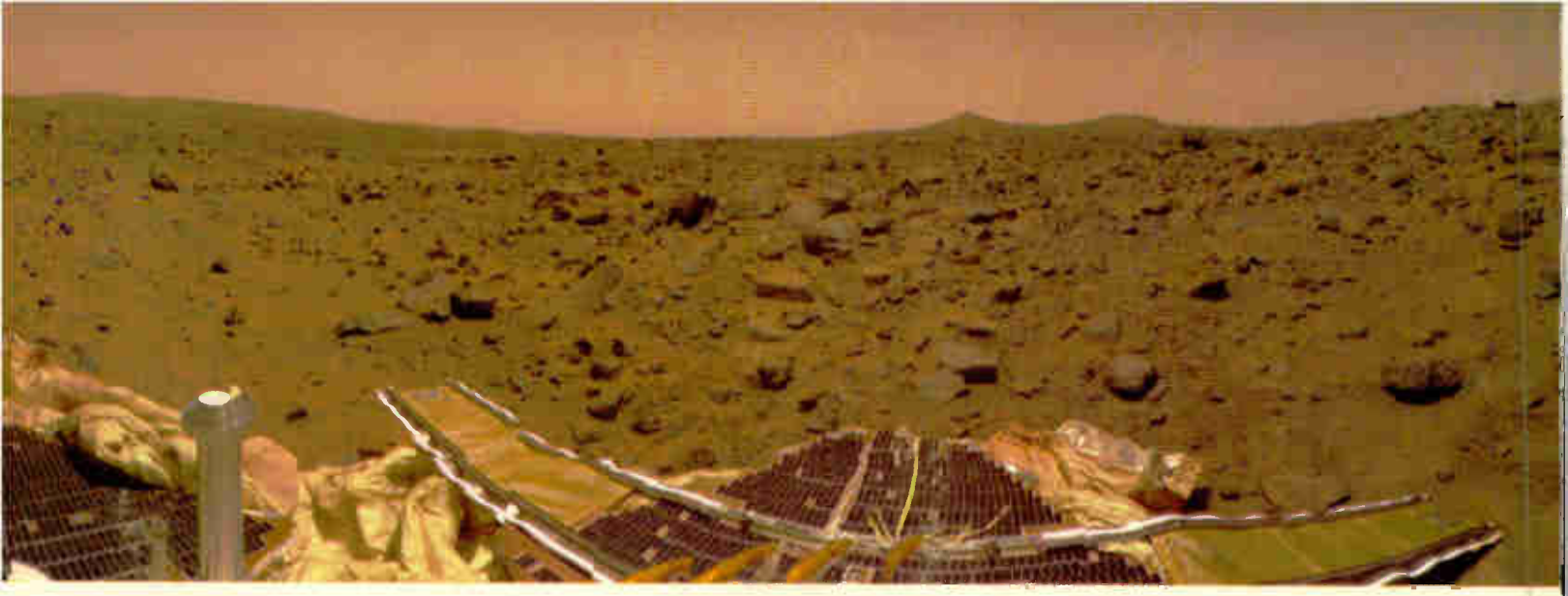
Pathfinder's landing was incredibly popular. The Mars Pathfinder World Wide Web sites received almost 100 million hits on July 4, a new Internet record. Even with 42 mirror sites it was very difficult to get through for the first couple of days.

The rover, Sojourner, communicated with the lander via fairly ordinary radio modems. It uses a frequency of 459.7 MHz, with a differential gaussian minimum shift keying (DGMSK) modulation system. The rover features a 45-cm whip antenna with a voltage standing wave ratio (VSWR) ratio of 1.09:1.

Controllers sent the commands for the rover to descend on the second day. Engineers were worried when the first images showed an empty ramp without the rover. But it turns out that that particular frame was just before the rover came into view. The next frame showed the rover on the ramp, then starting its descent onto the Martian surface, and, finally, all six wheels on the ground.

The first soil sample showed the soil was virtually identical to the soil samples

This 360 degree "monster" panorama was taken by the deployed Imager for Mars Pathfinder (IMP) on Sol 3. All three petals, the perimeter of the deflated airbags, deployed rover Sojourner, forward and backward ramps and prominent surface features are visible. The IMP stands 1.8 meters over the Martian sufrace. The curvature and misalignment of several sections are due to image parallax.



analyzed by Viking, even though they were in vastly different locations. Scientists feel that Martian winds have mixed and spread the soil over the entire planet and any sample anywhere on Mars would show the same chemicals.

By measuring horizon features, including the famous "twin peaks," scientists were able to determine Pathfinder's location precisely on 21-year-old Viking images at 19.33 North latitude and 33.55 West longitude.

Planetary geologists were as ecstatic as a child at Christmas, giving nicknames to each of the interesting rocks close to Pathfinder's landing site. The most interesting rocks, close to the lander, were selected for up-close examinations. The first four were Barnacle Bill, Yogi, Scoobie Doo, and Souffle.

On July 6 the controllers sent up a "wakeup call" to Sojourner, similar to the wakeup calls for shuttle astronauts. The rover's wakeup call was *Final Frontier*, the theme song from the TV series *Mad About You*.

Barnacle Bill's chemical analysis showed that it was unusually rich in silicon, which is more characteristic of Earth rocks than Martian rocks.

For Sojourner's early trips, a rover team sent commands to instruct the rover's movements. The rover drivers used virtual reality systems which displayed three dimensional views of the Martian landscape, based on the images taken by Pathfinder. The commands were transmitted to Pathfinder and relayed to the rover. Sojourner then completes its commands autonomously, with Pathfinder's camera following its journey. Several Sojourner's movies are available on the Mars Pathfinder Web site.

Sojourner's second target was a large rock nicknamed "Yogi." The rover team sent up the command sequence and was very surprised to see that it performed a "wheelie" with one wheel raised off the surface and touching Yogi. The driver had misestimated the distance to Yogi, resulting in the first sideswipe on another planet! Fortunately, the rover's onboard computer was smart enough to stop when it realized something unexpected had happened.

Sojourner was designed with a nominal lifetime of seven Martian days and quickly exceeded that goal. While engineers are hoping for a long life, they readily acknowledge that the lifetime will be limited by the harsh Martian temperatures. It's highly unlikely that Sojourner will ever go to distant objects on the Martian horizon, like the "couch" or "twin peaks." There are just too many closer objects to examine.

The lander was designed for a one month lifetime. It's hoped that it will continue to return images and meteorological data for a year or more before it fails.

This view to the northeast of the lander is annotated to show the variety of rocks in this landing site and what they tell us. The red arrows point to rounded boulders and rocks, thought to have been shaped by the forces of water in flood (rough edges knocked off by the tumbling action of the water). The blue arrows indicated rocks with sharp edges and points, most probably ejected from nearby impact craters and/or ancient volcanic activity. The white areas (of which Scooby Doo is one) are believed to be deposits left behind by evaporating water, or aggregates of materials fused together by the action of water.

Here Come the Tourists

As Mars Pathfinder finishes its primary mission, Martian exploration continues. Mars Global Surveyor, the replacement for the failed Mars Observer spacecraft, arrives at Mars on September 12, 1997. It will use a conventional rocket engine to

slow it into orbit around Mars. An innovative aerobraking technique, using the Martian atmosphere, will gradually change its high altitude elliptical orbit into a low altitude, circular operational orbit. Several months of aerobraking will be required before Global Surveyor reaches its mapping orbit. Upper atmospheric data collected during Pathfinder's entry is being used to optimize MGS's aerobraking burns.

Due to the launch failure of the Russian Mars 96 mission, the Mars relay instrument will not be used until the next series of Martian landers. Mars Global Surveyor's four other scientific instruments—the Mars orbiting camera, Mars laser altimeter, thermal emission spectrometer, and magnetometer—will spend over two years examining Mars. In addition "bonus science" is obtained by examining the spacecraft's radio signals. By analyzing the carrier scientists can determine Mars' precise shape and its atmospheric structure.

MGS's camera faces straight down, and can only view what's directly under the spacecraft's path. It's hoped that the camera can obtain high resolution images of the Viking, Pathfinder, and Russian landing sites. In addition NASA has promised to attempt to take photos of the infamous "Mars face." Certainly nobody disputes that it's a feature which looks like a face. But, few scientists believe it's anything other than a bunch of rocks which happen to look like a face, just like many similar natural features on Earth.

Mars Global Surveyor and Mars Pathfinder are fairly inexpensive spacecraft—examples of NASA's "better, cheaper, and faster" philosophy. They've taken about two years to develop and fly on relatively inexpensive launch vehicles. One old style planetary spacecraft remains—Cassini.

Going Nuclear on Saturn

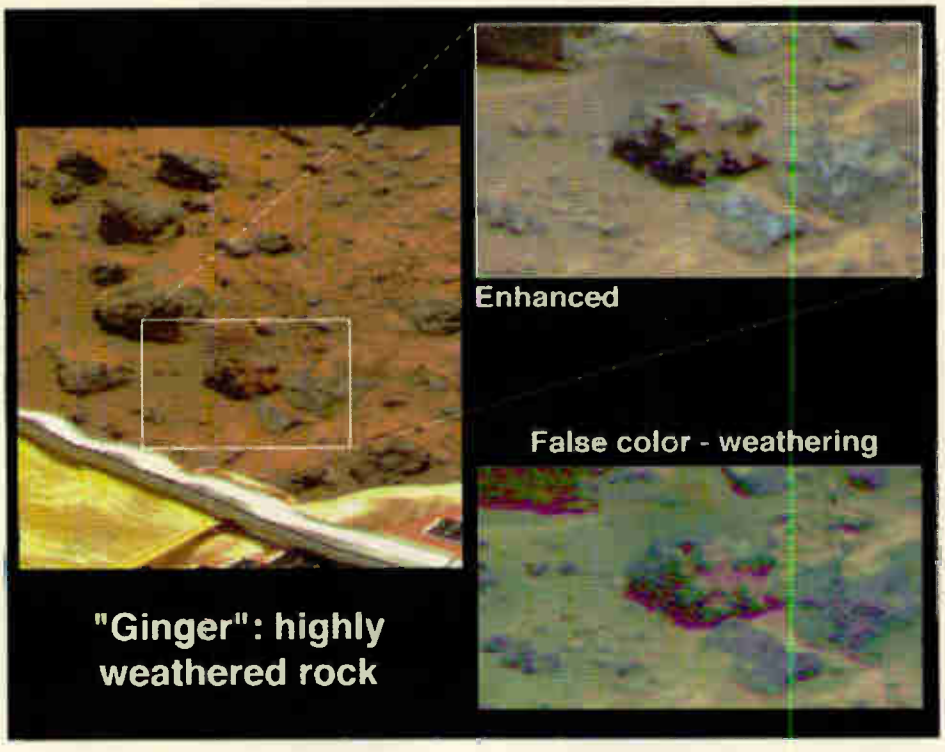
Cassini was supposed to be the first Mariner Mark II spacecraft—a sophisticated planetary spacecraft based on a common bus to reduce costs. The follow-on Mariner Mark II, Comet Rendezvous Asteroid Flyby (CRAF), never materialized due to cutbacks, so Cassini ended up the only Mariner Mark II model. Over $1.1 billion has been spent on Cassini, and the total project through completion is expected to cost $3.4 billion—many times the cost of the Discovery-class missions.

Cassini will make 60 orbits around the giant ringed planet Saturn, examining the planet, its rings, and moons. A European-built probe, Huygens, will land on Saturn's largest moon, Titan. Titan is the solar system's only moon with a substantial atmosphere.

The "Presidential Panorama" taken from the lander the landing site in a 360-degree mosaic. The Sojourner Rover is shown taking its APXS measurement of Yogi just to the right of center.

Cassini is an extremely large planetary spacecraft. At launch it weighs 5,655 kg, including the 373 kg. Huygens probe. The only larger planetary probes were the Soviet Phobos 1 and 2, and Russian Mars 96 spacecraft, which all failed in their missions to explore Mars.

Probes to the outer solar system cannot use solar power since they're too far from the Sun. Pioneer 10/11, Voyager 1/2, Ulysses, and Galileo have all relied on nuclear batteries—radioisotope thermoelectric generators (RTGs). RTGs have



This is the clearest image yet of Yogi (with the Sojourner Rover taking its Alpha Proton X-ray Spectrometer measurement). It clearly shows the "two-toned" surface of this large rock, which may be due to wind-blown dust accumulated on the surface (the rock is leaning into the prevailing wind) or might be evidence of a break from a larger boulder as it was deposited in the ancient flood that scoured this area. The false color image of the area surrounding Yogi shows clear evidence of "scalloped" features in the soil associated with wind-blown dust. Such evidence indicates clearly the direction of prevailing winds in this area, and gives further proof of the aeolian nature of erosional processes on Mars.

also been used on planetary surfaces (Apollo lunar experiments, Viking), and a few tests in Earth orbit (Nimbus and Transit).

There have been four cases where RTGs were involved in accidents and in each case their containment systems operated as designed. In an early Navy Transit satellite failure, the RTG was designed to disperse its nuclear material as finely as possible. It added as much additional background radiation to the atmosphere as all of the atmospheric tests of nuclear weapons during the Cold War. Later RTGs were designed with a containment philosophy—under any plausible circumstances the nuclear material would not be released.

The nuclear material is in a ceramic form and encapsulated in several layers of very tough heat resistant materials. Nimbus 3 proved that this system works. The Thor-Agena rocket failed shortly after launch on May 18, 1968. The RTG was recovered intact from the bottom of the Santa Barbara channel and reprocessed for use on a future spacecraft.

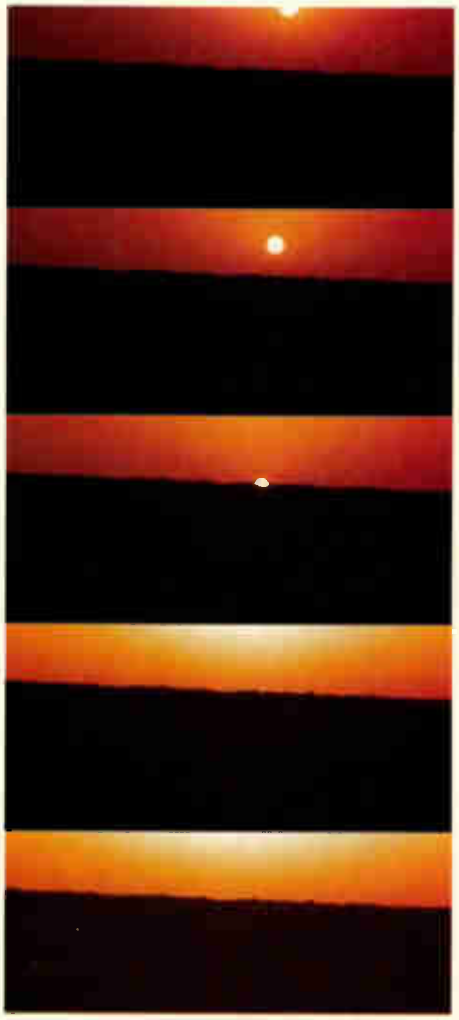
Apollos 12 through 17 carried RTG-powered experiments which were set up by the astronauts. Since Apollo 13 never landed, its RTG ended up reentering the Earth's atmosphere with the Lunar Module *Aquarius*. Its canister was designed to withstand the heat of an accidental reentry and it remains at the bottom of the Pacific Ocean.

The Russian Mars 96 mission included a 153-watt RTG. It was launched on November 16, 1996, but failed to leave Earth orbit and reentered. In its United Nations report Russia stated "As was reported earlier, the radionuclide energy sources based on plutonium-238 which were on board the space object Mars-96 will not disintegrate in any unforeseen circumstances."

Each of Cassini's three RTGs contains 10.8 kg (24 lbs) of Plutonium 238. The heat from the Plutonium's decay is converted to electricity using silicon-germanium thermocouples. At launch the RTGs will generate a total of 855-watts of power.

Cassini's launch is scheduled for October 6, 1997, at 5:38 a.m. EDT on a Titan IVB-Centaur launch vehicle. The first Titan IVA started flying in 1989, and the Titan IVB version with upgraded solid motors has flown once.

Cassini will be the first use of the Titan IVB with the Centaur upper stage. Even though this combination is the most powerful currently operational launch vehicle, it isn't enough energy to send Cassini all of the way to Saturn. So Cassini will use a series of gravitational assists to send Cassini to Saturn. Cassini will fly by Venus in April 1998 and June 1999. The spacecraft will make its Earth flyby on August 1999, and a Jupiter flyby in December 2000 before its arrival at Saturn in July 2004. In November 2004 the European-built Huygens probe will be released to explore Titan. Cassini is expected to spend about four years exploring the Saturn system.



Still photos of a Martian sunrise. Bottom frame is the earliest.

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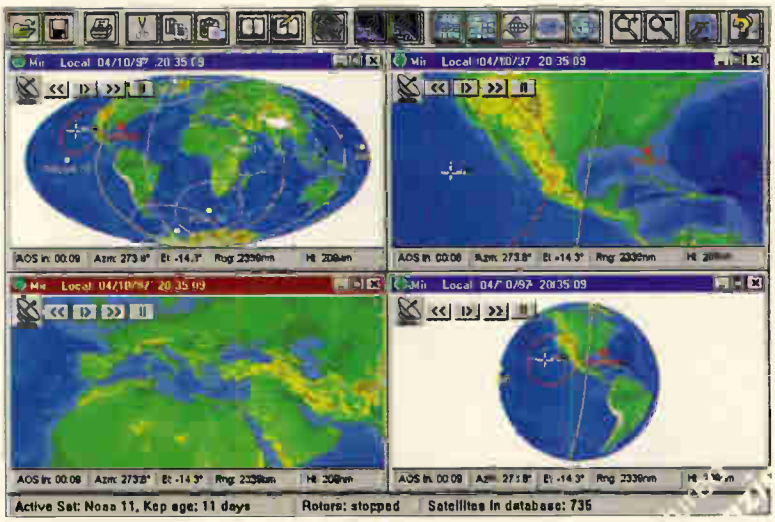

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The World Wide Web *has single-handedly raised the awareness level of thousands (if not millions) of earth-dwellers about the planet Mars. There are dozens of Pathfinder sites on the web, ranging from serious to silly. Some of the sites have doctored photos showing Marvin Martian, Luke Skywalker, and even Beavis and Butthead on the Martian surface. But the the best and most informative site is certainly the JPL site* **http://mpfwww.jpl.nasa.gov/** *which will direct you to one of the mirror sites.*

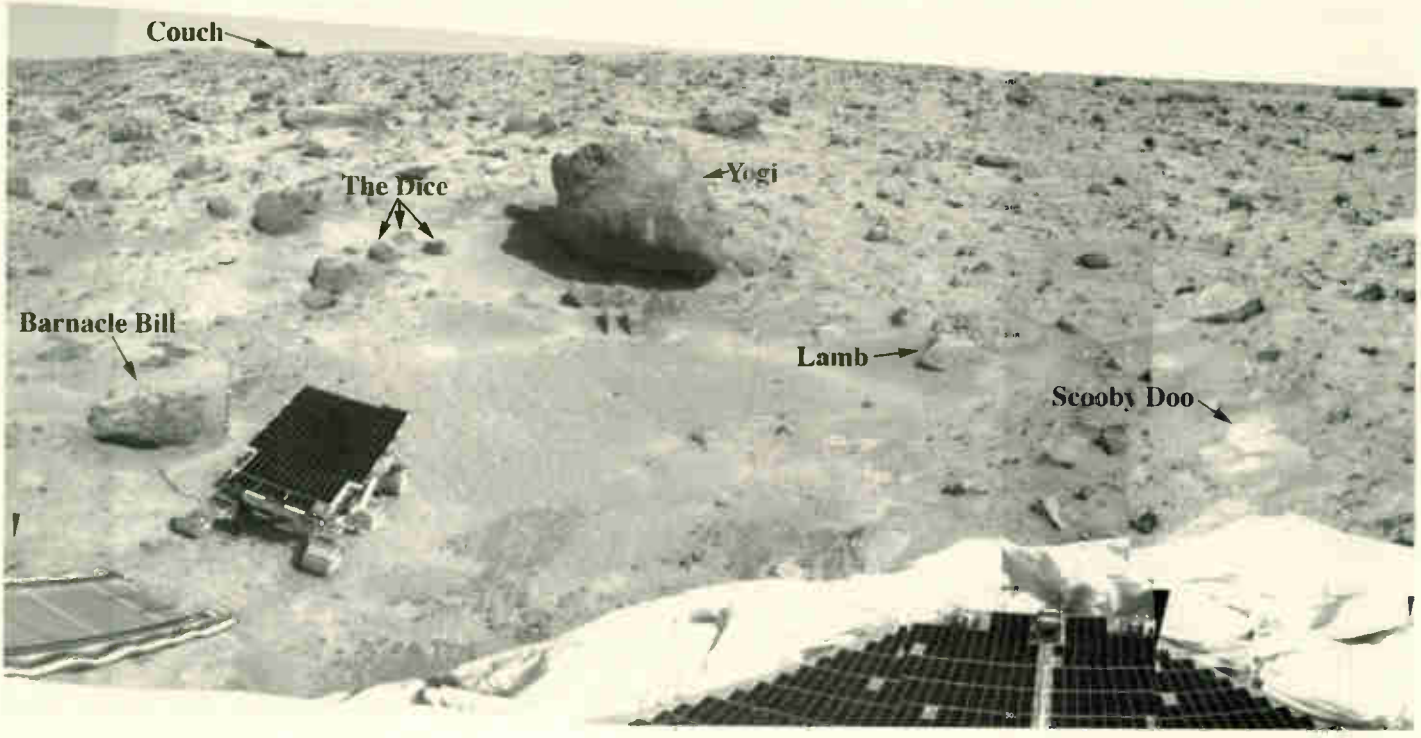
One unique outside site is by Italian ham radio operator Maury Bertolino. He's written an MS DOS program which decodes the telemetry from the rover. It's available for free at his web site: **http://www-dx.deis.unibo.it/htdx/**

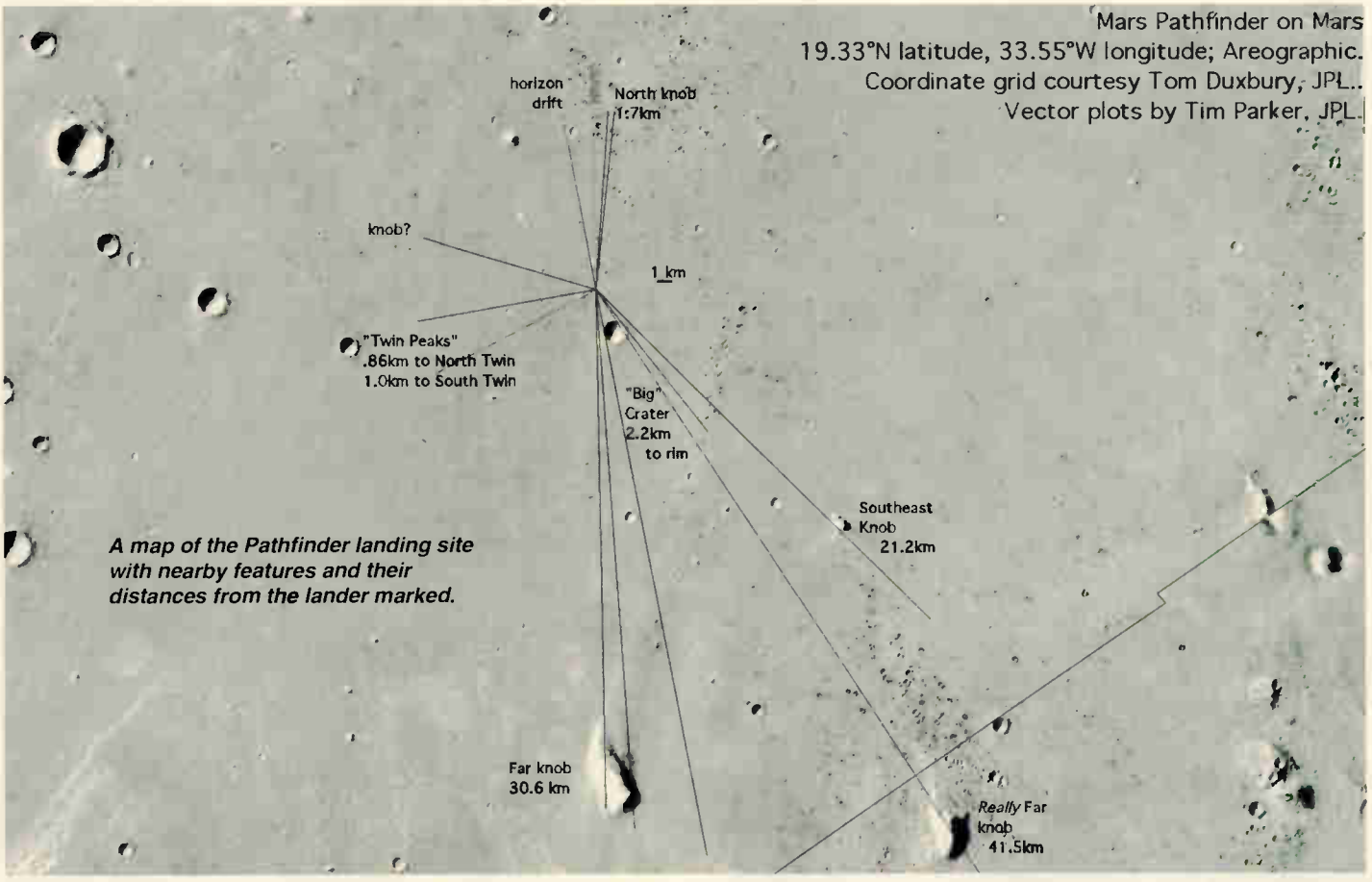
The official Mars Global Surveyor web site is **http://mgs-www.jpl.nasa.gov/**. *It's got excellent links to information about Mars.*

The official Cassini Web site is **http://www.jpl.nasa.gov/cassini/**.

Above: A Mars Global Surveyor satellite image from the web site maintained by Malin Space Science Systems (http://barsoom.msss.com/http/new_directories/newhome.html). At left, a horizon shot from the Pathfinder mission.

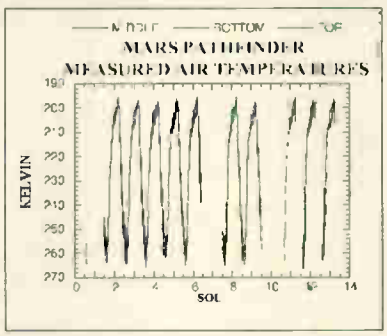
How Best to Visit Mars?





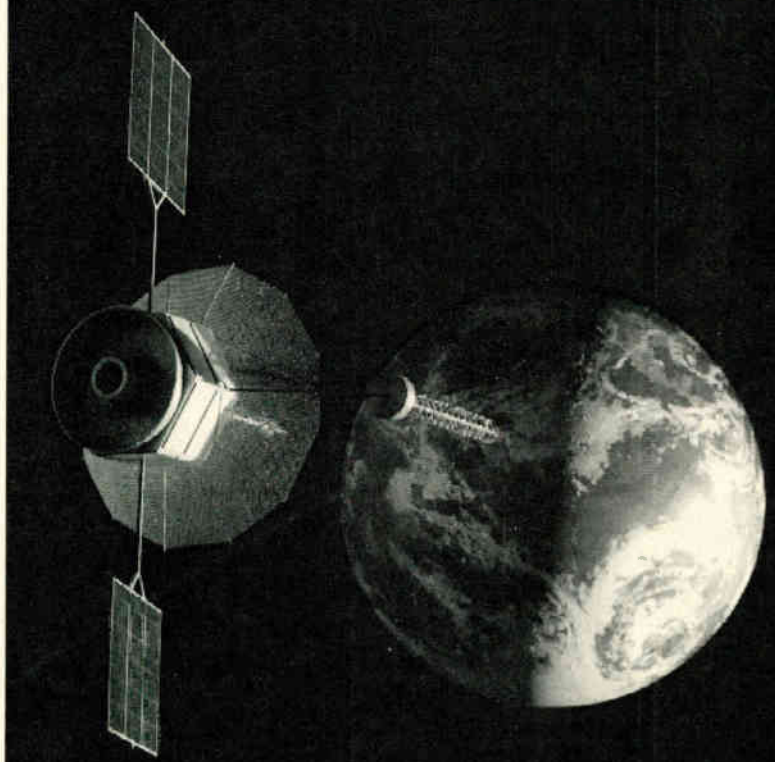
A map of the Pathfinder landing site with nearby features and their distances from the lander marked.

By Keyboard & Mouse!



Sharp photos from both the lander and the rover (which looked back at the lander in the photo above) have given scientists a very clear idea of the terrain and the nearby features of the landing site. Tracks from the rover (right) reveal insights about the soil consistency. Want to know details about Martian weather? Check out the weather charts at http://mars.sgi.com/default.html.

The Darker Side of DEEP BLACK



In part one of this series on U.S. military satellites (Satellite Times May/June 1997, page 10) we looked at the USA numbering system, and the first six types of satellites to use the numbering scheme—GPS navigation satellites, Keyhole photographic reconnaissance satellites, Hitchhiker satellites, and the SDS high altitude comsats.

Part two (Satellite Times July/August 1997, page 10) explored military satellites used for missile early warning, ocean surveillance, Satellite Defense Initiative (or Star Wars), electronic intelligence, and much more!

In this issue of Satellite Times, we present the conclusion of Philip Chien's extensive look into the U.S. military space program—Deep Black, Part 3.

Last of a three-part series

By Philip Chien

USA 53 remains one of the biggest mysteries in the U.S. military space program. It was launched on the STS-36 classified shuttle mission.

The facts—space shuttle *Atlantis* put a large satellite into a 62 degree inclination orbit, higher than the normal 57 degree shuttle safety limit. It was decided that the satellite, which was originally scheduled for launch on a shuttle flying out of Vandenberg Air Force Base in California was of "national interest," and therefore a waiver was made to the shuttle's flight rules.

During the ascent the shuttle went over Cape Hatteras, North Carolina, and Cape Cod, Massachusetts. The Air Force decided that, if a catastrophic failure happened while the trajectory computers predicted that the shuttle would hit land, they would do nothing and let the shuttle fall wherever it chose to fall, rather than send a destruct command which would determine who would die and who wouldn't. In practice the risks were minimal with just a couple of seconds of exposure in each location.

Since the launch and mission were classified, civilian populations were not notified. However, personnel at military bases on the East Coast were prepared for nighttime rescue or damage control operations if a disaster did occur. Reliable reports stated that as many extraneous items as possible were left off *Atlantis* to make the high energy requirements for the unusually high orbit, with normal items like extra-vehicular activity (EVA) handrails removed to lighten the shuttle.

Media Speculation

According to media speculation, the name of the spacecraft was AFP-731 (Air Force Program 731) and it was a next generation Keyhole satellite. It was flying on the shuttle out of Florida because no California-based launch vehicle was operational which could handle such a large payload.

It was widely reported that the launched satellite had accidentally exploded or had broken into several pieces, and that additional items from the launch were tracked in the NORAD catalog. Several months later, observers found the satellite in a stable 800 km (497 mile) high, 65 degree inclination orbit, indicating that the satellite had made several maneuvers but certainly hadn't failed or exploded.

What's most frustrating is that the satellite appears to be a one-of-a-kind, not matching the characteristics of any other satellite. This has reinforced speculations that it is a Keyhole, in a compromise orbit because of the lack of availability of West Coast launch vehicles.

The Payload Disappears

In the summer of 1990 the payload disappeared from view, adding further confusion. There is no way for a satellite to magically vanish. Dozens of highly skilled amateur satellite observers monitor the high interest satellites in low orbits, especially classified satellites where the U.S. refuses to release orbital elements. It's beyond the realm of comprehension that all of these observers should suddenly decide to ignore an object the size of a schoolbus, or pretend that they aren't seeing it anymore.

If the satellite had failed for any reason, then it still would remain visible—either as a tumbling object once it lost control, or as multiple pieces if it exploded. So the only logical conclusion is that the satellite was moved into a different orbit. Satellites in a higher orbit are dimmer, due to the greater distance from the observer. It's possible to spot satellites in very high orbits, but only by luck or through a deliberate search with a fairly good knowledge of the orbit the satellite moved into.

If the satellite did move into a higher orbit then it isn't likely that it was an imaging satellite. With the greater distance from the target, the spacecraft camera resolution isn't likely to be adequate though. Lower resolution, larger area photos are extremely useful for military purposes to assess the "big picture." They are already available from weather satellites and commercial remote sensing satellites like Landsat and Spot.

An alternative is the satellite could have moved into a lower orbit for higher resolution images. It's feasible that the satellite could have remained unrecognized by the amateur satellite monitoring community for a couple of months. On the other hand, the penalty for achieving incredibly high resolution images in a low orbit is an extremely limited lifetime, due to drag in the Earth's upper atmosphere.

USA 53 disappeared in the summer of 1990 after Iraq invaded Kuwait—while Operation Desert Shield built up U.S. and allied forces in Saudi Arabia and the entire Persian Gulf region. It's been speculated that USA 53 was purposely sacrificed as a critical asset for the Gulf War. Under this scenario the satellite's controllers, knowing that it would result in less than a year's useful lifetime, instructed USA 53 to go into a lower altitude orbit.

Since the lifetime was limited, the large propellant supply on the satellite could be used for many maneuvers to make it more difficult for adversaries to track and to select the most appropriate passes over important targets on the ground. After the Gulf War was over the satellite was permitted to die as it reentered the Earth's atmosphere.

It's an interesting scenario, and fits the known facts, but until it's verified by sources with actual knowledge, it will remain only a theory.

Stealth Technology Suspected

There has been much speculation that this particular satellite tested some form of stealth technology. But while the stories have come from a mixture of reliable and unreliable sources, it doesn't seem to fit what we known. Other than in James Bond movies, there is no way to make a true stealth spacecraft, invisible to both visual and radar trackers.

There are many materials which absorb or deflect radar, and many which absorb or deflect visible energy, but few materials which can do both. The principle behind a stealth aircraft is to minimize the radar signature—not to eliminate it. An F-117A has roughly the same radar cross section as a hummingbird. But as thousands of air show attendees can attest, it's quite spectacular to see—and hear-in flight. Even if you assume that there's some top-secret military material which absorbs all forms of radiation it still wouldn't work.

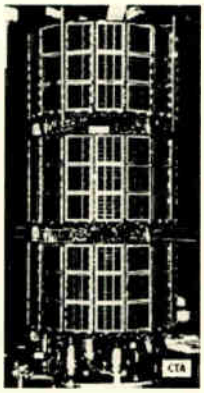
A spacecraft's light and dark surfaces are carefully selected to maintain the proper heat balance and thermal control. Spacecraft operate in a near-perfect vacuum—like a Thermos bottle. And spacecraft systems generate heat which must be rejected. A stealth spacecraft (e.g. dark matte black surfaces) would quickly heat up to temperatures which would roast its electronics.

On the other hand, it is possible to reduce the visibility of a spacecraft simply by rotating it. Again the thermal balance must be considered, but an edge-on spacecraft appears much dimmer than one which is at the appropriate angle to catch the sun.

The Hubble Space Telescope can brighten by several magnitudes when its surfaces catch the sun just right. And a spacecraft which has its narrow end facing a ground-based radar installation or visual tracking station does result in a weaker signature. The problem with this hypothesis is that it assumes that the spacecraft is actively playing "hide and seek" with a tracking station in a known location; it doesn't work if the adversary has two tracking stations in separate locations which can view the target at the same time from different perspectives.

Is it possible that USA 53 was the first of the new Keyhole satellites? Certainly it's one of the likely candidates. But did it have some kind of magical stealth capabilities which permits it to elude the tracking capabilities of major super powers and amateur satellite observers? You'll have to show me a lot more evidence than a bunch of rumors.

AFP Trio is Launched



USA 56, 57, and 58 were a trio of research satellites launched together on an Atlas E launch vehicle. Together they flew as AFP 87-2. The trio were: USA 56 POGS (Polar Orbit Geomagnetic Survey), USA 57 TEX (Transceiver experiment), and USA 58 SCE (Selective Communications Experiment).

NOSS Launch From Florida

USA 59 through 62 were launched on a Titan IV from Florida. Careful examination of the launch time, launch azimuth, and eventual sightings in orbit determined an unusual launch trajectory. On the way to orbit the rocket made a "left turn," resulting in a higher inclination than the one which would normally be predicted by the launch direction. The vehicle could certainly have flown directly to the operational orbit, but it's still unknown why the vehicle was launched on such an unusual trajectory.

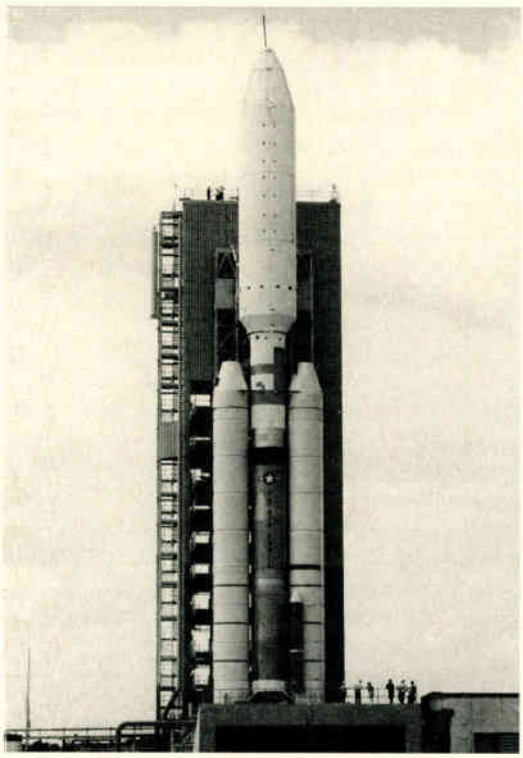
Given the amount of USA numbers it was highly likely to be a new class of larger Navy Ocean Surveillance Satellites (NOSS), and a bright triad was quickly spotted. Unlike the earlier NOSS, which are dim objects which must be viewed with binoculars, the new NOSS series are fairly bright visible to the naked eye objects. The Titan IV has much more capacity than the Atlas rockets used for previous NOSS constellations.

In addition, an extra object is listed and presumably is the primary payload. While the Titan upper stage and primary payloads have been observed in low earth orbit after Titan IV-NOSS launches, the primary payload has disappeared in each case, implying a large satellite with an onboard propulsion system to transfer it in a higher altitude orbit—too far to be easily observed by amateur satellite watchers.

Recently the propulsion module for the NOSS dispenser has come out of the deep black world. Originally known as the shuttle launch dispenser, and then as the Titan launch dispenser, it's now known as the Interim Control Module—the bus which NASA is planning as a backup for the space station if the Russian service module is not available in time. This has added an extra piece of information to the hard facts about classified satellites—the NOSS satellites were originally intended for launch on the shuttle and were transferred to the Titan IV after the *Challenger* accident.

Due to several military satellites being launched in a short period, the next NOSS series had its USA designators jumbled: USA 72 is the primary, and USA 74, 76, and 77 are the rest of the payloads associated the NOSS 2-2 constellation. These satellites were launched together on a Titan IV from Vandenberg Air Force Base. The NOSS inclination permits launches from either Florida or California, but it appears that the Air Force prefers to launch them from California.

A trio of NOSS satellites was lost in a launch accident on August 2, 1993, when the Titan IV failed shortly after launch. Since they didn't reach orbit they didn't get USA designations. The identity of the satellites was verified by examining the launch vehicle's trajectory and launch time, which would have resulted in an orbit complementary to the two earlier NOSS-2 constellations.



Titan IV rocket on the launch pad.

The most recent NOSS-2 triad was launched on May 12, 1996. Its orbit, precessed backwards in time, matches the launch time for the previous series which failed to reach orbit. This series was designated USA 120-122, and the primary payload was assigned USA 119.

Last Shuttle Classified Mission

STS-38 was supposed to be the last classified shuttle mission. It was launched on November 15, 1990, and deployed a large satellite, USA 67, several hours later. Visual observers noted that the spinning satellite remained within the shuttle's vicinity for several orbits before its upper stage motor was fired.

Normally an upper stage fires about 45 minutes after it's deployed by the shuttle, permitting the shuttle to move away to a safe viewing position. Contrary to reports at the time, the satellite certainly had nothing to do with the Desert Shield military build-up in Saudi Arabia since it had been built several years earlier. Reports that the astronauts retrieved the satellite because it had malfunctioned are certainly completely false, since that shuttle had no way to retrieve any payload on that mission.

The NORAD catalog lists four objects from this launch—the space shuttle, the USA 67 payload, and two additional components. Some reports have listed those pieces as the two parts of an Inertial Upper Stage (IUS). The IUS, used for most classified shuttle payloads destined for high altitude orbits, is inertial stabilized and would not appear as a flashing object, so this isn't likely.

Based on available tracking information it appears that the satellite was designed for geosynchronous orbit, but did not use an Inertial Upper Stage. So far the only logical conclusion is the satellite is a geosynchronous version of the SDS satellite, but that information must be considered tentative until it's confirmed by additional information.

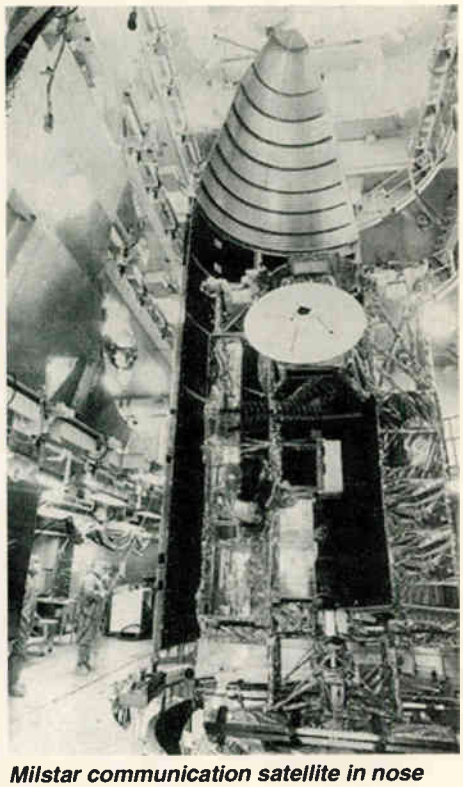
UFOs, NATO, and Milstar

USA 95 was given to the second UHF follow-on satellite (*Satellite Times* September/October 1995, page 14). Since UHF-

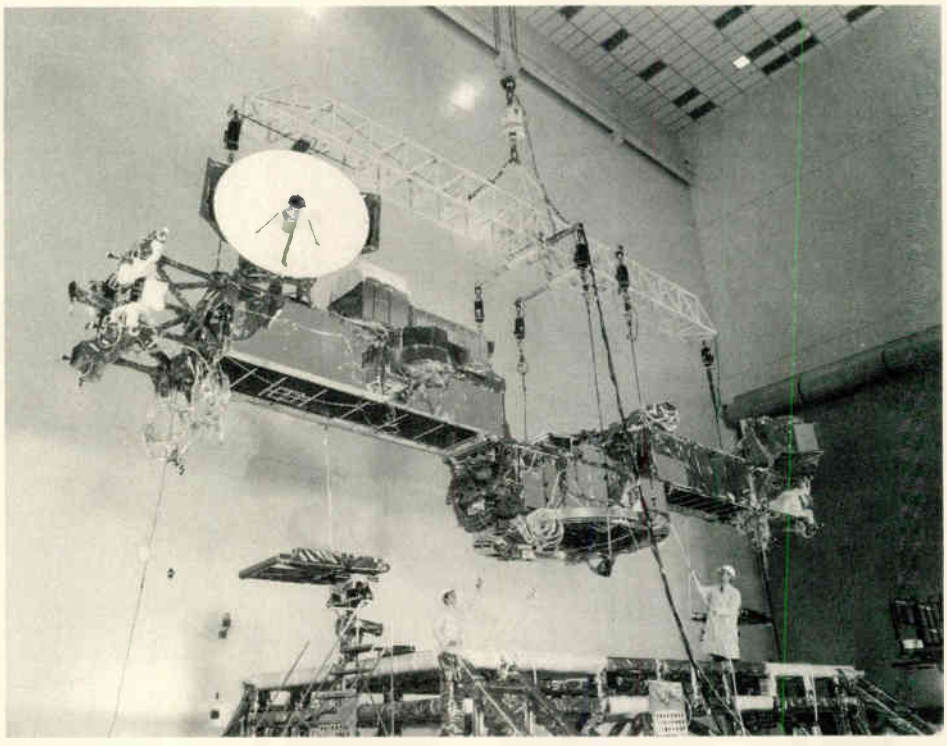
1 was never turned over to the Navy it didn't get a USA designation, even though it's in orbit. USA 104 was given to UHF 2. Later satellites in the series were designated EHF due to the additional Extremely High Frequency payload. They were given the USA designations USA 108, USA 111, USA 114, and USA 127.

USA 98 was assigned to NATO 4B. The big mystery is why a USA designation was given to an unclassified international communications satellite, especially since NATO 4A did not get a USA designation. In all probability a mistake was made in assigning the designation, but once assigned it would be more difficult to reassign the number to another satellite.

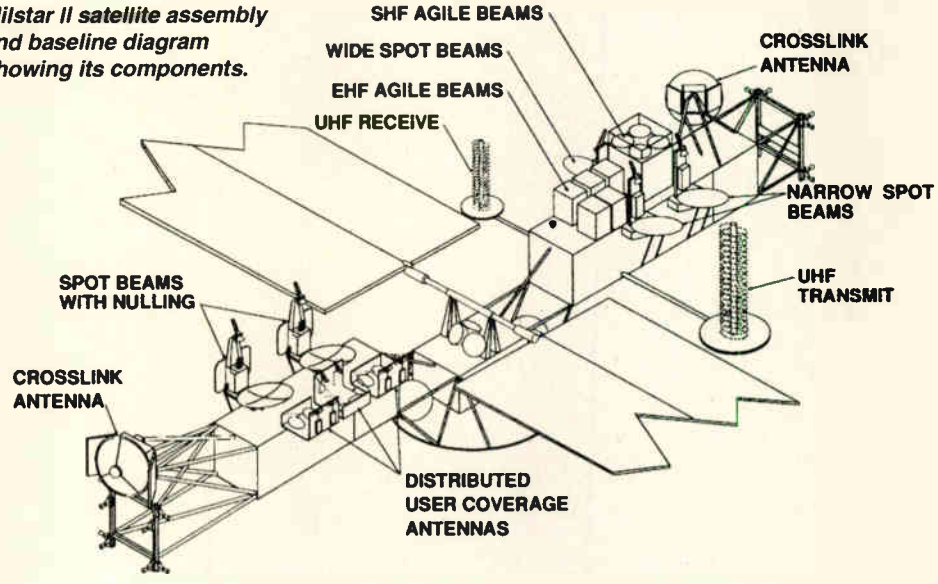
USA 99 was given to the first Milstar communications satellite, DFS-1, and USA 115 was given to DFS-2. Milstar (*Satellite Times* January/February 1996, page 84) was the first Titan IV-Centaur payload, and the most capable "switchboard in the sky." Its purposes and locations are for the most part unclassified. The first satellite carried a set of classified transponders, rumored to be relay units for the Keyhole satellites. Due to the end of the Cold War the transponders became redudant and were replaced with ballast on DFS 2. Contrary to a front page story in the *Los Angeles Times* the ballast was not sand!



Milstar communication satellite in nose cone.



Milstar II satellite assembly and baseline diagram showing its components.



DARPA Launches Research Satellites

After DARPA (Defense Advanced Research Projects Agency) developed the air-launched Pegasus launch vehicle, they felt that there was a need for a similar tactical ground-based launch vehicle. The call for proposals outlined a portable launch vehicle which could be transported in normal trucks and caravaned to any flat concrete surface. Within five days the launch team should be able to assemble and check out the launch vehicle and mate the satellite. In theory such a system could have led to dozens of launch vehicles stockpiled in military bases around the United States, ready to launch tactical satellites if they would be useful in a regional war.

OSC won the competition with its Taurus launch vehicle derived from the Pe-

(Continued on page 24)

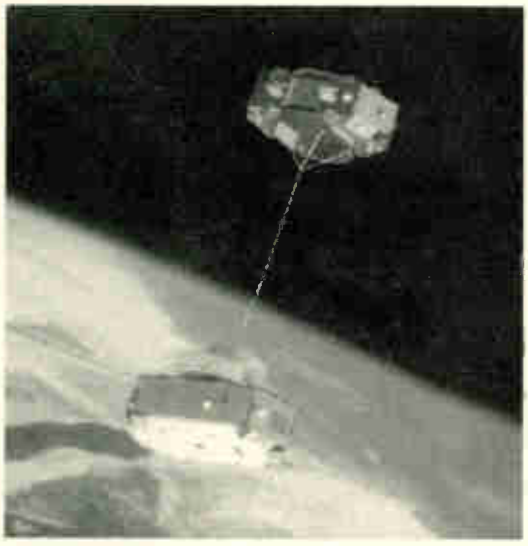
TABLE 1: U.S. MILITARY PAYLOADS LAUNCHED WITH A USA DESIGNATION

Intl Design	Spacecraft Name	USA Desig	Orbit	Satellite Launch Agency/Manuf	Launch Vehicle	Launch Date
1984-59A	Navstar 9	USA 1	12 hr orbit	USAF-GD	Atlas F	6/13/84
1984-65A	KH 9-19	USA 2	Sunsync orbit	USAF-Martin	Titan 34D	6/25/84
1984-65C	Hitchhiker 45	USA 3	Sunsync orbit	USAF-Martin	Titan 34D	6/25/84
1984-91A	SDS 9	USA 4	63° MEO	USAF-Martin	Titan 3B-Ag D?	8/28/84
1984-97A	Navstar 10	USA 5	12 hr orbit	USAF-GD	Atlas F	9/8/84
1984-122A	KH 11-6	USA 6	Sunsync orbit	USAF-Martin	Titan 34D	12/4/84
1984-129A	DSP F6R?/IMEWS or DSCS-3??	USA 7	8.1°W GEO	USAF-Martin	Titan 34D/Trans	12/22/84
1985-10B	Ferret (Aquacade/Magnum)	USA 8	178°E GEO	STS-Boeing	IUS	1/24/85
1985-14A	SDS 10	USA 9	63° MEO	USAF-Martin	Titan 3B-Ag D?	2/8/85
1985-93A	Navstar 11	USA 10	12 hr orbit	USAF-GD	Atlas F	10/9/85
1985-92B	DSCS-3 B2	USA 11	? GEO	STS-Boeing	IUS	10/3/85
1985-92C	DSCS-3 B3	USA 12	? GEO	STS-Boeing	IUS	10/3/85
1985-114A	AFITV-1 (AFP 8?-16)	USA 13	37.1° LEO	NASA-LTV	Scout	12/12/85
1985 114B	AFITV-2 (AFP 8?-16)	USA 14	37.1° LEO	NASA-LTV	Scout	12/12/85
1986-14A	NOSS 7	USA 15	63°? HEO	USAF-GD	Atlas F	2/9/86
1986-14E	NOSS 7A	USA 16	63°? HEO	USAF-GD	Atlas F	2/9/86
1986-14F	NOSS 7B	USA 17	63°? HEO	USAF-GD	Atlas F	2/9/86
1986-14H	NOSS 7C	USA 18	63°? HEO	USAF-GD	Atlas F	2/9/86
1986-69A	DM 43 (SDI-1)	USA 19	LEO	NASA-MD	Delta 3920	9/5/86
1986-96A	Fltsatcom-7	USA 20	100°W GEO	NASA-GD	Atlas-Centaur	12/4/86
1987-15A	SDS 11	USA 21	63° MEO	USAF-Martin	Titan 3B	2/11/87
1987-43A	NOSS 8	USA 22	63°? HEO	USAF-GD	Atlas H	5/15/87
1987-43E	NOSS 8A	USA 23	63°? HEO	USAF-GD	Atlas H	5/15/87
1987-43F	NOSS 8B	USA 24	63°? HEO	USAF-GD	Atlas H	5/15/87
1987-43H	NOSS 8C	USA 25	63°? HEO	USAF-GD	Atlas H	5/15/87
1987-53A	DMSP 8 (B5D2-3)	USA 26	Sunsync	USAF-GD	Atlas E	6/20/87
1987-90A	KH 11-7	USA 27	Sunsync	USAF-Martin	Titan 34D	10/26/87
1987-97A	DSP phase 2?	USA 28	? GEO	USAF-Martin	Titan 34D	11/29/87
1988-6A	DMSP 9 (B5D2-4)	USA 29	Sunsync	USAF-GD	Atlas E	2/3/88
1988-8A	Thursted Vector (SDI-2)	USA 30	LEO	NASA-MD	Delta 3910	2/8/88
1988-77A	VORTEX Elint/Sigint	USA 31	? GEO	USAF-Martin	Titan 34D?	9/2/88
1988-78A	NTS	USA 32	85°? LEO	USAF-Martin	Titan II	9/5/88
1988-99A	KH11-8	USA 33	Sunsync	USAF-Martin	Titan 34D	11/6/88
1988-106B	Lacrosse 1	USA 34	57.1° MEO	STS	RMS	12/2/88
1989-13A	Navstar II-1	USA 35	12 hr orbit	USAF-MD	Delta 6925 PAM	2/14/89
1989-26A	Delta Star	USA 36	47° LEO	USAF-MD	Delta 3920	3/24/89
1989-35A	VORTEX Elint/Sigint	USA 37	? GEO	USAF-Martin	Titan 34D Trans?	5/10/89
1989-44A	Navstar II-2	USA 38	12 hr orbit	USAF-MD	Delta 6925 PAM	6/10/89
1989-46A	DSP-14	USA 39	145°E GEO	USAF-Martin	Titan IV-IUS	6/14/89
1989-61B	SDS 2-1	USA 40	63° MEO	STS	SPDS?	8/8/89
1989-61C	GLOMR?	USA 41	57.1° LEO	STS	GAS eject	8/8/89
1989-64A	Navstar II-3	USA 42	12 hr orbit	USAF-MD	Delta 6925 PAM	8/8/89
1989-69A	DSCS 2-16	USA 43	60°E GEO	USAF-Martin	Titan 34D IUS	9/4/89
1989-69B	DSCS 3A4	USA 44	? GEO	USAF-Martin	Titan 34D IUS	9/4/89
1989-72A	NTS-3	USA 45	Polar orbit	USAF-Martin	Titan II	9/5/89
1989-77A	Fltsatcom-8	USA 46	23°W GEO	NASA-GD	Atlas-Centaur	9/25/89
1989-85A	Navstar II-4	USA 47	12 hr orbit	USAF-MD	Delta 6925 PAM	10/21/89
1989-90B	Ferret Aquacade	USA 48	? GEO	STS-Boeing	IUS	11/23/89
1989-97A	Navstar II-5	USA 49	12 hr orbit	USAF-MD	Delta 6925 PAM	12/11/89
1990-8A	Navstar II-6	USA 50	12 hr orbit	USAF-MD	Delta 6925 PAM	1/24/90
1990-15A	LACE	USA 51	43° LEO	MDSSC	Delta 6920	2/14/90
1990-15B	RME	USA 52	43° LEO	MDSSC	Delta 6920	2/14/90
1990-19B	AFP-731	USA 53	62.2° MEO	STS	SPDS?	2/28/90
1990-25A	Navstar II-7	USA 54	12 hr orbit	USAF-MD	Delta 6925 PAM	3/25/90
1990-28B	GLOMR-2	USA 55	Polar orbit	OSC	Pegasus	4/5/90
1990-31A	POGS (AFP 87-2)	USA 56	Polar orbit	USAF-GD	Atlas E/Altair	4/11/90
1990-31B	TEX (AFP 87-2)	USA 57	Polar orbit	USAF-GD	Atlas E/Altair	4/11/90
1990-31C	SCE (AFP 87-2)	USA 58	Polar orbit	USAF-GD	Atlas E/Altair	4/11/90
1990-50A	NOSS 2-1	USA 59	63°? HEO	USAF-Martin	Titan IV NUS	6/8/90
1990-50B	NOSS 2-1 subsat B	USA 60	63°? HEO	USAF-Martin	Titan IV NUS	6/8/90
1990-50C	NOSS 2-1 subsat C	USA 61	63°? HEO	USAF-Martin	Titan IV NUS	6/8/90
1990-50D	NOSS 2-1 subsat D	USA 62	63°? HEO	USAF-Martin	Titan IV NUS	6/8/90
1990-68A	Navstar II-8	USA 63	12 hr orbit	USAF-MD	Delta 6925 PAM	8/2/90
1990-88A	Navstar II-9	USA 64	12 hr orbit	USAF-MD	Delta 6925 PAM	10/1/90
1990-95A	DSP-15	USA 65	37.442°E GEO	USAF-Martin	Titan IV-IUS	11/12/90
1990-103A	Navstar II-10	USA 66	12 hr orbit	USAF-MD	Delta 7925 PAM	11/26/90
1990-97B	SDS 2-2? (AFP-658?)	USA 67	? GEO	STS	????	11/15/90
1990-105A	DMSP 10 (B5D2-5)	USA 68	Sunsync orbit	USAF-GD	Atlas E	12/1/90
1991-17A	Lacrosse 2	USA 69	68° MEO	USAF-Martin	Titan IV	3/8/91
1991-31C	GLOMR-MPEC	USA 70	57.1° LEO	STS	GAS-MPEC	5/6/91
1991-47A	Navstar II-11	USA 71	12 hr orbit	USAF-MD	Delta 7925 PAM	7/3/91
1991-76A	NOSS 2-2	USA 72	63°? HEO	USAF-Martin	Titan IV NUS	11/7/91
1991-82A	DMSP 11 (B5D2-6)	USA 73	Sunsync	USAF-GD	Atlas E	11/28/91
1991-76C	NOSS 2-2	USA 74	63°? HEO	USAF-Martin	Titan IV NUS	11/7/91
1991-80B	DSP-16 (Liberty)	USA 75	70.736°W GEO	STS-Boeing	IUS-14	11/24/91
1991-76D	NOSS 2-2	USA 76	63°? HEO	USAF-Martin	Titan IV NUS	11/7/91
1991-76E	NOSS 2-2	USA 77	63°? HEO	USAF-Martin	Titan IV NUS	11/7/91
1992-6A	DSCS 3B5 (MLV-1)	USA 78	52.5°W GEO	USAF-GD	Atlas II	2/10/92
1992-9A	Navstar II-12	USA 79	12 hr orbit	USAF-MD	Delta 7925 PAM	2/23/92
1992-19A	Navstar II-13	USA 80	12 hr orbit	USAF-MD	Delta 7925 PAM	4/9/92
1992-23A	NTS	USA 81	85° LEO	USAF-Martin	Titan II	4/25/92
1992-37A	DSCS 3B6 (MLV-2)	USA 82	? GEO	USAF-GD	Atlas II	7/2/92
1992-39A	Navstar II-14	USA 83	12 hr orbit	USAF-MD	Delta 7925 PAM	7/7/92

Intl Design	Spacecraft Name	USA Desig	Orbit	Satellite Launch Agency/Manuf	Launch Vehicle	Launch Date
1992-58A	Navstar II-15	USA 84	12 hr orbit	USAF-MD	Delta 7925 PAM	9/9/92
1992-79A	Navstar II-16	USA 85	12 hr orbit	USAF-MD	Delta 7925 PAM	11/22/92
1992-83A	KH-11A (Kennan/Crystal)	USA 86	Sunsync orbit	USAF-Martin	Titan IV	11/28/92
1992-89A	Navstar II-17	USA 87	12 hr orbit	USAF-MD	Delta 7925 PAM	12/18/92
1993-7A	Navstar II-18	USA 88	12 hr orbit	USAF-MD	Delta 7925 PAM	2/2/93
1992-86B	SDS 2- ? (DoD-1)	USA 89	63° MEO	STS	SPDS??	12/2/92
1993-17A	Navstar II-19	USA 90	12 hr orbit	USAF-MD	Delta 7925 PAM	3/29/93
1993-32A	Navstar II-20	USA 91	12 hr orbit	USAF-MD	Delta 7925 PAM	5/12/93
1993-42A	Navstar II-21	USA 92	12 hr orbit	USAF-MD	Delta 7925 PAM	6/26/93
1993-46A	DSCS 3B9 (MLV-3)	USA 93	60°E GEO	USAF-GD	Atlas II	7/19/93
1993-54A	Navstar II-22	USA 94	12 hr orbit	USAF-MD	Delta 7925 PAM	8/30/93
1993-56A	UFO 2	USA 95	72°E GEO	GenDynamics	Atlas I	9/3/93
1993-68A	Navstar II-23	USA 96	12 hr orbit	USAF-MD	Delta 7925 PAM	10/26/93
1993-74A	DSCS 3B10 (MLV-4)	USA 97	? GEO	USAF-GD	Atlas II	11/28/93
1993-76A	NATO 4B	USA 98	? GEO	MDSSC	Delta 7925 PAM	12/7/93
1994-09A	Milstar DFS-1	USA 99	120°W GEO	USAF-Martin	Titan IV-Centaur	2/7/94
1994-16A	Navstar II-24	USA 100	12 hr orbit	USAF-MD	Delta 7925 PAM	3/9/94
1994-17A	STEP 0 (AFP 90-5) TAOS	USA 101	Polar orbit	OSC	Taurus	3/13/94
1994-17B	DARPASAT	USA 102	Polar orbit	OSC	Taurus	3/13/94
1994-26A	Jumpseat? (Aquacade/Magnum?)	USA 103	63° MEO	USAF-Martin	Titan IV-Centaur	5/3/94
1994-35A	UFO 3	USA 104	15°W GEO	GenDynamics	Atlas I	6/24/94
1994-54A	VORTEX Elint/Sigint	USA 105	? GEO	USAF-Martin	Titan IV-Centaur	8/27/94
1994-57A	DMSP 12 (B5D2-7)	USA 106?	Sunsync orbit	USAF-GD	Atlas E	8/29/94
1994-84A	DSP-17	USA 107	103.5°W GEO	USAF-Martin	Titan IV-IUS	12/22/94
1995-3A	EHF 4	USA 108	177°W GEO	GenDynamics	Atlas II	1/28/95
1995-15A	DMSP 13 (B5D3-1)	USA 109	Sunsync orbit	USAF-GD	Atlas E	3/24/95
1995-22A	Advanced Orion?	USA 110	? GEO	USAF-Martin	Titan IV-Centaur	5/14/95
1995-27A	EHF 5	USA 111	72.5°E GEO	GenDynamics	Atlas II	5/31/95
1995-34A	Jumpseat?	USA 112	63° MEO?	USAF-Martin	Titan IV-Centaur	7/10/95
1995-38A	DSCS 3B7 (MLV-5)	USA 113	? GEO	USAF-GD	Atlas IIA	7/31/95
1995-57A	EHF 6	USA 114	100°W GEO	GenDynamics	Atlas II	10/21/95
1995-60A	Milstar DFS-2	USA 115	4°E GEO	USAF-Martin	Titan IV-Centaur	11/6/95
1995-66A	KH-11A	USA 116	Sunsync orbit	USAF-Martin	Titan IV NUS	12/5/95
1996-19A	Navstar II-25	USA 117	12 hr orbit	USAF-MD	Delta 7925 PAM	3/27/96
1996-26A	Advanced Orion?	USA 118	? GEO	USAF-Martin	Titan IV-Centaur	4/24/96
1996-29A	NOSS 2-3R	USA 119	63°? HEO	USAF-Martin	Titan IV NUS	5/12/96
1996-29C	NOSS 2-3R	USA 120	63°? HEO	USAF-Martin	Titan IV NUS	5/12/96
1996-29D	NOSS 2-3R	USA 121	63°? HEO	USAF-Martin	Titan IV NUS	5/12/96
1996-29E	NOSS 2-3R	USA 122	63°? HEO	USAF-Martin	Titan IV NUS	5/12/96
1996-29E	TiPS- Ralph tether exp	USA 123	63° MEO	USAF-Martin	Titan IV NUS	5/12/96
1996-29F	TiPS- Norton tether exp	USA 124	63° MEO	USAF-Martin	Titan IV NUS	5/12/96
1996-38A	?	USA 125	55° LEO initial	USAF-Martin	Titan IV-NUS	7/2/96
1996-41A	Navstar II-26	USA 126	12 hr orbit	USAF-MD	Delta 7925 PAM	7/16/96
1996-42A	EHF 7	USA 127	172°E GEO	GenDynamics	Atlas II	7/25/96
1995-56A	Navstar II-27	USA 128	12 hr orbit	USAF-MD	Delta 7925 PAM	9/12/96
1996-72A	KH-11A	USA 129	Sunsync orbit	USAF-Martin	Titan IV-NUS	12/20/96
1997-8A	DSP-18	USA 130	GEO	USAF-Martin	Titan IVB-IUS	2/28/97
1997-12A	DMSP 14 (B5D2-14)	USA 131	Sunsync orbit	USAF-Martin	Titan II	4/4/97

TABLE 2: U.S. MILITARY PAYLOADS LAUNCHED SINCE 1984 WITHOUT A USA DESIGNATOR

Intl Design	Spacecraft Name	Orbit	Satellite Launch Agency/Manuf	Launch Vehicle	Launch Date
1984-93C	Syncom IV-2	177°W GEO	HCI-USN	STS 41D/MM3	8/30/84
1984-110A	NOVA III	Polar orbit	USN/NASA-LTV	Scout/S-208C	10/11/84
1985-21A	Geosat	?	USN/USAF-GD	Atlas E/A-?	3/13/85
1985-28C	Syncom IV-3	105°W GEO	HCI-USN	STS 51D/MM3	4/12/85
1985-66A	Transit 19 (SOOS-I/Oscar 24)	Polar orbit	USN/NASA-LTV	Scout/S-209C	8/2/85
1985-66B	Transit 20 (SOOS-I/Oscar 30)	Polar orbit	USN/NASA-LTV	Scout/S-209C	8/2/85
1985-104B	GLOMR-1R	57.1° LEO	DARPA	STS 61-A/GAS eject	10/30/85
1986-88A	Polar BEAR (AFP 87-11)	Polar orbit	USN/NASA-LTV	Scout/S-199C	11/13/86
1987-80A	Transit 21 (SOOS-II/Oscar 27)	Polar orbit	USN/NASA-LTV	Scout/S-204C	9/16/87
1987-80B	Transit 22 (SOOS-II/Oscar 29)	Polar orbit	USN/NASA-LTV	Scout/S-204C	9/16/87
1988-33B	Transit 24 (SOOS-III Oscar 32)	Polar orbit	USN/NASA-LTV	Scout/S-211C	4/25/88
1988-33A	Transit 23 (SOOS-III Oscar)	Polar	USN/NASA-LTV	Scout/S-211C	4/25/88
1988-52A	NOVA II	Polar orbit	USN/NASA-LTV	Scout/S-213C	6/15/88
1988-74A	Transit 25 (SOOS-IV/Oscar 25)	Polar orbit	USN/NASA-LTV	Scout/S-214C	8/25/88
1988-74B	Transit 26 (SOOS-IV/Oscar 31)	Polar orbit	USN/NASA-LTV	Scout/S-214C	8/25/88
1990-2B	Syncom IV-5	72.5°E GEO	HCI-USN	STS-32/MM-3	1/9/90
1990-43B	Macsat 2	Polar orbit	USAF-LTV	Scout/S-212C	5/9/90
1990-43A	Macsat 1	Polar orbit	USAF-LTV	Scout/S-212C	5/9/90
1990-65A	CRRES	GTO [operational]	USAF-NASA-GD	Atlas I/AC-69	7/25/90
1991-31B	IBSS (SPAS II)	57.1° LEO	SDIO	STS-39/RMS	4/28/91
1991-31x	CRO (3 sats A/B/C)	57.1° LEO	SDIO	STS-39/ejectable	4/28/91
1991-45A	REX (AFP 89-1A)	Polar orbit	DoD/NASA-LTV	Scout/S-216C	6/29/91
1991-47B	LOSAT-X	40° LEO	SDIO/USAF-MD	Delta 7925 PAM	7/3/91
1991-51A-G	MICROSATs	Polar orbit	DARPA/OSC	Pegasus-HAPS	7/17/91
1992-77A	MSTI	Polar orbit	SDIO/NASA-LTV	Scout	11/21/92
1993-26A	ALEXIS (AFP 89-1B)	70° LEO	Los Alamos/OSC	Pegasus	4/25/93
1993-41A	RADCAL (AFP 92-A)	Polar orbit	USAF/STP/NASA-LTV	Scout	6/25/93
1994-04A	Clementine	Lunar-Asteroid	SDIO/USAF/Martin	Titan IIG	1/25/94
1994-28A	MSTI 2	Polar orbit	SDIO/NASA/LTV	Scout	5/9/94
1994-29A	STEP 2 (AFP 91-2/ SIDEX)	Polar orbit	USAF/OSC	Pegasus-HAPS	5/19/94
1994-46A	APEX (AFP 90-6)	Polar orbit	USAF/OSC	Pegasus	8/3/94
1996-14A	REX-2	Polar orbit	DoD/OSC/USAF/SELV	Pegasus XL	3/8/96
1996-24A	MSX	Polar orbit	BMDO/MDSSC	Delta 7920-10	4/23/96
1996-31A	MSTI 3	Polar orbit	SDIO/OSC	Pegasus	5/16/96



Artist's rendition of the Tether Physics and Survivability Experiment. The thether material and the two TiPS satellite are shown below.

gasus and the MX ICBM. An MX first stage replaces the airplane normally used with a Pegasus. The wing is deleted, but the three Pegasus stages are used basically unmodified as the upper stages of the Taurus.

The first Taurus featured two test satellites, the TAOS STEP 0 research satellite (USA 101), and a classified lightsat nicknamed 'DARPASAT' (USA 102). Based on the mass it's possible that USA 102 is another GLOMR class satellite.

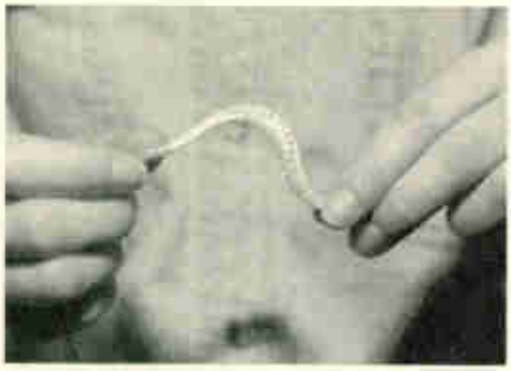
NOSS Takes on Hitchhikers

The May 12, 1996, launch of a Titan IV with the NOSS 2-3R constellation carried an unusual pair of hitchhikers—the Tether Physics and Survivability (TiPS) experiment. TiPS are the first unclassified National Reconnisance Office (NRO) satellites. The experiment featured two mini satellites connected with a 4-km tether. While the experiment was unclassified, researchers refused to talk about it or even acknowledge its existence until after the deployment.

The NRO still does not acknowledge which launch vehicle put TiPS into orbit, and gives misleading information in the unclassified orbital elements. The actual NORAD object numbers and international identifiers are left out, since these could reveal the launch vehicle or when the launch took place. But running orbital calculations in reverse clearly indicate their launch with the latest NOSS constellation. Suppliers without classified clearances, including NASA's Marshall Spaceflight Center and the tether supplier, were not informed about the orbit's characteristics or the launch until after the pair was deployed in orbit.

The two TiPS satellites have been dubbed "Ralph" and "Norton" after the characters from the *Honeymooners*. Appropriately Ralph is the larger of the two satellites. The tether is a high strength Spectra 1000 fiber, twisted with acrylic knitting yarn—very fluffy with a large diameter to make it as visible as possible.

When the satellites were deployed a battery-powered transmitter sent back data on the tether's deployment and dynamics. The battery has long since died, but the experiment continues using laser retroreflectors. Each of the satellites has 18- to 25-cm diameter laser reflectors. Ground-based lasers zap pulses at the satellite and monitor the return signals to determine their range to the satellites.



Norton's reflectors are uncoated, while Ralph's reflectors are coated with titanium oxide and silicon dioxide. Ralph's coatings absorb infrared lasers, permitting ground sites to determine which satellite they're hitting. A green laser will reflect off either set of reflectors while infared lasers will only reflect off of Norton. A passive UHF dipole antenna was embedded into the tether at the center of gravity which permits ground-based radar tracking stations to monitor the system's dynamics.

TiPS's primary goal is to model tether dynamics over a long period. It has been extended in orbit for over 200 days, far longer than any previous space tether experiment. The tether increases the surface area of the system by several orders of magnitude. Statistically this increases the chances that it will be hit by a micrometeoroid or piece of space debris. If the tether is hit at orbital velocities it will quickly sever, and Ralph and Norton will fling into separate orbits—just as if a rocket engine had fired. Investigators are extremely interested monitoring just how the system would react if this occurs.

Amateur satellite observers have been monitoring TiPS since its deployment, and it's rather incredible. It looks a bit like a glowing worm travelling across the sky and is spectacular in binoculars. Keplerian elements, without the proper object number, are available along with other information at the TiPS home page: **http://hyperspace.nrl.navy.mil/TiPS/home.html**

The Biggest Mystery Yet—USA 125

USA 125 is the most mysterious. Again we start with the known facts. On July 2, 1996, a Titan IV launched a large payload into an orbit which resulted in a 55 degree inclination. The Air Force released the direction the rocket would travel ahead of time, and the general direction was verified visually by observers at the launch site.

Amateur satellite observers spotted the upper stage and payload in orbit for a couple of days. Some time between July 8, at 22:43 UTC and July 9, 1996, at 06:14 UTC, the payload made a major maneuver. These times mark the last observation by an experienced observer, and the first non-observation by another experienced observer. Many other amateur satellite observers verified that, while the Titan upper stage was still in the parking orbit, the primary payload was nowhere to be found.

The next edition of the NORAD *Satellite Situation Report* listed an additional object from this launch, and the most logical assumption is some kind of upper stage motor which was ejected after it burned out. The rocket was serial number 2—which implies that the payload was

delayed for several years. Early Titan IVs were customized to adapt payloads originally intended for flight on the shuttle so it's possible that this payload had originally been intended for a classified shuttle mission in the 1986-1990 timeframe.

Beyond that there are no hard facts about USA 125. The inclination is extremely odd—no other classified satellite has used that inclination. And upper stages are very, very rarely used for launches between 30 and 60 degreee inclination. So the question remains—what is the mission of USA 125?

A Future Full of USA Designators

It's likely that the Department of Defense will continue to use the USA designations and continue to desire to fly classified payloads. While the Soviet Union doesn't exist anymore and Russia is more of an ally than an adversary these days, there are many threats from other areas around the globe. We can hope that with the end of the Cold War much of the unecessary secrecy involving military satellites, which has been an unncessary economic burden on the U.S. taxpayer, will be deleted.

As a footnote to this story, Corona spy satellite imagery from 1961 to 1972 has been declassified and the images have proven to be fascinating for historians, space buffs, and environmental scientists. The declassification of the decades old technology has not hurt national security in any way, and has given pride and credit to the people who made it possible. With this auspicious beginning, hopefully more military satellite programs will become declassified in the future. ST

TABLE 3: ABBREVIATIONS AND ACRONYMS

AFITV	Air Force Instrumented Test Vehicle
AFP	Air Force Program
Ag	Agena
ALEXIS	Array of Low Energy X-ray Imaging Sensors Satellite
APEX	Advance Photovoltaic and Electronics Experiment
BEAR	Beacon Auroral Research
BMDO	Ballistic Missile Defense Organization
CRO	Chemical Release Observation
CRRES	Chemical Release and Radiation Effects Satellite
DARPASAT	Defense Advanced Research Projects Agency Satellite
DFS	Development Flight Satellite
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense
DSCS	Defense Satellite Communications System
DSP	Defense Support Program
EHF	Extremely High Frequency
Elint	Electronic Intelligence
Fltsatcom	Fleet Satellite Communications
GAS	Get Away Special
GD	General Dynamics
GEO	Geostationary Earth Orbit
Geosat	Geodetic Satellite
GLOMR	Global Low Orbit Message Relay
GTO	Geo Transfer Orbit
HAPS	Hydrazene Auxilliary Propulsion System
HCI	Hughes Communications International
HEO	High Earth Orbit
Hr	Hour
IBSS	Infrared Background Signature Survey
IMEWS	Integrated Missile Early Warning Satellites
IUS	Inertial Upper Stage
KH	Keyhole
LACE	Low Atmospheric Composition Explorer
LEO	Low Earth Orbit
LOSAT	Low Altitude Satellite Experiment
LTV	LTV Aerospace Corporation
Macsat	Multiple Access Communications Satellites
MD	McDonnell Douglas
MDSSC	McDonnell Douglas Space Systems Company
MEO	Medium Earth Orbit
Milstar	Military Stategic Tactical Relay
MLV	Medium Launch Vehicle
MM3	Minuteman 3
MPEC	Multipurpose Experiment Canister
MSTI	Miniature Seeker Technology Integration
MSX	Mid-Course Space Experiment
NATO	North Atlantic Treaty Organization
NOSS	Navy Ocean Satellite Surveillance
NOVA	Standardized Tip Navigation Satellite
NTS	Navigation Technology Satellite
OSC	Orbital Sciences Corporation
PAM	Payload Assist Module
POGS	Polar Orbit Geomagnetic Survey
RADCAL	Radar Calibration
REX	Radiation Experiment
RME	Remote Mirror Experiment
RMS	Remote Manipulator System
SCE	Selective Communications Experiment
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDS	Satellite Data System
SIDEX	Signal Identification Experiment
Sigint	Signal Intelligence
SOOS	Stacked Oscar on Scout
SPAS	Shuttle Pallet Satellite
SPDS	Shuttle Payload Deployment System
STP	Space Test Program
STS	Space Transportation System (shuttle)
Sunsync	Sun synchronous orbit
TAOS	Technology for Autonomous Operational Survivability
TEX	Transceiver experiment
TiPS	Tether Physics and Survivability
Trans	Transtage
UFO	UHF Follow On
UHF	Ultra High Frequency
USAF	U.S. Air Force
USN	U.S. Navy

TABLE 4: U.S. MILITARY PAYLOAD FAILURE SINCE 1984 (NO USA DESIGNATOR ASSIGNED)

Intl Design	Spacecraft Name	Satellite Launch Agency/Manuf	Launch Vehicle	Launch Date	Reason for Failure
————	KH-11-x (7)	USAF/CIA/Martin	Titan 34D	8/28/85	Premature 1st stage shutdown
————	KH- 9-x	USAF/CIA/Martin	Titan 34D	4/18/86	Vehicle exploded
————	Fltsatcom-6	USN/NASA/GD	Atlas-Centaur	3/26/87	No trial (lightning launch)
1993-15A	UFO-1	Hughes/USN/GD	Atlas I	3/25/93	Atlas failure, lower apogee than planned
————	NOSS 2-3	USN/USAF/Martin	Titan IV	8/2/93	Failure end of SRBs burn
————	Navstar II-27	USAF-MD	Delta 7925 PAM	1/16/97	Solid failure

ST THE VIEW FROM ABOVE

By Lawrence Harris
lawrenceh@ndirect.co.uk

Views From China's New Weather Satellite

The launch on June 10, 1997, of China's first geostationary meteorological weather satellite Fengyun-2 (which translates as wind and cloud) was a milestone in the grand plan of a worldwide constellation of geostationary weather satellites. On June 17 it was maneuvered into its permanent position at longitude 105 degrees East, and on June 21 (the summer solstice) it transmitted what appears to have been its first visible light image (Figure 1).

FIGURE 1: Fengyun-2 first visible-light IMAGE

This image was made available by Mr Xu Jianmin of the National Satellite Meteorological Center (NSMC), China Meteorological Administration, People's Republic of China. The NSMC is encouraging the use of Fengyun-2 images so I hope that more will become available through their Internet site at:
http://ocean.gcn.ou.edu/xhu/fy2.htm

To illustrate the high quality of the image, I have extracted a small portion—see figure 2—showing the region around Indonesia, the South China Sea, Sumatra, and Malaysia.

The satellite itself is shown in figure 3, below right.

NASA obtained permission from Professor Fang of the National Meteorological Center in Beijing, to receive and share Fengyun-2 data. The satellite will provide coverage of the Asian hemisphere on an hourly basis.

Professor Torben Nielsen of the University of Hawaii has arranged to receive the data in Adelaide, Australia, at the University of Southern Australia, and to transmit full-resolution data, as well as calculated real-time products and localized sectors, over the Internet to NASA's Ames Research Center and Goddard Space Flight Center. There, the data will join similar data already being provided for GOES-8/9 and GMS-5. Data will be a full-resolution and product archive. Thanks to Dennis Chesters for providing this information (see Figure 4).

To put this newly operational satellite into context I have prepared a graphic showing the current footprints of the official operational geostationary weather satellites (see figure 5).

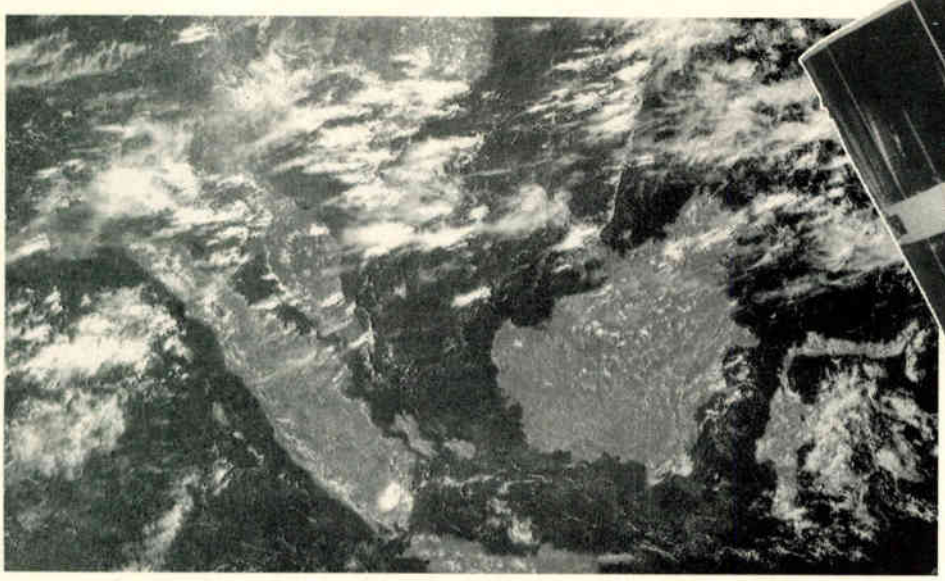


FIGURE 2: Fengyun-2 close-up

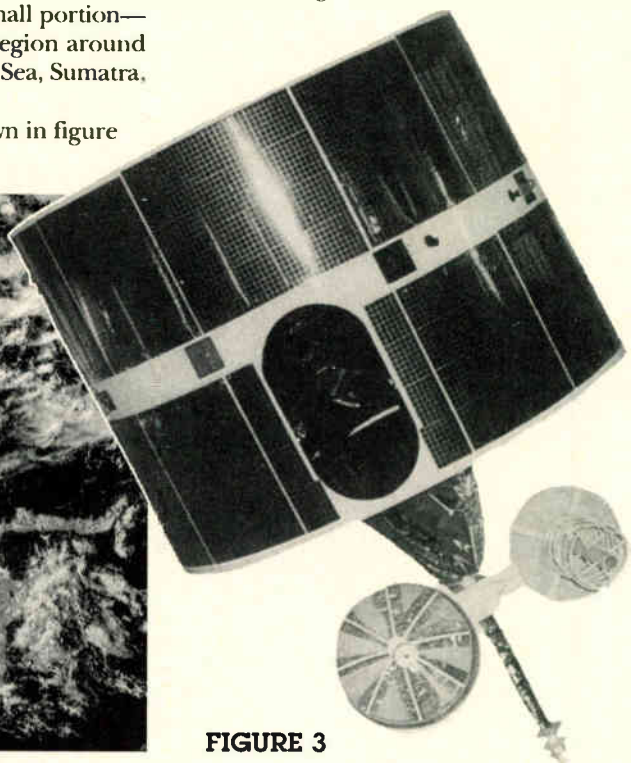


FIGURE 3

NASA obtained permission from Professor Fang of the National Meteorological Center in Beijing, to receive and share Fengyun-2 data. The satellite will provide coverage of the Asian hemisphere on an hourly basis.

FY-2 Spacecraft

Attitude Stability	Spin stabilized (100 rotation/min)
Orbital Altitute	35800km
Services	S-VISSR, L-Fax, etc

Scan Radiometer

Channel	Waveband	Nadir Resolution	Temporal Resolution
Visible	0 55-1 05 micron	1 25 x 1 25 (km x km)	1 hour
Water Vapour	6 2 - 7 6 micron	5 x 5 (km x km)	1 hour
IR	10 5-12 5 micron	5 x 5 (km x km)	1 hour

FIGURE 4: FENGYUN-2 specification

The Fengyun-2 image (figure 1) was taken on the day of the summer solstice, and I used a combination of direct weather satellite reception and Internet scavenging to obtain a summer solstice image from each of the other geostationary satellites: (figures 6-10 below).

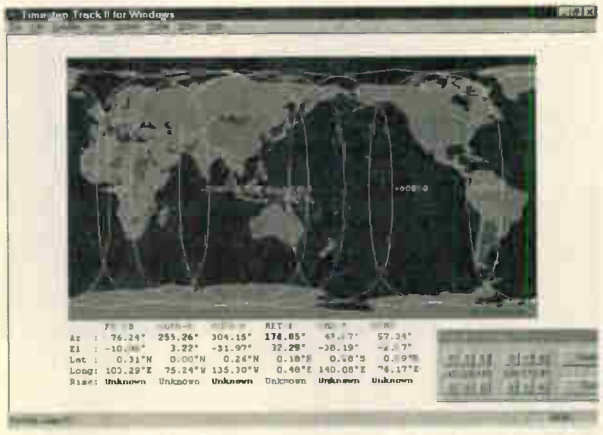


FIGURE 5: METEOSAT, GOMS, GOES-8, GOES-9, FENGYUN-2, and GMS-5 footprints.

FIGURE 6: METEOSAT-6 21 June at 1200 UTC.

FIGURE 8 (above): GOES-8 21 June at 1745 UTC.

FIGURE 9: GOES-9 21 June at 2100 UTC.

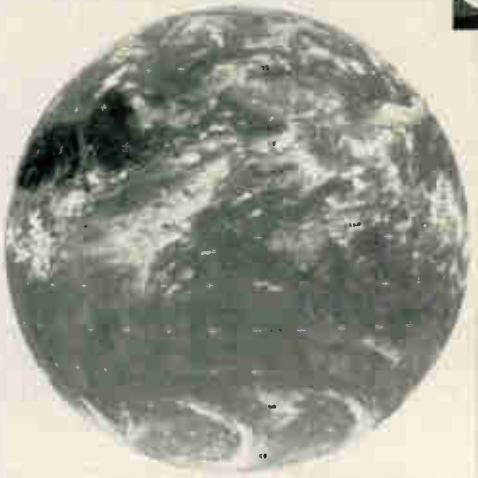


FIGURE 7: GOMS 21 June at 1500 UTC.

FIGURE 10 (right): GMS-5 21 June (uncertain time). GMS image provided by the University of Hawaii Satellite Oceanography Laboratory

Antenna coverage from the INSATs is essentially limited to India, its island territories and surrounding regions. The data is transmitted in digital format and is not encrypted. Due to the high data rate and low power transmission, the receive system is fairly complex.

INSAT

The Indian satellite INSAT could arguably be included in this listing, but officially it is a communications satellite which also performs some imaging operations. The images, at least as far as I am aware from correspondence with INSAT engineers and scientists, are not yet disseminated in the same manner as those listed above.

INSAT does provide earth imagery, so to find out more about its on-board instruments and India's data transmission policy I contacted K Narayanan, the Program Director of INSAT, and he kindly provided the following information:

> "INSAT carries a very high resolution radiometer (VHRR) operating in both visible and infrared regions. Spatial resolution is 2-km in the visible, and 8-km in the infra-red. There are three operational INSAT satellites with this kind of radiometer. The satellites are geostationary, multipurpose satellites performing telecommunications, broadcasting and meteorology, and operated by the Department of Space, Government of India."

Collection of data, processing, use, and distribution is the responsibility of the India Meteorological Department, Government of India. The radiometer takes about 23 minutes to take an image of the earth's full disc, and sector scans are possible. Normally images are taken once every three hours. However, as per WMO (World Meteorological Office) standards, half hour consecutive images are taken at specified timings. During the cyclone season, or any special events (such as a developing weather system), images are taken every 30 minutes.

Full resolution image data is transmitted to the ground using one of the telecommunications antennae on board the satellite. Antenna coverage from the INSATs is essentially limited to India, its island territories and surrounding regions. The data is transmitted in digital format and is not encrypted. Due to the high data rate and low power transmission, the receive system is fairly complex.

Processed images, along with other meteorological data, is broadcast via INSAT in the S-band, in a hybrid digital/analog mode, in the clear (unencrypted). Simple, inexpensive receivers could be used for this purpose. This transmission is something similar to WEFAX.

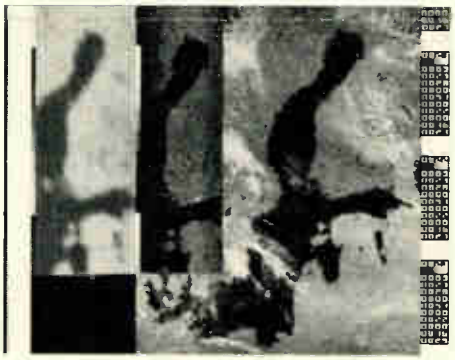


FIGURE 11: OKEAN 1-7 August 20, 1995

The Meteorological Data Dissemination (MDD) channel can be received by anyone in the coverage area of INSAT satellites (India and neighboring countries). INSAT-2E will incorporate a VHRR with an additional water vapor channel and a one kilometer resolution, three visible channel, CCD camera, and is getting ready for launch in the first half of 1998. My grateful thanks to K Narayanan, Program Director, INSAT, Department of Space in Bangalore, India, for this information.

Okean 1-7 (aka Okean-4), and Sich-1 operations

These two oceanographic satellites have not been transmitting frequently, apparently due to on-board system problems. There have been rare reports of one or the other being heard transmitting imagery (on 137.40 MHz) so it was encouraging to receive a list of scheduled transmissions for Okean-4 from Alex Ivanov, covering the period from 21 to 26 July implying that more might be forthcoming. I received a schedule for the following week a few days later.

The Okean-01 series began with the launch and testing of the Cosmos-1500 experimental satellite on September 28, 1983. It was then that my own satellite activities changed from operations with UK-6 and IRAS to monitoring the Russian weather satellite scene.

I made some cassette tape recordings of several satellites, often before I could positively identify them! Early recordings of Cosmos 1500 were followed by recordings of Cosmos-1602, Cosmos-1766, and later Cosmos-1809. In those days it was exceedingly difficult for me to find out about Russian launches, because my contacts worked in different fields. Eventually, information concerning the Russian weather satellite scene came from a friend of a friend who knew Geoff Perry, a British expert on such matters.

Okean-01 was launched on July 5, 1988, and the series provide radar, microwave, and optical images of Earth for marine shipping, fishery, and exploitation of the world ocean shelf zones. One of the primary missions of the series is the observation of ice conditions in the Arctic, Antarctic, and northern seas, and for ship routing under complicated ice conditions. The most important all-weather information under cloud is obtained at any time of the day by side-looking radar (SLR) and data collection systems from independent sea and ice stations.

The satellites are placed into near-polar orbits of 600-650 km with an inclination around 82 degrees. Their information system operates both in a direct data transmission mode and in a preliminary onboard data storage mode, with data transmission made to the ground later.

To illustrate Okean imagery, I delved into my collection and retrieved this sample received directly from Okean 1-7 during summer 1995 when transmissions were being received regularly, for a few minutes at a time, several times per week (Figure 11).

The number sequences on the right-hand side of the image include parameters identifying the systems which are operating. The first number in each sequence is the number of minutes that have elapsed since midnight in Moscow, so this allows us to identify whether the image content is "live" or if it is a recorded "playback."

This particular image corresponded to the satellite's actual footprint at the time of reception—it was live—and at that time Okean provided several scans of the same region for several days.

The image content includes a visible-light portion showing the Gulf of Bothnia and the Baltic Sea, with two inset images—the microwave sounder and a radar track. I

The Okean-01 series began with the launch and testing of the Cosmos-1500 experimental satellite on September 28, 1983. It was then that my own satellite activities changed from operations with UK-6 and IRAS to monitoring the Russian weather satellite scene.

(and many other people who were closely monitoring Okean transmissions) recorded many images of this region, particularly during the winter and spring months. To illustrate how different the content of Okean pictures can be, figure 12 is one received on another occasion.

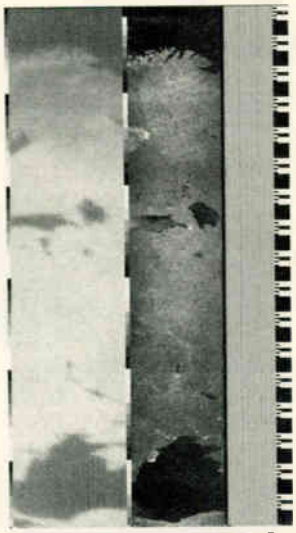


FIGURE 12: OKEAN 1-7 April 30, 1995

This image has just two sensors displayed—the radar and the microwave sounder. For those who have not seen many Okean images, the area covered is a vertical slice from North Cape and the Barents Sea, through Finland and down to the Black Sea. The feature referred to as "piano key" telemetry runs the length of the image on the outside; I have yet to learn of its significance, though an Internet correspondent of mine who works in the weather satellite field in Commonwealth of Independent States (Russia) is hoping to pass this information on.

Nostalgia anyone?

While looking through my image collection I found several images with a tale to tell.

Figure 13 is one of many Meteosat image transmissions showing the eastern Mediterranean region during the Gulf War. A wall of smoke stretching for hundreds of miles can be seen in this visible-light "C3D" format image from Meteosat. The oil spills which stained the desert sands could be clearly seen for a long time after the end of the war.

FIGURE 13: METEOSAT February 10 1991 Gulf war smoke plume.

At the time of the invasion, I wrote a letter to our local paper about monitoring the region by satellite, and within a day or so there were three television crews and countless reporters suddenly discovering that I (and every other Meteosat-watching person) had a grandstand view of the events!

The images from Meteor 3-5 were extremely good, but were transmitted in "reversed" grey scale and it takes a little time to get used to their visual interpretation! Instead of dark areas being warm, they represent cooler temperatures. Clouds are therefore usually dark and the warm seas (in winter images) are white. ST

View From Above Frequency Guide

- NOAA-14 transmits continuous APT on 137.620 MHz
- NOAA-12 transmits continuous APT on 137.500 MHz
- NOAA satellites transmit beacon data on 137.770 or 136.770 MHz
- METEOR 3-5 is on 137.850 MHz in sunlight only
- Okean-4 transmits on 137.400 MHz on command only
- Sich-1 (137.400 MHz) is believed to be off
- METEOSAT-5 (where receivable) uses 1691 and 1694.5 MHz for WEFAX
- GOES-8 and GOES-9 use 1691 MHz for WEFAX
- Mir 145.80 and 143.625 MHz

By John Magliacane, KD2BD
magliaco@email.njin.net

RS-16 is Launched, Phase 3D is Postponed, and Problems With *Mir* Continue

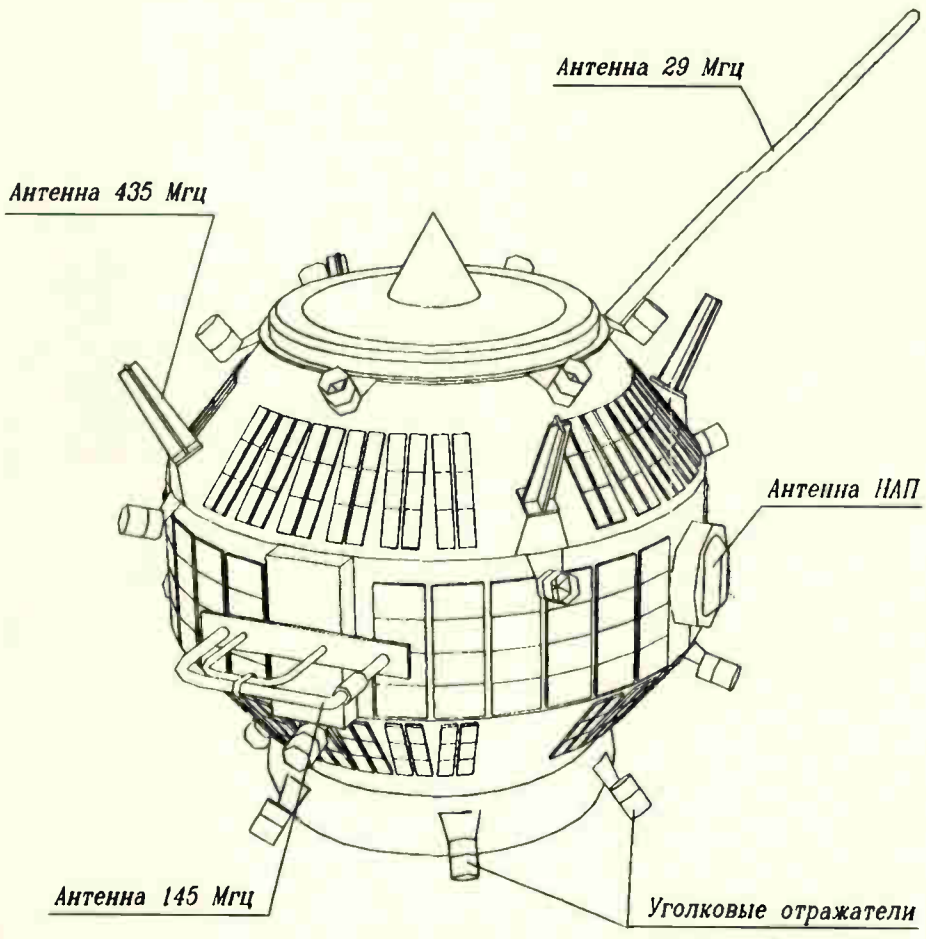
The spring and summer months saw many problems and controversies surrounding activities taking place within the amateur satellite program. A new amateur satellite took to the skies when the Russian Zeya military satellite was launched in March, carrying with it an amateur radio communications package identified as RS-16.

Two months after RS-16's launch, RS-10 went silent for reasons that to this day remain a mystery. Problems surrounded the *Mir* space station and the frequencies used by *Mir* for amateur radio operations, and the launch of the Phase 3D satellite was postponed due to changes imposed by the European Space Agency. All in all, it was a very eventful and stressful period.

The loss of RS-10 came as a surprise to many as it had provided nearly 10 years of uninterrupted service prior to its sudden silence. RS-10 could not be brought back to life in time for 1997 Field Day activities in late June, and RS-16 was undergoing tests during the same time period.

The Zeya satellite, and some of the people who helped make it a reality.

Drawing of the Zeya satellite carrying the RS-16 amateur radio communications package.



The launch of Zeya and the RS-16 satellite marked the first launch to take place from the new Svobodnyi Cosmodrome in the Amur Oblast. Zeya was launched into low earth orbit aboard a Start-1 booster rocket designed around a modified SS-25 ballistic missile. Zeya is equipped with GLONASS and GPS receivers, along with 20 laser reflectors for tracking purposes and the RS-16 amateur radio communications package.

Since no facilities exist for controlling amateur satellites at the Svobodnyi Cosmodrome, the ground control center near Moscow that was previously used for controlling the RS-14/AO-21 satellite is now being used to control RS-16. With this ground control center back in operation, the possibility exists that the once popular RS-14/AO-21 satellite may eventually be commanded back into operation.

RS-16 carries a Mode A linear transponder with an uplink passband between 145.915 and 145.948 MHz and a corresponding downlink passband between 29.415 and 29.448 MHz. Beacon transmitters are located at 29.408, 29.451, 435.504, and 435.548 MHz. The 29 MHz beacons operate with either 1.2-watts or 4-watts of transmitter power, while the 435 MHz beacons operate with 1.6-watts of power.

The beacon transmitters carry telemetry information using continuous wave

RS-16 carries a Mode A linear transponder with an uplink passband between 145.915 and 145.948 MHz and a corresponding downlink passband between 29.415 and 29.448 MHz. Beacon transmitters are located at 29.408, 29.451, 435.504, and 435.548 MHz.

TABLE 1: RS-16 CW Telemetry Equations

P	PSU voltage volts	x0.1
O	Solar panel voltage Volts.	x0.1
N	Solar panel current mA	
M	TX 29 MHz output power mW	x10
L	TX 29 MHz current mA	
K	TX 29 MHz voltage 7V nominal	
J	TX 435 MHz output power mW	x10
I	TX 435 MHz current mA	
H	TX 435 MHZ voltage V	x0.1
G	U of the transponder V	x0.1
F	U of stabilizer V	x0.1
E	Temperature of the charger in degrees C.	
D	Temperature TX 29 MHz in degrees C.	
C	Temperature TX 435 MHz in degrees C.	
B	Temperature RX 145 MHz in degrees C.	
A	Temperature of the stabilizer in degrees C.	

Parameters M, L, J, I are valid in FM mode only. Parameter G is the voltage of the transponder (in volts), while F is the voltage on the battery charge regulator (BCR) and ranges between 14 and 27 volts. It used only for scientific experimental equipment on RS-16.

(CW) telegraphy at 25 words per minute. Table 1 lists the significance of the parameters relayed through RS-16's CW telemetry beacons.

Mexico-OSCAR-30 Failure

MEXICO-OSCAR-30 is a Microsat satellite built at UNAM (The Autonomous University of Mexico) in Mexico City by XE1TU and his students. The basic spacecraft was of the same design as the other AMSAT Microsats, including LUSAT, DOVE, WEBERSAT, ITAMSAT, and EYESAT.

MEXICO-OSCAR-30 was launched last year, and, in addition to providing a digital store-and-forward communications transponder, the satellite also carried a 40 MHz radar transmitter for detecting and ranging meteors entering the earth's atmosphere. It is the second in a series of satellites built by the Autonomous University of Mexico.

The first UNAMSAT satellite was lost along with the Israeli TECHSAT satellite when the Russian START launch vehicle exploded shortly after its launch from Plesetsk. The second UNAMSAT satellite, which later became known as MEXICO-OSCAR-30 after successful launch, was built from spare parts and launched late last summer on a different launch vehicle, but also from Plesetsk. The satellite successfully reached orbit and transmitted telemetry for only a short period of time, and then went silent.

The weather at the launch pad the day MEXICO-OSCAR-30 reached orbit was very cold. The satellite separated from the launcher at a temperature of about -30 degrees C. It is believed that the frigid temperatures prevented the first local oscillator of the satellite's uplink receiver from oscillating, rendering the satellite totally deaf. With no functioning uplink receiver, battery charging parameters suitable for the unanticipated cold temperature could not be loaded, and the satellite ran out of power. Later attempts to revive MEXICO-OSCAR-30 were unsuccessful and the satellite is considered dead.

Finding a Frequency for Mir

Amateur radio activities taking place from the Russian space station *Mir* have been the subject of much controversy and debate, particularly with respect to the frequencies upon which *Mir* communicates with ground stations. Much of the amateur radio activity from *Mir* has taken place on the 2-meter band which has grown overcrowded in recent years with repeater stations and packet nodes in many populated areas of the world. Indeed, this has become a problem not only for activities taking place from *Mir*, but for those taking place on the U.S. space shuttles as well.

The problem of selecting a frequency for *Mir* operations that will not cause or suffer interference from existing satellite or terrestrial communications has become a daunting task. To make matters worse, air-to-ground transmitters aboard *Mir* operating in the VHF region have been the cause of overloading and desensing of the 2-meter amateur radio station on *Mir*, rendering it useless when commercial voice and data transmissions take place from *Mir*.

A filter to help alleviate these problems will be delivered to *Mir* along with the Mir 24/NASA 5 crew this month (September 1997). In the meantime, it is wise to keep informed of *Mir*'s latest operating frequency through official AMSAT News Service bulletins, *SpaceNews*, and various Internet web pages that specialize in *Mir* news.

Astronaut Mike Foale, KB5UAC has been very active on the amateur radio station onboard Mir. In July, he reported to be the first to successful grow plants from seeds produced in space. (NASA photo)

A Possible Solution

One solution to *Mir*'s frequency problems that appears to have been overlooked is the use of the 10-meter amateur band for communications between *Mir* and amateur radio operators on earth. A 10-meter station was originally planned for the maiden SAREX mission on the Space Shuttle in the early 80's, but plans were changed, due to difficulties in installing a 10-meter whip antenna on the exterior of the Space Shuttle.

While the move to the 10-meter band would require the addition of a new antenna and transceiver on *Mir*, 10-meter operation carries several major advantages over those currently taking place on the 2-meter and 70-cm bands.

First of all, there is considerably less Doppler shift on 10-meters than on higher

Following analysis of data from the ill-fated Ariane 501 launch, the European Space Agency significantly increased their estimates for the acceleration and vibration environments that spacecraft riding on Ariane 502 are expected to encounter during launch. AMSAT was informed of these findings...

TABLE 2: Message from Mike Foale KB5UAC onboard the *Mir*

Posted : 07/25/97 09:53
To : ALL
From : R0*Mir*
Subject: *Mir* status

Lost power to tnc again—lost all messages. Possibly will get new tnc, with memory protection, in August, with next crew. We are doing experiments, especially Vassily and Sasha, even though they now have very little time. Leiroda and Krisctal still without power, but a little drier now, though still dark. I planted the first ever space produced seeds, two days ago, in Greenhouse. No sprouts yet.

—*Mike. kb5uac.*

Mike Foale, KB5UAC, kept in frequent contact with amateur radio operators on the ground throughout all the crises on *Mir* using the *Mir* Personal Message System.

frequencies. This would allow practical use of single sideband voice communications with *Mir*, significantly reducing the power requirements for the amateur radio equipment on *Mir*. Narrowband FM can still be used above 29 MHz for packet radio communications or possible crossband repeating to either the 2-meter or 70-cm bands.

Another advantage of using 10-meter equipment on *Mir* is that it would be unaffected by commercial VHF air to ground transmissions taking place on *Mir*. In addition, the upper portion of the 10-meter is nowhere near as populated as the 2-meter band, and with the dwindling number of OSCAR and RS satellites carrying Mode A downlinks in this band, it is likely to remain uncongested for years to come. Furthermore, ground station requirements would be considerably relaxed, as a simple dipole antenna would provide excellent performance without the need for directional antenna systems or AZ-EL rotators.

And lastly, as the solar flux index begins to rise over the next few years and the maximum usable frequency approaches 30 MHz, exciting sub-horizon communications with *Mir* should be possible during daylight hours by utilizing ionospheric propagation via the Earth's F-layer.

Phase 3D Launch Delay

Following analysis of data from the ill-fated Ariane 501 launch, the European Space Agency significantly increased their estimates for the acceleration and vibration environments that spacecraft riding on Ariane 502 are expected to encounter during launch. AMSAT was informed of these findings in July and began re-evaluating the structural capabilities of the Phase 3D space frame.

An independent structural engineer was called upon to review the spacecraft's design and construction, and he concluded that in order to be sure of surviving the increased vibration and acceleration parameters set by the European Space Agency, a number of modifications would have to be made to the spacecraft.

The work required for these modifications delayed the launch readiness of Phase 3D beyond the August 10 deadline set by the European Space Agency. In order for ESA to maintain the planned mass characteristics of the Ariane 502 vehicle, AMSAT was required to supply a mass simulator equal to the Phase 3D spacecraft to be sent aloft on the flight in its place.

AMRAD-OSCAR-27 Shifts Frequency

The AMRAD-OSCAR-27 satellite, which carries a highly sensitive single-channel amateur radio transponder along with a commercial communications payload, is slowly drifting lower in frequency as a result of the natural aging of the transmitter crystal. Controllers can compensate for this drift to some extent, but once the drift moves out of the range of compensation, the satellite's downlink jumps significantly lower in frequency.

The current downlink frequency is approximately 436.792 MHz, while the uplink remains 145.850 MHz. AMRAD-OSCAR-27 is currently functioning as a single channel narrowband FM communications transponder, and the latest AO-27 satellite news and operating schedule may be obtained from spacecraft controllers via the Internet at: **http://www.umbra.com/sats/**.

More Satellite Software Available For Linux

Bent Bagger, OZ6BL, and Peter Scott Bentsen, OZ2ABA, released versions of PB and PG for execution under the Linux operating system in early July. PB and PG are traditional DOS-based programs developed by Jeff Ward for communications with Microsat store-and-forward communication satellites.

PB is used for receiving transmissions made by Microsat satellites and for requesting downloads of files and directory information, while PG is used strictly for uploading files to Microsat satellites. PB also has facilities for logging transmissions received from Microsat satellites to disk for later analysis of telemetry, beacon text messages, and other data transmitted by Microsat downlink transmitters.

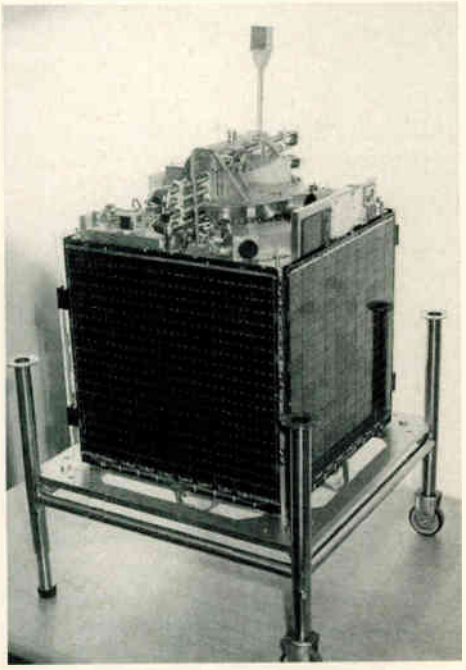
PB and PG for Linux are largely based on earlier work by John Melton and Jonathan Naylor who authored a suite of Microsat communications utilities for Linux. These utilities were described in the September/October 1996 issue of *Satellite Times*, and operate under the X Window System graphical environment.

The new versions of PB and PG for Linux need not be run under a graphical environment, and are instead designed primarily for unattended and automatic operation. Since Linux is a multi-user and multi-tasking operating system, it is possible to run PB and PG simultaneously to allow concurrent upload and download of files from any of the Microsat store-and-forward communication satellites. This feature allows mail, directory information, and other data broadcast by the Microsat satellites to be captured by ground stations, while allowing time consuming uploads of large files to take place simultaneously.

PB and PG for Linux operate with a standard packet radio terminal node controller (TNC) capable of "KISS" operation, and utilize the native and standard AX.25 protocol networking drivers integrated within the Linux operating system kernel.

PB and PG are available free of charge via anonymous FTP, and may be found in

Astronaut Mike Foale, KB5UAC, kept in frequent contact with amateur radio operators on the ground through the amateur radio station on board Mir throughout the summer. Much of the good news Mike had to report concerning the success of his experiments on Mir and the health and condition of his crewmates went unreported...



South Africa's SUNSAT satellite sits on a handling frame awaiting a safe ride into earth orbit. Launch is now expected to occur sometime in 1998.

the **pub/Linux/apps/ham** subdirectory at **sunsite.unc.edu**.

Progress Continues Toward Launch of SUNSAT

SUNSAT has experienced yet another delay in getting off the ground and into earth orbit. Originally planned for a 1995 launch, SUNSAT has experienced yet another launch delay due to difficulties experienced with the complex commercial ARGOS parent satellite with which SUNSAT is sharing its ride into space. Launch is not expected to occur until sometime in 1998.

SUNSAT will carry a plethora of experiments that will be of particular interest to educators. There will be a lot more to report on this satellite as the launch date draws near.

Mir PMS Beats Mainstream Media

The mainstream media did much to damage public perception of manned space operations following the collision of the *Mir* space station and a Progress supply vessel in June. Despite reports of grave living conditions on *Mir*, the *Mir* packet radio station was up and running just several days after the collision with Progress, effectively putting to rest concerns about the lack of power on *Mir* and near-death living conditions.

Astronaut Mike Foale, KB5UAC, kept in frequent contact with amateur radio operators on the ground through the amateur radio station on board *Mir* throughout the summer. Much of the good news Mike had to report concerning the success of his experiments on *Mir* and the health and condition of his crewmates went unreported by commercial radio and television news reports.

Air to ground communications from *Mir* heard on 143.625 MHz FM also provided insight into the real issues concerning the inhabitants of *Mir*, and provided a sense of relief that conditions on *Mir* were not as bad as the news reporters would have the public believe.

Amateur radio equipment was also used to good advantage in allowing Mike Foale to speak with his mother through a phone patch coordinated by MirEX team members Dr. Dave Larsen, N6CO, and G. Miles Mann, WF1F, during the summer. Mike also got the opportunity to speak with several space shuttle *Columbia* crew members during mission STS-94 using the 2-meter station on *Mir* relayed through the W5RRR amateur radio club station at the Johnson Space Center in Houston, Texas. Some brief direct ship-to-ship contacts were also made on 2-meters using the SAREX equipment on the space shuttle during the same mission.

Conclusion

All in all, it has been an eventful couple of months filled with delays, disappointments, and success. Despite the disappointments and delays, it is important to realize that there are still many exciting activities possible within the amateur satellite program.

Thoughts of placing amateur spacecraft on the Earth's moon or on Mars have been tossed back and forth recently, and the results of these discussions were that if such projects are eventually undertaken, perhaps the main goals of these missions should center around low-cost, non-commercial, scientific research, rather than providing yet another two-way communications resource. Perhaps research will be the goal of future OSCARs. Only time will tell. ST

By Donald E. Dickerson, N9CUE

Digital Phones

Cellular phone services in the U.S. and around the world have traditionally used standard FM transmission modes since the mid-80s. With the development of digital voice transmission techniques the cellular industry has been switching from analog to digital formats.

Satellite based phone services planned for the near future include Globalstar, Iridium, and Odyssey. Each is using a unique transmission format.

Qualcomm

The world's producer of digital cell phones is Qualcomm Personal Electronics (QPE). QPE is a joint venture between Qualcomm Incorporated and Sony Electronics. Qualcomm and Sony have chosen the most sophisticated transmission mode available with current technology—code division multiple access (CDMA). They have just produced over one million digital phones, according to a recent article in Qualcomm's publication *Transportation Times.* CDMA is currently being deployed in 54 markets nationally and 19 foreign countries.

Not surprisingly, the Globalstar satellite phone system will also use CDMA. Globalstar phones will be able to operate on either satellite or local CDMA cellular networks worldwide. The FCC recently granted Globalstar final authorization for its requested feeder link frequencies. This insures Globalstar's access to domestic telecommunications markets. The frequencies for the feeder links are in the 19 and 29 GHz bands for downlinks and uplinks respectively.

Globalstar CDMA handsets will be produced by TELITAL. This Italian company was recently licensed to design, develop, manufacture, and sell the dual-mode handsets for Globalstar satellite communications systems worldwide.

Qualcomm is one of the major participants in the development of Globalstar. This is a big LEO (Low Earth Orbit) satellite-based system, which in layman's terms means the satellites deliver voice and data on frequencies above 1-GHz.

Globalstar consists of 48 satellites. Qualcomm hopes to have them in orbit and operational by 1998. Before you can launch a satellite, however, you must make sure the equipment you put onboard can make the grade. In September the Globalstar engineers successfully completed the first CDMA satellite phone test transmission. This achievement establishes the foundation for space based operations. The Qualcomm engineering team demonstrated that their state-of-the-art technology performed as expected.

Qualcomm's "Q" phone (above) is the world's smallest and lightest CDMA digital PCS 1900 MHz phone, weighing about 5 ounces. At right is the Qualcomm 1900 MHz CDMA digital PCS/800 MHz analog phone.

CDMA/TDMA/FDMA/ DIGITAL ANALOG

Code division multiple access was not always known as CDMA. Back in the old days when it first appeared in limited service on some of the C-band TV satellites, it was called spread spectrum multiple access. CDMA is a spread spectrum technique first used by the military and intelligence services. It modulates the signal across the available bandwidth. Each bit of information is divided into an even larger number of even smaller bits, called chips.

This facilitates the spreading of the information over a wide area or bandspread. These chips of audio and data information are then applied to a specific, coded waveform. This is accomplished by lacing the chips in a unique code sequence, called pseudo-random noise sequence or PNS. A multitude of signals can overlap in this fashion because the receivers (in this case the satellite phones) ignore all signals but the one carrying its specific coded waveform or PNS.

At the other end of the spectrum is the frequency division multiple access or FDMA format. With FDMA, uplink and downlink

Each of the CDMA, TDMA, and FDMA systems are designed to increase the number of users that can have access to the allocated bandwidth at any given moment. It looks as though CDMA should win any contest with the other formats hands down, however.

frequency assignments are made for each user in the allocated bandwidth. This, of course, is a self-limiting system when compared to CDMA.

The next format is the time division multiple access or TDMA. Each user in this system is assigned a specific portion of each second—or more accurately, millisecond—in which to transmit its data.

Each of the CDMA, TDMA, and FDMA systems are designed to increase the number of users that can have access to the allocated bandwidth at any given moment. It looks as though CDMA should win any contest with the other formats hands down, however.

Iridium

One of the other major contenders in the mobile satellite service market is Iridium, a Motorola company. The engineers at Iridium have chosen a combination of FDMA/TDMA/TDD for their fleet of 66 satellites. The TDD stands for time division duplex. This complex format will be used for the L-band links.

FDMA requires accurate frequency control for adjacent frequency protection, to keep phone calls separate and distinct. In the mobile satellite service this is particularly important and difficult to accomplish. Doppler shift and the relative motion of both the transmitting station and receiving stations means that the velocity of the spacecraft also has to be corrected for. Mobile terminals use a synchronization frequency between the two terminals and the spacecraft to help combat these effects.

With the use of TDMA the frequency stabilization is easier to achieve. The Iridium system uses a sophisticated method of time and frequency sharing on each channel. This allows both the uplink and downlink signals to be transmitted on the same channel. This duplexing is called TDD.

The Iriduim TDMA transmission frame is repeated at 90-ms intervals or 11.1 frames per second. Each frame is divided into three segments. The first 20.32-ms in duration is used for paging and ring alerting of the Iridium phones for incoming calls. The next segment of the frame contains four 8.28-ms uplink time slots. The next segment consists of four 8.28-ms downlinks.

The voice signals run at 2400 bps. Iridium's unique format helps reduce possible interference, desensing of receivers, and allows for simpler antenna design.

A final technical milestone was passed recently when the big three of mobile satellite service systems—Globalstar, Odyssey, and Iridium—signed formal agreements on the allocation and use of the L-band frequencies that the FCC has assigned the mobile satellite service. It won't be long now before personal communication satellites are online and ready to serve.....till next time around. ST

By Keith Stein
kstein@erols.com

The S-band: Are You Experienced?

Any hobbyists out there have a S-band tracking system? Not too many, I think. When you're dealing with the S-band region, a satellite dish, two antenna tracking motors, antenna control software, more advanced receivers, and some cash will probably be required.

The S-band is predominantly used for federal terrestrial and space telemetry systems, like the NASA Tracking and Data Relay Systems (TDRS) and the Air Force Space Ground Link Subsystem (SGLS). These two systems provide the telemetry, telecommand, and control for all federal satellite systems and some activities with national security implications. There is a growth of about 80 new assignments per year in this band.

TDRS satellite operations from 2200 to 2290 MHz are essential to NASA Earth exploration, space operations, and space research activities. This includes space-to-Earth and space-to-space transmissions. Over 50 U.S. and foreign space missions are supported from launch, transfer orbits, and once the satellite becomes operational.

These telecommunication links are made available to private sector expendable launch vehicle operations also. Some 123 satellites from nine countries are planned for or are operational in the 2200-2290 MHz band. The band also supports similar space-to-Earth and space-to-space telemetry, telecommand, and control for military satellites through the Air Force SGLS system.

The following chart is not complete, but it gives a rough idea what is available in the S-band region.

Type of Downlink	Amount
Scientific	36
Earth Observation	14
Communication	8
Launch Vehicles	7
Meteorological	4
Cargo	1
Military	1
Navigation	1
Total	72

S-BAND FREQUENCY SAMPLER (2200 - 2290 MHZ)

Frequency	Satellite/Rocket
2202.500	Atlas Centaur stage
2203.000	Ariane 4 and 5 Launch Vehicle
2205.000	Automated Transfer Vehicle (ATV)
2205.930	Systeme Probatoire d'Observation de la Terre-3 (SPOT-3)
2206.000	Ariane 4 Launch Vehicle
2206.500	Atlas Centaur stage
2207.130	Telecom 2C and 2D (TC2C & TC2D)
2207.500	Defense Meteorological Satellite Program (DMSP)
2208.586	Geostationary Operational Environmental Satellite (GOES I-M) Metsat Project
2208.1629	FREJA, ODIN, and ASTRID
2209.006	SIRIUS-2
2209.086	Geostationary Operational Environmental Satellite (GOES I-M) Metsat Project
2210.500	Atlas Centaur stage/Lockheed Martin Launch Vehicle (LMLV)
2211.000	Atlas Centaur stage/Tracking and Data Relay Satellite System (TDRSS)
2212.000	Engineering Test Satellite VI (ETS-VI)
2215.000	Fast Auroral Snapshot Explorer (FAST)/ Sampex/Submillimeter Wave Astronomy Satellite (SWAS)/Wide-Field Infrared Explorer (WIRE)
2215.500	Atlas Centaur stage
2217.500	Space Shuttle/International Cometary Explorer (ICE)/IUS Stage (part of Titan IV booster)
2218.000	Ariane 4 and 5 Launch Vehicle/Systeme Probatoire d'Observation de la Terre (SPOT-4)
2220.000	Advanced Earth Observing Satellite (ADEOS)/Japan Earth Resources Satellite (JERS)/Marine Observation Satellite-1B (MOS 1B)/Engineering Test Satellite-VII (ETS-VII/Target)
2227.000	Ariane 5
2227.500	Global Positioning Satellite (GPS)
2230.000	RADARSAT
2232.500	Tracking and Data Relay Satellite System (TDRSS)
2235.000	Hispasat 1A and 1B
2237.104	Hispasat 1A and 1B
2237.500	Defense Meteorological Satellite Program (DMSP)
2241.500	Delta II Launch Vehicle
2242.000	Cluster 1
2244.500	Delta II Launch Vehicle
2245.000	Solar Heliospheric Observatory (SOHO)
2245.500	X-ray Astronomy Satellite (SAX)
2247.500	National Oceanic and Atmospheric Administration-K, L, M, N, N (NOAA)
2249.000	Cluster 2
2249.800	International Ultraviolet Explorer (IUE)
2250.000	Space Shuttle
2250.500	L-1011 aircraft video downlink
2252.500	Delta II Launch Vehicle/Defense Meteorological Satellite Program (DMSP).
2255.500	Satelite de Aplicaciones Cientificas (SAC-B)/Tropical Rainfall Measuring Mission (TRMM)/Hubble Space Telescope/ Wideband Instrumentation System (part of Titan IV booster)
2256.000	Cluster Spare
2256.220	ASCA (ASTRO-D)/Yohkoh (Solar-A)
2259.910	Geotail, LUNAR-A
2260.500	MUSAT
2263.6018	Space Flyer Unit (SFU)
2264.625	European Telecommunications Satellite II (EUTELSAT II)
2264.818	Hotbird-2
2265.000	Polar/International Space Station (ISS)
2266.500	Infrared Space Observatory (ISO)
2267.500	Defense Meteorological Satellite Program (DMSP)
2269.500	Pegasus Launch Vehicle
2269.680	COMETS
2270.000	Cluster 4
2270.400	International Cometary Explorer (ICE)
2272.000	High Extreme Transient Experiment (HETE)
2272.500	Seastar-SeaWIFS/Centaur Stage (part of Titan IV)
2273.000	Clementine/Lunar Prospector
2273.500	Total Ozone Mapping Spectrometer-Earth Probe (TOMS-EP)
2273.760	Space Technology Research Vehicle (STRV 1-a & 1-b)
2275.000	Wind
2275.300	Small Spacecraft Technology Initiative (SSTI) (LEWIS)/Transition Region & Coronal Explorer (TRACE).
2276.500	Roentgensatellit (ROSAT)
2276.990	Engineering Test Satellite-VII (ETS-VII/ Chaser)
2277.000	Cluster 3
2278.350	Advanced Composition Explorer (ACE)
2280.500	Lockheed Martin Launch Vehicle (LMLV)
2280.721	Geostationary Meteorological Satellite-5 (GMS-5)
2282.500	Midcourse Space Experiment (MSX)
2287.500	X-ray Timing Explorer (XTE)/Space Shuttle/Advanced X-ray Astrophysics Facility-Imaging (AXAF-I)/Cosmic Background Explorer (COBE)/Earth Radiation Budget Satellite (ERBS)/Extreme Ultraviolet Explorer (EUVE)/ Gamma Ray Observatory (GRO)/Hubble Space Telescope (HST)/Landsat 4, 5 and 7/Upper Atmosphere Research Satellite (UARS)/Earth Observing System-AM (EOS-AM)/Titan IV Stage/International Space Station (ISS)/ Interim Control Module (ICM)
2288.500	Pegasus Launch Vehicle
2289.600	Hypersonic Flight Experiment (Hyflex)

Swagur Enterprises answered a call by the monitoring community for INMARSAT monitoring equipment when they came out with their Apartment Dwellers' Special. This system is great for reception of GOES weather satellites and INMARSAT.

New Ground Terminals for EOS Missions

Two new ground terminals in Alaska and Svalbard (Norway), are being coordinated and registered with the National Telecommunications Information Agency (NTIA) for operation with NASA's Earth Observing Satellite-AM system. The EOS system will downlink to these stations in both S- and X-band.

ESA/NASA RFI Problems in the Future

The annual European Space Agency/National Aeronautics and Space Administration (ESA/NASA) meeting held in Paris this year identified interference problems with the ESA INTEGRAL and NASA small explorer satellites. Both systems use 2215.000 MHz for downlink. Starting in the year 2001, frequency-sharing operational coordination with ESA will be required.

MISSIONS INVOLVED

Sampex	Launched 07/03/92	NASA
FAST	Launched 08/21/96	NASA
WIRE	Scheduled 09/15/97	NASA
SWAS	Scheduled 01/99	NASA
INTEGRAL	Scheduled 2001	ESA

Notes:

FAST	Fast Auroral Snapshot Explorer
WIRE	Wide-Field Infrared Explorer
SWAS	Submillimeter Wave Astronomy Satellite
INTEGRAL	International Gamma-Ray Astrophysics Laboratory

NASA Replaces ARIA Support with U.S. Navy P-3 Aircraft

Changes are coming to aircraft missions that are normally heard on high frequency (HF) shortwave in connection with NASA space launches. The U.S. Air Force 452nd Flight Test Squadron at Edwards AFB, California, currently operates eight Advanced Range Instrumentation Aircraft (ARIA). These aircraft will be replaced for NASA missions by three Navy P-3 aircraft operated by the Naval Air Warfare Center, Weapons Division at Point Mugu, California. These aircraft are used as flexible airborne telemetry data recording and relay stations during missile launches.

The three EP-3A aircraft fly with the Pacific Missile Test Center at Naval Air Station Point Mugu. The Extended Area Test System (EATS), comprised of a phased-array antenna in a fuselage fin projection on each EP-3A aircraft and is used for range support.

The Lockheed Martin Titan and Atlas launch vehicles have changed over to NASA's Tracking and Data Relay Satellites (TDRS) for launch support. But due to weight and cost concerns, the McDonnell Douglas Delta, Orbital Sciences Corp. Pegasus, and Taurus vehicles will not make the configuration change and will require the Navy P-3 support. At an hourly rate of about $4,200, and half the crew size of an ARIA, the Navy P-3s will save NASA $25 million over the next eight years. ARIA is currently at a hourly cost of $11-15,000 for support. The Navy P-3's have been supporting missile launches since 1970, ARIA since the 60's.

The first NASA launch support by the Navy P-3s was scheduled for the launch of the Delta/Advanced Composition Explorer (ACE) mission last month (August 1997) from Vandenberg Air Force Base, California. Check the following frequencies for pre-launch, launch, and post-launch action.

POINT MUGU NAWS FREQUENCY LIST (ALL AM MODE)

120.750	CLEARANCE DELIVERY
121.600	GROUND CONTROL
124.850	TOWER
125.550	AUTOMATIC TERMINAL INFORMATION SERVICE
126.200	TOWER
135.500	TOWER
267.500	BASE OPERATIONS
277.200	AUTOMATIC TERMINAL INFORMATION SERVICE
319.300	AIR NATIONAL GUARD OPERATIONS
327.100	TOWER
339.400	CLEARANCE DELIVERY
340.200	TOWER
341.300	METRO
360.200	GROUND CONTROL
382.800	TOWER

MIR VHF Support Update

NASA's Wallops and Dryden *Mir* VHF support stations under went some system upgrades during the month of June. Also, a third station was put into operation in early July at the White Sands Complex in New Mexico with $300,000 in government funds.

Additional stations in this network may be built in Sioux Falls, South Dakota, and Hawaii.

Classified or Unclassified?

On July 16, 1997, the North American Aerospace Defense Command (NORAD) at Cheyenne Mountain, Colorado, made public the following information about an upcoming classified Titan launch. The original message had information rarely seen made public on classified Department of Defense space missions.

"UNCLASSIFIED" LAUNCH INFORMATION

NAME:	TITAN IVA/NUS, A-18/K-18/NUS
LAUNCH AGENCY:	4 SPACE LAUNCH SQUADRON
LAUNCH SITE:	WESTERN RANGE
LAUNCH AZIMUTH:	153.0000 DEG
LAUNCH WINDOW:	19 JUL 97 0500Z TO 19 JUL 97 0900Z
LAUNCH VEHICLE:	TITAN IVA
NOMINAL ORBIT:	PARKING ORBIT
EPOCH (D/HH:MM:SS.SSS):	200/05:08:58.825
PERIOD (MIN):	95.730
INCLINATION (DEG):	56.999
ECCENTRICITY (DEG):	0.018460
SEMI-MAJOR AXIS (KM):	6931.9931
ARGUMENT OF PERIGEE (DEG):	160.923
RA OF ASCENDING NODE (DEG):	97.773
MEAN ANOMALY (DEG):	353.359
START ORBIT TIME (HHH:	MM:SS.SSS)MET: 000:08:58.825
END ORBIT TIME (HHH:MM:SS.SSS)MET:	005:00:00.000
HEIGHT (KM):	428.1239
INJECTION LATITUDE (DEG):	21.59N
INJECTION LONGITUDE (DEG):	248.67E
INJECTION INERTIAL AZIMUTH (DEG):	144.192
INJECTION TIME (D/HH:MM:SS.SSS):	200/05:08:58.825

SEQUENCE OF EVENTS

EVENT	HH:MM:SS
LIFTOFF	00:00:00
STAGE 1 IGNITION	00:01:57
STAGE 1 SHUTDOWN	00:05:02
STAGE 2 IGNITION	00:05:02
JETTISON STAGE 1	00:05:03
STAGE 2 SHUTDOWN	00:08:38
PARK ORBIT INJECTION	00:08:58

This historic launch of a Super Loki sounding rocket was performed from Cape Henlopen State Park in Lewes, Delaware, on Sunday, May 11, 1997. The 11-foot tall, solid propellant rocket carried an amateur TV (ATV) and global positioning system (GPS) experiment.

OBJECTS TO ACHIEVE ORBIT: TWO-PAYLOAD AND 2ND STAGE ROCKET BODY. THE PAYLOAD PARAMETERS ARE CLASSIFIED. THE STAGE 2/PAYLOAD COMBINATION IS APPROXIMATELY 115.6 FEET BY 16.7 FEET. IT IS THREE AXIS STABILIZED. THERE WILL BE A STAGE 2 RETROGRADE BURN TO SEPARATE THE PIECES.

LAUNCH VEHICLE DESCRIPTION: THE TITAN IVA/NUS (NO UPPER STAGE) UTILIZES TWO STRAP-ON SOLID ROCKET MOTORS AND THE TWO STAGE TITAN IVA CORE VEHICLE.

COMMUNICATIONS FREQUENCIES: THE TITAN CORE VEHICLE TRANSMITS TWO DATA STREAMS:

(1) PCM 384 KBPS REMOTE MONITORING INSTRUMENTATION SYSTEM (RMIS) DATA ON 2287.5 MHZ.

(2) ANALOG WIDEBAND INSTRUMENTATION SYSTEM (WIS) DATA ON 2255.5 MHZ NOTE: THE ANALOG AND DIGITAL DATA STREAMS ARE EACH RELAYED THROUGH TWO SEPARATE ANTENNAS; ONLY ONE WIS, AND ONE RMIS ANTENNA IS TRANSMITTING AT ONE TIME.

IN ADDITION, THERE IS A C-BAND RADAR BEACON, RADIATING THROUGH TWO 6 SEPARATE ANTENNA; THE BEACON CAN BE INTERROGATED THROUGH EITHER ANTENNA AT ANY TIME TUNED TO 5765 MHZ.

OBJECT DESIGNATIONS:

INT OBJECT	COMMON NAME	DSG	CTY
PAYLOAD	USA XXX	A	US
ROCKET BODY	TITAN 4 R/B	B	US

At presstime, the launch of this mission is on hold due to a fuel leak found in the Titan vehicle. And now for your intercepts during the last two months.

Listening Post Intercepts (all times in UTC)

M123.125 Heard someone with French accent giving some flight levels and arrival times. Shortly after, I heard same person come up on M284.0 (Houston south Approach/ Departure) as "NASA 917," 2200, AM mode. (Chris Parris-Conroe, TX) *This is a T-38A aircraft, tail number N917NA based at Ellington Field, TX-Keith*

M126.500 NASA Wallops Tower working NASA 425 (T-39, tail number N425NA) inbound from 6,500 feet, AM mode. (Keith Stein-Woodbridge, VA)

M126.650 NASA 946 active out of Kennedy Space Center, Fl. This is the shuttle pre-launch weather spotting plane, AM mode. (John Mayson, KC4VJO-Palm Bay, FL)

M127.220 NASA 984 (T-38 aircraft flight of 2) out of 22,000 feet for 27,000 ft through Kansas City Center, requesting 33,000 feet as final altitude, 1605, AM mode. (Greg Horine-N9PBD)

M134.950 At 1515, NASA 912 was told to contact the NASA (KSC) tower on M128.55, AM mode. (Al Stern-Satellite Beach, FL)

M137.500 US weather satellite NOAA 12 heard at 1221, NFM mode. (John Corby-Caledon, Canada)

M137.950 Argentine MuSat-1 heard at 1208, AM mode. (John Corby-Caledon, Canada)

M143.625 Russian voice communications heard from Russian *Mir* space station, 1122, NFM mode. (John Corby-Caledon, Canada)

M145.800 During a 0900 pass of *Mir* I worked Mike Foale, KB5UAC. Mike was using the R0MIR call and we had a nice long chat about his grandmother who lives in Minneapolis, Minnesota. He also talked about his vacations to northern Minnesota, NFM mode. (B.J. Arts, WT0N-Hibbing, MN)

M145.985 U.S. Astronaut Mike Foale was heard aboard the *Mir* space station testing out new amateur radio frequency at 1953, NFM mode. At the same time, Russian cosmonauts were heard on M143.625, NFM mode. (David Stein-Springfield, VA)

M149.910 Russian Parus military navigation satellite Cosmos 2341 heard at 0053. NFM mode. (John Corby-Caledon, Canada)

M149.940 Russian Parus military navigation satellite Cosmos 2279 heard at 1150, NFM. (John Corby-Caledon, Canada)

M150.000 Russian Tsikada civilian navigation satellite Nadezhda 4 heard at 1144, NFM. Also heard Cosmos 2315 at 1239, NFM mode, Nadezhda 3 is still active here, and on M400.0, and M1544.5. (John Corby-Caledon, Canada)

M150.030 Russian Parus military navigation satellite Cosmos 2142 heard at 1156, NFM. Also heard Cosmos 2334 at 1247, NFM mode. (John Corby-Caledon, Canada)

M235.400 I heard several NASA flights call in to NASA Ops for weather updates. Saw NASA 955, which was a flight of two T-38's, one was marked as most NASA T-38's, but the other was completely white, no markings at all. Also saw NASA 959 and 930 come back to EFD from wherever they were. (Chris Parris-Conroe, TX)

M255.000 NASA 425 (T-39, tail number N425NA) working Giantkiller for W-107 at 1721, waiting to join up with Smash 21. Also used M261.0 MHz. (Jim)

M255.600 NASA 99 heard cleared to 6,000 feet at 1335, AM mode. (Lorin Winchester-Oak Grove, KY)

M261.625 Lizard 90 Romeo calling Lizard 06 with no joy over UHF Follow-On military satellite channel 13 (Papa bandplan), NFM mode. (Magnus Hammarstedt-Ostersund, Sweden)

M263.725 Bravo calling Echo 5 Golf with no joy over UHF Follow-On military satellite, channel 18, (Papa bandplan), NFM mode. (Hammarstedt-Sweden)

M289.600 NASA 982 (T-38A aircraft, tail number N982NA) heard landing at Buckley ANGB airport with new radio for NASA 919 (T-38A aircraft, tail number N919NA). Both aircraft were then cleared to Amarillo. AM mode. (Sandy-Denver, CO)

M289.600 NASA 904 (T-38) heard landing at Hill AFB. AM mode. (Brent Clark, Utah)

M296.700 NASA 706 (ER-2 aircraft, tail number N706NA) heard above 60,000 feet, 1630, AM mode. (Rick-Sacaramento, CA)

M4199.504 Telstar 5 beacon (79 degrees West) with telemetry present. Telstar 2 (97 degrees West inclined) with one beacon with telemetry and one full transponder digital carrier. (Chris K)

M4199.528 Telstar 2R (87 degrees West) with many video carriers (Chris K) ST

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

SuperAudio—Classical Collections	G5, 21	6.30/6.48 (DS)
WFMT-FM (98.7) Chicago, IL.	G5, 7	6.30/6.48 (DS)

Satellite Computer Services

Planet Connect, Planet Systems, Inc		
19.2 kbps service	G4, 6	7.398
T4, 4	7.398	
Planet Connect, Planet Systems, Inc		
100 kbps service	G1, 9	7.80
T4, 4		7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
T4, 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
SuperAudio—*Light and Lively Rock*	G5, 21	5.96, 6.12 (DS)
Unidentified station —Upbeat music	C4,5	5.58
WYEZ-FM 96.9 South Bend, IN	G4, 15	6.48, 7.30 (DS)

Country Music

SuperAudio—*American Country Favorites*	G5, 21	5.04/7.74 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, TN., ID-*The Hit Kicker*	G6, 7	6.20
WSM-AM (650) Nashville, TN	C4, 24	7.38, 7.58

Easy Listening Music

Easy Listening Music (English)	T5, 14	6.80
Easy Listening Music (French)	T5, 14	6.20
IAM Radio-easy listening music	G4, 6	7.69
SuperAudio—*Soft Sounds*	G5, 21	5.58/5.76 (DS)
FCC Mandated safe-harbor program audio-easy listening music	G3R, 10	6.80
	G5,2 6.80	
United Video—easy listening music	C4, 8	5.895 (N)

Foreign Language Programming

Anteena Radio (Greek)	S4, 14	7.80
Apna Sangeet Radio India	T5, 12	6.80
Arab Network of America radio network	GE2, 22	5.80
CBC Radio-East (French)	E2, 1	5.38/5.58 (DS)
	E2, 1	7.36
DZMM-Radyo Patrol (from Philippines)	G4, 24 (Ku-band)	6.80
Indian ethnic radio	GE1,16	7.38
La Cadena CNN Radio Noticias (CNN Radio News in Spanish)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA—Asian Radio	GE1, 22 (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 Dubai (Arabic)	G7, 10	7.48
Radio Maria (Italian-Religious programming)	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Tropical	GE1,4	7.60
Unidentified station-foreign language	GE-1,22 (Ku)	5.80
WCRP-FM (88.1) Guyama, Puerto Rico-Spanish language religious	G4, 6	6.53
XEX-FM (101.7) Mexico City, Mexico (Spanish), ID-*Vox FM*	M2, 14	7.38
XEWA-AM (540) Monterrey, Mexico (Spanish), ID-*Super Estelar*—contemporary music	M2, 8	7.38

Jazz Music

Jazz Worldbeat Radio (2300-0500 UTC)	T4, 6	6.20
KLON-FM (88.1) Long Beach, CA., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio—*New Age of Jazz*	G5, 21	7.38/7.56 (DS)

News and Information Programming

Business Radio Network	C4, 10	8.06 (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
	G5, 22	6.30
Standard News	S3, 17	5.20
USA Radio Network-news, talk and information (ch 2)	S3,13	5.01 (ch 1), 5.20
Virginia News Service	G5,11	5.94
WCBS-AM (880) New York, NY—news	G7, 19	7.38
WCCO-AM (830) Minneapolis, MN	G6, 15	6.20
WTLT-AM (1480) Charlotte, NC—news/talk/Charlotte Knights AAA minor league baseball	G1R, 17	7.92

Religious Programming

Ambassasor Inspirational Radio	S3, 15	5.96, 6.48
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5, 11	6.12
Christian Music Network Lakeland, FL	GE1, 14	6.20, 7.60
KHCB-FM (105.7) Houston, TX	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, IN, ID-*Harvest FM*	G4, 15	5.58/5.78
WROL-AM (950) Boston, MA (occasional Spanish)	S3, 3	6.20
Z-musis—Christian rock	G1, 6	7.38/7.56

Rock Music

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, NJ/Skylark Radio network—Oldies	GE1, 6	5.80

Sports

Atlanta Braves international radio network	G1R, 16	7.38
Prime Sports Radio—sports talk and information	S3, 24	5.80

Speciality Formats

Aries In Touch Reading Service	C4,10	7.87
California State Legislature audio	S4, 24	6.80
Colorado Talking Book Network	C1,3	5.60
In-Store Networks	S3, 24	5.04, 5.21, 5.40
Ozarkana Satellite Radio network	G4, 6	7.96
SuperAudio—Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
Wisdom Radio Network	GE1, 12	7.10
Yesterday USA—nostalgia radio	G5, 7	6.80
	G1R, 24	7.38

Talk Programming

American Freedom radio network	GE1, 7	5.80
Amerinet Broadcasting	G1R, 17	8.10
For the People radio network	C1, 6	7.50
Friday Night Live (Friday 8-11 p.m. ET)	GE1, 6	5.80
Talk America Radio Network #1—talk programs	S3, 9	6.80
Talk America Radio Network #2—talk programs	S3, 9	5.41
Talk Radio Network—talk programs	C1, 5	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network (tech talk) (occasional network on when Megabingo is present)	SBS6, 13B (Ku-band)	6.20
World Web News Network	G7, 14	7.70
Worldwide Freedom Radio network	GE1, 7	7.56
WWTN-FM (99.7) Manchester, TN—news and talk	G5, 18	7.38, 7.56

Variety Programming

CBC Radio (occasional audio)	E2, 1	5.78
CBM-AM (940) Montreal, PQ Canada—variety/fine arts	E2, 1	6.12
CJRT-FM (91.1) Toronto, ON Canada—fine arts/jazz-nights	E2, 26 (Ku-band)	5.76/5.94 (DS)
KBVA-FM (106.5) Bella Vista, AR., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSL-AM (1160) Salt Lake City, UT—news/talk/country-overnight	C1, 6	5.58
West Virginia Public Radio	GE1, 12	7.38
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

Satellite Radio Guide/SCPC Services Guide

FM SQUARED (FM²) AUDIO SERVICES

Another type of satellite audio carrier is known as FM Squared. FM Squared signalsdo not require a video carrier to exist. These signals are similar to audio subcarriers as we know it except that they are normally located below the 5.00 MHz audio subcarrier frequency that a normal satellite receivers can tune to. The new Universal SC-50 can tune these frequencies and was used to update this section.

Spacenet 3 Transponder 13 (C-band)

Ambassador Inspirational Radio: 1.410, 4.470, and 4.650 MHz
Blank audio carriers: 1.050, 3.390, 3.570, and 3.750 MHz
Data transmissions: 4.160 MHz
Focus on the Family
.510 (ch. 1), .780 (ch. 2), and 1.230 MHz
International Broadcasting Network: 4.830 MHz
USA Radio Network: .330, 5.010 (ch 1), 5.200 MHz (ch. 2)

Spacenet 3 Transponder 17 (C-band)

Blank audio carriers: .330 and 3.570 MHz
Data Transmission: .800 MHz
Focus on the Family: 1.050 and 1.410 MHz
In-Touch—religious: 4.470 MHz
Salem Satellite Network: 4.650, 4.840, 5.010 (ch.1), and 5.200 MHz (ch. 2)
SRN News: .330 MHz
Skylight Radio Network—religious: 1.770 and 4.280 MHz

Spacenet 3 Transponder 18 (C-band)

Data Transmissions: 4.800 MHz

Galaxy 4 Transponder 3 (Ku-band)

Blank Audio Carriers: 1.150, 2.060, 3.250, 3620, 4340, 4.400, and 4.450 MHz
Data transmissions: 1.000, 2.950, 3.070, and 3.190 MHz
Generic News: 3.530 MHz
In-Store audio network ads (various companies): .710, .810, .910, 1.260, 3.440, 3.700, 3.800, 3.880, and 3.970 MHz
Muzak Services .150, .270, .390, .510, 1.360, 1.480, 1.600, 1.720, 1.840, 1.960, 2.190, 2.310, 2.440, 2.560, 2.680, 2.800, 3.340, 4.080, and 4.200 MHz

Galaxy 4 Transponder 4 (Ku-band)

Data transmissions: .100, .700, 1.250, 2.190, 2.360 MHz
Music: .150, .270, .410, .750, .870, .990, 1.110, 1.350, 1.470, 1.590, 1.710, 1.830, 1.950, 2.070 MHz
Tone: 2.270 MHz

Galaxy 4 Transponder 16 (Ku-band)

Blank audio carriers: 1.230 and 2.280 MHz
Data transmissions: .645, 2.140, 2.350, 2.730, 3.205, 3.245, 3.265, 3.620, 3.735, and 3.970 MHz
In-Store audio networks: .150, .270, .390, .755, .870, .990, 1.110, 1.350, 1.470, 1.590, 1.710, 1.800, 1.965, and 2.070 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.

GE-2 Transponder-Horizontal 12 (C-band)

1204.90 (75.1)	*Radio Marti*—U.S. Spanish radio service to Cuba

Spacenet 3 Transponder-Horiz. 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
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
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

Galaxy 4 Transponder 1-Horizontal (C-band)

1443.80 (56.2)	Voice of Free China (ISWBC) Taipei, Taiwan
1443.60 (56.4)	KBLA-AM (1580) Santa Monica, CA—*Radio Korea*
1443.40 (56.6)	Voice of Free China (ISWBC) Taipei, Taiwan
1438.30 (61.7)	WWRV-AM (1330) New York, NY—Spanish religious programming and music, ID - *Radio Vision Christiana de Internacional*
1436.50 (63.5)	West Virginia Metro News

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0)	Illinois News Network
1404.80 (55.2)	KOA-AM (850)/KTLK-AM (760) Denver, Colo—news and talk/Colorado Rockies MLB radio network
1404.60 (55.4)	WGN-AM (720) Chicago, IL—news/talk/Chicago Cubs MLB radio network
1404.40 (55.6)	Illinois News Network
1404.20 (55.8)	Tribune Radio Networks
1404.00 (56.0)	KFRC-AM (610) San Francisco, CA—oldies/Oakland Athletics MLB radio network
1402.70 (57.3)	WLAC-AM (1510) Nashville, TN—news/talk
1401.80 (58.2)	Michigan News Network
1401.50 (58.5)	Occasional Audio/Agrinet/USA Radio Network
1399.60 (60.4)	Talk America Radio Network 1
1399.20 (60.8)	Talk America Radio Network 2
1399.00 (61.0)	Sports Byline USA/Sports Byline Weekend/*On Computers* radio show
1398.80 (61.2)	United Broadcasting radio network—talk
1398.50 (61.5)	Occasional audio
1398.30 (61.7)	WSB-AM (750) Atlanta, GA—news/talk/Atlanta Braves MLB radio network
1398.00 (62.0)	Occasional audio
1397.80 (62.2)	Occasional audio

(Continued on Page 42)

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

(Continued from Page 41)

1397.50 (62.5) Minnesota Talking Book network
1397.30 (62.7) Occasional audio
1397.10 (62.9) WTMJ-AM (620) Milwaukee, WI - talk/Milwaukee Brewers MLB radio network/Wisconsin Radio Network
1396.90 (63.1) Chicago White Sox MLB radio network
1396.70 (63.3) Radio America/American Entertainment Network
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, IA—talk/Iowa News Network
1395.80 (64.2) WTMJ-AM (620) Milwaukee, WI - talk/Milwaukee Brewers MLB radio network/Wisconsin Radio Network
1395.60 (64.4) WGST-AM/FM (640/105.7) Atlanta, GA ID *Planet Radio*—news/talk
1395.40 (64.6) Michigan News Network
1395.00 (65.0) Occasional audio
1394.70 (65.3) WJR-AM (760) Detroit, MI—news/talk/Detroit Tigers MLB radio network
1394.50 (65.5) XEPRS-AM (1090) Tijuana, Mexico—Spanish language
1391.00 (69.0) 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, CO—news/talk/Colorado Rockies MLB radio network
1384.20 (75.8) WSB-AM (750) Atlanta, GA—news and talk/Atlanta Braves MLB radio network
1383.70 (76.3) Motor Racing Network (occasional audio)
1383.40 (76.6) United Broadcasting Network—talk
1383.90 (76.9) KIRO-AM (710) Seattle, WA—news/talk/Seattle Mariners MLB radio network
1382.90 (77.1) Michigan News Network
1382.60 (77.4) Soldiers Radio Satellite (SRS) network—U.S. Army information and entertainment
1382.00 (78.0) Tennessee Radio Network
1381.80 (78.2) WHO-AM (1040) Des Moines, IA - news/talk/Iowa News Network
1381.60 (78.4) KEX-AM (1190) Portland, OR—news/talk
1381.40 (78.6) Occasional audio
1381.20 (78.8) KJR-AM (950) Seattle, WA - sports talk
1377.40 (82.6) Data transmission (packet burst/tones)
1377.10 (82.9) In-Touch—reading service for blind
1376.90 (83.1) Data Transmissions
1376.00 (84.0) Kansas Audio Reader Network
1375.40 (84.6) USA Radio Network/Agrinet Ag service

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1) WCRP-FM (88.1) Guayama, PR—Spanish language religious programming

Anik E2 Transponder 1-Horizontal (C-band)

1446.00 (54.0) Canadian Broadcasting Corporation (CBC) Radio—North (Quebec) service

Anik E2 Transponder 13-Horizontal (C-band)

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

Anik E2 Transponder 17-Horizontal (C-band)

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

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

Anik E2 Transponder 23-Horizontal (C-band)

1006.00 (54.0) Radio Canada International (ISWBC)
1005.50 (54.5) Canadian Broadcasting Corporation (CBC) Radio

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)

1013.60 (80.4) Wal-Mart in-store network (English)
1013.20 (80.8) Wal-Mart in-store network (English)
1012.80 (81.2) Sam's Wholesale Club in-store network (English)
1004.00 (90.0) Wal-Mart in-store network (English)
1003.60 (90.4) Wal-Mart in-store network (English and Spanish ads)
1003.20 (90.8) Wal-Mart in-store network (English)

SBS5 Transponder 12-Vertical (Ku-band)

1095.00 (91.0) Russian-American Radio Network

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2) RFD Radio Service
1404.60 (55.4) KGHL-AM (790) Billings, MT—country music
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 Agriculture Network/University of Nebraska sports
1396.20 (63.8) Missouri Network/St. Louis Cardinals MLB radio network
1396.00 (64.0) Occasional audio
1395.90 (64.1) KGHL-AM (790) Billings, MT—country music
1395.70 (64.3) Missouri Net/WIBW-AM (580) Topeka, KS—news and talk/Kansas City Royals MLB radio network
1386.40 (73.6) Learfield Communications
1386.20 (73.8) Radio Iowa
1386.00 (74.0) United broadcasting Network—talk
1384.60 (75.4) Capitol Radio Network
1384.00 (76.0) Occasional audio/ABC Direction Network
1383.80 (76.2) Occasional audio
1383.40 (76.6) Capitol Radio Network
1382.90 (77.1) Missourinet
1382.30 (77.7) Virginia News Network
1382.10 (77.9) Learfield Communications/Missourinet
1378.10 (81.9) Occasional audio

RCA C5 Transponder 21-Vertical (C-band)

1043.60 (56.4) Blank audio carrier
1043.40 (56.6) CNN Radio Network
1043.20 (56.8) Blank audio carrier
1042.80 (57.2) Blank audio carrier
1042.60 (57.4) Blank audio carrier
1042.40 (57.6) Blank audio carrier
1042.20 (57.8) Data transmissions
1042.00 (58.0) Blank audio carrier
1041.80 (58.2) CNN Radio Network
1034.40 (65.6) Blank audio carrier
1034.20 (65.8) Data transmissions
1034.00 (66.0) Blank audio carrier
1033.20 (66.8) Blank audio carrier
1032.80 (67.2) Data transmissions
1032.40 (67.6) Blank audio carrier

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

Alphastar (United States/Canada)

The Alphastar DBS service is no longer operational. Based on press reports we have received, the company has gone bankrupt.

DirecTV and USSB (United States)

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

DIRECTV.

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

100	Direct Ticket Previews
101-199	Direct Ticket Pay Per View
120/121	Letterbox
140-142	Unknown service (LC)
200	Direct Ticket Previews
201	DirecTV Information Updates
202	CNN: Cable Network News
203	Court TV
204	CNN HN: Headline News
205	DirecTV Special Events Calendar
206	ESPN
207	ESPN 2
208	ESPNews
211	DirecTV Sports Schedule
212	TNT: Turner Network Television
213	HSC: Home Shopping Network
214	HGTV: Home and Garden TV
215	TV Food Network
217	E! Entertainment TV
218	DirecTV Access Card Information
220	AMC: American Movie Classics
221	TCM: Turner Classic Movies
222	Romance Classics
224	Direct Ticket Previews
225	STARZ! (East)
226	STARZ! (West)
228	STARZ! 2 (East)
229	DirecTV Platinum Presents Promo
230	Encore (East)
231	Encore (West)
232	Encore 2—Love Stories
233	Encore 3—Westerns
234	Encore 4—Mysteries
235	Encore 5—Action
236	Encore 6—True Stories!
237	Encore 7—WAM!
238	Bravo
239	IFC: Independent Film Channel
240	A&E: Arts and Entertainment
241	The History Channel
242	Disney Channel (East)
243	Disney Channel (West)
245	Discovery Channel
246	TLC: The Learning Channel
247	Cartoon Channel
248	Animal Planet
252	ESPN Game Plan Promo
253	USA Network
254	Sci-Fi Channel
256	WGN Chicago, IL
258	The Family Channel
259	WTBS Atlanta, GA
260	Trio
261	QVC Shopping Channel
262	TNN: The Nashville Network
263	CMT: Country Music TV
265	Access Television
267	Platinum Presents Channel
268	BET: Black Entertainment TV
269	MuchMusic USA
271	C-SPAN 1
272	C-SPAN 2
274	Bloomberg Information Television
275	CNBC
276	MSNBC
277	TWC: The Weather Channel
278	FOX News Channel
279	CBC Newsworld International
280	CBS Eye on People
281	CNN International/CNN fN
283	Channel Earth
286	TBN: Trinity Broadcasting
289	America's Health Network
290	WRAL-CBS Raleigh, NC
291	KPIX-CBS San Francisco, CA
292	WNBC-NBC New York, NY
293	KNBC-NBC Los Angeles, CA
294	PBS National Service
295	WJLA-ABC Washington, DC
296	KOMO-ABC Seattle, WA
297	FOXNet
299	Guthy-Renker TV
300	DirecTV Sports Offers
301	Sports Special Events Calendar
302	Special Events Calendar
304	The Golf Channel
305	Classic Sports Network
306	Speedvision
307	Outdoor Life Channel
308	Platinum Presents Channel
309	SportsChannel New England
310	Madison Square Garden
311	New England Sports Network
312	SportsChannel New York
313	Empire Network
314	SportsChannel Philadelphia
315	Fox Sports Pittsburgh
316	Home Team Sports
317	Fox Sports South
318	Sunshine
319	SportsChannel Florida Sports
320	Pro AM Sports
321	SportsChannel Ohio
322	SportsChannel Cincinnati
323	SportsChannel Chicago
324	Midwest SportsChannel
325	Fox Sports Southwest
326	Fox Sports Rocky Mountain
327	Fox Sports Midwest
329	Fox Sports Arizona
330	Fox Sports Northwest
331	Fox Sports West
332	Fox Sports West 2
333	SportsChannel Pacific
330-348	NFL Sunday Ticket
380	DirecTV Sports Schedule
400	Adult Television pay-per-view
401	Spice
402	Playboy
501	Music Choice—Hit List
502	Music Choice—Dance
503	Music Choice—Rap
504	Music Choice—R&B Hits
505	Music Choice—Reggae
506	Music Choice—Blues
507	Music Choice—Jazz
508	Music Choice—Lite Jazz
509	Music Choice—New Age
510	Music Choice—Eclectic Mix
511	Music Choice—Alternative Rock
512	Music Choice—Metal
513	Music Choice—Classic Rock
514	Music Choice—80s Power
515	Music Choice—70s Super Hits
516	Music Choice—Solid Gold Oldies
517	Music Choice—Soft Rock
518	Music Choice—Today's Country
519	Music Choice—Country Horizons
520	Music Choice—Classic Country
521	Music Choice—Easy Listening
522	Music Choice—Big Bands
523	Music Choice—Singers and Standards
524	Music Choice—Show Tunes
525	Music Choice—Classics Favorites
526	Music Choice—Classical Masterpieces
527	Music Choice—Contemporary Christian
528	Music Choice—For Kids Only
529	Music Choice—Sounds of the Seasons
530	Music Choice—Spectrum I
531	Music Choice—Spectrum II
550	Music Choice—Lite Classical
551	Music Choice—EE-Vocals
552	Music Choice—Soft Album Mix
553	Music Choice—The Trend
554	Music Choice—Tropical
555	Music Choice—Mexicana
599	Music Choice-NRTC (realtor channel)
757	Microsoft TV
790	RealNet — Real Estate Channel

USSB

USSB (United States)

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

899	USSB Programming Higlights
900	Special Event programming
901	Special Event programming
910	HBO East
911	HBO 2 East
912	HBO 3
913	HBO West
914	HBO 2 West
916	HBO Family East
917	HBO Family West
920	Showtime East
921	Showtime 2
922	Showtime 3
923	Showtime West
929	Flix
930	Cinemax East
931	Cinemax 2
932	Cinemax West
940	The Movie Channel East
941	The Movie Channel West
945	Sundance Channel
960	Nick at Nite's TV Land
962	Lifetime TV
963	All New Channel
964	Comedy Central
965	VH1: Video Hits One
966	MTV: Music Television
967	M2: Music Television 2
999	USSB Programming Highlights

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

ECHOSTAR

EchoStar (United States)

The new Echostar 1/2 high power DBS (Ku-band 12.2-12.7 GHz) satellites are now operational at 119° 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 on Demand Previews
102	USA Network
104	Comedy Central
106	Nick at Nite's TV Land
108	Lifetime
110	TV Food Network
112	HGTV: Home and Garden Network
114	E! Entertainment TV
116	Game Show Network
118	A&E: Arts and Entertainment
120	The History Channel
122	Sci-Fi Channel
124	BET: Black Entertainment TV
132	TCM: Turner Classic Movies
138	TNT: Turner Network Television
140	ESPN
141	ESPN Alternate
142	ESPN2
143	ESPN2 Alternate
144	ESPNews
160	MTV: Music Television
161	M2: Music Television 2
162	VH-1: Video Hits 1
166	CMT: Country Music Television
168	TNN: The Nashville Network
170	Nickelodeon (East)
171	Nickelodeon (West)
172	The Disney Channel (East)
173	The Disney Channel (West)
176	The Cartoon Network
178	TLC: The Learning Channel
180	The Family Channel
182	The Discovery Channel
184	Animal Planet
200	CNN: Cable News Network
202	CNN HN: Headline News
204	Court TV
206	CNN International/CNN fN
208	CNBC
210	C-SPAN 1
212	C-SPAN 2
214	TWC: The Weather Channel
216	NET: National Empowerment TV
220	The Travel Channel
222	HSC: Home Shopping Channel
230	TBS: WTBS Atlanta, GA
232	KTLA Los Angeles, CA
234	WPIX New York, NY
236	WSBK Boston, MA
240	WGN Chicago, IL.
241	WNBC-NBC New York, NY
242	KNBC-NBC Los Angeles, CA
243	WRAL-CBS Raleigh, NC
244	KPIX-CBS San Francisco, CA
245	WJAL-ABC Washington, DC
246	KOMO-ABC Seattle, WA
247	FOXNet
249	PBS National Service
260	TBN: Trinity Broadcasting Network
261	EWTN: Eternal Word TV Network
270	The Worship Channel
271	Praise TV
272	FamilyNet
273	Cornerstone TV
274	100 Plus Ministries
275	Home School Channel
300	HBO East
301	HBO 2 East
302	HBO 3 East
303	HBO West
304	HBO 2 West
305	HBO Family
310	Showtime East
311	Showtime West
312	Showtime East 2
318	Sundance
319	FLIX
320	Cinemax East
321	Cinemax East 2
322	Cinemax West
330	The Movie Channel East
331	The Movie Channel West
401	The Golf Channel
412	MSG: Madison Square Garden
414	Fox Sports Rocky Mountain
416	Fox Sports Southwest
417	Fox Sports West
418	Fox Sports Midwest
420	Fox Sports South
422	Sunshine Network
424	Home Team Sports
426	Fox Sports Northwest
428	Fox Sports Pittsburgh
430	Pro-Am Sports
432	Empire Sports Network
434	New England Sports Network
436	Midwest Sports Channel
500	PPV 1 DISH-on-Demand (events)
501	PPV 2 DISH-on-Demand
502	PPV 3 DISH-on-Demand
503	PPV 4 DISH-on-Demand
504	PPV 5 DISH-on-Demand
505	PPV 6 DISH-on-Demand
506	PPV 7 DISH-on-Demand
507	PPV 8 DISH-on-Demand
508	PPV 9 DISH-on-Demand
509	PPV 10 DISH-on-Demand
551	AgCast (Data Service)
600	RAI (Italy)
602	ART (Arab Radio and Television)
604	Antenna TV Greece
620	MTV Latino
626	Fox Sports Americas
628	Telemundo
700	DISH 2 (Showroom Promo)
900	Business TV 1
901	Business TV 2
TBA	Lawyers Communications Network

DISH CD ™

950	New Country
951	Country Classics
952	Country Currents
953	Jukebox Gold
954	70's Song Book
955	Adult Favorites
956	Adult Contemporary
957	Adult Alternative
958	Hot Hits
959	Classic Rock
960	Modern Rock Alternative
961	Power Rock
962	Non-Stop Hip Hop
963	Urban Beat
964	Latin Styles
965	Fiesta Mexicana
966	Eurostyle
967	Jazz Traditions
968	Contemporary Jazz Flavors
969	Americana
970	Contemporary Instrumentals
971	Concert Classics
972	Light Classical
973	Easy Instrumentals
974	Big Band Era
975	Contemporary Christian
976	Kid Tunes
977	New Age
978	Blues
979	Reggae
980	LDS Radio Network
995	American Family Radio
996	Calvary Satellite Network
997	Bob Jones University Radio

ExpressVu (Canada)

Canadian digital medium power direct-to-home satellite TV service. Expressvu will provide Canadian, American, and international video and audio programs. The service will be offered using Canada's Anik E2 (Ku-band 11-.7-12.2 GHz) satellite at 107.3° West. Channel assignments were 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**

Programming: CBC Network, SRC Network (French), TV Ontario, La Chaine Francaise de TV Ontario, Open Learning Agency-Knowledge Network, Saskatchewan Communications Network, Alberta Access-Access Network, Radio Quebec, CTV Network, Global, Quartre Saisons, CFTM-TVA, Atlantic Satellite Network, CPAC (English/French), Television Northern Canada, CFMT-Multicultural TV, CTEQ-Multicultural TV, ExpressVu Electronic Programming Guide, ExpressVu PPV Marketing Channel, ExpressVu Marketing Channel, CFCF (CTV), BCTV (CTV), CFTO (CTV), ATV (CTV), CHCH-Hamilton, CITY-Toronto, CITV-Edmonton, WXYZ-ABC, WTOL-CBS, WUHF-FOX, WDIV-NBC, WTVS-PBS, The Sports Network, Reseau des Sports (French), MuchMusic, Musique Plus, Vision TV, Weather Network, Meteo Media, Canadian Home Shopping Network, Discovery Channel, Showcase, Life Network, Bravo!, WTN, CBC Newsworld, RDI-SRC, Canal Famille, Canal D, TV-5, New Country Network, YTV, Fanily Channel, A&E, Learning Channel, CNN, Headline News, CNBC, Nashville Network, Black Entertainment TV, WGN-Chicago, WPIX-NY, KTLA-Los Angeles, TBS-Atlanta, WSBK-Boston, WWOR-NY, Fairchild TV, Telelatino, The Movie Network, Superchannel, Super Ecran, MoviePix, MovieMax, PPV-30 channels, digital pay audio channels.

Allego audio channels: Just For Kidz, Divertimento, Nos Souvenirs en Musique, Blues Deluzxe, Country Coast-to-Coast, Jazz-Plus, Love Songs, The Beat, Classic Rock, Hot Hits, The Edge, 70s-90s Superstars, 50s-60s

Direct Broadcast Satellite (DBS) Systems

Soundtrack From Your Life, Today's Country, 30s-50s Silver Memories, Rock Leger

Galaxy audio channels: Rock Gold, Brave New Waves, Francophone Pop Rock, Adult Contemporary, Contemporary Hits, Urban Contemporary, Musial Poets, Blues, Chansons of Yesterday, Chansons of Today, The Great Chansons, Celtic, World Roots, Tropical, Country Classics, New Country, Big Band, Classic Jazz, Contemporary Jazz, Light Classics, Music from the Movies, All Baroque, Classical Hits, The Classical Salon, Opera, The Gothic Ages, The New Music, Tranquility Base, For Kids, Pour Penfance

Canadian Radio Stations: CBC-FM Atlantic/Eastern/Pacific, CBW-AM Winnipeg, CBU-AM-Vancouver, CHFI-FM Toronto, CIRK-FM Edmonton, CISN-FM Edmonton, CHFA Edmonton, CFMI-FM Vancouver, CKNM Yellowknife, CKRW-FM Whitehorse, CHON Whitehorse, VOCM St. John's, CBL-AM Montreal (French), CBF-AM Montreal (French), CBM-AM/FM Montreal (English), CKAC Montreal (French), CITE-FM Montreal (French)

Galaxy Latin America (Mexico, Central and South America)

Galaxy Latin America, 2400 East Commerical Boulevard, 9th Floor, Ft. Lauderdale, FL USA
Web site has instructions for obtaining service in each country or write the provider direct.
Web site: **http://www.directvnet.com**
Latin American digital medium power direct-to-home satellite TV service carried on Galaxy 3R at 95° West (Ku-band, 11.7-12.2GHz). Service for Caribbean, Mexico, Central, and South America. Galaxy Latin America will have 144 channels of video (72 channels, 12 transponders in Spanish/72 channels, 12 transponders in Portuguese). Pay-per-view movies (Cinedirect) and events (Direct Events) are available. A 1.1-meter dish is needed to utilize the service. Channel assignments were not available at presstime. Galaxy Latin America (GLA) is backed by DirecTV International, Venezuela's Cisneros Group, Mexico's MVS Multivision, and Televisao Abril.

Programming: GLA Coming Attractions/Programming, TNT Latin America, TeleUno, Sony Entertainment TV (SET), WBTV (The Warner Channel), MAS Mexican Channel, GEMS, TVE Television Espanola, Antena 3 Espana, RAI Italia, Deutsche Welle, RTPI, TVN Chile, TV Azteca Canal 7 Mexico, TV Azteca Canal 13 Mexico, Cartoon Network, ZAZ, Locomotion, MTV Latino, ESPN International, CBS Telenoticias, BBC World Service, CNN International, Bloomberg, Travel Channel, Discovery Channel, MultiPremier, Bravo, MultiCinema, Cine Latino, HBO Ole West, HBO Ole East, HBO Ole 2, Cinemax West, Cinemax East, AdultVision, CL@SE Educational channel for Latin America, CineCanal 1, CineCanal 2, Telecine 1, Telecine 2, Playboy, ABC, NBC, CBS, HBO Brasil, HBO Brasil 2, ESPN South, TV Senado, CMT, MTV Brasil, Bravo Brasil, E! Entertainment, Mundo, National Geographic, CNA - Canal de Noticias de TVA, Canal de Noticias NBC, Bloomberg Business TV in Portuguese, Cinemax Brasil, CNN en Espanol, RBN News (Brasil), Televen International, Univision, Venevision International, Zeta, 60 CD-Quality audio channels, ESPN Dos

Primestar (United States)

Primestar is a medium power Direct-to-Home satellites service carried on GE-2 satellite at 85° West (Ku-band 11.7-12.2 GHz). Primestar uses GE-2 satellite transponders 1-6 and 8-24 transponders).

Primestar Partners, 3 Bala Plaza West, Suite 700, Bala Cynwyd, PA 19004, 1-800-966-9615
Web Site: **http://www.primestar.com**

1-22 News and Info Channels

1	PrimeView One (Information/Preview Channel)
2	Prevue Guide
3	CNN HN: Headline News
4	CNN: Cable News Network
5	CNNSI
6	CNBC
7	CNNfn/CNNI
8	MSNBC
9	MSNBC Weather by Intellicast: Northeast
10	MSNBC Weather by Intellicast: Mid Atlantic
11	MSNBC Weather by Intellicast: Southeast
12	MSNBC Weather by Intellicast: Midwest
13	MSNBC Weather by Intellicast: South Central
14	MSNBC Weather by Intellicast: Central Plains
15	MSNBC Weather by Intellicast: Northern Plains
16	MSNBC Weather by Intellicast: Four Corners
17	MSNBC Weather by Intellicast: Southwest (Pacific)
18	MSNBC Weather by Intellicast: Northwest
19	C-SPAN 1
20	C-SPAN 2
21	TWC: The Weather Channel
22	CourtTV

33-43 Broadcast Channels

33	WSB-ABC Atlanta, GA
34	KABC-ABC Los Angeles, CA
35	WUSA-CBS Washington, DC
36	KOIN-CBS Portland, OR
37	WHDH-NBC Boston, MA
38	KCRA-NBC Sacramento, CA
39	WTXF-FOX Philadelphia, PA
40	KTVU-FOX San Francisco, CA
41	PBS National Service
42	WGN Chicago, IL
43	TBS: WTBS Atlanta, GA

44-53 Variety Channels

44	A&E: Arts and Entertainment
45	USA Network
46	TNT: Turner Network Television
47	Nick at Nite's TV Land
48	Comedy Central
49	TNN: The Nashville Network
50	BET: Black Entertainment Television
51	QVC Shopping Channel
52	E! Entertainment TV
53	Game Show Network

66-69 Music Channels

66	VH1: Video Hits 1
67	MTV: Music Television
68	CMT: Country Music TV
69	MuchMusic (U.S.)

77-85 Family Channels

77	Nickelodeon/Nick At Nite
78	Cartoon Network
79	Disney Channel (East)
80	Disney Channel (West)
81	Lifetime
82	Family Channel
83	Sci-Fi Channel
84	Odyssey
85	TBN: Trinity Broadcasting Network

88-93 Living and Learning Channels

88	Discovery Channel
89	TLC: The Learning Channel
91	The History Channel
92	TV Food Network
93	HGTV: Home and Garden TV Net

99-115 Movie Channels

100	HBO
101	HBO 2
102	HBO 3
103	Showtime (East)
104	Showtime 2 (West)
105	STARZ!
106	Encore
107	Encore Westerns
108	Encore Mystery
109	Cinemax
110	Cinemax 2
111	Sundance Channel
112	IFC: Independent Film Channel
113	TCM: Turner Classic Movies
114	AMC: American Movie Classics
115	Romance Classics

122-143 PrimeCinema Channels

123	PrimeCinema Today (Promo for PPV)
124	PrimeCinema 1
125	PrimeCinema 2
126	PrimeCinema 3
127	PrimeCinema 4
128	PrimeCinema 5
129	PrimeCinema 6
130	PrimeCinema 7
131	PrimeCinema 8
132	PrimeCinema 9
133	PrimeCinema 10
143	Playboy TV

166-215 Sports Channels

166	Prevue Guide
167	ESPN
168	ESPN 2
170	ESPN Alternate
171	ESPN 2 Alternate
172	CNNSI
173	Classic Sports Network
174	Outdoor Life Network
175	Speedvision
176	The Golf Channel
177	NESN
178	SportsChannel New England
179	MSG
180	SportsChannel New York
181	Empire Sports Network
182	SportsChannel Philadelphia
183	HTS
184	Fox Sports South
185	Sunshine Network
186	SportsChannel Florida
187	Fox Sports Pittsburgh

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

188 PASS
189 Fox Sports Midwest
190 SportsChannel Ohio
191 SportsChannel Cincinnati
192 SportsChannel Chicago
193 MSC
194 Fox Sports Rocky Mountain
195 Fox Sports Southwest
196 Fox Sports Arizona
197 Fox Sports Northwest
198 Fox Sports West
199 SportsChannel Pacific
211 Sports Plus 1
212 Sports Plus 2
213 Sports Plus 3
214 Sports Plus 4
215 Sports Plus 5

288-299 Spanish Channels
288 Prevue Guide-Spanish/DMX
289 Univision
290 Cartoon Network
291 Family Channel
292 HBO en Espanol
293 HBO 2 en Espanol
294 HBO 3 en Espanol
295 Showtime En Espanol
296 STARZ!
298 Cinemax Selecciones
299 Cimemax 2 Selecciones

311-340 PrimeAudio by DMX
311 Symphonic
312 Bluegrass
313 Children's
314 Christian Inspirational
315 Gospel
316 Contemporary Christian
317 Hottest Hits
318 Alternative Rock
319 80's Music
320 Album Rock
321 Adult Contemporary
322 Contemporary Instrumentals
323 Soft Hits
324 Traditional Blues
325 Traditional Country
326 Classic Jazz
327 Modern Country
328 Lite Classical
329 Lite Jazz
330 Folk Music
331 70's Oldies
332 Classic Rock
333 60's Oldies
334 Big Band/Swing
335 50's Oldies
336 Motor City Sound
337 Urban Adult Contemporary
338 R&B/Rap Hits
339 Latin Contemporary
340 Salsa

401-402 Other Channels
401 TV Japan (English)
402 TV Japan (Spanish)

500-699 Sports Channels
501-554 NBA League Pass Package
556-599 NHL Center Ice package
656-699 MLB Extra Innings package
TBA The People's Network Private Television Network

STARCHOICE MARKETING INC.

StarChoice (Canada)

Canadian digital medium power direct-to-home satellite TV service. The service will provide English and French language Canadian broadcast networks, specialty and multi-cultural channels, eligible U.S. broadcast networks and specialty channels, and licensed Canadian pay-per-view channels. The receive system must be purchased (manufactured by Echostar) and uses a 24-inch dish. Channel assignments were not available at presstime. This service was formerly known as Direct Choice TV.

Fredericton, New Brunswick Canada
Telephone: 1-888-554-STAR (7827)/506-328-4608
Web site: **http://www.compuweb.nb.ca/allenc/StarChoice/home.htm**

Programming: A&E, ABC, Atlantic Satellite Network, Bravo, Canal Indigo PPV (French), CBC, CBC Newsworld, CBS, CNN, CNN Headline News, CTV, CTV-ATV Halifax, Canal Famille, Country Music TV, Discovery Channel, FOX, Life, Movie Max, Movie Pix, MuchMusic, Musique Plus, NBC, PBS, RDI, RDS, Showcase TV, SRC, SuperChannel, Super Ecran, TSN, The Family Channel, The Learning Channel, The Movie Network, The Nashville Network, TQS, TV5, TVA, Viewer's Choice-15 Channels (English), WGN-Chicago, WSBK-Boston, WTBS-Atlanta, Youth TV, 30 CD-quality, commercial free music channels

Coming Soon: Black Entertainment TV, CITV Edmonton, CITY Toronto, CNBC, CPAC, CTV Sportsnet, Canal Indigo PPV (more offerings), Fairchild (Chinese) History, KTLA Los Angeles, CA, Telelatino, Teletoon, The Movie Network 2/3/4, The Weather Network, WPIX New York, NY, Women's Television Network

Sky TV (Mexico)

Mexican digital medium power direct-to-home satellite TV service. SKY TV is a service which is being offered by News Corp., Brazil's Globo, Mexico's Grupo Televisa and TCI International. The service will provide Spanish language Mexican broadcast networks, specialty channels, eligible U.S. cable channels in Spanish, and 48 channels of Sky audio. No additional information is available on channel assignments, equipment, subscription cost, or service contacts at presstime. Sky TV is carried on Solidaridad 2 Ku-band at 112.9 degrees.

Programming: Art, Arte, Banda Max, BBC World, Canal 2, Canal 22, Canal 4, Canal Fox, Cartoon Network, Casa Club, Cinecanal, Cinecanal 2, CineCanalb, Cinemax East, Cimemax West, CNBC, CNI Canal 40, CNN Espanol, CNN International, Conexion Financiera, Corte Latino, Deutschelle Welle, Discovery Channel, Discovery Kids, E! Latino, ECO, ESPN 2, ESPN International, Estrellas, Family Channel, Film Y Arts, Fox Kids, Fox Sports Americas, Fut Todo Futbol, Galeusca, Galicia TV, Gems, Golden Choice 1/2, Golf Channel, Guadlajara, Hallmark, HBP Ole East, HBO Ole West, HBO Ole 2, Headline News, Jewish TV, Monterrey, Mosiaco, Movie City 1/2, MSNBC, MTV Latino, Mundo Ole, NHK TV Japan, Nickelodeon, Outdoor Life, RAI, Ritmoson, Sky Promo, Sky Premier PPV, Sky Special 1/2/3/4, Sony, Sppedvision, Tele Uno, Telehit, THTV, TNT, Toro, Travel Channel, TV Food, TV5, TVE, Unicable, USA, Warner, Weather Channel, XEIPN Once TV, XEQ-TV Canal 9, XEW-TV Canal 2, XHDF Canal 13, XHGC Cabal 5, XHIMT Canal 7, XNTV Canal 4.

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

SBS 6 (SBS6) 74° West

1	11717-H	Data transmissions/FamilyNet [digicipher]
2	11749.5-V	FOX SNG feeds
3	11774-H	MSNBC feeds
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/[digital video] (occ)
9	11921-H	Occ video
10	11945.5-V	Occ video/CONUS Communications (occ)/ CONUS [digital video] (upper half)
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	Occ video
15	12075-H	Occ video
16	12092.5-V	Occ video
17	12110-H	Unknown User [digital video]
18	12141.5-V	Occ video
19	12174-H	CNN Newsbeam (occ)

SBS 4 (SBS4) 77° W. (Inclined orbit)

Transponders 2-10 on this satellite are used for NBC feeds.

1	11725-H	Data transmissions

Satcom K2 (K2) 82° West

5	11847-H	PBS Digicipher 2 Testing
15	12142-H	GE Americom K2 ID slate

GE-2 (GE2) 85° West

Transponders 1-6 and 8-24 consists of Primestar programming encrypted and compressed using the Digicipher system. A complete Primestar channel guide is presented in the DBS section of *Satellites Times* Satellite Service Guide.

7	11840-V	TV Asahi feeds [LEITCH]

Spacenet 3R (S3) 87° West

19	11740-H	Data transmissions
21	11900-H	Data transmissions
22	11980-H	SUNY Ed Net/NY Lottery feeds/Occ video (East spot beam)
23	12060-H	Occ video (West spot beam)
24	12140-H	Occ video (East spot beam)

Telstar 4 (T4) 89°West

1	11730-V	AT&T Tridom [digital]
3	11790-V	AT&T Tridom [digital]
4	11803-H	AT&T Tridom [digital]
5	11850-V	Data transmissions
7	11910-V	PBS Adult Learning Service (analog lower half)
7	11910-V	PBS Schedules 5A0, 5A5, 5B5, 5B6, X (digicipher upper half)
8	11923-H	Data transmissions
9	11971-V	Occ video
11	12033-V	South Carolina Educational TV [digicipher]
15	12157-V	DMX for Business [digital data-lower half transponder]
16	12170-H	Unknown User [digital video]

Galaxy 7 (K7) 91° West

TCI Headend in the Sky [digicipher] uses transponders 1, 4, 6-7, 9-10, 12-13, 15, 19, and 21-22. Using a 4DTV receiver, an unidentified digital audio service (40 channels: 820-859) has been observed on this satellite.

2	11750-H	Data transmissions
3	11750-V	Indiana Higher Education [Spectrumsaver]
5	11810-H	Data transmissions
8	11870-H	Data transmissions
11	11930-H	Wescott Communications? [Spectrumsaver]
14	11990-H	Occ video (half transponders common)
16	12020-V	Occ video
17	12050-H	Westcott Communications [Spectrumsaver]
17	12050-H	Westcott Communications ASTN [B-MAC]/National Weather Networks (upper half occasional)
18	12050-V	Westcott Communications [Spectrumsaver]
20	12110-H	Data transmissions
23	12170-H	Data transmissions
24	12170-V	Data transmissions

Galaxy 3R (G3R) 95° West

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

Telstar 5 (T5) 97° West

Frequency layour not known at presstime. Only transponders where activity has been seen are listed.

	11790-V	Occ video
	12178-V	TelQuest [digital video]
	12182-V	TelQuest [digital video]

Galaxy 4 (K4) 99° West

1	11720-H	FM² 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)/ Other data transmissions
5	11810-V	Data transmissions
6	11810-H	Video Plus Contract Channel (occ video)
7	11840-H	Chinese Television Network *Chung Ten* - Chinese/Taiwan all-news service
8	11870-V	Data transmissions
9	11870-H	Data transmissions
10	11900-H	CNN Airport Network [Powervu]/Data transmissions
11	11930-V	Occ video (half-transponders common)/The Asian Network (TAN)
12	11930-H	Occ video
13	11960-H	Occ video
14	11990-V	Data transmissions
15	11990-H	Fordstar [digicipher 2]
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) [videocrypt]
19	12080-H	Data transmissions
20	12110-V	Data transmissions
21	12110-H	Asian-American TV Network (occ)/Occ video
22	12140-H	Data transmissions
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

Transpinders 19, 21, and 23 have failed on this satellite.

20	11820-H	Data transmissions
22	11980-H	Data transmissions
24	12140-H	Georgia Public TV [digicipher] (lower half)
24	12140-H	E.M.G. courses [digicipher] (upper half)

DBS-1 101.2° W./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.

GE-1 (GE1) 103° West

1	11720-H	(none)
2	11740-V	Data transmissions
3	11760-H	NBC Eastern Time Zone programming
4	11780-V	Data transmissions
5	11800-H	(none)
6	11820-V	Empire Sports [Wegener digital]/Kentucky Educational TV (KET) [digicipher]
7	11840-H	NBC Pacific Time Zone programming
8	11860-V	Qualcomm data [digital]
9	11880-H	NBC Mountain Time Zone programming
10	11900-V	Qualcomm data [digital]
11	11920-H	NBC feeds [Wegner digital]/ Data transmissions
12	11940-V	Microspace Velocity [digital]
13	11960-H	NSN data transmissions [digital]
14	11980-V	Qualcomm data [digital]
15	12000-H	NBC Contract Channel
16	12020-V	(none)
17	12040-H	NBC Contract Channel
18	12060-V	Starnet [digicipher]
19	12080-H	NBC News Channel
20	12100-V	Cyclesat [digital]/Occ video
21	12120-H	NBC/MSNBC/CNBC/NBC NewsChannel SNG feeds [Wegner digital]
22	12140-V	Chinese Communications Channel (CCC) [Oak]
23	12160-H	NBC Newschannel SNG/NBC Contract Channel
24	12180-H	Fed Ex TV [BMAC]/Dcc video

GSTAR-4 (GST4) 105° West

1	11730-H	Data transmissions
2	11791-H	Data transmissions
3	11852-H	CNN Newsource (Primary) [Leitch]
4	11913-H	Data transmissions
5	11974-H	Occ video/Court TV Backhauls (occ video)
6	12035-H	CBS NewsNet SNG feeds
7	12096-H	CNN Newsbeam/Occ video
8	12157-H	CNN Newsbeam (occ vdieo)/ CNN Newsource International
9	11744-V	Data transmissions
10	11805-V	Data transmissions
11	11866-V	ABSAT (ABC) SNG feeds
12	11927-V	Data transmissions
13	11988-V	CNN Newsbeam/occ video
14	12049-V	Data transmissions
15	12110-V	CNN Newsource (secondary)/ occ video
16	12171-V	Data transmissions

Anik E2 (A1) 107.3° West

Expressvu DBS service will use transponders 2, 11, 13-14, 21-23, and 32 (starting the summer of 1997). Star Choice DBS service will use transponders 9-10 and 27-28.

1	11717-V	Telesat Canada DVC: MovieMax!, Family Channel E&W, SuperChannel [digital video]
3	11778-V	CanCom [digital video]
4	11804-V	Shaw [digital video]
5	11839-V	Canadian Parliamentary Access Channel, Youth TV E&W, Vision TV, CHSC Shopping [digital video]
6	11865-V	Moviepix!; The Movie Network [digital video]
7	11900-V	Rogers Network [digital video]
8	11926-V	Rogers Network [digital video]
12	12048-V	Saskatchewan CommunicaNetwork [digital]
15	12144-V	Telesat Canada stationkeeping (GLACS)
16	12170-V	Knowledge Network [digital video]
17	11730-H	Bravo Canada, MuchMusic Canada [digital video]
18	11756-H	Showcase E&W/Discovery Channel Canada/Life Network/ The Sports Network [digital]
19	11791-H	Telesat [digital video compression]
20	11817-H	Telesat [digital video compression]
24	11939-H	Ontario Legislature
25	11974-H	La Chaine (TV Ontario's French lanaguage service)
26	12000-H	TV Ontario (English)
29	12096-H	Atlantic Satellite Network (ASN)
30	12122-H	Telesat Canada stationkeeping (GLACS)
31	12157-H	CBC 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 7-8, 11-16, 21-26, and 29-32 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	DirectPC [digital]
6	11865-V	NovaNet FM² Services
9	11961-V	Occ video
10	11987-V	Occ video
17	11730-H	Woman's Television Network E&W [digital video]
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	SCPC/Data transmissions/ Shaw:New Country Network, Access Network of Alberta [digital video]
27	12035-H	Expressvu DBS (summer 1997)
28	12061-H	RDI feeds

Solidaridad 2 (SD2) 112.9° West

Sky TV services can be found in the DBS section of *Satellite Times*. Sky TV uses transponders 1-4, 6-9, 14-16 on SD2.

5	11974-H	Data Transmissions
10	11805-V	Data Transmissions
11	11866-V	Data Transmissions
12	11927-V	Data Transmissions
13	11988-V	Data Transmissions

Anik C3 (C3) 114.9° W. (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)

Anik C1 (C1) 118.6° West

32	12183-H	Occ video

EchoStar 1/2 & Tempo 1 119°West

A complete channel guide for TheDISH Television Network is presented in the DBS section of *Satellites Times* Satellite Service Guide. These satellites operate in the 12.2-12.7 GHz BSS band.

SBS 5 (SBS5) 123° West

1	11725-H	On Command Video [Spectrumsaver]
2	11780-H	SCPC services/Data transmissions/National Tech University [Spectrumsaver]
3	11823-H	Data transmissions
4	11872-H	PBS Regionals/Station backhauls (digicipher 2)
5	11921-H	Data transmissions
6	11970-H	Data transmissions
7	12019-H	Data transmissions
8	12068-H	Data transmissions
9	12117-H	Data transmissions
10	12166-H	WalMart [V2+]/Occ video
11	11748-V	Data transmissions
12	11898-V	WMNB Russian-American TV [inverted video]
14	12141-V	Occ video/Data Transmissions

GSTAR-2 (GST2) 125° West

6	12035-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

	Galaxy 6 (G6) 74°	GE-2 (GE2) 85°	Spacenet 3 (S3) 87°	Telstar 402R (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 5 (T5) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	GE-1 (GE1) 103°	Anik E2 (A1) 107.3°
1	Tokyo BS New York feeds	(none)	Data Transmissions	(none)	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	Unmodulated carriers (occ)	SCPC services	Data Transmissions	MLB International/o/v	CBC-H English Eastern
2	o/v	ABC feeds (o/v)	American Independent Network (AIN) [CLI Spectrumsaver]	Data Transmissions	CBS West [occ VC1]	TVN Theatre 2 [V2+]	(none)	Buena Vista TV distribution	STARZ! 2 [V2+]	Data Transmissions	o/v
3	Gospel Music Television	o/v	WSBK-UPN Boston [V2+]	XXXplore TV (adult) [V2+]	Action PPV [V2+]	TVN Theatre 3 [V2+]	(none)	SCPC services	Data Transmissions	(none)	CBC feeds (occ)
4	o/v	La Cadena de Milagro	Nebraska Educational TV (NETV) [4DTV]	Shop at Home	fX East [V2+]	TVN Theatre 4 [V2+]	(none)	Data Transmissions	Encore-Westerns [V2+]	SC Ohio/Cincinnati [V2+]	Cancom [PowerVu]
5	CNN feeds/o/v	NASA Contract Channel	Univision [V2+]	FOX feeds	fX West [V2+]	TVN Theatre 5 [V2+]	(none)	4 Media Company feeds	Data Transmissions	Hero Teleport (GEMS/HTV) [digital]	o/v
6	NHK (TV Japan) feeds	o/v	(none)	Eurotica Promo (adult) [V2+]	Game Show Network [V2+]	TVN Theatre 6 [V2+]	(none)	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	WNBC-NBC New York (PT24E) [V2+]	o/v
7	Video Catalog Channel (VCC)	o/v	Data Transmissions	Adam and Eve/Spice (adult)/Williams Infomerical [Digicipher]	The Golf Channel [V2+]	Guthy-Renker TV (Infomercials)	(none)	Warner Brothers Dom TV/WB Network	Basil Bassett Bingo (3BTV)	Cornerstone TV (Rel)	CBC-M English
8	Horse Racing [digital]	Data Transmissions	Data Transmissions	ABC feeds East [occ LEITCH]	o/v	Pandamerica Home Shopping	ABC NewsDne	Telemundo/Telenoticias [PowerVu]	KOMO-ABC Seattle (PT24W) [V2+]	SC Chicago [V2+]	Global TV (Leitch)/Global feeds
9	MuchMusic U.S. [V2+]	NASA TV	WPIX-Ind New York [V2+]	Horse Racing [digital]/Fashion Network TV/o/v	CBS Eye on People/WI Sports Networks [PowerVu]	TVN Theatre 9 [V2+]	FOX Feeds	o/v	Data Transmissions	Fox Sports South [V2+]	CBC-B English Atlantic
10	Horse Racing [digital]	Data Transmissions	Data Transmissions	FOX News Edge	United Arab Emirates TV Dubai	TVN Theatre 10 - adultTVision (adult) [V2+]	FOX Feed East	UPN network programs/o/v	FOXNet (PT24E/W) [V2+]	WJLA-ABC Washington (PT24E) [V2+]	Cancom [PowerVu]
11	o/v	NHK NY	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	Gem Shopping Network/o/v	Exxxtasy (adult) [V2+]	o/v	STARZ! East [V2+]	UniVision [digital]	CBC-A French [Powervu]
12	TV Asia [PowerVu]	Data Transmissions	Data Transmissions	Horse Racing [digital]/ACN (occ)	Romance Classics [V2+]	MCI Andover o/v/RAI TV	Exotica (adult) [V2+]	o/v	(none)	Wisdom Network/TurnerVision Promo/o/v	Cancom [PowerVu]
13	RTPi	Data Transmissions	SCPC/FM2 services	FOX feeds West	Ovation/CSN/Kaleidoscope/Bloomberg/-Box [Digicipher]	Horse Racing [digital]/o/v	FOX feeds East	o/v	Data Transmissions	Fox Sports South/SC Alternate (occ)/o/v	CBC-C English Pacific
14	Horse Racing [digital]	USIA Worldnet TV/VOA radio [PowerVu]/Data Transmissions	Data Transmissions	ABC NewsOne Channel	Independent Film Channel [V2+]	Eurotica Promo (adult)	True Blue (adult) [V2+]	o/v	WWOR-UPN New York [V2+]	SC New England [V2+]	Cancom [PowerVu]
15	Midwest Sports Channel [V2+]	Unknown User [digital video]	KTLA-Ind Los Angeles [V2+]	The X! Channel (adult) [V2+]	Your Choice TV [Digicipher]	o/v	o/v	World Harvest TV (Rel)	Data Transmissions	(none)	o/v
16	Horse Racing [digital]	Data Transmissions	CNN International/CNN fN [V2+]	Eurotica (adult) [V2+]	Access Television [Digicipher]	HBO 2 East [V2+]	o/v	CBS West [occ VC1]	NPS Promo Channel	SC Pacific [V2+]	Cancom [PowerVu]
17	o/v	Data Transmissions	FM2 services	FOX feeds	ESPN Intl Pacific Rim [B-MAC]	Cinemax 2 East [V2+]	(none)	CBS East [occ VC1]	(none)	SC Philly/SC Alternates (occ)/o/v	CBC-D feeds
18	Unknown user [digital]	o/v	o/v	PBS Schedule X	Teleport Minnesota/CBS feeds/o/v	Inforamerica TV (Informercials)	o/v	CBS feeds/ Eyemark syndicated feeds	STARZ! West [V2+]	SC New York [V2+]	Telesat [digital]
19	University Network-Dr. Gene Scott (Rel)	Data Transmissions	SSN Extra [V2+]	Natl Jewish TV/Exotica Promo (adult) [V2+]	CBS East [occ VC1]	HBO 3 [V2+]	(none)	CBS East [occ VC1]	(none)	National Empowerment TV (Net)	Telesat [digital]
20	CNN Feeds (o/v)	o/v	(none)	(none)	FOX News Channel	HBO 2 West [V2+]	o/v	CBS East [occ VC1]	(none)	AFRTS [Powervu]	o/v
21	o/v	o/v	SSN Pro Am Sports (Pass) [V2+]	ABC feeds West [occ LEITCH]	BET on Jazz	o/v	ABC West Hot Backup	CBS feeds/o/v	Data Transmissions	Univision feeds (occ)	[illegible]
22	Horse Racing [digital]	Arab Network of America (ANA)	American Collectibles Network (ACN)	ABC feeds East [occ LEITCH]	o/v	Horse Racing [digital]	ABC East Hot Backup	Paramount feeds/o/v	Data Transmissions	o/v	o/v
23	Worship TV/Praise TV (Rel) [Nokia]	NHK Secondary Feeds	SSN Home Teams Sports (HTS) [V2+]	(none)	fX Movies [V2+]	3 Angels Broadcasting	o/v	SCOLA [Wegener]/LDS TV (occ)	Data Transmissions	(none)	CBC-E English
24	Horse Racing [digital]/o/v	o/v/El Commandante Horse Racing	America One	ABC feeds	Intl Channel/Encore Themed Channels [4DTV]	Horse Racing [o/v digital]/ACN o/v	(none)	CBS Newspath	KPIX-CBS San Francisco (PT24W) [V2+]	WRAL-CBS Raleigh (PT24E) [V2+]	(Inactive)

Satellite Transponder Guide

By Robert Smathers

Solidaridad 1 (SD1) 109.2°	Telesat E1 (A2) 111°	Solidaridad 2 (SD2) 112.9°	Morelos 2 (M2) 116.8°	Galaxy 9 (G9) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133°	Satcom C4 (F4) 135°	Satcom C1 (F1) 137°	
ata Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	BBC Breakfast News/Reuters Newsfeeds/o/v	Disney East [V2+]	Family Channel West [PowerVu]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Prime Network [V2+]	1
ata Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	Reuters Newsfeeds/o/v	Playboy (adult) [V2+]	The Learning Channel [V2+]	Univision/Galavision [PowerVu]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
SCPC services	Data Transmissions	Data Transmissions	Data Transmissions	NHK TV	Trinity Broadcasting (Rel)	Viewer's Choice PPV [digital]	Encore Themed Services [4DTV]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
ata Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	General Communication [digital]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food/Outdoor Life Networks [Digicipher]	Lifetime East [V2+]	Cal Channel [Powervu]/o/v	4
(none)	Data Transmissions	o/v	(none)	Showtime/TMC/SDC (West) [4DTV]	CNN [V2+]	Odyssey (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	5
ata Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	o/v	WTBS-Ind Atlanta [V2+]	Court TV/NW Cable News [4DTV]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
Unknown User [digital video]	Data Transmissions	o/v	Data Transmissions	TVN Digital Theaters 1-8 [4DTV]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN FOX Sports West [V2+]	7
ata Transmissions	(Inactive)	Data Transmissions	XHGC canal 5	General Communication [digital]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
Multivision DBS [Digicipher]	(Inactive)	(none)	Data Transmissions	TVN Digital Theaters 9-16 [4DTV]	ESPN [V2+]	Music Choice [4DTV]	ESPN2 Blackout [V2+]/SAH	QVC Network	FOX Sports Net Base	9
exican Government Channel	(Inactive)	(none)	XEIPN canal 11	TVN Digital Theaters 17-24 [4DTV]	MDR Music	America's Store	MSNBC [V2+]	Home Shopping Network (HSN)	SSN FOX Sports SW [V2+]	10
Multivision DBS [Digicipher]	(Inactive)	Unknown User [digital video]	Data Transmissions	TVN Digital Theaters 25-32 [4DTV]	Family Channel East [V2+]	Prime Network [V2+]	Eternal Word TV Network (Rel)	SpeedVision	Network One (N1	11
(none)	o/v	(none)	Data Transmissions	General Communication [digital]	Discovery West [V2+]	History Channel [V2+]	Valuevision	(none)	Data Transmissions	12
(none)	(Inactive)	Data Transmissions	Unknown User [digital video]	TVN Digital Theaters 33-35/GRTV [4DTV]	CNBC [V2+]	The Weather Channel [V2+]	Encore Themed Services [4DTV]	Travel Channel [V2+]	Fox Sports Midwest [V2+]	13
Data Transmissions	o/v	Data Transmissions	XEW canal 2	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Alternate [V2+]/SAH	(none)	KUSA-NBC Denver [V2+]	14
Multivision DBS [Digicipher]	(Inactive)	Data Transmissions	Unknown user [digital video]	Showtime West [V2+]	HBO East [V2+]	Showtime East [V2+]	CNNSI/CNN fn/CNN Intl/CNN Spanish [4DTV]	Animal Planet [V2+]	SC Florida [V2+]	15
Data Transmission	CTV Network [PowerVu]	Data Transmissions	XEIMT Canal 22	General Communication [digital]	Cinemax West [V2+]	M2 Music Television	Turner Classic Movies [V2+]	Request TV 1 [V2+]	FOX Sports Arizona/Americas [Digicipher]	16
o/v	(Inactive)	(none)	Unknown User [digital video]	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN FOX Sports (alternates) [V2+]	17
o/v	(Inactive)	(none)	Clara Vision (Rel)	The Movie Channel West [V2+]	TNN [V2+]	TVLand	HBO/Cinemax [4DTV]	Viewer's Choice [Digicipher]	FOX Sports Rocky Mountain [V2+]	18
Data Transmissions	TV Northern Canada [digital]	Data Transmissions	Unknown user [digital video]	MTV West [V2+]	USA East [V2+]	Showtime/TMC/SDC (East) [4DTV]	Cinemax East [V2+]	C-SPAN 2	FOXNet [V2+]	19
(none)	(Inactive)	(none)	Data Transmissions	General Communication [digital]	BET [V2+]	Jones Computer/GAC/PIN [4DTV]	Home and Garden Network [V2+]	Showtime 2 [V2+]	(none)	20
(none)	SCPC services/ Data Transmissions	(none)	Mexican Cable [Digicipher]	ESPNews [V2+]	Knowledge TV	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	FOX Sports West 2 [V2+]	21
(none)	(Inactive)	(none)	XHIMT canal 7	o/v	CNN/HN [V2+]	Animal Planet/Discovery Channel Services [Digicipher]	Nostalgia Channel [V2+]	FLIX [V2+]	SSN FOX Sports NW [V2+] (occ)	22
(none)	(Inactive)	Data Transmissions	Mexican Cable [Digicipher]	Computer Network TV	A&E [V2+]	E! Entertainment TV [V2+]	HBO/Cinemax [4DTV]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
(none)	(Inactive)	(none)	XHDF canal 13	General Communication [digital]	Showtime/Movie Channel [PowerVu]	Digital Music Express Radio (DMX) [digital]	Outdoor Channel	CMT [V2+]	SSN Sunshine Network [V2+]	24

LEGEND:

Unscrambled/ non-video

Subscription

Not available in U.S.

o/v = occasional video

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.

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.

CHINA RADIO INTERNATIONAL

China Radio International, Beijing, China 100866. Telephone +86-10-6092274/6092760 (voice), +86-10-8513174/5 (fax). Asiasat-1(105.5 east) FDM transmission centered on 4160 MHz

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) 7.02, 7.22, 7.38/7.56, 7.74 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 707 (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 707 (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: +613 9626 1800 (voice), +613 9626 1899 (fax)
Palapa C1 (113.0 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) 7.92 MHz audio, Hispasat 1A/B (31.0 west) Tr 6 (12149 MHz RHCP) 7.92 MHz audio, and Asiasat-2 (100.5 east) 4000 MHz H. MPEG-2.

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. Galaxy 7 (91.0 west) Tr 14 (3980 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.

International Shortwave Broadcasters via Satellite

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, and Intelsat K (21.5 west) Tr 7 (11605 MHz H) 8.10 MHz audio multilingual 24 hours.

TRANS WORLD RADIO (TWR)

Astra 1A (19.2 east) Tr 16 (11436 MHz V) 7.38/7.56 MHz audio with German language 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 Hotbird (13 east) 10987 MHz V; Intelsat 603 (34.5 west) 4097.75 MHz LHCP; and Intelsat 704 (66 east) 4152.45 MHz RHCP.

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 707 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*.

WRN 1 North American English Program Schedule

Galaxy 5 (125 deg West) tr 6-3.820 GHz V (TBS) 6.8 MHz audio. WRN is also available on cable and local radio stations. WRN program details can be heard at 0625, 1425 and 1955 Eastern Time, and are also available on TBS text page 204. All times below are Eastern Daylight (UTC +4 hours)

0000	RTE Dublin, Ireland-*Irish Collection*
0100	SABC Channel Africa, Johannesburg (Mon-Sat)
	Copenhagen Calling (Sun)
0130	*BBC Europe Today* (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	UN Radio from New York (Sun)
0200	Polish Radio-Warsaw
0230	Radio Canada International
0300	ABC Radio Australia
0400	Voice of Russia-Moscow
0500	Radio Prague, Czech Republic
0530	Radio Netherlands-Hilversum
0630	YLE Radio Finland
0700	ABC Radio Australia
0800	RTE Dublin, Ireland
0900	Radio Prague, Czech Republic
0930	SABC Channel Africa (Mon-Sat)
	UN Radio from New York (Sun)
1000	YLE Radio Finland
1030	Radio Vlaanderen-Brussels Calling
1100	Radio France International-Paris
1200	Caribbean Tempo from CANA Radio (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	SABC Network Africa (Sun)
1215	Vatican Radio World News (Mon-Fri)
1230	ORF Radio Austria International
1300	BBC Europe Today (Mon-Fri)
	UN Radio from New York (Sat)
	Copenhagen Calling (Sun)
1330	RTE Dublin, Ireland
1400	Radio Vlaanderen-Brussels Calling
1430	Radio Netherlands-Hilversum
1530	Radio Sweden
1600	Voice of Russia-Moscow
1630	Polish Radio-Warsaw
1700	RTE Dublin, Ireland-*Ireland Tonight* at 1800
1900	Radio Netherlands, Hilversum
2000	ABC Radio Australia
2100	YLE Radio Finland-Helsinki
2130	Radio Sweden
2200	Radio Prague, Czech Republic
2230	ORF Radio Austria International
2300	Polish Radio-Warsaw
2330	Radio Budapest, Hungary

WRN 2 North American Multilingual Program Schedule

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 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.

WRN Asia-Pacific Service

AsiaSat-2 (100.5 deg East) 4.000 GHz V, MPEG2 DVB, Symbol Rate 28.125 Mbaud, FEC 3/4, Select WRN1 from audio menu.

WRN Middle East and Africa Service

Intelsat 707 (1 deg West) 3.9115 GHz, RHCP, Symbol Rate 8.022 Mbaud, FEC 3/4, MPEG2 Audio Stream. "WRN1"
PanAmSat 4 (68.5 deg East). MultiChoice digital direct-to-home service, audio channel 51

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 9 1480 4320 (voice), +358 9 1481 1169 (fax). Toll free in the US 800-221-YLEX (9539). WWW URL: www.yle.fi/fbc/radiofin.html. E-mail: *rfinland@yle.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.

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 249 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/Janes *Spaceflight Directory* Editor: Mr. Phillip Clark; Baylin Publications: Dr. Frank Baylin; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; Havard-Smithsonian Center for Astrophysics: Jonathan McDowell; 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. # indicates that the satellite has started into an inclined orbit.

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
22912	1993-073B Meteosat 6 (MOP 3) (ESA)	0.6E#	Met (L)
23730	1995-067A Telecom 2C (France)	2.9E	Dom FSS/Gov-Mil (X/C/Ku)
23712	1995-060A USA 115 (Milstar-2) (US)	4.0E/i	Mil-Comm (P/S/K)
19919	1989-027A Tele X (Sweden)	5.0E	Reg BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.2E	Reg BSS (Ku)
22921	1993-076A USA 98 (NATO 4B)	6.0E/i	Mil-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	7.0E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg FSS (Ku)
19596	1988-095A Raduga 22 (Russia)	11.5E/i	Dom FSS/Gov-Mil (X/C)
22557	1993-013A Raduga 29 (Russia)	11.6E#	Dom FSS/Gov-Mil (X/C)
22269	1992-088A Cosmos 2224 (Russia)	11.7E#	Mil-Earl Warning (X)
24665	1996-067A Eutelsat II F7 (Hot Bird 2)	13.2E	Reg BSS (Ku)
23537	1995-016B Eutelsat II F6 (Hot Bird 1)	13.2E	Reg BSS (Ku)
24208	1996-044A Italsat 2 (Italy)	13.2E	Dom-Telephone/Mob (L/S/K/Ka)
21055	1991-003A Italsat 1 (Italy)	13.2E	Dom-Telephone (S/K/Ka)
20777	1990-079B Eutelsat II F1	13.3E	Reg FSS (Ku)
21803	1991-083A Eutelsat II F3	16.0E	Reg FSS (Ku)
23331	1994-070A Astra 1D	19.1E	Reg BSS (Ku)
23842	1996-021A Astra 1F	19.2E	Reg BSS (Ku)
19688	1988-109B Astra 1A	19.2E	Reg BSS (Ku)
22653	1993-031A Astra 1C	19.3E	Reg BSS (Ku)
21139	1991-015A Astra 1B	19.4E	Reg BSS (Ku)
23686	1995-055A Astra 1E	20.0E	Reg BSS (Ku)
19331	1988-063B Eutelsat 1 F5 (ECS 5)	21.4E/i	Reg FSS (VHF/Ku)
22175	1992-066A DFS 3 (Germany)	23.8E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.5E/i	Reg FSS (VHF/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	25.9E	Reg FSS/BSS (C/Ku)
20659	1990-054A Gorizont 20 (Russia)	26.2E/i	Dom/Gov FSS (C/Ku)
20706	1990-063B DFS 2/Kopernikus (Germany)	28.6E	Dom BSS (S/Ku/K)
24652	1996-062A Arabsat 2B (Arabsat)	30.9E	Reg FSS/BSS (C/Ku)
21894	1992-010B Arabsat 1C (Arabsat)	31.2E#	Reg FSS/BSS (S/C)
23200	1994-049B Turksat 1B (Turkey)	31.2E	Reg FSS (Ku)
15629	1985-025A Intelsat 510	33.1E/i	Int FSS (C/Ku)
20263	1989-081A Gorizont 19 (Russia)	34.1E/i	Dom/Gov FSS (C/Ku)
21821	1991-087A Raduga 28 (Russia)	35.0E/i	Dom FSS/Gov-Mil (X/C)
23717	1995-063A Gals 2 (Russia)	35.8E	Dom BSS (Ku)
22963	1993-002A Gals 1 (Russia)	36.0E	Dom BSS (Ku)
20929	1990-095A USA 65 (DSP F15) (US)	37.4E#	Mil-Early Warning (S/X)
23775	1996-005A Gorizont 31 (Russia)	39.7E#	Dom/Gov FSS (C/Ku)
23949	1996-040B Turksat 1C (Turkey)	41.9E	Reg FSS (Ku)
22981	1994-008A Raduga 1-3 (Russia)	48.8E#	Dom FSS/Gov-Mil (X/C)
23880	1996-034A Gorizont 32 (Russia)	53.0E#	Dom/Gov FSS (C/Ku)
19687	1988-109A Skynet 4B (UK)	53.0E/i	Mil-Comm (P/S/X/Ka)
13040	1982-006A DSCS II E15 (US)	57.0E/i	Mil-IOR reserve operational (S/X)
20203	1989-069B USA 44 (DSCS III A2) (US)	57.0E/i	Mil-IOR primary operational (P/S/X)
23305	1994-064A Intelsat 703	57.1E	Int FSS (C/Ku)
20667	1990-056A Intelsat 604	60.1E	Int FSS (C/Ku)
22913	1993-074A USA 97 (DSCS III B10) (US)	60.0E/i	Mil-IOR primary operational (P/S/X)
24742	1997-009A Intelsat 801	62.0E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	62.6E	Int FSS (C/Ku)
23839	1996-020A Inmarsat 3 F1	63.9E#	Int Mar (L/C)
21814	1991-084B Inmarsat 2 F3	65.1E#	Int Mar-POR (L/C)
23461	1995-001A Intelsat 704	65.9E	Int FSS (C/Ku)
23636	1995-040A PanAmSat 4 (PAS 4)	68.5E	Int FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	70.0E#	Dom FSS/Gov-Mil (X/C)
22787	1993-056A USA 95 (UFO-2) (US)	71.9E/i	Mil-IOR primary (P/S)
13595	1982-097A Intelsat 505	72.1E/i	Int FSS/Mar (L/C/Ku)
08882	1976-053A Marisat 2 (US)	72.3E/i	Int Mar-IOR (P/L/C)
10669	1978-016A Ops 6391 (FltSatCom 1) (US)	72.5E/i	Mil-IOR Reserve (P-Alpha/S/X)
23589	1995-027A USA 111 (UFO-5) (US)	72.8E/i	Mil-IOR reserve (P/S/K)
24820	1997-027B Insat 2D (India)	73.1E	Dom FSS/BSS/Met (S/C)
22027	1992-041A Insat 2A (India)	73.9E	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#	Tracking & Relay SDRN-2 (Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.4E	Reg FSS (C/Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.5E	Reg FSS (C/Ku)
24768	1997-016A Thaicom 3 (Thailand)	78.5E	Reg FSS (C/Ku)
24435	1996-058A Express 2 (Russia)	80.0E	Int FSS (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	80.0/i	Dom/Gov FSS (C/Ku)
23653	1995-045A Cosmos 2319 (Russia)	80.4E#	Data Relay (C)
20643	1990-051A Insat 1D (India)	83.0E	Dom FSS/BSS/Met (S/C)
22836	1993-062A Raduga 30 (Russia)	85.8E#	Dom FSS/Gov-Mil (X/C)
19548	1988-091B TDRS F3 (US)	86.0E/i	Gov-Tracking & Relay (C/S/Ku)
18922	1988-014A Zhongxing 1 (DFH2A-1/PRC-22) (China)	88.5E/i	Dom FSS (C)
22880	1993-069A Gorizont 28 (Russia)	90.1E#	Dom/Gov FSS (C/Ku)
23765	1995-003A Measat 1 (Malaysia)	91.3E	Dom FSS/BSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.3E	Dom FSS/BSS/Met (S/C)
23731	1995-067B Insat 2C (India)	93.4E	Dom FSS/BSS/Met (S/C/Ku)
22245	1992-082A Gorizont 27 (Russia)	96.1E#	Dom/Gov FSS (C/Ku)
20473	1990-011A Zhongxing 3 (DFH2A-3/PRC-26) (China)	98.5E#	Dom FSS (C)
22210	1992-074A Ekran 20 (Russia)	99.0E#	Dom BSS (P)
23723	1995-064A AsiaSat 2	100.5E	Reg FSS (C/Ku)
21922	1992-017A Gorizont 25 (Russia)	103.2E/i	Dom/Gov FSS (C/Ku)
24834	1997-029A Fengyun 2B (China)	104.1E#	Met (L)
20558	1990-030A Asiasat 1	105.4E	Reg FSS (C/Ku)
20570	1990-034A Palapa B2R (Indonesia)	107.9E	Reg FSS (C)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	108.8E	Dom BSS (Ku)
23176	1994-040B BS-3N (Japan)	109.2E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.4E	Dom BSS (Ku)
24769	1997-016B BSAT-1A (Japan)	109.7E	Dom BSS (Ku)
19710	1988-111A Zhongxing 2 (DFH2A-2/PRC-25) (China)	111.3E#	Dom FSS (C)
23864	1996-030A Palapa C2 (Indonesia)	112.6E	Reg FSS (C/Ku)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	115.0E	Dom FSS/BSS (Ku)
14985	1984-049A Zhongxing 5 (Chinasat 5/Spacenet 1)	115.6E#	Dom FSS (C/Ku)
23768	1996-003A Koreasat 2 (Mugunghwa 2)	115.7E	Dom FSS/BSS (Ku)
21964	1992-027A Palapa B4 (Indonesia)	118.0E	Reg FSS (C)
20217	1989-070A GMS-4 (Himawari 4) (Japan)	120.2E/i	Met (P/L)
24798	1997-021A Zhongxing 8 (DFH 3-2) (China)	124.8E	Dom (C)
23649	1995-043A JCSAT 3 (Japan)	128.0E	Dom FSS (Ku)
21132	1991-014A Raduga 27 (Russia)	128.3E/i	Dom FSS/Gov-Mil (X/C)
23651	1995-044A N-Star 1 (Japan)	131.7E	Dom/Mob FSS (S/C/Ku/Ka)
23943	1996-039A Apstar 1A (China)	133.9E	Reg FSS (C)
23781	1996-007A N-Star 2 (Japan)	136.0E	Dom/Mob FSS (S/C/Ku/Ka)
23185	1994-043A Apstar I (China)	137.9E	Dom BSS (C)
23522	1995-011B GMS-5 (Himawari 5) (Japan)	139.9E#	Met (P/L)
20953	1990-102A Gorizont 22 (Russia)	140.1E/i	Dom/Gov FSS (C/Ku)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.2E#	Reg FSS (C/Ku)
17706	1987-029A Palapa B2P (Indonesia)	144.2E#	Reg FSS (C)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
20923	1990-094A Gorizont 21 (Russia)	144.5E/i	Dom/Gov FSS (C/Ku)
20066	1989-046A USA 39 (DSP F14) (US)	145.4E/i	Mil-Early Warning (S/X)
24653	1996-063B Measat-2 (Malaysia)	147.9E	Dom FSS/BSS (C/Ku)
24732	1997-007A JCSAT 4 (Japan)	149.1E#	Dom FSS (Ku)
19874	1989-020A JCSAT 1 (Japan)	149.2E#	Dom FSS (Ku)
18316	1987-070A ETS V/Kiku 5 (Japan)	150.2E/i	Experimental (L/C)
23779	1996-006A Palapa C1 (Indonesia)	150.4E	Reg FSS (C/Ku)
18350	1987-078A Optus A3 (Aussat K3)	152.0E#	Dom FSS/BSS (Ku)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	153.7E	Dom FSS (C/K)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom FSS (Ku)
23227	1994-055A Optus B3 (Australia)	156.0E	Dom BSS/Mob (L/Ku)
12994	1981-119A Intelsat 503	156.5E/i	Int FSS (C/Ku)
22253	1992-084A Superbird A1 (Japan)	158.0E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	159.9E	Dom BSS/Mob (L/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	160.8E#	Reg FSS (C/Ku)
21893	1992-010A Superbird B1 (Japan)	162.1E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	163.9E/i	Dom BSS (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	169.0E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(US)	171.9E/i	Mil-POR reserve (P-Bravo/ S/X)
22871	1993-066A Intelsat 701	174.0E	Int FSS (C/Ku)
24846	1997-031A Intelsat 802	174.0E	Int FSS (C/Ku)
22719	1993-046A USA 93 (DSCS III B9) (US)	175.0E/i	Mil-WPAC primary operational (P/S/X)
23124	1994-034A Intelsat 702	177.0E	Int FSS (C/Ku)
24674	1996-070A Inmarsat 3 F3	178.2E/i	Int Mar (L/C)
20918	1990-093A Inmarsat 2 F1	179.1E#	Int Mar-IOR (L/C)
16117	1985-092C USA 12 (DSCS III B5) (US)	180.0E/i	Mil-WPAC reserve operational (P/S/X)
15873	1985-055A Intelsat 511	180.0E/i	Int FSS (C/Ku)
23467	1995-003A USA 108 (UFO-4) (US)	177.4W/i	Mil-POR (P/S/K)
19121	1988-040A Intelsat 513	177.1W#	Int FSS (C/Ku)
21639	1991-054B TDRS F5 (US)	174.4W	Int FSS/Gov-Tracking & Relay (C/S/Ku)
23613	1995-035B TDRS F7 (US)	171.1W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
18631	1987-100A Raduga 21 (Russia)	170.6W/i	Dom FSS/Gov-Mil (X/C)
20499	1990-016A Raduga 25 (Russia)	169.7W/i	Dom FSS/Gov-Mil (X/C)
21392	1991-037A Satcom C5 (Aurora II)(US)	138.9W	Dom FSS (C)
20945	1990-100A Satcom C1 (US)	137.1W	Dom FSS (C)
23581	1995-025A GOES 9 (US)	135.3W#	Met (P/L/S)
22096	1992-057A Satcom C4 (US)	135.1W	Dom FSS (C)
21873	1992-006A USA 78 (DSCS III B14) (US)	135.0W/i	Mil-EPAC primary operational (P/S/X)
23016	1994-013A Galaxy 1R (US)	133.0W	Dom FSS (C)
22117	1992-060B Satcom C3 (US)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (US)	129.9W/i	Mil-EPAC reserve operational (P/S/X)
21906	1992-013A Galaxy 5 (US)	125.1W	Dom FSS (C)
16649	1986-026A Gstar 2 (US)	124.9W#	Dom FSS (Ku)
23877	1996-033A Galaxy 9 (US)	123.1W	Dom FSS (C)
19484	1988-081B SBS 5 (US)	122.8W	Dom FSS (Ku)
22988	1994-009A USA 99 (Milstar 1) (US)	120.0W	Mil-Comm (P/S/K)
15826	1985-048D Telestar 3D (303) (US)	120.1W#	Dom FSS (C)
24313	1996-055A Echostar 2 (US)	119.9W	Dom BSS (Ku)
23754	1995-073A EchoStar 1 (US)	119.0W	Dom BSS (Ku)
24748	1997-011A Tempo 2 (US)	118.8W#	Dom BSS (Ku)
16274	1985-109B Morelos 2 (Mexico)	116.8W	Dom FSS (C/Ku)
23313	1994-065A Solidardad 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)	107.2W	Dom FSS (C/Ku)
23846	1996-022A MSAT M1 (Canada)	106.5W	Dom Mobile (L/X)
03029	1967-111A ATS 3 (US)	106.2W/i	Experimental (VHF/C)
23696	1995-057A USA 114 (UFO-6) (US)	105.4W/i	Mil-CONUS (P/S/K)
15677	1985-035A Gstar 1 (US)	105.1W#	Dom FSS (Ku)
20946	1990-100B Gstar 4 (US)	105.0W	Dom FSS (Ku)
19483	1988-081A Gstar 3 (US)	104.8W/i	Dom FSS/Mob (L/Ku)
08747	1976-023B LES 9 (US)	104.4W/i	Mil-Experimental (P/Ka)
24786	1997-019A GOES 10 (USA)	104.1W#	Met (P/L/S)
24315	1996-054A GE-1 (US)	103.1W	DOM FSS (C/Ku)
23435	1994-084A USA 107 (DSP F17) (US)	103.0W#	Mil-Early Warning (S/X)
22930	1993-078A DBS 1 (US)	101.2W	Dom BSS (Ku)
21227	1991-028A Spacenet 4 (US)	101.1W	Dom FSS (C/Ku)
23553	1995-019A AMSC 1 (US)	101.0W	Dom Mobile (L/X)
23598	1995-029A DBS 3 (US)	100.9W	Dom BSS (Ku)
23192	1994-047A DBS 2 (US)	100.8W	Dom BSS (Ku)
17181	1986-096A USA 20 (FltSatCom F7)(US)	100.3W/i	Mil-CONUS (P/S/X/K)
22796	1993-058B ACTS (US)	100.0W	Experimental (C/K/Ka)
22694	1993-039A Galaxy 4 (US)	99.0W	Dom FSS (C/Ku)
15237	1984-093D Telestar 3C (302) (US)	97.5W#	Dom FSS (C)
24812	1997-026A Telstar 5 (US)	97.0W	Dom FSS (C/Ku)
23741	1995-069A Galaxy 3R (US)	95.0W	Dom/BSS (C/Ku)
08746	1976-023A LES 8 (US)	93.8W/i	Mil-Experimental (P/Ka)
16650	1986-026B SBTS 2 (Brazil)	92.1W#	Dom FSS (C)
22205	1992-072A Galaxy 7 (US)	91.1W	Dom FSS (C/Ku)
23670	1995-049A Telstar 402R (US)	89.1W	Dom FSS (C/Ku)
18951	1988-018A Spacenet 3R (US)	87.1W	Dom FSS (L/C/Ku)
24713	1997-002A GE-2 (US)	85.0W	Dom FSS (C/Ku)
15561	1985-015B SBTS 1 (Brazil)	79.1W/i	Dom FSS (C)
15235	1984-093B SBS 4 (US)	77.2W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (US)	76.3W/i	Dom FSS (C)
16276	1985-109D Satcom K2 (US)	75.6W#	Dom FSS (Ku)
23051	1994-022A GOES 8 (US)	75.5W	Met (P/L/S)
20872	1990-091A SBS 6 (US)	74.1W	Dom FSS (Ku)
20873	1990-091B Galaxy 6 (US)	74.1W	Dom FSS (C)
24714	1997-002B Nahuel 1A (Argentina)	71.9W	Dom FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.3W	Dom FSS (C)
21805	1991-080B USA 75 (DSP F16) (US)	70.0W#	Mil-Early Warning (S/X)
23536	1995-016A Brasilsat B2 (Brazil)	65.4W	Dom FSS (C/X)
16101	1985-087A Intelsat 512	55.6W/i	Int FSS (C/Ku)
21149	1991-018A Inmarsat 2 F2	55.2W/i	Int Mar-AOR-W (L/C)
24819	1997-027A Inmarsat 3 F4	54.2W#	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	53.0W	Int FSS (C/Ku)
23628	1995-038A USA 113 (DSCS III B4) (US)	52.5W/i	Mil-WLANT primary operational (P/S/X)
21940	1992-021B Inmarsat 2 F4	51.5W/i	Int Mar-AOR-W (L/C)
23915	1996-035A Intelsat 709	50.1W	Intl FSS (C/Ku)
22314	1993-003B TDRS F6 (US)	47.1W	Int FSS/Gov-Tracking & Relay (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 USA 11 (DSCS III B7) (US)	42.5W/i	Mil-ATL reserve operational (P/S/X)
19883	1989-021B TDRS F4 (US)	41.0W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
12089	1980-098A Intelsat 502	40.8W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (US)	37.6W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.7W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A (UK)	34.0W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.5/i	Int FSS/Mar (L/C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	Dom BSS/FSS (Ku)
22723	1993-048A Hispasat 1B (Spain)	30.0W	Dom BSS/FSS (Ku)
21765	1991-075A Intelsat 601	27.6W	Int FSS (C/Ku)
15386	1984-114B Marecs B2	26.4W/i	Int Mar-AOR (L)
21653	1991-055A Intelsat 605	24.5W	Int FSS (C/Ku)
20253	1989-077A USA 46 (FltSatCom 8) (US)	23.5W/i	Mil-AOR (P-Charlie/S/X/K)
23967	1996-042A USA 127 (UFO-7) (US)	22.9W/i	Mil-AOR (P/S/K)
21989	1992-032A Intelsat K	22.9W	Int FSS (Ku)
19772	1989-006A Intelsat 515	21.5W	Int FSS (C/Ku)
20391	1989-101A Cosmos 2054 (Russia)	18.9W/i	Tracking & Relay WSDRN (Ku)
15391	1984-115A NATO III D	18.4W/i	Mil-Comm (P/S/X)
20705	1990-063A TDF 2 (France)	18.1W	Dom BSS (Ku)
23528	1995-013A Intelsat 705	18.0W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W/i	Mil-Comm (P/S/X)
23426	1994-082A Luch 1 (Russia)	15.9E#	Tracking & Relay CSDRN (Ku)
24307	1996-053A Inmarsat 3 F2	15.6W/i	Int Mar (L/C)
23132	1994-035A USA-104 (UFO-3)(US)	14.1W/i	Mil-AOR primary (P/S)
23319	1994-067A Express 1 (Russia)	14.1W	Int FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	13.4W#	Dom Data Relay (C)
22009	1992-037A USA 82 (DSCS III B12) (US)	12.0W	Mil-ELANT primary operational (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	10.5W/i	Dom/Gov FSS (C/Ku)
21140	1991-015B Meteosat 5 (MOP 2) (ESA)	9.6E#	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom FSS/Gov-Mil (X/C/Ku)
24209	1996-044B Telecom 2D (France)	5.1W	Dom-FSS/Gov-Mil (C/X/Ku)
21939	1992-021A Telecom 2B (France)	5.1W	Dom FSS/Gov-Mil (X/C/Ku)
23865	1996-030B Amos 1 (Israel)	4.1W	Dom FSS (C)
23816	1996-015A Intelsat 707	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.0W#	Mil-comm (P/S/X/Ka)
20168	1989-062A TV Sat 2 (Germany)	0.6W	Dom BSS (Ku)
20762	1990-074A Thor 1/Marcopolo 2 (BSB R-2)	0.3W	Reg BSS (Ku)
24808	1997-025A Thor 2A	0.2W	Reg BSS (Ku)

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode	Frequencies
OSCAR 10 (AO-10) (Notes 1 & 10)	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)
RS-12/13 (Notes 2, 3 & 4)		Dn 29.410 420 430 440 29.450 29.454 Up 21.210 220 230 240 21.250 (CW) 21.129
	Bcn	29.408
RS-15 (Note 10)	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
RS-16 (Note 10)	[a]	Dn 29.415 29.425 29.435 28.445 29.448 Up 145.915 145.925 145.935 145.945 145.948
	Bcn	29.408 29.451 435.504 435.548
UoSat 11 (UO-II) (Note 13)	Bcns	Dn 145.826 435.025 2401.500 Up None
PACSAT (AO-16) (Notes 7, 8 & 10)	[a]	Dn 437.025 (Sec)437.050 Up 145.900 145.920 145.940 145.960
DOVE (DO-17) (Notes 9 & 10)	[b,c]	Dn 145.825 2401.220 Up None
WEBERSAT (WO-18) (Note 10)	[a]	Dn 437.075 437.100 (Sec) Up None
LUSAT (LO-19) (Notes 7 & 10)	[a]	Dn 437.125 437.150 (Sec) Up 145.840 145.860 145.880 145.900

NOTES

1. 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.
2. RS-12/13 are mounted on common spaceframes, along with comunication and navagation packages.
3. 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.
4. 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.
5. Transmitters on both AO-16 & LU-19 are currently using Raised Cosine Mode.
6. 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.
7. 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.
8. 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)
9. PO-28 is available to amateurs on an intermittent, unscheduled basis.
10. Modes of operation used include: CW,/USB/FAX/Packet/RTTY
11. Modes of operation used include: FM (AFSK) & PSK Data.
12. Modes of operation used include: Packet & FM Voice.
13. Operation as a single channel narrowban d FM transponder.

Amateur Satellite Frequency Guide

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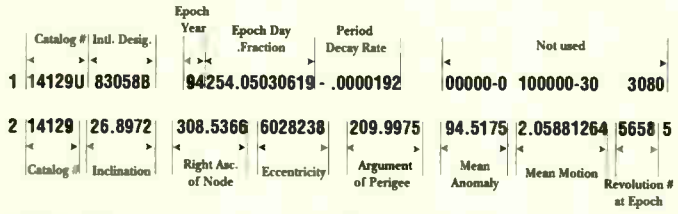
Satellite	Mode	Frequencies
JAS-1b (FO-20) (Notes 8 & 10)	JA Linear	Dn 435.800 810 820 830 840 850 860 870 880 890 435.900
		Up 146.000 990 980 970 960 950 940 930 920 910 900
	Bcn	435.795 (CW)
	JD [a] Dgtl	Dn 435.910
		Up 145.850 145.890 145.910
OSCAR 22 (UO-22) (Note 8)	[c]	Dn 435.120
		Up 145.900 145.975
KITSAT A (KO-23) (Note 8)	[c]	Dn 435.173
		Up 145.850 145.900
KITSAT B (KO-25) (Note 8)	[c]	Dn 435.175 436.500
		Up 145.870 145.980
IT-AMSAT (IO-26) (Note 8)	[a,c]	Dn 435.820 (Sec.) 435.867
		Up 145.875 145.900 145.925 145.950
EYESAT /AMRAD (AO-27) (Note 13)		Dn 436.792
		Up 145.850
POSAT (PO-28) (Notes 8, 9 & 10)	[c]	Dn 435.250 435.280
		Up 145.925 145.975
FUJI/ OSCAR 29 (FO-29) (Notes 8 &10)	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
	JD Digtl (b,c)	Dn 453.910
		Up 145.850 145.870 145.890 145.910
MIR (Note 12)	[b] FM Voice	Dn 145.800 145.550 145.485
		Up 145.200 145.550 145.985
SHUTTLE (SAREX) (Note 12)	[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



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 97209.89567768 -.00000124 00000-0 10000-3 0 4957
2 14129 26.0640 134.8941 6056122 138.2150 288.7072 2.05881317 78249
OSCAR 11 (UoSAT 2, UoSAT 11, UOSAT OSCAR-11, UO-11)
1 14781U 84021B 97215.96773725 .00000043 00000-0 15052-4 0 9912
2 14781 97.8393 195.2991 0010757 207.0187 153.0458 14.69569201718277
Russian Mir Space Station
1 16609U 86017A 97218.99057827 .00000295 00000-0 10000-4 0 5052
2 16609 51.6535 190.6366 0004749 357.4107 2.6837 15.59612558654953
OSCAR 16 (PACSAT, AMSAT OSCAR-16, AO-16)
1 20439U 90005D 97216.25221488 -.00000002 00000-0 15970-4 0 832
2 20439 98.5350 299.9150 0012193 68.9437 291.3047 14.30013968393105
OSCAR 17 (DOVE, DOVE OSCAR-17, DO-17)
1 20440U 90005E 97219.24171660 .00000060 00000-0 39817-4 0 831
2 20440 98.5357 303.7389 0012151 60.9863 299.2525 14.30157378393563
OSCAR 18 (WEBERSAT, WEBERSAT OSCAR-18, WO-18)
1 20441U 90005F 97216.30227648 .00000004 00000-0 18169-4 0 884
2 20441 98.5382 300.7486 0012729 66.5640 293.6879 14.30124383393147
OSCAR 19 (LUSAT, LUSAT OSCAR-19, LO-19)
1 20442U 90005G 97216.19574050 -.00000031 00000-0 49007-5 0 869
2 20442 98.5421 301.3394 0013322 68.3522 291.9083 14.30239626393152
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 97218.94275146 -.00000024 00000-0 26347-4 0 9850
2 20480 99.0476 170.9914 0540013 262.5263 91.4194 12.83238165351210
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 97215.62239872 .00000030 00000-0 15508-4 0 9974
2 21089 82.9216 243.4597 0028963 162.4380 197.7784 13.74084237325671
OSCAR 22 (UoSAT-F, UoSAT-5, UOSAT OSCAR 22, UO-22)
1 21575U 91050B 97217.19294139 .00000009 00000-0 17083-4 0 7900
2 21575 98.2976 276.0005 0008373 100.6823 259.5306 14.37078540317521
OSCAR 23 (KITSAT-A, KITSAT-1, KITSAT OSCAR-23, KO-23)
1 22077U 92052B 97215.94958704 -.00000037 00000-0 10000-3 0 6808
2 22077 66.0764 45.2300 0007259 200.7520 159.3203 12.86302707233896
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR-27, AO-27
1 22825U 93061C 97218.73256722 -.00000015 00000-0 11163-4 0 5763
2 22825 98.5414 291.8195 0009416 90.2614 269.9649 14.27732126201282
OSCAR 26 (ITAMSAT, ITAMSAT OSCAR-26, IO-26)
1 22826U 93061D 97218.76720317 -.00000025 00000-0 72205-5 0 5736
2 22826 98.5389 292.1160 0010093 92.9670 267.2667 14.27842114201307
OSCAR 25 (KITSAT-B, KITSAT-2, KITSAT OSCAR-25, KO-25)
1 22828U 93061F 97218.71928825 .00000005 00000-0 19145-4 0 5524
2 22828 98.5386 292.1541 0011017 77.1577 283.0826 14.28186247169425
OSCAR 28 (POSAT, POSAT OSCAR-28, PO-28)
1 22829U 93061G 97218.25056978 -.00000011 00000-0 12883-4 0 5682
2 22829 98.5405 291.7958 0011065 78.7259 281.5165 14.28170488201271
RS-15 (Radio Sputnik 15)
1 23439U 94085A 97218.00785088 -.00000039 00000-0 10000-3 0 2372
2 23439 64.8181 72.2839 0147672 122.8762 238.6478 11.27528386107556
OSCAR 29 (FUJI 3, FUJI OSCAR-29, FO-29)
1 24278U 96046B 97216.14760422 -.00000010 00000-0 23338-4 0 973
2 24278 98.5355 250.8261 0352353 61.9367 301.6931 13.52632897 47603
RS-16 (Radio Sputnik 16)
1 24744U 97010A 97218.21087877 .00002280 00000-0 77113-4 0 643
2 24744 97.2707 122.3257 0005587 280.9677 79.0937 15.31630803 23742

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 7 (Standby Geostationary Spacecraft-USA)
1 17561U 87022A 97212.89160272 -.00000136 00000-0 10000-3 0 3703
2 17561 3.8557 66.6982 0002634 321.9922 140.3087 1.00252378 21419
GOES 8 (Operational East-USA)
1 23051U 94022A 97211.89583333 -.00000272 00000-0 00000+0 0 7966
2 23051 0.1278 93.4673 0002350 98.8575 3.2406 1.00288704 19460
GOES 9 (Operational West-USA)
1 23581U 95025A 97217.33663936 .00000071 00000-0 10000-3 0 5195
2 23581 0.2976 271.3262 0002383 291.7800 96.8953 1.00280945 8075
GOES 10 (Standby Geostationary Spacecraft-USA)
1 24786U 97019A 97217.20058288 -.00000114 00000-0 00000+0 0 900
2 24786 0.2823 276.2609 0001782 24.5934 341.1743 1.00285308 1046
ELEKTRO (Operational-Russia)
1 23327U 94069A 97214.83823440 -.00000119 00000-0 00000+0 0 3153
2 23327 0.8688 91.9343 0008336 55.6752 181.6591 1.00273728 10123
Feng Yun 2B (Operational-China)
1 24834U 97029A 97217.40994792 -.00000343 00000-0 00000+0 0 483
2 24834 1.1146 263.7885 0000542 243.1717 58.7723 1.00269703 551
Meteosat 5 (Operational ESA, aka MOP-2)
1 21140U 91015B 97211.38764961 .00000000 00000-0 10000-3 0 3637
2 21140 1.3503 78.0659 0002668 162.3442 197.6688 1.00269204 25704
Meteosat 6 (Operational-ESA)
1 22912U 93073B 97213.71907045 -.00000020 00000-0 00000+0 0 7623
2 22912 0.2745 46.8203 0001483 48.9491 114.0627 1.00281099 11979
GMS 4 (Standby-Japan, aka Himawari 4)
1 20217U 89070A 97218.37507523 -.00000377 00000-0 10000-3 0 6084
2 20217 2.6103 73.1920 0001161 233.2645 263.7232 1.00270880 29587
GMS 5 Operational-Japan, aka Himawari 5)
1 23522U 95011B 97212.46451389 -.00000306 00000-0 00000+0 0 3691
2 23522 0.4222 356.8799 0002223 200.9481 58.3627 1.00263109 8557

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning spacecraft-USA 137.500 MHz)
1 21263U 91032A 97218.78703471 .00000100 00000-0 63502-4 0 4775
2 21263 98.5370 231.5023 0013001 141.2833 218.9280 14.22738224323554
NOAA 14 (Operational afternoon spacecraft-USA 137.620 MHz)
1 23455U 94089A 97218.84797756 .00000028 00000-0 40232-4 0 1413
2 23455 98.9952 170.2567 0009611 144.2433 215.9387 14.11682563134098
Meteor 2-21(Off at last report)
1 22782U 93055A 97219.17925809 .00000022 00000-0 68615-5 0 5814
2 22782 82.5518 17.4564 0021012 252.0654 107.8206 13.83078480198632
Meteor 3-5 (Operational-Russia 137.850 MHz)
1 21655U 91056A 97217.52012645 .00000051 00000-0 10000-3 0 9968
2 21655 82.5521 27.8306 0012862 212.8436 147.1886 13.16855251287206
Meteor 3-6 (Off at last report)
1 22969U 94003A 97217.26400955 .00000051 00000-0 10000-3 0 3636
2 22969 82.5589 328.3400 0014587 286.6855 73.2671 13.16746494169548
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 97218.87957958 .00000030 00000-0 39193-4 0 3270
2 23233 98.7724 276.3220 0013550 80.2318 280.0380 14.12823244151526
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 97218.88032230 -.00000001 00000-0 22925-4 0 783
2 23533 98.8478 222.1937 0007112 326.7404 33.3319 14.12799668122320
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 97218.73638429 .00000060 00000-0 56136-4 0 1318
2 24753 98.9313 262.9012 0008087 269.5505 90.4739 14.12991458 17524

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Okean 4-Russia 137.400 MHz)
1 23317U 94066A 97208.08131083 .00000022 00000-0 84760-8 0 2586
2 23317 82.5444 46.5284 0024919 202.3227 157.7568 14.74116068150189
SICH-1 (Oceanographic satellite-Russia 137.400 MHz)
1 23657U 95046A 97216.54406679 .00000209 00000-0 28487-4 0 1865
2 23657 82.5336 180.0602 0028691 144.2310 216.0829 14.73568580103706
IRS-1C (Remote Sensing-India)
1 23751U 95072A 97216.26012541 -.00000044 00000-0 00000+0 0 2303
2 23751 98.7053 290.7300 0001299 66.0978 294.0336 14.21630335 83129
IRS-P3 (Remote Sensing-India)
1 23827U 96017A 97218.21342948 -.00000044 00000-0 00000+0 0 1883
2 23827 98.7128 296.3241 0001179 92.4479 267.6833 14.21448087 71450
TOMS-EP (Total Ozone Mapping Spectrometer-USA)
1 23940U 96037A 97218.78304178 .00002061 00000-0 91117-4 0 1374
2 23940 97.4185 125.1299 0012301 334.6925 25.3708 15.22775176 60848

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-86	Sept. 1997 Atlantis*	51.6/213	10+1 days	S/MM-07**
STS-87	Nov. 1997 Columbia***	28.5/160	16 days	USMP-4 & Spartan

*Crew Assignment: CDR: James D Wetherbee, PLT: Michael J Bloomfield, MS: Scott E Parazynski, MS: Vladimar G Titov (Russia), MS: Jean-Loup Chretien (France), MS: David Wolf (U).

**Mir Crew Assignment: CDR: Anatoly Solovyov, FLT ENG: Pavel Vinogradov, DR: Michael Foale (U.S)(D).

***Crew Assignment: CDR: Kevin R. Kregel, PLT: Steven W. Lindsey, MS: Winston E. Scott, MS: Kalpana Chawla, MS: Takao Doi (Japan), MS: Leonid Kadenyuk (Ukraine).

STS	Downlink Frequency Assignments:
VHF Voice	130.1625 MHz (STS-86 Only)
UHF Voice	243.0 (AM), 259.7 (AM), 279.0 (AM), and 296.8 (AM)
UHF Boosters	240.0, and 242.0 MHz (recovery beacons)
S-band TLM	2217.5, 2250.0, and 2287.5 MHz.
C-band TRK	5400-5900.0 MHz

Mir	Downlink Frequency Assignments:
VHF Voice	121.750, 143.625 MHz
VHF Voice	145.2, 145.8 MHz, 145.985 MHz (Amateur Radio)
UHF Voice	437.925, 437.950, 437.975 MHz (Amateur Radio)

Chinese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
September 1997	Long March 3B	Xichang	Apstar 2R

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
September 1997	Taurus	VAFB	GFO
September 1997	Atlas IIAS	CCAS	Echostar
September 1997	Delta II	VAFB	Iridium #4
October 1997	Pegasus XL	WFF	STEP-4
October 1997	Titan IVB	CCAS	Cassini
October 1997	LMLV 2	CCAS	Lunar Prospector
October 1997	Atlas	CCAS	DSCS III
November 1997	Taurus	VAFB	STEX
November 1997	Delta II	VAFB	Iridium #5
November 1997	Delta II	CCAS	GPS IIR-3
November 1997	Pegasus XL	WFF	SNOE & ORBCOMM-1
November 1997	Atlas IIAS	CCAS	Galaxy-8i

Taurus	Downlink Frequency Assignments
S-band TLM	2269.500, and 2288.500 MHz
C-band TRK	5765.000 MHz

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

Delta II	Downlink Frequency Assignments
S-band TLM	2244.500, 2241.500, and 2252.500 MHz
C-band TRK	5765.000 MHz

Iridium #4	Downlink Frequency Assignments
L-band	1616 - 1626.500 MHz
Ka-band	19.4 - 19.6 GHz

Pegasus XL	Downlink Frequency Assignments
S-band TLM	2269.500, and 2288.500 MHz
C-band TRK	5765.000 MHz

Titan	Downlink Frequency Assignments
S-band	2217.5, 2255.5, 2272.5, 2287.5 MHz

Cassini	Downlink Frequency Assignments
S-band	2298.333333 MHz, 2299.074074 MHz
X-band	8427.222222 MHz, 8429.938272 MHz
Ka-band	32023.444444 MHz, 32028.604938 MHz, 32033.765432 MHz

LMLV	Downlink Frequency Assignments
S-band	2208.5, and 2210.5 MHz
C-band	5765.0 MHz

Lunar Prospector	Downlink Frequency Assignments
S-band	2273.0 MHz

DSCS III	Downlink Frequency Assignments
UHF-band	243.6945 MHz

Iridium #5	Downlink Frequency Assignments
L-band	1616-1626.500 MHz
Ka-band	19.4-19.6 GHz

GPS IIR-3	Downlink Frequency Assignments
L-band	1227.6, 1381.05, 1575.42 MHz
S-band	2227.5 MHz

Orbcomm	Downlink Frequency Assignments
VHF-band	137.680, 137.710 MHz

Satellite Launch Schedules

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
September 1997	Kosmos-3M	???????	FAISAT 2V
November 1997	???????	???????	TechSat 2

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
September 1997	Ariane 5	Kourou	Phase-3D, MagSat
October 1997	Ariane 44L	Kourou	Sirius-2A
November 1997	Ariane 44L	Kourou	Equator-S

Ariane 5	**Downlink Frequency Assignments**
S-band	2203.0, 2218.0, 2227.0 MHz
C-band	5400 - 5900 MHz

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 - 24078.750 GHz

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

Sirius-2	**Downlink Frequency Assignments**
S-band	2209.006 MHz

Japanese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
October 1997	H-II	Tangashima	TRMM & ETS-7

TRMM	**Downlink Frequency Assignments**
S-band	2255.500 MHz

ETS-7	**Downlink Frequency Assignments**
S-band	2220.000, 2276.990 MHz

List of Abbreviations and Acronyms

Apstar 2R	Asia Pacific Telecommunications Satellite owned by Chinese government-backed companies.
Cassini	A spacecraft planned to conduct a four year detailed exploration of the Saturnian System and an ESA probe planned to penetrate and study the thick atmosphere of the moon Titan.
C-band	3700 to 6500 MHz.
CCAS	Cape Canaveral Air Station, FL
CDR	Commander
(D)	Crew member coming down from Russian Space Station MIR.
DR	Doctor.
DSCS III	Military telecommunications satellite.
ECHOSTAR	A direct-to-home TV system working through 45 cm dishes.
ETS-7	Engineering Test Satellite-7.
FAISAT	The system will provide data acquisition services, remote monitoring, tracking, personal and business non-voice messaging, and emergency communications/distress calls.
FLT ENG	Flight Engineer.
Galaxy	Hughes telecommunications satellite with principal applications including network TV, radio, VSAT, business video and data services.
GFO	The GEOSAT Follow-On program is the Navy's initiative to develop an operational series of radar altimeter satellites to maintain continuous ocean observation from the GEOSAT Exact Repeat Orbit.
GHz	Gigahertz
GPS	U.S. Air Force global positioning satellite for military and civilian navigation services.
Iridium	The Iridium system is a planned commercial communications network comprised of 66 low earth orbiting satellites. The system will use L-band to provide global communications services through portable handsets.
L-band	1500 - 1549 MHz
LMLV	Lockheed Martin Launch Vehicle.
Lunar Pro	Unmanned satellite to earth's moon.
MHz	Megahertz
MS	Mission Specialist, a member of Shuttle flight crew primarily responsible for Orbiter subsystem and payload activities.
ORBCOMM	Orbcomm will provide low-cost alpha numeric data communications and position determination for emergency assistance, data acquisition and messaging services using pocket portable and mobile subscriber terminals.
PHASE 3-D	Fourth launch of the third generation of amateur radio satellites by AMSAT.
PLT	Pilot, a member of the Shuttle crew whose primary responsibility is to pilot the Orbiter.
S-band	2000 to 2300 MHz
Sirius-2	A telecommunications satellite for Nordiska Satellitaktiebolaget (NSAB) to be placed at 5 degrees East longitude.
S/MM-07	Shuttle mission to the Russian Space Station MIR to support design and assembly of the International Space Station.
SNOE	Student Nitric Oxide Explorer, University of Colorado payload; first in series of low-cost university small research/science payloads.
SPARTAN	Shuttle Pointed Autonomous Research Tool for Astronomy. X-ray astronomy, medium energy survey mission, using retrievable free flyer.
STEP-4	The fifth U.S. Air Force Space Test Experiment Platform.
STEX	Sensor Technology Experiment, demonstrates radiation measurement technology.
TechSat	Israeli technology satellite.
TLM	Telemetry
TRK	Tracking
TRMM	Tropical Rainfall Measuring Mission. A joint mission between NASA and the Japanese space agency (NASDA). The mission will study the distribution and variability of precipitation and latent heat release over a multi-year data set.
(U)	Crew member going up to Russian Space Station MIR.
UHF	Ultra High Frequency (390 to 499 MHz)
USMP-4	Series of flights that conduct materials processing and fundamental experiments in the microgravity environment available in the Orbiter cargo bay while in low earth orbit.
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
X-band	8000 and 10,999 MHz
XL	Extra Large

ST 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 May and June 1997. 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. Phillip is also the editor of *Jane's Space Directory*.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee
1997 May 5/1455	1997-020A	Iridium 8		657 kg
1997 May 5.79	86.40 deg	97.41 min	626 km	643 km
1997 May 24.68	86.40 deg	100.41 min	773 km	783 km
1997 May 5/1455	1997-020B	Iridium 7		657 kg
1997 Jun 1.14	86.40 deg	100.40 min	773 km	782 km
1997 May 5/1455	1997-020C	Iridium 6		657 kg
1997 May 25.57	86.41 deg	100.39 min	771 km	783 km
1997 May 5/1455	1997-020D	Iridium 5		657 kg
1997 May 31.21	86.40 deg	100.41 min	769 km	787 km
1997 May 5/1455	1997-020E	Iridium 4		657 kg
1997 May 30.65	86.40 deg	100.40 min	771 km	784 km

First launch of Iridium communications satellites. The original launch using a Delta-2 had been planned for January 1997, but was delayed because of the Navstar 28 launch failure: for the revised first launch two additional satellites were carried. Satellites have a dry mass 556 kg. The complete Iridium system will comprise 66 satellites in six orbital planes, each plane having ten operating satellites plus one spare. It is planned to dispose of dying satellites by de-orbiting them, with a nominal operational lifetime of around two years. Launched from Cape Canaveral using a Delta-2 (7920). Note that the initial and final orbits are shown for only Iridium 8: the remaining satellites only have their final orbits shown.

1997 May 11/1617	1997-021A	Zhongxing 8 (DFH-3)		2,230 kg?
1997 May 11	28.49 deg	633.20 min	211 km	35,885 km
1997 May 22.15	0.32 deg	1,435.92 min	35,778 km	35,788 km

Second DFH-3 (Dong Fang Hong, The East is Red) communications satellite: the name Zhongxing 8 (China Star) is believed to have been applied to the satellite, but see the comments which follow. The first apogee burn of the satellite took place May 12 at 0811 and the third May 14 at 0828: the time of the second manoeuvre was not apparently announced. Satellite located over 125 deg East. Launched from Xi Chang using a CZ-3A.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee
1997 May 14/0033	1997-022A	Cosmos 2342		1,250 kg?
1997 May 14.56	62.83 deg	708.47 min	513 km	39,381 km
1997 May 23.48	62.83 deg	717.68 min	525 km	39,825 km

Oko early warning satellite: orbital plane is 80 deg to the west of that for Cosmos 2340 (1997-015A). Launched from Plesetsk using a Molniya-M.

1997 May 15/0808	1997-023A	Atlantis (STS-84)		100,284 kg
1997 May 15.36	51.66 deg	89.05 min	158 km	297 km
1997 May 17.58	51.66 deg	92.34 min	383 km	396 km

Sixth Shuttle-Mir Mission (SMM-6) launched from Kennedy Space Center, carrying six astronauts comprising a truly international crew: C J Precourt (commander, US), E M Collins (pilot, US), J-F Clervoy (missions specialist MS-1, European Space Agency astronaut, France: EVA astronaut EV-1 if required)), C I Noriega (MS-2, US national born in Peru), E T Lu (MS-3 and EV-2, US), Y V Kondakova (MS-4, Russian Space Agency cosmonaut, Russia) and C M Foale (MS-5, US/dual nationality born in UK). Foale was left aboard the Mir complex until the STS-86 mission in September 1997 and the shuttle returned to Earth with Jerry Linenger who had flown to Mir aboard STS-81/SMM-5. Atlantis docked with the Docking Module attached to the Kristall module of the Mir complex May 17 at 0233: undocking was May 22 at 0104 and the landing two days later at 1327 was at the Kennedy Space Center.

1997 May 15/1210	1997-024A	Cosmos 2343		7,000 kg?
1997 May 15.50	64.86 deg	89.39 min	197 km	292 km
1997 May 18.17	64.86 deg	89.82 min	206 km	325 km

Sixth generation photoreconnaissance satellites, similar to those which were launched annually during 1989-1993 and which terminated their missions by exploding. This is the first Russian photoreconnaissance satellite to be operating since the de-orbiting of Cosmos 2320 (1995-051A) on Sep 28, 1996—an unprecedented break in the photoreconnaissance satellite program. Launched from Baikonur using a Soyuz-U.

1997 May 20/0707	Cosmos	3,250 kg?
Failed to reach orbit		

Payload was a Tselina-2 ELINT satellite. The first stage engine of the Zenit-2 suffered an emergency shut down 48 seconds after launch, with the launch vehicle crashing some kilometres from the launch pad at Baikonur. The intended orbit was 71 deg, circular at 850 km. The announced launch time allows a calculation of how the satellite would have fitted into the constellation of recent launches in the Tselina-2 program. In the order of increasing ascending node longitudes the orbital launches starting 1992 have been:-

1992-076A	Cosmos 2219	0 deg
1992-093A	Cosmos 2227	89 deg
1994-077A	Cosmos 2297	128 deg
1994-023A	Cosmos 2278	168 deg

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
	1994-059A		Cosmos 2263	208 deg
	1995-054A		Cosmos 2322	263 deg
	1993-016A		Cosmos 2237	312 deg
	1996-051A		Cosmos 2333	323 deg
	1997 fail		Cosmos	4 deg

The first group of launches is suggestive of a constellation of nine satellites with orbital planes 40 deg apart, with six orbital planes being filled. However, it will be noted that Cosmos 2237 and Cosmos 2322 do not fit into this pattern: Cosmos 2322 is approximately 55 deg away from Cosmos 2263 and 50 deg away from Cosmos 2237.

1997 May 21/2239	1997-025A		Thor 2	1,300 kg?
1997 May 21.45	19.72 deg	666.33 min	1,314 km	36,471 km
1997 Jun 11.20	0.05 deg	1,436.12 min	35,781 km	35,794 km

Thor 2 is an HS-376HP communications satellite, operated by Telenor Satellite Services AS. Mass quoted is at launch: on-station it is approximately 700 kg. Located over 359 deg East. Launched from Cape Canaveral using a Delta-2 (7925)

1997 May 24/1700	1997-026A		Telstar 5	3,650 kg
1997 May 24.76	51.71 deg	632.34 min	219 km	35,833 km
1997 Jun 4.40	0.04 deg	1,436.12 min	35,731 km	35,843 km

First flight of a new-generation high power telecommunications satellite (based upon the FS-1300 bus) to be operated by Loral Skynet. Mass quoted is at launch:

dry mass is approximately 1,400 kg. Located over 263 deg East. Launched from Baikonur using a Proton-K plus a Block DM4-1L fourth stage.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1997 Jun 3/2321	1997-027A		INMARSAT-3 4	1,999 kg
1997 Jun 4.20	7.02 deg	631.37 min	207 km	35,795 km
1997 Jul 1.09	0.27 deg	1,448.43 min	36,016 km	36,040 km
1997 Jun 3/2321	1997-027B		INSAT 2D	2,079 kg
1997 Jun 4.20	6.93 deg	630.74 min	230 km	35,739 km
1997 Jun 16.87	0.18 deg	1,436.05 min	35,742 km	35,829 km

INMARSAT-3 4 is a mobile telecommunications satellite, operated by INMARSAT (UK). Mass quoted above is at launch: in geosynchronous orbit the mass is 1,149 kg and the dry mass is 895 kg. Satellite briefly located over 27-28 deg East, but to be operated over 306 deg East. INSAT 2D is a telecommunications satellite (broadcast, fixed and mobile communications) launched for ISRO. Satellite initially located over 71-72 deg East, but to be operated over 74 deg East. Launched from Kourou using an Ariane-44L.

1997 Jun 6/1757	1997-028A		Cosmos 2344	5,000 kg?
1997 Jun 7.03	63.42 deg	130.13 min	1,509 km	2,747 km
1997 Jun 28.15	63.42 deg	129.95 min	1,509 km	2,732 km

New class of intelligence-gathering satellite, details of which are unknown: the satellite has the factory designator 11F664. The type of intelligence being gathered is not obvious from the orbit: perigee is too high for photographic or radar work to be done (although some Russian reports suggest that this is an imaging satellite) and the orbit is too low for an early warning role. Although the Proton-K could launch a mass of around ten tons into this kind of orbit, visual observations suggest that this is not an over-large payload and therefore a mass of around 5 tons is assumed—a typical mass for the Block D/DM family of upper stages to support. Launched from Baikonur using a Proton-K plus a Block DM-5 fourth stage.

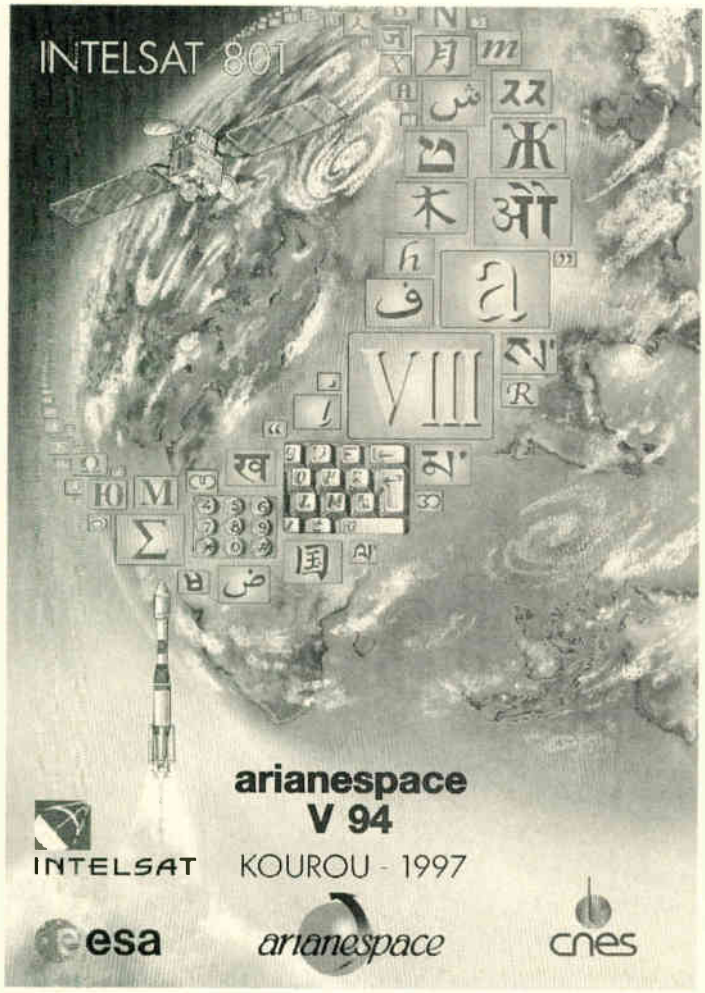
1997 Jun 10/1201	1997-029A		Feng Yun-2 1R	1,380 kg
1997 Jun 10.73	28.19 deg	638.68 min	297 km	36,081 km
1997 Jun 17.49	1.19 deg	1,436.08 min	35,780 km	35,792 km

Feng Yun-2 1R (Wind and Cloud) is China's first geosynchronous orbit meteorological satellite: the first FY-2 satellite was due for launch in April 1994, but on April 2 the satellite was destroyed during its propellant loading—thus the new launch is designated 1R (for Replacement). Satellite dry mass is approximately 700-800 kg. Apogee motor is expected to have separated in geosynchronous orbit, but has yet to be catalogued. Satellite located over 105 deg East. Launched from Xi Chang using a CZ-3.

1997 Jun 18/1402	1997-030A		Iridium 14	657 kg
1997 Jun 18.77	86.35 deg	94.86 min	501 km	523 km
1997 Jul 1.98	86.40 deg	95.81 min	555 km	560 km
1997 Jun 18/1402	1997-030B		Iridium 12	657 kg
1997 Jul 2.19	86.41 deg	96.94 min	608 km	616 km
1997 Jun 18/1402	1997-030C		Iridium 10	657 kg
1997 Jul 1.31	86.40 deg	95.79 min	555 km	558 km
1997 Jun 18/1402	1997-030D		Iridium 9	657 kg
1997 Jul 1.58	86.40 deg	95.87 min	560 km	561 km
1997 Jun 18/1402	1997-030E		Iridium 13	657 kg
1997 Jul 1.32	86.41 deg	96.30 min	580 km	583 km
1997 Jun 18/1402	1997-030F		Iridium 16	657 kg
1997 Jul 1.32	86.40 deg	96.44 min	585 km	591 km
1997 Jun 18/1402	1997-030G		Iridium 11	657 kg
1997 Jul 1.31	86.40 deg	98.20 min	670 km	676 km

Second launch of Iridium communications satellites. In the above listing the initial and later orbits are only given for Iridium 14: for the other satellites only the initial and operational (or early July if still manoeuvring) orbital data are shown. Launched from Baikonur using a Proton-K with a Block DM-5 fourth stage.

1997 Jun 25/2344	1997-031A		INTELSAT 802	3,435 kg
1997 Jun 25.79	6.98 deg	630.93 min	216 km	35,763 km
1997 Jun 30.79	0.01 deg	1,431.68 min	35,618 km	35,782 km

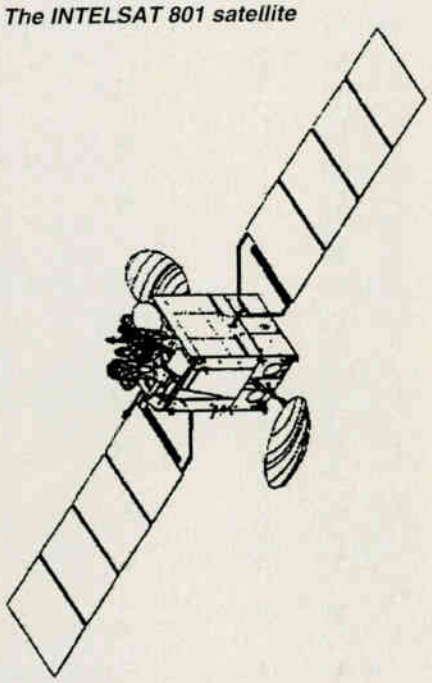


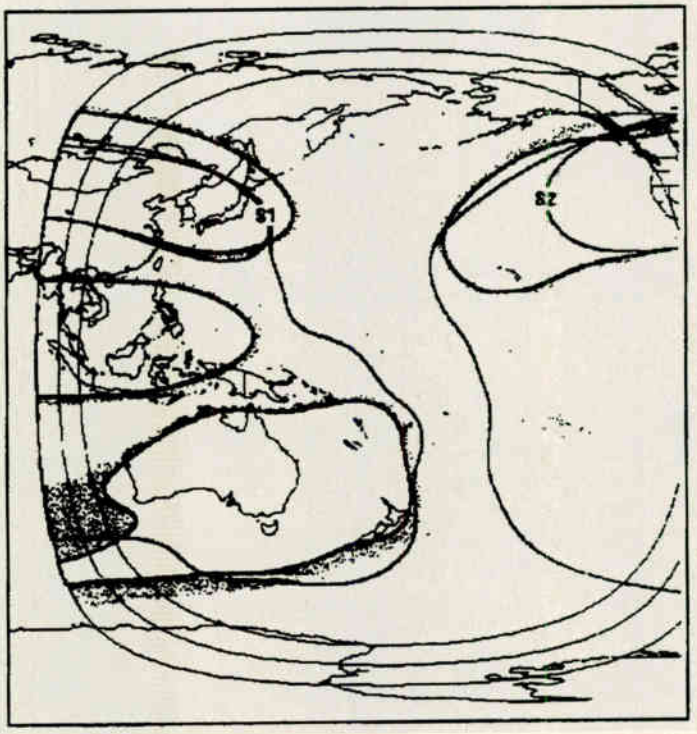
Telecommunications satellite launched for INTELSAT. Mass quoted is at launch: in geosynchronous orbit the mass is 2,059 kg and the dry mass is 1,601 kg. Satellite to be operated over 174 deg East. Launched from Kourou using an Ariane-44P.

Updates for Previous Launches

International Designation	Comment
1976-017A	MARISAT 1 has been drifting around the geosynchronous orbit band since Apr 2, 1997, and is thought to have been retired.
1982-106A	DSCS-2 15 has been drifting around the geosynchronous orbit band since Apr 5, 1997, and is thought to have been retired.
1982-110C	Anik-C 3 was manoeuvred off-station over 245 deg East Jun 17, 1997.
1983-059B	Anik-C 2 was manoeuvred off-station over 283-284 deg East approximately Jun 10, 1997.
1985-028B	Anik-C 1 had its longitude re-stabilised over 241 deg East approximately May 9, 1997.
1988-106B	USA 34 (Lacrosse 1) is believed to have been de-orbited in late March 1997: the satellite was seen by visual observers on March 24 but was not seen at the predicted time two days later, and it has not been seen since.
1989-004A	Gorizont 17 has been drifting around the geosynchronous orbit band since January 1997 and is thought to have been retired.
1989-062A	TVSat 2 was manoeuvred off-station over 359 deg East approximately May 26, 1997.
1991-015B	METEOSAT 5 had its longitude stabilised over 349-350 deg East approximately May 10, 1997.
1991-050A	There was a worry that ERS 1 might suffer a collision with Cosmos 614 (1973-098A) during 1997 Jun 25, and therefore the orbit of ERS 1 was adjusted to remove the chance of a collision. Orbital data for the two satellites: Cosmos 614: 1997 Jun 25.14 74.05 deg 100.27 minutes 754 km 788 km ERS 1: 1997 Jun 25.52 98.55 deg 100.54 minutes 783 km 785 km 1997 Jun 25.66 98.55 deg 100.58 minutes 784 km 788 km 1997 Jun 26.77 98.55 deg 100.54 minutes 783 km 785 km
1994-082A	Luch 1 had its longitude restabilised over 344 deg East approximately May 10, 1997.
1995-028A	Cosmos 2313, which was manoeuvred off-station in April 1997 and started to decay from orbit, partially disintegrated Jun 26, 1997 at 0257: up to 86 pieces of debris were tracked but none have yet appeared in the USSPACECOM catalogue primarily because of their rapid decays from orbit. This is the first break-up of an EORSAT since November 1987.
1996-008A	NEAR performed a fly-by of asteroid 253 Mathilde at a distance of 1,200 km on Jun 2, 1997: on Jul 3, 1997, the spacecraft performed a manoeuvre in advance of the Earth fly-by in January 1998 before encountering asteroid 433 Eros nearly a year later.
1996-046A	Following a gradual loss of power over a period of a week, contact was lost with Midori (ADEOS 1) 1997 Jun 30. Early speculative reports suggested that the satellite had been hit by a piece of space debris, but these reports are considered to be incorrect.
1996-068A	Mars Pathfinder successfully landed on Mars on Jul 4, 1997, landing at approximately 19 deg North, 326 deg East in the Ares Vallis region. The schedule of the landing was as follows: Jul 4, 1997 1622 UTC Separation of lander from cruise stage. 1652 UTC Entry into the martian atmosphere (altitude 125 km). 1654 UTC Parachute deployment. 1655 UTC Separation of aeroshell. 1656 UTC Initial landing on Mars (following by bounces). 1706 UTC Confirmation of landing received at Jet Propulsion Laboratory

The INTELSAT 801 satellite





(JPL).

	1836 UTC	Confirmation of landing craft's petal deployment received at JPL
Jul 6, 1997	0538 UTC	Sojourner deployed on the martian surface. After landing on Mars, Mars Pathfinder was renamed the Carl Sagan Memorial Station.

1997-014A Progress-M 34 undocked from the rear port of the Mir complex Jun 24, 1997, at 1022 UTC, and the following day an attempt was made to re-dock the cargo freighter with the Mir complex under manual control of the crew on board Mir: at the time the mass of Progress-M was 6,220 kg. During the docking attempt—which was approximately Jun 25, 1997, at 0910 UTC—the freighter missed Mir itself and collided with one of the vanes of solar cells on the Spektr module, causing part of the panel to break off and also puncturing the hull of Spektr, causing the module to slowly depressurise. The hatch of Spektr connecting with the Mir multiple docking adapter was closed at 0938 UTC. Attempts to re-dock Progress-M 34 with the Mir complex were abandoned and the freighter was de-orbited Jul 2, 1997 at 0534:58s with debris falling into the Pacific Ocean about 0632.

1997-016B B-SAT 1A reached its operational longitude of 110 deg East Jun 25, 1997.

NAMES OF CHINESE COMMUNICATIONS SATELLITES

It would appear that the Chinese adopted a practice in the 1980s of naming their satellites retrospectively: certainly, the early launch announcements did not carry names of the satellites. The communications satellites launched into (or intended for) geosynchronous orbit have had a variety of names attached to them and the list which follows is a summary.

1984-008A	DFH-2	Shiyan Weixing
1984-035A	DFH-2	Shiyan Tongbu Tongxin Weixing
1984-049A	Spacenet 1*	Zhongxing 5
1986-010A	DFH-2	Shiyong Tongbu Tongxin Weixing 1
1988-014A	DFH-2A	Shiyong Tongbu Tongxin Weixing 2 [Zhongxing 1]
1988-111A	DFH-2A	Shiyong Tongbu Tongxin Weixing 3 [Zhongxing 2]
1990-011A	DFH-2A	Shiyong Tongbu Tongxin Weixing 4 [Zhongxing 3]
1991-088A	DFH-2A	Shiyong Tongbu Tongxin Weixing 5 [Zhongxing 4]
1994-080A	DFH-3	Zhongxing 6
1996-048A	HS-376**	Zhongxing 7
1997-021A	DFH-3	[Zhongxing 8]

* Spacenet 1 was a United States communications satellite, purchased by China in December 1992

** satellite was built by Hughes for China.

DFH is Dong Fang Hong (The East is Red), a generic name for Chinese communications satellites. Three satellites have been named Zhongxing (China Star) in Chinese literature, with only numbers 5, 6, and 7 being identified: logically, the May 1997 DFH-3 satellite will be Zhongxing 8, but this has yet to be confirmed.

The question naturally arises concerning the first four Zhongxing satellites. In the listing shown above it is assumed that they are the four DFH-2A model satellites which were launched, since this would give a chronological numbering sequence in the order that the Chinese started operating the satellites. In the listing the unconfirmed Zhongxing numbers are shown in square brackets.

ST THE BEGINNER'S COLUMN

By Ken Reitz, KS4ZR
KS4ZR@compuserve.com

Science Beats Fiction in a K.O.

It was the middle of summer and the radio spectrum was deep in the doldrums. The entire high frequency shortwave bands were between solar cycles; the amateur radio community was pensively waiting the postponed launch of Phase 3D; weather satellite imagery showed a listless tropical storm season; and the usually interesting July satellite TV trade show in Nashville was promising to be a bonanza of warmed over DBS thrills. What would it take to put some sizzle into satellite monitoring?

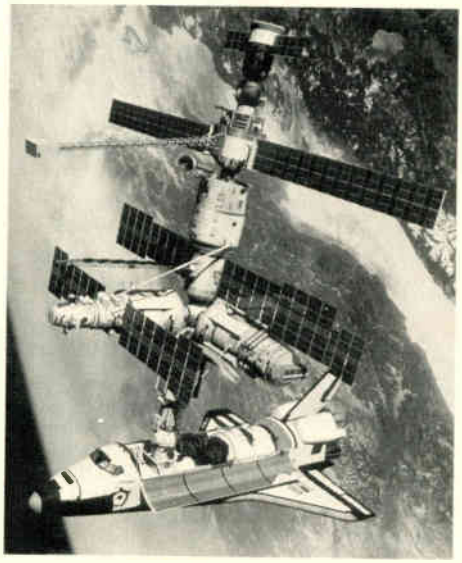
It seemed that the only space related news story involved science fiction nuts crowding into Roswell, New Mexico: True Believers chasing after 50 year old crash dummies in the desert. It was enough to make me want to hit the fast forward button of life.

A Mir Fiasco

Then came the drama of the *Mir* space station accident. Real live spacemen in a genuine spacecraft were in trouble. It seems an unmanned supply ship had a wobbly approach to *Mir* and the resulting collision put the space station and its inhabitants at risk. This put the Roswell circus in perspective.

In no time at all *ST* editor Larry Van Horn had put the word out on E-mail: "For those of you who have not seen this, here is a *Mir* space station update. The only downlink that I am aware of in use over the last 24 hours is the 143.625 MHz. I have been told that all the ham (downlinks) are off due to the severe shortage in station power. More as it becomes available."

Here was a gripping space saga and it was happening in our near space. Within minutes of receiving the news I fired up



my 2-meter HT and stored the frequency in memory. I removed the rubber stubby antenna and connected instead to an attic-mounted ground-plane, I backed off the squelch control, set the volume at a low, but audible, level of hiss and went back to work. Within an hour the speaker came to life as the signal quickly rose. The crippled *Mir* space station with its exhausted crew were less than two hundred miles over my house!

In the days that followed I monitored many *Mir* passes. I monitored them in the house, out in the yard, and in the car. Sometimes it was the hurried voices of Russian cosmonauts I heard, other times it was the recognizable voice of U.S. astronaut Michael Foale. Sometimes the transmissions were animated discussions of procedure, sometimes there were interviews with the press. Once I heard astronaut Foale talk about floating around in *Mir* with a flashlight clenched in his teeth as he moved storage batteries from one compartment to another.

Here it was live, real, and direct. For those 10 minutes or so that the space station was within range, nobody had a better link to *Mir* than I did. This was some sobering monitoring.

Yogi Does Mars

The week following the initial *Mir* story was dominated by the culmination of years of hard work and planning by NASA's Mars Pathfinder mission. The mission had planned a 4th-of-July extravaganza involving live video from the red planet. The little robot car zipped around the surface visiting Martian rocks named by NASA project managers after cartoon characters. Again, I had a front row seat to a commercial free, step by step, presentation unequaled by any network.

Was I an honored guest at mission control? In the VIP room at JPL? No, I just watched the whole thing as it unfolded on NASA TV, the video press service of NASA which provides coverage for all space related events via C-band satellite, unencrypted and without commercial interruption.

Trying to find satisfactory coverage of Pathfinder on conventional TV was difficult at best.

But, at NASA TV, hours of live and video tape replays of previously live events gave viewers the chance to gaze unhindered at the miracle of this human feat. We saw Mars images and more of them than on any network, and without the annoying dog food and denture commercials. Not only that, but we got expert commentary from project managers who were given all the time they needed to describe what we were seeing.

In fact, NASA TV was really hopping in those two weeks. Between coverage of the *Mir* situation and Pathfinder, NASA was covering a routine space shuttle launch. There were news briefing from Kennedy Space Center, Goddard Space Flight Center, and Jet Propulsion Laboratory. The real news of the activities of humans in space dwarfed silly speculation about strange lights and pie-plate style "sightings."

If you've never watched a full blown NASA press conference, you're missing some of the most intriguing science chat you'll ever be privileged to hear. Depending on the situation, these conferences can go more than an hour, especially

when astronaut lives are in the balance.

These give and take sessions with the world's premier science reporters allows you to be privy to information which rarely makes the evening news. Another interesting thing is that you'll actually be able to put a face on the familiar radio and print journalists you've be reading and listening to for years. NASA experts painstakingly answer each question and take follow-up questions as trained journalists, such as *ST*'s Phil Chien, probe the minds of NASA engineers, managers, and directors for insight into current space issues.

How To Lend Your Ears

It doesn't take a lot of fancy (read: expensive) equipment to enjoy some out-of-this-world monitoring. Any scanner capable of tuning around the 2-meter amateur radio band can monitor the transmissions from *Mir* and the space shuttle. You can even monitor packet radio transmissions from both spacecraft by taking the audio output of your scanner or 2-meter HT and, using a simple software program and interface, "read the mail" from space.

There's no need for a license for this because, remember, you're just listening! For the latest information on shuttle mission assignments and frequencies, see the *Satellite Service Guide* in this magazine under the "Space Transportation System" heading in the *Satellite Launch Schedules* column.

Of course, listening by chance is very tedious. You need to know where the spacecraft is in order to tune in. For this you will need a satellite tracking program. If you have a PC you'll find many capable programs which are widely available and cost anywhere from $50 up. If you don't have a PC you can track them the cheap and easy way by re-reading *The Beginner's Column* in the May/June 1996 *Satellite Times, Tracking Those Elusive AMSATS (Cheaply!).*

Tuning in to NASA TV can be almost as easy and as cheap. You'll need a basic TVRO satellite receiver, a dish with a C-band feedhorn/LNB, and the necessary connecting cables.

Whoa! I know, you're saying, "Isn't this running into some big bucks?" Not at all. Used C-band satellite systems, without Videocipher II decoding modules, can be found for as little as $100. Full dressed, new, off-the-shelf systems can be purchased for as little as $1,000. Shop around, look for friends or neighbors who have gone to the small DBS systems and are eager to get rid of their C-band system. Haunt your local satellite dealer. He or she may have tons of old C-band gear they can't sell and will be happy to have you take it away.

Keep in mind that NASA TV is on satellite 24 hours a day. In addition to transmitting on-going space activities, it also transmits hundreds of hours of educational science programming aimed at America's public schools. Also keep in mind that NASA TV is available on only a few cable systems in the country and none of the DBS satellite services. And, even if it was, you'd be paying for the privilege! This is one place in which you can be proud of where your tax dollars are going and benefit from them at the same time!

Following Through

Here's where you can find more information on monitoring real space events. For the latest Keplerian element sets (to keep your tracking program up to date), news about Phase 3D, downloadable software and other interesting Internet items, contact AMSAT, The Radio Amateur Satellite Corporation, at **http://amsat.org**. You can also get free Keplerian elements at *ST*'s own TS Kelso Celestial Web site at **http://www.grove.net/~tkelso/**.

For the latest NASA action go to the NASA homepage at **http://nasa.gov**. You can spend hours checking out the various associated pages here.

If you're not on-line and you'd like a decent tracking program for your computer write AMSAT for more info on their program. Your purchases will help fund the worthy efforts of this non-profit group. They're at 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703, or call them at 301-589-6062.

If you have a satellite tracking program and a scanner or 2-meter HT, check out these frequencies for space activity: 145.985 MHz *Mir* amateur voice (FM) and packet (1200 bps AFSK AX-25) downlink; 143.625 MHz voice air-to-ground narrowband FM downlink, and from the space shuttle: 145.840 MHz amateur voice and packet.

You won't need a tracking program to pick up NASA TV: they're on GE-2 (85 degrees West) channel 9 with 6.80 MHz audio. A schedule of programming is given between programs throughout the broadcast day with special events pre-empting the regular schedule.

Hearing Is Believing

When I first heard *Mir* on a pass over the house I ran to my wife, Peggy, HT in hand. "Listen to this!" I said, thrusting the HT at her. She listened to the excited voices of the Russians cosmonauts shouting to their ground controllers.

"This is the *Mir* space station and it's right over our house!" I exclaimed. The clarity of the audio was such that we could hear background noises of other cosmonauts and on-board speakers spewing out packet bursts. We listened closely as the signal peaked and then started its rapid fade as the space station streaked out over the East Coast of North America toward the waters of the Atlantic at more than 17,000 miles per hour. If you can't get excited about this, you need another hobby.

ST

By Steve Dye, gpsyes@aol.com

T-NASA and GANE

In this issue of *Navigation Satellites* we will focus on GPS' role in two major developments within the last 12 months for the aerospace industry—T-NASA and GANE.

Airport Taxiing

The United States is presently faced with a projected 32 percent increase in air traffic over the next decade. NASA and the Federal Aviation Administration (FAA) are always keen to develop advanced technologies that will improve the traffic-handling capacity at existing airports.

One of those technologies is called (very cleverly) the Taxiway Navigation And Situation Awareness, or T-NASA. This system helps pilots to taxi safely—particularly in low visibility weather conditions—from the runway to the terminals. T-NASA is a combination of software and navigational devices designed to operate on the aircraft's flight deck. Unlike other air traffic management tools now being tested by NASA and the FAA, T-NASA is not automated, and pilots will continue to manually control taxi maneuvers.

The goal of T-NASA is to safely get the aircraft from the gate to the runway and from the runway to the gate as rapidly and efficiently as possible. Safety is the main criteria as we would expect, but increasing the throughput of air traffic at an airport is of obvious economic benefit, too. Runways and terminal areas are the most common traffic bottlenecks, and a system such as T-NASA would benefit every airport. As the amount of traffic in the air increases, airline schedules become tighter and more intertwined; bad weather at one major airport can cause tremendous disruptions of schedules nationwide. Making traffic movement on the runway more efficient will improve these backups.

FIGURE 1. *The view a pilot would see from the cockpit. Photo courtesy of NASA.*

The integrated system was developed as part of NASA's $100 million Terminal Area Productivity (TAP) program and is being tested at NASA's Ames Research Center in Mountain View, California.

Today, a pilot taxis at an airport in much the same way he or she did in the 1950's—receiving verbal instruction for the route they have to follow for clearance, and for following the signs placed at important points at the airport. The advent of GPS has given a surveyor the ability to measure with precision down to a cm or better. GPS allows a mariner to navigate a boat through a narrow waterway with an accuracy of 15 meters or better, using GPS receivers and its own built-in map database. It stands to reason GPS could also be used to safely guide an aircraft and its passengers at an airport—the most congested part of an aircraft's journey—finally replacing the paper chart.

For pilots who are unfamiliar with the larger, more complex airports, T-NASA will assist greatly as taxiing will require less intervention and assistance from the ground crew and a pilot will be able to find his or her own way to the terminal.

The system

T-NASA is a cockpit display system that consists of three components.

1) The cleared taxi route display
2) A head-up display (HUD)
3) Audio traffic warning system

The cleared taxi route is shown on a glass visor in front of the cockpit windshield. The HUD works in a virtual reality manner, and indicates the pilot's aircraft position and that of other aircraft on an electronic moving map of the airport. Audible traffic warnings are produced via virtual 3-D audio techniques in which the warning sounds emanate from the direction of the traffic.

Using GPS satellite positioning and an airport layout database, T-NASA updates the displays in real time. The HUD depicts the edges of the taxiway with a series of virtual "cones." In addition, when there's a turn, virtual turn signs show the angle and direction of the turn. As the pilot taxis, these virtual cones and signs move and change as if they were actual objects on the taxiway. The pilot's cleared route ends up looking like a virtual highway on the ground.

One obvious off-shoot of this technology could be its application to vehicles. The T-NASA system has strong potential for automobiles; if a T-NASA system for road vehicles could be developed, accidents involving drivers going off the road during heavy fog, rain, or snowstorms could be easily avoided.

The photo in figure 1 shows the view a pilot would see from the cockpit. Photo is courtesy of NASA.

Global Positioning System Attitude and Navigation Experiment (GANE)

Readers who follow this column regularly (and those who have read my book) will be familiar with one unique aspect of GPS—its capability for determining the attitude of a vehicle using three or four

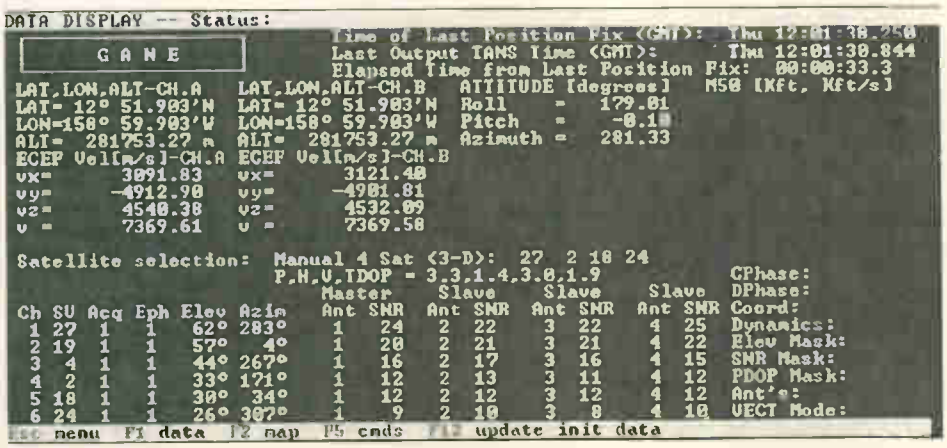


FIGURE 2. *Photo courtesy of NASA*

antennas and measuring the carrier phase through each antenna. This technique has been successfully tested on road vehicles, ships, and aircraft. GANE has now proven its application for spaceborne vehicles.

GPS antennas, appropriately placed at the corners of a spacecraft will each report their location. This location is, in reality, a measure of the GPS receiver's position relative to the satellite constellation. Using extremely accurate receivers, the measurements performed will easily indicate a difference in each antenna's position and thus each antenna's position relative to the GPS constellation. Software developed for this experiment was able to calculate the pitch, roll, or yaw of the spacecraft.

GANE Experiment Description

The International Space Station (ISS) will use GPS not only for position, velocity, and time information, but attitude determination as well. To assure GPS attitude can be measured to the necessary 0.1 degrees or less per axis of rotation, a flight experiment aboard the space shuttle was proposed back in 1994. This flight experiment was designed to fly readily available, off-the-shelf, and ISS-supplied equipment to determine the accuracy of processed GPS data from an orbital environment.

GANE was comprised of a mechanical structure called the GPS antenna mounting structure (GAMES), designed and built in-house at the Johnson Space Center (JSC). GAMES provided the rigid structure necessary to maintain the accurate alignment of the four antennas during the thermal variation experienced during the shuttle's day-night cycles.

Roll, pitch, and yaw information for determination of the attitude is derived from a GPS receiver/processor that receives the GPS signal through the four antennas. The differential phase of the received carrier wave is computed post-flight at JSC. The experiment used an inertial reference unit (IRU), supplied by the ISS program to act as a reference for the attitude calculated during the post-processing.

Results of the Experiment

The GANE mission was a success. Data from the GPS and IRU were recorded throughout all four of the primary data acquisition phases. Approximately eight days of both GPS and IRU data were collected and post-processed through navigation and attitude algorithms identical to those planned for the space station GPS receiver/processor and guidance, navigation, and control processor. The post processed results provided a valuable insight into the performance of the algorithms and the changes necessary to improve performance.

Interestingly, two satellite selection algorithms were evaluated in real-time. The most effective satellite selection algorithm was the one that selected satellites based on maximum elevation angle. The minimum PDOP (position dilution of precision) algorithm reduced satellite tracking time significantly. Figure 2 shows the screen display of a laptop computer used during the data collection. Notice the altitude reading just below the latitude and longitude; they were certainly above the clouds.

Well, that's all for this edition's look at satellite navigation. If you want a more indepth look at satellite navigation, you can find it in my new book, *The GPS Manual—Principles and Applications*, which is available through Grove Enterprises. ST

By Dr. T.S. Kelso
tkelso@grove.net

Space Surveillance

For most of us, our satellite-tracking interests extend to only a small handful of satellites. Whether it be the amateur radio or weather satellites, TVRO, or even the combined GPS/Glonass constellation, we're typically talking about tens of satellites. Even if we consider all of the operational satellites on orbit, we're still only talking about hundreds of satellites. But there are those among us whose duty it is to track the now 8,500 satellites in earth orbit—payloads, spent boosters, and other debris—on a daily basis. These are the men and women of the Space Control Center (SCC), buried deep within Cheyenne Mountain.

FIGURE 1. ***Cheyenne Mountain Command Center***

Part of the Cheyenne Mountain Operations Complex or CMOC, the SCC is responsible for detection, identification, and daily tracking of all man-made objects in space. Run by U.S. Space Command for the North American Aerospace Defense Command (NORAD), it is manned primarily by personnel from the Air Force, Naval, and Army Space Commands and the Canadian Air Force. Their basic mission is to protect the North American continent and U.S. and Canadian interests worldwide against threats from space.

These threats come from a variety of sources. They can arise from dangers such as overhead surveillance of military forces during conflict. Or, they can also result from accidental events, such as the reentry of a space object—which might threaten a population center or trigger a false missile-attack warning—or the collision of a dead satellite or a piece of debris with an operational satellite such as the U.S. space shuttle. The only real way to guard against these threats is to detect any and all space objects, identify what they are (and what their missions are), and know where they are (or will be) at all times.

The Space Surveillance Network

To accomplish its mission, the SCC relies on the Space Surveillance Network or SSN as its eyes and ears. The SSN is a network of sensors located at two dozen sites worldwide and operated by U.S. Army, Navy, and Air Force personnel. The SSN uses three primary types of sensors to monitor the earth's population of artificial satellites: conventional radars, phased-array radars, and an optical system known as the Ground-Based Electro-Optical Deep Space Surveillance system or GEODSS.

FIGURE 2. ***Space Surveillance Network Locations***

The SSN's conventional radars consist of both tracking and immobile antennas. Typically, these antennas operate in bistatic mode—that is, one antenna transmits a pulse and another receives the return. One of the more interesting conventional radars in the SSN is the NAVSPASUR system—a network of three transmitting and six receiving radar sites spanning the continental U.S. from San Diego, California, to Tattnall, Georgia. Laid out as a fence of electromagnetic energy along the 32nd-33rd parallel through which all satellites with orbital inclinations greater than 33 degrees must pass twice a day (over 80 percent of the current population), it can detect objects crossing it out to a distance of more than 25,000 kilometers.

The SSN phased-array radars can track a dozen or more satellites simultaneously and scan large volumes of space because they have no moving mechanical parts. Instead, these radars are composed of thousands of small elements which can be phased to electronically steer the antenna. Of the SSN's phased-array radars, the AN/FPS-85 at Eglin AFB in Florida is the workhorse of the network. It is made up of almost 6,000 transmitter antennas and 20,000 receiver antennas and can track objects from just above the horizon to just short of the zenith over an azimuth of 120 degrees. Capable of generating 30 megawatts of radio frequency power, it can track space objects in excess of 40,000 kilometers in range.

FIGURE 3. ***AN/FPS-85 Phased-Array Radar***

Each GEODSS site combines three telescopes—two primary 40-inch telescopes and one 15-inch auxiliary—to image objects in space 10,000 times dimmer than can be seen with the unaided human eye. Rather than using photographs, as the earlier Baker-Nunn cameras did, it uses charge-coupled devices (CCDs) to electronically image each satellite track. Computer processing then removes the stars and other background light sources to produce the observations. As with any optical system, GEODSS can only be operated at night and in clear weather.

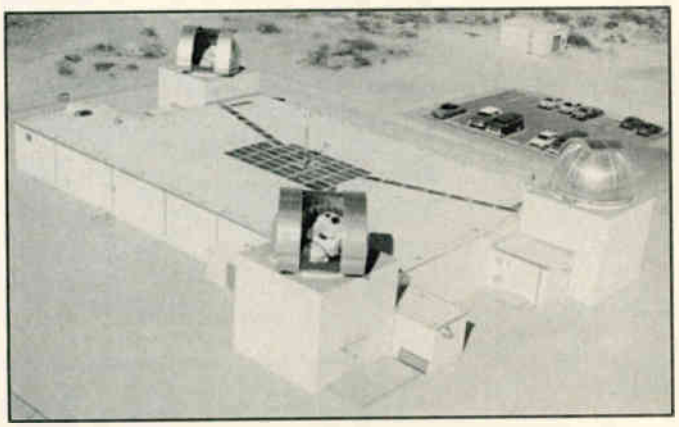


FIGURE 4. ***GEODSS Site***

This network of dedicated and collateral sensors generates up to 80,000 satellite observations each day and sends them back to the SCC via redundant communications systems. While this may seem to be a lot of observations, it still does not permit continual tracking of everything in earth orbit—primarily because of the limitations arising from the geographical distribution of the ground-based sensors. As a result, the SSN uses a predictive technique to monitor the catalog of space objects—periodically making sure each object is where it is predicted to be and generating new element sets when they aren't.

The Satellite Catalog

In order to be able to keep track of everything once it's detected, the 1st Command and Control Squadron (1st CACS) maintains a catalog of all space objects orbiting the earth (and some beyond) which are ten centimeters (about the size of a baseball) or larger in size. Over the years, they have catalogued almost 25,000 objects. Of the 8,500 objects being tracked today, only about 7 percent are operational satellites, 15 percent are rocket bodies, and the remaining 78 percent are either inactive satellites or other assorted space debris.

Subtracting out the number of active satellites from the total population, it quickly becomes apparent that there are almost 8,000 uncontrolled objects of various sizes and shapes tumbling through space at velocities ranging from 3 to 10 kilometers/second. Being hit by one of these could ruin your whole day. Keeping track of potential collisions—especially with manned spacecraft such as the U.S. space shuttle or *Mir* space station—is an important part of the SCC mission.

According to U.S. Space Command, most debris—about 84 percent—orbits above 800 kilometers—an altitude more than twice that of either the U.S. space shuttle or *Mir* space station. They assess the likelihood of a significant collision with one of these manned spacecraft as extremely remote—about one chance in 10,000 years. Space is—after all—a pretty big place. Unfortunately, the likelihood of a collision with something smaller than ten centimeters in size is higher and unknown since the SSN cannot currently track these objects.

Each item in the Satellite Catalog (SATCAT) is identified by two unique identifiers. The first is the International Designation. Prior to 1963, the International Designation was made up of two parts: (1) the launch of the year (the year itself being implicit) and (2) the piece of the launch. The launches of each year were designated (in order) by the letters of the Greek alphabet and the pieces of each launch were numbered.

This system was more than adequate in the 1950s since there were only a handful of launches each year. In 1961, however, the number of launches exceeded the number of letters in the Greek alphabet, so launches after the 24th launch of 1961 were preceded with the letter Alpha (which is abbreviated to A in the database, e.g., A ALPHA, A BETA). With even more launches in 1962, launches after the 48th were preceded with the letter Beta (e.g., B ALPHA, B BETA). It was quickly becoming apparent that a new system was required.

In 1963, the International Designation was changed to consist of three parts: (1) the year of the launch, (2) the launch of that year (000 through 999), and (3) the piece of that launch (A through ZZZ). For example, the *Mir* space station has the International Designation 1986-017A, that is, it was piece "A" of the 17th launch of 1986.

The second unique identifier is the NORAD Catalog Number. It is simply a number indicating the sequence in which space objects have been added to the SATCAT. The NORAD Catalog Number and International Designation do not always track together since it is possible to detect a piece of a launch well after the first piece of that launch was detected. The *Mir* space station—International Designation 1986-017A—is NORAD Catalog Number 16609. However, the last garbage dump from *Mir* (yes, even these are catalogued) was International Designation 1986-017MA, NORAD Catalog Number 24673. The International Designation system considers any subsequent debris—no matter how many years later—to be part of the original launch.

Identifying satellites by name can be problematic. Because many satellites have multiple payloads onboard, it is common for the same platform to be referred to by different names. Several amateur radio satellites fall in this category because they are piggybacked on another payload, being referred to by the name of the amateur radio payload by the amateur community and by the name of the main payload by its user community. Other satellites simply have multiple names, as with the Cosmos series of satellites. It is always best to use one of the unique identifiers above when referring to a specific satellite to ensure there is no ambiguity.

An Online Satellite Catalog

Having access to the current SATCAT can be a useful tool for those involved with satellite tracking. Whether it is used to find something specific such as the NORAD Catalog Number for a satellite in order to obtain the proper element set or just to perform some statistical analyses (e.g., number of payloads on orbit, percent of the catalog launched by the U.S.), the results can be both helpful and enlightening. If I had more space, I could regale you with various space trivia showing trends within the SATCAT. Perhaps I'll save that for another day.

Instead, I am working on providing an online version of the SATCAT on the Celestial WWW site. Based largely on NASA's *Satellite Situation Report* combined with information from *Jonathan's Space Report* and the monthly NSSDC's *SPACEWARN Bulletin*, it will provide a fully-searchable online catalog with weekly updates. It should be available online by the time this issue reaches you. The goal is to provide a current catalog along with various statistics and charts to make it easier for you to answer your questions about the population of earth-orbiting satellites. I hope you'll find it useful.

As always, if you have any questions or comments regarding this column, please feel free to contact me at **tkelso@grove.net**. Until next time, keep looking up! ST

ST On The Air

By Steven J. Handler
ontheair@grove.net

Worldwide Television News Captures History In The Making

Iraq invades Kuwait. The United States invades Panama. Hong Kong is returned to the Chinese. What do all of these events have in common? Worldwide Television News (WTN) was there providing coverage for television networks around the world.

WTN is the video equivalent of a newspaper wire service. It covers international news, sports, and entertainment. With 119 bureaus in 102 countries, it has a presence on every continent except Antarctica. Often the first on breaking news stories, it distributes its video and audio coverage to more than 1,100 broadcast clients throughout the world via satellite.

WTN is 80 percent owed by ABC/Capital Cities (part of Walt Disney) and 10 percent by ITN in the United Kingdom and The Nine Network in Australia.

With almost a half century of service, the company was created in 1952 when United Press and 20th Century Fox Movietone News formed the world's first television news agency called UP-Movietone. Early newsfilm clients included the BBC.

Ownership has changed over the years. In 1963, 20th Century Fox dissolved its interest and UPI became the sole owner. Later, in 1967, ITN formed a partnership with UPI, calling the company UPIITN. In 1982, ABC and The Nine Network acquired interests in the company.

In 1983, UPI sold its interests in the company. The company was renamed Worldwide Television News in 1985.

WTN is one of the premier news gathering organizations in the world. It was the only broadcaster covering the U.S. invasion of Panama. It also was one of the last remaining television news services in Baghdad, Iraq during the Gulf War, providing footage that other broadcasters were unable to obtain.

WTN Broadcast Services Manager, David Weiss, coordinates an uplink.

WTN

Worldwide Television News

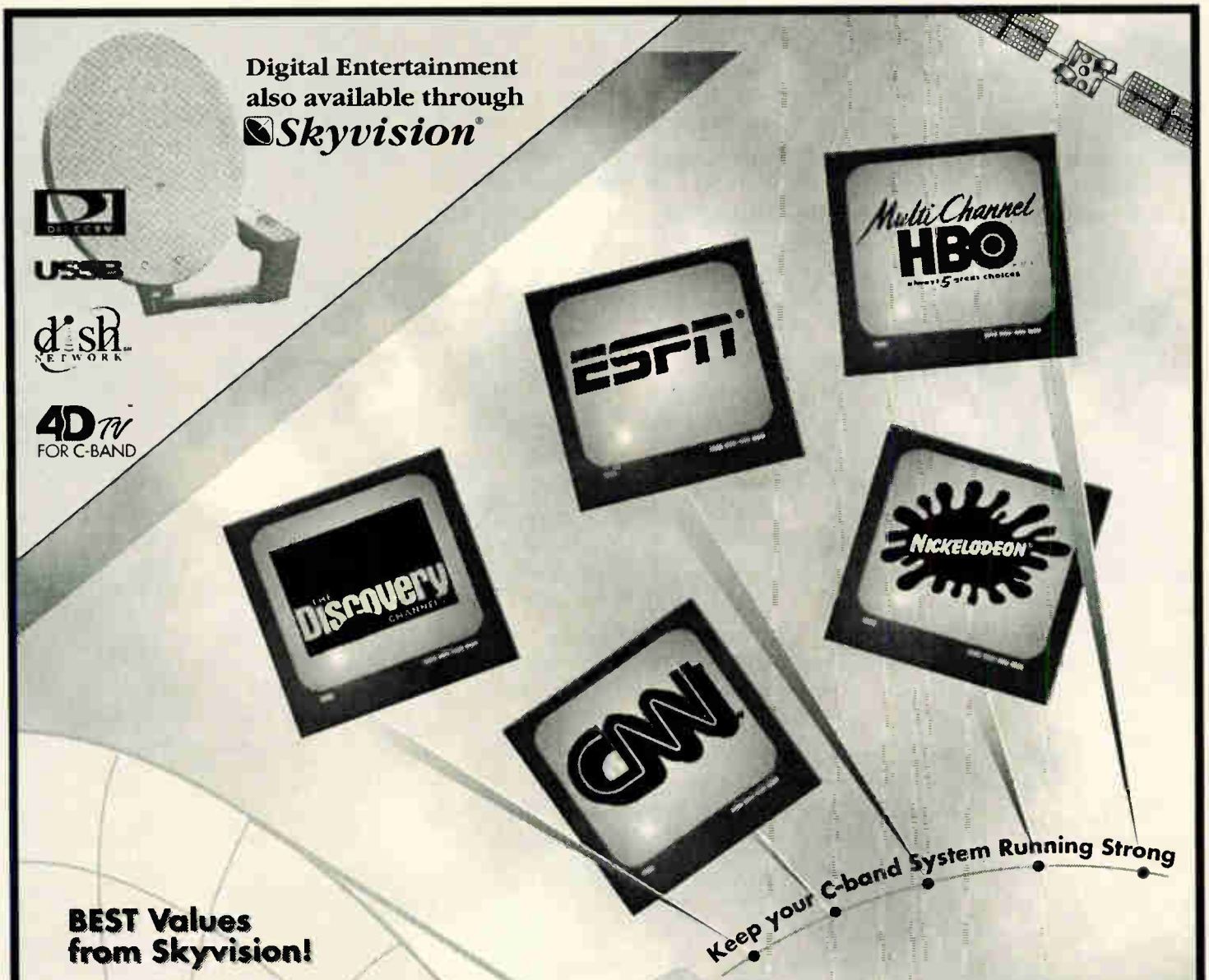
In addition to its own copyrighted news gathering, WTN holds the international distribution rights to pictures from two of the most important news gathering organizations in the world, ABC, and the BBC.

Through the use of a global network of satellites, WTN operates 24 hours a day with a fixed daily schedule of news feeds and programs as well as flash broadcasts of significant breaking news events. The feeds are timed to meet the main news programs' deadlines of its broadcasting clients throughout the globe.

Floods, earthquakes, and the normal business news and international politics all find a home in WTN's hard news feeds. In addition, WTN provides several daily sports news feeds covering the top international sporting events. A weekly sports news round-up is compiled each weekend. Twice weekly, a half-hour program of show business events from around the world is also aired.

WTN's master control room in London is complemented by studios in Moscow, New York, and Frankfurt. Their three major editing sites are London, Hong Kong, and New York.

WTN also owns and operates Starbird Satellite Services. It is comprised of a fleet of uplink trucks, commonly referred to as SNGs, or satellite news gathering trucks. This fleet of trucks is based out of London. They are available for hire by any



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WTN Amman cameraman, Yaser al-Naji, with King Hussein of Jordan

news gathering organization and can be delivered by airplane almost anywhere in the world. SNG trucks provide a mobile platform to connect to C-band or Ku-band orbiting above the earth. The truck can either uplink live video footage of events or edited video using the satellite as an orbiting relay station to feed the material to their broadcasting organization's offices.

Here in the U.S., WTN's New York office acts as the hub of their activity. News distribution takes place 24 hours a day. At 3:50 p.m. local New York time, a scheduled daily satellite feed is received from WTN London. Clients to whom this feed is distributed read like a who's who of American broadcast media, including ABC, CBS, CNN, and Fox. WTN New York also provides other daily feeds of news events to Central and South America.

WTN's Atlantic service is beamed by satellite from London to New York. In New York, domestic U.S. stories are added to the European coverage. In addition to its own domestic news gathering sources, WTN also has the international video rights to use ABC's news video. After editing the European and American footage, WTN New York beams scheduled feeds to Asia, Central, and South America.

According to Earl Adams, a WTN spokesman in New York, WTN provided all of the facilities and uplinks in Baghdad for CNN during the Gulf War. Also, according to Adams, "international journalists can use our feeds to feed back to their home port their reports. With the crash off Mauritius last year we provided French and Italian journalists stand up facilities so they could broadcast live back to their home base."

WTN provides video of breaking news events which its clients can incorporate into their broadcast. All of this is made possible by a global network of interconnected satellite transponder paths. Four satellites currently comprise the backbone of WTN's satellite distribution network. These are augmented by additional satellite transponders as events require.

WTN uses a digitally compressed path on Asiasat 2. For Pan-European distribution, they use Eutelsat II F-2 at 10 degrees East. For transatlantic distribution they have a compressed path on Intelsat 601 at 27.5 degrees West. Out of New York, for Latin America, Africa, and the Middle East, they operate two digitally compressed paths on 601, one for 24 hour news distribution and one for program distribution and ad hoc use, via Intelsat 706 located at 53 degrees West.

Satellite distribution is supported by teleports (land based uplink and downlink facilities) WTN owns in London and Moscow, and contractual teleports in Jerusalem and New York. Currently, MicroNet provides the uplink for the New York teleport.

Domestic distribution here in the U.S. takes place using the Galaxy 4 satellite. According to Terry O'Reilly, WTN's VP, Americas, they have a contractual commitment to purchase a bulk number of hours on Galaxy 4. According to Adams, "in the U.S. we have used just about every satellite that is in common use for either news backhalls or flash distributions." During the Hong Kong handover in June, WTN booked 12 hours of satellite time to provide coverage.

Although it has not been widely reported, O'Reilly also pointed out that WTN did the uplink in Baghdad during the Gulf War to get CNN's Peter Arnet on the air.

According to O'Reilly, all of their satellite news gathering feeds are migrating to digital compression formats because of the satellite transponder crunch. Compression allows WTN to

WTN staff covering Dominican Aircrash

The Oklahoma City Media village

efficiently carve up satellite transponder bandwith and also provides security. Currently they use DMV DigiMediaVision MPEG-2 format.

"We like that for news distribution purposes we get the security of a compressed system, and it is fully addressable, and we can shut down unauthorized viewers. In a business where our most important business is distributing 10 or 15 of the most important seconds of the most important news event of the day, one of the ways we provide value is to assure them that folks not paying for it don't get it," said O'Reilly.

At WTN's teleport in Moscow they receive their Pan European feed from London, turn it around, and uplink it for Asian distribution. This digital passthrough allows almost the identical picture sent from London to be seen on the ground in Asia. It differs from analog video which may suffer some slight degradation in the process of being received and re-uplinked.

In addition to its video distributed by satellite, WTN uses the satellite channels' high quality audio subcarriers for both voice and data. Their data path can provide customers with video scrips, breaking stories and updates. A data port on the back of a customer's IRD allows easy access to the incoming information.

WTN brings its customers the news anytime, from almost anywhere. Using satellite to distribute their broadcasts, it's just one of the many great things *On The Air*.

When he is not surfing with the TV remote control in his hand, *On The Air*'s Steve Handler can be reached via e-mail at: ontheair@grove.net

ST

NEWS FEEDS ON C-BAND

Domestically, WTN operates on Galaxy 4 satellite. One of their regular broadcasts uses channel 21 at 3:30 p.m. EDT for roughly a half hour broadcast.

Other television news services also use C-band for distribution of news footage. The Galaxy 4 satellite traditionally has been a hotbed for occasional and breaking story news feeds by a number of media organizations. CBS's Newspath service which provides video and audio of news and sports for their affiliates has been a long time resident of G4 channel 24.

ABC News One provides regular domestic distribution of ABC's news video to their affiliates. They can be found on Telstar T-402R, (which is sometimes called T-4) channel 14.

By George Wood
wood@rs.sr.se

Digital War and Peace in the Clarke Belt

The European Parliament and European Union's Council of Ministers have finally given formal approval to new EU broadcasting legislation, once again rejecting France's attempts to impose firm quotas to keep out American programming and films. The revised "Television Without Frontiers" law also guarantees that European viewers can see major sports events, by letting each country draw up a list of priority events that have to be available on terrestrial TV. The issue arose when new satellite and cable pay-TV channels with limited audiences began buying up exclusive rights to popular events long available free to the public.

What it doesn't do is provide for the promise of the Maastrict Agreement guaranteeing access to the services across the entire European Union. Satellite TV stations usually cite agreements based on copyright laws and from the pre-satellite days, in order to restrict their offerings. That's led to a flourishing business in pirate decoder cards, and European magazines are filled with advertisements for such equipment. Rather than force broadcasters to follow the spirit of Maastrict and offer subscriptions anywhere in the EU, the European Commission has dealt with the situation by proposing legislation to outlaw pirate decoders and decoding smartcards for pay-TV and online computer services. Many EU members already have bans, but there are notable exceptions, like Germany and Britain, where it is legal to buy equipment to receive stations that are not available by subscription in that country.

One of the main targets of those pirate decoder cards, Rupert Murdoch's British Sky Broadcasting, is reportedly set to announce changes in its packaging system, by unbundling one popular premium channel. According to the *Independent* newspaper, cable and satellite viewers will be able to subscribe to the Disney Channel without having to subscribe to Sky's two main film channels.

There are versions of the Disney Channel in several languages in Europe, and more are coming. But the only English version has been sewn up tight by Murdoch, available only to those who subscribed to his full movie package, and only available to viewers in Britain and Ireland. The Independent Television Commission, the watchdog which oversees commercial television in Britain, has been investigating the way Sky markets its channels, following a complaint from cable operators. The *Independent* says BSkyB is taking pre-emptive action, opening access to Disney before the ITC acts.

Preparations continue for marketing new satellite digital services in Europe in time for Christmas. Britain is scheduled to follow much of the rest of Europe into the digital age this fall, when BSkyB launches its 200 channel service from an (as yet unlaunched) Astra satellite at 28 degrees East. But talks between BSkyB and the BBC about carrying BBC programs on the digital service are close to breaking down, according to the *Daily Telegraph*. The newspaper says the two have been unable to agree on how much the BBC should pay for transmission.

Murdoch has suffered another digital set-back. Besides the digital satellite venture, BSkyB was also part of a consortium seeking a terrestrial digital television license in Britain. But the Independent Television Commision was worried that Murdoch would gain too much power over British broadcasting if the consortium, called British Digital Broadcasting, got the concession. BSkyB was forced to withdraw, and the ITC then granted to the license to the remaining partners, terrestrial broadcasters Granada Television and Carlton Television.

The new 30 channel terrestrial digital service, DTT, would be divided into six five-channel clusters: three would be allocated to existing providers, including the non-commercial BBC; three others would be run by BDB. Twelve of the channels would be available for a basic subscriber fee; the others would cost extra.

BDB plans a 12-channel basic subscription package. It will also offer three premium channels showing sports and movies. While Murdoch is out of the consortium with the license, undoubtedly BSkyB channels will be among the program offerings. The BBC plans to carry a 24-hour news channel (BBC World or something like it?) as well as its existing BBC1 and BBC2. Commercial networks ITV and Channel 4 will share one channel while part of the third has been allocated to S4C (the Welsh Channel 4) and the new Channel 5. DTT is set for launch in mid-1998 and viewers will need a new set-top decoder box to receive the signals.

Peace has been signed between Germany's pay-TV rivals, maverick media baron Leo Kirch and the Bertelsmann/CLT corporate empire. Under the new agreement, the two sides will hold equal shares in Premiere, the German pay TV group with 1.5 million subscribers, and Premiere and Kirch's struggling DF1 satellite digital service will cooperate. Anti-trust officials have expressed doubts about the deal if it involves a complete merger of Premiere and DF1. The European Commission blocked one such attempt a few years ago. While the Kirch Group says this will not be the case, in the future Premiere and DF1 will be partners and not rivals.

The two media companies are now awaiting European Commission approval.

The deal would mean a new high-profile introduction of digital TV in Germany later this year. Deutsche Telekom, which operates the country's only national cable

network, wants to launch a major digital TV promotion in time for the Christmas shopping season.

There's peace as well in Italy, where France's Canal Plus has signed a preliminary accord with a group of top media and telecommunications companies for the joint creation of a single digital television platform. Besides Canal Plus and its Italian pay-TV service Telepiu, the agreement involves the communications group Mediaset, public broadcaster RAI, the state-controlled telecommunications group Telecom Italia, and Cecchi Gori Communications. In early July Canal Plus increased its stake in Telepiu to 91 percent, but now says it could reduce the holding to less than 51 percent, with Telecom Italia and RAI set to become shareholders.

RAI has confirmed the launch of three new thematic satellite channels which are to start broadcasting from September 29, via RAI's digital transponders on Hot Bird 2. The channels are to be called RAISAT 1, 2, and 3, and include a cultural channel (broadcasting six hours a day, repeated four times), a children's channel (9-15 hours a day), and an educational service (six hours a day, repeated four times). A "multi-ethnic" channel is set to follow, as well as an all-news radio service. These channels will broadcast in the clear.

Telepiu has announced that it will launch a new 24 hour music channel called Match Music Satellite, which will join Telepiu's digital package in October, and will be offered to subscribers as part of the basic package of channels. Telepiu has also confirmed the launch of other thematic channels: Marco Polo (devoted to travel and tourism, from September), a classic Italian movies channel called Cineclassics Italia, NBC Europe, and Canale Disney (to start in December). A horseracing channel is in the planning stages, as are channels dedicated to hunting, nature, classical music, business, and cars. All will be part of the basic package.

But digital satellite television also continues to inspire powerful rivalries. In France, Canal Plus is suing the national terrestial channels over their refusal last April to accept a commercial promoting Canal Plus' pay-TV service. Canal Plus says private channels TF1 and M6 and public channels France 2 and France 3 have "seriously abused their position to the deteriment of the principles of freedom of commerce and competition."

In response, TPS, the digital satellite television service operated by TF1, which rivals Canal Plus' Canalsatellite, has taken Canal Plus to the competition court, saying the pay TV group has used its dominant position to prevent competitors from buying film rights.

The Spanish digital TV wars continue unabated. The European Commision gave the Spanish government an ultimatum to change a recent law on digital decoders that was widely seen as favoring Via Digital, the government-back digital consortium, which has yet to begin broadcasts. Under parliament's order, if an agreement on a single digital encryption standard cannot be reached, Via Digital's (as yet non-existent) decoder standard would be chosen, rather than the established encryption system of rival Canal Satelite Digital, which has some 40,000 subscribers.

Via Digital is 35 percent owned by public telecoms operator Telefonica, along with Radio Television Espanola, and Mexico's Grupo Televisa, and plans to begin broadcasting in September with 35 channels featuring films, sports, multimedia services.

Canal Satelite Digital is owned by Sogecable, which in turn is 25 percent held by France's Canal Plus, 25 percent by Spain's largest media company Grupo Prisa, and 15 percent by Antena 3. The controversy has become even more confused, as Telefonica has made a move to acquire control of Antena 3, buying into the competition.

In less acrimonious digital news, Deutsche Welle TV, ESC, RTM 1, and France's TV 5 Europe have started on Astra 1F transponder 98 (12.363 GHz) in clear MPEG-2.

Digital satellite TV in Europe was preceded by digital satellite radio, but even that situation is a bit confused right now. For the last couple of years, Digital Music Express and Music Choice Europe have been fighting it out, with DMX available on satellite (Astra and Hot Bird), and MCE restricting itself to cable networks. The market has been too small for both, and a merger seemed likely.

DMX seemed to be in the lead, but it's been weakened by relying on a system developed for Astra called Astra Digital Radio (ADR). This was an after-thought by Astra, which runs ADR on previously analog audio subcarriers. Initially, the subcarrier at 6.6 MHz was the standard mono channel for Astra TV transponders, with stereo sound on 7.02/7.20 MHz. To create ADR, Astra took back the 6.6 MHz channels, and cleared and shuffled around many others.

DIGITAL MUSIC EXPRESS

A number of subscribers bought the special ADR receivers (which cost almost as much as their existing analog satellite TV receivers). But the long promised, and often postponed, coming of digital satellite televsion has hurt DMX. Subscribers who might have signed up probably put off buying an ADR receiver, since they expected they would have to buy an MPEG-2 model anyway. The MPEG-2 receivers for the new digital services are incompatible with ADR. Instead, each new digital package carries its own radio stations as part of the offerings.

DMX was well-positioned to sign-up many of these new services, but as the start of digital satellite TV has been pushed back in some areas, and rivalries have confused the issue in others, DMX seems to have run out of money a few months too early. In early July DMX shut down on both Astra and on Hot Birds 1 and 2. MCE replaced the DMX channels in the DF-1 package on Astra. Several Swiss radio stations have replaced DMX channels within ADR.

However, James Robinson reports that a new company called XTRA-Music is trying to relaunch DMX in the ADR format on Astra.

Analog Developments

On the analog front, Astra transponder 47, which has carried no less than seven of what Sky (rather misleadingly) calls "channels," is splitting up. The Christian Channel Europe, Sky Soap, the History Channel, and the Sci-Fi Channel have all started on transponder 24 (which used to carry BSkyB promos).

On transponder 44, where Galavision has cut back its broadcast hours, Sky Travel and Sky Movies Gold (two other refugees from transponder 47) are now broadcasting, with Galavision mornings, Sky Travel weekday afternoons, and Sky Movies Gold the rest of the time. Sky Movies Gold is leaving transponder 60.

On transponder 47, Sky Sports 2, which had been broadcasting Thursday and Friday evenings and weekends, is now 24 hours, and will be sold as a separate premium

channel. Sky Sports 3 has become a bonus channel, free either with a subscription to Sports or Sky's movie channels.

Another new member of the Sky Multichannels family is the National Geographic Channel, which starts on Astra transponder 7 on September 1. This has been carrying Fox Kids and Sky 2, which has suffered from low ratings. National Geographic is also beaming to Scandinavia among the satellites at 1 degree West as part of the new Sky News and Documentaries channel there.

Also on September 1, Granada Talk TV on transponder 59 is changing into Granada Sports Talk. After sign-off at 1900 British Time, during the slot that has been used by Sky Scottish, Sky Box Office is likely to start, offering pay-per-view events like boxing matches and pop concerts.

There's one new English language Astra channel that's not part of the BSkyB subscription monopoly. Bloomberg TV has started in clear PAL on transponder 11. Some months ago Warner Brothers TV was supposed to launch as part of the Sky Multichannels package. That never happened because of the conflict between Time Warner and Murdoch over access to Murdoch's Fox News on Time Warner's cable network in Manhattan. Now that the two sides have settled their differences, the way is clear for WBTV to appear on Astra. Transponder 11 would have been a good spot.

Once again this Summer, Radio Nederlands has broadcast a special satellite TV service for Dutch tourists spending their vacations outside the country. Zomer TV was broadcast on Astra in uncoded PAL on transponder 58 (after the Computer Channel signed off every night) and in uncoded MPEG-2 on transponder 102 (12.441 GHz).

The Auction Channel has put off its decision on whether to join the Sky Multichannels package until September. Rupert Murdoch's music TV station Channel V, part of Star-TV in Asia, is also expected to join Sky's analog package later this year. According to reports, the German documentary channel Phoenix on Astra transponder 61 will move to transponder 36 in January when that transponder is vacated by Spain's Documania.

What Satellite TV says Richard Branson's Virgin Media Group is planning to launch a satellite channel dedicated to travel and music. The group has held talks with BSkyB about acquiring analog capacity and says it has "serious intentions of launching one or two TV services." Virgin had considered buying the cable channel Travel, but has now decided to launch a service with its own name instead.

Over on Eutelsat the biggest news is the appearance of Animal Planet in clear PAL on Eutelsat II-F1 on 11.055 GHz. Another new station reportedly coming to 13 degrees East later this fall is the Mosaic Channel, with Asian and Afro-Caribbean programming.

Eurotica and Rendez Vous have merged into a single sex channel called Eurotica-Rendez Vous. Eurotica's transmissions on Eutelsat II-F3 11.163 GHz have ceased, while the new channel continues on Hot Bird 2 11.785 GHz, daily between 0100 and 0500 CET.

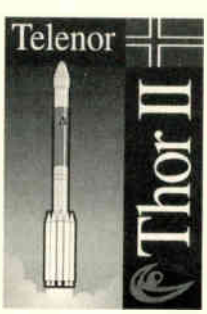
After Astra took on Deutsche Telekom as a share-holder and gained access to the orbital positions currently occupied by DT's Kopernikus satellites, rival Eutelsat has also expanded. Under an agreement with TDF (part of the France Telecom group), the TDF2 satellite has joined the Eutelsat fleet. The satellite has been repositioned from 19 degrees West to 36 degrees East to provide capacity for a private Russian TV broadcaster who will transmit programs over European Russia. The satellite downlinks in the 11.7-12.5 GHz BSS Ku-band. TDF2 will be joined next year at 36 degrees East by Eutelsat II-F2 (currently at 10 degrees East) and a new satellite called Sesat to establish what Eutelsat called a "key eastern orbital position."

A Jewish channel called the Shalom Channel is expected to start broadcasts to Europe during the first quarter of 1998. This will be a pay channel in both analog and digital modes. There's more information at:

http://perso.club-internet.fr/shalomtv

Scandinavia

Norway's new Thor 2 satellite at 1 degree West has been lighting up with new analog and digital services. On the analog side, the three stations owned by Disney/ABC's Scandinavian Broadcasting System, Sweden's Kanal 5, Norway's TV Norge, and the new Danish TV Danmark, have all appeared in the clear.



Kanal 5, which also continues to broadcast on Sweden's aging Tele-X satellite at 5 degrees East, will move to Sirius 2 at that position when it launches.

A number of digital services are on Thor 2 as well. Here is the latest list of what is available:

11.216 GHz	TV Danmark (D2-MAC)
11.229 GHz	Canal Digital package (MPEG-2): TNT, Cartoon Network, and Kanal 5
11.247 GHz	Telenor package (MPEG-2): DR1, TV2 (Denmark), SVT1, SVT2, and NRK1
11.261 GHz	Canal Plus Denmark package (MPEG-2)
11.278 GHz	Canal Digital package (MPEG-2): FilmNet 1 Nordic, FilmNet 2 Nordic, Nelonen, and Hallmark Nordic
11.293 GHz	Canal Plus Norway (MPEG-2)
11.309 GHz	1 degree West promos (MPEG-2)
11.325 GHz	NRK 2 (D2-MAC)
11.341 GHz	Kanal 5 (PAL)
11.357 GHz	NRK 1 (D-MAC)
11.372 GHz	
11.389 GHz	TVS-Sportskanalen (D2-MAC)
11.403 GHz	
11.421 GHz	TV Norge (PAL)
11.434 GHz	MTV Europe (D2-MAC)

With Thor 2 in orbit, Nethold's Multichoice Nordic has now left Intelsat 601, 11.504 GHz.

FILMNET

Now that Canal Plus has taken over Filmnet/Nethold, there are a number of changes in Scandinavia's largest pay-TV service. SuperSport went off the air on July 1, and has been replaced on Intelsat 707 by the Slovakian VTV, which is now on 11.534 GHz in clear PAL. (VTV has been succeeded on Eutelsat II-F2 10.972 GHz by the anti-Turkish Kurdish station Med-TV.)

Filmnet 1 and 2 had offered the same movies, time-shifted. Films and TV programs in Scandinavia are subtitled, rather than dubbed, and the D2-MAC system used allowed viewers to choose the subtitled language, so both channels could serve all of Scandinavia. But the two channels are being replaced by a single pan-Nordic channel called Canal Plus Gul ("Gul" means "Yellow" in Swedish), and four local (that is,

national) channels. The digital package launches officially on September 1st, and will probably also include Cineclassica, which will show black and white film classics, the Disney Channel, and a nature and recreational (apparently largely hunting) channel. Sports programs are being placed into the local national channels.

There is other activity at 1 degree West. TV Finland is now broadcasting in MPEG-2 on Intelsat 707 on 10.960 GHz. TV Finland is also included in an NRK digital package on 11.174 GHz, along with NRK 1, TV Norge, and Radio Finland. Sky Entertainment and Sky News and Documentaries are also scheduled to begin at 1 degree West on September 1.

The Science Fiction Channel's Scandinavian service has returned. Sci-Fi had been using Norway's aging TV-Sat, which is also at 1 degree West, but the transponder broke down. Telenor, which operates the transponders at 1 degree West, solved the problem by splitting up the D2-MAC Intelsat 707 transponder used by TV1000 Cinema. Sci-Fi is now on 11.912 GHz, while TV1000 Cinema is on 11.888 GHz.

The rivalry between the Swedes and the Norwegians continues, but the new Swedish satellite at 5 degrees East, Sirius 2, has been delayed. Its Ariane launch has been pushed back until October at the earliest.

Third generation satellites are coming to both 1 degree West and 5 degrees East. McDonnell Douglas (now merged with Boeing) has been awarded a contract by Telenor to launch Thor 3 in July 1998. The satellite, a Hughes HS 376, will initially have 14 active Ku-band transponders, for direct-to-home TV programming to Scandinavia as well as Eastern and Central Europe. The Norwegians have an option with Hughes for a Thor 4 satellite, which will be larger, and will cover parts of Europe besides Scandinavia and the Baltic states.

A month after Thor 3, Sirius 3 is to be in orbit. It will also be on an HS 376 platform, with 15 transponders for 5 degrees East. It's scheduled to be launched by Ariane in August 1998.

Islamic Objections to the Sexy French

A blunder in early July by the state-owned telecommunications company, France Telecom, may have cost France its satellite TV audience in the Middle East. Canal France International has been removed from Arabsat 2A, 3.946 GHz, after showing 30 minutes of an X-rated film during the time slot scheduled for a children's program. Arabsat says the channel has been banned for violating Islamic codes of decency. According to CFI the transmission was a mistake on the part of France Telecom over which it had no control. The porno film was supposed to have been carried on another satellite.

According to the *South African Mail and Guardian*, Nethold's M-Net is planning a pan-African satellite music channel. Thirty percent of the 24 hour broadcast day will be devoted to South African music, 10 percent to other parts of Africa, and the rest to black American music. The new music station will be part of the 40 channel DSTV package that already includes the Carlton Network, BET on Jazz, and Zee TV.

Rupert Murdoch is taking the Indian government to court over its ban on direct satellite broadcasting, saying this infringes on the right to information. Murdoch's Indian Sky Broadcasting was expecting the government to license direct-to-home broadcasts in mid-July, when the ban was announced instead. The suit was filed the following day. The Indian government said the prohibition is only temporary. Broadcasting Minister Jaipal Reddy said his government's first step in opening up the airwves would be giving the state-owned broadcasters more autonomy. Once that is accomplished, Reddy said DTH would be legalized.

Murdoch's Star-TV already has a popular free-to-air service in India using the C-band, which requires large antennas used mainly by cable operators. The new DTH service could transmit directly to homes with smaller Ku-band antennas. The Broadcast Bill is expected to be moved in parliament for approval later this year. Australia's Seven Network, owned by media mogul Kerry Stokes, has bought Australia Television from the Australian Broadcasting Corporation. The English-language satellite service would continue to be based around the ABC's news and current affairs programs. Seven says it would add its own news, light entertainment, drama, and sports programming to the channel.

Formed by the ABC four years ago, Australia Television broadcasts on Indonesia's Palapa C2 satellite and reaches a potential audience of 20 million an area from Beijing in the North to Western Samoa in the East and India in the West. Seven could use digital technology to broadcast between 6 and 8 channels on the transponder. Australia Television was set up under the former Labor government to project Australia into the increasingly important Asian market, but has failed to attract enough advertising to pay for itself. The current right wing Australian government forced the ABC to sell the station through a budget cut-back, despite widespread protests from around the Pacific.

The Cartoon Network was launched in Japan on September 1 by Turner Broadcasting, Time Warner, and Japan's Itochu. The 24 hour channel will offer 10,000 titles from Time Warner's library, with sound in Japanese, although the original English will also be available for some programs on a separate audio channel. Cartoon Network Japan will be delivered to subscribers via satellite and cable providers, including PerfecTV, a direct satellite broadcasting venture headed by Itochu, that began broadcasting last year.

In launch news, Japan's JCSAT 1A (JCSAT 4) has taken over from JCSAT 1 at 150 degrees East. Japan's Superbird-C satellite was launched from Cape Canaveral on July 28. The satellite will be used by DirecTV Japan to launch its digital multichannel broadcasting service. It carries 24 transponders.

Korea's KBS 1 and KBS 2 are on Koreasat 1/2 on 11.823 GHz. They are part of a 29 channel digital South Korean package.

A new digital Indonesian package has started on Asiasat 2, on 3.740 GHz in encrypted MPEG-2. It includes: Channel V Asia, Film Indonesia, HBO Asia, BBC World, MGM Gold, Discovery, ESPN, CNN International, TNT, Cartoon Network, and Rajawali Citry TV.

The launch of Indostar 1 with Ariane has been delayed until October. It will be launched together with Sirius 2.

Thanks to the Satco DX Chart, Richard Karlsson, James Robinson, Frank Oestergren, *What Satellite TV*, *Tele-satellit News*, Curt Swinehart, and Michael Murray for their contributions. ST

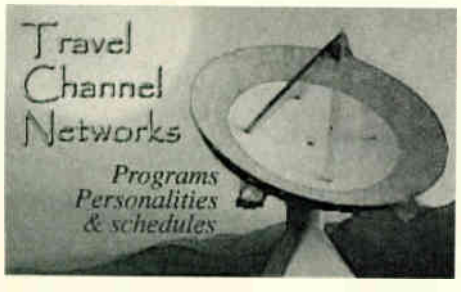
By Doug Jessop

Travel Channel Under New Management

Order now and for only $1 million more you get this ginzu knife...

Infomercial king Lowell (Bud) Paxson snapped up the Travel Channel, a 24-hour cable network with 20 million subscribers, for an impressive $75 million. Paxson's announcement, a surprise to many, came on the heels of a recent agreement with fellow media mogul Michael Bloomberg to carry Bloomberg TV on Paxson's New York station, WBIS. Paxson is about to announce a major deal to start a national television network, sources added. With that kind of dough, Bud is going to have to sell a lot of three-easy-payment exercise equipment.

Sources indicate that News Corp. and Tele-Communications Inc. are close to an agreement to purchase 40 percent of Cablevision Corp.'s sports-programming services, including the Madison Square Garden Properties. The transaction is reportedly about $850 million. Once complete, the deal will put about a $2 billion overall value on the sports portion of Cablevision's Rainbow Programming Holdings. The venture, a 50-50 partnership of News Corp's Fox Sports and TCI's Liberty Media Corp., owns a chain of 14 regional sports channels across the country that are marketed as the Fox Sports Network. The goal of the partners is to fuse Fox's growing properties with Cablevision's services to create a sports network that would rival Walt Disney Co.'s ESPN.



Disney in the morning, Disney in the evening, Disney on your radio...

The Walt Disney Co. announced this week that it will launch Radio Disney, a network of AM stations, in October. The network, which has just completed a six-month test in Atlanta, Minneapolis, Salt Lake City, and Birmingham, has been designed for children between the ages of five to nine. According to the company, a sample hour of Radio Disney includes pop music, contests, kids making requests, and one-minute features from the company's vast empire.

News Corporation

CBS, which recently purchased the Spanish-language all-news cable TV service TeleNoticias, is reported to be interested in the French-based service Euronews. According to the French business newspaper *Les Echos*, CBS has placed a bid for the 49 percent stake in Euronews now controlled by telecommunications company Alcatel. Euronews, which is said to have had difficulty turning a profit, has its headquarters in Lyons. It is seen throughout the continent and in North Africa and is delivered by cable and satellite. Its programming airs in six different languages and competes against television news services run by the BBC and Rupert Murdoch's SkyTV.

On the subject of the French...satellite program distribution giant Keystone Communications was recently acquired by the French telephone monopoly France Telecom. France Telecom had been a minority stockholder for quite some time and wanted to own the company outright. The company name has now been changed to Globecast. While Globecast is not a household name, a huge amount of program distribution and (hint, check the *ST Satellite Services Guide*) wild feeds are delivered in the clear via satellite.

Soundview Technologies Incorporated reports that its new V Chip Converter will be available utilizing the recently agreed upon TV rating system. At an estimated price of $60, the V Chip Converter, a set-top unit, provides American parents with an alternative to buying a new television set, Soundview said. The company said the chip will be available in about three or four months compared to the 12-18 months it will take to manufacture new televisions with the V-chip.

Satellite television is going to the dogs....

Pet lovers welcomed My Pet TV Network, a new cable channel allied with the Humane Society of the United States, which debuted in early August. Initially, the channel will be available for one hour a day on several cable systems, including Century Communications, Cox Communications, Time Warner, TCI, and Comcast. Sources at My Pet TV Network said that the channel aims to expand to 24-hours a day in May, offering programs like *Petsville USA*, with money-saving tips, *Two Tails Up*, a showcase of motion pictures centered around animals, and *Hollywood's Rich and Furry*, which will focus on celebrity pets.

On a related note, Hollywood mouths are flapping about the possibility of Sarah Ferguson hosting a revamped version of *Lifestyles of the Rich and Famous*, the syndicated show formerly hosted by Robin Leach. According to a story in the Hollywood Reporter, The Duchess of York has been approached about the project by Rysher Entertainment, which recently announced it would revive the show for syndication. Rumors of "Fergie" joining *Lifestyles* came on the heels of an announcement by ABC that she would host a one-hour prime-time special this fall for the network—tentatively titled *Adventures with the Duchess*. A network spokeswoman said that it is "premature" to confirm a *Time* magazine report that "if the first special flies" it could develop into several a year.

Daisy Fuentes, a model and host of MTV's *House of Style*, will soon add *America's Funniest Home Videos* to her high brow (sic) resume. ABC announced that it has signed Fuentes to host the popular program when it returns halfway through the 1997-98 TV season. Fuentes is not the only change the show will undergo. According to producers, *America's Funniest Home Videos* will get an entire makeover, including a new set and an additional half hour to its current 30 minutes. In June, Bob Saget, who had hosted the show since inception in 1990, released a statement saying he'd enjoyed doing the show but it was time to move on.

Gayle King, whose talk show will launch this fall on 205 stations, may be Oprah Winfrey's best friend and, sure, she sounds like her, but, says King, that's where the comparisons should end. "There is only one Oprah," King said. "Do I have a talk show because of her? I think that it would be foolish to deny that the fact that I'm her friend has an appeal...(But) I don't think that's the only reason I got it." And, with all of the controversy surrounding talk shows these days, King assured reporters that her show will take the high road. "We're looking for guests who have all their teeth...classy, articulate people talking about things that matter."

Court TV recently launched a new weekday talk show, *Legal Cafe*. The program, hosted by June Grasso, airs on the cable network daily from 9 to 11a.m. EST and is telecast from a cafe-like setting. During the program, Grasso takes questions about specific legal topics from viewers via live call-ins, the Internet, fax, and on-camera field shots. Each day, Grasso will be joined by a legal expert specializing in the day's topic.

Internet Sites

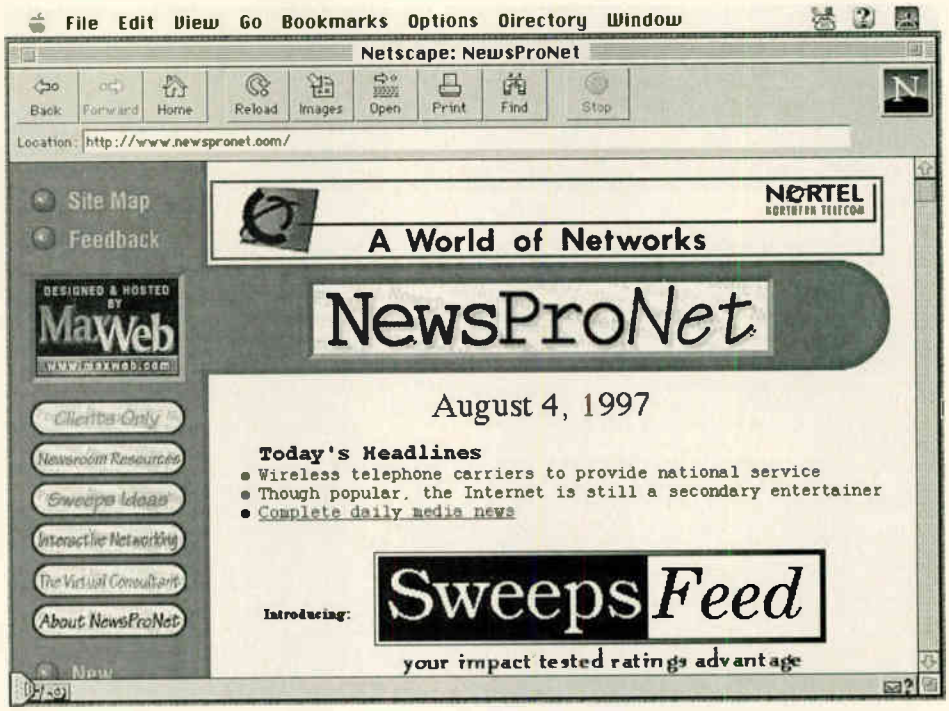
You can now hear what viewers have to say about ABC, CBS and NBC network newscasts. The voice-capture responses from Advanced Research Services recent national survey are available on the web at: **www.newspronet.com** using RealAudio.

And finally, you probably have heard about the photos from Mars on the NASA site. Just be careful that you punch in the right URL. NASA is a government site thus we get **http://www.nasa.gov**. It seems that school kids across the world have been getting an eyeful by punching in another more common domain ending.

Sources for this installment of *Domestic TVRO* in *Satellite Times* include various friends and neighbors in the business as well as: BroadcastingLinks.com, *Hollywood Reporter*, Journalism Forum on CompuServe, *LA Times*, PR Newswire, *NY Daily News*, *NY Post*, *Time Magazine*, *Washington Post*, and *Wall Street Journal*. As always your comments are welcome at: **http://www.searcher.com/STcomments.html**

Doug Jessop has been in the broadcasting industry since 1979 and was the architect of the Keystone Communications North American Satellite Guide.

ST



World Radio Network Schedules

WRN 2 North American Multilingual Program Schedule
Galaxy Five (125 deg West) transponder 6-3.820 GHz (TBS) vertical polarization, audio subcarrier 6.2 MHz. Please note that programs listed below are subject to pre-emption without notice. All times Eastern Daylight (UTC +4 hours).

0030	WRN Announcements, until....
0200	YLE Radio Finland (Mon-Sat)
0255	YLE, Church Service (Sunday only)
0400	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, News in Finnish
1005	YLE, Regional News
1030	YLE, News in Finnish
1100	YLE, News in Swedish
1130	YLE, Easy Listening Music and Chat in Finnish
1200	Radio Netherlands in Dutch
1400	WRN Announcements, until....
1500	Radio Vlaanderen International in Dutch
1530	WRN Announcements, until....
1630	ORF Radio Austria International in German
1700	Radio Budapest in Hungarian
1800	Polish Radio Warsaw in Polish
1830	YLE Radio Finland, Devotional Music
1855	YLE, News in Swedish
1900	YLE, News in Finnish
1930	YLE, Easy Listening Music and Chat in Finnish
2010	YLE, Current Affairs in Finnish
2030	YLE, Oocumentaries in Finnish
2030	YLE, New Classical releases in Finnish (Sunday)
2130	YLE, Easy Listening Music in Finnish
2230	YLE, News in Finnish
2300	WRN Announcements, until....
2330	ORF Radio Austria International in German

WRN 1 European English Program Schedule
Astra 1B (19 deg East) transponder 22-11.538 GHz (VH-1) vertical polarization, audio subcarrier 7.38 MHz. WRN is also available on cable and local radio stations. WRN program information can be heard daily at 0125 and 1025 BST. It is also available on VH-1 text pages 222, 223, 224. All times BST/CET (British Summer Time/ Central European Time). For UTC, subtract one hour from BST.

BST/CET	
0000/0100	Radio Budapest
0030/0130	Radio Netherlands
0127/0227	*Earth and Sky* (Daily Science Series)
0130/0230	ORF Radio Austria International
0200/0300	NPR *All Things Considered* (repeat)
0300/0400	CBC *As It Happens* (Tue-Sat)
	RCI News, and Features (Sun and Mon)
0400/0500	Polish Radio Warsaw
0430/0530	*BBC Europe Today* (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	UN Radio From New York (Sun)
0500/0600	PRI *Market Place* (Tue-Sat)
	SABC Channel Africa-Johannesburg (Sun)
	UN Radio from New York (Mon)
0530/0630	ORF Radio Austria International
0600/0700	Voice of America World Wide (Mon-Fri)
	VoA Saturday (Sat)
	VoA Sunday (Sun)
0700/0800	NPR *All Things Considered* (repeat)
0800/0900	ABC Radio Australia
0900/1000	Polish Radio Warsaw (Mon-Sat)
	C-Span Weekly Radio Journal (Sunday)
0930/1030	Radio Canada International (Mon-Fri)
	UN Radio (Sat)
1000/1100	Radio Prague
1030/1130	Radio Netherlands
1127/1227	*Earth and Sky* (Daily Science Series)
1130/1230	SABC Channel Africa-Johannesburg (Mon-Sat)
	Glenn Hauser's *World of Radio* (Sun)
1200/1300	NPR *Morning Edition* (Monday-Friday)
	NPR *Fresh Air* (Sat)
	NPR *Car Talk* (Sun)
1300/1400	NPR *Morning Edition* (Monday-Friday)
	NPR *Weekend Edition* (Saturday and Sunday)
1400/1500	Radio France International
1500/1600	Voice of Russia (Mon-Fri)
	UN Radio from New York (Sat)
	Voice of America-*Communications World* (Sun)
1530/1630	ORF Radio Austria International
1600/1700	ABC Radio Australia
1700/1800	Caribbean Tempo from CANA Radio (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	Copenhagen Calling (Sun)
1715/1815	Vatican Radio World News (Mon-Fri)
1730/1830	ORF Radio Austria International
1800/1900	SABC Channel Africa-Johannesburg (Mon-Sat)
	UN Radio and Health Watch (Sun)
1830/1930	RTE News at Six
1900/2000	Radio Vlaanderen International
1930/2030	Radio Netherlands
2025/2125	News in Esperanto from Polish Radio Warsaw
2030/2130	Radio Sweden
2100/2200	YLE Radio Finland
2130/2230	Polish Radio Warsaw
2200/2300	Voice of America *World Report* (Mon-Fri)
	VoA *Today* (Sat and Sun)
2300/0000	PRI *The World* (Mon-Fri)
	NPR *All Things Considered* (Sat and Sun)

WRN2 Multilingual European Program Schedule
Eutelsat II-F1 (13 deg East) transponder 25-10.987 GHz (NBC) vertical polarization, audio subcarrier 7.38 MHz. Please note that programs listed below with an asterisk (*) are subject to pre-emption without notice. All times British Summer Time (BST). For Central European Time (CET) add 1 hour

BST	
0000	*WRN1 (Mon-Fri)
0309	Vatican Radio
0745	*WRN1 (NPR and ABC Radio Australia)
0830	Vatican Radio (Sun) until 1130
0930	Vatican Radio (Mon-Sat) until 1130, except Wed to1200
1130	*WRN1 (SABC Channel Africa) except Wed
1200	Radio Studio Delta (Mon-Fri) until 1300
1200	*WRN1 (NPR Sat and Sun)
1300	Vatican Radio
1530	Radio Studio Oelta (Mon-Fri)
1530	*WRN1 (Sat and Sun Radio Vlaanderen-Brussels and ABC Radio Australia)
1630	Vatican Radio
2230	Radio Studio Oelta (Mon-Fri)
2230	*WRN1 (Sat and Sun)
2330	Radio Prague

WRN Asia-Pacific English Program Schedule
AsiaSat-2 (100.5 deg East) 4.000 GHz, vertical polarization, MPEG2 OVB, Symbol Rate 28.125 Mbaud, FEC 3/4, Select WRN1 from audio menu. AET-Australian Eastern Time (UTC +10 hours).

UTC/AET	
0000/1000	YLE Radio Finland (Mon-Fri)
	UN Radio (Sat)
	Copenhagen Calling (Sun)
0030/1030	ORF Radio Austria International (Mon-Fri)
	Radio Sweden (Sat)
	Polish Radio Warsaw (Sun)
0100/1100	NPR *All Things Considered*
0200/1200	PRI *The World* (Tue-Sat)
	PRI *The Best of Our Knowledge* (Sun and Mon)
0300/1300	RTE Dublin *Irish Collection*
0400/1400	PRI *Market Place* (Tue-Sat)
	UN Radio from New York (Sun)
	Copenhagen Calling (Mon)
0430/1430	ORF Radio Austria International
0500/1500	NPR *All Things Considered* (Repeat)
0600/1600	Polish Radio Warsaw
0630/1630	Radio Vlaanderen International
0700/1700	RTE Dublin
0900/1900	Voice of Russia
0930/1930	Radio Netherlands
1030/2030	YLE Radio Finland
1100/2100	Radio Australia
1200/2200	Radio Canada International
1300/2300	RTE Dublin
1400/0000	Radio Sweden
1430/0030	ORF Radio Austria International
1500/0100	Radio France International
1600/0200	Caribbean Tempo from CANA Radio (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	Copenhagen Calling (Sun)
1615/0215	Vatican Radio World News (Mon-Fri)
1630/0230	ORF Radio Austria International
1730/0300	Channel Africa (Mon-Sat)
	Glenn Hauser's *World of Radio* (Sun)
1730/0330	RTE Dublin
1800/0400	Radio Vlaanderen International
1830/0430	Radio Netherlands
1927/0527	*Earth and Sky*
1930/0530	Polish Radio-Warsaw
2000/0600	Radio France International
2100/0700	RTE Dublin
2200/0800	RTE Dublin *Ireland Tonight*
2300/0900	Radio Netherlands
2357/0957	*Earth and Sky* (Daily Science Series)

WRN Middle East and Africa English Program Schedule
Intelsat 707 (1 deg West) 3.9115 GHz, right-hand circular-polarization, Symbol Rate 8.022 Mbaud, FEC 3/4, MPEG2 Audio Stream "WRN1." WRN can be heard in South Africa on the MultiChoice digital direct-to-home service on PanAmSat 4 at 68.5 degrees West, audio channel 51. CAT-Central African Time (UTC +2 hours).

UTC/CAT	
Next five hours can be heard in South Africa on SAfm 104-107	
2200/0000	RTE Dublin *Ireland Tonight*
2300/0100	Radio Netherlands
2357/0157	*Earth and Sky* (Daily Science Series)
0000/0200	YLE Radio Finland (Mon-Fri)
	UN Radio (Sat)
	Copenhagen Calling (Sun)
0030/0230	ORF Radio Austria International (Mon-Fri)
	Radio Sweden (Sat)
	Polish Radio Warsaw (Sun)
0100/0300	NPR *All Things Considered*
0200/0400	PRI *The World* (Tue-Sat)
	PRI *The Best of Our Knowledge* (Sun-Mon)
0300/0500	RTE Dublin *Irish Collection*
0400/0600	PRI *Market Place* (Tue-Sat)
	UN Radio from New York (Sun)
	Copenhagen Calling (Mon)
0430/0630	ORF Radio Austria International
0500/0700	NPR *All Things Considered* (repeat)
0600/0800	Polish Radio Warsaw
0630/0830	Radio Vlaanderen International
0700/0900	RTE Dublin
0900/1100	Voice of Russia
0930/1130	Radio Netherlands
1030/1230	YLE Radio Finland
1100/1300	Radio Australia
1200/1400	Radio Canada International
1300/1500	RTE Dublin
1400-1600	Radio Sweden
1430/1630	ORF Radio Austria International
1500/1700	Radio France International
1600/1800	Caribbean Tempo from CANA Radio (Mon-Fri)
	Glenn Hauser's *World of Radio* (Sat)
	Copenhagen Calling (Sun)
1615/1815	Vatican Radio World News (Mon-Fri)
1630/1830	ORF Radio Austria International
1700/1900	SABC Channel Africa (Mon-Sat)
	Glenn Hauser's *World of Radio* (Sun)
1730/1930	RTE Dublin
1800/2000	Radio Vlaanderen International
1830/2030	Radio Netherlands
1927/2127	*Earth and Sky*
1930/2130	Polish Radio Warsaw
2000/2200	Radio France International
2100/2300	RTE Oublin

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There are places in this world that few others have ever seen, or can even imagine. These places have no telephone lines, cell towers, couriers or mailboxes—only you and your need to communicate.

Despite this need, there has been no affordable or practical way to communicate from remote areas...until now.

Magellan has created the GSC 100, the world's first hand-held global satellite communicator. The GSC 100 gives you the ability to **send and receive e-mail messages to and from anywhere on Earth**. It lets you stay in touch wherever life takes you. And, with its **integrated GPS receiver**, the GSC 100 not only lets you know where you are, it guides you anywhere you want to go. You can also relay that position to anyone, anywhere—no matter how remote you may be—with a GSC 100 e-mail message.

The GSC 100 utilizes the **ORBCOMM network**—the world's first wireless, two-way satellite personal communications system, providing true global coverage. Because the GSC 100 uses standard e-mail protocols, sending and receiving messages is easy. Communicate to any e-mail (Internet) address or another GSC 100. **Added services will allow you to send your message via fax or voice.**

The GSC 100 communicates with the satellites on a standard narrow-band VHF frequency. Your e-mail message goes up to an ORBCOMM satellite and then down to a gateway station and is routed to its final destination via traditional methods. Retrieving your incoming e-mail is just as easy.

Unlike traditional land-line, cellular, and paging systems, the space-based ORBCOMM network offers global coverage, eliminating dead zones and providing seamless worldwide communications. The GSC 100 is a **convenient, reliable, and affordable solution for your global communication and navigation needs.**

Deliveries of the GSC 100 from Magellan are expected to begin soon. Reserve yours now! Your credit card will not be billed until the unit is shipped! Phone access card required for operation.

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ST WHAT'S NEW

by Wayne Mishler, KG5BI

Magellan Introduces World Satellite Phone

Magellan Systems Corporation has announced a new global satellite telephone that sells for $3,995. Service is billed at $2.99 per minute.

The unit measures 2.2 by 10.2 by 10.2 inches, including the antenna, and weighs 5 pounds, including battery, which lasts for 3 hours with heavy transmission or 48 hours on standby.

Using Inmarsat-3 spot beam technology, the phone is useful for travel, boating, pilots, geo-sciences professionals, remote field crews, and others who are often out of range of traditional services.

With the phone's fax and data capability, customers can send and receive faxes, access electronic mail, transfer files, and surf the Internet. Industry standard RJ-11 fax and RS 232 data ports are compatible with standard fax machines and PCs.

Instructions displayed on the unit's high-resolution window screen lead the user through all of the phone's features and functions. Multi-purpose keys provide instant access to the phone's menus. There is a free, 24-hour Magellan customer service to use for technical assistance if needed.

The World Phone can store 99 entries of up to 29 characters each in its electronic phone book, and it can remember the last 10 numbers dialed.

It is constructed of impact-resistant copolymer and will operate in temperatures ranging from -25 to +55 degrees Celsius.

A detachable waterproof antenna/lid with coax cable (included) enables you to mount the antenna up to three meters away for straight line access to satellites. Optional extension antenna cables enable you to position the antenna up to 80 meters away from the phone. This lets you place the antenna outside, even in sub-zero temperatures or rain while you make your call inside.

The phone comes complete with a transceiver unit, handset, detachable antenna with three-meter cable, compass, universal AC adapter, user manual, user guide and activation instructions.

Optional accessories include DC power cable with cigarette lighter adapter, additional NiMH rechargeable battery, soft carrying case, hard transit case, and antenna extension cables.

The phone will also accommodate SIM (Subscriber Identity Module) with user information and personalized electronic phone book.

For more information, contact Magellan Systems, 960 Overland Ct., San Dimas CA 91773, 909-394-5000.

Intelsat offers new thin route DAMA global service

They call it thin route on demand service. It is a usage based, state of the art digital solution for public switched telephone networks. It provides instant dial-up global connectivity. And now it is operational and available worldwide from Intelsat.

"Thin route on demand service is one of the most flexible multiple access technologies available on the market today," says Gary Smith, Intelsat vice president of sales and marketing.

"It is clearly one of the most cost effective ways for users with low traffic requirements to replace existing analog or SCPC circuits, and it allows the introduction of advanced digital applications to remote and rural areas using VSATs."

Thin line on demand connectivity is especially useful to customers with communications needs such as off-shore drilling, cruise ships, and distance education.

Intelsat implemented this service in three phases, one ocean region at a time, over a six month period.

"The beauty of [this service]," says Sesh Simha, Intelsat senior product manager, "is that it is offered over our three high connectivity satellites, operating with nearly 300 gateway earth stations in over 140 countries."

This means that when customers sign up for thin route on demand service, they have instant access to this enormous existing community of public switched telephone network users.

If you think you might need this service, but have questions about what it can do for you, there is a Web site you need to visit. The address is **http://www.intelsat.int/**. There are reams of information on thin line technology in Intelsat's news magazines and press releases.

You can also call Tony Trujillo at Intelsat's Washington headquarters, telephone number 202-944-7500.

Precision farming never had it so good

I can remember when high-tech farming was air conditioning and a coffee pot in an enclosed tractor cab. Those were the old days. To compete in the farming business today you need satellites in the sky and something just released by the Trimble company called the AgGPS 132 differential GPS receiver.

That's the receiver for precision farming applications, of course. It has something called The Choice technology built into it. This unit is a combined state of the art GPS receiver, a high performance Coast Guard beacon differential correc-

tion receiver, and a satellite differential receiver, all in a single compact package.

"The AgGPS 132 is a major technology breakthrough that allows farmers to achieve sub-meter GPS accuracy without establishing their own reference station in many parts of the world," says Jim Sorden, executive vice president of Trimble's commercial systems group.

"Unlike any other product on the market, this unit with The Choice technology lets the user decide whether to use beacon services or satellite services with the touch of a button."

As a part of a precision agriculture system, this unit sends sub-meter differential GPS position information to yield monitors, variable rate planters, fertilizer and chemical application controllers, soil sampling systems, and portable field computers.

Grampa used to squeeze the dirt in his hand to see if it was ready to plant.

Today the AgGPS 132 allows farmers to use differential GPS data to improve the efficiency of their farming operations and the consistency of their products.

An important benefit of improved farm management, through the use of location information, is reduced environmental impact from agricultural chemical runoff. Chemicals can be applied precisely to specific areas where they are needed.

The unit was to begin shipping in July. You'll find more information about it at **http://www.trimble.com**.

Now if they could only come up with an instrument to predict agricultural market fluctuations.

New satellite will see one-meter objects on ground

Beginning in January 1998, the satellite *Ikonos One* will be the first commercial satellite to see and produce images of objects on the Earth only one meter in diameter, says its manufacturer, Space Imaging EOSAT.

Such precision imagery holds great promise for mapping, commercial development, and other urban applications.

The precision *Ikonos One* is to be launched from Vandenburg Air Force Base, California, in December.

"Our company's goal is to become the world's largest, most diverse supplier of Earth information products and services," says John Copple, Space Imaging EOSAT's CEO.

"The one-meter *Inonos One* is part of a large and expanding constellation of satellites and aerial platforms that produce products for a variety of applications, including infrastructure and property mapping, environmental monitoring, precision agriculture, weather monitoring, and, in the future, ocean mapping."

The company currently markets their highest resolution space imagery available to commercial customers, says Copple.

Their Web site is **http://www.spaceimage.com/**.

Paragon announces new imaging software

Paragon Imaging, Inc., provider of commercial image processing and viewing software, recently announced two software packages for commercial imaging.

Their ELT/7000 R.3 software is a comprehensive product for processing, exploiting and communicating large geospatial images. It combines advanced tools for working with full frame images with a user-friendly graphical user interface.

Exploitation is the process of extracting information from images of the Earth that typically are captured by satellites and aerial cameras.

Their other new software package is called the ELT/Global Image Viewer software. This provides efficient viewing of full frame images (satellite and other gigabyte-size images), vector maps, and related multimedia data with a graphical user interface.

This software is built specifically for professionals within government agencies and commercial organizations who rely on image-based analyses, presentations, and briefings to guide their decision making, planning, and operations.

For more information, contact Paragon Imaging's Web site at **http://www.paragon.com/**.

New generation of two-way satellites announced

SatCom Media Corporation has announced plans to launch a family of revolutionary and affordable two-way satellite-based telecommunications products. The ISDN compatible devices promise a low-cost, PC alternative to existing services and traditional cabling infrastructures. The new series of products promises to boost available Internet and intranet bandwidth, as well as to provide access in areas where other cost-effective solutions have not been available.

"We have a unique and exciting corporate mission to enable all of the world to take part in the telecommunications revolution through our high-speed global access products," says Les Stevens, vice president for sales and marketing.

"While new Web-based multimedia applications such as video conferencing, collaborative computing, and even voice over data are providing us with an effective means of communicating, they are also clogging existing slow data pipelines," says Stevens.

SATCOM MEDIA CORP.
Your Smartest Connections Around The World™

"With our SatNET networking products, we are bringing satellite-based two-way telecommunications directly to the desktop PC, with ISDN protocol emulation, and with speeds of up to T-1 rates (one megabyte per second). The immediate benefit is the elimination of bandwidth bottlenecks users are experiencing around the world. And we're doing it at a price that can be easily justified."

SatNET customers will be able to monitor direct broadcast service (DBS) television. This lets users view broadcast video as well as IP multicasting, which eliminates the problems of transferring large data files to remotely located offices.

The company is forming strategic partnerships with established satellite services providers to establish local presence throughout the world.

"We offer these telecommunications companies solutions that will greatly expand their satellite communications subscriber base without major investments to their infrastructure," Stevens says.

You'll find SatCOM on the Internet at **http://www.satmedia.com** ST

ST SPACE WATCH

By Larry Van Horn

Farthest Galaxy in the Universe Discovered

An international team of astronomers has discovered the most distant galaxy found in the universe to date, by combining the unique sharpness of the images from NASA's Hubble Space Telescope with the light-collecting power of the W. M. Keck Telescopes—with an added boost from a gravitational lens in space.

The results show the young galaxy is as far as 13 billion light years from us, based on an estimated age for the universe of approximately 14 billion years. This would place the galaxy far back in time during the "formative years" of galaxy birth and evolution, less than a billion years after the birth of the universe in the Big Bang.

The detailed image shows that bright dense knots of massive stars power this object. Due to the firestorm of starbirth within it, the galaxy is intrinsically one of the brightest young galaxies in the universe, blazing with the brilliance of more than ten times our own Milky Way.

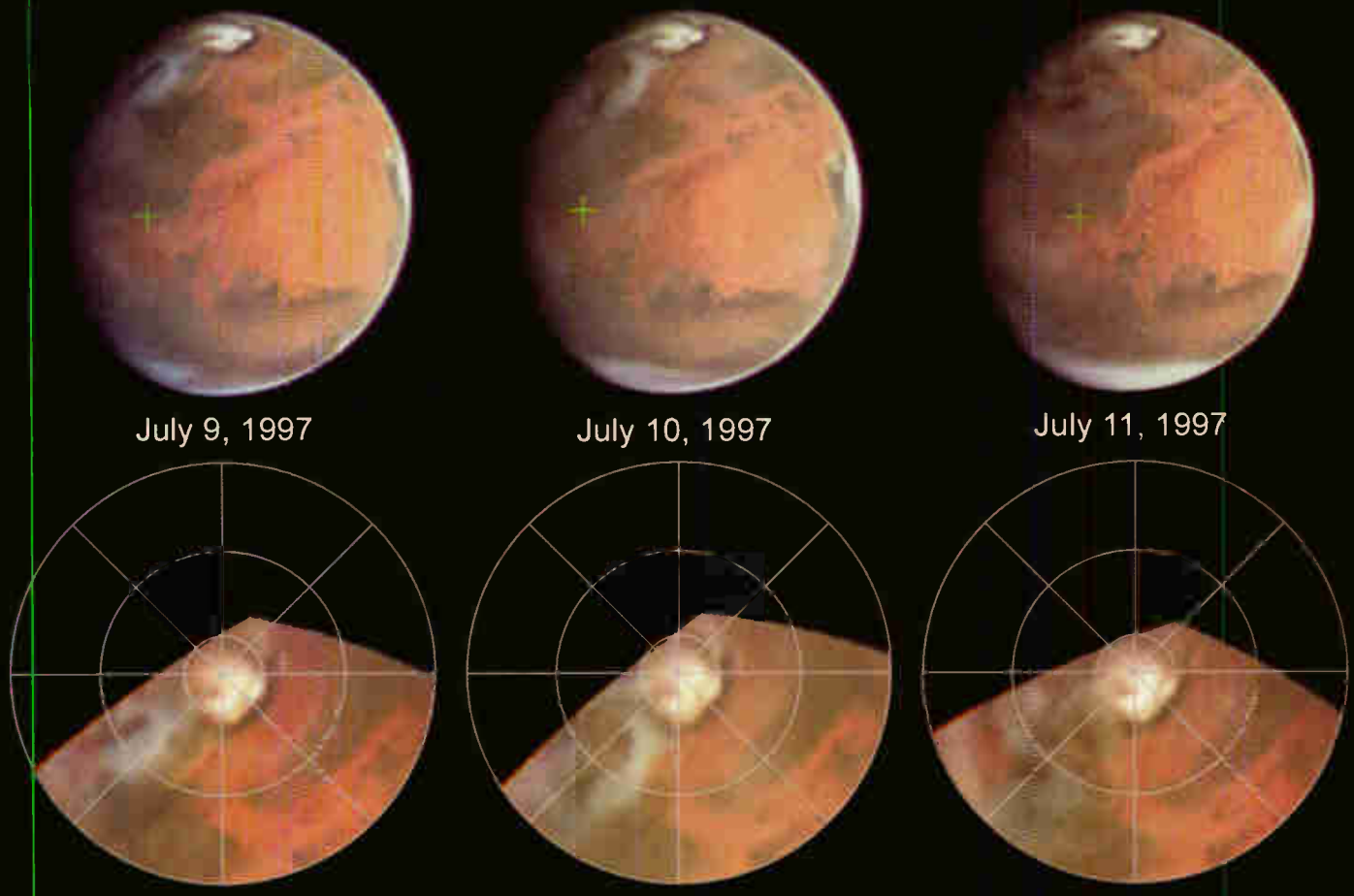
"We were excited by the possibility that we may have found a unique example of a galaxy in formation at the time of the earliest quasars," said Marijn Franx of the University of Groningen in the Netherlands.

Predicted by Einstein's theory of general relativity, gravitational lenses are collections of matter (such as clusters of galaxies) that are so massive they warp space in their vicinity, allowing the light of even more-distant objects to curve around the central lens-mass and be seen from Earth as greatly magnified.

Due to a rare and fortunate alignment of the young galaxy behind the foreground cluster, astronomers gain a magnified view that is five to ten times better than Hubble alone can yield for an object at such a great distance. A telltale sign of the lensing is the smearing of the remote galaxy's image into an arc-shape by the gravitational influence of the intervening galaxy cluster.

The smeared image of the galaxy stood out because of its unusual reddish color. "Such magnified galaxies had been observed before, but never with such a color. The special color of the galaxy in the arc is due to absorption by the matter in the universe between us and the galaxy, and suggested to us that it was at a great distance," says Franx.

Though candidates for still more distant objects have been proposed, they have not been confirmed spectroscopically. The previous most-distant known object was the quasar PC1247+34.



Rapid Weather Changes Observed on Mars

NASA Hubble Space Telescope images of Mars, obtained over three consecutive days between July 9 and 11, 1997, dramatically show that the behavior of dust and water-ice clouds exhibit substantial daily variations. The full-disk images are shown along the top (Pathfinder landing site marked by the green crosses), and maps of the North polar region are shown along the bottom. (The maps are oriented with 0 degrees longitude to the bottom, and extend from 40 degrees North latitude to the pole; latitude circles are shown at 40, 60, and 80 degrees, and lines of longitude are shown every 45 degrees.) About 24 hours separates each of the images.

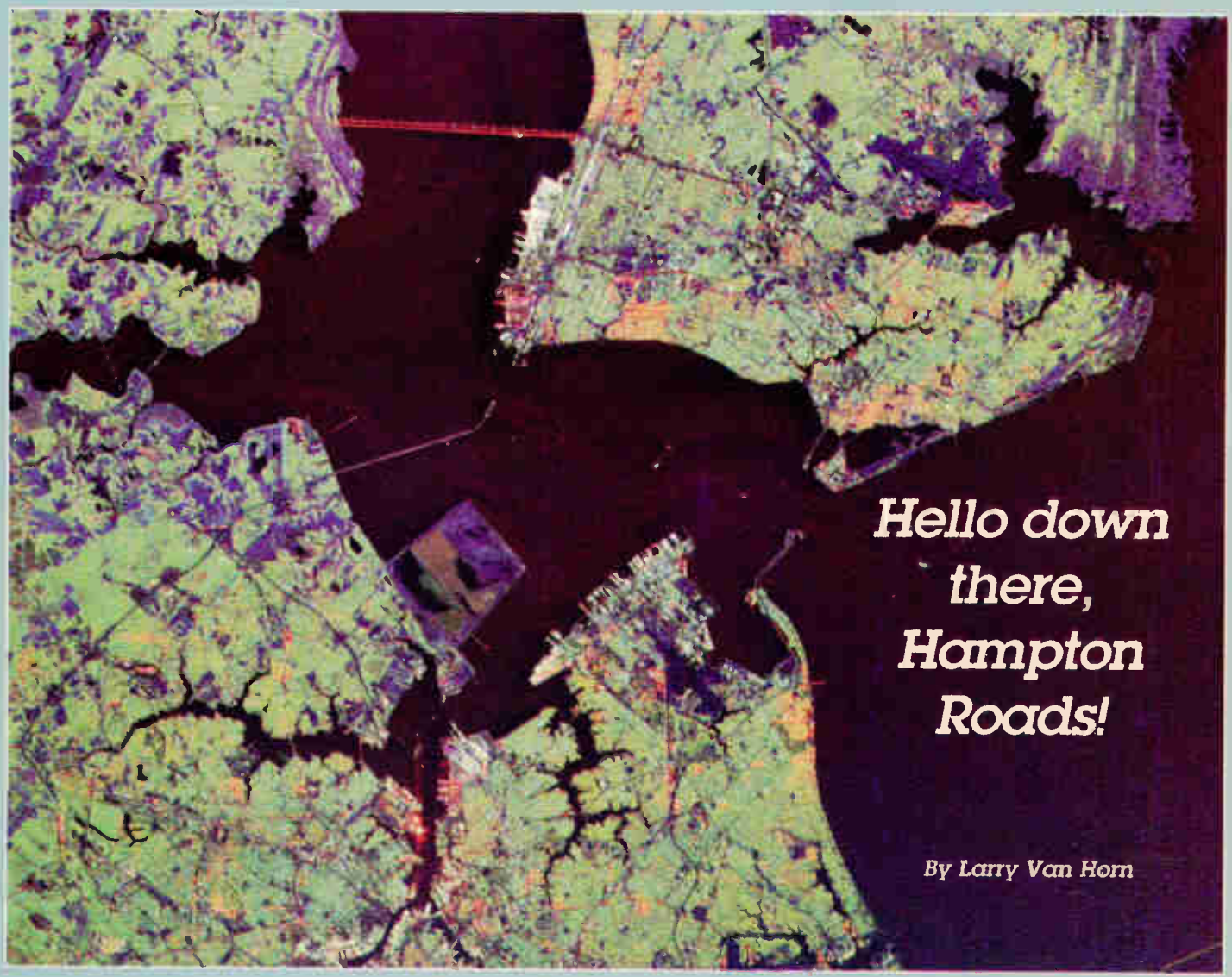
The polar maps document the movement of bright water-ice clouds as they are seen to progress eastward, perhaps driven by a passing weather front on Mars. Between July 9 and 10, the polar cloud seen near 60 degrees North latitude is measured to have moved about 550 km eastward over a period of about 24 hours, corresponding to a velocity of about 22 km/hour. The cloud has dissipated considerably by July 11.

Clouds in the southern hemisphere seem to thicken considerably over this three day period as well. The bluish south polar hood, composed of water-ice clouds, is seen along the bottom of the images. We cannot see the south polar cap, since the north polar cap is tilted toward us during this season and the south cap is in winter darkness.

On the July 9 image and map, a streamer of dust is visible in the North polar region, extending about 1200 km southward from the dark sand dunes surrounding the polar ice cap; diffuse dust is visible over much of Acidalia, the dark region to the north of the Pathfinder landing site. This dust cloud is apparently diffusing with time, as it seems to become less distinct in each successive image. This dust storm may be supplying some of the dust seen overhead by the Pathfinder spacecraft.

These HST images support the conclusion that Pathfinder landed during a period when large changes in the regional distributions of dust and clouds were taking place on Mars, a point not readily evident from the localized Pathfinder site observations. These and future simultaneous observations between HST and Pathfinder will help place the detailed observations made by Pathfinder into the global perspective offered by HST.

Photo Credit: Steve Lee (Univ. Colorado), Phil James (Univ. Toledo), and Todd Clancy (Space Science Inst.)



Hello down there, Hampton Roads!

By Larry Van Horn

This radar image shows the Hampton Roads, Virginia region, where the James River (upper left center) flows into the Chesapeake Bay. The city of Norfolk is the bright area on the peninsula in the lower center. Norfolk is home to a large naval base, part of which can be seen as the bright white port facilities near the center of the image.

The cities of Hampton and Newport News occupy the peninsula in the upper right of the image. The dark blue areas on this peninsula are the runways of Langley Air Force Base, which also houses NASA's Langley Research Center. Forested areas, including suburbs, appear as green on the image. Cities appear as green, white and orange. The purple areas along the shorelines are wetlands; blue areas are cleared for agricultural use. Faint ship wakes can be seen in the water behind ships entering and leaving Hampton Roads.

Scientists are using radar images like this one to study delicate coastal environments and the effects of urbanization and other human activities on the ecosystem and landscape.

The image was acquired by the Spaceborne Imaging Radar-C/X-band Synthetic Aperture (SIR-C/X-SAR) imaging radar when it flew aboard the space shuttle *Endeavour* on October 5, 1994. The image is centered at 36.9 degrees north latitude, 76.4 degrees west longitude. North is towards the upper right. The area shown is 37 kilometers by 29 kilometers (23 miles by 18 miles).

Colors are assigned to different frequencies and polarizations of the radar as follows: red is L-band horizontally transmitted, horizontally received; green is L-band horizontally transmitted, vertically received; blue is C-band horizontally transmitted, vertically received. SIR-C/X-SAR, a joint mission of the German, Italian and United States space agencies, is part of NASA's ongoing Mission to Planet Earth program.

Asteroid Mathilde Reveals Her Dark Past

More than 100 years after her discovery, asteroid 253 Mathilde has been sharing her secrets with scientists in the Science Data Center at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. A 25-minute flyby of the asteroid by NASA's Near Earth Asteroid Rendezvous (NEAR) spacecraft on June 27, 1997, has resulted in spectacular images of a dark, crater-battered little world assumed to date from the beginning of the solar system.

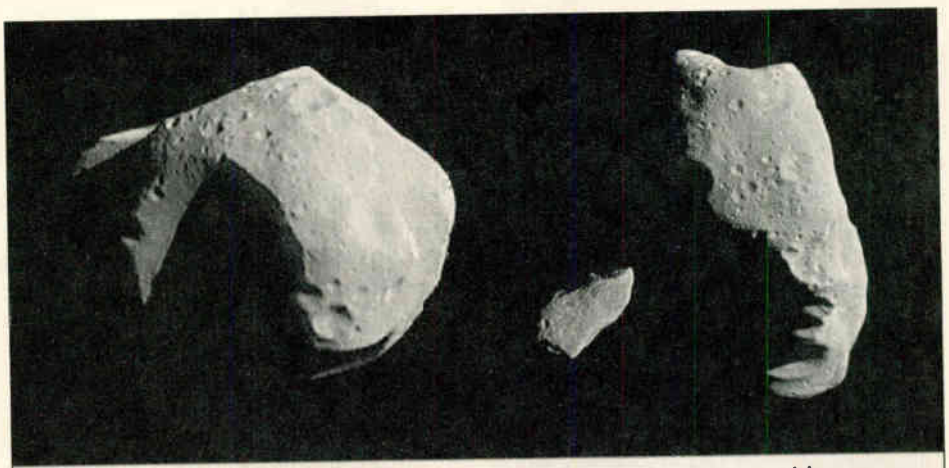
The Mathilde flyby is the closest encounter with an asteroid to date and the first with a C-type asteroid. The asteroid's mean diameter was found to be 33 miles (52 kilometers), which is somewhat smaller than researchers originally estimated. A study of the asteroid's albedo (brightness or reflective power) shows that it reflects three percent of the Sun's light, making it twice as dark as a chunk of charcoal. Such a dark surface is believed to consist of carbon-rich material that has not been altered by planet-building processes, which melt and mix up the solar system's original building block materials.

The Mathilde flyby met all its initial goals: getting a clear image of the sunlit side of the asteroid, getting color images that will give clues to the types of rock that make up the asteroid, and getting images that will help researchers determine if Mathilde has any moons.

"The Mathilde encounter was one of the most successful flybys of all time," said Dr. Robert W. Farquhar, of the Applied Physics Laboratory, NEAR Mission Director. "We got images that were far better than we thought possible, especially since the spacecraft was not designed for a fast flyby."

Only the multispectral imager, one of six instruments on the spacecraft, was used during the flyby in order to conserve power provided by solar-powered panels. The spacecraft was approximately 186 million miles from the Sun, too far to provide power for NEAR's other instruments.

"Even though this was a very difficult undertaking," said Dr. Stamatios M. Krimigis, head of the APL Space Department that managed the program for NASA, "the NEAR Operations Team was so well prepared there was little doubt that it would succeed; not only that, but this was the smallest operations team of any planetary encounter, proving that the Discovery Program paradigm of 'smaller, faster, cheaper' is alive and well."



Mathilde Gaspra Ida

Although Mathilde proved to be rounder than asteroids such as Gaspra and Ida, Dr. Joseph Veverka of Cornell University, Ithaca, NY, who leads the mission's imaging science team, said, "Mathilde turned out to be more irregularly shaped than most of us expected. The degree to which the asteroid has been battered by collisions is astounding. At first glance there are more huge craters than there is asteroid."

The imager found at least five craters larger than 12 miles (20 kilometers) in diameter just on the lighted side of the asteroid. Scientists wonder how the asteroid can remain intact after having been hit by this many projectiles, each probably at least a mile wide.

The craters reveal evidence of the asteroid's makeup. "We knew that C-asteroids are black, but we did not expect their surfaces to be as uniformly black and colorless as Mathilde's surface turned out to be," Veverka said. "This global blandness is an important clue telling us that asteroids such as Mathilde are made of the same dark, black rock throughout because none of the craters, which are punched deep into the asteroid, show evidence of any other kind of rock." Such uniformity seems to confirm that C-type asteroids are in fact pristine samples of the primitive building blocks of the larger planets.

Dr. Donald K. Yeomans of the Jet Propulsion Laboratory, Pasadena, CA, who heads the radio science team formed to determine Mathilde's mass said, "Mathilde is an asteroid with a very tortured past." By determining the bulk density of the asteroid, researchers will have a clue to how it was formed. A composite of objects would have a lower density than a solid chunk from a larger asteroid. Data analysis to determine density will not be complete until later this year, but Dr. Yeomans said, "Preliminary results suggest that Mathilde is much less dense than we had thought."

One mystery that remains is Mathilde's extraordinarily slow (17.4 days) rotation rate. Its collision history could be a factor, but more research needs to be done to determine what role such collisions have played. The search for Mathilde moons continues; none has yet been discovered.

The NEAR spacecraft was launched Feb. 17, 1996, from Cape Canaveral Air Station in Florida. The mission was profiled in *Satellite Times* in the July/August 1996 issue.

ST

ST RADIO ASTRONOMY

Jeff Lichtman

Disappearing RA Spectrum

As I write this issue's column I have just returned from the 16th annual Society of Amateur Radio Astronomers (SARA) conference, held at the National Radio Astronomy Observatory (NRAO) at Greenbank, West Virginia. As usual, SARA members gave their reports on their own research and construction projects, including Jim Carroll's 408 MHz receiver and Radio Astronomy Supplies' ULTRA CYBER computer controlled, 1.4 GHz radio telescope. Members also had time on two of the professional radio telescopes.

One of the lectures at this year's gathering hits very close to home. In fact it was similar to a conversation that *ST* editor Larry Van Horn and I recently had on radio astronomy allocations. SARA member, Charles Osborne, WD4MBK, presented *I'll Take Another Slice of Spectrum Please.* It was an eye opener. In this issue of *RA* we will present Charles" paper.

I'll Take Another Slice of Spectrum Please

As amateur radio astronomers, we are largely spectators in the grand game of spectrum auctions and assignment sharing that has been picking up pace for the past five years. I thought it would be a good time to look at what's ahead and how to best use our spectral resources.

What does a "protected" assignment really mean?

Most of us have heard about protected frequencies, where radio astronomy can proceed without the competition of transmitters from other services. Key frequency allocations for us are (from *Radio Astronomy* by Kraus, A-24): 73-74.6, 150-153, 322-328.6, 406.1-410, 608-614, 1330-1427, 1610.6-1613.8, 1660.5-1670, 2690-2700 MHz, plus many others.

The problems begin when we look at assignments adjacent to ours, broadcast TV in particular. The 73-74 MHz assignment is a sliver between channels 4 and 5. The 608-614 MHz is actually TV channel 37 with no stations in the United States assigned to it. However, channel 36 and 38 can host TV stations with almost one megawatt of EIRP.

Almost every assignment started out in the clear with adjacent services scattered widely across the country. As demand for spectrum grew, the FCC tried to place more benign services next to us, but gradually had no choice but to just "pack them in." Thus began the search for "middle of nowhere" sites like West Virginia, New Mexico, Puerto Rico, Peru, and Hawaii. The game was to minimize interference by going for areas with minimal population.

Satellites

Then came satellites. Now, there is nowhere that is protected from the occasional satellite passing overhead. Satellites are one massive area of communications growth. We could have 1000+ new non-geostationary satellites within 10 years. Worse, many are on lower frequencies like 1.5-2.5 GHz, transmitting enough power to be heard on cell phone size receivers.

PCS and Wireless

With a projected three billion transmitters, this service plans to put digital messaging and telephone service within arm's reach of everyone. If you thought the proliferation of cell towers was getting ridiculous, you ain't seen nothin yet. Wireless in general is local area computer networks without wires. All the above means: 902-928 MHz, 1.8, 3.4, and 5.7 GHz will be getting lots of newer, dirtier, cheap, low power, unlicensed transmitters—just one step above garage door opener transmitters for quality and spectral purity.

Cable TV

Yes, I know, in theory this is a contained system and should not radiate. Don't you believe it. Every unknowing TV watcher who leaves the rabbit ears plugged in parallel with the cable on their TV is a transmit site. Every unused piece of RG-6 coax has RF hitting that open circuited end and folding backwards onto the outside of the shield. Presto, another antenna.

Older sets with 300-ohm twinlead inside from rear panel to tuner radiates a little. Cable signals are not small: usually 1-10 microwatts per channel. I've talked 2300 miles on 50 MHz with less power. Plus, remember that we have several million miles of distributed antenna and the summed energy of 60+ channels. Even a 100-dB down, RF leakage can take maximum effect when there are hundreds of leaks radiating.

My cable system here in Berkeley Lake, Georgia, is so tight I can transmit 100,000 watts EIRP on 432 MHz and not see it on a TV, in the same room, on cable channel 59. However my 432 receiver sure noticed a few dB rise in the noise when cable channel 59 was added to the system.

Radar, Airborne, Land Mobile, Cellular, etc, etc.

Add to the picture FAA traffic radars at 1290-1330 MHz, transponder transmitters on planes, plus land mobile, and cellular. Well, you get the picture. Congestion. So what can we do?

Fighting Back with Filters

Filtering is our first and best tool to exclude nearby transmit energy. How do we know when we have enough filtering, or how do we know when we have interference at all?

Point at cold sky. Usually by looking straight up or at the particularly boring region between Galactic Center and

Orion we can get hours of fairly steady system nothingness. Try shortening your integration time constant to less than a second. If you see unpredictable jumps in the output dc signal, replace the antenna connection to the LNA with a 50 ohm load. If they don't go away, your observing system is noisy with popcorn noise or even mechanical or loose connections in cables. Find the loose connector and tighten it. If you suspect an amplifier, substitute a different gain stage one by one, till you see the behavior change to smooth steady noise from cold sky, or a 50-ohm load.

Once you can truly convince yourself that the noise bursts are from outside your equipment, swing the antenna around and see if the bursts get stronger on some heading near ground level (thermal noise, of course, will increase but remain largely constant.) If it's line noise, find out locally where the problem is coming from and correct it before proceeding. If all indices point to a local cellular or land mobile tower, it's time to start filtering or to change bands.

A scanner is a handy tool. Use it to search out the exact frequency that pops in as the noise increases. Then figure how far in frequency it is to the nearest spectrum that you wish to use for your radio astronomy. The more dB per MHz that you must reject, the tougher the task.

With our 1 megawatt (+9dBm), UHF TV example on channel 36, and radio astronomy on channel 37 (at maybe -170 dBm), it would probably take a filter machined from silver and coated in superconductor to get near the desired rejection.

But, once we take into account the range to the transmitter, we get 100 dB loss in two miles. It increases 6 dB in loss each time the range doubles. So at 16 miles = -118 dB. On an omni antenna we would see about -28 dBm. That is close to what I see on a spectrum analyzer here in the Atlanta area, when connected to just a single stage mast mounted preamp. That's a strong signal to most preamps. TV channels 14, 17, 30, 36, 46, and 69 are my tormentors.

Bottom line, do the best you can. Retest/redesign better filters until the TV or cellular noise no longer shows up in the system's detected dc output. Use high intercept point GaAsFET preamps instead of Mosfets or bipolars. Cascade filters by placing filtering throughout your system. Jim Carroll's 408 MHz receiver (available through SARA as a club project) is a superb example of careful application of these rules.

Often people go for bandpass filters when notch filters are more appropriate. If you have one TV channel that you know will be a problem, notch it out. Sometimes it takes both BPF and notches. Typically it's best to limit the bandpass to 40 MHz or less, since few of the under 3 GHz clear spots are any wider than that.

Lowpass filters are good for excluding interference and noise power pickup in the IF stages and are simply good all-around insurance. Limit noise spectrum to just what you plan to use. For instance, a 50-90 MHz IF would be a good candidate for a 100 MHz lowpass filter at the input or output. All it takes is simple filters since the end effect is cumulative.

Self Generated Intermodulation Distortion

That's a mouthful. What it means is that adjacent transmitters can cause your receiver to overload or your preamp to overload. As soon as any stage begins to saturate and go nonlinear the radio astronomy signal is affected, even though it's much weaker or on a different frequency. One way to test for this is by injecting a test signal, at two different levels, into your LNA/front end via a coupler (as if it was a noise calibration signal). If the IF power does not vary exactly the same number of dB as the input signal, something is using up all the power output capability of the front end, before the radio astronomy signal even gets there. Compressing stages are nonlinear and corrupt the accuracy of the desired radio astronomy signals.

A much more damaging aspect of this is that even if the radio astronomy noise was supposed to be flat and constant, any transient signal on a nearby frequency might modulate the noise in a time base creating a false radio astronomy signature.

Again, to test for interference, point the antenna at something with a constant noise signature, either cold sky, or foliage. If you still see unpredictable changes, suspect interference. Try changing frequency a few MHz. You may move the interference culprit far enough outside the receiver filter passband to alleviate the problem.

Sometimes noise is part of the culprit. Filtering at IF can exclude hundreds of MHz of noise bandwidth that is outside the desired range for the system. If not done, this noise energy adds up to be a strong pre-bias in using up system capability. Narrow the filter bandwidth where possible to exclude this unwanted noise. A side benefit is that any spurs that show up in that "outside the passband" region also get excluded.

IF Shielding from RFI/EMI

Interference can get into unshielded inductors or IF amplifier circuitry. Again, 70 MHz is right in the middle of the low VHF TV channels, and it's also a common IF for amateur equipment, due to availability of prebuilt surplus stages and filters. So box it up tight.

Even DC lines need to be filtered in bolt style 1000-pf typical feedthrough capacitors. This will stop TV and radio signals from riding in on the little antennas created by the interchassis wiring. And if using a 30 MHz IF, remember this is close to ...well, you know, "good buddy."

In general, try to think of shielding as if you were making the box containing the circuit water-tight.

Filter the DC lines with larger value capacitors as well, to absorb any transient noise bursts from motors, automobile engines, or lawn mowers.

Computers, while an integral part of our observing systems today, also can be the sources of much noise. Use good quality shielded cases with all the screws in. Ferrite split cores can be clamped onto keyboard and monitor cables to help absorb noise before it is radiated. Power line filters can also help isolate the computer's switching power supply from the rest of the wiring in your house.

Take a look at frequency allocation charts and avoid "downlink" frequencies. An analogy ... it's easier to look in the same direction as a searchlight than to look into it head on.

A few satellite downlink frequencies are:

400.1 MHz	Mobile Satellite Service
1227 and 1575 MHz	GPS
1452-1559 MHz	Broadcast Satellite Service (most crowded 1525-1559 MHz)
1610-1626.5 MHz	Mobile Satellite Service
1675-1710 MHz	Mobile Satellite Service
1930-2010 MHz	Mobile Satellite Service
2120-2270 MHz	Mobile Satellite Service
2483.5-2690 MHz	Broadcast Satellite Service
3625-4200 MHz	C-band TVRO
6975-7075 MHz	Mobile Satellite Service
7250-7750 MHz	Military satellites
10700-12750 MHz	Fixed Satellite Service, Ku-band Fized/DBS TV

Links that might eventually get prolific enough to be a nuisance:

406-406.1 MHz	Earth-Space, Mobile Satellite Service
608-614 MHz	Earth-Space, Mobile Satellite Service
1850-1990 MHz	Personal Communications Service

Possible clear areas:

2270-2300 MHz	NASA deep space probe S-band downlinks
8400-8450 MHz	NASA deep space probe X-band downlinks

Phase Noise and Harmonics

Sometimes interference is directly on our "protected" frequency assignments. Then there is very little one can do to exclude it.

Phase Noise. This is the noise that surrounds all oscillators. On good ones, like crystal oscillators, it can be 140-dB down, 100-Hz away from the LO itself. Most are nowhere near this good. A TV transmitter for instance starts at +90-dBm. Even if it is -140-dBc (which it won't be), that's still 90-dB above the noise floor in a good receiver. At 50 miles away, I once battled the S9 intermodulation or phase noise from a channel 13 TV transmitter, as we contested on 220.1 MHz. No amount of filtering helped. So we knew it was directly covering our frequency and impossible to remove.

Harmonics. Again, TV and FM transmitters are a likely culprit. The fourth harmonic of FM stations would fall near our 408 MHz frequencies. And even if the station is clean, somewhere a diode across a receiver input, or a rusty fence joint, will multiply it with a second or third strong station. Preamps will do the same mixing internally when overloaded.

Bandwidth and Averaging

One factor helping our battle against spurious signals is that they are usually narrowband. If we compare the energy of a narrow spur with the noise energy in a 100 MHz wide sample of spectrum, often the noise looks lower, but is actually higher on a power meter (which is all our detectors really are).

A second factor is our long integration times. If a spur is only there one percent of the time, then on a long integration it drops 20-dB in relation to the noise. But if you're doing SETI spectral line work, it becomes a false "hit."

The antenna pattern is also useful as a filter. It allows us to reject and deemphasize interfering signals. So be sure your dish has a good clean pattern to exclude interference behind or beside the dish. Feeds that are too wide "overilluminate" the dish. This picks up much more ground thermal noise or interference. Slight under-illumination is better. You lose a little gain but make up for it with quieter, less jumpy, real signal.

A passive shield, made by placing the dish near a hedge or trees, can be used to absorb interference. A more drastic alternative is to use window screens to reflect interference away from the dish surface or feed. Place these just outside the pattern for the dish at oblique angles.

Another trick is to place the dish inside a gully or low spot surrounded by trees. That's one advantage of radio astronomy—we're usually looking up.

Isolation

The best way to ensure against future interference problems is to isolate yourself from the world, buy lots of property so you control the proximity of future transmitters, and stay away from satellite downlink frequency ranges (i.e., become a recluse). Ha! Otherwise: filter, shield, ground, adjust frequency, and hope for the best.

Summary

In summary, our tools are:

- Ability to move to new clearer frequencies
- Filter to exclude spurs and interference
- Filter to limit the bandwidth typically to 40 MHz or less
- Don't overload the front end/ LNA/ or IF amps
- Use the antenna pattern to help reject interference
- Shield with trees, shrubs, earth berms, or screens

Good luck. Hopefully I've given you a few new tools for the next time interference torments your observing, and corrupts your data. Fight back!

Charles may be reached at: Charles Osborne, WD4MBK, 881 Lakeshore Dr., Berkeley Lake, GA 30096 or **cosborne@pipeline.com**

I would like to thank Charles for this timely paper. This information will help all.

If you would like to give or have one of our SARA members give a talk to your school or radio club, please contact me for information. SARA is a 501c3 educational charter. We will be happy to supply information to all interested people. You can reach me at **jmlras@juno.com**

For those of you looking for books and radio astronomy equipment, check out Radio Astronomy Supplies' new URL. It may be found at: **http://www.nitehawk.com/rasmit/ras.html**

ST

Astronomers Make First Images With Space Radio Telescope

Marking an important new milestone in radio astronomy history, scientists at the National Radio Astronomy Observatory (NRAO) in Socorro, New Mexico, have made the first images using a radio telescope antenna in space. The images, more than a million times more detailed than those produced by the human eye, used the new Japanese HALCA satellite, working in conjunction with the National Science Foundation's (NSF) Very Long Baseline Array (VLBA) and Very Large Array (VLA) ground-based radio telescopes. The landmark images are the result of a long-term NRAO effort supported by the National Aeronautics and Space Administration (NASA).

"This success means that our ability to make detailed radio images of objects in the universe is no longer limited by the size of the Earth," said NRAO Director Paul Vanden Bout. "Astronomy's vision has just become much sharper."

HALCA, launched on Feb. 11, 1997, by Japan's Institute of Space and Astronautical Science (ISAS), is the first satellite designed for radio astronomy imaging.

On May 22, 1997, HALCA observed a distant active galaxy called PKS 1519-273, while the VLBA and VLA also observed it. Data from the satellite was received by a tracking station at the NRAO facility in Green Bank, West Virginia. Tape-recorded data from the satellite and from the radio telescopes on the ground were sent to NRAO's Array Operations Center (AOC) in Socorro, NM.

The quasar 1156+295 as seen using the HALCA satellite in conjunction with the VLBA. This image shows the quasar's core, bottom right, and a jet of subatomic particles emerging from the core toward the top left.

In Socorro, astronomers and computer scientists used a special-purpose computer to digitally combine the signals from the satellite and the ground telescopes to make them all work together as a single, giant radio telescope.

This dedicated machine, the VLBA Correlator, built as part of the VLBA instrument, was modified over the past four years to allow it to incorporate data from the satellite. Correlation of the observational data was completed successfully on June 12, 1997, after the exact timing of the satellite recording was established. Further computer processing produced an image of PKS 1519-273—the first image ever produced using a radio telescope in space.

The first image showed no structure in the object, even at the extremely fine level of detail achievable with HALCA; it is what astronomers call a "point source." This object also appears as a point source in all-ground-based observations.

Active galaxy (PKS 1519-273) as imaged with HALCA satellite, along with the VLBA and VLA ground-based radio telescopes. This is the first VLBI image ever made using an orbiting radio-astronomy satellite.

A second observing target, the quasar 1156+295, observed on June 5, 1997, made a more interesting picture. Seen by ground-based radio observatories, this object, at a distance of 6.5 billion light years, has been known to show an elongation in its structure to the northeast of the core.

However, seen with the space-ground system, it is clearly shown to have both a core and a complex "jet" emerging from the core. Such jets, consisting of subatomic particles moving near the speed of light, are seen in many quasars and active galaxies throughout the universe. In fact, 1156+295 is one of a class of objects recently found by NASA's Compton Gamma-Ray Observatory to exhibit powerful gamma-ray emission; such objects are among the most compact and energetic known in the universe.

Radio astronomers, like astronomers using visible light, usually seek to make images of the objects at which they aim their telescopes. Because radio waves are much longer than light waves, a radio telescope must be much larger than an optical instrument in order to see the same amount of detail. Greater ability to see detail, called resolving power, has been a quest of radio astronomers for more than half a century.

To see a level of detail equal to that revealed by optical telescopes would require a radio-telescope dish miles across. In the 1950s, British and Australian scientists developed a technique that used smaller, widely-separated antennas, and combined their signals to produce resolving power equal to that of a single dish as large as the distance between the smaller dishes.

This technique, called interferometry, is used by the VLA, with 27 antennas and a maximum separation of 20 miles, and the VLBA, with 10 antennas and a maximum separation of 5,000 miles. Systems such as the VLBA, in which the antennas are so widely separated that data must be individually tape-recorded at each site and combined after the observation, are called Very Long Baseline Interferometry (VLBI) systems. VLBI was developed by American and Canadian astronomers and was first successfully demonstrated in 1967.

The VLBA, working with radio telescopes in Europe, represents the largest radio telescope that can be accommodated on the surface of the Earth. With an orbit that carries it more than 13,000 miles above the Earth, HALCA, working with the ground-based telescopes, extends the "sharp vision" of radio astronomy farther than ever before. Using HALCA, radio astronomers expect to routinely produce images with more than 100 times the detail seen by the Hubble Space Telescope.

Launched from Japan's Kagoshima Space Center, HALCA orbits the Earth every six hours, ranging from 350 to 13,200 miles high. The 1,830-pound satellite has a dish antenna 26 feet in diameter. The antenna, folded like an umbrella for the launch, was unfolded under radio control from the ground on Feb. 26, 1997. The antenna was pointed toward PKS 1519-273 after a three-month checkout of the spacecraft's electronics, computers, and guidance systems.

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ST SPACE GLOSSARY

The following are some terms used in the satellite business and are described in layman's terms.

ALTITUDE (ALT): The distance between a satellite and the point on the earth directly below it, same as height.

AQUISITION OF SIGNAL (AoS): The time at which a particular ground station begins to receive radio signals from a satellite.

APOGEE: The point in a satellite's orbit farthest from the Earth's center.

ARGUMENT OF PERIGEE: This value is the number of degrees from the ascending node the perigee point occurs. The perigee point is the point where the satellite is the closest to the earth (assuming an orbit which is elliptical to some degree). This number may be entered as a real value between 0.0 and 360.0.

ASCENDING NODE: Point at which the satellite crosses the equatorial plane from the southern hemisphere to the northern hemisphere. (See RIGHT ASCENSION OF THE ASCENDING NODE.)

AZIMUTH (AZ): The angle measured in the plane of the horizon from true North clockwise to the vertical plane through the satellite.

CATALOG NUMBER: A 5-digit number assigned to a cataloged orbiting object. This number may be found in the NASA Satellite Situation Report and on the NASA Two Line Element (TLE) sets.

COORDINATED UNIVERSAL TIME (UTC): Also known as Greenwich Mean Time (GMT). Local time at zero degrees longitude at the Greenwich Observatory, England. Uses 24 hour clock, ie. 3:00 pm is 1500 hrs.

CULMINATION: The point at which a satellite reaches its highest position or elevation in the sky relative to an observer. (Known as the Closest Point of Approach)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups pooling resources for space exploration and development.

FOOTPRINT: A set of signal-level contours, drawn on a map or globe, showing the performance of a high-gain satellite antenna. Usually applied to geostationary satellites.

GROUND STATION: A radio station, on or near the surface of the earth, designed to receive signals from, or transmit signals to, a spacecraft.

INCLINATION (INC): The angle between the orbit plane and the Earth's equatorial plane, measured counter-clockwise. 0 (zero) degrees inclination would describe a satellite orbiting in the same direction as the Earth's rotation directly above the equator (orbit plane = equatorial plane). 90 degrees inclination would have the satellite orbiting directly over both poles of the earth (orbit plane displaced 90 degrees from the equatorial plane). An inclination of 180 degrees would have the satellite orbiting again directly over the equator, but in the opposite direction of the Earth's rotation. Inclination is given as a real number of degrees between 0.0 and 180.0 degrees.

INTERNATIONAL DESIGNATOR: An internationally agreed upon naming convention for satellites. Contains the last two digits of the launch year, the launch number of the year and the piece of the launch, ie. A-indicates payload, B-the rocket booster, or second payload, etc.

LATITUDE (LAT): Also called the geodetic latitude. the angle between the perpendicular to the Earth's surface (plane of the horizon) at a location and the equatorial plane of the earth.

LONGITUDE (LONG): The angular distance from the Greenwich (zero degree) meridian, along the equator. This can is measured either east or west to the 180th meridian (180 degrees) or 0 to 360 degrees west. For example, Ohio includes 85 degrees west longitude, while India includes 85 degrees east longitude. But 85 degrees east longitude could also be measured as 275 degrees west longitude.

LOSS OF SIGNAL (LoS): The time at which a particular ground station loses radio signals from a satellite.

MEAN ANOMALY (MA): This number represents the angular distance from the perigee point (closest point) to the satellite's mean position. This is measured in degrees along the orbital plane in the direction of motion. This number is entered like the argument of perigee, as a value between 0.0 and 360.0.

MEAN MOTION (MM): This is the number of complete revolutions the satellite makes in one day. This number may be entered as a value greater than 0.0 and less than 20.0. (See DECAY)

NASA: U.S. National Aeronautics and Space Administration.

ORBITAL ELEMENTS: Also called Classical Elements, Satellite Elements, Element Set, etc. Includes the catalog Number; epoch year, day, and fraction of day; period decay rate; argument of perigee, inclination, eccentricity; right ascension of ascending node; mean anomaly; mean motion; revolution number at epoch; and element set number. This data is contained in the TWO LINE ORBITAL ELEMENTS provided by NASA.

OSCAR: Orbiting Satellite Carrying Amateur Radio.

PERIOD DECAY RATE: Also known as Decay. This is the tendency of a satellite to lose orbital velocity due to the influence of atmospheric drag and gravitational forces. A decaying object eventually impacts with the surface of the Earth or burns up in the atmosphere. This parameter directly affects the satellite's MEAN MOTION. This is measured in various ways. The NASA Two Line Orbital Elements use revolutions per day.

PERIGEE: The point in the satellite's orbit where it is closest to the surface of the earth.

POSIGRADE ORBIT: Satellite motion which is in the same direction as the rotation of the Earth.

RETROGRADE ORBIT: Satellite motion which is opposite in direction to the rotation of the Earth.

REVOLUTION NUMBER: This represents the number of revolutions the satellite has completed at the epoch time and date. This number is entered as an integer value between 1 and 99999.

REVOLUTION NUMBER AT EPOCH: The number of revolutions or ascending node passages that a satellite has completed at the time (epoch) of the element set since it was launched. The orbit number from launch to the first ascending node is designated zero, thereafter the number increases by one at each ascending node.

RIGHT ASCENSION OF THE ASCENDING NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period, inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

By Bob Grove, Publisher
E-mail address: st@grove.net

Closing the Skies

Last evening I saw *Contact*, posthumously dedicated to its primary author, Carl Sagan; I enjoyed its imaginative, intelligent story line. For those unfamiliar with the plot, it revolves around the Search for Extraterrestrial Intelligence (SETI) program, and graphically illustrates the constant struggle between pure science and pragmatic politics.

The scene in which the principal scientist (portrayed by Jodie Foster) was being bullied in a Congressional hearing room was particularly hard hitting to me since it looked exactly like, and sounded exactly like, my own confrontational experience with our illustrious legislators last February.

Today I was handed a news article which proved with stunning clarity that the struggle is real. By this fall, the beleagured radio astronomers at the Green Bank, West Virginia, observatory will be conducting an experiment to see how much interference—in and out of band—is going to be generated by just one Motorola Iridium low-earth-orbitting (LEO) satellite operating at full power.

In all due fairness to Motorola, their engineers have been conducting bieweekly meetings with radio astronomers at the National Radio Astronomy Observatory (NRAO) at Green Bank, West Virginia; Arecibo in Puerto Rico; and Jodrell Bank in Great Britain, to resolve interference concerns. Under a Memorandum of Understanding, Motorola engineers must agree that out-of-band spurious emissions from their 1621.35-1626.5 MHz Iridium transmitters will not interfere with radio astronomy's exclusive 1610.6-1613.8 MHz hydroxyl radical (OH) monitoring telescopes. To be in compliance, Iridium's spurs must be below -238 dBW/M /Hz threshhold.

But that's just the beginning of the worries. The full Iridium constellation will have 66 simultaneously transmitting satellites, and they won't be alone. The spectrum 1420-1427 MHz, heretofore guarded by the Federal Communications Commission (FCC) for deep space radio astronomy, has been petitioned for reassignment by a satellite paging consortium. Under growing pressure for fiscal survival, can the FCC dare to resist the Congressional influence of heavily-funded commercial interests?

Scientists keep a stiff upper lip, reassuring one another that even if Earth's skies become electromagnetically polluted, they could still build a radio astronomy facility on the far side of the moon, shielded from terrestrial interference.

But they overlook the fact that even minimally-funded, earth-bound radio astronomy efforts are fed hand to mouth, always facing budget cuts. The multi-billion-dollar telecommunications lobby has far more clout in Washington than a group of stoic, fair minded, well meaning idealists. How would they fare in a head-to-head debate over funding a far-fetched lunar laboratory with no tangible rewards?

It is entirely conceivable that, in our lifetime, when we could be on the threshhold of finally hearing that elusive signal calling to us from somewhere out there—at once reassuring and unsettling, letting us know that we aren't alone in the universe—that voice will be silenced forever by man's overriding lust for profit, filling the skies with impenetrable noise, and blocking forever our first contact. ST

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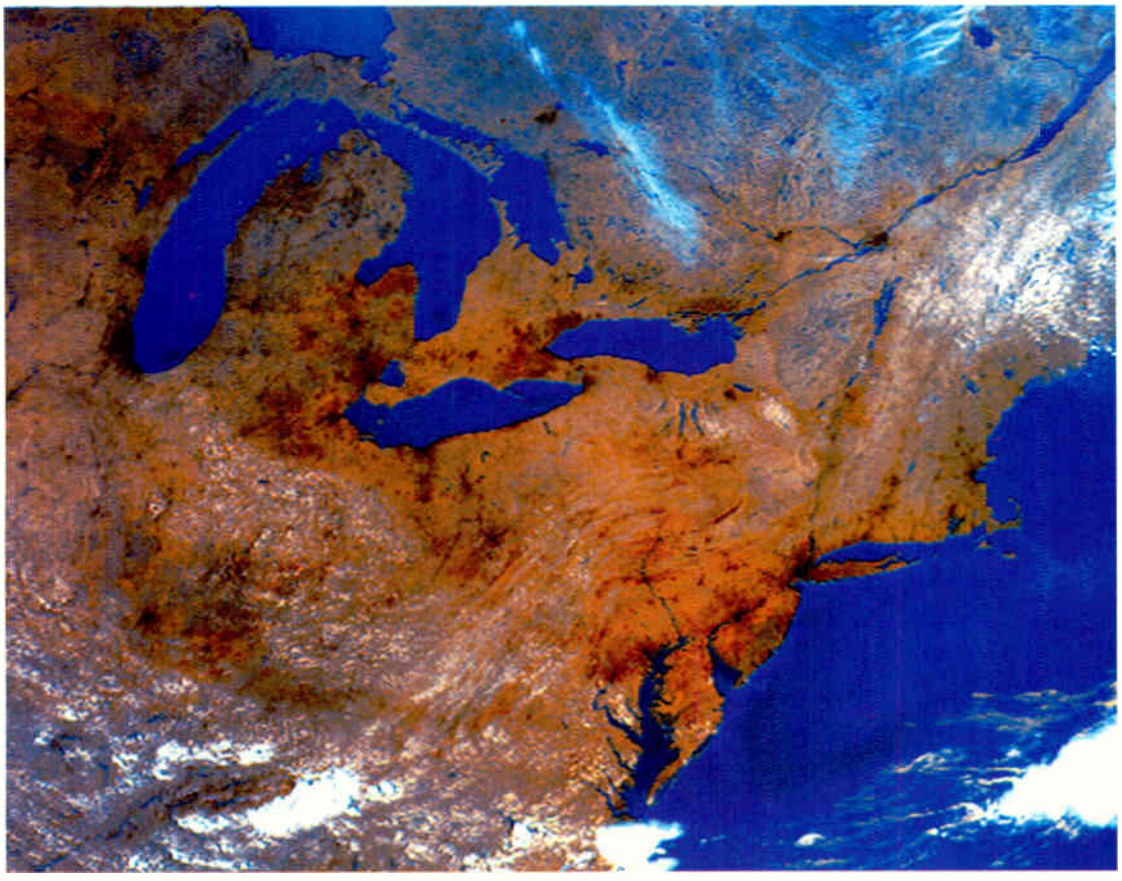

◄ Section of a multi-spectral, false-colorized NOAA APT image of the Northeast US. This image was created directly from a raw image file using the MFCOLOR software from Weather Dynamics.

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