SPECIAL REPORTS: *Life on Mars? Water on Europa?*

Satellite Times®

A publication of Grove Enterprises

$3.50 US
$5.75 CAN

Volume 3, Number 1
September/October 1996

Russian Eyes *scan* American Skies

Satellite Times

Cover Story

***Cover Photo:** This dramatic color photo of San Francisco was acquired by the Spaceborne Imaging Radar-C/X-band Synthetic Aperture (SIR-C/X-SAR) experiment when it flew aboard the space shuttle Endeavour on October 3, 1994. Military photo recon imagery offers much higher pixel resolutions to military planners in the United States and Russia. Learn more about the Russian military photo recon program in this issue's cover story.*

Inside the Russian Photo Recon Program

By Phillip S. Clarke

Photographic reconnaissance was one of the first dedicated military missions to be performed by satellites. Satellite Times commissioned Russian space program expert and staff member Phillip Clarke to look into this military program and see were it stands today. Story on page 10.

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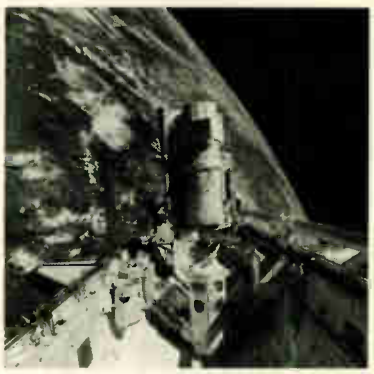
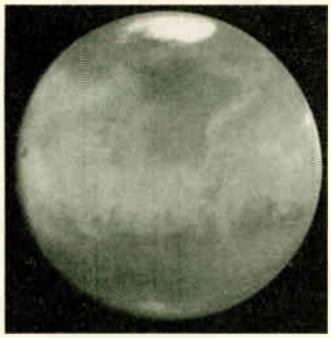




Life on Mars and Water on a Jupiter Moon?

No, we are not talking about little green men on Mars, or a lake on Europa. But scientists from NASA and other research facilities have made some significant scientific announcements during the month of August. See stories on pages 88 and 91.

DEPARTMENTS

ST

SATELLITE TIMES (ISSN: 1077-2278) is published bi-monthly by Grove Enterprises, Inc., Brasstown, North Carolina, USA.

Address: P.O. Box 98, 7540 Highway 64 West, Brasstown, NC 28902-0098
Telephone: (704) 837-9200
Fax: (704) 837-2216 (24 hours)
Web site: http://www.grove.net/hmpgst.html
Internet Address: steditor@grove.net

Subscription Rates: $19.95 in US and $28.50 in Canada. Call for air mail rates for other countries.

Postmaster:
Send address changes to *Satellite Times*, P.O. Box 98, Brasstown, NC 28902-0098.

Correspondence to columnists should be mailed c/o Satellite Times. Any request for a personal reply should be accompanied by an SASE.

World Radio History

DOWNLINK

By Larry Van Horn
Managing Editor

Was There Really Life on Mars?

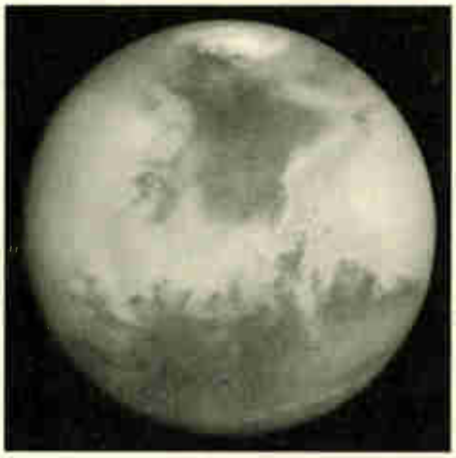
As we go to press with this, the first issue in volume 3 of *Satellite Times*, some truly remarkable scientific discoveries have been announced by NASA.

First, a two-year investigation by a NASA research team found organic molecules, mineral features characteristic of biological activity, and possible microscopic fossils inside an ancient Martian rock that fell to Earth as a meteorite nearly 13,000 years ago. The largest, possible fossils are less than 1/100th the diameter of a human hair in size, while most are ten times smaller.

This revelation has created an air of excitement in the press and general public that hasn't been felt since the days of *Apollo*. While researchers admit that the results are not conclusive, the announcement does open the door toward possibly answering the basic question that mankind has asked for centuries, "Are We Alone?"

A week later, on the heels of the of that exciting discovery, NASA announced that the *Galileo* space probe has found evidence of "warm ice" or even liquid water on one of Jupiter's moons—Europa. *Galileo* has also made some other remarkable new findings about the Jovian planet's Great Red Spot, and giant sulfur volcanoes on the moon Io. You can read more about all of these exciting new discoveries and view the pictures from other worlds in this issue of *Satellite Times*.

Some exciting astronomy was also accomplished on board the space shuttle during the Astro 1 and 2 missions. Philip Chien takes an in-depth look at those missions in his story *Exploring the Astro Shuttle Mission*. This year's Grove Expo keynote speaker, Ron Parise, participated in both these missions and you will learn more about him and the shuttle amateur radio experiments (SAREX) he conducted while in orbit.



Speaking of SAREX, Phil Chien also provides *ST* readers with a "how to" article in this issue on listening to, or making, your first satellite contact via amateur radio. You don't even need to learn Morse code to communicate via these ham satellites.

Finally in this issue's cover story, Phillip Clarke, *ST* staffer and world renowned space analyst Phillip Clarke ventures into the unknown and looks into the secret world of the Russian space program. Phillip provides a historical prospective of the Russian photo reconnaissance program and with an analyses of where that program is today now that the Cold War is over.

Letters

Several readers have commented in recent correspondence to me that they do not understand some of the material presented in *ST*. I would like to remind all our readers that *ST* is only a tool, and that space is limits what can be covered in each issue. But you have at your disposal a rich reserve in the wonderful staff of writers that pen each issue of *ST*. These gentlemen are the experts, and are only a letter away from helping you understand the exciting medium of space communications.

Over the past two years, I have seen only a handful of letters to our staff asking questions. If there is something you don't understand, drop that columnist some snail mail or e-mail. If there is something you want to see presented in a column—write. Without your valuable input, we can not sharpen our skills in presenting the world of space communications to our readers. As an old Navy chief once told me many years ago, "The only dumb question is the one you didn't ask."

Another topic that has been brought up from time to time is the lack of clear voice signals. The world of technology is changing rapidly, and voice communications in this day and age just isn't fast or reliable enough for certain applications. A lot of satellite communications is via digital signals. This is an area that needs to be explored, and we stand ready to provide the insight into these aspects of communications through articles in *ST* when they become available.

Finally, a lot of exciting communication opportunities are just over the horizon. Soon, companies such as WorldSpace will offer direct-to-home audio broadcast from international shortwave broadcasters from around the world. Amateur operators next year will launch into space the most sophisticated amateur satellite ever. New satellite technologies will soon make it possible for you to communicate with anyone, from anywhere on Earth.

Satellite communications is more than just listening to a few signals from space on your scanner. It is something in which each reader can participate if they take the time to learn about the opportunities that are available. This is the purpose of *ST*, and I hope that each of you joins in as we begin our third year of the adventure and excitement that is space communications and *Satellite Times*.

Satellite Monitor

By Wayne Mishler, KG5BI
E-mail: mishler@aol.com

An Alternative to Satellites?

Steel platforms the size of football stadiums floating at 100,000 feet on helium blimps above weather and airliners but below ionospheric RF barriers could replace satellites as telecommunications relay terminals by the turn of the century.

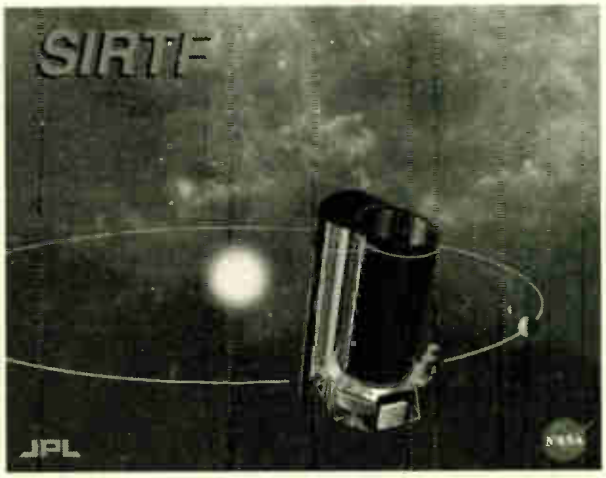
They don't have to be shot into space aboard rockets, with the expense and risk that entails. "They just float up. It's not high-tech," says a consultant for the northern Virginia company developing the concept.

The company, aptly named Sky Station, plans to build and launch 250 of the platforms. When floated into position, the platforms are to be monitored by Earth stations. New ion-propulsion motors fueled by solar power would keep the platforms in geostationary registration with the Earth. They would require no conventional fuel, and would have a life span of about ten years. For service or replacement they could simply be floated back to Earth. Even if the platforms began an unexpected descent, they would fall slowly because of the blimps and could be caught and guided to Earth by helicopters, says Sky Station.

An artist's conception of the prototype resembles a shallow box the size of a football field, with eight square solar panels on its top and two helium-filled blimps attached to its opposite ends. The platform itself would weigh about two tons. Two large horizontal antennas resembling log-periodic beams protrude forward on long booms from the box, which bristles with dish antennas.

It would cost far less to build, launch, and power these floating platforms than putting satellites in orbit, Sky Station says. The company expects to raise $1.8 billion to get the project off the ground. The idea is already drawing attention from financial backers.

Sky Station intends to provide wireless access to the Internet for a dime a minute, says company president Alexander Haig, son of retired General Alexander Haig, Jr., former presidential chief of staff and secretary of state. The idea steals some thunder from a company called Teledesic which plans to launch 1,000 small satellites to relay Internet traffic worldwide without telephone lines. The Teledesic project was proposed by Microsoft and McCaw Cellular Communications.



Sky Station is seeking government approval of their project. They will need an FCC license for use of commercial frequencies. And they'll need FAA approval to launch the platforms. "The FAA is trying to figure out [where we fit in]," Haig says. "We won't operate in commercial air space, but we will pass through it when launching the platforms."

The basic idea of sky stations is not new, but until now the concept has been impractical using conventional propulsion systems. The discovery of ion-propulsion using electricity from solar panels makes Sky Station's platforms feasible. Japanese officials are considering a version of these floating platforms for their own emergency communications system.

The big question is: How will Sky Station affect the satellite industry? The answer depends on a number of variables. There are obstacles to overcome. But it is interesting to note that the floating platforms, if put into operation, will offer several communications services currently being proposed by telecommunications giants like Motorola and others.

NASA Space Observatory Planned for 2001

NASA is moving ahead with plans to launch a cryogenically-cooled space observatory that will conduct infrared astronomy during its 30-month mission beginning at the turn of the century. It will be called SIRTF (for space infrared telescope facility), and will be developed jointly by Lockheed Martin Missiles & Space and Ball Aerospace.

The spaceborne observatory will consist of a 0.85-meter diameter infrared telescope and the latest in large-format infrared detector array technology. SIRTF will carry three essential instruments on board: an infrared array camera, an infrared spectrograph, and a multi-band imaging photometer. The equipment must be cryogenically cooled because heat interferes with infrared observations.

Infrared observations reveal cool states of matter. Objects in space ranging in size from pebbles to planets emit varying degrees of heat. Most of the energy radiated by spatial bodies lies in the infrared range, and so infrared observations are important in studying objects in space.

Cosmic dust blocks our view of many astronomical environments. But this dust is mostly invisible to infrared sensors. Heat emitted by our atmosphere blinds infrared equipment on the Earth's surface—a problem that would not affect an observatory in space. All of this gives rise to the need for SIRTF.

Many atoms and ions have special features in the infrared range which can open the secrets of stellar atmospheres and interstellar gas. This enables scientists using infrared sensors in space to explore regions that cannot be seen with optical instruments.

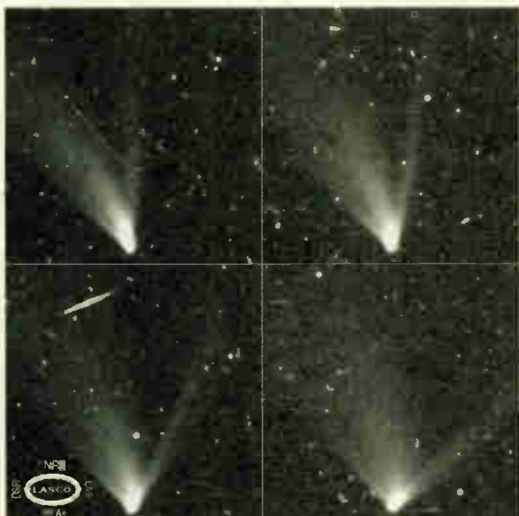
SIRTF will be launched on a Delta 7920 rocket, and will go into orbit behind the Earth (relative to the Sun). This orbit will permit a better view without the Earth getting in the way. Plus, its equipment won't be seeing heat from the Earth, and this promises a more stable thermal environment, allowing the exterior of the sensitive telescope to reach the necessary low temperature for optimum viewing.

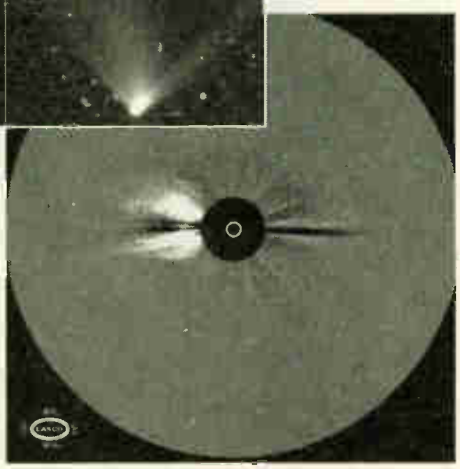
A transmitting antenna one meter in diameter fixed to the bottom of the spacecraft will be used twice daily to transmit 12 hours of stored science data to stations of NASA's Deep Space Network.

A Near Collision with the Sun

The Comet Hyakutake is safe for another 10,000 years. At least, safe from a smash-up in our solar system. It will be that long before its return and its next opportunity to collide with our Sun, which nearly happened earlier this year. And we've just learned that scientists have the near miss on film, so to speak.

The European Space Agency, NASA, and the U.S. Navy Research Laboratory (NRL) have released a set of unprecedented images resembling a time-lapse movie of the comet's solar encounter. The pictures are from observations made during April 29 to May 6. They were recorded via the NRL-built Large Angle Spectrometric Chronograph (LASCO) instrument on the Solar and Heliospheric Observatory (Soho) spacecraft.





"Comet Hyakutake could have passed through the solar system many times before," says Dr. Guenter Brueckner of the NRL. "How many times remains a mystery." During its last visit 10,000 years ago no one took pictures. At least no one that we know of. But this time there was a photographer.

From studying the images, researchers hope to learn much about the comet and about the solar corona through which it passed.

As the comet entered the outer atmosphere of the Sun, it reacted with the solar environment and was actually used as a scientific probe of the solar corona. LASCO images show the head of the comet and the three separate tails behaving differently as Hyakutake swung around the Sun. The tails are made of dust, chunks of ice, and atomic particles. Each material reacted differently with the Sun's environment. The particles were repelled from the comet by the solar wind and seemingly lined up with the magnetic field of the solar corona.

Speeding through the corona at 37 miles per second, and influenced by strong forces in the Sun's atmosphere, the comet's tails changed their directions several times over the seven-day observation period.

In observing the comet, LASCO also revealed coronal mass ejections (CMEs) in which hot gases were expelled and accelerated by the corona's magnetic field. Although the comet was out of LASCO's view when it crossed the equatorial plane of the Sun, presumably there was a strong reaction between the CME gases and the atomic particles in the comet's tails.

On its return trip, Hyakutake's orbit will carry it back into the so-called "Oort Cloud," a vast collection of billions of comets located 1.4 light years away from the solar system. These comets presumably are the remnants of the cloud from which the solar system formed billions of years ago.

Scientists Edge Closer to Forecasting Solar Storms—But Hold the Antacid

Imagine a bubble of super-heated plasma as large as 17,000 Earths bursting through the Sun's outer atmosphere and spewing charged particles into space at a million miles per hour.

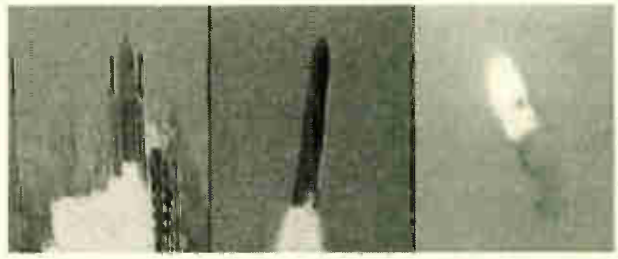
No, it's not a dream inspired by a late-night dose of Aunt Maud's chili. It's called a coronal mass ejection (CME) and scientists watching these solar events through the Lockheed Martin Soft X-ray Telescope (SXT) have discovered that they leave behind huge voids with a message. That is, the voids leave hints of CME to come. A measured decrease in soft x-ray emissions can give up to 70 hours of advance warning of solar storms that could damage power grids on Earth and satellites in space.

"The hot ionized gas that streams across space during a solar storm interacts with the Earth's magnetic field. The resulting electromagnetic force induces a charge which generates electric current in power grids on the Earth's surface. If there's an increase in power from the induced current, and if the generators aren't ready to accept the increase, a surge can result causing serious damage (to the power system)," explains scientist Dr. James Lemen of Lockheed Martin.

"CMEs have been observed by white-light coronagraphs for a long time," Lemen says. "Now we're seeing them in SXT images right down into the lower corona (outer solar atmosphere)."

SXT images are an improvement over white-light coronagraphs unable to show important details of CMEs, which occur every two or three days. Scientists believe that CMEs are related to the solar cycle. One of the largest such events occurred on April 14, 1994.

The SXT itself is mounted aboard the Japanese Yohkoh satellite. Scientists view images from the SXT at ground stations on Earth. The satellite was launched on August 30, 1991, from Kagoshima Space Center in Japan, in a cooperative mission involving Great Britain and the United States, in addition to Japan. The SXT itself is a joint experiment of the National Astronomical Observatory of Japan and NASA of the U.S.



The ill-fated Ariane 501 launch.

Amateur Radio Satellite Will Ride Next Ariane Flight

Despite the loss earlier this year of the European Space Agency's (ESA) Ariane 501 rocket and payload, the Radio Amateur Satellite Corporation (AMSAT) has announced that its sophisticated new phase 3-D international satellite will be aboard Ariane 502 which could blast off as early as mid-February 1997. In making the announcement, several AMSAT officials expressed confidence in ESA to correct the causes of the Ariane 501 launch failure.

"We have been given strong assurances that ESA has taken the recommendations of the AR 501 Inquiry Board to heart and are now 'rolling up their shirtsleeves' to correct [deficiencies] in time for the Ariane 502 launch next year," says Dr. Karl Meinzer, DJ4ZC.

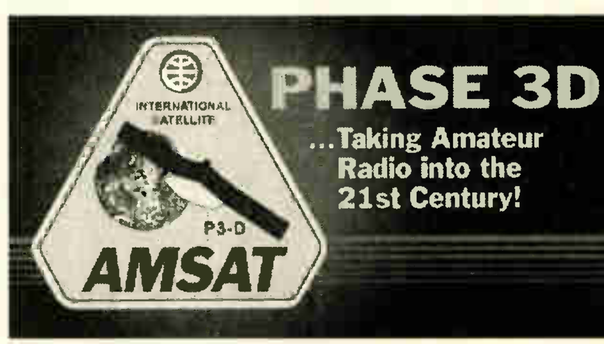
Keith Baker, KB1SF, added his support. "The fact that the investigators were able to use recovered debris and laboratory analysis to duplicate the exact sequence of events that caused the AR 501 failure gives renewed confidence for the prospects of a successful launch of Ariane 502."

The new phase 3-D satellite, now under construction by AMSAT, will be the largest, most complex and most expensive amateur radio satellite ever built.

When in orbit, the satellite will be used by amateur radio operators for hobby and stand-by emergency communications and research in keeping with AMSAT's mission. Since its founding more than 25 years ago, AMSAT, a non-profit organization, has used volunteer labor and donated resources to design, build, and launch over two dozen amateur radio communications satellites into orbit, with assistance from government and commercial agencies.

U.S. Solar Panels Supplying Power for Russia's Mir

The first American-made component ever installed on the Russian space station *Mir*—a six-kilowatt solar array—is working well, thank you, effectively supplying life-giving electrical power for *Mir*'s



space operations.

The U.S. array, one of two delivered to *Mir* by the space shuttle *Atlantis*, was built by California-based Lockheed Martin Missiles & Space. The other array was designed by Russian engineers. Both arrays were ferried to *Mir* simultaneously aboard *Atlantis*. They were folded and mounted to the shuttle's docking module, where they remained until the rendezvous with Mir. During a spacewalk, the cosmonauts transferred the arrays to *Mir*'s Kvant module.

The array has a solar panel surface area of 42 square meters. It contains 84 individual panels. Each has 80 silicon solar cells and eight bypass diodes. Each cell produces about one watt of power when exposed to the Sun. Lockheed produced the panels using the same type of materials and processes that are going into construction of the international space station solar panels.

Mexico and U.S. to Swap Satellite Television Broadcasts

Mexico and the U.S. have signed a two-way agreement which states, in essence, that Mexican satellites will be allowed to provide service to the U.S. to "enhance rather than distort competition in the U.S. market," and that the U.S. will be allowed to provide satellite television service to Mexico.

The agreement does not directly cover direct-to-home service, but it does provide a framework for adding this provision later, according to the FCC.

Hughes Communications reportedly is preparing to provide direct-to-home service for viewers in Mexico and other Latin American countries via its satellite. PanAmSat may compete by offering similar services from its satellite.

American viewers may ultimately receive Mexican programming as a result of the agreement.

The agreement is expected to give consumers in both countries more choices of programming, and open new marketing opportunities for broadcasters.

There's a Mexican law that requires treaties of reciprocity in such cases. So there may have to be some political maneuvering before the U.S. can deliver television programming to Mexican customers. But an FCC official says it might be possible to work around this law.

"I expect to see an exchange of services similar to the North American Free Trade Agreement," says an industry spokesman.

And Finally ... Alas, Antarctica will never be the same

Its inhabitants are mostly scientists who discover things. Recently they discovered that the Intelsat satellite they've been using for communications also carries live television.

"There goes the neighborhood," one resident said.

Now in the Antaractic summertime from October to February when temperatures soar to near freezing and the population of the U.S. McMurdo Station blossoms to as many as 1500, nobody goes for walks anymore. There are two bars, and nobody's there, either.

"Gee, the clubs are awfully dead. And [the people] are not out hiking. I guess they're all watching live TV," the resident said. "We're making cultural changes."

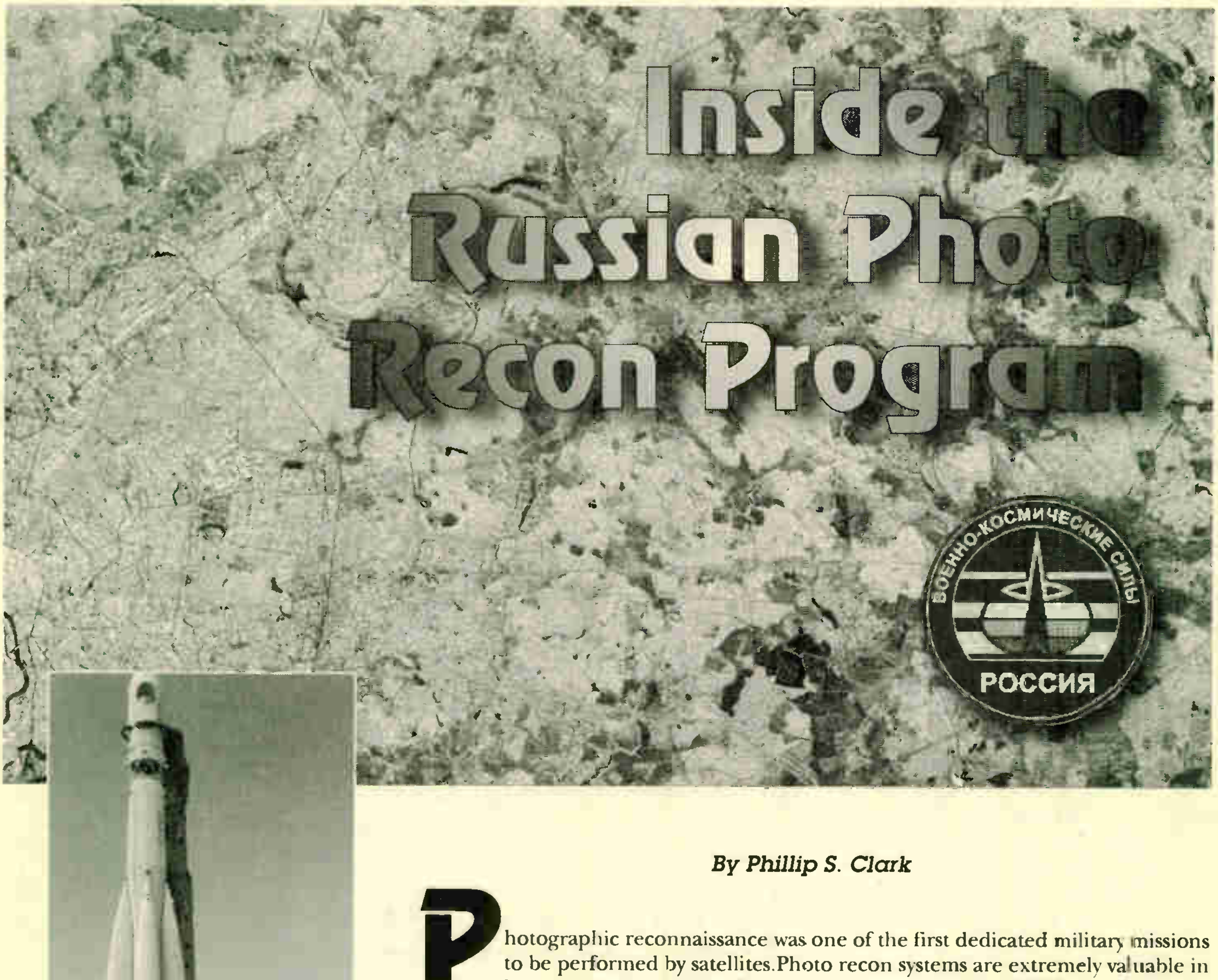
The "cultural change" is that they've become hooked on Armed Forces Radio and Television Service television. AFRTS is produced for reception by low-power television stations at U. S. military bases. Its programming includes live broadcasts of news and sporting events from the major networks. Did someone just say "live sports"?

"It helps to eliminate the sense of being cut off from the world, things being so remote [here]," said one member of the National Science Foundation. "[It makes] you feel more connected to the outside world."

These days when winter falls on McMurdo Station and the populace shrinks to 233 it doesn't matter that outside it's 50 below zero Celsius. Inside on the tube there's hot basketball. Uh oh, the doorbell. It's UPS with another delivery of popcorn. ST

Sources: Broadcasting & Cable, European Space Agency, Lockheed Martin Missiles & Space, Radio Amateur Satellite Corporation, Washington Times courtesy of Art Audley N3KUQ

Inside the Russian Photo Recon Program



Vostok booster on the launch pad. The satellite photo above is actually a U.S. space shuttle photo of "Star City," where the Russian cosmonauts train.

By Phillip S. Clark

Photographic reconnaissance was one of the first dedicated military missions to be performed by satellites.Photo recon systems are extremely valuable in both war and peace. But times have changed and the Cold War is over. Russia is no longer the military threat it once was. *Satellite Times* commissioned Russian space program expert and staff member Phillip Clark to look into the history of the Russian photo recon satellite program and where it stands today-Larry Van Horn, Managing Editor.

Introduction

Previous articles written by this writer[1] have provided a review of the Russian [2] photoreconnaissance satellite program, and this article will provide a further overview through to the middle of 1996.

Table 1 notes the series of photoreconnaissance satellites which have flown. We have now some details of the internal designators for the satellites discussed in Russian literature and these have been included in Table 1.

By the end of 1995, out of the 2,496 launches which reached Earth orbit there were 766 orbital missions which were dedicated to the photoreconnaissance satellite program —31% of the total. In addition, newly-available information indicates that since

1961 there have been 34 launches (the last being June 1996) of photoreconnaissance satellites which failed to reach orbit.

Photoreconnaissance satellites have been used to fly recoverable remote sensing missions, while the same basic satellite design has been used for biological satellites and materials processing payloads.

The First and Second Generation Satellites

The original photoreconnaissance satellites (which the Russians called "Zenit," although this name did not become public knowledge until the early 1990s), was little more than a modified Vostok. In fact, it is still unclear from available historical information whether Vostok is simply a manned variant of what was originally the Zenit photoreconnaissance satellite, or whether the photoreconnaissance satellite was simply an unmanned version of Vostok.

Most probably, in 1958 Sergei Korolyov already knew that he wanted to design a manned spacecraft and he anticipated the need for a photoreconnaissance satellite. Since the same basic rocket—the Vostok in its 8K72, 8K72K and 8K92 versions—would be used to launch both classes of satellites, it would make sense to design a single standard spacecraft which could be modified for a series of different missions, manned and unmanned.

Both the Vostok and the Zenit photoreconnaissance satellites had two sections. At launch, the top was the 2.3-meters diameter spherical reentry module, and beneath this was a double-cone service module which also carried the retrorocket.

The first generation photoreconnaissance satellites started to fly with the aborted launch on December 11, 1961, out of Tyuratam. Orbit was finally achieved on April 26, 1962, when Cosmos 4 entered a 65 degree inclination orbit after launch from Tyuratam. It remained in orbit for three days before being returned to Earth. At the end of the year the fifth of these satellites to reach orbit—Cosmos 12—became the first of the "eight day wonders," satellites which would remain in orbit for eight days before being recovered.

The second generation of satellites retained the same basic design as the earlier payloads, but they were flown using the Voskhod rocket (an early variant of the Soyuz launch vehicle) indicating a mass of 5.5-6 tons compared with 4.5-5 tons for the first generation satellites. Based upon telemetry the second generation satellites could be divided into close look and area survey satellites: both of these groups were retired in 1970.

By this time an improved version of the second generation satellite was introduced—classified as the extended duration sub-group. The extended duration satellites had two characteristics which separated them from the earlier series: first, they would remain in orbit typically for twelve days before recovery, and secondly, they would usually discard a drum-shaped module in orbit at the time of recovery. The discarded module appears to have been a package which could carry supplementary scientific and other non-recoverable experiments, although on later biological and materials-processing satellites it reappeared as a supplementary battery pack.

TABLE 1: Types of FSU Photoreconnaissance Satellites

Series/Subgroup	Russian Designator	First Orbital Flight	Final Orbital Flight
First Generation	Zenit-2	Apr 26, 1962 (4)	Apr 4, 1967 (153)
Second Generation			
Low Resolution	Zenit-2?	Jun 8, 1966 (120)	May 12, 1970 (344)
High Resolution	Zenit-4?	Nov 16, 1963 (22)	Aug 7, 1970 (355)
Extended Duration	Zenit-2M?	Mar 21, 1968 (208)	May 5, 1978 (1004)
Third Generation			
Morse Code	Zenit-4M	Oct 31, 1968 (251)	Jul 25, 1974 (667)
Two-Tone			
Low Resolution	Zenit-4MK?	Dec 27, 1971 (470)	Aug 3, 1982 (1398)
High Resolution	Zenit-4MKM?	Dec 23, 1969 (317)	Jun 7, 1994 (2281)
Medium Resolution	Zenit-4MKM?	Oct 23, 1976 (867)	Jun 19, 1990 (2083)
Fourth Generation			
Close Look	Yantar	Sep 5, 1975 (758)	Still Operating
Topographic/ Mapping	Cometa	Feb 18, 1981 (1246)	Still Operating
Fifth Generation		Dec 28, 1982 (1426)	Still Operating
Sixth Generation		Jul 18, 1989 (2031)	Still Operating?
Seventh Generation	Kuban	Aug 26, 1994 (2290)	Still Operating

Notes: The Russian designators for the satellite classes are shown without question marks when they are known from Russian literature: other designators are known from Russian literature, although the specific mission class is uncertain and these have been assigned in what appears to be a logical manner but are followed by question marks above. The number of launches which have reached orbit for each program is shown in the right-hand column: failures to reach orbit are not included in any of these figures. It is unclear whether the third generation close look and sixth generation programs are still continuing.

Third Generation Satellites

The third generation satellites had a slightly heavier mass compared with the second generation satellites, but retained the same basic design. An innovation—a logical one—with the third generation series was the addition of a conical in-orbit maneuvering system atop the spherical reentry module. The Resurs-F remote sensing satellites, which used the basic photoreconnaissance satellite but with multispectral camera rather than a high resolution photoreconnaissance system, had a mass of 6.3 tons.

In 1989 this writer learned from a representative of KB Foton—responsible for developing the unmanned Vostok variants—that the re-entry modules for Resurs-F satellites were typically re-used for three missions. Later it was acknowledged that Foton satellite re-entry modules were also re-used. Since it would be naive to assume that the re-use of re-entry modules appeared only with Resurs-F and Foton satellites, we can assume that all third generation satellites had the reentry modules re-used—and perhaps so did some second or even first generation satellites. At the time of some manned Vostok and Voskhod flights it was commented (although no one took the suggestion seriously at the time) that the re-entry module was in such good shape it could be re-used.

Whenever the re-use of Zenit re-entry modules started, it is now clear that Columbia was not the world's first re-usable spacecraft!

It would also be reasonable to assume the camera systems for these (and earlier) satellites were being re-used: since they should not be damaged during re-entry and recovery, the cameras could make regular trips to orbit and back—far more than the typical three trips of the re-entry modules.

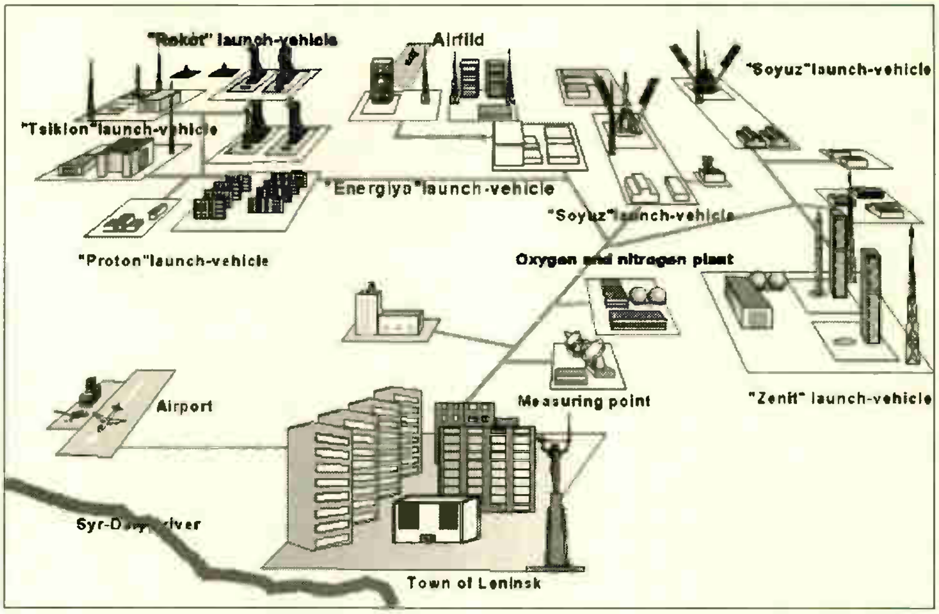
The first flights to be classified as third generation missions transmitted telemetry as Morse code PCM on 19.15 MHz: the satellites started to fly in 1968 and were phased out in 1974—a relatively short operational period compared with the other third generation satellites. Most Morse code satellites maneuvered in orbit, indicating that they were a new generation rather than part of the second generation payloads. At the end of the mission the forward manoeuvering engine was discarded in orbit just before the descent module was de-orbited.

The other classes of third generation missions operated over a longer period. First to appear were the close look satellites which transmitted as two-tone FSK on 19.989 MHz: as such, the satellites became known as "Two-Tone" missions. The Two-Tone close look satellites started to fly in 1969, supplanted the Morse code satellites in 1974, and continued to operate until 1994. Like the Morse code satellites, these would regularly maneuver in orbit.

Like other third generation satellites, the typical flight time was 14-15 days, although in the late 1980s the flight times were extended so that a few satellites remained in orbit for up to 24 days.

An extension not seen within the photoreconnaissance program was the addition of a pair of solar panels to the manoeuvring engine on the Resurs-F2 missions, allowing missions to last thirty days. Since the Resurs-F1 satellites some of which flew three weeks missions—relied on chemical batteries and not solar panels, it can be assumed photoreconnaissance missions utilized chemical batteries as well.

A second group of Two-Tone satellites, transmitting PDM on 19.994 MHz, is classified as an area survey system, because they did not perform any maneuvers in orbit. At the end of each mission another sizable object appeared in orbit: since the satellites did not maneuver, it would be reasonable to assume that this was a cylindrical package similar to the science modules and battery packs flown on the second generation extended duration missions.



Russian Space Forces diagram of the Baikonur Cosmodrome.

The third group of Two-Tone satellites can be considered to be a sub-group of the close look payloads. Called area survey, high apogee (ASHP) missions by western observers, these satellites transmitted PDM telemetry on 19.989 MHz, but were characterised by their maneuvers within a day of launch to a high 360-415 km orbit.

Unlike the other groups of satellites which would fly at virtually any operational orbital inclination, the ASHP missions were primarily restricted to flights at 70-73 degrees inclination. Launches from Tyuratam used inclinations of 70.0 degrees (ten flights) and 70.4 degrees (19 flights), while Plesetsk launches at 72.9 degrees accounted for 55 launches: missions at 62.8 degrees and 82.3-82.6 degrees together account for less than flights.

The standard lifetime for the ASHP mission was 14 days with very little variation. The use of a standard operating orbit meant that the satellite groundtrack would repeat after 201 circuits in the high orbit for an inclination of 70-73 degrees, with approximate recovery conditions being repeated two days earlier and two days later.

In 1984 two experiments were flown to test the storage of photoreconnaissance satellites in orbit: Cosmos 1587 launched August 6, and Cosmos 1613 launched November 29. In each case the satellite was launched into a 72.9 degrees, 195 km perigee, 355-370 km apogee orbit, but there was no early maneuver to the high orbit. While the normal profile called for ascent to the high orbit on the eight or ninth orbit of the Earth, these satellites remained in the parking orbit for 11.5 days, not manoeuvring until orbit 183-184. After this, the satellites were in a standard 355-415 km orbit for thirteen days as usual and were then returned to Earth.

The two-week missions of the Two-Tone satellites were the standard ones for approximately two decades, even though more capable, longer-lived satellites of a new generation had been introduced in the 1970s. The area survey satellites were phased out in the early 1982, a time which coincided with the introduction of the topographic and mapping satellites: ASHP satellites were phased out in 1990, and the final close look mission took place in 1994.

As for third generation derivatives, the Resurs-F1 remote sending satellites were phased out in 1993 and the final Resurs-F2 mission was flown in 1995. Foton and Bion missions are continuing for the time being, but the status of the infrequently-flown Resurs-T missions is unknown.

Closeup view of the Vostok spacecraft.

Fourth Generation Satellites

The first flight of a fourth generation Yantar satellite in September 1975— the name change being indicative of a new class of satellite—introduced a new orbital inclination slot for Plesetsk—67.1 degrees. With the exception of two third generation missions, this slot has been used exclusively for Yantar missions.

The satellite lifetimes have gradually increased over the years, as shown in Table 2. During the time in orbit, the spacecraft return small data capsules, with a large re-entry module returning to Earth at the end of the mission.

Up to the end of 1995 there had been 111 orbital launches in the Yantar close look photoreconnaissance program with the majority of launches coming at two inclinations: Tyuratam has seen 30 launches at 64.9 degrees (but none since 1989), while the Plesetsk slot of 67.1 degrees has accounted for 61 flights. There were just five launches from Tyuratam to 70.4 degrees during 1981-1983. Launches from Plesetsk were at 62.8 degrees during two periods: two launches in 1977-1979 and then 13 launches during 1988-1993 the latter period coinciding with the apparent retirement of these missions from Tyuratam.

Unlike the earlier maneuverable satellites, the Yantar payloads have a standard altitude regime from which they rarely deviate: perigee of 165-180 km and apogee of 340-360 km. The satellites maneuver routinely to maintain orbital altitude and "fine-tune" the orbit for passes over targets.

No telemetry is known to have been picked up in the West from these satellites and at the end of flight no major pieces of debris are left in orbit (although one or two small pieces are often discarded). It would therefore be reasonable to deduce that the in-orbit maneuvering engine is also used for the de-orbit maneuver—a change from the third generation satellite design.

For some time the Russians liked to operate at least one Yantar satellite in orbit all of the time: as one mission ended another satellite would be launched either shortly before the recovery or within a few days. Cutbacks in the Russian launch rate have meant that there are now regular gaps in reconnaissance cover by Yantar satellites.

The lack of major pieces of debris at mission end permits a connection to be drawn with the Cometa topographic and mapping satellites that transmit PCM on 150.3 MHz and 400.8 MHz. All launches of these satellites have been from Tyuratam, using the standard 64.9 degrees inclination and more recently 70.0 degrees and 70.4 degrees.These satellites operate in a more circular orbit, with perigee typically 210-215 km and apogee 260-290 km. The standard lifetime has now grown to 43-45 days from 23 days with the maiden flight.

Since the third generation area survey satellites seemed to concentrate on geodetic work and they were phased out in 1982, it is reasonable to assume that the Cometa satellites have replaced them.

Unlike the Yantar satellites, Cometa payloads fly only once or twice a year. Although flights started in 1981, By the end of 1995 there have only been 17 launches which reached orbit.

In the summer of 1996 the Russians suffered a double embarrassment in the fourth generation satellite program. On May 17 the Soyuz-U launch vehicle carrying a Cometa satellite was launched from Tyuratam on a mission which was to include some US-requested photography over the United States at a resolution of 2 meters (the SPIN-2 program). Some 49 seconds after launch, the payload shroud disintegrated and, after separation of the four strap-on boosters about 70 seconds later, the launch vehicle veered off-course and crashed 310 seconds after launch.

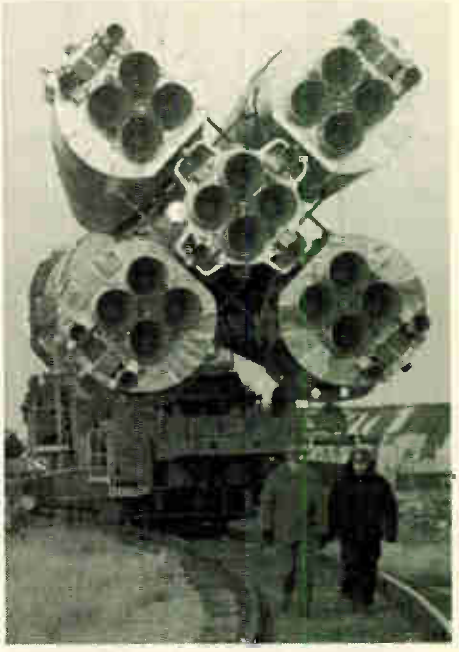
There was a near-repeat of this failure when a satellite (most probably a Yantar) was launched from Plesetsk on June 20 using a Soyuz-U. Following another shroud failure, the vehicle crashed 8 km from the launch site.

The usually-reliable Soyuz-U launch vehicle itself was not at fault. In July it became known that Russian enquiries into the failures had discovered that the two payload shrouds were from the same defective batch. Presumably, launches in the programs which use these shrouds are now on "hold" until repairs take place or replacement shrouds are made available.

TABLE 2: Fourth Generation Yantar Satellite Lifetime Increases

Launch Date	Launch	Inclination Site	Satellite degrees	Lifetime days
Feb 20, 1976	Plesetsk	67.1	Cosmos 805	20
Apr 26, 1977	Plesetsk	67.1	Cosmos 905	30
Apr 29, 1980	Plesetsk	67.1	Cosmos 1177	44
Apr 2, 1982	Tyuratam	70.4	Cosmos 1347	50
Jul 31, 1984	Tyuratam	64.8	Cosmos 1585	59
Jan 19, 1993	Plesetsk	67.1	Cosmos 2231	65
Jul 20, 1994	Plesetsk	67.1	Cosmos 2283	71
Mar 14, 1996	Plesetsk	67.1	Cosmos 2331	89

Note: This is an up-date of Table 5 included in the paper *The Soviet Photoreconnaissance Satellite Programme, 1982-1990.*



Russian Soyuz booster on a rail car headed to the launch pad at Baikonur Cosmodrome.

Fifth Generation Satellites

The fifth generation of photoreconnaissance satellites introduced an innovation to the program: rather than return data in the form of photographic film, as had been the practice with all previous Russian photoreconnaissance satellites, the fifth generation satellites returned images via digital transmission. Since the satellites are not consuming once-only film or having to return data capsules, they fly in orbit for far longer periods than earlier Russian photoreconnaissance satellites had done.

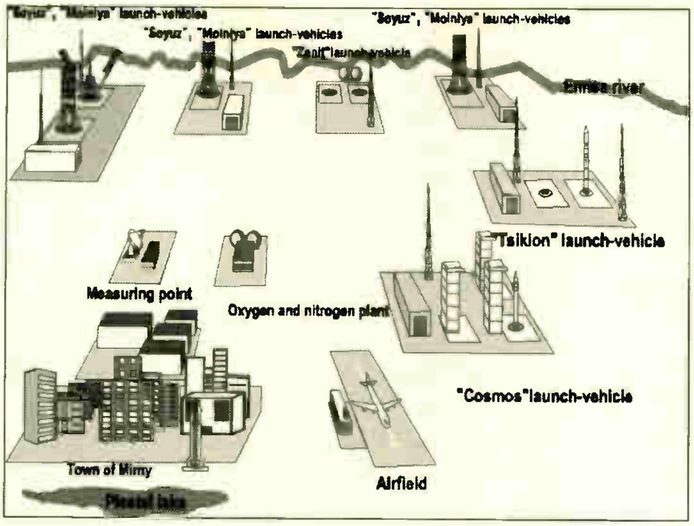
The first test flight of the new class of satellite was Cosmos 1426, which flew at the rarely-used Tyuratam inclination of 50.6 degrees. Operational missions started with the launch of Cosmos 1552 in March 1985, and this satellite immediately set a new duration record for any type of Russian photoreconnaissance satellite—207 days. The operational lifetime of these satellites has increased over the years, to the current record-holder, Cosmos 2267, which flew for 419 days starting in November 1993. Details of the mission durations are given in Table 3.

Twenty fifth-generation satellites have been flown to orbit by the end of 1995; the majority from the Tyuratam slot of 64.9 degrees (17 missions). Cosmos 1426, the test-bed, had flown at 50.6 degrees, and two missions (Cosmos 2267 launched November 1993 and Cosmos 2280 launched April 1994) have flown at 70.4 degrees from Tyuratam. There have been no fifth generation launches from Plesetsk to date.

The fifth generation satellites have a standard orbit from which they rarely deviate: perigee close to 240 km and apogee close to 280 km. Throughout their times in orbit, the satellites allow the orbits to decay and then the orbits are boosted back to the standard altitudes. At the end of their missions the satellites are simply de-orbited with no attempt to recover part of the spacecraft.

In recent years the Russians have tried to have one fifth generation satellite operational at any one time: as one satellite is coming to the end of its life another is readied for launch—sometimes just before the older craft is due to be de-orbited, sometimes a few weeks after being deorbited.

No transmissions from the fifth generation satellites have been picked up in the West and there have been persistent reports that the satellites relay their intelligence using space-space-ground communications as well as directly to the ground when flying over Russia. It is therefore significant that the military Potok geosynchronous orbit data-relay satellite system parallels development of the fifth generation photo recon satellites. The Potok system started tests in May 1982 and reached operational status in the mid-1980s. Table 4 lists the Geizer satellites (launched within the Cosmos program) which have formed the Potok system. Note that from the launch of Cosmos 1738 in April 1986 the Russians have tried to have one Potok satellite operating over 80 degrees East and one over 346.5 degrees East. This would provide communications coverage with the fifth generation satellites throughout most of their orbits around the Earth.



Russian Space Forces diagram of the Plesetsk Cosmodrome.

TABLE 3: Fifth Generation Yantar Satellite Lifetime Increases

Launch Date	Launch Site	Inclination degrees	Satellite	Lifetime days
Dec 28, 1982	Tyuratam	50.6	Cosmos 1426	67
May 14, 1984	Tyuratam	64.9	Cosmos 1552	173
Mar 25, 1985	Tyuratam	64.9	Cosmos 1643	207
Feb 7, 1986	Tyuratam	64.9	Cosmos 1731	238
Dec 26, 1986	Tyuratam	64.9	Cosmos 1810	259
Apr 8, 1992	Tyuratam	64.9	Cosmos 2183	314
Dec 9, 1992	Tyuratam	64.9	Cosmos 2223	372
Nov 5, 1993	Tyuratam	70.4	Cosmos 2267	419

A Possible Sixth Generation Series

A group of five photoreconnaissance satellites launched at a rate of one per year during 1989-1993 has yet to be fully explained. The first of the series was Cosmos 2031 which flew for 44 days after launch on July 18, 1989. The orbital inclination of 50.6 degrees recalled the Cosmos 1426 test flight from 1982-1983, and it was expected that Cosmos 2031 was a similar precursor to a new generation of photoreconnaissance satellites.

At the end of its mission Cosmos 2031 started a new trend. Historically, if a photoreconnaissance satellite failed in orbit the Russian controllers would simply explode a small charge carried on board for such purposes, thus destroying the satellite and ensuring that the photographic film would not fall into non-Soviet hands if the re-entry module had decayed from orbit and somehow survived all of the way to the ground.

After 44 days in orbit (matching the standing Cometa mission duration—coincidence?) Cosmos 2031 was deliberately exploded on an orbital pass which would have allowed a recovery in the standard Kazakhstan—landing site. Western observers concluded that something had gone wrong with the satellite in orbit.

Flights were then switched to an inclination of 64.9 degrees. Unlike the fourth and fifth generation satellites, these new satellites would operate at a variety of altitudes, some indicative of close look operations, others suggesting an area survey mission. Four further flights took place: Cosmos 2101 (launched October 1, 1990)—60 days in orbit; Cosmos 2163 (October 9, 1991)—58 days; Cosmos 2225 (December 22, 1992)—58 days; and Cosmos 2262 (September 7, 1993)—101 days. The first three of these missions flew for what was the standard Yantar satellite duration: was this a coincidence? Of course, Cosmos 2262 flew for far longer than any Yantar mission has ever done, although Cosmos 2331 in 1996 did fly for 89 days.

Like Cosmos 2031, the four satellites at 64.9 degrees ended their missions with an explosion on an orbital pass which could have permitted recovery. A "recovery pass" could be a little misleading—it might simply be the best pass for the ground controllers to issue to "destruct" command. For whatever reason the standard mode of mission termination was clearly the intentional explosion of the satellite in orbit.

The reason for this mode of mission termination is not known. Why not simply de-orbit the satellites and allow them to be destroyed during burn-up in the atmosphere? There were some suggestions that these satellites were precursors to a large satellite to be flown operationally on the Zenit-2 launch vehicle (a designator which has no relation to the Zenit photoreconnaissance satellites). Some speculated that the Soyuz-U or Soyuz-U2 launch vehicle could not lift the planned satellite completely loaded, so part of the recovery system was omitted for the flights.

Since the Zenit-launched reconnaissance satellites had a mass of 10.6 tons, and the Soyuz-U/U2 launch vehicles could lift about 7-7.25 tons, one wonders what was omitted: the complete Vostok-class reentry module? In terms of intelligence gathering this makes no sense, since the re-entry module would carry the camera system as well as the exposed film; without this somewhat essential equipment photoreconnaissance could a satellite do?

There were also suggestions that the planned large satellite had had its mass reduced by simply leaving off the heat shield, but a heat shield that reduces the mass of the satellite by more than three tons?—This is not credible.

There have been no launches of the presumed "sixth generation" satellites since 1993, and therefore their role and current status are open to question.

A Seventh Generation Satellite

Whatever the role of the five "sixth generation" satellites might have been, a truly new class of satellite made its orbital debut on August 26, 1994, when a Zenit-2 launch vehicle placed the 10.6 ton Cosmos 2290 into orbit: this was the first photoreconnaissance mission to be launched by the Zenit-2 launch vehicle, and it allowed a 50% increase in the payload mass placed into orbit.

Photographic details of Cosmos 2290 have not been revealed, but if the satellite looks like the proposed NIKA series of applications satellites it had a cylindrical service module which included the maneuvering and de-orbit propulsion systems, an equipment module which could carry non-recoverable instrumentation, and a forward spherical reentry module which looks to be no more than the standard Vostok reentry vehicle. It carries two large solar panels as well as a large heat-radiator panel which at first looks like a third solar panel.

The promised NIKA series of satellites has been described in Russian commercial literature: NIKA-T is planned as a technology satellite to replace Foton; NIKA-B will be a biomedicine research satellite to replace Bion; NIKA-E is planned as a high-energy particle monitoring satellite; and NIKA-K is a remote sensing satellite, to replace Resurs-F. Models of the Resurs-F replacements were displayed at the Paris Air Show in 1995, and they looked to be the NIKA-T satellites without the spherical re-entry modules. They appeared to be returning images digitally, and thus might well be derived from the fifth generation satellites.

In fact, it is possible that the NIKA satellites (and thus the seventh generation photoreconnaissance satellites) have taken the basic fifth generation satellite, substituted new, non-recoverable reconnaissance equipment where the imaging system is currently located, and transferred the imaging system to the reentry module. In terms of mass, the Vostok descent module is about 2.5 tons. Taking the simplistic approach of adding this to the 7-7.25 ton mass the fifth generation satellites give a mass of about 9.5-9.75 tons. Of course, this does not take into account any new equipment that might be carried, which could easily bring the mass up to 10.6 tons—the mass of Cosmos 2290.

After launch Cosmos 2290 regularly maneuverd in orbit. During the mission, perigee gradually decreased from 210-215 km to 180 km, while apogee was increased: initially it was within the range 350-390 km. In February 1995 it started to be in excess of 400 km, and the final in-orbit maneuver resulted in a 182-577 km orbit.

At about the time of the final maneuver on March 28, 1995, four extra objects appeared in orbit. The satellite was finally de-orbited on April 4, 1995, with any debris which survived reentry falling into the Pacific Ocean some 2,720 km northwest of New Zealand. No apparent attempt was made to recover any part of the spacecraft.

The flight of Cosmos 2290 has yet to be repeated, and therefore it is not possible to say what behaviour was anomalous and what was routine.

In Summary

The Russians have now moved to the operation of longer-life satellites, with the original Vostok-derivatives which flew for 2-3 weeks being retired after three decades of service.

Budget cut-backs have meant that launch vehicles and satellites are not available for maintaining a Yantar satellite in orbit at all times. The recent extensions to Yantar lifetimes is possibly an attempt to overcome the cut-back in the launch rates.

Fifth generation satellites are launched at a rate of one, possibly two, a year, thus ensuring that there is always one of these payloads operating in orbit.

The status of the sixth generation satellites is unclear (is the series really dead? —has it evolved somehow into the larger seventh generation?), but the flight of the seventh generation Cosmos 2290 points the way ahead. Like the fifth generation satellites, the seventh generation payloads soon should be operating in orbit with typical lifetimes in excess of a year, but with the camera system and film being recovered at the end of the mission. It is possible that the seventh generation satellites might also incorporate a film return capability with small capsules which have not been shown on the NIKA drawings published by the Russians.

Whatever happens, the Russian photoreconnaissance program is sure to remain an interesting part of the Russian space program for western observers to monitor. ST

References

1. The following are earlier articles by Phillip Clark dealing with the FSU photoreconnaissance satellite program:

Aspects of the Soviet Photoreconnaissance Satellite Programme, Journal of the British Interplanetary Society, vol 36 (1983), pp 169-184.

Soviet Spacecraft Recoveries, Journal of the British Interplanetary Society, vol 36 (1983), pp 186-191.

The Soviet Photoreconnaissance Satellite Programme, Jane's Soviet Intelligence Review, February 1990, pp 84-90.

The Soviet Photoreconnaissance Satellite Programme, 1982-1990, Journal of the British Interplanetary Society, vol 44 (1991), pp 537-552.

Russia's Latest Spy Satellite, Jane's Intelligence Review, February 1996, pp 71-74.

The Flight of Cosmos 2290 (1994-053A), Journal of the British Interplanetary Society, vol 47 (1996), pp 259-266.

Recoverable Satellites Flown at 81.3-82.6 Degrees Orbital Inclinations, Journal of the British Interplanetary Society (to be published: paper presented June 1st 1996).

2. Since all decision-making concerning the photoreconnaissance satellite programs were taken in Russia during the days of the Soviet Union, describing the program as "Russian" is justified, even though other Soviet republics did have associations with the program.

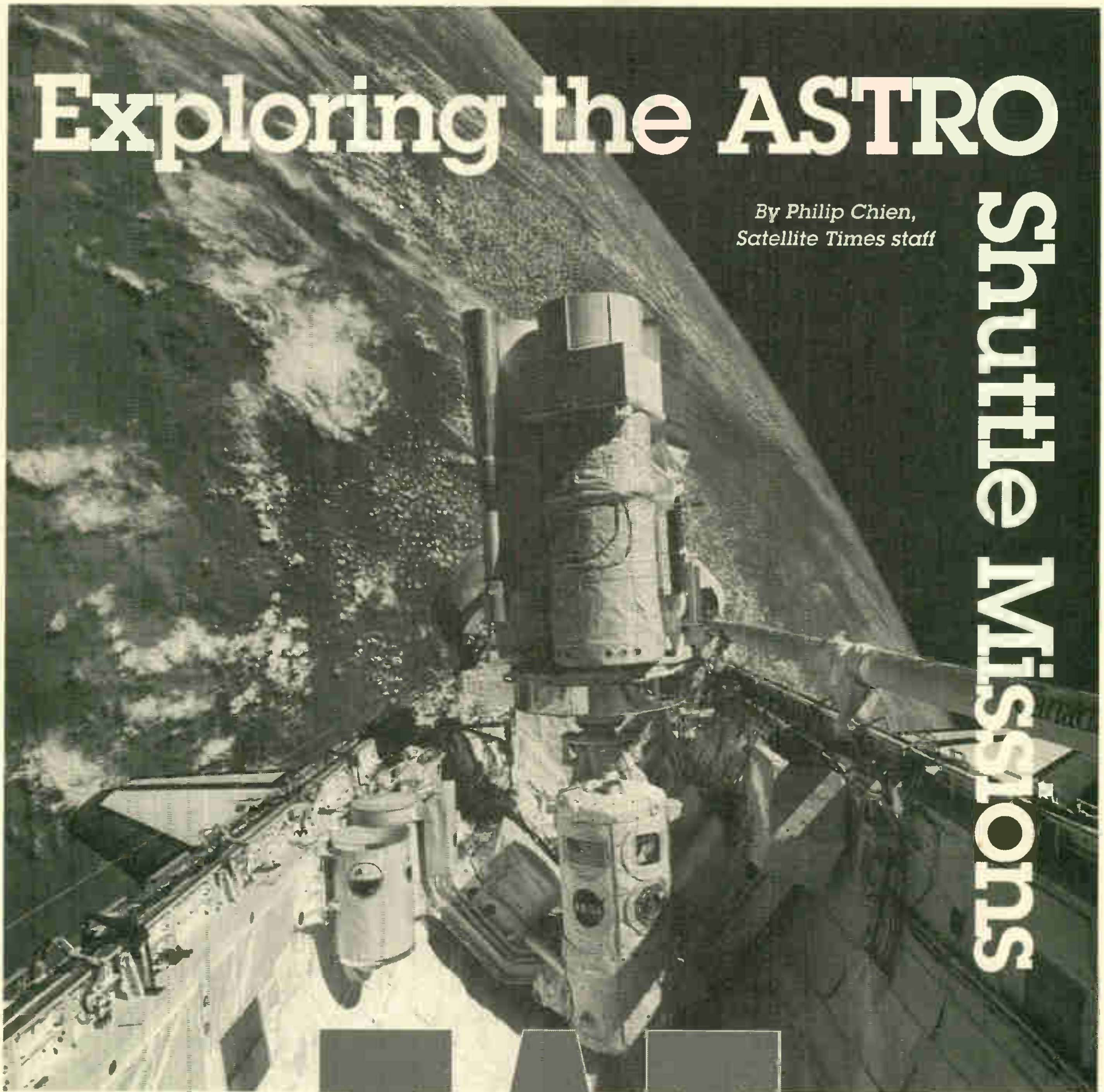
TABLE 4: Launches of Geizer Data-Relay Satellites in the Potok System

Launch Date	Satellite	Location History	
May 16, 1982	Cosmos 1366	80 deg E	May 1982-Nov 1987
Mar 2, 1984	Cosmos 1540	80 deg E	Mar 1984-1988 end
Apr 4, 1986	Cosmos 1738	346.5 deg E	Apr 1986-Aug 1989
Oct 1, 1987	Cosmos 1888	80 deg E	Oct 1987-Aug 1990
		346.5 deg E	Sep 1990-Dec 1994
Aug 1, 1988	Cosmos 1961	346.5 deg E	Aug 1988-Mar 1992
		0 deg E	Apr 1992-1993 mid
Jul 18, 1990	Cosmos 2085	80 deg E	Jul 1990-Feb 1995
Nov 22, 1991	Cosmos 2172	346.5 deg E	Dec 1991-Mar 1996
Sep 21, 1994	Cosmos 2291	80 deg E	Sep 1994-Sep 1995
		346.5 deg E	Nov 1995-date
Aug 30, 1995	Cosmos 2319	80 deg E	Sep 1995-date

Notes: Three Potok locations have been registered for use: Potok-1 over 346.5 deg E, Potok-2 over 80 deg E and Potok-3 over 192 deg E. Satellites which are still operating at the end of October 1995 are noted as "- date" under the location history.

Exploring the ASTRO Shuttle Missions

*By Philip Chien,
Satellite Times staff*



Above:
The Astro-2 Spacelab pallet backdropped against a desert area of Nambia. (NASA)

When is a satellite not a satellite? When it's a payload operating within the shuttle's cargo bay. Many space shuttle detractors forget one of the shuttle's best capabilities—as a temporary research platform. Microgravity experiments, earth observations, and astronomy are just some of the fields where instruments can be mounted within the shuttle's cargo bay. A cargo bay payload can rely on the shuttle for pointing, power, thermal control, and other resources, reducing the cost to build the "satellite."

In 1978, as the shuttle was being built, NASA's Office of Space Science offered scientists space on upcoming Spacelab flights. This resulted in the selection of three diverse instruments—the Ultraviolet Imaging Telescope (UIT), Hopkins Ultraviolet Telescope (HUT) and Wisconsin Ultraviolet Photo Polarimeter Experiment (WUPPE). In 1982 management was transferred to the Marshall Space Flight Center (MSFC), home of the Spacelab program, and the program was named "Astro."

UIT, developed by the Goddard Spaceflight Center, is most similar to a backyard telescope. However, it is a telescope with a camera carrying a thousand exposures of 70 mm astronomical film, with a violet filter and an f/9 lens which can view an area larger than the moon (40 arc minutes).

HUT was developed by Johns Hopkins University. It's a spectrograph, spreading light into a rainbow of different "colors," ranging from the near to extreme ultraviolet frequencies. By monitoring the intensities of different colors astronomers can determine the chemical composition of stars, the dust between the stars and the Earth, and how fast the star is moving or rotating.

WUPPE, pronounced "whoopee" is an ultraviolet polarimeter. It measures how light is polarized, similar to the way polarized sunglasses cut glare. Starlight can be polarized or it can get reflected when it passes through clouds of gas during its journey to Earth.

The three telescopes cover the ultraviolet frequencies from 425 to 3200 Angstroms in the near and far ultraviolet. All three telescopes are mounted on the same platform, pointed towards the same target.

Astro's wide field telescopes are designed to complement Hubble and other astronomical investigations. Many astronomers have commented that Astro is the finder telescope, to help them discover targets to view more closely with Hubble in the future. All together, the Astro payload weighs 12,479 kg (27,454 lb), and cost $150 million, including all of the delays.

Any astronomer, on the ground or in space, is limited to a portion of the sky at any moment. Different portions of the sky are only visible at certain times of the year. In addition, there are moving targets, like planets, and temporary targets, like comets, nova, and supernova. The timeline has to take all of these factors into account, depending on the actual launch date and time. So the Astro program needed three shuttle flights to map the entire sky.

Each of the three instrument teams selected payload specialist candidates. Payload specialists are scientists who fly with their experiments aboard the shuttle. Unlike full-time astronauts who have many other responsibilities during their careers, a payload specialist can dedicate much more time to operating their particular instruments. The candidates were put through medical tests, and in 1984 the three payload specialists were announced—Ron Parise (UIT), Sam Durrance (HUT), and Ken Nordsieck (WUPPE).

Ultraviolet image of the Crab Nebula supernova remnant by NASA's UIT during the Astro-1 mission on STS-35. (NASA)

By 1985 the crew was selected for the STS 61-E/Astro-1 mission—commander Jon McBride, pilot Dick Richards, mission specialists Dave Leestma, Bob Parker, and Jeff Hoffman, and payload specialists Ron Parise and Sam Durrance. The backup payload specialist was Ken Nordsieck.

The original manifest included the commercial Westar VI-S communications satellite. Westar's requirements complicated the Astro viewing schedule. NASA decided to delay Westar until June 1986, increasing the flexibility for mission operations and permitting additional viewing time.

1986 was supposed to be the "Year of Space Science" with Astro-1, probes to Jupiter and the Sun, and a new era for Spacelab and other scientific missions. Astro was NASA's only planned spacecraft to view Halley's comet. The Soviet Union, Europe, and even Japan sent spacecraft to Halley's vicinity. But cash-strapped NASA was limited to one shuttle flight viewing the once-in-a-lifetime comet from a distance.

Besides the Astro telescopes there were two piggyback passengers. The Wide Field Camera (WFC) was mounted with the Astro instruments. Basically a remotely controlled camera it was added to take pictures of Halley's comet. Also aboard was the educational CANDO getaway special—a set of four 35 mm cameras with similar goals.

By January 1986, the Astro-1 crew was undergoing their final intensive period of preflight training. *Columbia* was being prepared to accept Astro-1 as the next shuttle launch after *Challenger's* 51-L mission. Then, the *Challenger* accident put shuttle flights on hold, and eliminated any opportunity for a U.S. astronomical spacecraft to take photos of Halley. The only U.S. space astronomers who got to study Halley were the ones associated with the Russian VEGA, Japanese Suisei, or European Giotto spacecraft.

After the return to flight, science was put on the back burner again while technology and military flights took priority. Missions to deploy the critical Tracking Data and Relay Satellites (TDRS) and national priority military payloads flew first. Eventually science payloads got assigned—Astro-1 to STS-32 in December 1989, and the LDEF (Long Duration Exposure Facility) retrieval to STS-35. Enter the Sun's eleven year solar cycle.

More Setbacks

LDEF was launched in April 1984, with a planned lifetime of a year. Retrieval had been scheduled for April 1985, but a prob-

The seven STS-35 crew members aboard the Columbia middeck. Vance Brand is at the bottom center. Others clockwise from lower left are: Robert Parker, Ron Parise, Jeffery Hoffman, Guy Gardner, Mike Lounge, and Samuel Durrance.

lem with TDRS caused NASA managers to decide to combine two missions—and delay LDEF's retrieval until the summer of 1986. The *Challenger* accident delayed LDEF's planned return even longer until 1991. But increases in the sun's solar activity resulted in LDEF's altitude decreasing faster than anticipated—below the lowest safe shuttle retrieval altitude by March 1990. So NASA decided to swap the LDEF and Astro missions, resulting in yet another Astro delay.

While technically not part of the Astro mission, NASA managers decided to "marry" the three ultraviolet telescopes with broadband x-ray telescope (BBXRT). BBXRT was a ground-controlled telescope which was originally intended to fly on the shuttle high energy laboratory (SHEAL) mission. Astronomers at Goddard pushed for BBXRT to be added to the Astro mission to view supernova 1987A, the closest supernova in the past 400 years.

The many delays to the Astro mission caused several flight crew changes. Jon McBride retired from NASA and Dick Richards and Dave Leestma were assigned to the STS-28 military mission. They were replaced by commander Vance Brand, pilot Guy Gardner, and mission specialist Mike Lounge. Vance Brand was selected as an Apollo astronaut in 1966. His first flight was aboard Apollo-Soyuz in 1975, followed by two shuttle commands—STS-5 and STS 41-B. Guy Gardner had flown as a pilot on the STS-27 mission, and Mike Lounge flew on the STS 51-I and STS-26 flights.

STS-35 had enough space for SAREX, the shuttle amateur radio experiment. Unlike previous amateur radio missions STS-35 flew a low inclination orbit which would travel over less of the Earth. Making up for the lower coverage was the first use of packet radio aboard a crewed spacecraft. Packet radio permits computers to communicate via radio. The SAREX Packet robot could operate without an astronaut, permitting many more contacts. STS-35 also marked the first use of the now-common SAREX phone bridge. Phone bridges permit schools to contact the shuttle which normally would not be possible due to the school's location or the shuttle's orbit.

By the beginning of 1990 it seemed like Astro-1 was finally getting its chance. The astronauts flew to the Kennedy Space Center for their terminal countdown demonstration test (TCDT), a final dress rehearsal with the launch team, and a simulated main engine cutoff and emergency exit from the shuttle. But Sam Durrance came down with an illness which forced his removal from flight status. At this point backup Ken Nordsieck was on his way back to Wisconsin for the final mission preparations. As soon as his plane arrived he was informed of his sudden change in flight status, and asked to catch the next flight to Florida.

While Ken had trained along with Sam and Ron and was prepared to fly under almost any circumstance, specialized training was required for the final weeks before flight. Support astronaut Mike McCulley said he felt Ken had the proper mental attitude, which was the most important aspect of preparing for flight, and almost as important, he fit into the launch and entry suit originally planned for Sam. The payload specialists had a running gag that they all wore the same size clothing (40 regular), and speculated that Ken would have to fly the STS-35 flight wearing Sam's monogrammed clothing! As it turned out Sam quickly recovered from his illness and was put back on flight status. But just in case, NASA's crew equipment contractor ordered a set of clothing monogrammed with Ken's name.

By this point a record 11 astronauts had been assigned to the Astro-1 mission through its many changes. Jeff Hoffman, Bob Parker, and Ron Parise, had stayed with the program through all of the changes.

Hundreds of astronomers and engineers prepared to travel to the Marshall Spaceflight Center in Huntsville, Alabama, to operate the telescopes which they had spent most of their professional careers preparing for flight. Dozens of schools prepared to make amateur radio contacts with *Columbia* during its nine days in space. In addition, thousands of astronomers not directly associated with Astro prepared to coordinate their observations. A network was set up so if any new object, like a nova, was discovered, it would be reported to the payload operations control center (POCC). Several astronomical spacecraft already in orbit were readied to coordinate their observations with Astro.

Columbia was ready to launch on May 29, 1990. Unfortunately, a set of exasperating hydrogen fuel leaks, and NASA's attempts to launch Astro before the *Ulysses* planetary mission critical launch period kept *Columbia* grounded for several months. *Columbia* was rolled back to its hangar; its fuel line was replaced and it was rolled back out to the launch pad for a second launch attempt September 5, 1990, once again, it didn't get off the ground due to fuel leaks. A quick attempt to fix the leaks on the pad failed, resulting in another scrubbed launch attempt on September 17. On each of the launch attempts the crew was ready to go aboard, the astronomical teams were ready to begin observations, other astronomers around the world prepared for the joint observations, and ham radio operators prepared for their shuttle contacts.

Some astronomers joked that it would be easier to prepare a set of proposed observations for every single day of the year: The overall effort would be simpler than making a new mission timeline after each delay. Astronomer Jeff Clayton came out with a T-shirt listing all of Astro's planned launch dates, laundry marker provided to add any additional dates as necessary.

While all of these delays were occurring with Astro, NASA suffered another blow to its image—the discovery of the spherical aberration in the Hubble space telescope's primary mirror. While the problems were not related, many people were wondering if NASA knew what it was doing. NASA engineers nicknamed *Columbia* the "Penguin"—a black and white colored flightless bird. And one joke asked, "What do the Jetsons and NASA have in common?" The punchline: "A dog named Astro."

A new set of leak tests and fixes solved *Columbia's* fuel problems—but the engineers still had their fingers crossed when *Columbia* was fueled for flight once more. The fourth time was a charm and *Columbia* didn't leak. Launch took place at 1:41:01 a.m. EST on December 2, 1990. It had taken a record seven months to get *Columbia* off the ground.

By coincidence another launch took place that day: the Soyuz TM-11 spacecraft carrying two Soviet cosmonauts and Japanese reporter Toyohiro Akiyama. The Tokyo Broadcasting System was celebrating its 40th anniversary in a big way—paying the USSR $12 million to send its reporter to Mir for a week. With two cosmonauts already on the Mir space station and seven people aboard the shuttle, a record twelve people were aloft in space.

Getting Down to Work

Astro's crew's first day involved setting up the three instruments. UIT's first target was a bright Quasar named 1700 + 64 and a cluster of galaxies named Abell 2246 at 12:13 p.m. EST on December 3.

During the mission Jeff Hoffman commented "This [Astro] was the first telescope I controlled with my own hands. And it's worth the trip—it's worth the trip."

The general public got the impression that the STS-35 mission was problem plagued, and failing to meet its goals. Newspaper headlines read "Potty problems in orbit threaten to cut short shuttle mission," but the crew found ways to store the excess water and the stopped up drain system was only an inconvenience. The most serious problem was the failure of the data display system (DDS) computers. Both DDSs had shut down by 4 days 5 hrs 27 min into the mission—less than halfway through the flight. Ground controllers worked out an unusual set of procedures.

The guidance navigation and control (GNC) officer at the Johnson Space Center in Houston, Texas, would point the instrument pointing system (IPS) toward its target. The telescope controllers at the Marshall Spaceflight Center would control the instruments, and the astronauts in orbit would do the job of the DDS by pointing the telescopes at their targets manually, with a video-game-like controller. Included in the crew's daily fax reports was a message from the GNC officer, "Thanks for the keys to the car," and the inspirational quote of the day, "One machine can do the work of fifty ordinary men—no machine can do the work of one extraordinary man." Ultimately the complicated system worked out better than expected and toward the end of the mission Astro was able to actually outperform the original schedule DDS.

HUT sent back spectra from 75 targets, WUPPE sent back polarization data from 70 targets, and BBXRT sent back X-ray data on 76 targets. UIT exposed 900 frames of film from 64 different targets. All together, 135 different astronomical targets were viewed, with many targets observed more than once and many targets viewed by more than one experiment—some being viewed simultaneously by all four instruments. While the astronomers didn't get as many observations as they had originally hoped for, they still collected a massive amount of information—more ultraviolet information on this one week mission than every single ultraviolet sounding rocket and spacecraft put together. Within a couple of weeks astronomers announced that they were preparing over 100 technical papers for astronomical journals.

Because of expected bad weather at Edwards Air Force Base in California, and NASA's reluctance to land *Columbia* in Florida in darkness, the mission was cut short by a day, landing on December 10. Astro's instruments were removed from *Columbia's* cargo bay and put into storage. Before the next Spacelab mission the DDS computers were replaced by a version of the computer which runs the shuttle's systems.

Managers had hoped for a short turnaround to keep the teams together and reduce the overall cost for a second Astro mission. It didn't turn out to be that easy until, somebody casually mentioned to Senator Barbara Milkulski that three of the four Astro telescopes were from her home district, (WUPPE being the sole exception). So Congress allocated $45 million and ordered NASA to fly Astro-2.

At this point, Ken Nordsieck had decided that he had spent enough of his career on WUPPE and wanted to move on to other projects. Kennedy Space Center engineer Scott Vangen was selected as the backup payload specialist. His selection was somewhat controversial since he is a payload engineer, not a Ph.D. astronomer. However, payload specialists are there primarily to operate the instruments, not to select targets or do scientific analysis during the mission.

Astronaut Tammy Jernigan was selected as the payload commander. A veteran of the STS-40 and STS-52 spaceflights, her graduate work was in astrophysics. Rookie astronaut John Grunsfeld was the only astronomer in the 1992 astronaut class. Grunsfeld had put in a request to chief astronaut Hoot Gibson, that, if personal preference was being considered, Astro was the mission he wanted because it complemented his previous career as an astronomer. Luckily, he got his choice.

The crew was rounded out by commander Steve Oswald, a veteran of the STS-42 and STS-56 missions; rookie pilot Bill Gregory; and rookie mission specialist Wendy Lawrence.

Ham Talk

Parise encouraged his fellow crewmembers to get their ham radio licenses, and most of them cooperated. Ron Parise, WA4SIR, had earned his ham radio license in 1962 at age eleven.

Commander Steve Oswald had already obtained KB5YSR while training for his previous mission, STS-56. He commented, "I shared an office with my commander on STS-56 [Ken Cameron, KB5AWP] who thought it would be a wonderful idea if we all had our amateur radio licenses, and so we all did. Since then, I operated the radio on STS-56 and it was a great experience; I was glad to have gone to the effort. I don't regret for a second that I put in the effort to get that license. However, I did not require that our crew [STS-67] all go off and get their licenses."

Sam Durrance, N3TQA - "I was fortunate enough to use the ham radio on Astro-1. I was not a ham radio operator at the time. Since that time, Ron has talked me in to getting my license, and I'm looking forward to using it."

Tammy Jernigan, KC5MGF - "I also share an office with Ron, and I think he got to most of us over time. He mentioned that we'd be able to talk to a lot of school kids and get them interested and excited about the space program while we were in orbit. So I thought it's a very good investment."

Bill Gregory, KC5MGA - "I did a speaking engagement here in Houston for a national convention of ham radio operators. They found out that I didn't have my license and gave me infinite grief and made me promise that I would have my ham radio license before I flew—so that's what I did."

Wendy Lawrence, KC5KII - "Well, I don't share an office with Ron, but he's still pretty persuasive. I don't really have anything else to add. I agree with everyone it's such a wonderful opportunity to talk to the school kids. I remember as a school kid I was very interested in the space program, so I hope to be able to instill the same excitement in school kids—not just in the United States, but around the world."

The crew holds the record for six licensed hams on one mission. The only member of the crew without a license was John Grunsfeld. But he is planning to obtain his license for his next shuttle flight, the STS-81 mission in January 1997.

Using the shuttle amateur radio experiment, payload specialist Ron Parise talks to students on Earth from the flight deck of Endeavor during the STS-67 mission. (NASA)

Doing the Launch Date Limbo

The Astro-2 mission was scheduled for January 1995 on shuttle *Columbia*—immediately drawing a strong reaction from the astronomers. A January launch would result in an almost identical view as the December sky which was observed on Astro-1. While many hoped for a change in the launch date, what actually happened was a strange twist of events.

Several people within and outside NASA suggested the possibility of swapping the Astro-2 mission with the International Microgravity Laboratory-2 slot in July 1994. The July mission coincided with Comet Shoemaker-Levy 9 smashing into Jupiter. Astro's instruments are not optimized for viewing such a small area as a spot on a planet, but some thought it certainly wouldn't hurt to try.

Unfortunately there wasn't enough interest or money to justify the mission exchange. However, an important space station vote was coming up and congressman George Brown, an influential member of the space committee, was wavering in his support. NASA managers encouraged him to vote for the space station, and somehow the decision was made to send Columbia back to Palmdale, California—in George Brown's district for an overhaul, even though it had recently completed one. As a result the Astro mission was transferred from *Columbia* to *Endeavour*, and delayed until February. Then *Endeavour's* STS-68 mission was delayed by several weeks due to an engine shutdown, resulting in a mission delay to March. By coincidence, the March launch of STS-67 resulted in the same sky which would have been observed on the STS 61-E mission back in 1986, had it flown as originally planned.

Besides Astro, Endeavour's cargo bay carried two getaway specials with the Australian Space Telescope, a payload which had previously flown on the STS-42 mission in 1992.

STS-67/Astro-2 was planned as a 16 day mission. In addition to the science teams who built the instruments, NASA opened up the use of Astro's instruments to any astronomer who could come up with a good proposal. Unlike the Astro-1 mission NASA decided not to prepare an entire timeline in advance. The astronomers would choose and select which targets they wanted before each shift. However, several less responsible members of the press somehow came up with an arbitrary figure of 400 targets as the goal for the mission.

Endeavour was launched with the Astro-2 payload in its cargo bay on March 2, 1995.

New Frontiers, New Records

Several Internet gurus at the Marshall Spaceflight Center decided to set up a worldwide web page for the Astro-2 mission. Riding the crest of the Internet explosion, Becky Brayer and John Piner set up a web site showing what the astronauts were doing at any given moment, what target they were observing, and a tour of the Payload Operations Control Center. Internet visitors could sign in a log book and ask questions of the payload controllers, some of which would even be sent up to the crew in orbit.

About two dozen questions were collected at Marshall and uplinked to the crew. What no one at Marshall realized was that is lead flight director Chuck Shaw, a former Air Force officer, decided to add his own question to Steve Oswald, a former Navy aviator. The question read, "Oz, wouldn't you really rather have been in the Air Force than the Navy?" There was an interesting reaction from orbit, but Steve never did answer the question.

Overall, the STS-67 home page was visited by 260,000 viewers from 59 countries during the two-week mission. The web page is still active, although it isn't updated anymore. It can be accessed at URL: **http://astro-2.msfc.nasa.gov/**

One of the most exciting observations was Nova Aquilla, a variable star which temporarily became visible. Astro-2 scooped every other astronomical spacecraft, obtaining 2 minutes of data by the WUPPE experiment.

All together *Endeavour* made over 400 maneuvers, including 377 to point the telescopes towards their targets. The SAREX team accomplished a record 28 school contacts, plus over 1200 packet contacts, and many random voice contacts with hams around the world.

Towards the end of the Astro-2 mission additional space travelers were rocketed in to space. Russian cosmonauts Vladimir Dezhurov and Gennady Strekalov, and American colleague Norm Thagard, were launched aboard the Soyuz TM-21 spacecraft. With the seven members of the Astro-2 crew and three Russians already aboard Mir, a new record was set of 13 people in space at the same time. Coincidentally, Ron Parise, Sam Durrance, and Gennady Strekalov had also been in space when the previous record of 12 was set in December 1990. Twelve of the thirteen were authorized to use the amateur radio equipment on their respective spacecraft, setting another record.

Endeavour was scheduled to land at the Kennedy Space Center, but bad weather forced the shuttle to land at its backup site at Edwards Air Force Base in California. The mission set a shuttle record of 16 days, 15 hours, and 8 minutes which held until July 1996.

All 23 planned science programs were completed on the Astro-2 mission. Mission Scientist Dr. Chip Meegan confirmed, "This has been an outstanding mission."

UIT took about two dozen pictures of large spiral galaxies for an ultraviolet atlas. The atlas will be a fundamental resource for astronomers for many years to come. UIT also made the first ultraviolet images of the entire moon.

HUT made more than 200 separate successful observations for 21 separate investigations—14 carried out by permanent members of the HUT team and seven by guest investigators.

WUPPE sampled some 20 different views for its study of the interstellar medium, using hot stars located behind interstellar dust clouds to measure the properties of the grains. In addition to examining the dust clouds in the Milky Way, WUPPE studied the interstellar medium in a nearby galaxy, the Large Magellanic Cloud. WUPPE also got excellent observations of four Wolf-Rayet stars, an evolutionary stage of massive stars in which strong stellar winds eject shells of material into the interstellar medium.

Astro has enough funding to keep the instruments in flight-ready condition for at least another year. Right now there isn't room—or funding—for any additional science space shuttle missions. We should to note that the additional incremental cost for an Astro-3 mission would be relatively small—about $50 million to add an additional mission to the existing shuttle manifest and about $20 million to process the Astro instruments, pay for the scientists, and process the data.

A major slip in the space station schedule or other unforeseen factors which might open up additional shuttle manifest slots opening up could result in additional Astro missions. It isn't likely, but over the fascinating history of the Astro payload, stranger things have happened. ST

Your First Satellite CONTACT

By Philip Chien

How easy is it to listen to, or make your first satellite contact via amateur radio? Pretty easy actually. A handheld scanner or 2 meter amateur radio rig is adequate for listening to many satellites, and a conventional packet modem can be used to decode telemetry from a handful of satellites. A simple no-code amateur radio license is adequate for communicating via all of the amateur radio satellites, with the sole exception of the Russian RS-12/13 satellite. Even if you live in an antenna-unfriendly location there are many satellites which you can monitor.

As a general rule low altitude satellites are easier to listen to than higher ones—simply because they're closer to you. Satellites which have downlinks at higher frequencies are more difficult to tune in because of doppler shift, but more sophisticated setups can automatically tune your radio, making doppler compensation painless.

The first step in monitoring is the problem of determining when the satellite you want to work will be over your location and in operation. Before computers, predicting satellite passes was a chore, involving carefully distorted maps of the Earth with plastic overlays and grease pencils. Now there are hundreds of computer programs—ranging in price from free to several thousand dollars—designed to track satellites and predict when they will be in view at a particular location. Many of these tracking programs will also predict when satellites can be viewed visually by observers on the ground.

Some of the more popular shareware tracking programs include InstantTrak, WISP, STS Orbits, Logsat, WinTrak, Orbitrack, and MacSPOC. These programs can be obtained from several of the popular Internet software sites.

A satellite tracking program is only as good as the data which you enter. You must have your time zone and location entered correctly for the program to work. Orbital data must be entered for each satellite you want to monitor or track. This data is known as Keplerian elements or Keps. "Keps" are the mathematical quantities which define a satellite's orbit. The best source of the latest Keps is Celestial Web BBS, located on Grove Enterprises web server. This site is run by *ST Computer and Satellite* columnist Dr. T.S. Kelso. The web address is: **http://www.grove.net/~tkelso**.

Your satellite tracking program will calculate the satellite's location, based on the keps for that satellite, and extrapolate its predicted location over time. Small errors will gradually build up over time, unless you update your keps. In addition many satellites make maneuvers, resulting in a different orbit which has to be recalculated.

Some satellites transmit on a continuous basis. Others are only activated when they pass over prescheduled ground stations, and still others are only active when the astronaut feels like talking on the radio.

One of the most popular spacecraft to work/monitor is Mir, the Russian space station. Mir has had an amateur radio station on board since 1989. Most of the time the cosmonauts operate on 145.55 MHz. simplex. The signal is extremely strong, and can easily be received on a handheld radio or scanner. The Mir crews use a Moscow timetable (UTC + 3 hours) and have been a favorite target among amateur radio operators. More often than not you'll just hear one end of a conversation, since the downlink footprint can cover several thousand square miles.

Communicating directly with Mir is a bit more of a challenge. A directional antenna helps, along with higher power. Still, I've successfully contacted Mir using a 5 watt handheld radio into a simple $20 J-Pole antenna. When working Mir, let the cosmonaut

FIGURE 1A: Raw DOVE Telemetry

```
DOVE-1>TIME-1:PHT: uptime is 055/13:26:09. Time is Thu Feb 08 03:55:03 1990

DOVE-1>TLM:00:58 01:58 02:84 03:2E 04:58 05:58 06:6D 07:47 08:6A 09:6A 0A:A2 0B:D8 0C:E8 0D:D7
0E:00 0F:23 10:CC 11:AA 12:01 13:02 14:A2 15:90 16:9C 17:96 18:96 19:98 1A:94 1B:91 1C:9B 1D:99
1E:22 1F:5E 20:BC

DOVE-1>TLM:21:94 22:7A 23:28 24:24 25:30 26:00 27:00 28:01 29:00 2A:00 2B:00 2C:00 2D:2A 2E:00
2F:9A 30:C8 31:9B 32:12 33:EA 34:BC 35:92 36:A2 37:A1 38:AA 39:96 3A:00

DOVE-1>STATUS: 80 00 00 88 B0 18 EE 02 00 B0 00 00 B0 00 00 00 00 00 00 00
```

control the conversation. If they're talking to friends then they don't want to get interrupted any more than anybody else likes to get interrupted in the middle of a conversation. But if they want to chat—by all means chat.

A satellite with a more predictable schedule is DOVE—Digital Orbiting Voice Encoder. DOVE is a microsat—a 9 inch cube packed with a computer, batteries, solar cells, and a transceiver. Its flight antennas can literally be picked up at any hardware store—just ask the salesperson for a retractable tape measure. Prior to launch the tape measure material was cut to the proper lengths and tucked against the side of the satellite. After launch the satellite was ejected from its launch vehicle and the tape measures (antennas) popped out to their operating positions.

DOVE has been in space since February 1990 and is still operating well. DOVE transmits on 145.825 and 2401.2205 MHz. Its data is standard AX.25 AFSK format, the most popular format on amateur radio packet networks. It's important to note that you do not need an amateur radio license to receive DOVE signals. An inexpensive scanner, a $25 Baycom modem, and a simple omnidirectional antenna (J-Pole, ground plane, or eggbeater) is all you need to copy DOVE telemetry. Figure 1a shows a typical DOVE data stream, and Figure 1b is the information it contains. There are many freeware programs available for decoding DOVE data.

Since the mid 1960s amateurs have been decoding data from weather satellites. Automatic picture transmission (APT) was intentionally designed to be as simple as possible to receive. Early monitors used oscilloscopes and surplus military radios as parts of their APT receiving stations. Today, it's a bit simpler—a computer with an audio input port and a scanner with a modified IF filter to increase its bandwidth is all the hardware that is needed. NOAA satellites transmit on 137.5 and 137.62 MHz. You can hear the downlink signal on a conventional scanner, but you will need a wider bandwidth to be able to decode the pictures successfully. NOAA has a World Wide Web site with excellent information at **http://www.nnic.noaa.gov/SOCC/SOCC_Home.html**.

If you have an amateur license you can do much more than just monitor satellite data—you can make contact with other hams directly via satellite. The easiest amateur satellite to work into is AMRAD-OSCAR 27 *aka* Eyesat-1. Eyesat was originally built as an experimental microsat by Interferometrics. When not in use for experimental communications it functions as a single channel amateur repeater. Recently it's been operating almost full time in its amateur mode. AO-27 receives signals at 145.850 MHz and transmits on 436.80 MHz. All you have to do is wait until AO-27 is over your horizon and use a 2 meter FM radio to transmit (uplink) on 145.850 MHz, and listen to 436.80 MHz (downlink) for your return signal. Some folks have made successful contacts using only a handheld 2 meter rig, but you would have a better chance of making a contact using a higher power 2 meter/70 cm mobile unit.

AO-27's sensitive receiver has turned out to be one of its biggest problems. All of the International Telecommunications Union (ITU) countries have agreed that 144-146 MHz is an exclusively amateur band worldwide. However, certain areas of the world do have additional allocations, for example in the U.S. the 2 meter amateur band ranges from 144 to 148 MHz. Countries are supposed to enforce correct usage of the bands within their borders. Unfortunately, many countries are not as diligent as they should be, and there are many abuses.

So what does this have to do with AO-27? The satellite is in high enough an orbit that its "footprint" covers a large portion of the Earth's surface. When AO-27 is visible over the United States and Latin America it is quite common to hear Spanish conversations by taxi drivers. They're illegally using the 2 meter band, and if they transmit on the 145.85 MHz uplink while AO-27 is overhead, their conversations will be heard by anybody within AO-27's footprint who is monitoring the 436.80 MHz downlink.

The Russian RS-10/11 is also a popular beginner's satellite. Russian hams do

Astronaut Dr. Owen Garriott (W5LFL) used an ordinary amateur radio 2 meter handheld transceiver during preliminary tests for his SAREX mission aboard STS-9. Garriott was the first man in space to operate an amateur radio station. (NASA)

Astronomer Ron Parise (WA4SIR) sets up for a session at the SAREX station on Columbia's middeck during ST-35. (NASA)

not normally have access to high power transmitters, so RS-10/11 was designed with an extremely sensitive receiver. RS-10/11 is a 2 meter/10 meter crossband satellite. You uplink on 2 meters and listen on 10 meters.

Inexpensive 10 meter shortwave receivers are fairly easy to find. The best choices for 10 meter antennas include turnstiles or dipoles, but some folks have used $5 long wires successfully to hear this Russian satellite. You will need a more sophisticated transmitter, though, and like most OSCAR satellites RS-10/11 uses linear transponders which require single sideband (SSB) capability.

A linear transponder can be thought of as a multi-lane highway. Instead of just one transmit and receive frequency a linear transponder covers a wide range of frequencies, permitting many simultaneous conversations. For RS-10/11 the uplink range is 145.860-145.900 MHz, and the downlink range is 29.360-29.400 MHz.

In the United States it is illegal for a Technician class (no-code) ham to operate in the 10 meter band. However, it is perfectly legal to use RS-10 since you are only transmitting within the 2 meter band—the satellite is the entity doing the transmitting on 10 meters.

The best source for information about amateur satellites is AMSAT's worldwide web site. Its address is: **http://www.amsat.org/**. AMSAT members get the bimonthly *AMSAT Journal* which includes frequent articles on the launch of future amateur satellites, how to communicate via amateur spacecraft, and construction projects.

While amateur satellites and simplified weather data are fun to receive many more sophisticated satellites intentionally transmit their information for anybody who can decode the data. Equipment is available to obtain the raw data from the weather satellites. NASA's Total Ozone Mapping Spectrometer (TOMS) has an S-band transmitter, which will tell you how thick the ozone layer is over your location as it passes overhead. The High Energy Transient Explorer (HETE), scheduled for launch in early 1997, also plans to use a network of inexpensive ground stations to receive its data.

Once you've listened to some of the simpler satellites and made your first contact (QSO) on amateur satellites you can then start to move up to more sophisticated satellites. Data transmissions can be monitored on a wide number of bands, from VHF to microwave. You can use OSCAR amateur radio satellites for high speed data transmissions, slow scan television, and all of the other modes available for amateur radio operators. And who knows, one of these days when you transmit your call sign on a satellite uplink frequency—you may be lucky enough to hear an astronaut or cosmonaut returning your call from space. ST

FIGURE 1B: Decoded DOVE Telemetry

Using N5KOB's Dove-1 Telemetry Decoder for the Macintosh

Receive (Rx) E/F Audio (W)	2.1648 V (peak-peak)
Receive (Rx) E/F Audio (N)	2.1648 V (peak-peak)
Mixer Bias	1.3464 V
Oscillator Bias	.4692 V
Receive (Rx) A Audio (W)	2.1648 V (peak-peak)
Receive (Rx) A Audio (N)	2.1648 V (peak-peak)
Receive (Rx) A DISC	.31834 kHz
Receive (Rx) A S Meter	71 counts
Receive (Rx) E/F DISC	-.88226 kHz
Receive (Rx) E/F S Meter	106 counts
+5 Volt bus	4.941 V
+5 Volt Receive (Rx) Current	21.6 mA
+2.5 Volt VREF	90.712 V
8.5 Volt bus	8.4065 V
IR Detector	0 counts
LO Monitor I	1.295 mA
+10 Volt bus	10.353 V
GASFET Bias I	4.42 mA
Ground REF	.01 V
+Z Array voltage	.2046 V
Receive (Rx) Temp	3.0238 deg C
+X (RX) Temp	13.9156 deg C
Battery (Bat) 1 voltage	1.26149 V
Battery (Bat) 2 voltage	1.26806 V
Battery (Bat) 3 voltage	1.26876 V
Battery (Bat) 4 voltage	1.25243 V
Battery (Bat) 5 voltage	1.27335 V
Battery (Bat) 6 voltage	1.28058 V
Battery (Bat) 7 voltage	1.27157 V
Battery (Bat) 8 voltage	1.26556 V
Array voltage	9.653 V
+5 Volt bus	4.8648 V
+8.5 Volt bus	8.5174 V
+10 Volt bus	10.6902 V
BCR set point	132.636 counts
BCR load I (current)	.1921 A
+8.5 V bus I (current)	.059164 A
+5 V bus current	.2119 A
-X array current	-.01075 A
+X array current	-.01349 A
-Y array current	-.00957 A
+Y array current	-.01141 A
-Z array current	-.01653 A
+Z array current	-.01137 A
External power current	-.02 A
BCR input current	.19436 A
BCR output current	-.01724 A
Battery 1 temperature	7.8646 deg C
Battery 2 temperature	-19.97 deg C
Baseplate temperature	7.2595 deg C
FM TX #1 RF output	.0367744 W
FM TX #2 RF output	4.28863 W
PSK TX HPA temperature	-12.7088 deg C
+Y array temperature	12.7054 deg C
RC PSK HPA temperature	3.0238 deg C
RC PSK BP temperature	3.6289 deg C
+Z array temperature	-1.817 deg C
S-band TX output	.5594 W
S-band HPA temperature	101.05 deg C

THE VIEW FROM ABOVE

By Jeff Wallach
Dallas Remote Imaging Group

Direct Readout Systems: 2000 and Beyond

Those of you in the computer industry know the significance of the term "Year 2000." On December 31, 1999, at 11:59 p.m., thousands of computer programs will be in jeopardy of ceasing to function. The reason: these computer programs were not designed to deal with the calendar date being other than 19XX. New Year's Day, January 1, 2000, will be a historic moment for insurance companies, financial institutions, government computer systems, and even some early personal computer programs. Applications in these industries will have to be redesigned to handle this new date format, and detailed planning will be required to handle a simple date change in these computer programs.

The "Year 2000" and beyond will also impact the space segment, ground segment, and user segments of weather satellite direct readout systems. Fortunately, detailed planning has already taken place, and new systems are already in the process of being designed and implemented. The extent of change for weather satellite systems—post Year 2000—was recently reviewed at the Fourth Polar-Orbiting Operational Environmental Satellite User's Symposium held June 10-12, 1996, in Annapolis, Maryland.

This column will review some of the significant changes that will take place over the next ten to fifteen years, and make recommendations on how to best position your ground station to take advantage of these new technologies.

Current POES Systems and Future Launches

The United States has provided satellite based, global meteorological and environmental monitoring of the Earth since April 1960. For over 36 years polar-orbiting operational environmental satellites (POES) have collected imagery of the Earth and measured atmospheric temperature, cloud cover, surface temperatures, and a host of other critical data points for the good of mankind. These satellites transmit their data in real time, and at no cost, to users with the appropriate receiving and processing equipment.

This highly successful satellite program continues today with a minimum two satellite constellation flying in complementary. circular, sun-synchronous orbits. Currently the NOAA 12 satellite is the primary morning bird, with NOAA 14 acting as the primary afternoon scanning platform. Each satellite has an orbital period of approximately 102 minutes, thus making 14 complete orbits of the Earth each day. The morning satellite is at an 833 km. altitude, inclined 98.66 degrees to the equator, while the afternoon satellite is at an 870 km altitude, inclined 98.70 degrees to the equator. NOAA 12 and NOAA 14 represent the fourth generation of NOAA polar-orbiting spacecraft.

Let's briefly review the satellite instruments so that we can compare the current spacecraft with the next generation of weather satellites. These satellites have a base instrumentation set that consists of the following sensors:

- **Advanced Very High Resolution Radiometer/2 (AVHRR/2):** This instrument is a five channel scanning radiometer which produces images of the Earth. There are two channels in the visible/near infrared wavelengths, and three channels in the infrared spectrum. The visible and near infrared channels allow observation of snow and ice, clouds, lakes, rivers, and vegetation. The other three infrared channels are capable of detecting thermal radiation from clouds, oceans, waterways, and land. The AVHRR/2 instrument produces high resolution picture transmission (HRPT) and automatic picture transmission (APT) images that we receive on our weather satellite ground station terminals—this is one instrument that will have some significant changes in future generations of spacecraft.
- **Microwave Sounding Unit (MSU):** This instrument is a microwave scanning radiometer that has four channels for measuring cloudy regions in the atmosphere.

For over 36 years polar-orbiting operational environmental satellites (POES) have collected imagery of the Earth and measured atmospheric temperature, cloud cover, surface temperatures, and a host of other critical data points for the good of mankind.

- **High Resolution Infrared Radiation Sounder (HIRS/2):** This sensor is a filter wheel infrared radiometer. It takes radiance measurements in 19 spectral regions of the infrared band, and one in the visible light band for relatively high resolution measurements to an altitude of about 40 km. in the atmosphere.
- **Space Environment Monitor (SEM):** The SEM is a multichannel, charged particle spectrometer that measure activity in the Earth's radiation belts and the particle acceleration resulting from solar wind activity.
- **Solar Backscatter-Ultraviolet Spectral Radiometer (SBUV):** This instrument measures the solar irradiance and backscattered solar irradiance in the ultraviolet spectral range. It is possible to use measurements from this instrument to assess the total ozone concentration in the atmosphere.
- **ARGOS Data Collection System (DCS):** Data collection platforms (buoys, remote weather stations, free floating balloons) send their data to the polar-orbiter, where it is stored onboard and later relayed to ARGOS processing centers.
- **Search and Rescue (SAR):** The SAR instrument receives distress signals from emergency beacons on ships and planes (121.5 MHz, 243 MHz, 406 MHz) and transmits the signals to Air Force command centers. Based on location of the satellite and doppler effect, a position 'fix' is calculated and rescue teams deployed.

Changes to the POES Instrumentation

NOAA J (NOAA 14) was the last of the fourth generation of polar orbiters to be launched. The next satellite (NOAA K or NOAA 15 once in orbit) will be the first of the fifth generation of advanced TIROS weather satellites. The NOAA K-N' satellites will be essentially identical to the current operational satellites, with the following exceptions:

The NOAA K satellite will be significantly heavier than previous spacecraft (4920 lbs vs 3775 lbs) and require more powerful apogee kick motor and booster. New solar panels have been added and advanced antennas will be deployed for better signal strengths.

The AVHRR/2 instrument will be upgraded to the AVHRR/3 instrument and contain a sixth channel (channel 3A) at 1.6 microns wavelength for improved snow/cloud discrimination and atmospheric aerosol detection. Channel 3A will operate during the daylight part of the orbit, while the channel 3B (current channel 3) will operate during the night-time portion of the orbit. The new AVHRR/3 will provide spectral and gain changes to the visible channels to allow improved snow and ice discrimination.

The APT user will see channel 3A as channel 6 using the wedge six grey scale modulation index. The APT image will incorporate channel 3A or 3B, whichever is operational. The HRPT data change involves the minor frame format. The exact data format changes are still being finalized. A new Polar Orbiter User Guide is being developed by National Oceanic and Atmospheric Administration (NOAA) which will detail the specifics of the new data formats. This new users guide will be accessible on the Dallas Remote Imaging Group Web site (http://www.drig.com), and also in hard-copy from NOAA/NESDIS).

The MSU instrument will be replaced by the advanced microwave sounding unit (AMSU)-A and (AMSU)-B with extended three year life times. The AMSU-A is a 15 channel microwave sounding unit providing higher resolution temperature sounding capability and improved measurements of sea ice, precipitation, snow cover, and surface emissivity. The AMSU-B is to be provided by the United Kingdom Meteorological Office, and is a five channel water vapor profiler allowing measurements of moisture in the atmosphere.

Data rates on the DCS subsystem will be increased from 1200 bps to 2560 bps, and the Search and Rescue processor will be upgraded to handle more global distress messages and better detection of interfering signals.

Projected Launch Dates for NOAA K-N' Satellites

The National Oceanic Atmospheric Administration and NASA launch new po-

Perhaps the greatest change to occur in the next generation of weather imaging satellites is the replacement of the analog APT low resolution imagery with a new digital format called low rate picture transmission (LRPT).

lar-orbiting weather satellites in a "launch on demand" mode. This means that new satellites are launched when the on-orbit satellite constellation requires replenishment. The launch planning dates are assessed on a three year spacing based on an average historical performance of the satellite platforms.

Current POES launch schedule (including the new European polar-orbiting satellites)

Satellite	Orbit	Planned Launch
NOAA-K	AM	1997
NOAA-L	PM	2000
NOAA-M	PM	2001
METOP-1	AM	2002 (European satellite)
NOAA-N	PM	2004
METOP-2	AM	2006 (European satellite)
NOAA-N'	PM	2007

Convergence of U.S. NOAA Civilian, Military, and European Operations

On May 5, 1994, President Clinton signed a milestone directive that merges the U.S. civil and military meteorological satellite programs into a single, unified system capable of satisfying civil and national security requirements for operational meteorological satellites.

For over 30 years the U.S. has maintained two separate operational systems: the NOAA Polar-Orbiting Operational Environmental Satellites (POES) and the Department of Defense's (DoD) Defense Meteorological Satellite Program (DMSP). Changes in the economy and the world political climate has resulted in the formation of a joint program known as the National Polar-Orbiting Operational Environmental Satellite System (NPOESS). This new integrated approach is expected to provide up to $300 million in cost savings through the end of this century and over $1 billion dollars over the life of the joint program..

On October 3, 1994, NOAA, NASA, and Department of Defense created the Integrated Program Office (IPO) to develop, manage, acquire, and operate the NPOESS office. NOAA has the overall responsibility for this office and is responsible for satellite operations. DoD is responsible to support the IPO for systems acquisition and launch support. NASA is responsible for developing new cost-effective technologies for the combined system. NOAA will take over command, control, and communications of the existing DMSP satellites and NOAA POES satellites in 1998. The first new combined satellite is expected to be available sometime after 2005, when the current NOAA and DMSP satellite constellations are exhausted.

NPOESS Overview:

- Two U.S. satellites on orbit at any given time to fulfill the operational missions for NOAA and DoD.
- Combined operations of DMSP and NOAA POES in 1998 at the NOAA Suitland, Maryland, ground station.
- European participation with European Meteorological Satellite Organization (EUMETSAT) and launch of METOP 1 (Meteorological Operational Program) post 2001. A subset of the NPOESS instruments will be flown on the METOP satellites as port of the primary NPOESS constellation.
- Issues of DMSP image encryption and availability for civilian use are still being discussed.

LRPT data on NOAA O-P-Q series satellites

Perhaps the greatest change to occur in the next generation of weather imaging satellites is the replacement of the analog APT low resolution imagery with a new digital format called low rate picture transmission (LRPT). The goal of future digital LRPT imagery is to provide higher quality, 1 km resoultion imagery instead of the current APT 4 km resolution data, and to increase by increasing the number of data channels to three. The LRPT stations will receive the digital data at a rate of 72 kilobits per second. Data compression will most likely use the Joint Photographic Expert Group (JPEG) standard, which most of us are already using for image capture and display.

Due to frequency allocation problems projected for the late 1990's and beyond, the downlink frequency of the LRPT signal will also change from the current APT frequencies: 137.500 and 137.620 MHz. The new LRPT downlink frequencies are projected to be 137.100 and 137.9125 MHz. It is estimated that the first LRPT imagery will be downlinked from a European METOP-1 platform around the year 2002.

Ground Station Requirements

Obviously, with the switch from analog to digital data transmission, the APT demodulator card and software will have to be replaced. The good news is that with digital signal processing (DSP) hardware prices dropping dramatically, it is conceivable that a small DSP modem will allow reception of LRPT data within the same box at prices comparable to current APT demodulators.

Changes in the downlink frequency will require either a crystal change in crystal receivers, or merely dialing in the new frequencies on synthesized radios.

As further details of the new NPOESS system and ground station requirements become available, we will review them here in the *View From Above* column in *Satellite Times.*

Closing Comments

John Boyer, of the Remote Imaging Group in the United Kingdom, has been capturing daily images from the Russian OKEAN, SICH, and Meteor polar satellites. He has been posting these images on the DRIG Web site at the folllowing URL: **http://www.drig.com/~johnb**. Figures 1 and 2 are samples of some of the interesting images that John has captured. The images were taken by these Russian satellites over Europe.

Until next time, we hope you continue to enjoy the many facets of direct weather satellite imagery and the View From Above. ST

TABLE 1
Listing of Current Active POES Meteorological Satellites:

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

By John A. Magliacane
magliaco@email.njin.net

Linux and Satellites: Perfect Together

Computers have been a part of the amateur satellite program since its inception. Microcomputers control spacecraft subsystems onboard OSCAR (Orbiting Satellite Carrying Amateur Radio) satellites, and personal computers play a major role at satellite groundstations by providing orbital prediction calculations, antenna tracking functions, and in some cases, completely automated digital satellite communications.

In the first issue of *Satellite Times* (Vol. 1 No. 1), I briefly described the history of the amateur satellite program and pointed out some of the many accomplishments and technical achievements made possible through this program by amateur radio operators working solely with a personal aim, without pecuniary or business interests.

One of the remarkable realities of volunteer work is that if all participants are diligent, intelligent, carry strong dedication, and are true believers in their work, then the resulting product quality is very often many times higher and many years ahead of that which may be available commercially at a much higher cost. It is also not uncommon to find technology developed and perfected in the non-commercial world of amateur radio making its way into commercial industry. Our microsat technology is just one recent example of this.

As it turns out, the amateur radio service is not the only arena where non-commercial technical innovation often surpasses that of commercial industry. For several years, an international collaboration of computer programmers under the direction of Linus Torvalds, a computer science student at the University of Helsinki, have been developing a free Unix-like operating system called "Linux" for use on personal computers.

The goal of Linux (pronounced "Lynn-nicks" by its creator) was to exploit some of the task switching capabilities of the 32-bit Intel-series of microprocessors, and use those capabilities to create an operating system with greater capabilities than that of the Minix operating system. What Linux has become, however, just a few short years after its inception, is something far greater than what anyone had ever imagined.

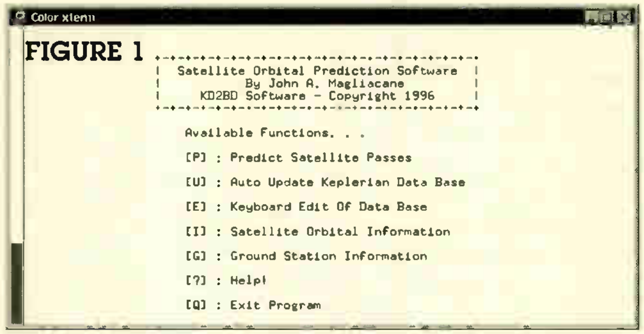


FIGURE 1

```
Color xterm
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Satellite Orbital Prediction Software    |
|          By John A. Magliacane             |
|     KD2BD Software - Copyright 1996        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   Available Functions. . .

   [P] : Predict Satellite Passes

   [U] : Auto Update Keplerian Data Base

   [E] : Keyboard Edit Of Data Base

   [I] : Satellite Orbital Information

   [G] : Ground Station Information

   [?] : Help!

   [Q] : Exit Program
```

PREDICT opening screen displaying all available options.

What is Linux?

Linux is a powerful multi-user, multi-tasking, multi-processing, multi-platform computer operating system patterned after Unix. It is a bit-size-independent operating system in the sense that it operates as a 32-bit operating system on 32-bit processors, and as a 64-bit operating system on 64-bit processors. It operates on Intel-based personal computers carrying 80386, 80486, or Pentium processors, and its symmetric multi-processing (SMP) capabilities allow it to take full advantage of motherboards containing as many as 16 Pentium processors.

Portable and modular coding has allowed Linux to be rapidly ported to other computing platforms such as the Acorn ARM, MIPS, Atari, Amiga, PowerPC, PowerMac, Sun SPARC and other SPARC-based machines, including the Fujitsu AP1000+ supercomputer, and to Digital Equipment Corporation's "Alpha" series of computers, where it takes full advantage of the Alpha's architecture and operates as a robust 64-bit operating system.

Linux offers power, stability, flexibility, and performance unmatched by many commercial computer operating systems at any price. As an example of its multi-platform support, consider that Linux was installed on one of the IBM Thinkpad laptop computers carried on the space shuttle during mission STS-75 in support of the tether experiments carried out on that mission. Since the ground-based applications to control those experiments ran on a DEC Alpha, it was a simple matter to port those applications to a Linux system for on-board use.

Another strength of Linux is its high-quality networking capabilities that support such protocols as TCP/IP (the protocol used on the Internet), IPX (the protocol used by Novell Netware), Appletalk (the protocol used by Apple Macintosh computers), SMB (the protocol used by Lan Manager, Windows 95, Windows for Workgroups, and several other DOS-related software packages), as well as AX.25 (the Amateur Packet Radio communications protocol). These networking capabilities are included within

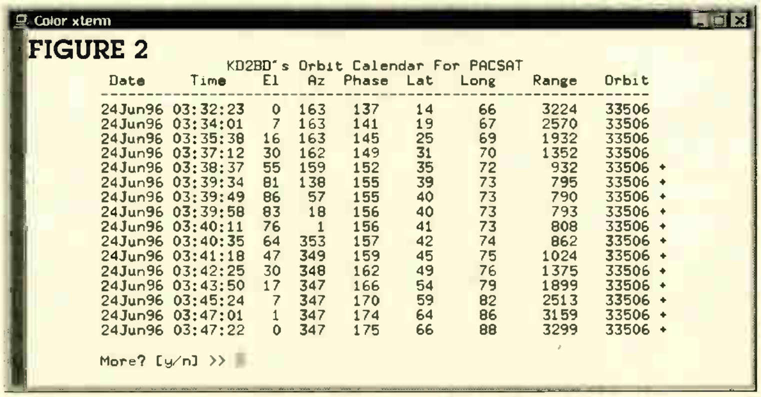


FIGURE 2

Color xterm

KD2BD's Orbit Calendar For PACSAT

Date	Time	El	Az	Phase	Lat	Long	Range	Orbit	
24Jun96	03:32:23	0	163	137	14	66	3224	33506	
24Jun96	03:34:01	7	163	141	19	67	2570	33506	
24Jun96	03:35:38	16	163	145	25	69	1932	33506	
24Jun96	03:37:12	30	162	149	31	70	1352	33506	
24Jun96	03:38:37	55	159	152	35	72	932	33506	+
24Jun96	03:39:34	81	138	155	39	73	795	33506	+
24Jun96	03:39:49	86	57	155	40	73	790	33506	+
24Jun96	03:39:58	83	18	156	40	73	793	33506	+
24Jun96	03:40:11	76	1	156	41	73	808	33506	+
24Jun96	03:40:35	64	353	157	42	74	862	33506	+
24Jun96	03:41:18	47	349	159	45	75	1024	33506	+
24Jun96	03:42:25	30	348	162	49	76	1375	33506	+
24Jun96	03:43:50	17	347	166	54	79	1899	33506	+
24Jun96	03:45:24	7	347	170	59	82	2513	33506	+
24Jun96	03:47:01	1	347	174	64	86	3159	33506	+
24Jun96	03:47:22	0	347	175	66	88	3299	33506	+

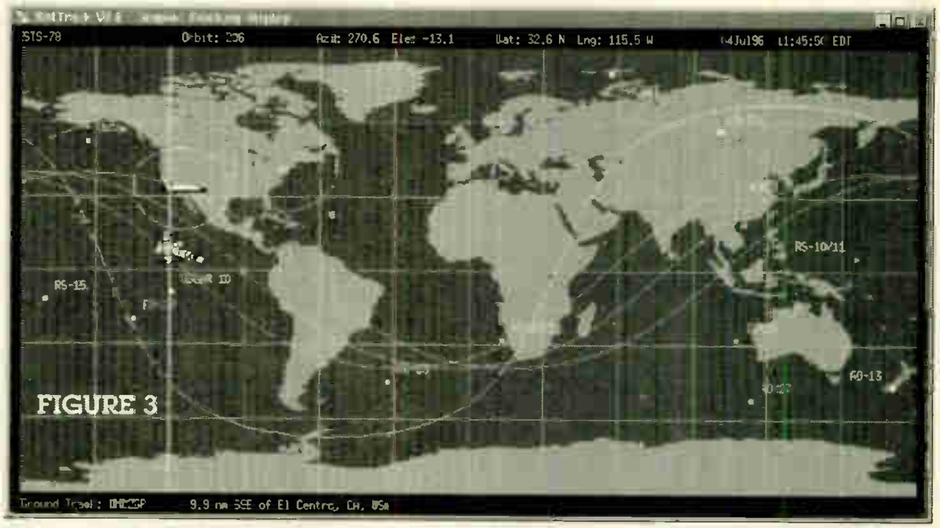
More? [y/n] >>

Orbital predictions made by PREDICT showing passes of the AMSAT-OSCAR-16 satellite.

For several years, an international collaboration of computer programmers under the direction of Linus Torvalds, a computer science student at the University of Helsinki, have been developing a free Unix-like operating system called "Linux" for use on personal computers.

the Linux operating system kernel, and effectively eliminate the need for external protocol drivers such as those required under layered (and unstable) environments such as Microsoft Windows.

It seems quite fitting that some of the developers of the Linux operating system are themselves amateur radio operators. For example, the Linux AX.25 and NET/ROM networking code was created and written by Jonathan Naylor (G4KLX) and Alan Cox (GW4PTS). Others, including myself, have authored amateur radio-related software applications for Linux that provide communications, satellite tracking, and orbital prediction functions. These applications, along with the multi-tasking capabilities of the Linux operating system, make it an ideal environment for use in amateur satellite communications.



Tracking STS-78, Mir, and 14 OSCAR satellites simultaneously under SatTrack Version 3.1.5 on a Linux-based PC.

Linux and Satellites

The advantage of a multi-tasking operating system is that it allows many programs to be executed concurrently on a single computer. Under a multi-tasking environment such as Linux, it is neither necessary nor desirable to integrate all the functions required of a satellite groundstation into one large program. Instead, small programs are made to run independently, allowing the operating system to intelligently manage the resources needed by all running applications.

The major requirement of an OSCAR groundstation computer is to process numerical data and provide orbital predictions for a particular groundstation location. Digital "Pacsat" satellites also require the groundstation computer to provide communication functions and negotiate file transfers with the satellite, download directories, check for mail, and so forth. If directional antennas are used, it is also convenient to have the computer aim them toward the satellite as it arcs across the sky, and even tune the uplink transmitter and downlink receiver during the pass to compensate for the effects of Doppler shift. It might also be nice to process satellite telemetry transmissions to keep tabs on its health.

Even a "lowly" 80386-based PC has more than enough processing power to perform all these operations simultaneously with plenty of muscle to spare if they are executed under an efficient operating system such as Linux.

Satellite Tracking and Orbital Predictions

Figure 1 is a screen snapshot showing PREDICT, a satellite orbital prediction program running under Linux. Although text-based, the program was run under a graphical terminal for the purposes of this article under the X Window System using an experimental window manager known as FVWM-95.

FVWM-95, a name that stands for "Frugal Virtual Window Manager," was designed to have an appearance similar to that of Windows 95. The X Window System is a graphical windowing system developed at the Massachusettes Institute of Technology for Unix and other hardware independent operating systems. Many different window managers can run under X, providing flexibility not possible under other windowing environments.

The second figure shows orbital prediction information for the AMSAT-OSCAR-16 Pacsat satellite. The information provided by PREDICT is more than adequate for determining the optimum times to access an OSCAR satellite over a particular groundstation location. PREDICT was written in "C" and originally developed on a 1 MHz Commodore 64 computer in the early 90's. It has since been ported to several Sun workstations, MS-DOS, and most recently to Linux where it runs substantially faster than it does under MS-DOS on the same hardware.

The difference between satellite tracking and orbital prediction functions is that tracking is done in real-time and predictions are made before time in preparation for the actual event. A truly robust and feature-rich program that combines the functions of both satellite tracking and orbit predictions is SatTrack by Dr. Manfred Bester (DL5KR/W6). Written in "C," SatTrack is designed to operate on high-end Unix workstations such as Sun SPARCs running SunOS or the Solaris operating system, the HP Apollo 9000 series, the IBM RS-6000, the SGI Indigo 2 running IRIX 5.3, and the DEC Alpha running AXP/OSF. It also compiles and runs very nicely on PCs running Linux. Several versions of this program are available at the current time. Version 3 is available free of charge via the Internet provided it is used for non-commercial purposes.

Figure 3 shows SatTrack's graphical output as it tracks Space Shuttle *Columbia* on mission STS-78, the *Mir* space station, and 14 OSCAR satellites simultaneously. This was done on a 33 MHz 80486-based PC running Linux version 2.0.0 with 8 megabytes of system RAM. In this mode, SatTrack used only 1272 kilobytes of system RAM and just 6 percent of the CPU's processing time, keeping plenty of resources available

In addition to providing information required for satellite communications, SatTrack is also useful for visually tracking satellites. It has been successfully used to control a two-telescope Infrared Spatial Interferometer for just that purpose.

for other applications.

In single satellite tracking mode, SatTrack provides output data that is useful for real-time satellite commmunications. Figure 4 shows real-time data for tracking the AMSAT-OSCAR-16 satellite. Doppler shift, the vector velocities of the spacecraft, and even the angle of the sunlight hitting the spacecraft is shown.

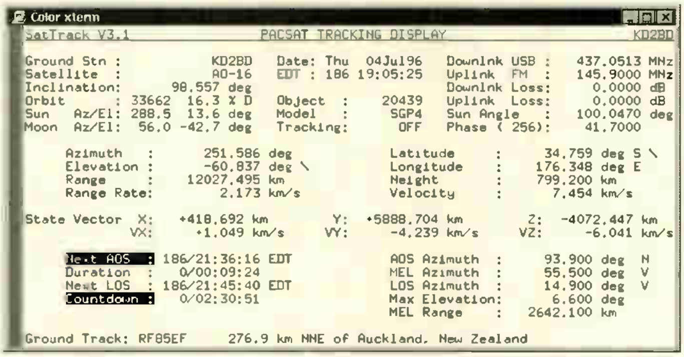


FIGURE 4: ***SatTrack real-time tracking data for the AMSAT-OSCAR-16 satellite. The program also features audible alarms to attract the attention of the groundstation operator prior to AOS and LOS.***

In addition to providing information required for satellite communications, SatTrack is also useful for visually tracking satellites. It has been successfully used to control a two-telescope Infrared Spatial Interferometer for just that purpose. In the interest of accurate optical tracking, SatTrack even goes to extent of using measurements of local air pressure, temperature, and humidity to calculate and compensate for the refractive index of the atmosphere over the groundstation.

Microsat Groundstation Software

Jonathan Naylor (G4KLX) and John Melton (G0ORX/N6LYT) have developed a suite of applications that allow communications with Pacsat satellites under the Linux operating system. These applications operate graphically under the X Window System. Hardware requirements include a KISS-capable packet radio terminal node controller (TNC) and a Pacsat modem, in addition to 2-meter and 70-cm radio equipment. They also require that AX.25 protocol drivers be compiled into the Linux kernel. These drivers have become "standard equipment" since the release of Linux version 2 in June 1996. AX.25 utilities such as "axattach" also need to be used to set the hardware address (callsign) and KISS interface of the serial port attached to the TNC.

The Microsat Groundstation Software suite includes XPB, a program similar in function to PB, a DOS-based Pacsat communications program written by Jeff Ward. XPB requests and captures file and directory information broadcast by Pacsat satellites, displays satellite status messages, and can also capture satellite telemetry and other data to a KISS log file for later analysis.

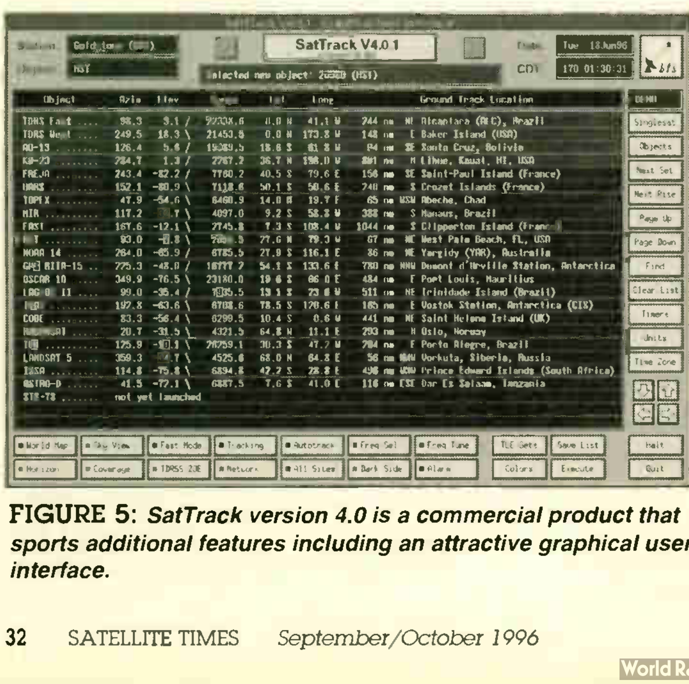


FIGURE 5: ***SatTrack version 4.0 is a commercial product that sports additional features including an attractive graphical user interface.***

XPG is a second program that is used to upload files to a Pacsat satellite. It can be used independently or concurrently with XPB to allow simultaneous full-duplex upload and download of files to and from the satellite. Double-clicking on the file entry within the XPG window forces it to be uploaded to the satellite.

A third program called MESSAGE may be called from XPG to prepare messages for upload to a Pacsat satellite. Figure 6 shows an example of MESSAGE's use in preparing a message for uploading to the AMSAT-OSCAR-16 Pacsat satellite by XPG.

Also included in the suite is a program called DIRECTORY that displays up to 2000 of the latest satellite directory entries. Files may be listed in order of Date/Time, message number, subject, source, or destination. Other utilities included are VIEWTEXT that displays Pacsat messages after their download, VIEWLOG that decodes and displays spacecraft activity, XTLM that decodes UoSAT telemetry data in real-time and from pre-recorded files, XWEBER that captures earth images taken by the WEBERSAT-OSCAR-18 satellite, and several others.

Perfect Together

XPB, XPG, MESSAGE, DIRECTORY, and SatTrack have all been successfully executed on a 33 MHz 80486-based PC with 8 megabytes of RAM under Linux 2.0.0, and used to communicate with the AMSAT-OSCAR-16 and LUSAT-OSCAR-19 satellites at KD2BD in New Jersey. Figure 7 shows a small sample of directory entries captured from the AMSAT-OSCAR-16 satellite by XPB. It is interesting to note that with all these applications running simultaneously along with 40 other system processes on the same PC, the CPU remained better than 80% idle.

Linux and the Future

The number of amateur radio software applications available for Linux is growing at a rapid rate. Unlike proprietary and expensive commercial software, the complete "C" source code for SatTrack, the Microsat Groundstation Software Suite, and even the Linux operating system itself is freely available via the Internet, allowing users the freedom to modify the programs to meet their particular needs and make

XPB, XPG, MESSAGE, DIRECTORY, and SatTrack have all been successfully executed on a 33 MHz 80486-based PC with 8 megabytes of RAM under Linux 2.0.0.

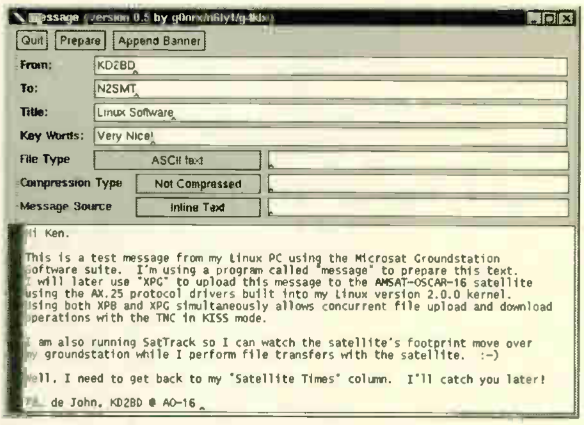


FIGURE 6: ***A program called MESSAGE is used to prepare messages for upload to Pacsat satellites.***

rapid improvements as they see fit.

John Melton is currently developing a system to make use of World Wide Web tools, CGI (Common Gateway Interface) scripts, and Unix e-mail technology to allow a Web browser such as Netscape to display Pacsat file directories. The mail interface within Netscape would be used for sending and receiving Pacsat mail. Anyone willing to work with John in the development of Microsat software is encouraged to do so. John may be contacted at: jmelton@slob.icl.co.uk.

Bdale Garbee (N3EUA) is developing Phase 3D satellite control software for Linux. Apparently, this software will be standard equipment for all Phase 3D groundstation controllers.

Klaus Kudielka (OE1KIB) has developed several Phase 3D satellite telemetry analysis programs. These programs work with a G3RUH 400-bps modem and allow data capture, error detection, and telemetry analysis under Linux.

A Linux network is in use at WA3NAN, the amateur radio club station at the Goddard Spaceflight Center in Greenbelt, Maryland. The software was installed by space shuttle astronaut Dr. Ron Parise (WA4SIR), who also runs Linux on some of his own computers. Ron will be the keynote speaker at the Grove Comm Expo in October in Atlanta.

Terry Dawson (VK2KTJ) authors several "HOWTO" documents that describe amateur radio software available for the Linux operating system. His HAM-HOWTO file describes software available for amateur communications, while his AX25-HOWTO describes the AX.25 networking capabilities native to the Linux operating system. Terry's HAM-HOWTO file is available via the Internet at: **http://sunsite.unc.edu/mdw/HOWTO/HAM-HOWTO.html**.

A comprehensive home page describing the Linux operating system with links to many other pages may be found at: **http://sunsite.unc.edu/mdw/linux.html**. Further information on the FVWM-95 Window Manager may be found at: **http://ltiww.epfl.ch/~barth/fvwm95.html**, while the official SatTrack home page may be found at: **http://www.primenet.com/~bester/sattrack.html**.

See you in Atlanta at the Expo. ST

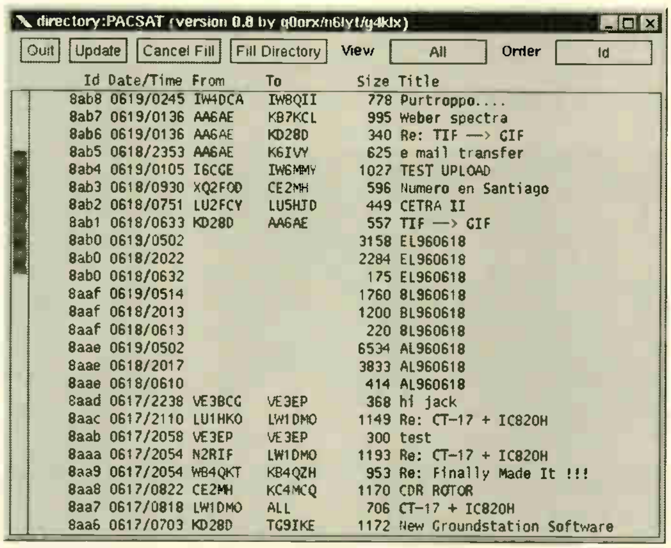


FIGURE 7: ***DIRECTORY is used to display files available on a Pacsat satellite.***

By Donald E. Dickerson, N9CUE

Final Analysis—The Russian Connection

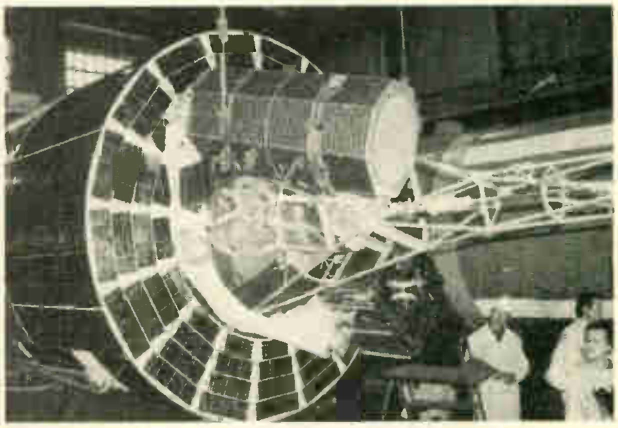
They launched it from Plesetsk cosmodrome, a military base 600 miles north of Moscow, near Arkhangelsk. It was the first U.S. spacecraft to be launched by the former Soviet Union. The satellite was called *FAISAT 1* (FinalAnalysis Inc. Satellite), and it was strapped to a Russian built Cosmos launch vehicle as a secondary payload. The primary payload was a Tsikada class Russian navigation satellite. It will be the first of 30 planned launches of U.S. satellites on Cosmos launch vehicles during the next five years. Fact or Fiction?

A few short years ago it would have been fiction of the type only seen in old *Star Trek* episodes. Even though it is true, it is still hard to believe that the project cleared the Commerce and State Departments (that took 10 months), CIA, and military intelligence, much less their Russian counterparts.

FAISAT 1 is the property of Final Analysis of Greenbelt, Maryland. Final Analysis is one of several competitors in the race to provide a data and non-voice type satellite services for a variety of customers from a constellation of small, inexpensive, low-earth-orbit satellites. The company will provide the usual paging, messaging ,and data collection services, as well as some more exotic services we will look at later.

President of Final Analysis, Nader Modanlo, and colleague Mike Ahan founded the privately owned company in 1992. Mr. Modanlo admits there was a lot of red tape involved in doing business with Russia, especially when high-technology—and its transfer to Russia—is still a concern for both governments. Not only is the Cold War over, it has apparently been all but forgotten.

Final Analysis has a long-term agreement with the Russians. Their Russian partner is Polyot Aerospace based in the town of Omsh in Siberia. Polyot builds Russian missiles, deep space probes, the *Glonass* and *Tsikada* class navigation satellites, the *COSPAR* search and rescue satellite transponders, and the *Cosmos* launch vehicle. It is the most reliable launch vehicle in the world. In fact it is rated at 99.1 percent reliable. Surpassing anything built by Europe or the U.S., it is one of the main reasons Final Analysis decided to work with the Russians. They did consider several American launch vehicles, including Orbcomm's *Pegasus*, which is launched like a missile from an aircraft, before they decided on Polyot.



The Faisat 1 spacecraft (top, center) is attached to a Russian Tsikada navigation satellite at the Plesetsk.

The $80 million agreement between Final Analysis and its Russian partner, Polyot, is unique. It is, in fact, a barter agreement: Polyot will provide launch vehicles of the *Cosmos* variety for the next 30 satellites Final Analysis is planning to launch. The next scheduled launch will take place sometime in the fall of 1996. The last satellite of this constellation is tentatively scheduled to be in orbit by 2001.

In exchange for these services, Final Analysis is prepared to build a ground station and network hub in Russia. In addition, Polyot's technical and sales staff will receive training from Final Analysis engineers and sales reps. Polyot will be the only company to market Final Analysis satellite services in the Commonwealth of Independent States (CIS). In the process Final Analysis will be transforming itself from a largely engineering firm to a service provider.

The Faisat was launched at night from Plesetsk on the Cosmos launch vehicle.

System Profile

Before all this can become a reality, there are a couple of hurdles slowing the process down. According to Final Analysis Senior Staff Advisor Barbara Duffy, they are still waiting on the Federal Communications Commission to issue their license. This will happen before *FAISAT 2V*, their second satellite, is launched this fall. This satellite will be of a different design from *FAISAT 1*, already in orbit.

The second hurdle slowing everyone in the little Earth orbit (LEO) race is the shortage of frequency space. The large aerospace companies have just about locked up the available spectrum for the big LEO satellite systems that they are currently developing. This leaves a relatively small portion of the 400 MHz and 150 MHz band for the non-voice satellite services to share. Current time division multiple access (TDMA) and frequency division multiple access (FDMA) technology will allow the final competitors to cohabit. If code division multiple access (CDMA) is used by all parties it may simplify the crowding problem considerably. Final Analysis is currently studying the benefits of CDMA. *FAISAT 1* transponders used TDMA and FDMA.

FAISAT 1 is a small spacecraft, like all

Final Analysis has a long-term agreement with the Russians. Their Russian partner is Polyot Aerospace. Polyot builds Russian missiles [including] the Cosmos launch vehicle. It is the most reliable launch vehicle in the world.

LEOs. It measures 40 inches tall and is 20 inches in diameter. It weights in at a smart 250 lbs. It is designed to operate for up to seven years.The first two spacecraft are expected to cost $6 to $8 million. The planned constellation of satellites will be placed in four planes of six satellites each, with an inclination of 66 degrees. Two additional satellites will orbit in their own plane at 83 degrees. Four spare spacecraft will be launched as well. Each of the four planes of six satellites will have an additional satellite for backup. It will remain in orbit as a spare to be used as needed. Altitude for the fleet will be approximately 650 miles.

Mike Fatig, Final Analysis Director of Business Development, says that the launch of *FAISAT 2V* is tentatively set, (as all launches are), for September 6, 1996. Final testing is now being done on the spacecraft to see if it will be space worthy in time for the September launch. According to Mr. Fatig gateway ground stations are under construction in Logan, Utah, and Norway. These two stations will be able to maintain communication with the 2V satellite during each of its 14 orbits per day.

The *FAISAT* spacecraft was strapped to a *Tsikada* class Russian navigation satellite. This was the same method used by the Russians to launch their amateur radio class of satellites during the 1980's.

The spacecraft uses store-and-forward data techniques with speeds of up to 9.6 kbps. This means almost any form of two-way data messaging will be possible. The relatively inexpensive equipment could be used to collect data from scientific and weather stations, truck fleets, personal beepers the list is endless. No doubt, uses that has not been even dreamed of will emerge as the LEOs come on line. In fact, Nader Modanlo has already discovered an application in the utility market. Yes, as in public utilities, the ones that provide our gas and electric services. In a few short years the meter man may become obsolete, due to a system designed by Final Analysis by which your utility meters can be read from space by a miniature satellite. Current technology allows a single spacecraft to read up to 20,000 meters in a 12 minute period.

This new technology could also open a whole new personal security service. Inexpensive personal ID tags could be used to literally keep track of children, employees, and the elderly, not just equipment, cargo, and freight. Who could deny such a useful service? Radiolocation and personal ID would be a safety feature that could become affordable—if not desirable—in the not too distant future.

Final Analysis' client list includes not only public utilities, but NASA, DoD, universities, hospitals and trucking companies. In fact, one of Final Analysis' most notable projects was carried on the *FAISAT 1* spacecraft for the Air Force and Phillips Laboratory. This in itself makes the whole launch all the more intriguing.

The project was called the small satellite thermal technology project or SSTT. It was to tests the capacity of a capillary loop pump used for cooling equipment in space. As part of the deal the Air Force flew the *FAISAT 1* spacecraft to Plesetsk cosmodrome on a National Guard aircraft. The Air Force, however, failed to come up with the $1 million for the project. So the Air Force SSTT project was simply not turned on.

Final Analysis may have space for you on one of their next launches. They are making space available for scientific and commercial experiment packages on their spacecraft. Universities, the military, and others can acquire space on *FAISAT 2V*. For more information on this project call Barbara Duffy, Final Analysis Senior Staff Advisor, at (301) 474-0111

2V to Carry VITA Transponder

The second spacecraft in the Final Analysis fleet will carry additional transponder space which will be used by VITA (Volunteers In Technical Assistance). VITA has in the past used space on some of the English AMSAT (or more appropriately, AMSAT-UK), spacecraft. This group provides emergency and routine medical assistance via satellite to third world countries and remote areas of the Earth. This accommodation was reached after VITA lost one of its satellites in 1995 when a Lockheed launch vehicle failed. VITA plans to build gateway Earth stations in South Africa, Chile, Norway, and Australia. They will allow remote terminals to connect to the Internet, among other things.

According to an article written by Tania Anderson for *Washington Technology* newspaper, Final Analysis President Nader Modanlo has said that the French aerospace companies like Arianespace, Spot Image, and Alcatel are the driving force behind the space industry. "International companies spend 10 days preparing for a launch, while the U.S. firms take several months," said Modanlo. "Using international companies is cheaper and more efficient."

Final Analysis is a great name for an aerospace company led by a man like Nader Modanlo. His aggressive leadership style, "can do" attitude, and ability to make thoughtful decisions has brought this young company with only 32 employees onto a very competitive playing field in which he seems to be making great progress. Knowing what he wants and getting there by the simplest and most cost-effective manner is the hallmark of Nader Modanlo's Final Analysis. ST

By Keith Stein
kstein@erols.com

Battle Plans From Orbit

As we move higher and higher in the radio spectrum, reception of satellites does become more difficult for the monitor. Don't let this discourage you. You should take your monitoring efforts one step at a time. As we move into monitoring the 225-400 MHz band, put on your flight suit (Air Force), lace up your combat boots (Army), set sail (Navy) or just flex your muscles (Marines); military action is at your finger tips.

Some of the most interesting military voice transmissions can be heard in this area of the spectrum. Phil Pittard in Australia provided us with some interesting military intercepts in our last issue. Now it's your turn to see what is available in your area. The majority of the signals heard in this spectrum come from geostationary satellites, but some low earth orbiters can also be found. There are so many frequencies in this postion of the spectrum, we really need to break our examination of the band into several smaller segments. We will start our exploration of the military band satellites in this issue with a couple of geostationary satellite systems.

Defense Satellite Communications System III (DSCS III)

This constellation of geostationary satellites consists of four active satellites, plus two in-orbit spares. The DSCS system is designed to provide communication support to military commanders and troops in the field. These spacecraft provided 80% of all communications during the U.S. involvement in Operation Desert Shield and Storm (1990-1991). Today, Bosnia is center stage, and DSCS III satellites are playing a major role in the operation.

DSCS III B7 is the newest member of the constellation, launched July 31, 1995, and currently positioned at 52.5 degrees West longitude. The next spacecraft—DSCS III B13 scheduled for launch—year and is currently undergoing full thermal vacuum chamber and acoustic testing at Lockheed Martin Missiles and Space in Sunnyvale, California.

Designed for a lifetime of five years, some of these spacecraft have operated for over 14 years. One upgrade in the DSCS III series over the II series is increased communications capacity. For example, a 21 watt "Single Channel Transponder" downlinks between 243.6945-250.0 MHz:. Signals will hop over this band at a rate of 200 hops per second. *Satellite Listening Post* doesn't leave any stone unturned, eeven though you are not going to hear any of these transmissions on an average receiver. The remainder of the DSCS system downlinks are in the 7 GHz area.

In case of a catastrophic failure in the DSCS constellation, the U.S. Army is always on call to operate a HF system located on the Marshall Islands in the Pacific Ocean on the following HF frequencies: 4540, 4924, 5260, 5810, 7590, 8162, 11100, 13680, 23150 kHz.

Catalog No	Intl Desig	Spacecraft	Position
13637	1982-106B	DSCS III A1	130.0 W
16116	1985-092B	DSCS III B4	42.5 W
16117	1985-092C	DSCS III B5	180.0 E
14675	1989-069B	DSCS III A2	57.0 E
21873	1992-006A	DSCS III B14	135.0 W
22009	1992-037A	DSCS III B12	12.0 W
22913	1993-074A	DSCS III B10	60.0 E
22719	1993-046A	DSCS III B9	175.0 E
23628	1995-038A	DSCS III B7	52.5 W

LEASAT/Syncom System

One of the oldest, but yet still active, of the current UHF military satellite systems is the U.S. Navy Leasat/Syncom constellation (see Tables 1 and 2 on next page). This dying family of five satellites was first launched in 1984 aboard the U.S. space shuttle. The primary mission for these Hughes-built spacecraft is to provide communications between ships, aircraft, and ground facilities. But, it has been a rocky road to orbit for LEASAT.

LEASAT 3 was left in the wrong orbit when its apogee kick motor fail to ignite to place it in a geostationary orbit. LEASAT 4 failed completely after it reached geostationary orbit.

For a more in-depth look at LEASAT/Syncom, check out Larry Van Horn's article on p.22-23 in the Julu/August 1995 issue of *Satellite Times.*

NASA Upgrades Merritt Island; Indian Ocean Closed

NASA's Networks Division, located at the Goddard Space Flight Center, Greenbelt, Maryland, has completed installation and testing of a Quad-Helix antenna at their Merritt Island tracking station, Florida. Merritt Island is the primary facility that provides communications between the space shuttle and NASA's mission control during launch. The Quad-Helix antenna was transferred from the closed Dakar, Senegal, station in mid-May. It was refurbished and installed at Merritt Island in early June. This additional communications installation will serve as a backup to the primary TelTrac UHF system.

The first test of the system was performed in June by the Checkout and Test Lab at Kennedy Space Center. Two-way voice checks were made on 243.0, 259.7, and 296.8 MHz. A second test was conducted with the rotating service structure (RSS) around the shuttle on the launch pad, and a third test was performed with the RSS retracted. A fourth and final test occurred during the STS-78 launch on June 20, 1996.

The closure of the Indian Ocean Station (IOS) is proceeding on schedule. The facility ceased operations on August 15, 1996. Equipment and personnel should be off the island no later than December 31, 1996. The station's S-band equipment will be moved to Diego Garcia to begin NASA tracking support in November 1996. The station's UHF system electronics will be shipped to NASA's Goddard Space Flight Center (GSFC); the antennas will be put in storage at the station.

The primary mission for these Hughes-built spacecraft is to provide communications between ships, aircraft, and ground facilities. But, it has been a rocky road to orbit for LEASAT.

TABLE 1: LEAFSAT Orbital Data

Satellite	Orbital	Location	International Designator	Satellite Catalog No	Launch Date
LEASAT F1	Retired		1984-113C	15384	11/10/85
LEASAT F2	177.6 W	1984-093C	15236		08/31/84
LEASAT F3	105.3 W	1985-028C	15643		04/12/85
LEASAT F4	Failed		1985-076D	-----	08/29/85
LEASAT F5	71.5 E		1990-002B	20410	01/09/90

TABLE 2: LEAFSAT UHF Downlink Bandplan

243.855	LEASAT ch.9 AFSATCOM Narrow Band Channel, Whiskey
243.860	LEASAT ch.10 AFSATCOM Narrow Band Channel, Whiskey
243.875	LEASAT ch.11 AFSATCOM Narrow Band Channel, Whiskey
243.900	LEASAT ch.12 AFSATCOM Narrow Band Channel, Whiskey
243.910	LEASAT ch.13 AFSATCOM Narrow Band Channel, Whiskey
243.955	LEASAT ch.9: AFSATCOM Narrow Band Channel, X-ray
243.960	LEASAT ch.10: AFSATCOM Narrow Band Channel, X-ray
243.975	LEASAT ch.11: AFSATCOM Narrow Band Channel, X-ray
244.000	LEASAT ch.12: AFSATCOM Narrow Band Channel, X-ray
244.010	LEASAT ch.13: AFSATCOM Narrow Band Channel, X-ray
244.055	LEASAT ch.9: AFSATCOM Narrow Band Channel, Yankee
244.060	LEASAT ch.10: AFSATCOM Narrow Band Channel, Yankee
244.075	LEASAT ch.11: AFSATCOM Narrow Band Channel, Yankee
244.100	LEASAT ch.12: AFSATCOM Narrow Band Channel, Yankee
244.110	LEASAT ch.13: AFSATCOM Narrow Band Channel, Yankee
244.155	LEASAT ch.9: AFSATCOM Narrow Band Channel, Zulu
244.160	LEASAT ch.10: AFSATCOM Narrow Band Channel, Zulu
244.175	LEASAT ch.11: AFSATCOM Narrow Band Channel, Zulu
244.200	LEASAT ch.12: AFSATCOM Narrow Band Channel, Zulu
244.210	LEASAT ch.13: AFSATCOM Narrow Band Channel, Zulu
250.350	LEASAT ch.1 Fleet Broadcast Channel, Whiskey
250.450	LEASAT ch.1 Fleet Broadcast Channel, X-ray
250.550	LEASAT ch.1 Fleet Broadcast Channel, Yankee
250.650	LEASAT ch.1: Fleet Broadcast Channel, Zulu
251.850	LEASAT ch.3 25 kHz Navy Relay Channel, Whiskey
251.950	LEASAT ch.3: 25 kHz Navy Relay Channel, X-ray
252.050	LEASAT ch.3: 25 kHz Navy relay Channel, Yankee
252.150	LEASAT ch.3: 25 kHz Navy Relay Channel, Zulu
253.550	LEASAT ch.4 25 kHz Navy Relay Channel, Whiskey
253.650	LEASAT ch.4: 25 kHz Navy Relay Channel, X-ray
253.750	LEASAT ch.4: 25 kHz Navy relay Channel, Yankee
253.850	LEASAT ch.4: 25 kHz Navy Relay Channel, Zulu
255.250	LEASAT ch.5 25 kHz Navy Relay Channel, Whiskey
255.350	LEASAT ch.5: 25 kHz Navy Relay Channel, X-ray
255.450	LEASAT ch.5: 25 kHz Navy relay Channel, Yankee
255.550	LEASAT ch.5: 25 kHz Navy Relay Channel, Zulu
256.850	LEASAT ch.6 25 kHz Navy Relay Channel, Whiskey
256.950	LEASAT ch.6: 25 kHz Navy Relay Channel, X-ray
257.050	LEASAT ch.6: 25 kHz Navy relay Channel, Yankee
257.150	LEASAT ch.6: 25 kHz Navy Relay Channel, Zulu
258.350	LEASAT ch.7 25 kHz Navy Relay Channel, Whiskey
258.450	LEASAT ch.7: 25 kHz Navy Relay Channel, X-ray
258.550	LEASAT ch.7: 25 kHz Navy relay Channel, Yankee
258.650	LEASAT ch.7: 25 kHz Navy Relay Channel, Zulu
260.350-260.850	LEASAT ch.2: 500 kHz Wideband Channel, X-ray
261.45-261.9500	LEASAT ch.2: 500 kHz Wideband Channel, Yankee
262.050-262.550	LEASAT ch.2: 500 kHz Wideband Channel, Zulu
263.55-264.0500	LEASAT ch.2 500 kHz Wideband Channel, Whiskey
265.250	LEASAT ch.8 25 kHz Navy Relay Channel, Whiskey
265.350	LEASAT ch.8: 25 kHz Navy Relay Channel, X-ray
265.450	LEASAT ch.8: 25 kHz Navy relay Channel, Yankee
265.550	LEASAT ch.8: 25 kHz Navy Relay Channel, Zulu

Satellite Listening Post Intercepts

All times in UTC. All voice transmissions in English unless otherwise noted.

AM	Amplitude Mdulation
DoD	Department of Defense
EVA	Extravehicular Activity
G	Gigahertz
K	Kilohertz
LSB	Lower Sideband
M	Megahertz
NFM	Narrowband Frequency Modulation
SAR	Search and Rescue
USAF	US Air Force
USB	Upper Sideband

K3840 AMSAT North America East Coast net heard at 0102 in LSB with W8GUS-Ron as net control station (Keith Stein-Woodbridge, VA)

K5700 At 0514 ABNORMAL 10 advised they were moving to 15793 USB. At 1010 ABNORMAL 10 called AIRBORNE Test and asked if they were ready to bring up the net (Brian Scott-Ft. Worth, TX) *This might have been a dress rehearsal test for the Pegasus/TOMS launch-Keith*

K5711 Cape Radio with other stations conducting test at 2243 in USB (JL Metcalfe-KY)

K6820 ARIA Control and Abnormal 10 heard between 0414-0513 working ARIA1 for tracking support of the Pegasus/TOMS launch in USB (K Stein-VA)

K6937 Marine vessels *Freedom Star* and *Liberty Star* heard at 1704 after launch of shuttle mission STS-78 in USB. "Plugs are now secured on both right hand and left hand boosters." (David Stein-Springfield, VA)

K7185 Amateur radio station WA3NAN heard providing retransmission of shuttle countdown for mission STS-78 at 1425 in LSB (David Moisan N1KGH-Boston, MA)

K7765 DoD Cape at 1038 in USB with announcement to Range Safety units that the shuttle is in orbit and announcement of Open Ocean bailout SAR Exercise..."this is a drill" in support of launch of space shuttle *Endeavour* on mission STS-77. KING 1 (USAF HC-130) Rescue aircraft at 1039 in USB working DoD Cape reporting on data marker buoy dropped at 3020N/7930W. *USS John Hancock* at 1044 in USB working DoD Cape and proceeding to 3020N/7920W, later confirms helo, CUTLASS 473 was airborne but loitering within 7 nm of ship. ORION 4 (USN P-3C) at 1103 in USB, working DoD Cape and proceeding to drill. *Liberty Star* vessel at 1843 in USB, calling Cape Radio, no joy. This is a booster recovery ship (Rick Baker-Austintown, OH)

K10352 At 0600, ABNORMAL 10 and ARIA 1 heard working in duplex for Pegasus/TOMS launch. Also heard on K11110. (Jeff Jones-San Francisco, CA)

NASA's Networks Division, located at the Goddard Space Flight Center, Greenbelt, Maryland, has completed installation and testing of a Quad-Helix antenna at their Merritt Island tracking station, Florida.

K10780 *USS John Hancock*, 2204, working Cape Radio in support of STS launch. *USS John Hancock* reported being underway and inquired if *Cape Osborne* was active on the net (Dave Wright-San Angelo, TX)

K11059 SAM 201 heard at 1448 having problems with SATCOM. They are uplinking on channel 10 and downlinking on channel 9. Encryption is bad (will not decode) and are testing in the clear with Andrews AFB VIP. Aircraft commander said she was using 1,000 watts into the uplink (John Burtenshaw-U.K.)

K14295 Shuttle rebroadcast service out of WA3NAN was active at 1807 in USB (Craig MacKinnon VE1JMA-Halifax, Nova Scotia, Canada)

M119.100 Aircraft heard at Washington National Airport in AM mode; NASA 8 (B200) landing at 1134; NASA 1 (G-1159) departing about 2015; and NASA 948 (G-1159) departing 2010. (K. Stein-VA)

M122.850 NASA 8 (B200) heard calling Langley AFB Metro after leaving Washington National airport at 1145, AM. (K Stein-VA)

M122.950 NASA 8 (B200) heard calling Washington National Airport Unicom requesting temperature and two taxis upon arrival at 2355 in AM (K Stein-VA)

M130.167 At 0520 an EVA seemed to be under way on board the Mir space station (or being wrapped up), also heard on 143.618 MHz. However, the voice dropped off the air at 0522 way above my horizon. Was this the end of the EVA? (Sven Grahn-Sollentuna, Sweden)

M132.225 NASA 928 (WB-57F Canberra) heard working up and down Lake Michigan shoreline at 2000 in AM. Pilot was given a block altitude between 57,000 and 63,000 ft. About 2115 he departed the area and requested direct to Wright Patterson AFB (Scott Miller)

M137.400 Spacecraft signal heard at 1116, NFM. Didn't sound like the normal Russian Meteor spacecraft, possibly one of the Okean's? (D Stein-VA) *An image received in England on this same frequency has been identified as coming from Cosmos 1602. This is a 12 year old Okean-type spacecraft; nice catch-Keith*

M137.500 U.S. weather satellite NOAA 12 heard at 0821, NFM (John Corby-Caledon, Ontario, Canada)

M137.620 U.S. weather satellite NOAA 14 heard at 1904, NFM (Josh R Williams, Monroe, MI)

M137.710 Picked up a satellite signal here between 1440-1449, non-APT like the weather satellites. (Lawrence Harris-Plymouth, UK)

M143.625 At 0824 the Mir crew was really busy at the microphones while passing over Europe. I could hear the commander and U.S. researcher Shannon Lucid talking, NFM (Grahn-Sweden)

M145.550 Astronaut Chuck Brady N4BQW was heard at 1617, NFM aboard the space shuttle Columbia during mission STS-78. About 1 hour and 23 minutes later U.S. astronaut Shannon Lucid was heard aboard the Russian space station Mir (D Stein-VA)

M145.800 At 0824 the flight engineer aboard Mir was heard speaking Russian to a radio amateur. He used "Komplex Mir" as his call-sign and was talking about their spacesuits. (Grahn-Sweden)

M145.825 Amateur radio satellite Dove (also known as DO-17 or Oscar 17) returned to operation at 0420, NFM, after experiencing a hardware problem. (Jim White WD0E-Parker, CO)

M146.835 Washington D.C., area AMSAT net heard at 0102, NFM with WD8LAQ as net control "looking for volunteers to act as net control over the summer." Stations checking in included: N3RUA, WD2AHA and KD4UPI. (K Stein-VA)

M147.450 Goddard Amateur Radio Club providing retransmission of STS-77 launch countdown at 1000, NFM. (K Stein-VA)

M149.970 Russian navigation satellite Cosmos 2173 heard at 0819, NFM. (Corby-Canada).

M150.000 Picked up a signal around 1305 and a second one around 2300, spacecraft unknown (Floyd Weaver-Lebanon, PA) *I would put my money on this being a Russian navigation satellite-Keith.*

M259.700 Voice downlink received from space shuttle mission STS-77 (1038) and STS-78 (1456) during launch, AM mode (K Stein-VA)

M260.750 Cape Osbourne working King 4 and King 5 (both HC-130 aircraft) on FLTSATCOM F1 (14.5 deg W) channel 2. Voice downlink was non-secure at 1325, NFM. This is the shuttle contingency support. King 4 was told by Cape that the mission (STS-78) was going well and that he could shut down and was not needed unless there was an actual contingency. (Jeroen Beijer-Holland)

M408.400 NASA Headquarters security units Alpha 11, Dispatch, Central and Alpha 5 heard conducting routine building surveillance at 1116, NFM (K Stein-Washington DC)

M463.725 NASA Headquarters building maintenance personnel heard at 1329, NFM (K Stein-DC)

G4.120 TDRS 6 (47 deg W), channel 21 horizonal, test slate booming at 0015. (Mario)

G6.200 Audio channel of Summer Sumo Wrestling Tournament direct from Japan viewed nightly on Galaxy 6, transponder 6, from 0735-0900. (Jerry Schonewille-San Jose,CA)

G11.790 Sports event "Euro96" viewed on Orion 1 (37.5 deg W), game between Germany and Czech Republic (channel 19, using Anik Ku format) PAL video standard. (David Pelling)

G11.960 Taped broadcast of sports events "Euro96" from Egyptian Satellite Channel viewed on Telstar 401 (97 deg W), transponder 9 vertical, at 2200 and 0230. (Amro-Pittsburgh, PA). ST

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INTRODUCTION

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

How to Use the Satellite Service Guide

The various sections of the SSG include:

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

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

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

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

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

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

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

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

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

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

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

AUDIO SUBCARRIERS

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

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

Classical Music

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

Satellite Computer Services

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

Contemporary Music

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

Country Music

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

Easy Listening Music

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

Foreign Language Programming

Antenna TV (Greece)	T3, 22	5.85
Arab Network of America radio network	G6, 10	5.80
CBC Radio-East (French)	E2, 1	5.38/5.58 (DS)
	E2, 1	7.36
CHIN-AM/FM (1540/100.7) Toronto, ON Canada, ID-*CHIN*—multilingual	E2, 2	7.89
DZMM-Radyo Patrol (from Philippines)	G4, 24 (Ku-band)	6.80
French language audio service	E2, 11	6.12
India ethnic radio	E2, 2	7.61
Indian Sangeet Sager	E2, 16 (Ku-band)	6.12
Irish music (Sat 1430-0000 UTC)	S3, 3	6.20
KAZN-AM (1300) Pasadena, CA—Asian Radio	K2, 8 (Ku-band)	6.20
Northern Native Radio (Ethnic)	E2, 26 (Ku-band)	6.43/6.53 (DS)
RAI Satelradio (Italian)	G7, 14	7.38
Radio Canada (French)	E2, 11	5.40/5.58 (DS), 5.76
Radio Dubai (Arabic)	G7, 10	7.48
Radio Maria (Italian-Religious programming)	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Sedeye Iran (Farsi)	S3, 15	6.20 (N)
Radio Tropical (Haitian Creole)	S2, 11	7.60
Reotto Network (Italian)	T402R, 18	5.80
Russian-American radio network	SBS5, 14 (Ku-band)	6.20
The Clanny Channel (Anti-Castro Cuban clandestine station programming)	S2, 4	7.56
Trinity Broadcasting radio service (Spanish) SAP—religious	G5, 3	5.96
WCMQ-FM (92.3) Hialeah, FL (Spanish), ID-*Mega 92*—contemporary hit radio	S2, 4	7.74, 7.92
WCRP-FM (88.1) Guyama, PR (Spanish)—religious	G4, 6	6.53
WLIR-AM (1300) Spring Valley, NY (Ethnic)	S2, 1	7.60
XEW-AM (900) Mexico City, Mexico (Spanish), ID-*LV de la America Latina*	M2, 14	7.38
XEW-FM (96.9) Mexico City, Mexico (Spanish), ID-*W-FM 96.9*	SD1, 7	7.38
XEWA-AM (540) Monterrey, Mexico (Spanish), ID-*Super Estelar*—contemporary music	M2, 8	7.38

Jazz Music

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)
WQCD-FM (101.9) New York City, NY, ID-*CD 101.9, Cool FM*	C4, 6	6.20

News and Information Programming

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

Religious Programming

Ambassasor Inspirational Radio	S3, 15	5.96, 6.48 (DS)
American Spirit Network/KYND-AM (1520) Houston, TX—Religious/variety (weekends)	S3, 24	7.40
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5, 11	6.12
	C3, 1	6.20
Christian Music Network Lakeland, FL	S2, 21	6.20, 7.60
Eternal Word Radio Network	G1, 11	5.40
Heaven Radio Network	G1, 17	7.92
Inspirational/Gospel music (no ID)	G5, 6	7.38
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

Satellite Radio Guide

Rock Music

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

Speciality Formats

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

Talk Programming

American Freedom Radio network	G6, 14	5.80
Amerinet Broadcasting	G6, 23	8.10
For the People radio network (Chuck Harder)—talk and information	C1, 2	7.50
KTRT-AM (1270) Claremore, OK	T3, 7	5.60
Omega Radio Network	G6, 14	7.56
One on One Sports radio network—sports talk	E2, 2	7.51
Practical Radio Communications (audio distribution circuit)	T3, 7	7.90
Prime Sports Radio—sports talk and information	S3, 24	5.80
Talk America—talk programs	S3, 9	6.80
Talk Radio Network—talk programs	C1, 5	5.80
WOKIE Network (tech talk)	SBS6, 13B	(Ku-band)
6.20 (occasional network on when Megabingo is present)		
WWTN-FM (99.7) Manchester, TN—news and talk	G5, 18	7.38, 7.56

Variety Programming

American Urban Radio—news/features/sports	S3, 9	6.30/6.48 (DS)
CBC Radio (English)	E2, 6	5.40/7.58, 5.58
CBC Radio (occasional audio)	E2, 1	5.78
CBC-FM Atlantic (English)	E2, 6	6.12/6.30 (DS)
CBC-FM Eastern (English)		E2, 6
	5.76/5.94 (DS)	
CBM-AM (940) Montreal, PQ Canada—variety/fine arts	E2, 1	6.12
CFR-FM	E2, 19 (Ku-band)	6.12/6.30
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
WAXY-AM (790) Miami, FL—variety	S2, 4	7.38
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

FM SQUARED (FM²) AUDIO SERVICES

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

Spacenet 3 Transponder 13

Ambassador Inspirational Radio: 1.420, 4.470, and 4.650 MHz
Blank audio carriers: 1.050, 2.130, 2.310, 2.500, 2.670, 2.860, 3.030, 3.390, 3.570, 3.750, 3.390, and 4.110 MHz
International Broadcasting Network: 4.830 MHz
Religious Backhauls (various): 1.235 MHz
USA Radio Network: .330 MHz
VCY America: .540 and .780 MHz
WJSO-FM (90.1) Pikeville, KY (Moody Broadcasting Network): 1 770 and 4.290 MHz

Spacenet 3 Transponder 17

Blank audio carriers: 3.570 and 3.750 MHz
Childrens Sunshine Network: 1.275 MHz
Data Transmission: .800, .840, and 1.225 MHz
Focus on the Family: 1.050 and 1.400 MHz
In-Touch—religious: 4.470 MHz
Salem Satellite Network: 4.650 and 5.010 Mhz
Skylight—religious: 1.770 and 4.260 MHz
UPI Radio Network: .330 MHz
WGNR-FM (88.9) Monee, IL—Good News Radio: 2.500 and 2.650 MHz

Spacenet 3 Transponder 18

Data Transmissions: 4.800 MHz

Galaxy 4 Transponder 3 (Ku-band)

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

Galaxy 4 Transponder 4 (Ku-band)

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

Galaxy 4 Transponder 16 (Ku-band)

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

Anik E1 Transponder 7 (Ku-band)

Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

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

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

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

Spacenet 2 Transponder 12-Vertical (C-band)

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

Galaxy 6 Transponder 3-Horizontal (C-band)

1405.60 (54.4) KIRO-AM (710) Seattle, WA—news, talk, and sports talk radio/Seattle Mariners MLB radio network
1405.40 (54.6) Sports Byline USA/Sports Byline Weekend
1404.60 (55.4) Talk America Radio Network
1403.80 (56.2) Occasional audio/Free Enterprise Radio Network
1403.20 (56.8) Motor Racing Network (MRN)
1400.80 (59.2) WBAL-AM (1090) Baltimore, MD—news/talk/Baltimore Orioles MLB radio network
1397.20 (62.8) WTMJ-AM (620) Milwaukee, WI—talk radio/Milwaukee Brewers MLB radio network
1393.40 (66.6) WGN-AM (720) Chicago, IL—talk radio/Interstate Radio Network (IRN)/Chicago Cubs MLB radio network
1393.20 (66.8) Wisconsin Radio Network/Illinois Radio Network/Tribune Radio Networks
1393.00 (67.0) USA Radio Network
1392.70 (67.3) WGN-AM (720) Chicago, IL—talk radio/Interstate Radio Network (IRN)/Chicago Cubs MLB radio network
1391.60 (68.4) XEPRS-AM (1090) Tijuana, Mexico—Spanish language programming, ID - *Radio Express*
1390.60 (69.4) Los Angeles Dodgers MLB radio network (English)
1390.40 (69.6) Los Angeles Dodgers MLB radio network (Spanish)
1389.70 (70.3) Occasional audio/data transmissions (burst)
1389.50 (70.5) Data transmissions (burst)
1386.70 (73.3) Michigan News Network (MNN)
1386.50 (73.5) WJR-AM (760) Detroit, MI—talk radio/Detroit Tigers MLB radio network
1386.30 (73.7) Illinois News Network
1385.10 (74.9) For the People Radio Network
1384.20 (75.8) California Angels MLB radio network
1384.00 (76.0) Chicago White Sox MLB radio network
1383.80 (76.2) KJR-AM (950) Seattle, WA—sports talk radio
1383.40 (76.6) Oakland A's MLB radio network
1383.20 (76.8) Occasional audio
1375.40 (84.6) USA Radio Network/Grow-wise Gardner Network
1374.10 (85.9) Northwest Direct—news and talk

Satcom K2 Transponder 2-Vertical (Ku-band)

1010.60 Unidentified foreign audio service

Spacenet 3 Transponder-Horizontal 13 (C-band)

1207.90 (52.1) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.20 (52.8) Good News Radio Network—christian radio
1207.00 (53.0) Good News Radio Network—christian radio
1206.70 (53.3) Data Transmission
1204.45 (55.55) KJAV-FM (104.9) Alamo, TX—spanish language religious, Nuevo Radio Christiana Network
1204.25 (55.75) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1201.90 (58.1) Occasional audio
1201.70 (58.3) Hot Tub Radio Party Network
1201.50 (58.5) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1201.30 (58.7) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious

Spacenet 3 Transponder 17-Horizontal (C-band)

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

Galaxy 4 Transponder 1-Horizontal (C-band)

1444.45 (55.55) Data transmissions
1443.80 (56.2) Voice of Free China (ISWBC) Taipei, Taiwan
1443.60 (56.4) KBLA-AM (1580) Santa Monica, 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*
1436.30 (63.7) KOJY-AM (540) Costa Mesa, CA/KJQI-AM (1260) Beverly Hills, CA—all news
1429.00 (71.0) Occasional audio

Galaxy 4 Transponder 2-Vertical (C-band)

1399.00 (81.0) Oklahoma News Network
1398.80 (81.2) Progressive Farmers Network
1398.00 (82.0) Oklahoma News Network
1397.20 (82.8) Oklahoma News Network

Galaxy 4 Transponder 3-Horizontal (C-band)

1404.80 (55.2) KOA-AM (850)/KTLK-AM (760) Denver, CO— news and talk/Colorado Rockies MLB radio network
1404.40 (55.6) Tennessee Radio Network (TRN)
1403.00 (57.0) Minnesota Public Radio
1402.40 (57.6) Minnesota Public Radio
1402.10 (57.9) KNOW-FM (95.3) St. Paul, MN—fine arts, Minnesota Public Radio
1401.90 (58.1) Occasional audio
1398.50 (61.5) Occasional audio
1398.30 (61.7) WSB-AM (750) Atlanta, GA—news/talk/Atlanta Braves MLB radio network
1398.10 (61.9) Occasional audio
1397.80 (62.2) Occasional audio
1397.50 (62.5) Minnesota Talking Book network
1396.90 (63.1) Occasional audio
1396.40 (63.4) Georgia Network News (GNN)
1396.20 (63.8) WCNN-AM (680) Atlanta, GA—all sports talk radio
1396.00 (64.0) WHO-AM (1040) Des Moines, IA—talk/Iowa News Network
1395.80 (64.2) Kentucky News Network
1395.60 (64.4) WGST-AM/FM (640/105.7) Atlanta, GA—news/talk
1395.10 (64.9) Occasional audio
1394.70 (65.3) WHAS-AM (840) Louisville, KY—adult contemporary music
1394.40 (65.6) Minnesota Public Radio
1394.00 (66.0) Minnesota Public Radio
1389.00 (71.0) Occasional audio
1388.90 (71.1) Data transmissions (burst)
1387.80 (72.2) Data transmissions (constant)
1384.40 (75.6) KOA-AM (850)/KTLK-AM (760) Denver, 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
1382.60 (77.4) Soldiers Radio Satellite (SRS) network—U.S. Army information and entertainment
1382.30 (77.7) Motor Racing Network (occasional audio)
1382.00 (78.0) WFAE-FM (90.7) Charlotte, NC—NPR affiliate
1381.80 (78.2) WHO-AM (1040) Des Moines, IA—talk radio/Iowa News Network
1377.40 (82.6) Data transmission (packet burst/tones)
1377.10 (82.9) In-Touch—reading service for blind
1376.00 (84.0) Kansas Audio Reader Network
1375.40 (84.6) National Public Radio

Galaxy 4 Transponder 4-Vertical (C-band)

1387.50 (52.5) Dakota Sports network/Dakota News network
1381.80 (58.2) Data transmissions
1379.00 (61.0) Louisiana Network/Louisiana Agriculture Network
1378.80 (61.2) WLAC-AM (1510) Nashville, TN—news and talk/Road Gang truck driver radio network (overnight)
1377.50 (62.5) Mid-America News Network/Mid-America Agriculture Network
1376.00 (64.0) Data transmissions

Single Channel Per Carrier (SCPC) Services Guide

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1) WCRP-FM (88.1) Guayama, PR—religous/educational (Spanish)

Anik E2 Transponder 11-Horizontal (C-band)

1246.00 (54.0) Radio Canada International (ISWBC)
1245.50 (54.5) Canadian Broadcasting Company (CBC) Radio—Yukon service

Anik E2 Transponder 13-Horizontal (C-band)

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

Anik E2 Transponder 15-Horizontal (C-band)

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

Anik E1 Transponder 17-Horizontal (C-band)

1126.00 (54.0) Canadian Broadcasting Company (CBC) Radio—northern Northwest Territories service
1125.50 (54.5) Canadian Broadcasting Company (CBC) Radio—Newfoundland and Labrador service

Anik E2 Transponder 19-Horizontal (C-band)

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

Anik E1 Transponder 21-Horizontal (C-band)

1024.30 (75.7) Canadian weather conditions and warnings
1036.70 (63.3) In-store music
1037.00 (63.0) In-store music
1037.50 (62.5) In-store music

SBS5 Transponder 2-Horizontal (Ku-band)

1010.60 (83.4) Wal-Mart in-store network (English)
1010.20 (83.8) Wal-Mart in-store network (English)
1009.80 (84.2) Sam's Wholesale Club in-store network (English)
1001.40 (92.6) Wal-Mart in-store network (English)
1001.00 (93.0) Wal-Mart in-store network (English and Spanish ads)
1000.60 (93.4) Wal-Mart in-store network (English)

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2) RFD Radio Service
1404.60 (55.4) WGN-AM (720) Chicago, IL—news/talk/Chicago Cubs MLB radio network (occasional audio)
KOA-AM (850) Denver, CO—news/talk/Colorado Rockies MLB radio network (occasional audio)
1400.60 (59.4) Learfield Communications
1400.40 (59.6) Learfield Communications/Missouri Net
1400.20 (59.8) Occasional audio/Data transmissions
1400.00 (60.0) Learfield Communications
1396.60 (63.4) Kansas Information Network/Kansas Agnet
1396.40 (63.6) Nebraska Agriculture Network
1396.20 (63.8) Missouri Network/St. Louis Cardinals MLB radio network
1396.00 (64.0) Occasional audio
1395.70 (64.3) Missouri Net/WIBW-AM (580) Topeka, KS—news and talk/Kansas City Royals MLB radio network
1387.30 (72.7) North Carolina News Network
1386.40 (73.6) Learfield Communications
1386.20 (73.8) Radio Iowa
1385.00 (74.0) People's Radio Network
1384.60 (75.4) North Carolina News Network/Capitol Sports Network
1384.00 (76.0) Occasional audio/ABC Direction Network
1383.80 (76.2) Occasional audio
1383.60 (76.4) Occasional audio
1383.40 (76.6) Capitol Sports Network
1382.90 (77.1) Missouri Net
1382.60 (77.4) North Carolina News Network
1382.30 (77.7) Virginia News Network
1382.10 (77.9) Learfield Communications/Missouri Net
1378.70 (81.3) Radio Pennsylvania Network
1378.50 (81.5) Radio Pennsylvania Network
1378.30 (81.7) Radio Pennsylvania Network/Philadelphia Phillies MLB radio network
1378.10 (81.9) Radio Pennsylvania Network

RCA C5 Transponder 21-Vertical (C-band)

1045.00 (55.0) Los Angeles Dodgers MLB radio network (English)
1043.60 (56.4) Unistar Music Radio — *Today's Hits, Yesterday's Favorites*
1043.40 (56.6) CNN Radio Network
1043.20 (56.8) Unistar Music Radio — *Today's Hits, Yesterday's Favorites*
1042.80 (57.2) Unistar Music Radio — *Original Hits*
1042.60 (57.4) Unistar Music Radio — *Original Hits*
1042.40 (57.6) Unistar Music Radio — *Good Times and Great Oldies*
1042.20 (57.8) Data transmissions
1042.00 (58.0) Unistar Music Radio — *Good Times and Great Oldies*
1041.80 (58.2) CNN Radio Network
1034.80 (65.2) Unistar Music Radio — *Country and Western*
1034.60 (65.4) Unistar Music Radio — *Country and Western*
1034.40 (65.6) Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*
1034.20 (65.8) Data transmissions
1034.00 (66.0) Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*
1033.70 (66.3) CNN Radio Network
1033.20 (66.8) Unistar Music Radio — *Country and Western*
1032.80 (67.2) Data transmissions
1032.40 (67.6) Unistar Music Radio — *Country and Western*

International Shortwave Broadcasters via Satellite

By Larry Van Horn and Robert Smathers

AFRICA NO. 1

B.P. 1, Libreville, Gabon. Telephone +241 760001 (voice), +241 742133. Intelsat 601 (27.5 west) Tr 23B (3915 MHz RHCP). 8.20 MHz audio (French).

ARAB REPUBLIC OF EGYPT RADIO

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

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)

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

BRITISH BROADCASTING CORPORATION (BBC)

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

C-SPAN AUDIO SERVICES

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

C-SPAN Audio 1

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

C-SPAN Audio 2

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

DEUTSCHE WELLE (DW)

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

ISLAMIC REPUBLIC OF IRAN BROADCASTING (IRIB)

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

ISRAEL RADIO

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

LA VOIX DU ZAIRE

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

RADIO ALGIERS INTERNATIONAL

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

RADIO AUSTRALIA

GPO Box 428G, Melbourne, Vic. 3001, Australia. Telephone: +61 3 9626 1800 (voice), +61 3 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) 7.56 MHz audio and Hispasat 1A/B (31.0 west) Tr 6 (12149 MHz RHCP) 7.92 MHz audio.

RADIO FRANCE INTERNATIONAL (RFI)

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

RADIO MEDITERRANEE INTERNATIONALE

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

RADIO NETHERLANDS

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

RADIOSTANTSIYA MAYAK

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

RADIO SWEDEN

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

RADIOTELEVISIONE ITALIANA (RAI)

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

RADIO VLAANDEREN INTERNATIONAL

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

RDP INTERNATIONAL

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

SWISS RADIO INTERNATIONAL

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

TRANS WORLD RADIO (TWR)

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

International Shortwave Broadcasters via Satellite

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

TUNIS INTERNATIONAL RADIO

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

VATICAN RADIO

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

VOICE OF AMERICA (United States Information Agency)

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

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

NTSC system baseband subcarrier frequencies

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

PAL system baseband subcarrier frequencies

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

VOICE OF THE ARABS

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

VOICE OF SAHEL

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

VOICE OF THE IRAQI PEOPLE (CLANDESTINE)

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

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

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

WORLD RADIO NETWORK

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

North American Service Schedule

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

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

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

European Service

WRN1 - Astra 1B (19.2 east) Tr 22 (11538 MHz V) 7.38 MHz audio. All broadcasts are in English. Program information is available on Astra 1B VH-1 text page 222, 223 and 224. WRN network information can be heard on the European service daily at 0125, 1025 and 2050 BST.
WRN2 - Eutelsat II F-1 (13 east) Tr 25 (10987 MHz V) 7.38 MHz. Multi-lingual programming.

Africa/Asia-Pacific Service

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

WORLDWIDE CATHOLIC RADIO - WEWN

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

YLE RADIO FINLAND

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

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

Alphastar (United States)

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

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

DirecTV and USSB (United States)

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

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

100	Direct Ticket Previews (DTV)	Previews
101-199	Direct Ticket Pay Per View (DTV)	PPV
120/121	Letterbox (LTBX)	
140-142	Unknown service (LC)	
200	Direct Ticket Previews (DTV)	Previews
201	DirecTV Information Updates (DTV)	Promo
202	Cable Network News (CNN)	News
203	Court TV (CRT)	Speciality
204	CNN Headline News (HLN)	News
205	DirecTV Special Events Calendar (DTV)	Promo
206	ESPN 1 (ESPN)	Sports
207	ESPN Alternate (ESNA)	Sports
208	ESPN 2 (ESN2)	Sports
210	DirecTV Sports Schedule (DTV)	Promo
212	Turner Network Television (TNT)	TV programming
213	Home Shopping Network (HSN)	Home Shopping
214	Home and Garden TV (HGTV)	Home Improvement
215	E! Entertainment TV (E!)	Speciality
216	MuchMusic (MUCH)	Music Videos
217	Black Entertainment TV (BET)	Entertainment
219	American Movie Classics (AMC)	Movies
220	Turner Classic Movies (TCM)	Movies
221	Arts and Entertainment (A&E)	TV
222	The History Channel (HIST)	History
223	The Disney Channel East (DIS1)	Movies/Kids
224	The Disney Channel West (DIS2)	Movies/Kids
225	The Discovery Channel (DISC)	Science/TV documentary
226	The Learning Channel (TLC)	Science/TV documentary
227	Cartoon Network (TOON)	Cartoons
229	USA Network (USA)	TV
230	Trio (TRIO)	TV
232	The Family Channel (FAM)	TV
233	WTBS-Ind Atlanta, Ga.(TBS)	Superstation
235	The Nashville Network (TNN)	Country/Outdoors
236	Country Music TV (CMT)	Country Music Videos
240	The Sci-Fi Channel (SCFI)	Science Fiction
242	C-SPAN 1 (CSP1)	Congress-House of Representatives
243	C-SPAN 2 (CSP2)	Congress-U.S. Senate
245	Bloomberg Information Television (BIT)	News
246	CNBC (CNBC)	Financial/Talk
247	MSNBC (MSNBC)	News
248	The Weather Channel (TWC)	Weather
250	Newsworld International (NWI)	News
252	CNN International (CNNI)/CNN fN	News/Financial
254	The Travel Channel (TRAV)	Travel Shows
258	Bravo (BRAV)	Arts
266	Independent Film Channel (IFC)	Movies
268	Direct Ticket Previews (DTV)	Previews
269	STARZ! - West (STZW)	Movies
270	STARZ! (STZE)	Movies
271	Encore (ENCR)	Movies
272	Encore-Love Stories (LOVE)	Movies
273	Encore-Westerns (WSTN)	Movies
274	Encore-Mystery (MYST)	Movies
275	Encore-Action (ACTN)	Movies
276	Encore-True Stories (TRUE)	Movies
277	Encore-WAM! (WAM!)	Movies
282	WRAL Raleigh, NC (CBS)	Network TV
283	KPIX San Francisco, CA (CBSW)	Network TV
284	WNBC New York, NY (NBC)	Network TV
285	KNBC Los Angeles, CA (NBCW)	Network TV
286	PBS National Feed (PBS)	Network TV
287	WJLA Washington, DC (ABC)	Network TV
288	KOMO Seattle, WA (ABCW)	Network TV
289	FoxNet. (FOX)	Network TV
298	TV Asia (TVA)	Ethnic Programming
299	In-store dealer info channel (DTV)	Retailers only
300-399	Regional and PPV Sports	Sports
300	DirecTV Sports Offers (DTV)	Promo
302	MLB Extra Innings Daily Program Lineup (DTV)	Sports
303	Newsport (NWSP)	Sports
304	The Golf Channel (GOLF)	Sports
305	Classic Sports Network (CSN)	Sports
306	Speedvision (SV)	Sports
307	Outdoor Life Channel (OL)	Sports
309	SportsChannel New England (SCNE)	Sports
310	Madison Square Garden (MSG)	Sports
311	New England Sports Network (NESN)	Sports
312	SportsChannel New York (SCNY)	Sports
313	Empire Network (EMP)	Sports
314	SportsChannel Philadelphia (SCPH)	Sports
315	Prime Sports KBL (PKBL)	Sports
316	Home Team Sports (HTS)	Sports
317	SportsSouth (SPTS)	Sports
318	Sunshine (SUN)	Sports
320	Pro AM Sports (PASS)	Sports
321	SportsChannel Ohio (SCOH)	Sports
322	SportsChannel Cincinnati (SCCN)	Sports
323	SportsChannel Chicago (SCCH)	Sports
324	Midwest SportsChannel (MSC)	Sports
325	Prime Sports Southwest (PSSW)	Sports
326	Prime Sports Midwest/Rocky Mountain /Intermountain West (PS)	Sports
330	Prime Sports Northwest (PSNW)	Sports
331	Prime Sports West (PSW)	Sports
332	SportsChannel Pacific (SCP)	Sports
333-348	NFL Sunday Ticket	Sports
336	MLB Extra Innings Daily Program Lineup (DTV)	Sports
350	NFL Sunday Ticket/NBA League Pass	Sports
356	NFL Sunday Ticket/NBA League Pass	Sports
380	MLB Extra Innings Daily Program Lineup (DTV)	Sports
401	Spice (SPCE)	Adult
402	Playboy (PBTV)	Adult
501	Music Choice — Hit List (MC1)	Audio
502	Music Choice — Dance (MC2)	Audio
503	Music Choice — Hip Hop (MC3)	Audio
504	Music Choice — Urban Beat (MC4)	Audio
505	Music Choice — Reggae (MC5)	Audio
506	Music Choice — Blues (MC6)	Audio
507	Music Choice — Jazz (MC7)	Audio
508	Music Choice — Singers and Standards (MC8)	Audio
509	Music Choice — Contemporary Jazz (MC9)	Audio
510	Music Choice — New Age (MC10)	Audio
511	Music Choice — Electric Rock (MC11)	Audio
512	Music Choice — Modern Rock (MC12)	Audio
513	Music Choice — Classic Rock (MC13)	Audio
514	Music Choice — 80's Retro (MC14)	Audio
515	Music Choice — Metal (MC15)	Audio
516	Music Choice — Solid Gold Oldies (MC16)	Audio
517	Music Choice — Soft Rock (MC17)	Audio
518	Music Choice — Love Songs (MC18)	Audio
519	Music Choice — Progressive Country (MC19)	Audio
520	Music Choice — Contemporary Country (MC20)	Audio
521	Music Choice — Country Gold/Classic Country (MC21)	Audio
522	Music Choice — Big Bands Nostalgia (MC22)	Audio
523	Music Choice — Easy Listening (MC23)	Audio
524	Music Choice — Classic Favorites (MC24)	Audio

Direct Broadcast Satellite (DBS) Systems

525	Music Choice — Classics in Concerts (MC25)	Audio
526	Music Choice — Contemporary Christian (MC26)	Audio
527	Music Choice — Gospel (MC27)	Audio
528	Music Choice — Big Kids Music (MC28)	Audio
529	Music Choice — Sounds of the Seasons (MC29)	Audio
530	Music Choice — Bluegrass (MC30)	Audio
531	Music Choice — Rock New Release Show (MC31)	Audio
599	NRTC Radio Service (NRTC) For private use only	
790	RealNet — Real Estate Channel (REAL)	

USSB

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

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

EchoStar (United States)

ECHOSTAR

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

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

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

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

971	Symphonic Classical	Audio
972	Light Classical	Audio
973	Beautiful Music	Audio
974	Mature Vocals	Audio
975	Contemporary Christian	Audio
976	Children's	Audio
977	LDS Radio Network	Audio

ExpressVu (Canada)

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

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

Galaxy Latin America (Mexico, Central and South America)

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

Primestar (United States)

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

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

1	HBO (East)	Movies
2	HBO 2 (East)	Movies
3	HBO 3	Movies
7	Cinemax (East)	Movies
8	Cinemax 2	Movies
13	TV Japan (English)	Not included in $50 a month package
14	TV Japan (Japanese)	Not included in $50 a month package
15	Future service	
17	Future service	
19	Future service	
27	Starz!	Movies
31	Encore 3 — Westerns	Movies
32	Encore 4 — Mystery	Movies
33	Encore	Movies
34	The Disney Channel (East)	Movies/Kids
35	The Disney Channel (West)	Movies/Kids
40	The Golf Channel	Sports
47	C-SPAN	Congress
48	CNBC—occasional service	Financial/Talk
49	The Weather Channel (TWC)	Weather
50	CNN International (CNNI)/CNN fN	News/Financial
51	Cable Network News (CNN)	News
52	CNN Headline News	News
	Ingenius News Service	Data Wire Services
55	PreVue Channel	Program Guide
56	Future service	
58	Turner Network Television (TNT)	TV
59	Turner Classic Movies (TCM)	Movies
63	WTBS-Ind Atlanta, GA (TBS)	Superstation
65	The Discovery Channel (TDC)	Science/TV documentary
66	The Learning Channel (TLC)	Science/TV documentary
68	Arts & Entertainment (A&E)	TV
70	USA Network	TV
71	The Sci-Fi Channel	Science Fiction
72	The Family Channel	TV
73	The Cartoon Channel	Cartoons
74	Nickelodeon/Nick at Nite	Kids
75	E! Entertainment Network	Speciality
76	Lifetime	TV
77	The Nashville Network (TNN)	Country/Outdoors
78	Country Music TV (CMT)	Country music videos
80	MTV	Music Videos
83	Faith and Values Network	Religious
84	QVC—occasional service	Home Shopping
111	WHDH-NBC Boston, MA	Network TV
112	WSB-ABC Atlanta, GA	Network TV
117	WUSA-CBS Washington, DC	Network TV
120	KTVU-FOX Oakland/San Francisco, CA	Network TV
124	WHYY-PBS Philadelphia, PA	Network TV
131	ESPN	Sports
133	ESPN2	Sports
137	Classic Sports Network (occ)	Sports
138	Mega+1	Sports
141	New England Sports Network (NESN)	Sports
142	Madison Square Garden Network (MSG)	Sports
143	Empire Sports Network	Sports
144	Prime Sports KBL	Sports
145	Home Team Sports (HTS)	Sports
146	SportSouth	Sports
147	Sunshine	Sports
148	Pro American Sports (PASS)	Sports
149	Future service	
152	Prime Sports Midwest	Sports
153	Prime Sports Rocky Mountain	Sports
154	Prime Sports Southwest	Sports
155	Prime Sports Inter-Mountain West	Sports
156	Prime Sports Northwest	Sports
157	Future service	
158	Prime Sports West	Sports
159	Midwest SportsChannel	Sports
181	HBO en Espanol	Movies
182	HBO2 en Espanol	Movies
183	HBO3 en Espanol	Movies
187	Cinemax Selecciones	Movies
188	Cinemax2 Selecciones	Movies
190	Univision	Spanish language
201	Viewer's Choice	PPV
202	Request 1	PPV
203	Request 5	PPV
204	Hot Choice	PPV
205	Continuous Hits 1	PPV
206	Continuous Hits 2—occasional service	PPV
207	Continuous Hits 3	PPV
208	Request 2	PPV
209	Request 3	PPV
210	Request 4	PPV
221	Playboy—occasional service	Adult
301	Superadio—Classical Hits	Audio
302	Superadio—America's Country Favorites	Audio
303	Superadio—Lite 'n' Lively Rock	Audio
304	Superadio—Soft Sounds	Audio
305	Superadio—Classic Collections	Audio
306	Superadio—New Age of Jazz	Audio
311	DMX Audio—Lite Jazz	Audio
312	DMX Audio—Classic Rock	Audio
313	DMX Audio—70's Oldies	Audio
314	DMX Audio—Adult Contemporary	Audio
315	DMX Audio—Hottest Hits	Audio
316	DMX Audio—Modern Country	Audio
317	DMX Audio—Traditional Blues	Audio
318	DMX Audio—Salsa	Audio
527	Testing Channel	Tests

Added in May: TVLand (channel unknown)

Ku-band Satellite Transponder Services Guide

By Robert Smathers

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

Spacenet 2 (S2) 69° West

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

SBS-2 (SBS2) 71° West

3	11872-H	NBC contract channel

SBS 6 (SBS6) 74° West

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

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

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

GE K2 (K2) 81° West

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

GE K1 (K1) 85° West

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

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

Spacenet 3R (S3) 87° West

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

Telstar 402R (T402) 89°West

Alphastar DBS uses many T402 Ku-band transponders

1	11730-V	AT&T Tridom [digital]
2	11743-H	AT&T Tridom [digital]
3	11790-V	AT&T Tridom [digital]
4	11803-H	AT&T Tridom [digital]
9	11971-V	Occ video (half transponder)
15	12157-V	DMX for Business [digital data]

Galaxy 7 (K7) 91° West

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

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

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

Galaxy 3R (G3R) 95° West

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

Telstar 401 (T401) 97° West

1	11730-V	SCPC transmissions
2	11743-H	AT&T Skynet TV [compressed video]
3	11790-V	South Carolina Educational TV State Network [Digicipher]
4	11798-H	National Tech University [compressed video]
5	11845-V	PBS [Digicipher]
6	11855-H	Global Access occ video transponder
7	11902-V	PBS educational services (half-transponders)
8	11915-H	PBS stations/regionals and backhauls
9L	11958-V	Egyptian TV
9U	11986-V	PBS digital video [Digicipher]/ VSAT traffic
10	11962.5-H	Louisiana Public TV State Network [Digicipher]
11	12040-V	Occ video
12	12046-H	Global Access occ video transponder
13	12095-V	Spectradyne Hotel Hotel In-room movies [compressed video]
14L	12093-H	Peachstar Educational Network (Distance Learning)
14U	12123-H	Georgia Public TV State Network (GPTV)
15	12147-V	ABC network and affiliate feeds (half-transponders)
16	12167-H	ABC network and affiliate feeds (half-transponders)

Galaxy 4 (K4) 99° West

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

Spacenet 4 (S4) 101° West

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

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

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

GSTAR-1 (GST1) 103° West

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

GSTAR-4 (GST4) 105° West

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

Anik E2 (A1) 107.3° West

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

Solidaridad 1 SO1 109.2° West

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

Anik E1 (A2) 111° West

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

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

Solidaridad 2 (SO2) 112.9° West

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

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

(This satellite rarely has video transmissions)

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

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

EchoStar 1 119°West

A complete channel guide for TheDISH Television Network is presented in the DBS section of *Satellites Times* Satellite Service Guide. This satellite (and in the near future Echostar 2) operate in the 12.2-12.7 GHz range.

SBS 5 (SBS5) 123° West

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

GSTAR-2 (GST2) 125° West

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

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69°	Galaxy 6 (G6) 74°	Telstar 302 (T2) 85°	Spacenet 3 (S3) 87°	Telstar 402R (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 401 (T1) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	Anik 1
1	SC New York [V2+]	Tokyo BS New York feeds	(none)	(none)	The Babe Channel/o/v	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	Exxxtasy (adult) Promo/VTC	SCPC services	Data Transmissions	CBC-I Ea
2	(none)	Global Access/Canadian Horse Racing/o/v	(none)	American Independent Network (AIN)	Channel America	CBS West [VC1]	TVN Theatre 2 [V2+]	Data Transmissions	SCPC services	STARZ! 2 [V2+]	The Spo
3	USIA Worldnet TV	SCPC services	(none)	WSBK-Ind Boston [V2+]	Dragnet/o/v	Action PPV [V2+]	TVN Theatre 3 [V2+]	Keystone/Parmount feeds/o/v	SCPC services	Data Transmissions	Telesat comp
4	H.TV (Spanish) [V2+]	Canadian Horse Racing/o/v	(none)	Nebraska Educational TV (NETV)	Shop at Home	fX East	TVN Theatre 4 [V2+]	Group W Videoservices/o/v	SCPC services	Encore-Westerns [V2+]	Canco Compre M
5	NASA Contract Channel-o/v [Leitch]	(none)	(none)	Univision [V2+]	FOX feeds East	fX West	TVN Theatre 5 [V2+]	Keystone o/v/MLB Backhauls	Global Access o/v	Data Transmissions	Telesat [comp
6	Data Transmissions	NHK (TV Japan) feeds	(none)	(none)	o/v	Game Show Network [V2+]	TVN Theatre 6 - Letterbox [V2+]/TVN Promos (occ)	Buena Vista TV feeds	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	CBC N
7	o/v	National Empowerment TV	(none)	Data Transmissions	Cable Video Store [V2+]	The Golf Channel [V2+]	America's Choicemall (infomercials)	Global Access o/v	Global Access o/v/NC Open Net	Basil Bassett Bingo	CBC-M
8	Data Transmissions	(none)	(none)	Data Transmissions	MLB Backhauls/o/v	o/v	Gospel Music TV	PBS X	Telemundo [SA MPEG]	KOMO-ABC Seattle (PT24W) [V2+]	Glo [Leitch] G
9	NASA TV	MuchMusic U.S. [V2+]	(none)	WPIX-Ind New York [V2+]	Horse Racing [digital]	(none)	o/v	FOX feeds East	Global Access o/v/Book TV	Data Transmissions	CBC-B Atl
10	Data Transmissions	Arab Network of America (ANA)	ABC West [Leitch]	Data Transmissions	XXXplore/XXXpose (adult) [V2+]	United Arab Emirates TV Dubai	TVN Theatre 9 - adulTVision (adult) [V2+]	FOX feeds East	WJLA-ABC Washington (PT24E) [V2+]	FOXNet (PT24E) [V2+]	Canco Compre MI
11	SC Philadelphia [V2+]	Keystone o/v/MLB Backhauls	(none)	CNN feeds/o/v	Outdoor Channel	Estacion Montellano (Spanish Rel)/o/v	o/v	ABC feeds	Global Access o/v/BBC Breakfast News	STARZ! East [V2+]	CBC-A
12	Data Transmissions	TV Asia [digicipher]	(none)	Data Transmissions	Horse Racing [digital]	(none)	MCI Andover o/v/RAI TV o/v	ABC NewsOne channel	Keystone o/v/MLB Backhauls	Keystone o/v/MLB Backhauls	Canco Compre M
13	Data Transmissions	RTPi	(none)	SCPC/FM2 services	FOX feeds West	CSN/Kaleidoscope/P-SS/The Box [digicipher]	o/v	FOX feeds East	Informercials/o/v	Data Transmissions	CBC-C Pa
14	Data Transmissions	Cornerstone TV WPCB-TV (Rel)	(none)	CNN [B-MAC]	TVLand [V2+]	Independent Film Channel [V2+]	o/v	FOX News Service	WRAL-CBS Raleigh (PT24E) [V2+]	(none)	Canco Compre M
15	HERO Teleport [digicipher]	Midwest Sports Channel [V2+]	(none)	KTLA-Ind Los Angeles [V2+]	Spice (adult) [V2+]	Intro Television [V2+]	o/v	True Blue (adult) [V2+]	World Harvest TV (Rel)	Data Transmissions	o
16	Data Transmissions	o/v	(none)	CNN International [B-MAC]	Adam and Eve (adult) [V2+]	(none)	HBO 2 East [V2+]	MLB Backauls/o/v	CBS West [VC1]	NPS Promo Channel	Canco Compre [SA-N
17	Data Transmissions	Keystone o/v/MSG II-o/v/MLB Backhauls	(none)	FM2/SCPC services	FOX feeds	ESPN Intl [B-MAC]	Cinemax 2 East [V2+]	MLB Backhauls/o/v	CBS East/o/v [VC1]	Data Transmissions	CBC-D
18	(none)	Global Access o/v	(none)	US Sat.Corp (infomercials)/ In-store audio	Kelly Broadcast Systems contract channel/o/v	Teleport Minnesota/CBS feeds/o/v	Univision Contract [occ analog/mostly digital	Keystone o/v/MLB Backhauls	CBS feeds/o/v [VC1]	STARZ! West [V2+]	Video Cha
19	Data Transmissions	University Network/Dr. Gene Scott (Rel)	(none)	SSN Sportsouth [V2+]	o/v	CBS East [VC1]	HBO 3 [V2+]	Keystone o/v/UPN/MLB Backhauls	CBS East/o/v [VC1]	Data Transmissions	o
20	Armed Forces Radio & Television Service [B-MAC]	CNN Headline News Clean Feed [V2+]	ABC East [Leitch]	(none)	Global Access/o/v	(none)	HBO 2 West [V2+]	ABC East [Leitch]	CBS East [VC1]	Data Transmissions	Exxtreme (adult)
21	SC New England [V2+]	XXXplore-XXXpose Promo/o/v	(none)	SSN Pro Am Sports (Pass) [V2+]	MLB Backhauls/o/v	BET on Jazz	Infomercials	ABC East [Leitch]	WB Syndication-Network/CBS feeds/o/v	Data Transmissions	Telesat [d comp
22	SC New York Plus [V2+]	Horse Racing [digital]	(none)	Data Transmissions	ABC feeds - L.A. Bureau	NewsTalk Television	Horse Racing [digital]	ABC West [Leitch]	WNBC-NBC New York (PT24E) [V2+]	Data Transmissions	XXXotic [V
23	NHK TV Japan secondary feeds	Worship TV (Rel)	(none)	SSN Home Teams Sports (HTS) [V2+]	La Cadena de Milagro (Spanish Rel)	fX Movies [V2+]	3 Angels Broadcasting	ABC East [Leitch]	SCOLA [Wegener]	Data Transmissions	CBC-E
24	(none)	Horse Racing [digital]/o/v	(none)	America One	PandaAmerica (Home Shopping)	International Channel [V2+]	FLIX [V2+]	Exxxtasy (adult) [V2+]	CBS Newspath feeds	KPIX-CBS San Francisco (PT24W) [V2+]	Inactive Transp

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

Satellite Transponder Guide

By Robert Smathers

2 (A1) ...3	Solidaridad 1 (SD1) 109.2º	Telesat E1 (A2) 111º	Morelos 2 (M2) 116.8º	Telstar 303 (T3) 121º	Galaxy 9 (G9) 123º	Galaxy 5 (G5) 125º	Satcom C3 (F3) 131º	Galaxy 1R (G1) 133º	Satcom C4 (F4) 135º	Satcom C1 (F1) 137º	
English ...rn	(none)	Data Transmissions	Data Transmissions	(none)	Global Access o/v	Disney East [V2+]	Family Channel West [V2+]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Prime Network [V2+]	1
...Network ...k]	(none)	(Inactive)	Data Transmissions	(none)	Global Access o/v	Playboy (adult) [V2+]	The Learning Channel	Spanish language networks [SA MPEG]	Request TV PPV [digicipher]	KMGH-ABC Denver [V2+]	2
...igital video ...ssion]	SCPC services	Data Transmissions	Data Transmissions	(none)	NHK TV Japan	Trinity Broadcasting (Rel)	Viewer's Choice PPV [V2+]	Encore [V2+]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
...n Video ...ion [SA-...EG]	(none)	Data Transmissions	Data Transmissions	(none)	General Communication [digital]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food Network [digicipher]	Lifetime East [V2+]	SC Pacific [V2+]	4
...igital video ...ession]	o/v	Data Transmissions	Data Transmissions	(none)	Global Access o/v	CNN [V2+]	Faith and Values Channel/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	5
...s ...orld ...ak]	(none)	(Inactive)	Data Transmissions	(none)	General Communication [digital]	WTBS-Ind Atlanta [V2+]	Court TV [digicipher]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
English	XEQ-TV canal 9	Data Transmissions	Data Transmissions	(none)	TVN Video Compression [digital]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN Prime Sports West [V2+]	7
...TV ...al feeds	(none)	(Inactive)	XHGC canal 5	(none)	General Communication [digital]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
English ...nic	o/v	(Inactive)	(none)	(none)	TVN Video Compression [digital]	ESPN [V2+]	Music Choice [digital]	ESPN2 Blackout [V2+]/SAH	QVC Network	Prime Sports Showcase	9
...n Video ...sion [SA ...EG]	Mexican Parliament	(Inactive)	(none)	(none)	TVN Video Compression [digital]	MOR Music	Home Shopping Club Spree	MSNBC [V2+]	Home Shopping Network (HSN)	SSN Prime Sports SW [V2+]	10
French	(none)	(Inactive)	XEIPN canal 11	(none)	TVN Video Compression [digital]	Family Channel East [V2+]	Newsport [V2+]	Eternal Word TV Network (Rel)	Speedvision	Network One 'N1' [V2+]	11
...n Video ...sion [SA-...EG]	Data Transmissions	CTV Network	Data Transmissions	(none)	General Communication [digital]	Discovery West [V2+]	History Channel [V2+]	Valuevision	Nustar (Promo Channel)	Data Transmissions	12
English ...cific	(none)	(Inactive)	(none)	(none)	TVN Video Compression [digital]	CNBC [V2+]	The Weather Channel [V2+]	Encore [digicipher]	Travel Channel [V2+]	SC Chicago [V2+]	13
...i Video ...sion [SA-...EG]	Data Transmissions	(none)	XEW canal 2	(none)	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Blackout [V2+]/SAH	Fit TV	KUSA-NBC Denver [V2+]	14
...v	Multivision [digicipher]	(Inactive)	Data Transmissions	(none)	Showtime West [V2+]	HBO East [V2+]	Showtime East [V2+]	CNN International/CNNfN [V2+]	WWOR-Ind New York [V2+]	SC Cincinnati/Ohio/Florida [V2+]	15
...Video ...sion/NT/ ...MPEG]	Data Transmission	CTV Network [digital]	Canal 22	(none)	General Communication [digital]	Cinemax West [V2+]	M2. Music Television [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Prime Sports West/ Prime Deportiva [digicipher]	16
...Feeds	o/v	(Inactive)	o/v	(none)	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN Prime Sports (various) [V2+]	17
Catalog ...nnel	(none)	(Inactive)	Clara Vision (Rel)	(none)	The Movie Channel West [V2+]	TNN [V2+]	TVLand [V2+]	HBO Multiplex [digicipher]	Viewer's Choice [digicipher]	Prime/Sunshine Alt/Cal-Span	18
...v	Multivision [digicipher]	TV Northern Canada [digital]	(none)	(none)	MTV West [V2+]	USA East [V2+]	Showtime/MTV [digicipher]	Cinemax East [V2+]	C-SPAN 2	FOXNet [V2+]	19
...Climaxxx ...[V2+]	(none)	Canadian Horse Racing/o/v	Data Transmissions	(none)	General Communication [digital]	[illegible] [V2+]	Jones Intercable [digicipher]	Home and Garden Network	Showtime 2 [V2+]	o/v	20
...igital video ...ession]	(none)	SCPC services/ Data Transmissions	(none)	(none)	Global Access o/v	MEU	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Sportchannel alt/SportsChannel Fla.	21
...a (adult) ...2+]	(none)	(Inactive)	XHIMT canal 7/TeleCasa	Antenna TV [V2+]/HRT Croatia/o/v	Global Access o/v	CNN/HN [V2+]	Your Choice TV [digicipher]	Nostalgia Channel	FLIX [V2+]	SSN PSNW [V2+]/Step Stair Ed Net	22
English	(none)	(Inactive)	(none)	(none)	The Computer Network	A&E [V2+]	E! Entertainment TV [V2+]	(none)	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
...e (Failed ...ponder)	(none)	(Inactive)	XHDF canal 13	(none)	General Communication [digital]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio (DMX) [digital]	Global Shopping Network	CMT [V2+]	SSN Sunshine [V2+]	24

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Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 254 active geostationary/synchronous satellites at publication deadline. Synchronous satellite location information is supplied to *Satellite Times* by NASA's Goddard Space Flight Center-Orbital Information Group (Mr. Adam Johnson). We are particularly grateful to the following individuals for providing payload information and analysis: Earth News: Philip Chien; Molniya Space Consultancy: Mr. Phillip Clark; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; U.S. Space Command/Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

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

Radio Frequency Band Key

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

Satellite Service Key

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

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
21140	1991-015B Meteosat 5 (MOP 2)	0.2E	Met (L)
23730	1995-067A Telecom 2C (France)	2.9E	Dom FSS/Gov-Mil (X/C/Ku)
24209	1996-044B Telecom 2D (France)	3.0E	Dom-FSS/Gov-Mil (C/X/Ku)
20929	1990-095A DSP F-15 (USA)	3.8E#	Mil-Early Warning (S/X)
23712	1995-060A USA 115 (DFS-2/Milstar-2)	4.0E	Mil-Comm (P/S/K)
19919	1989-027A Tele X (Sweden)	5.0E	Reg DTH/FSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.2E	Reg DTH (Ku)
22921	1993-076A USA 98 (NATO 4B)	5.9E/i	Mil-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	7.0E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.1E	Reg FSS (Ku)
24208	1996-044A Italsat F2 (Italy)	10.2E	Dom-Telephone-Mob (L/K/Ka)
19596	1988-095A Raduga 22 (Russia)	11.4E/i	Dom FSS/Gov-Mil (X/C)
22557	1993-013A Raduga 29 (Russia)	11.4E#	Dom FSS/Gov-Mil (X/C)
22269	1992-088A Cosmos 2224 (Russia)	12.4E#	Mil-Earl Warning (X)
20777	1990-079B Eutelsat II F1	13.0E	Reg FSS (Ku)
23537	1995-016B Hot Bird 1 (Eutelsat II F6)	13.1E	DTH (Ku)
21055	1991-003A Italsat 1 (Italy)	13.4E	Dom-Telephone (S/K/Ka)
21803	1991-083A Eutelsat II F3	16.0E	Reg FSS (Ku)
19688	1988-109B Astra 1A	19.2E	Reg DTH (Ku)
21139	1991-015A Astra 1B	19.2E	Reg DTH (Ku)
23331	1994-070A Astra 1D	19.2E	Reg DTH (Ku)
23686	1995-055A Astra 1E	19.2E	Reg DTH (Ku)
23842	1996-021A Astra 1F	19.2E	Reg DTH (Ku)
22653	1993-031A Astra 1C	19.3E	Reg DTH (Ku)
14234	1983-077A Telstar 3A (301) (USA)	20.2E/i	Dom FSS-Saudi Arabia (C)
19331	1988-063B Eutelsat 1 F5 (ECS 5)	21.4E#	Reg FSS (VHF/Ku)
13010	1981-122A Marecs 1 (ESA)	22.5E/i	Int Mar-EUR (L/C)
22175	1992-066A DFS 3 (Germany)	23.5E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.4E/i	Reg FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (Russia)	25.8E/i	Dom/Gov FSS (C/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	26.0E	Reg FSS/BSS (C/Ku)
20706	1990-063B DFS 2 (Germany)	28.6E	Dom BSS (S/Ku/K)
21894	1992-010B Arabsat 1C (Arabsat)	30.9E	Reg FSS/BSS (S/C)
19765	1989-004A Gorizont 17 (Russia)	33.8E/i	Dom/Gov FSS (C/Ku)
14128	1983-058A Eutelsat 1 F1 (ECS 1)	35.9/i	Reg FSS (Ku)
21821	1991-087A Raduga 28 (Russia)	34.6E/i	Dom FSS/Gov-Mil (X/C)
22963	1993-002A Gals 1 (Russia)	36.1E	Dom BSS (Ku)
23717	1995-063A Gals 2 (Russia)	36.7E	Dom BSS (Ku)
23775	1996-005A Gorizont 31 (Russia)	40.2E#	Dom/Gov FSS (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	42.0E	Reg FSS (Ku)
23949	1996-040B Turksat 1C (Turkey)	42.0E	Reg FSS (Ku)
19928	1989-030A Raduga 23 (Russia)	44.9E/i	Dom FSS/Gov-Mil (X/C)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
14421	1983-105A Intelsat 507	46.9E/i	Int FSS/Mar (L/C/Ku)
21038	1990-116A Raduga 1-2 (Russia)	48.8E/i	Dom FSS/Gov-Mil (X/C)
22981	1994-008A Raduga 1-3 (Russia)	48.8E#	Dom FSS/Gov-Mil (X/C)
22245	1992-082A Gorizont 27 (Russia)	52.6E#	Dom/Gov FSS (C/Ku)
23305	1996-034A Gorizont 32 (Russia)	52.8E	Dom/Gov FSS (C/Ku)
19687	1988-109A Skynet 4B (UK)	53.0E/i	Mil-Comm (P/S/X/Ka)
23305	1994-064A Intelsat 703	56.9E	Int FSS (C/Ku)
13040	1982-006A DSCS II E15 (USA)	57.0E/i	Mil-IOR reserve operational (S/X)
14675	1989-069B DSCS III A2 (USA 44)	57.0E/i	Mil-IOR primary operational (P/S/X)
15629	1985-025A Intelsat 510	57.0E/i	Int FSS (C/Ku)
22913	1993-074A DSCS III B10 (USA 97)	60.E/i	Mil-IOR primary operational (P/S/X)
20667	1990-056A Intelsat 604	60.0E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	62.9E	Int FSS (C/Ku)
23839	1996-020A Inmarsat 3 F-1	63.9E/i	Int Mar (L/C)
13595	1982-097A Intelsat 505	64.9E/i	Int FSS/Mar (L/C/Ku)
20918	1990-093A Inmarsat 2 F1	65.0E#	Int Mar-IOR (L/C)
13636	1982-106A DSCS II F16 (USA 43)	65.2E/i	Mil-IOR reserve operational (S/X)
23461	1995-001A Intelsat 704	66.0E	Int FSS (C/Ku)
23636	1995-040A PanAmSat 4 (PAS 4)	68.5E	Int FSS (C/Ku)
20083	1989-048A Raduga 1-1 (Russia)	70.1E/i	Dom FSS/Gov-Mil (X/C)
23448	1994-087A Raduga 32 (Russia)	70.1E#	Dom FSS/Gov-Mil (X/C)
22787	1993-056A USA 95 (UFO-2)	71.5E/i	Mil-IOR primary (P/S)
20410	1990-002B Leasat 5 (USA)	71.6E/i	Mil-IOR reserve (P/S/X)
12474	1981-050A Intelsat 501	72.2E/i	Int FSS (C/Ku)
23589	1995-027A USA 111 (UFO-5)	72.4E/i	Mil-IOR reserve (P/S/K)
08882	1976-053A Marisat 2	73.9E/i	Int Mar-IOR (P/L/C)
22027	1992-041A Insat 2A (India)	73.9E	Dom FSS/BSS/Met (S/C)
23327	1994-069A Elektro 1 (Russia)	76.1E#	Met (L)
23680	1995-054A Luch 1-1 (Russia)	77.0E/i	Tracking & Relay SDRN-2 (Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.4E	Reg FSS (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.5E	Reg FSS (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	80.0E/i	Dom/Gov FSS (C/Ku)
23653	1995-045A Cosmos 2319 (Russia)	80.4E#	Data Relay (C)
20643	1990-051A Insat 1D (India)	82.9E	Dom FSS/BSS/Met (S/C)
19548	1988-091B TDRS F3 (USA)	85.0E/i	Gov (C/S/Ku)
22836	1993-062A Raduga 30 (Russia)	85.6E#	Dom FSS/Gov-Mil (X/C)
18922	1988-014A PRC 22 (China)	87.7E/i	Dom FSS (C)
22880	1993-069A Gorizont 28 (Russia)	90.2E#	Dom/Gov FSS (C/Ku)
23765	1995-003A Measat 1 (Malaysia)	91.4E	Dom FSS/DTH (C/Ku)
22724	1993-048B Insat 2B (India)	93.4E	Dom FSS/BSS/Met (S/C)
23731	1995-067B Insat 2C (India)	93.4E	Dom FSS/BSS/Met (S/C)
23426	1994-082A Luch 1 (Russia)	95.1E#	Tracking & Relay CSDRN (Ku)
20263	1989-081A Gorizont 19 (Russia)	96.3E/i	Dom/Gov FSS (C/Ku)
20473	1990-011A PRC 26 (China)	98.1E#	Dom FSS (C)
19683	1988-108A Ekran 19 (Russia)	99.0E/i	Dom BSS (P)
22210	1992-074A Ekran 20 (Russia)	99.3E#	Dom BSS (P)
23723	1995-064A AsiaSat 2	100.4E	DTH (C/Ku)
21922	1992-017A Gorizont 25 (Russia)	103.3E#	Dom/Gov FSS (C/Ku)
23010	1994-012A Raduga 31 (Russia)	104.4E/d	Dom FSS/Gov-Mil (X/C)
20558	1990-030A Asiasat 1	105.3E	DTH (C/Ku)
20570	1990-034A Palapa B2R	107.9E	Reg FSS (C)
23176	1994-040B BS-3N (Japan)	109.5E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.8E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	110.0E#	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.5E#	Dom FSS (C)
23779	1996-006A Palapa C1	113.0E	Reg FSS (C/Ku)
23864	1996-030A Palapa C2	113.0E	Reg FSS (C/Ku)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.6E	Dom FSS (C/Ku)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	115.7E	Dom FSS (Ku)
23768	1996-003A Koreasat 2 (Mugunghwa 2)	115.9E	Dom FSS (Ku)
21964	1992-027A Palapa B4	118.0E	Reg FSS (C)
20217	1989-070A GMS-4 (Himawari 4)	120.3E#	Met (P/L)
23651	1995-044A N-Star A (Japan)	125.3E/d	Dom/Mob FSS (S/C/Ku/Ka)
21132	1991-014A Raduga 27 (Russia)	127.6E/i	Dom FSS/Gov-Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.6E	Dom FSS (Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	129.5E#	Reg FSS (C/Ku)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.9E	Dom FSS (C/K)
23943	1996-039A Apstar 1A (China)	134.0E	Reg FSS (C)
23781	1996-007A N-Star B (Japan)	135.9E	Dom/Mob FSS (S/C/Ku/Ka)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	136.1E	Dom FSS (C/K)
17706	1987-029A Palapa B-2P	137.0E/d	Reg FSS (C)

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OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
23185	1994-043A APStar I (China)	137.9E	DTH (C)
20107	1989-052A Gorizont 18 (Russia)	140.0E/i	Dom/Gov FSS (C/Ku)
20953	1990-102A Gorizont 22 (Russia)	140.0E/i	Dom/Gov FSS (C/Ku)
23522	1995-011B GMS-5 (Himawari 5)	140.1E#	Met (P/L)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.0E#	Reg FSS (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	145.0E/i	Dom/Gov FSS (C/Ku)
20066	1989-046A DSP F-14 (USA)	145.5E/i	Mil-Early Warning (S/X)
19874	1989-020A JCSAT 1 (Japan)	149.9E	Dom FSS (Ku)
18316	1987-070A ETS V (Japan)	150.3E/i	Experimental (L/C)
18350	1987-078A Optus A3 (Aussat K3)	151.9E#	DTH (Ku)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom FSS (Ku)
23613	1995-035B TDRS F7 (USA)	155.8E#/d	Int FSS/Gov (C/S/Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	DTH/Mob (L/Ku)
22253	1992-084A Superbird A1 (Japan)	157.9E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	160.0E	DTH/Mob (L/Ku)
21893	1992-010A Superbird B1 (Japan)	162.0E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	163.9E/i	DTH (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	168.9E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(USA)	171.0E/i	Mil-POR reserve (P-Bravo/S/X)
22871	1993-066A Intelsat 701	174.0E	Int FSS (C/Ku)
22719	1993-046A DSCS III B9 (USA 93)	175.0E/i	Mil-WPAC primary operational (P/S/X)
23124	1994-034A Intelsat 702	177.0E	Int FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	178.0E#	Int Mar-POR (L/C)
16117	1985-092C DSCS III B5 (USA 12)	180.0E/i	Mil-WPAC reserve operational (P/S/X)
15873	1985-055A Intelsat 511	179.9W/i	Int FSS (C/Ku)
15236	1984-093C Leasat 2 (USA)	178.0W/i	Mil-POR primary (P/S/X)
23467	1995-003A USA 108 (UFO-4) (USA)	177.6W/i	Mil-POR (P/S/K)
19121	1988-040A Intelsat 513	177.1W#	Int FSS (C/Ku)
21639	1991-054B TDRS F5 (USA)	174.2W	Int FSS/Gov (C/S/Ku)
09478	1976-101A Marisat 3	170.9W/i	Int Mar-POR (P/L/C)
20499	1990-016A Raduga 25 (Russia)	170.5W/i	Dom FSS/Gov-Mil (X/C)
18631	1987-100A Raduga 21 (Russia)	169.5W/i	Dom FSS/Gov-Mil (X/C)
21392	1991-037A Satcom C5 (Aurora II)(USA)	139.0W	Dom FSS (C)
20945	1990-100A Satcom C1 (USA)	137.1W	Dom FSS (C)
22096	1992-057A Satcom C4 (USA)	135.1W	Dom FSS (C)
21873	1992-006A DSCS III B14 (USA 78)	135.0W/i	Mil-EPAC primary operational (P/S/X)
23581	1995-025A GOES 9 (USA)	134.3W#	Met (P/L/S)
23016	1994-013A Galaxy 1R (USA)	133.0W	Dom FSS (C)
22117	1992-060B Satcom C3 (USA)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (USA)	130.2W/i	Mil-EPAC reserve operational (P/S/X)
21906	1992-013A Galaxy 5 (USA)	125.0W	Dom FSS (C)
16649	1986-026A Gstar 2 (USA)	125.0W#	Dom FSS (Ku)
23877	1996-033A Galaxy 9 (USA)	123.0W	Dom FSS (C)
19484	1988-081B SBS 5 (USA)	123.0W	Dom FSS (Ku)
15826	1985-048D Telestar 3D (USA)	120.9W#	Dom FSS (C)
22988	1994-009A USA 99 (DFS-1/Milstar 1)	120.0W	Mil-Comm (P/S/K)
23754	1995-073A EchoStar 1 (USA)	119.0W	DTH (Ku)
16274	1985-109B Morelos B (Mexico)	116.8W	Dom FSS (C/Ku)
13652	1982-110C Anik C3 (Canada)	114.9W/i	Dom FSS (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)	107.3W	Dom FSS (C/Ku)
08746	1976-023A LES 8 (USA)	107.2W/i	Mil-Exp comm (P/Ka)
23846	1996-022A MSAT M1 (Canada)	106.5W	Mobile (L/X)
23696	1995-057A USA 114 (UFO-6)	105.9W/i	Mil-CONUS (P/S/K)
08697	1976-017A Marisat 1	105.5W/i	Int Mar-AOR (P/L/C)
15643	1985-028C Leasat 3 (USA)	105.3W/i	Mil-CONUS reserve (P/S/X)
03029	1967-111A ATS 3 (USA)	105.3W/i	Exp comm (VHF/C)
20946	1990-100B Gstar 4 (USA)	105.1W	Dom FSS (Ku)
08747	1976-023B LES 9 (USA)	104.8W/i	Mil-Exp comm (P/Ka)
15677	1985-035A Gstar 1 (USA)	103.0W	Dom FSS (Ku)
23435	1994-084A DSP F-17 (USA)	103.6W#	Mil-Early Warning (S/X)
22930	1993-078A DBS 1 (USA)	101.2W	DTH (Ku)
21227	1991-028A Spacenet 4 (USA)	101.1W	Dom FSS (C/Ku)
23553	1995-019A AMSC 1 (USA)	101.0W	Mobile (L/X)
23598	1995-029A DBS 3 (USA)	100.9W	DTH (Ku)
23192	1994-047A DBS 2 (USA)	100.9W	DTH (Ku)
22796	1993-058B ACTS (USA)	100.0W	Exp Comm (C/K/Ka)
17181	1986-096A USA 20 (FltSatCom F7)(USA)	99.5W/i	Mil-CONUS primary (P/S/X/K)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
22694	1993-039A Galaxy 4 (USA)	99.1W	Dom FSS (C/Ku)
22927	1993-077A Telstar 401 (USA)	97.0W	Dom FSS (C/Ku)
23741	1995-069A Galaxy 3R (USA)	95.0W	Dom/DTH (C/Ku)
19483	1988-081A Gstar 3 (USA)	92.9W/i	Dom FSS/Mob (L/Ku)
16650	1986-026B SBTS 2 (Brazil)	92.1W	Dom FSS (C)
22205	1992-072A Galaxy 7 (USA)	91.0W	Dom FSS (C/Ku)
23670	1995-049A Telstar 402R (USA)	89.1W	Dom FSS (C/Ku)
18951	1988-018A Spacenet 3R (USA)	87.1W	Dom FSS (L/C/Ku)
15237	1984-093D Telestar 3C (302) (USA)	85.1W#	Dom FSS (C)
16482	1986-003B Satcom K-1 (USA)	84.9W	Dom FSS (Ku)
16276	1985-109D Satcom K-2 (USA)	81.0W	Dom FSS (Ku)
14050	1983-041A GOES 6 (USA)	78.0W/i/d	Met (P/L/S)
15235	1984-093B SBS 4 (USA)	77.0W/i	Dom FSS (Ku)
14133	1983-059B Anik C2 (Argentina)	75.8W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (USA)	75.7W/i	Dom FSS (C)
23051	1994-022A GOES 8 (USA)	74.7W#	Met (P/L/S)
20873	1990-091B Galaxy 6 (USA)	74.2W	Dom FSS (C)
20872	1990-091A SBS 6 (USA)	74.0W	Dom FSS (Ku)
15642	1985-028B Anik C1 (Argentina)	71.9W	Dom FSS (Ku)
15561	1985-015B SBTS 1 (Brazil)	71.6W#	Dom FSS (C)
12855	1981-096A SBS 2 (USA)	71.1W/i	Dom FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom FSS (C)
15385	1984-114A Spacenet 2 (USA)	69.2W	Dom FSS (C/Ku)
23536	1995-016A Brasilsat B2 (Brazil)	65.0W	Dom FSS (C/X)
23915	1996-035A Intelsat 709	57.1W	Intl FSS (C/Ku)
21940	1992-021B Inmarsat 2 F4	54.0W/i	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	53.1W	Int FSS (C/Ku)
23628	1995-038A DSCS III B7 (USA)	52.5W/i	Mil-WLANT primary operational (P/S/X)
23528	1995-013A Intelsat 705	50.1W	Int FSS (C/Ku)
13969	1983-026B TDRS F1 (USA) 49.0W/i	Gov (C/S/Ku)	
22314	1993-003B TDRS F6 (USA)	47.4W/i	Gov (C/S/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Int FSS (C/Ku)
23764	1996-002A PanAmSat 3R (PAS 3R)	43.1W	Int FSS (C/Ku)
16116	1985-092B DSCS III B4 (USA 11)	42.5W/i	Mil-ATL reserve operational (P/S/X)
19883	1989-021B TDRS F4 (USA)	41.1W	Int FSS/Gov (C/S/Ku)
12089	1980-098A Intelsat 502	40.4W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (USA)	37.5W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.6W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.0W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.6W/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)
21653	1991-055A Intelsat 605	24.6W	Int FSS (C/Ku)
22112	1002-059A Cosmos 2209 (Russia)	24.3W#	Mil-Early Warning (X)
20253	1989-077A USA 46 (FltSatCom 8)	22.3W/i	Mil-AOR primary (P-Charlie/S/X/K)
21989	1992-032A Intelsat K	21.6W	Int FSS (Ku)
16101	1985-087A Intelsat 512	21.3W#	Int FSS (C/Ku)
15391	1984-115A NATO III D	21.1W/i	Mil-Comm (P/S/X)
20705	1990-063A TDF 2 (France)	19.1W	DTH (Ku)
19621	1988-098A TDF 1 (France)	18.9W	DTH (Ku)
19772	1989-006A Intelsat 515	18.0W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.8W/i	Mil-Comm (P/S/X)
20391	1989-101A Cosmos 2054 (Russia)	16.1W/i	Tracking & Relay WSDRN (Ku)
21149	1991-018A Inmarsat 2 F2	15.5W/i	Int Mar-AOR-E (L/C)
15386	1984-114B Marecs B2	15.3W/i	Int Mar-AOR (L)
23132	1994-035A USA-104 (UFO-3)(USA)	14.9W/i	Mil-AOR primary (P/S)
10669	1978-016A Ops 6391 (FltSatCom 1) (USA)	14.7W/i	Mil-AOR reserve (P-Alpha/S/X)
23319	1994-067A Express 1 (Russia)	14.1W	Int FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	13.8 W#	Data Relay (C)
22009	1992-037A DSCS III B12 (USA 82)	12.0W/i	Mil-ELANT primary operational (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	11.4W#	Dom/Gov FSS (C/Ku)
22912	1993-073B Meteosat 6 (ESA)	10.3W#	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom FSS/Gov-Mil (X/C/Ku)
21805	1991-080B DSP F-16 (USA)	6.9W#	Mil-Early Warning (S/X)
21939	1992-021A Telecom 2B (France)	5.1W	Dom FSS/Gov-Mil (X/C/Ku)
23865	1996-030B Amos 1 (Israel)	4.1W	Dom FSS (
20776	1990-079A Skynet 4C (UK)	1.2W#	Mil (P/S/X/Ka)
23816	1996-015A Intelsat 707	1.0W	Int FSS (C/Ku)
20168	1989-062A TV Sat 2 (Germany)	0.8W	Dom BSS (Ku)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.6W	Reg BSS (Ku)

Amateur Satellite Frequency Guide

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Satellite / **Mode** / **Frequencies**

OSCAR 13 (AO-13) (Notes 1 & 13)

B (u/V)

Dn	145.828	838	848	858	868	878	888	898	908	918	928	938	948	958	968	145.978
Up	435.570	560	550	540	530	520	510	500	490	480	470	460	450	440	430	435.420

Bcns: 145.812 (RTTY, CW, PSK) … 145.985

S (u/S)

Dn	2400.711	720	730	740	2400.747
Up	435.601	610	620	630	435.637

Bcn: 2400.650 (RTTY, CW, PSK)

OSCAR 10 (AO-10) (Notes 2 & 13)

B (u/V)

Dn	145.825	835	845	855	865	875	885	895	905	915	925	935	945	955	965	145.975
Up	435.179	169	159	149	139	129	119	109	099	089	079	069	059	049	039	435.029

Bcn: 145.810 (Steady unmodulated carrier) … 145.987

RS 10/11 (Notes 3, 4, 5 and 13)

A (v/A)

Dn	29.360	370	380	390	29.400
Up	145.860	870	880	890	145.900

Robot (CW): 29.403 / 145.820

Bcn: 29.357 (CW)

RS-12/13 (Notes 3, 6 & 7)

K (h/A)

Dn	29.410	420	430	440	29.450
Up	21.210	220	230	240	21.250

Robot (CW): 29.454 / 21.129

Bcn: 29.408

RS-15 (Note 13)

A (v/a)

Dn	29.354	29.364	29.374	28.384	29.394
Up	145.858	145.868	145.878	145.888	145.898

UoSat 11 (UO-II) (Note 14)

Bcns

Dn	145.826	435.025	2401.500
Up	None		

PACSAT (AO-16) (Notes 8, 9 & 11)

[a]

Dn	437.025 (Sec) 437.050			
Up	145.900	145.920	145.940	145.960

DOVE (DO-17) (Notes 10 & 11)

[b,c]

Dn	145.825	2401.220
Up	None	

WEBERSAT (WO-18) (Note 11)

[a]

Dn	437.075	437.100 (Sec)
Up	None	

LUSAT (LO-19) (Notes 8 & 11)

[a]

Dn	437.125	437.150 (Sec)		
Up	145.840	145.860	145.880	145.900

NOTES

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

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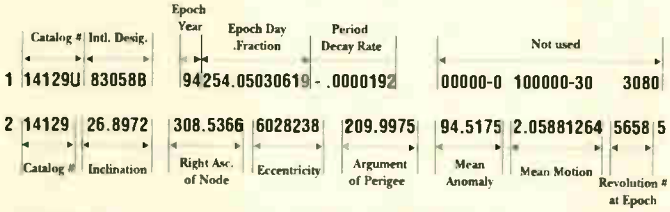
Satellite	Mode		Frequencies										
JAS-Ib (FO-20) (Notes 11 & 13)	JA Linear	Dn	435.800	810	820	830	840	850	860	870	880	890	435.900
		Up	146.000	990	980	970	960	950	940	930	920	910	145.900
	Bcn		435.795 (CW)										
	JD [a] Dgtl	Dn											435.910
		Up	145.850		145.890		145.910						
OSCAR 22 (UO-22)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

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

Amateur and Weather Satellite Two-Line Orbital Element Sets

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

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



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 96220.92304051 .00000021 00000-0 10000-3 0 4457
2 14129 26.0312 195.7517 6026571 38.4969 351.8988 2.05881743 70933
UOSAT 2 (UoSAT 2, UoSAT 11, UO-11)
1 14781U 84021B 96218.97702884 .00000105 00000-0 25511-4 0 9036
2 14781 97.8028 207.4920 0011385 297.1707 62.8330 14.69470081664965
RS-10/11 (Radio Sputnik 10/11, Cosmos 1861)
1 18129U 87054A 96220.23196377 .00000032 00000-0 18600-4 0 2427
2 18129 82.9263 110.8175 0012779 19.3463 340.8175 13.72367789457173
OSCAR 13 (AMSAT OSCAR 13, AO-13)
1 19216U 88051B 96220.12624942 .00014666 00000-0 18293-2 0 2531
2 19216 57.1662 99.8336 7439379 47.0223 355.1161 2.10523352 30914
OSCAR 16 (PACSAT, AMSAT-OSCAR 16, AO-16)
1 20439U 90005D 96217.28775268 -.00000016 00000-0 10713-4 0 9996
2 20439 98.5578 301.7080 0012183 62.2498 297.9917 14.29980552340946
OSCAR 17 (DOVE, DO-17)
1 20440U 90005E 96220.59353085 .00000008 00000-0 19792-4 0 04
2 20440 98.5606 305.6228 0012368 52.0641 308.1672 14.30122957341447
OSCAR 18 (WEBERSAT, WO-18)
1 20441U 90005F 96218.27561842 -.00000015 00000-0 11072-4 0 45
2 20441 98.5600 303.2768 0012814 60.9897 299.2569 14.30091984341116
OSCAR 19 (LUSAT, LO-19)
1 20442U 90005G 96221.20601615 .00000023 00000-0 25778-4 0 08
2 20442 98.5597 306.6709 0013333 50.0517 310.1842 14.30201900341556
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 96217.64566358 -.00000037 00000-0 -10627-4 0 8963
2 20480 99.0239 233.2834 0540629 14.7623 346.8565 12.83234041304105
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 96219.21186098 .00000094 00000-0 83042-4 0 9083
2 21089 82.9228 152.2466 0030625 91.2614 269.2051 13.74072513275909
OSCAR 22 (UoSAT-F, UoSAT 5, UO-22)
1 21575U 91050B 96220.22717316 .00000031 00000-0 24759-4 0 7064
2 21575 98.3478 285.0877 0008240 107.9405 252.2678 14.37031977265397
OSCAR 23 (KITSAT-A, KITSAT 1, KO-23)
1 22077U 92052B 96220.10038753 -.00000037 00000-0 10000-3 0 5960
2 22077 66.0766 82.8629 0014422 285.3959 74.5465 12.86296923187353
OSCAR 25 (KITSAT-B, AMSAT OSCAR 25, KO-25)
1 22830U 93061H 96220.69852374 .00000001 00000-0 17363-4 0 5033
2 22830 98.4622 283.8281 0012246 43.0165 317.1970 14.28112636149381
OSCAR 26 (ITAMSAT-1, ITALY OSCAR 26, IO-26)
1 22826U 93061D 96217.77655931 -.00000054 00000-0 -45023-5 0 4903
2 22826 98.5762 292.6205 0009928 84.2078 276.0233 14.27809337148934
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR 27, AO-27)
1 22825U 93061C 96218.76509649 .00000007 00000-0 20340-4 0 4928
2 22825 98.5765 293.4133 0009395 83.1779 277.0470 14.27700603149064
OSCAR 28 (POSAT-1, PO-28)
1 22829U 93061G 96219.79526850 -.00000001 00000-0 17100-4 0 4845
2 22829 98.5749 294.7286 0010965 68.0414 292.1915 14.28129111149259
HEATHSAT
1 22827U 93061E 96218.74083255 .00000017 00000-0 24173-4 0 5524
2 22827 98.5784 293.4731 0010156 71.9675 288.2612 14.27944664149089
ITAMSAT
1 22828U 93061F 96217.74620137 .00000021 00000-0 25798-4 0 4696
2 22828 98.5747 292.6526 0011130 72.9641 287.2759 14.28147807117046
RS-15
1 23439U 94085A 96221.25057006 -.00000039 00000-0 10000-3 0 1520
2 23439 64.8215 298.8904 0159525 189.9632 169.8119 11.27528365 66652

WEATHER SATELLITES
Geostationary Spacecraft
GOES 8 (Operational East-USA)
1 23051U 94022A 96213.47022580 -.00000273 00000-0 10000-3 0 5585
2 23051 0.1097 94.4136 0004501 61.2408 247.8539 1.00270501 15817
GOES 9 (Operational West-USA)
1 23581U 95025A 96220.52967083 .00000066 00000-0 10000-3 0 2235
2 23581 0.3058 268.0452 0000337 327.5423 136.4563 1.00269928 4440
ELEKTRO (Russia)
1 23327U 94069A 96214.74768142 -.00000121 00000-0 00000+0 0 1824
2 23327 0.1539 146.6085 0004706 315.2571 193.8164 1.00269199 6452
METEOSAT 5 (MOP-2 Operational-ESA)
1 21140U 91015B 96219.49173049 -.00000028 00000-0 00000+0 0 2407
2 21140 0.6470 77.2451 0003554 71.7784 343.4204 1.00264222 22119
METEOSAT 6 (Operational-ESA)
1 22912U 93073B 96220.06682417 -.00000105 00000-0 00000+0 0 5229
2 22912 0.1133 20.1425 0001205 115.4264 194.1984 1.00273441 8366
HIMAWARI 4 (GMS 4 Standby-Japan)
1 20217U 89070A 96219.67699653 -.00000387 00000-0 10000-3 0 4251
2 20217 1.8929 75.0042 0000901 209.8617 34.6218 1.00271744 25922
HIMAWARI 5 (GMS 5 Operational-Japan)
1 23522U 95011B 96216.48757405 -.00000304 00000-0 10000-3 0 1381
2 23522 0.3839 359.8269 0000502 92.7848 175.4426 1.00277284 4921

NEAR Polar/Polar Orbiting Spacecraft
NOAA 12 (Operational morning spacecraft-USA 137.50 MHz)
1 21263U 91032A 96220.90303983 .00000114 00000-0 70063-4 0 372
2 21263 98.5568 238.5273 0013629 120.3439 239.9085 14.22646392271814
NOAA 14 (Operational afternoon spacecraft-USA 137.620 MHz)
1 23455U 94089A 96220.81496620 .00000105 00000-0 82456-4 0 7009
2 23455 98.9480 166.1427 0010524 92.4579 267.7803 14.11602831 82734
Meteor 2-21 (Operational-Russia/off at last report)
1 22782U 93055A 96217.31146518 .00000041 00000-0 23992-4 0 5021
2 22782 82.5513 309.0029 0021094 200.6750 159.3535 13.83057687147782
Meteor 3-5 (Operational-Russia 137.850 MHz)
1 21655U 91056A 96220.49343776 .00000051 00000-0 10000-3 0 9082
2 21655 82.5526 284.2242 0014515 45.7350 314.4957 13.16848054239426
Meteor 3-6 (Operational-Russia/off at last report)
1 22969U 94003A 96219.75134546 .00000051 00000-0 10000-3 0 2742
2 22969 82.5567 224.8146 0016338 107.2996 252.9916 13.16736869121700
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 96220.78257952 .00000080 00000-0 66774-4 0 8779
2 23233 98.8210 278.7908 0013476 37.7280 322.4831 14.12725537100115
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 96220.92505781 -.00000009 00000-0 19010-4 0 6208
2 23533 98.8426 222.7257 0006099 274.1772 85.8702 14.12747802 70931
OKEAN 1-7 (Okean 4 Earth Resources-Russia 137.400 MHz)
1 23317U 94066A 96217.57130807 .00000065 00000-0 65177-5 0 1722
2 23317 82.5423 14.5138 0024865 286.4458 73.4022 14.74031122 97667
SICH-1 (Earth Resources-Russia 137.400 MHz)
1 23657U 95046A 96217.82133405 .00000090 00000-0 10439-4 0 988
2 23657 82.5340 155.7983 0025998 252.4766 107.3595 14.73484931 49995

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/ Drbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-79	Sep 96/ Atlantis*	51.6/213	9 days	S/MM-04**
STS-80	Nov 96/ Columbia***	28.5/190	16 days	WSF-03

*Crew Assignment: CDR:William F. Readdy, PLT:Terrence W. Wilcutt, MS (PLC):Thomas D. Akers, MS:Jerome Apt, MS:John E Blaha(U), MS:Carl E. Walz.

**Crew Assignment: CDR:Valery Korzun, FLT ENG:Aleksandr Kaleri, RSH:Dr. Shannon Lucid

***Crew Assignment: CDR:Kenneth D. Cockrell, PLT:Kent V Rominger, MS:Tamara E. Jernigan, MS:Thomas D. Jones, MS:F. Story Musgrave.

STS	**Downlink Frequency Assignment:**
VHF/UHF Voice	139.208 (STS-79 only), 145.55, 145.84, 243.0 (AM), 259.7 (AM), 279.0 (AM), and 296.8 MHz (AM)
S-band TLM	2217.5, 2250.0 and 2287.5 MHz
C-band TRK	5400-5900.0 MHz

MIR	Downlink Frequency Assignment:
VHF	143.625, 145.55, 145.8 MHz
UHF	437.925, 437.95, 437.975 MHz

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Sep 96	Soyuz	Baikonur	Progress M-33
Sep 96	Cosmos	Plesetsk	Cosmos, UNAMSAT and FAISAT 2
Sep 96	Start	????????	Worldview-1
Oct 96	Shtil-2	Barents Sea	Kompass
Oct 96	Soyuz	Plesetsk	Bion 11
Nov 96	Proton	Baikonur	Mars96

Progress M-33	**Downlink Frequency Assignment:**
VHF-band	165.0, 166.0 MHz
L-band	922.755 MHz

Bion 11	**Downlink Frequency Assignment:**
VHF-band	136.68 MHz

Mars 96	Downlink Frequency Assignment:
X-band	8417.68 MHz

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Sep 96	Delta II	CCAS	GPS II-27
Sep 96	Titan II	VAFB	NOAA-K
Oct 96	Titan 4	????	Classified
Oct 96	Pegasus XL	WFF	SAC-B & HETE
Nov 96	Delta II	CCAS	Mars Global Surveyor
Nov 96	Atlas	CCAS	HOT BIRD-2
Nov 96	Delta II	CCAS	Iridium #1
Nov 96	Pegasus XL	Spain	MINISAT 1

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

GPS II-27	**Downlink Frequency Assignments:**
L-band	1227.5 MHz
S-band	2227.5 MHz

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

Titan 4	**Downlink Frequency Assignments:**
S-band	2217.5, 2255.5, 2272.5, 2287.5 MHz

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

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

SAC-B	**Downlink Frequency Assignments:**
S-band	2255.500 MHz

HETE	**Downlink Frequency Assignments:**
VHF-band	137.960 MHz
S-band	2272.000 MHz

Mars Global	**Downlink Frequency Assignments:**
X-band	8417.716, 8417.71605, 8423.148147 MHz

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

HOT BIRD-2	**Downlink Frequency Assignments:**
S-band	2264.818 MHz

Satellite Launch Schedules

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Sep 96	Ariane 4	Kourou	Echostar 2
Oct 96	Ariane 4	Kourou	INSAT 2D & MEASAT 2
Nov 96	Ariane 4	Kourou	PAS 6

Echostar 2 **Downlink Frequency Assignments:**
Ku-band 12.2-12.7 GHz

List of Abbreviations and Acronyms

Bion 11 — Carrying two Rhesus monkeys for joint life sciences mission between NASA and Moscow's Institute of Biomedical Problems (IBMP).
C-band — 3,400 to 7,100 MHz
CCAS — Cape Canaveral Air Station
CDR — Commander, member of the shuttle flight crew in command of the flight. Classified payload that can not be identified due to National Security reasons.
Cosmos — Military and civilian navigation satellite for Russia.
(D) — Down
Echostar — A direct-to-home TV system working through 45 cm dishes.
FAISAT 2 — Demonstrating data store and forward from interrogated remote terminals in preparation for a six satellite constellation that would permit access to and receive/transmit every 50 minutes.
GHz — Gigahertz
GPS II-27 — U.S. Air Force global positioning satellite for military and civilian navigation services.
HETE — High Energy Transient Experiment: Spacecraft to study gamma ray burst sources and source locations, and x-ray burst sources and source locations.
Hot Bird — Will provide direct TV programming to 45 cm dishes across Europe.
Insat — Providing two high power TV broadcast and 12 telecommunications national coverage transponders, in addition to meteorological 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.
K-band — 15.4 to 27.5 GHz
Kompass — A small 70 kg spacecraft placed into a 400 km, 79 degree orbit on a six month mission aimed at predicting earthquakes from anomalies in the electromagnetic field.
L-band — 1,400 to 1,800 MHz
Mars96 — This mission to Mars will release two small landers before entering a highly elliptical polar orbit to undertake extensive surface mapping and other investigations.
Mars Global — Mars Surveyor Program: MSP program consists of a series of orbiter's and/or landers to be launched at every Mars opportunity roughly 25 months apart.
Measat — Provide domestic and regional telecommunications services to Malaysia.
MHz — Megahertz
Minisat — Program under the Interministerial Commission for Science & Technology (INTA). The spacecraft will carry a Extreme Ultraviolet Radiation Detector and Low Energy Gamma Ray Imager.
MS — Mission Specialist: A member of shuttle flight crew primarily responsible for orbiter subsystem and payload activities.
NOAA-K — Conducts research and gathers data about the global oceans, atmosphere, space and sun, and applies this knowledge to science and service that touch the lives of all Americans.
PAS 6 — Primarily for TV programming of U.S. or Mexican origin, and business data, video and voice traffic.
PLC — Payload Commander: A member of the shuttle crew having overall crew responsibility for planning, integration, and on-orbit coordination of payload mission activities.
PLT — Pilot: A member of the shuttle crew whose primary responsibility is to pilot the orbiter.
Progress — Unmanned cargo ship launched to the Russian *Mir* space station bringing food, water, fuel and equipment to present crew.
RNG — Ranging
SAC-B — Argentine spacecraft carrying hard x-ray spectrometer to investigate solar flares and cosmic transient x-ray emissions.
S-band — 1,800 to 2,700 MHz
S/MM-04 — Shuttle *MIR* Mission, shuttle mission to the Russian Space Station MIR to support design and assembly of the International Space Station.
TLM — Telemetry
TRK — Tracking
(U) — Up
UHF — Ultra High Frequency (225 to 1,000 MHz)
UNAMSAT — Main mission was meteor sounding by detecting echos from pulses transmitted. The system also carries amateur radio store and forward links.
VAFB — Vandenberg Air Force Base, California
VHF — Very High Frequency (30 to 225 MHz)
WBFM — Wideband FM
Worldview — The 3 meter resolution satellite of WorldView Imaging Corp of Livermore, California. Systems aims at the GIS and geographically-oriented multimedia uses.
WSF-03 — Wake Shield Facility: Satellite for molecular and chemical beam epitaxy growth of compound semiconductors, high temperature superconductors, and other materials using techniques requiring ultra-high vacuum, high pumping speeds, and relatively large working volumes.
X-band — 7,250 to 8,400 MHz

Keith Stein is a freelance writer based in Woodbridge, Virginia. You can contact him through his Internet home page at: **http://www.newspace.com/casr**

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 1996. The format of the listing is as follows:

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

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

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

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

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1996 May 5/0704	1996-028A	Progress-M 31		7,250 kg?
1996 May 5.47	51.61 deg	88.62 min	186 km	227 km
1996 May 7.35	51.65 deg	92.43 min	391 km	396 km

Unmanned cargo freighter, carrying supplies to the cosmonauts and astronaut aboard the Mir Complex. Docked with the Mir complex at the +X port (at the front longitudinal port) May 7 at 0854 UTC. Launched from Tyuratam using a Soyuz-U: third stage (Block I) in an orbit similar to the first one shown for Progress-M.

1996 May 5/2132	1996-029A	USA 119		?
No orbital data issued				
1996 May 5/2132	1996-029B	USA 120		?
No orbital data issued				
1996 May 5/2132	1996-029C	USA 121		?
No orbital data issued				
1996 May 5/2132	1996-029D	USA 122		?
No orbital data issued				

No details of the payload or orbital data released, but reportedly a PARCAE/White Cloud ocean surveillance mission. Previous missions have had one satellite deployed in approximately a 61-63 deg, 450 km near-circular orbit and three further satellites deployed in 63.4 deg, 1,150-1,160 km orbits. Launched from Vandenberg using a Titan-4.

A tether experiment has been released from this mission. The orbit is approximately 63.4 deg, 105.6 minutes, 1,022 km circular altitude. The tether is 4 km long and 2 mm diameter and the two end weights are 9 kg and 41 kg with laser corner reflectors. The project is sponsored by the Naval Research Laboratory. It is not known whether the tether experiment has been assigned one of the "USA" numbers shown above or hether it is one of the objects shown as "debris".

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1996 May 14/0855		Cosmos		6,500 kg?
Failed to reach orbit				

Cometa fourth generation topographic/mapping photoreconnaissance satellite, intended to remain in orbit for about 45 days. It was planned that the satellite would undertake experiments designated SPIN-2 which involved photography at a resolution of 2 metres (hence SPIN-2) of the United States. 49 seconds after launch the payload shroud broke into four pieces and shortly after the separation of the four strap-on boosters (Blocks B, V, G and D) control of the vehicle veered off-course and the central core (Block A) engine was shut down. The launch vehicle was destroyed 310 seconds after launch, presumably the time of ground impact.

1996 May 16/0156	1996-030A	Palapa-C 2		2,989 kg
1996 May 16.31	4.00 deg	632.22 min	321 km	35,725 km
1996 May 31.26	0.03 deg	1,435.94 min	35,779 km	35,788 km
1996 May 16/0156	1996-030B	Amos 1		996 kg
1996 May 16.32	4.05 deg	633.25 min	310 km	35,788 km
1996 Jun 3.08	0.09 deg	1,436.07 min	35,767 km	35,805 km

Palapa-C 2 is a communications satellite to be operated by P T Satelindo and PSN, Jakarta, Indonesia: it will supply services for Indonesia, south-eastern Asia and parts of China. Mass quoted is at launch: on-station at the beginning of operations it is 1,803 kg and the dry mass is 1.669 kg. Satellite initially located over 123-124 deg E approximately Jun 20 and was relocated over 113 deg E approximately Jun 23.

Amos 1 is a telecommunications satellite, to be operated by Israel Aircraft Industry/ MTB in Tel Aviv, Israel. Mass quoted is at launch: on-station at the beginning of operations it is 580 kg and the dry mass is 479 kg. Satellite located over 356 deg E.

Launched from Kourou using an Ariane-44L: third stage (H-10-3) is in an orbit similar to the first ones listed for each satellite.

1996 May 17/0244	1996-031A	MSTI 3		200 kg?
1996 May 17.21	97.04 deg	91.09 min	291 km	365 km
1996 May 25.26	97.12 deg	93.14 min	422 km	435 km

MSTI 3 (Miniature Sensor Technology Integration) was launched to test out new sensor technology for ballistic missile defense. The satellite carries three sensors: a mid-wave infra-red camera, a short-wave IR camera, and a visible imaging spectrometer. It is planned that the satellite will study the infra-red emission from the Earth to determine whether tactical ballistic missiles can be spotted during their coast phase against the bright Earth background. L-1011 carrier aircraft took off from Vandenberg carrying the Pegasus-XL: third stage in an orbit similar to the first one shown for the satellite.

Launch Date/Time	Int Des		Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1996 May 19/1030	1996-032A		Endeavour (STS-77)	115,612 kg
1996 May 19.46	39.01 deg	90.22 min	280 km	290 km

1996 May 19/1030	1996-032B		SPARTAN-207/IAE	1,296 kg
1996 May 21.05	39.02 deg	90.27 min	282 km	294 km
1996 May 21.62	39.02 deg	90.19 min	279 km	288 km

1996 May 19/1030	1996-032C		IAE	60 kg
1996 May 21.12	38.99 deg	90.25 min	278 km	296 km

1996 May 19/1030	1996-032D		PAMS/STU	52 kg
1996 May 22.52	39.01 deg	90.17 min	278 km	288 km

Shuttle mission, carrying six astronauts: J H Casper (commander), C L Brown Jr (pilot), A S W Thomas (mission specialist, MS-1), D W Bursch (MS-2, EV-2 if EVA work was required), M Runco Jr (MS-3, EV-1) and M Garneau (Canadian Space Agency astronaut, MS-4). Orbiter's payload bay carried SPACEHAB 4 module (mass 4,059 kg) for in-flight experiments. Mass quoted is that projected for the time of landing. Landed at the Kennedy Space Center, May 29 at 1109 UTC.

The sole payload for the SPARTAN 207 (Shuttle-Pointed Research Tool for Astronomy) was the IAE (Inflatable Antenna Experiment). IAE was an inflatable antenna with a diameter of 14 metres, attached to SPARTAN in its deployed mode by three 14 metres-long struts. The complete assembly as initially deployed in orbit May 20.48 at 1129 UTC had a mass of 1,296 kg, which comprised the complete IAE equipment (mass 450 kg) and the SPARTAN itself (846 kg). The IAE antennae was inflated at 1338 UTC. After completion of the experiment the IAE antenna itself was separated from SPARTAN 207 approximately 90 minutes after antenna inflation and SPARTAN was recaptured by the orbiter's remote manipulator May 21 at 1338 UTC. In addition to operations with the IAE, SPARTAN 207 tested a solid state recorder using flash EEPROM memory. This SPARTAN carrier had previously flown as SPARTAN 204 (1995-004B) as part of the Discovery STS-63 mission in February 1995.

The Passive Aerodynamically Stabilised Magnetically-Damped Satellite (PAMS) Satellite Test Unit (STU) was deployed from Endeavour May 22 at 0918 UTC and rendezvous and stabilisation experiments were performed with the satellite.

1996 May 24/0110	1996-033A		Galaxy 9	1,397 kg
1996 May 24.10	22.97 deg	686.21 min	1,879 km	36,907 km
1996 Jun 10.24	0.01 deg	1,436.22 min	35,784 km	35,794 km

Communications satellite launched for Hughes Communications Inc. Mass quoted is at launch: on station at the beginning of operations the mass is 654 kg. Initially located over 237 deg E for testing and later to relocated to 231 deg E. Launched from Cape Canaveral using a Delta-2 (7925): second stage left in a 25.83 deg, 104.19 minutes, 339-1,574 km orbit, third stage (PAM-D) in an orbit similar to the first orbit quoted for Galaxy 9.

1996 May 25/0205	1996-034A		Gorizont 32	2,125 kg?
1996 May 24.84	1.43 deg	1,477.37 min	36,510 km	36,671 km
1996 Jun 2.99	1.47 deg	1,436.20 min	35,725 km	35,852 km

Telecommunications satellite, to be used for both domestic and international broadcasts: also called "Presidentsky": deployed over 52-53 deg E. Launched from Tyuratam using a four-stage Proton-K: third stage discarded in a 51.62 deg, 88.25 minutes, 180-196 km orbit, fourth stage (Block DM-2) in an orbit similar to the first one listed for the payload.

1996 Jun 4. 12.34			Cluster 1	1,200 kg
Failed to reach orbit				

1996 Jun 4. 12.34			Cluster 2	1,200 kg
Failed to reach orbit				

1996 Jun 4. 12.34			Cluster 3	1,200 kg
Failed to reach orbit				

Launch Date/Time	Int Des		Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1996 Jun 4. 12.34			Cluster 4	1,200 kg
Failed to reach orbit				

Maiden flight of new-generation Ariane-5 launch vehicle from Kourou. Carried four identical Cluster satellites, prime contractor Dornier. Mass quoted includes propellant: the dry mass of each was 550 kg. Satellites were planned to fly in formation and investigate the interaction between solar particles and the Earth's magnetic field. Ignition of the Ariane-5 core engine took place at 12.33 59 seconds UTC (H0): 7.5 seconds later the two strap-on boosters ignited and the vehicle left the launch pad. Through to H0+37 seconds the flight was normal, the vehicle having a velocity of mach 0.7 (857 km/h) and an altitude of 3.5 km. During H0+37 to H0+39 seconds there was a sudden swivelling of the two strap-on booster nozzles which caused the vehicle to tilt, giving rise to high aerodynamic overloads on the vehicle, causing initial break-up. Following the loss of the launch vehicle's integrity the vehicle was destroyed by its on-board auto-destruct system. Preliminary enquiries suggest that there was a problem with the guidance software for the vehicle.

If the launch had been successful the four Cluster satellites would have entered a geosynchronous transfer orbit with the following parameters: inclination - 8.36 deg, period - 637.44 minutes (calculated from the perigee and apogee values), perigee - 528 km, apogee - 35,768 km, argument of perigee - 183.2 deg. The satellites would have been transferred to the following orbit: inclination - 90 deg, period - 4,424.62 minutes (calculated from the perigee and apogee values), perigee - 25,500 km, apogee 140,300 km.

1996 Jun 15/0655	1996-035A		INTELSAT 709	3,420 kg
1996 Jun 16.45	7.09 deg	662.49 min	122 km	37,469 km
1996 Jun 24.02	0.07 deg	1,436.11 min	35,783 km	35,791 km

INTELSAT 709 is a telecommunications satellite to be used for international telephone traffic, video conferencing and television transmissions, to be operated by INTELSAT. Mass of the satellite quoted is at launch: in geosynchronous orbit at the beginning of operations it is 2,085 kg and the dry mass is 1,473 kg. Satellite initially located over 303 deg E, but it is to be operated over 342 deg E. Launched from Kourou by an Ariane-44P: third stage (H-10-3) in an orbit similar to the first one quoted for the satellite.

1996 Jun 20/1449	1996-036A		Columbia (STS-78)	116,198 kg
1996 Jun 20.64	39.01 deg	90.09 min	273 km	286 km
1996 Jun 20.80	39.02 deg	89.98 min	268 km	278 km

Shuttle mission carrying seven astronauts: T T Henricks (commander), K R. Kregel (pilot), S J Helms (payload commander and mission specialist MS-2: if an EVA is required Helms is assigned as EV-1), R M Linnehan (MS-1, EV-2 if required), C E Brady (MS-3), J-J Favier (French Atomic Energy Commission and CNES astronaut, payload specialist PS-1) and R B Thirsk (Canadian Space Agency, PS-2). Main payload for the mission is the Life and Microgravity Sciences (LMS) payload being carried in the pressurised Spacelab module (mass 9,649 kg) in the orbiter's payload bay. Mass quoted is that projected for the time of landing.

1996 Jun 20 18.45			Cosmos	6,500 kg?
Failed to reach orbit				

Probably a "Yantar-2K" fourth generation photoreconnaissance satellite, flown following the recovery of Cosmos 2331 on June 11. After launch the four strap-on (Blocks B, V, G and D) engines and the central core (Block A) engine were shut-off automatically 50 seconds into the flight following the payload shroud disintegrating, thus indicating a near-repeat of the launch failure of a Cometa satellite on May 14. Debris from the launch impacted approximately 8 km downrange from the launch site.

A Feast for Ears and Palate

By Larry Van Horn
Expo '96 Publicity Chairman

Each year, the highlight of the Grove Communications Expo has been the Saturday night banquet and convention speaker. Such luminaries as Richard Carlson (Director VOA), Larry Magne, Dick Tauber (CNN), Carole Perry, Ian McFarland, and Joe Adamov (Radio Moscow) have keynoted the Expo banquets in past years.

This year's keynote speaker is special for a variety of reasons. He has flown twice into orbit on NASA's space shuttles. He was only the second astronaut in history to operate an amateur radio station from a shuttle in orbit. He is an astronomer and accomplished scientist. He is NASA Astronaut, Dr. Ron Parise, WA4SIR.

Ron was born May 24, 1951, in Warren, Ohio. He is the son of Mr. and Mrs. Henry Parise of Warren, Ohio. After some prodding, Ron enrolled in a novice amateur radio class with a friend. By age eleven, he had passed the test and earned a license. "I had a Hallicrafters SX-100 that I used to listen to shortwave," Ron told *Monitoring Times* in a 1990 interview. "I was quite a radio buff."

But Ron also had stars on his mind, and his education in later years reflected this interest. He received a bachelor of science degree in physics, with minors in mathematics, astronomy, and geology from Youngstown State University, Ohio, in 1973. In 1977 and 1979, Ron received his master of science degree and a doctor of philosophy in astronomy from the University of Florida in Gainesville.

Over the years, Ron has held many amateur radio callsigns. He was the first ham radio operator in his family. "My dad later became interested in ham radio and got his ticket," Ron said. "We have regular schedules on 40 meters to keep in touch."

What areas of amateur radio interest Ron the most? "I enjoy 40 meter ragchewing," Ron said. "I also like experimental forms of communication." Ron has even communicated through several of the OSCAR (Orbiting Satellites Carrying Amateur Radio) satellites from his home station in Maryland. Ron is a member of the Goddard Amateur Radio Club, WA3NAN.

Amateur radio is not Ron's only hobby. He also enjoys scuba diving, sailing, hiking, and camping. His professional prowess in astronomy extends worldwide, as he is a member of several organizations including the

Astronaut Ron Parise, Expo keynote speaker, is shown at AMSAT terminal aboard the Space Shuttle.

American Astronomical Society, the Astronomical Society of the Pacific, the Association of Space Explorers, International Astronomical Union (IAU), Sigma Xi, and Phi Kappa Phi.

Dr. Parise is a senior scientist in the Science Programs Department, Computer Sciences Corporation, in Silver Springs, Maryland. He is a member of the research team for the Ultraviolet Imaging Telescope (UIT)—one of the instruments that flew on STS-35 and STS-67 as part of the Astro 1/2 payloads. Besides working on UIT, Ron has performed ultraviolet astronomy using NASA's International Ultraviolet Explorer (IUE). He has studied the circumstellar material in binary star systems and is currently studying the evolutionary status of stars in globular clusters.

Ron has logged over 615 hours in space as a member of the crew of space shuttle *Columbia* for STS-35, and the space shuttle *Endeavor* for the STS-67 mission. He is currently assigned to the Goddard Space Flight Center Laboratory for Astronomy and Solar Physics in Greenbelt, Maryland. He is a member of the research team analyzing ultraviolet images returned from the STS-67/Astro-2 space shuttle flight.

Tickets for the Saturday night's banquet are $25.95 and seating is limited. You should make your banquet reservations as soon as possible to ensure a confirmed reservation.

Folks You'll Want to See

Exhibitors have been signing up for the Expo at a steady clip. Exhibitors that will be at the Expo as of presstime include: AMSAT, Atlanta Astronomy Club, Bay Area Scanner Club, Bearcat Radio Club, Cellular Security Group, Christian Science Monitor, Computer Aided Technology, Dallas Remote Imaging Group (DRIG), Drake, Electronic Distributors (EDCO), Grove Enterprises, ICOM, Image the Earth, *Monitoring Times*, Optoelectronics, Radio Astronomy Supplies, Radio Progressive, *Satellite Times*, Scan Master, Signal Intelligence, ScanStar, Society of Amateur Radio Astronomers (SARA), Sony, Swagur Enterprises, Transel Technologies, and Woodhouse Communications. A few booths are left, and companies, clubs, and broadcasters can get more information by contacting one of the following:

Debbie Davis	*Satellite Times* Advertising Manager (704) 837-6412 or via email: debbie@grove.net
Beth Leinbach	*Monitoring Times* Advertising Manager (704) 389-4007 or via email: beth@grove.net

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

To register for the Expo or banquet by phone, get information on our special radio tours, the educators forum, or information on special American Airline and Avis Rental car rates, call the Grove order line at 1-800-438-8155 or by fax at (704) 837-2216 today!

The more than 50 forums, equipment demonstrations, tours, new products, and special events are only part of the Grove Communications Expo 96 at the Atlanta Airport Hilton, October 18-20, 1996. The best part may not be on the schedule—meeting and monitoring with other radio enthusiasts. Do yourself a favor: Don't miss the radio event of the year.

GROVE COMMUNICATIONS EXPO

Mark Your Calendars: October 18-20, 1996!

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

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

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

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

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

Atlanta Airport Hilton
October 18-20, 1996

Registration $55 per person (take $10 off if you bring a first-time registrant). Banquet $25.95. Rooms at the Airport Hilton available at the convention rate of $76 per night, single or double occupancy. Call 1-800-Hiltons.

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

ST *Domestic TVRO*

By Doug Jessop

Black Out Bingo

Satellite Times managing editor Larry Van Horn and I were visiting recently about the increase in the number of digital signals in the sky. It seems that programmers are looking at satellite video grid reports like a "black out" bingo game. Well, here is another service to black out on your TVRO video grids.

HBO plans to convert its HBO and Cinemax feed to MPEG-2 compressed digital transmission by the fourth quarter of this year. They will upgrade the GI DigiCipher I systems on HBO2 East/West, HBO3, and Cinemax 2 East to MPEG-2. HBO also plans to offer its primary feeds of HBO East/West and Cinemax East/West in MPEG-2 via the Galaxy 1R satellite.

The first MPEG-2 digital feeds are slated to begin in September. Analog transmission will continue on Galaxy V and Galaxy 1R.

The move to MPEG-2 will give HBO enough capacity on their current transponders to launch four more multiplex feeds in 1996 and 1997: namely, HBO4, Cinemax 2 West, Cinemax 3, and Cinemax 4.

Bob Zitter, HBO's senior VP of technology, commented, "Our affiliates are beginning to install the digital set-top decoders that everyone has been waiting for...we are not doing anything with set top decoder authorization. That's our affiliates' side of the equation. We're just giving them the programming in the form they want."

GI the Giant

General Instrument Corporation has agreed to acquire the assets of the Magnitude MPEG-2/DVB product family of Compression Labs, Inc., for a purchase price of $12.5 million in cash and the assumption of $2 million in liabilities. The Magnitude line consists of modular video and audio encoders and decoders for the delivery of entertainment and information services over cable, satellite, and telephone networks, including direct to home.

"As the world leader in providing secure broadband networks, we view this acquisition as a strategic addition to our already strong product portfolio," said Richard S. Friedland, Chairman and CEO of General Instrument Corporation. "We are now the only manufacturer offering a complete product line of digital compression and transmission systems, including ATSC, MPEG-2, and DVB compliant solutions."

"The Magnitude product family provides GI with additional technology, development expertise, and customer relationships that will enhance our leadership in the growing global market for digital broadband equipment, estimated to be over $2 billion," Friedland noted. "The Magnitude line already has established success in Africa, Australia, China, India, and Russia, as well as numerous accounts in the business and distance learning market. We are also very excited to continue servicing the Magnitude product family's North and South American customer base, including DirecTV, USSB, and Galaxy Latin America."

"We are very pleased that our leading-edge digital broadcast product line will become part of one of the leading broadcast companies in the world," said Gary Trimm, CEO and President of CLI.

CLI will retain the SpectrumSaver product line for broadcast of business television over satellite, and all the accounts receivable related to the Broadcast Products Division, valued at $14.9 million on December 31, 1995.

MPEG-2 is the worldwide standard for high quality full motion video, developed by the Moving Pictures Experts' Group (MPEG) under the direction of the International Standards Organization. Digital Video Broadcasting (DVB) standards are being promulgated by the European Broadcasting Union and administered by the European Telecommunications Standards Institute. The Advanced Television Systems Committee (ATSC) is a private sector organization in the U.S. developing voluntary standards for the entire spectrum of advanced television systems, including high definition television.

DBS News

Our favorite government agency in Washington, the Federal Communications Commission, has rejected a bid by Tele-Communications Inc. and TelQuest Ventures LLC to bring television programs to U.S. customers using Canadian satellites. The FCC called the bid "premature," saying that before any decision could be made, the Canadian government would first have to license TCI and TelQuest (both U.S. companies) to use the direct-broadcast service.

The agency's international bureau dismissed the applications without prejudice, saying that both companies could re-file once the satellite rights had been approved by Canada. "The FCC is telling us that we have to get the final go-ahead" from Canada, said Larry Boisvert, president of Telesat Canada, which currently licenses the satellite slots. "That's exactly what we plan to do."

Shortly after last column on the V-Chip hit the newstands, the folks at DirecTV sent an information packet to let us know about their parental lock-out feature. According to their materials, DirecTV subscribers can access the parental lock-out feature through on-screen graphic menus and use a personal identification number (PIN). Users can restrict access to specific channels or rated programs as well as setting spending limits on pay per view programming.

In other DBS news, Echostar Communications Corp. has teamed with Liberty Satellite Sports to add all of regional sports services to the DISH network programming lineup.

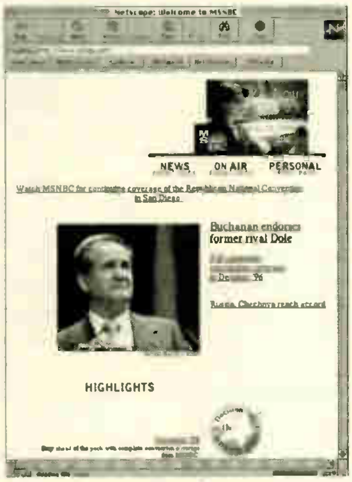
Liberty Satellite Sports will provide regional games from the NBA, NHL, and Major League Baseball as well as a fair amount of collegiate action.

A two tiered launch of the LSS regional sports programming is being evaluated with a fall launch of MSG, HTS, Sunshine, SportSouth, PS-Southwest, PS-West, PS-KBL, and PS-Rocky Mountain. The remaining seven sports networks will be added to the DISH Network upon the launch of EchoStar II slated for this fall.

Officials from EchoStar's DISH Network announced a limited promotion in response to rising cable rates, (as their press release states) , "to lead the crusade to fight this television injustice." While their language may seem a bit verbose to me, their offer of a digital satellite service for $199 to any customer who purchases an annual programming package (for another $300) sounds fairly decent. Of course, here is the fine print...this offer is only good in seven markets where cable rates have seen a significant rate hike: Phoenix, Arizona; Portland, Oregon; Cheyenne, Wyoming; Washington D.C./Baltimore, Maryland; Grand Rapids, Michigan; Fort Smith, Arkansas; and Greenville/Spartanburg, South Carolina.

General Instruments recently announced that its subsidiary, DBS Service, Inc. (DBSSI), has agreed to become the master TVRO distributor of Gospel Music Television (GMT) programming services.

Gospel Music Television touts itself as the television industry's first, 24-hour-a-day, Southern Gospel music video programming service. They feature taped Southern Gospel music video and concerts along with Blue Grass Gospel and old style country Gospel formats. I don't know the difference between Southern Gospel and Blue Grass Gospel either...but hey, that's what the press release said. GMT is currently transmitted on Galaxy 3R, transponder 8.



Get a free peek at MSNBC before they encrypt...on the transponder previously occupied by "America's Talking."

According to GI sources, TVRO program distributors in the U.S. and Canada will deal directly with DBSSI rather than GMT for home satellite service. GMT will be broadcast using VCII Plus and VideoCipher RS.

Programmers and distributors of programming services interested in Gospel Music Television can contact Julie Rayle of DBSSI at (619) 597-3986. Home satellite TV dealers and individual subscribers can ask their programming distributor about receive Gospel Music Television.

MSNBC Debuts

Following its debut July, Microsoft and NBC's new cable network channel, MSNBC (Galaxy 1R transponder 10) has received nothing but glowing reviews from Internet users across the country. Concern still lingers, however, about just how objective news coverage of the computer industry will be in the future.

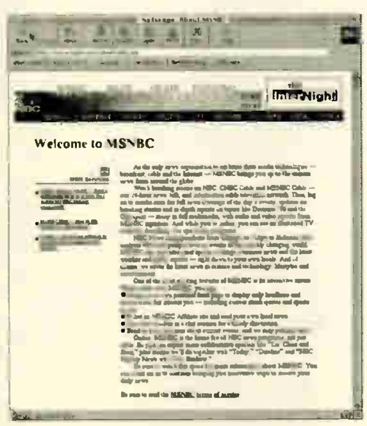
"There has to be a temptation to avoid being critical of Microsoft, just like there must be at a newspaper where there's a problem with a large advertiser," said Jay Fenton, a software programmer and Web site developer. MSNBC received good marks from Fenton and other programmers, all of whom liked the ability to customize the news they get from the site. "I think anything that brings the Internet and normal TV together is a good thing," said Dave Greely, a police officer from Ohio. "People have been waiting for this for a long time."

The ability to customize news on the Web is not new. Some companies, like the Point Cast Network, have been doing it for a year. MSNBC, however, is the first to combine custom capabilities with television.

Controversial radio talk host Don Imus is expected to sign a contract to do his nationally syndicated show on MSNBC. The plan calls for the NewYork-based Imus to perform his show weekday mornings live on MSNBC and the radio.

CNN's answer to the question, "Is MSNBC serious competition?" was answered when MSNBC was credited by wire services for early reports that a TWA jet had exploded and crashed in the Atlantic Ocean off Long Island and for its interview with a Pentagon official about the incident. MSNBC broke the story at 9:37 p.m. EDT, during anchor Brian Williams' scheduled news program. The show continued with coverage into the night. CNN, on the other hand, broke the story during "Larry King Live" at 9:45 p.m. EDT and then returned to the show, resuming coverage of the airline disaster at 10 p.m.

On the flip side of the coin, apparently some of the NBC affiliates weren't too happy when the net left its West Coast affiliates hanging with one pre-recorded breaking news cut-in. They reportedly played it twice and even put what time it was recorded, 10:55 p.m. EDT. NBC affiliates are also a little miffed that the network is running promos from MSNBC. As one local station person I spoke to put it, "why would I want to air something that tells my viewer to change the channel?"



Find out what makes MSNBC tick (http://www.msnbc.com/aboutmsnbc.asb).

MSNBC joined *Wired* announcing a "new television program for citizens of the next century." *Wired: The Netizen* will be the first weekly current events program to emerge "literally, from the Internet," said MSNBC. "Born from *Wired* magazine's popular World Wide Web site **(http://www.hotwired.com/)**, *Netizen* is also a monthly longform column in *Wired* and is syndicated by the *New York Times*." A host for the program will be announced shortly they said. In a shocking move the show will be produced in San Francisco (which just happens to be where *Wired* is based).

All News Channel Wars

Westinghouse Electric Corp. plans to launch a news-related cable channel, accelerating its expansion into broadcasting since its 1995 takeover of CBS television network. Company Chairman Michael Jordan (no, not the basketball player) has targeted cable as the company's new top priority. Once the company's deal to buy out the huge radio group Infinity Broadcasting Corp. goes through, Westinghouse will receive half of its revenues from media operations. To fuel the planned growth in radio revenues, Jordan said Westinghouse will look to compete aggressively with U.S. newspapers and local television stations.

Fox News announced that its new all-news cable channel, which will compete with CNN and MSNBC, will debut on October 7. Fire up the wildfeeds folks; if Fox follows the example of MSNBC, there should at least be a window of free viewing before they decide to encrypt.

The network was not specific, however, about just what viewers will be able to find on the channel. Roger Ailes, chairman of Fox News, told reporters that anchors, reporters, and programming were still being determined for the 24-hour news channel. He added that, while he is talking to prominent and well-known news talent, he wants to place emphasis on credible journalists who may not be as well-known to the public.

Rupert Murdoch announced that Tele-Communications Inc. has agreed to launch the Fox 24-hour cable news channel this fall for around 10 million of its subscribers. TCI has agreed to make the Fox channel available to 90 percent of its 16 million subscribers over the next two years. No mention was made in the announcement of the $10-per-subscriber payment offer Murdoch made at the recent National Cable Television Association convention. Fox Chairman Ailes said that TCI and Murdoch have discussed a possible equity position of 20 percent in the Fox operation. No details were revealed. Industry sources have expressed doubt that Fox News will have an organization ready to compete with MSNBC and CNN by fall.

As far as the question of Rush Limbaugh, who many have speculated will be joining the network, Ailes said there was "no status." He did not say, however, whether talks with the conservative show host were ongoing. One little tidbit to consider, Roger Ailes who heads up Fox News, also happens to be Rush's TV Executive Producer. I could say something about the media being characterized as liberal, but I'll hold my tongue.

Rush Limbaugh said that he was fed up with the time slots he's been receiving and will therefore give up television in the upcoming season. "I'm disappointed with traditional television syndication," he said. "We're seeing an increased number of networks, but they're demanding more and more blocks of time in late night. I've been pushed later and later and, in the process, lost a lot of potential audience." At present, Limbaugh's show maintains favorable ratings for the time slots it does occupy. Nevertheless, Limbaugh plans on concentrating on his radio talk show and various speaking and writing deals. "I will now concentrate on finding the best way to integrate television work into the rest of my expansive media empire."

Feeling the pressure to lure some big-name news talent, CNN's Tom Johnson conceded that the channel held talks recently with NBC's Tom Brokaw and ABC's Ted Koppel about the possibility of joining the cable network once their contracts expire next year. At the annual Television Critics Association Tour in July, Johnson appeared concerned that toe-to-toe against MSNBC, CNN's talent would pale in comparison to NBC's network news stars.

"We're going to watch very carefully the impact of the very high-visibility celebrity talent that will be thrown against us by NBC," he told critics. "We have not made a decision to go in any one direction, but we are holding preliminary conversations with a number of more visible correspondents and anchors to add to our current team, not to replace our current team."

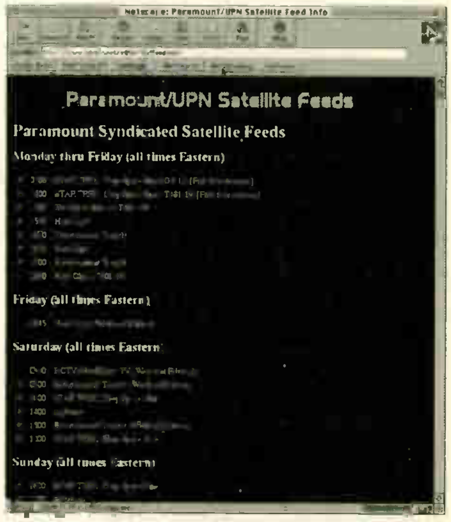
Johnson added that competition is nothing new to CNN and that the network is more than ready for competition from the two new all-news channels. "We will try to compete as fiercely, professionally, and responsibly as we know how," Johnson said. "We are not going to let you down, and we are not going to let our viewers down as we go into this new competitive world. We will not go into tabloid journalism."

CNNfn (Galaxy 1R, transponder 15), Ted Turner's financial network, expanded into prime-time late July with two hours of nightly business news coverage of the entertainment and media industry, personal finance, and consumer products. Unfortunately, CNNfn and Turner's most recently launched network, CNN International, are quickly finding out that one satellite frequency can't support both of them. After July 29, CNNI will have to give up two more hours of its programming to make room for CNNfn's expansion. Also to be factored in will be the Dec. 17 launch of CNNSI, the 24-hour sports news network in which CNN is partnered with Time Warner's *Sports Illustrated*. In an interview with *Daily Variety*, CNN executive VP Lou Dobbs said that nobody knows yet how satellite space will be shared, if it will be. "That will be up to Ted (Turner)," he said.

New Bird on the Way

PanAmSat Corporation reports that major performance tests of the PAS-6 Atlantic Ocean Region satellite are underway at the Space Systems/Loral plant in Palo Alto. The spacecraft level testing is designed to simulate the operating environment in orbit. They expect the testing to continue for several months in preparation for the launch of the bird in December of this year.

PAS-6 is the second of three planned satellites to provide DBS services to Latin America. The players in the DBS partnership include Organizacoes Globo, Grupo Televisa S.A., The News Corporation Limited, and Tele-Communications International, Inc. After the launch of PAS-5 in mid-1997, the consortium plans to use 48 transponders to deliver hundreds of television channel to subscribers throughout Latin America.



Paramount Wildfeeds (http://www.cdsnet.net/vidiot/SatFeed.html): Here's a fun tidbit for you wildfeed fans.

For you techies, PAS-6 is a Space Systems/Loral FS-1300 bus with 36 Ku-band transponders. PAS-7 and PAS-8 are under construction and are scheduled for delivery in late 1997 and early 1998, respectively.

After the performance tests are completed PAS-6 will be shipped to the Guiana Space Center in Kourou, French Guiana, for launch by Arianespace. The satellite will be launched into its 43 degrees West slot aboard an Ariane 4 launch vehicle.

Satellite Newsgroup Q&A

In my lurking on the Internet, a question that I've been asked fairly often came up and I thought I would share it with *ST* readers.

Q: I am trying to tune in the American-Russian station on SBS5 on transponder 14. I got the audio channel fine, but the video is inverted. How do I get a video inverter that works on a flip of a switch?

A: Use the C-band input for the Ku signal, and it will be inverted. Some video-fine tuning will probably be required. You could split the Ku signal into two lines: Run one into the Ku input, then put an A/B switch on the C input—"A" for the C-band LNB and "B" for the split Ku-band LNB. ST

Doug Jessop has been in the broadcasting industry since 1979. He can be reached online at: http://www.searcher.com/STcomments.html

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By George Wood
wood@rs.sr.se

Digital Dreams

After tests at 27.8 degrees East, the new all-digital Astra 1F satellite has been moved into position alongside the other Astra satellites at 19.2 degrees East. There are now six satellites at that position, and with some digital capacity on Astra 1D and with both 1E and 1F all digital, MPEG-2 broadcasting is finally getting underway in a big way in Europe.

Astra's owner SES says it's leased 16 of the 22 transponders on Astra 1F. Four have gone to France's Canal Plus, four to the Bavarian media mogul Leo Kirch, three to Nethold, two to Luxembourg's CLT, and one to Germany's Pro-7. Astra 1G is now expected to launch in June 1997, rather than at the end of 1996 as previously scheduled, on a Russian Proton rocket. In addition, SES is having Hughes modify the Astra 1H satellite, currently under construction, to include a Ka-band payload (2 transponders) for interactive applications across Europe. 1H is scheduled for launch in 1998. Both 1G and 1H will also be positioned at 19 degrees East.

SES has also ordered the Astra 2A satellite from Hughes. It will be launched in August 1997 into Astra's new orbital position of 28.2 degrees East. 2A will have 28 active Ku-band 100 watt transponders. The companion satellite Astra 2B is being built by Matra Marconi Space, and will be launched to 28.2 degrees East in late 1998. Sixteen of the 28 transponders will cover an area stretching from the former Soviet Union to India, the Middle East, and Africa, as well as Central Europe. Like Astra 1H, 2B will have multimedia applications. British Sky Broadcasting, finally revealing its digital plans, was the first customer to sign up for 28.2 degrees East. According to SES, BSkyB has entered into firm, long term lease agreements for 14 transponders on Astra 2A. These will be used for the BSkyB digital package aimed at Britain and Ireland, which starts in the fall of 1997.

Europe's digital plans have been chaotic, but things are finally settling into a pattern. It seems there will be two blocs fighting for the digital satellite TV market across most of the Continent, with two different decoder standards.

Initially German rivals Bertelsmann and the Kirch Group, France's Canal Plus and Havas, and British Sky Broadcasting were all discussing a single joint standard. At the last minute Kirch pulled out, but the others actually agreed to launch a joint digital satellite television service, known as Newco. This was apparently strengthed when Bertelsmann announced a merger with Luxembourg's mighty CLT, owner of 14 television and 18 radio stations in 9 countries.

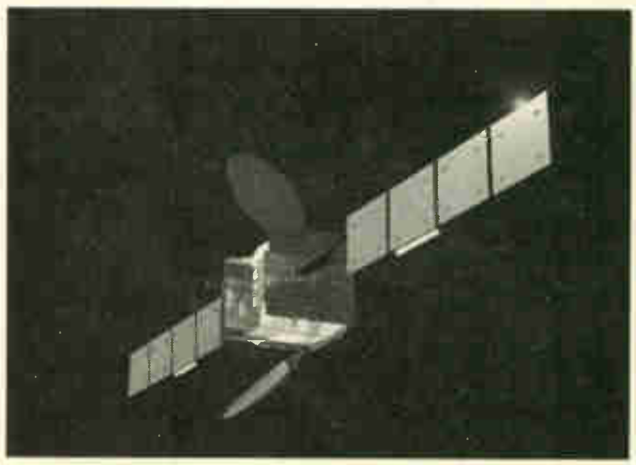
But the merger plan turned off some of the other partners. British Sky Broadcasting immediately pulled out of the alliance, and Canal Plus was worried about CLT's involvement in a rival digital package in France, until Bertelsmann announced it was shelving that plan. On July 8, when Bertelsman and CLT sealed the merger of their television units, Rupert Murdoch's BSkyB announced plans to take a stake in Kirch's 17 channel rival digital platform to Germany, DF1. In return, Kirch is planning to buy a stake in BSkyB. This leaves two blocks: Bertelsmann-CLT and BSkyB-Kirch, with Nethold close to Kirch and Canal Plus most likely leaning towards Bertelsmann.

Meanwhile, even before the blocks were in place, digital satellite television was already underway in Europe. With Telepiu (owned mostly by Kirch and Nethold) broadcasting to Italy, Canal Plus and AB Productions aimed at France, Kirch to Germany, and Nethold/Multichoice with packages to the Benelux and Scandinavia, there have been broadcasts, but few receivers.

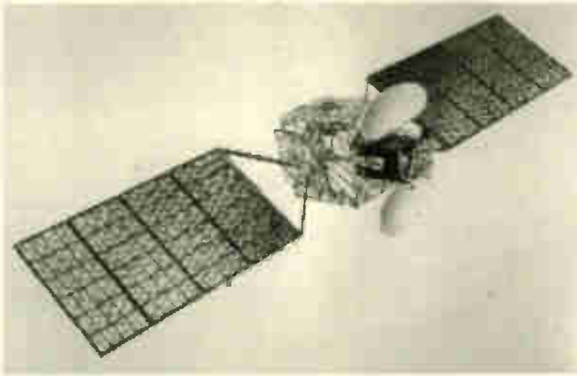
Bertelsmann/CLT and BSkyB will be joining them soon. More players are also on the way. Hughes says its DirecTV broadcast satellite service will operate globally in the near future, with announcements about services to Europe and Japan within the next year. Hughes executives say agreements to take part in the service already exist with several European TV channels, including the BBC, Spain's Antena 3, Italy's RAI, and Germany's Deutsche Welle.

The BBC, possibly the world's most respected broadcaster, also has its own digital plans. BBC World and 20 DMX radio channels have already started on Hot Bird-1 in MPEG-2 on 12.542 GHz. Coming BBC TV channels reportedly include: BBC Gold, BBC Learn, BBC Nature, BBC History, BBC Sport, BBC Theatre, BBC Home Channel, and a Discovery-like channel called Planet.

BBC World Service radio is also exploring the idea of a 24 hour digital news



channel, which would enable it to sell programs to other radio stations. Managing Director Sam Younger told a meeting of Britain's Royal Institute of International Affairs that the new channel would run alongside the World Service's existing service of news, culture, and educational programming. Younger says the new service will be available via satellite for broadcast by subscribing radio stations and cable companies.



Tele-X

More digital channels are coming on Astra's rival Eutelsat, which is concentrating its entertainment outlets at 13 degrees East, currently the home of Eutelsat II-F1 and Hot Bird-1. Viacom was first with MPEG-2 broadcasts on Hot Bird, for 24 hour relays of the Sci-Fi Channel (which is otherwise carried for a few hours a day as one of the 7 Murdoch "channels" on Astra transponder 47), along with Bloomberg TV, MTV, and VH-1.

Many more digital channels will be carried on Hot Bird-2, which is scheduled for launch with an Atlas rocket on September 4. SF DRS Switzerland has already announced plans to broadcast in uncoded MPEG-2 over Hot Bird-3, which is expected to be launched in the middle of 1997.

Scandinavia

Digital projects also continue in Scandinavia, both on Astra and on the "Nordic" satellites at 5 degrees East and 1 degree West. A number of Scandinavian channels have started broadcasts in MPEG-2 on 12.322 GHz on Tele-X, which shares 5 degrees East with the Sirius satellite. These include public broadcaster Swedish Television's channels 1 and 2, Denmark's DR1 and the private TV2 Denmark, and Norway's NRK 1 and private TV 2 Norway.

There are also reports Denmark's public service DR1 will begin digital broadcasts on Intelsat 707, at 1 degree West, on 11.592 GHz. This is intended as a feed to terrestrial (PAL) TV transmitters, and not a DTH service to home viewers. From August 30 the new DR2 channel will be included in the same digital package as DR1. For copyright reasons, the programs are to be scrambled, but no decision has been made yet on the scrambling system.

DR2 is also being carried in analog D2-MAC on this same satellite on 11.667 GHz. For copyright reasons, these DR2 transissions will be scrambled in Eurocrypt-M. Danmarks Radio says that all Danes who have paid their viewer license fees are to get a free smartcard from Multichoice or Viasat (Scandinavia's rival pay-TV distributors, representing respectively Nethold/FilmNet and Kinnevik/TV1000).

While the analog signals will be on a beam with uncertain reception in southern Europe, the digital package should have reliable reception in the south. Danmarks Radio plans to negotiate for transmission rights to southern Europe, so that it will be legally possible to supply Danish viewers in these areas with suitable smartcards.

A digital Finnish television channel may beat Danmarks Radio to become the first Nordic TV channel to be made available to viewers in continental Europe. Norway's telecommunications operator Telenor has agreed with Finland's YLE public service broadcaster to distribute a channel called FTV to European viewers, starting this fall. While a number of Swedish and Norwegian channels can be watched in Europe by those with pirate cards or large enough dishes to pick up spill-over from Nordic beams, FTV will be the first Nordic channel to obtain rights to broadcast to Europe.

FTV will be a composite of YLE's channels 1 and 2, with programming as well from Finland's commercial channel MTV, in Finnish and Swedish. The channel will be distributed digitally from a Eutelsat for the first two years, and later from a satellite operated by Telenor.

Over on Astra, Bloomberg TV and the Discovery Channel have replaced European Business News and Sport 7 in Nethold's Multichoice package on transponder 77 (11.954 GHz on the Astra 1E satellite) in MPEG-2. Besides its own FilmNet and SuperSport, Nethold's digital satellite package is to include Swedish Television's two channels, the Adult Channel, CMT Europe, TV5 Europe, and TV4 Plus, which seems to be the new satellite channel planned by private Swedish broadcaster TV4, which conveniently shares a brand new building in Stockholm with Nethold's FilmNet. But apparently there aren't any plans for a VH-1 Scandinavia, corresponding to the coming VH-1 Benelux.

In Scandinavian analog broadcasting, Nethold's SuperSport has returned with soft-scrambled D2-MAC broadcasts, but not from its former home on Astra (from which the Kirch Group reportedly suddenly broke a promise and pulled the plug on loaned equipment). SuperSport is now on Intelsat 707 on 11.540 GHz. According to FilmNet's Information Department, SuperSport will continue to use this transponder until at least August, and there's also a report it will be scrambling from September 1. Sister station FilmNet 1 is also now using Intelsat 707 at 11.133 GHz.

There was a report that arch-rivals FilmNet and Kinnevik were planning to merge their pay-movie channels FilmNet 1 and TV1000, along with the competing sports channels SuperSport and Sportkanalen. There was no word about their respective second movie channels, FilmNet 2 and TV1000 Cinema. The Scandinavian market is probably too small to support two competing pay-film outlets, especially when digital technology is about to allow each to greatly increase the number of channels per transponder.

The two sports channels were also in trouble. The appearance of SuperSport forced Kinnevik to cut back on its plans for Sportkanalen. Instead of a 7 day a week operation, it took over weekends from Kinnevik's existing TV6 channel, otherwise aimed at women. But then Sweden's largest cable operator, Telia Kabel-TV, accused Kinnevik of violating its contract by changing the format of TV6, and removed TV6/Sportkanalen from its networks, reducing its audience by 75 percent. The two sides finally reached a new agreement, but Sportkanalen has not been profitable for Kinnevik.

Kinnevik faces other problems with its TV3 general entertainment channel. The Swedish Performing Rights Society (STIM) is threatening to withdraw permission for TV3, along with TV4 and Kanal 5, to broadcast copyrighted music. (They will be able to broadcast Bach, Mozart, and other "unprotected" composers.) The disagreement is over how music royalties are to be paid. STIM wants a straight percentage of each station's advertising revenues, without regard for how much music is played or the number of viewers. The stations want the same system that is applied to public broadcaster Swedish Television, based on exactly how much music is played, and the size of the audience.

Kinnevik is fighting back on another front. Part of a joint Nordic satellite project, blocked by the European Union last summer, has been presented to Brussels for reassessment. The project, known as Nordic Satellite Distribution, involves the Danish telecommunications group Tele Danmark, Norway's Telecom A7S, and Sweden's Kinnevik.

While the first two participants are PTTs, Kinnevik is a programmer, and the EU objected to the plan initially because it would give Kinnevik a gatekeeper role, capable of keeping competitors off NSD satellites. According to the head of Tele Danmark, the project has been split into three separate elements: satellite operation, wholesale sales, and retail sales. NSD has submitted the satellite section to Brussels to hear if it requires EU approval.

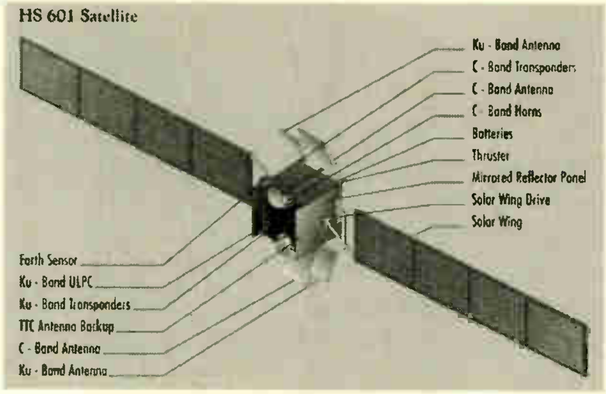
Norway's NRK will be encoding its satellite transmissions on Intelsat 707 beginning August 31. Unfortunately for Swedes who enjoy watching Norwegian TV, subscription cards will only be available to those with Norwegian addresses, although NRK admits it will be difficult to prevent a Norwegian from buying a card on behalf of a Swedish friend. There is now a test card for NRK2 on 11.486 GHz, due to launch on August 31.

Radio Sweden and Swedish Radio have a new satellite channel to Europe, on the Sirius satellite at 5 degrees East, on the TV 4 transponder at 11.938 GHz, audio 7.38 MHz. This is in parallel with the service on the Kanal 5 transponder on the aging Tele-X satellite, on 12.472 GHz, audio 7.38 MHz.

Africa and The Middle East

Nethold has also begun digital broadcasts to Africa. The MultiChoice DStv MPEG package is broadcasting on PAS-4 using IRDETO encoding in the Ku-band. There are also MultiChoice channels in MPEG-2 IRDETO on the same satellite in the C-band, on 3.711 and 3.743 GHz. The SABC Satellite Channel on PAS-4 is on 12.734 GHz.

The Arabic programmer ART is testing various channels on PAS-4, one being 11.522 GHz. And Iran's IRIB TV4 has started broadcasts on Intelsat 602 on 10.962 GHz in SECAM.



On July 9 an Ariane 4 rocket put two new Middle Eastern satellites into orbit, Arabsat-2A and Turksat-1C. The Arab League's Arabsat will provide telecommunications and direct broadcast television to the Arab-speaking nations of the Middle East and northern Africa, as well as Arab-speakers in southern Europe.

Turksat is the third satellite in Turkey's less than totally successful program. Turksat-1A plunged into the Atlantic when an Ariane rocket exploded after launch in January 1994. Turksat-1B was successfully launched with Ariane in August, 1994. But while its main beam to Turkey may be working, as well as its relays to the newly independent Turkic-speaking countries of the the former Soviet Central Asia, its European beam, intended to reach the many Turkish guest workers and immigrants in Germany and Scandinavia, is apparently a failure, with a very weak signal. Consequently, no less than seven Turkish channels remain spread out on three Eutelsat satellites, choosing to reach Europe that way rather than trust Turksat.

(The newest Turkish channels, both on Eutelsat II-F3 are KRAL on 11.631 GHz and Number One on 12.599 GHz. Surprisingly, both are using MPEG-2—the first Middle Eastern stations to join the digital race.)

Hopefully, Turksat-1C will do a better job than its predecessor. Israel's newly launched, first satellite, Amos-1, is already showing itself to be better at reaching Europe than Turksat-1B. The satellite has gone into operation at 4 degrees West, clearing transponders on nearby Intelsat 707, which previously carried a number of Israeli channels. I've been receiving a clear test pattern from Amos-1's 11.308 GHz transponder with a 1.2 meter dish in Stockholm, even though Scandinavia is outside the footprint of the Central European beam.

Here are the first reported frequencies from Amos-1 (H transponders are directed towards Central Europe; V is the Israeli beam):

11.000 GHz V	Tests
11.056 GHz V	Test card
11.150 GHz V	Tests, audio 7.20 MHz
11.155 GHz H	Tests
11.173 GHz V	Tests
11.308 GHz H	Amos-1 test card (PAL)
11.346 GHz H	Tests
11.471 GHz V	Israel Channel 2 tests
11.558 GHz V	Amos-1 test card (PAL, audio 6.60 MHz)
11.652 GHz V	Israel Capital studio tests (audio 6.60 MHz)

Curiously, after Amos-1 went into operation, a new Israeli channel turned up on Intelsat 707: channel 6 on 10.970 GHz.

Rupert Murdoch's Star-TV is negotiating to join the Orbit Middle East digital package on PAS-4. About five channels from the Star digital package on Asiasat-2 will be included, aimed at the large population of Indian "guest workers" in the region.

This follows Orbit's termination of its contract with the BBC (after the BBC objected to Orbit's censorship of the BBC Arabic service). It is expected that CNN Financial News will fill this hole, with the full CNN service adopted "as soon as decency will allow." In the longer term, CNN is said to be willing to provide an Arabic-language service.

Asia

Asia Business News says it has signed a joint-venture agreement to create a 24 hour business news TV channel for the Japanese market, teaming up with Japan's Jupiter Programming, Ltd, and the Kyodo news agency. It's expected to launch in early 1997, with both current ABN programming as well as programs specifically produced for Japanese viewers.

Microsoft and Nintendo announced a tie-up on June 26 to provide on-line information by satellite, which should cut costs of Internet access on Japan's extremely expensive telephone system. The higher bandwidth will also allow the user to receive information much more quickly. The service is set to start in mid-1997.

South Korea's KBS national broadcaster launched a new digital TV package on July 1, but the number of viewers is unknown. The new service consists of two digital channels: KBS Satellite 1, carrying arts, culture, and sports; and KBS Satellite 2, providing relays of replays of existing programming for areas with poor terrestrial reception. Beginning next year, programming will shift to include more news, sports, and entertainment on KBS 1 and more culture on KBS 2. The service is carried on the high-powered DBS Koreasat, which can also be received in China and Japan. The number of viewers is unknown, as sales of the expensive receivers have been very poor.

Channel KTV, Singapore's Chinese karaoke TV, is now broadcasting digitally on PAS-2 (169 degrees East) on 12.730 MHz.

NBC Asia has officially launched its second regional TV channel. The 24 hour English-language channel, called simply NBC, is devoted to a mix of Asian and global news, information and entertainment programming. It is being broadcast encrypted on PAS-2. Along with NBC Asia's existing CNBC business and financial news channel, it will also be broadcast later this year as part of the Star-TV package on Asiasat-2.

A test card has been seen on the recently launched Palapa C2 satellite at 124 degrees East, on 4.000 GHz PAL. This satellite will replace Palapa C1 at 113 degrees East.

The Voice of America and Radio Australia are on Palapa C1 on 3.880 GHz. CNN Radio News is on 3.980 GHz, 6.30 MHz.

Rimsat G1 at 130 degrees East is carrying:

Sun TV on 3.725 GHz
ASEAN Net on 3.825 GHz
Sun Music on 3.925 GHz

China successfully launched Apstar 1A on a Long March rocket on July 3. This was the first Chinese launch attempt since the ill-fated Intelsat 708 on February 15. Apstar 1A carries 24 C-band transponders, and will be located at 131 degrees East.

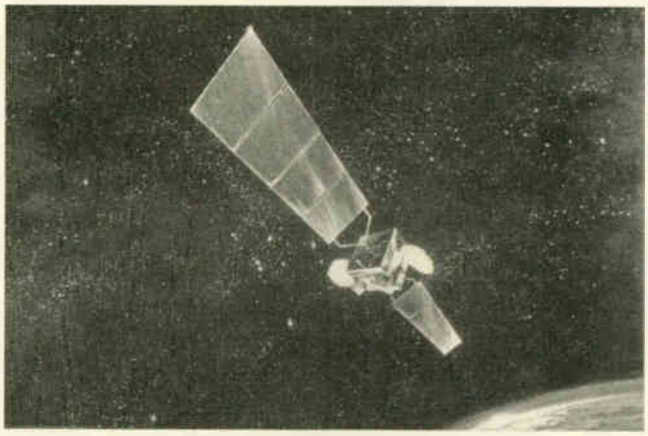
Thanks to James Robinson, Curt Swinehart, Frank Oestergren and Richard Karlsson of *Aftonbladet, Tele-satellit,* Christian Lyngemark and his excellent *SATCO DX Satellite Chart,* and Goro Amihari for their contributions. ST

ON THE AIR

By Steven J. Handler

The Reuters Stuff

Want to add a "continental" flavor to the news that you watch? Reuters Television airs a number of daily news feeds. Jay Lebowitz, operations manager for Reuters Television in Washington, D.C., points out that they are the largest worldwide television news gathering organization.



TV Land and Missing Kids alert both use AT&T's new satellite, Telstar 402-R channel 14. (AT&T)

The hub of Reuter's operations is the main news room in London. From their news bureaus in New York, Washington D.C., Miami, Moscow, and Tokyo, as well as from reporters in 137 other cities around the world, Reuters Television gathers news stories. These stories are "packaged" into news feeds and distributed throughout the world. Programs include the *World Report* and *LANA* (Latin America/North America).

Domestically, Reuters Television makes use of transponders on a number of satellites, depending upon availability. Many of their domestic feeds take place on the Hughes *Galaxy 4*, *Galaxy 6*, and *Galaxy 7* satellites. Feeds have also been observed on the AT&T *Telstar T-401* and *T-402R* satellites.

Intelsat-K is used for Reuters' seven to eight daily feeds from London to the United States. Three and a half transponders are used for both analog and digital channels. Reuters Brightstar News Channel uses one satellite channel from the U.S. to London, one channel from London and Moscow to the U.S., and also a digital channel for Reuters Financial TV. An 8.33 MHz SCPC, digital compression format is used on the digital channels. Additionally, Reuters uses digital compression for its broadcasts carried via *Intelsat 704* to Asia and *Intelsat 702* to Africa.

The times of the news feed broadcasts, as well as satellite and transponders are subject to change and you may have to do some searching to find them. Judging by the quality of what I have seen of their news feed broadcasts, the search is well worth the effort. *Galaxy 4* channel 7 is a good bet at 1800 UTC for the *LANA* Prequentials broadcast, at 1915 UTC for the *LANA* 1 Americas broadcast, and at 1900 and 1945 UTC for the *Sports Wrap*. Around 2110 try *Galaxy 4* channel 5. Weekday evenings their *American Report* has been viewed broadcasting on Galaxy 4 channel 9 at 0130 UTC. Prior to Daylight Savings Time, Reuters was observed using *Galaxy 4* channel 7 at 1301 UTC and 1900 UTC, as well as using *Galaxy 4* channel 9 at 0135 UTC. The *LANA* broadcast was seen at 2200 UTC on *Galaxy 4* channel 9. *Telstar T401* channel 10 was noted with a Reuters news feed at 2008 UTC.

Missing But Not Forgotten

There were over one million missing children in the United states last year, according to Missing Kids International. *Missing Kids Alerts* is a new service that uses satellite to distribute its programming to television stations and cable networks. Prepared in 10, 15, and 30 second formats, the missing children alerts contain photographs and information about missing children. They are produced and distributed nationally by Missing Kids International, Inc. The alerts are delivered nationwide to broadcast affiliates, independent television stations, and cable systems. The toll free hotline maintained by the National Center for Missing and Exploited Children, is used to report sightings and information for children featured in the alerts.

Telstar T402R transponder 20 (4100 MHz) is used from 1630 to 1700 UTC every third Tuesday of the month. Go to the *Missing Kids Alert* participating broadcasting stations page of their Internet web site located at **http://www.access.digex.net/~mki/** for the latest broadcast schedule.

TVLand Comes to TV Land

The Ed Sullivan Show, Burke's Law, The Phil Silvers Show, Mannix, and *Petticoat Junction* are a few of the vintage TV programs airing on "TV Land". Located on *Telstar 402R* channel 14, this new entry is brought to you by those fine folks that give us *Nick at Nite* (Nickelodeon). If you like vintage television, you may want to tune in. They are also airing "Retromercial" segments that contain vintage television commercials.

Brasilsat A1—Are You Inclined to View This Bird?

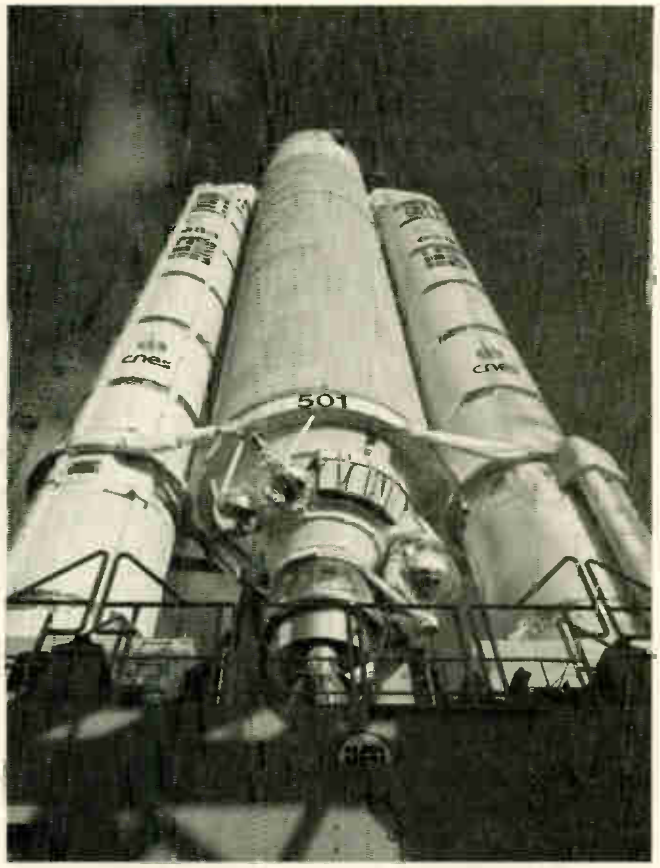
Until last fall, GE Americom's *Spacenet 2* marked the east end of the traditional domestic C-band satellite arc. Then Hughes Communications Inc. took over operation of *Brasilsat A1* at its 63 degrees west longitude slot from Embratel for domestic use.

According to HCI, *A1* was acquired in response to the shortage of available C-band transponder capacity. It was originally used for broadcast and data service for a portion of South America. HCI realigned the antenna to provide services including video, audio, and data to users in the continental U.S., Mexico, Central America, and the Caribbean basin.

Brasilsat A1 is a Hughes HS-376, spin stabilized satellite. Its payload, according to HCI, consists of twenty four 36-MHz channels. Output power is provided to each transponder by 10-Watt travel-

ing wave tube amplifiers (TWTAs). Brasilsat A1 utilizes a 5-for-4 amplifier ring redundancy arrangement, in which 30 TWTAs are separated into six groups of five TWTAs. This arrangement provides one spare for every four essential amplifiers (5-for-4 redundancy).

HCl points out that *A1* is in an inclined orbit at its current operating location of 71.4 degrees west. This means that the satellite's north/south daily movement will increase over time. HCI indicated the inclination was roughly 1.0 degress as of December 1, 1995. The satellite's orbital inclination will continue to increase in magnitude. The inclination was at 1.42 degrees on July 1, and projections indicate that it should reach 2.0 degrees sometime near April 2, 1997.



Ariane 501: A tragic ending cut this flight short. Live video of the launch from Arianespace was carried on Telstar 401 channel 7. (European Space Agency and CNES)

For users with computerized satellite tracking capabilities to move the dish, there is no operational impact. The dish will be able to remain peaked on the satellite. For the average TVRO dish owner the effects due to the increased inclination will be pronounced. Most dishes are polar mounted and are set to point at the geosynchronous arc as the dish is moved from satellite to satellite. Repositioning the dish by the TVRO user only changes which point on the geosynchronous arc the dish is pointed at. As *A1*'s inclination increases, the north/south movement will cause a complete loss of *A1*'s signal during certain periods of the day.

Brasilsat has been observed in use by a number of TVRO dish owners. During March madness, a number of NCAA games were observed on *Brasilsat A1*, including channels 4, 8, and 23.

Ariane 501: Dreams Go Up in Smoke

The launch of Ariane 501 was broadcast live to North America by Arianespace on *Telstar T401* channel 7. As I watched the broadcast of the first launch of an Ariane 5 rocket, I stared in disbelief as the booster exploded a little more than half a minute into its maiden flight. A plume of smoke trailed downward as fiery pieces fell to Earth. The work of thousands of people disappeared in an instant. Memories of a cold January morning when a similar fate befell the *Challenger* were vivid in my mind. The explosion of the shuttle *Challenger* and the resulting loss of life was a tragedy whose images shocked America into sadness.

Both of these events underscore that the exploration of space is anything but routine. With each additional successful launch we become more complacent with mankind's ability to shed the confinement of Earth and reach to the sky. So it must have been for the people of the 15th and 16th centuries as they watched the great ships sail, headed out to explore the New World and return with the rewards of their adventures—or not to return at all.

My heart goes out to those whose dreams went up in smoke on June 4th. Mercifully, another Ariane 5 rocket can be built, unlike the crew lost in the *Challenger* accident.

Commercial launches, and especially manned space flights are fraught with risks. We should not become so smug with our successes that we fail to recognize that each time a countdown reaches zero and a rocket lifts off, we are continuing mankind's exploration of space.

Just as many of the great ships never made it back from exploring the new world, there will be losses in the quest for space. They are unfortunate, but inevitable. The commercialization and exploration of space has its benefits and rewards for mankind. We must not forget that rewards only come at the expense of risks.

Yes, You too Can Start a New Satellite Channel

Have an idea for a new satellite channel? Earlier this year I was informed that a group was looking into renting a C-band transponder on GE's *Spacenet 4* satellite. The price—a cool $100,000 a month. Do you have that kind of spare change in your checking account? If so, you, too, can be *On The Air*. ST

NAVIGATION SATELLITES

By Steve Dye, *sdeye99@aol.com*

More GPS Applications

As readers may recall from my first column explaining Differential GPS (DGPS), selective availability is an intentional error that can be totally eradicated using Differential GPS, greatly adding to its accuracy. Selective availability is inserted in the C/A timing signal so that less accurate readings—compared to those used by the military—are obtained. The C/A timing signal is, of course, the GPS downlink signal allocated for civilian/non-military applications.

C/A, as readers of the last issue will remember, is the clear or course acquisition code known more commonly as the civil access code. The civil code is a pseudo random signal that consists of 1023 bits with a period of one millisecond, meaning the sequence repeats itself over every 1/1000 of a second. The military code, known as the precision ranging (P-code), has a much longer sequence with a period of 38 or more weeks! This certainly illustrates the exclusive use the military can enjoy, and the level of difficulty that would be experienced in trying to decode the sequence. DGPS, is added to eradicate selective availability because the timing error, induced by a process known as dithering, can be corrected by comparing the timings obtained from the GPS constellation to the timings that should be received from a location of precisely known coordinates.

A question many people ask me, (and one which I once asked myself) is "What stops a terrorist from home brewing a missile that would be GPS controlled with the final destination set for the Pentagon?" Well, nothing's impossible these days, but GPS receivers do have a built-in safety feature that causes them to shut down once they achieve a certain velocity. "Velocity" is the keyword here: aircraft of a civilian nature have speed, missiles attain velocity. There is a way around this apparently, but it requires a lot of software development on behalf of the user, no doubt demanding more than the rocket science needed to build the missile.

Now that we've discussed DGPS, it appears that not only science can correct SA: a signature from Bill Clinton would be just as effective. As recently as April of this year the Clinton Administration stated they will seek ways to phase out selective availability during the next decade, and will continue to offer the GPS system free to all users on a global scale. In doing this, the GPS industry would be stimulated to achieve its $8 billion growth predicted for the year 2000.

Don't hold your breath, however. Differential GPS will still provide better results than a GPS signal with no SA, and what's more, none of this will take place until the Pentagon finds a solution that will protect the GPS signal from enemy manipulation. In addition to this, it will take an estimated 4-10 years to phase SA out. It's all very political and won't happen overnight. We must acknowledge though, that GPS without SA widens the door to GPS-guided weapons of any form, and such issues must be weighed against the benefits of GPS as a global standard during peacetime.

GPS Receivers

Casting politics away and looking at something more down to earth, I would like to discuss types of receivers. GPS opens up to all walks of life a myriad of applications too numerous to mention. This in turn calls for a variety of GPS receiver types. Below is a closer look at some of them.

Aviation

Airborne GPS receivers are generally used for navigational purposes. A wide range of receivers is available to fit just about every budget from the USAF to the local soaring club. A variety of GPS receiver configurations can be used to navigate and to determine the attitude of the aircraft and assist in blind landings.

Portable and Hand-Held Receivers

Hand-held GPS units are becoming widely available today, and no doubt one will be advertised in this very magazine. Go to any Kmart store; you'll see them between the fishing rods and the camping equipment. They are generally a small unit about the size of a cellular phone, and will have a large LCD display. In general, your position, along with bearing and speed, will be displayed. Many are intended to fit a specific purpose such as land navigation, boating, aviation, and even industrial mapping. The range of features is therefore fairly diverse. Some are available at prices as low as $300 with some high end mapping units running up to $4000.

Mapping

These receivers are intended for mapping buildings, parks, etc., for inclusion on a map or in a mass storage system holding terrain features as well. All these receivers have differential (DGPS) capability, and most will have the ability to store a number of text annotations. These units will start around $1000 and go up from there.

OEM Modules

Original Equipment Manufacture (OEM) modules are bare-bones GPS receivers with no case and are essentially a board intended to be incorporated into a custom designed piece of equipment. Many are outfitted with one or two data (RS-232) ports for which the user is responsible to program the unit and interprete the output. The price range can be $100 to several thousand dollars. One OEM manufacturer I spoke to recently managed to make a board in the shape of a sextant! The application speaks for itself, but it illustrates what is possible.

PC Card (PCMCIA)

These are my favorite GPS receivers. They are the size of a credit card, and just a little thicker. They fit neatly into a lap-top or notebook PCMCIA slot, and used in conjunction with the software supplied, will soon tell you where you are. Such set-ups are ideal for locating yourself in unfamiliar towns and surroundings. Liinkkuva is one company I have dealt with which manufactures such receivers.

Marine Navigation

These are used almost exclusively for navigation purposes and are equipped with the appropriate interfaces for connecting to the ship's electronics.

Surveying

This application demands accurate results to derive a measurement between two points. For surveyors, it is the relative relationship between two receivers which is important; from this relationship an absolute "position" may be derived. These receivers are generally priced well above the $25K range

Frequency and Time Source

As mentioned in the last issue, the timing signals derived from a GPS receiver can be used to accurately time communications equipment. The Trimble Palisade antenna is an example, specifically manufactured for communications applications.

Space

Space applications for GPS receivers are generally used for attitude determination. One constraint here is that you may be in space and use GPS only so long as you are below the altitude of the satellites. Providing this, your altitude and position in space as well as your attitude can be determined.

The attitude determination deserves some explanation. For more on this subject I recommend reading Philip Chien's article in the March/April 1996 issue of *Satellite Times.*

The following offers a brief explanation of the principle using a two-dimensional example. Using GPS receivers mounted appropriately on the spacecraft, the phase differences between the arriving timing signals at each GPS receiver can be measured using appropriate algorithms in the processing. This phase difference can be converted to a timing difference and thus a position difference. If all receiver positions are known, their relative position to the GPS satellites can be determined.

With two GPS receivers mounted on the wings of the spacecraft they receive the signals at different times, and a phase difference between the timing signals is produced. The resulting phase difference will translate to a relative distance from the spacecraft for each GPS receiver. If this is known, then the pitch, roll, and yaw of the spacecraft can be determined. The accuracy is an important issue here; extremely accurate clocks are used in the GPS receivers, and coupled with the fact that no atmospheric delays are present in space, accurate readings can be obtained.

One receiver that really caught my attention recently was similar to the moving map GPS receiver, except that the map remained static. It has a motorized set of crosshairs that will track your position on any map you insert into the receiver's map window. This receiver is the Pointer Mark 2, manufactured by Azimuth. The user simply inserts any standard paper map or aerial photograph in the map window and the moving cursor will indicate his position in real time. The unit also has an LCD display, providing all navigational data. It's dust proof, water proof, weighs 2.4 kg (5.3lb), and measures 328 x 251 x 71 mm (12.9" X 9.9" X 2.8"). Expect to pay around $3000 for this, batteries not included. This has to be the most practical and easiest to use GPS receiver on the market. Its applications are diverse and it's DGPS ready.

GPS A-Z

Continuing the GPS A-Z, here are some more abbreviations and acronyms explained.

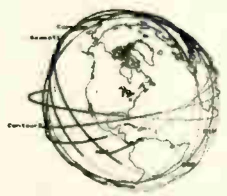
Differential GPS (DGPS): A type of receiver that uses a signal sent from a precise location to correct the position error it may receive due to SA, timing errors, and atmospheric conditions.

Dilution of Precision: An error in the measurements caused by the geometry between the user and the satellites.

Dithering: The introduction of digital noise into the signal that induces errors (used in selective availability).

Doppler-shift/aiding: The Doppler effect describes the change in frequency caused by the relative speeds of a transmitter and receiver. Some receivers measure the GPS signal's Doppler shift to allow more precise velocity and position calculations. (Doppler aiding).

I would like to remind readers that I can be contacted via the magazine address or directly by e-mail at the following address: *gpsyes@aol.com.* If you have any specific questions on GPS, I will be happy to reply to you, helping where I can. ST



Jeff Lichtman

Galactic Methanol Masers, An Amateur Project

Recently, an excellent paper that deals with observing the galactic methanol masers (6668.518 MHz) crossed my desk. The research was done by Mr. Charles Osborne, WD4MBK of Berkley Lakes, Georgia **(cosborne@eng.tridom.com)**. The original title was *Beyond 1420: Galactic Methanol Masers at 6668.518 MHz.*

In past columns, I have promised to publish material dealing with various projects associated with amateur radio astronomy. This is the first one of a series to run over the next few issues about these types of projects.

Spectrum Pollution

One problem with working in the satellite industry is seeing the future on paper before most people have gauged its possible impact. Names like: Globalstar, Iridium, and Teledesic are all over the trade publications. But, let me translate that into what it means to my other hobby, radio astronomy. It means over one thousand high powered 1.8-2.0 GHz satellites in low Earth orbit.

We already have a couple dozen GPS and Inmarsat satellites showering us with 1575.42 and 1227.6 MHz interference. Guess where radio astronomy resides: 1420.405 MHz right in the middle of these satellite downlinks. As PCS (Personal Communication Satellites) put hand held satellite uplink capability within everyone's reach, it's gradually raising the noise floor with phase noise and intermodulation noise. This is our radio equivalent to the light pollution that plagues visible observing astronomers. My answer to the dilema is to move to a quieter neighborhood of frequencies at 6.7 GHz and Methanol Masers observing.

Similar to the hydrogen line emissions at 1420.405 MHz, but emitting at a rest frequency of 6668.518 MHz, methanol (CH_3OH) was initially overlooked by most observers. The frequency range had no protected radio astronomy assignments, so the radio telescopes of the world seldom were built for this frequency range. Recent observations have cataloged over 200 sources. The strongest one is 5090 Jy! The measurements proved that methanol was second only to hydrogen line in signal strength.

Good Fortune

I began working on the pair of 30 meter dishes owned by Georgia Tech near Woodbury Georgia. Discussions of what we could do to get them operational always seemed to come back to leaving the existing 4 and 6 GHz feed and subreflector in place on at least one of the antennas. One antenna's feed was in much better shape than the other, so it was an obvious choice. The feed and diplexer assembly is 22 feet long, so removing it would be too difficult anyway.

Observing in the 5.925-6.425 GHz range would be a little risky. After all, there were many hundreds of satellite uplink transmitters pointed skyward with 3,300 watt transmitters and typical antenna gains of 40 dB. We expected that even the reflected energy from the satellites themselves (like radar) would give us a few bright spots to contend with. Luckily this has not been the case so far. And, by moving out of band to the 6668 MHz range, we are even less likely to have this problem.

Other potential polluters of this spectrum are point to point telephone microwave links and military satellite and terrestrial transmitters. Only time will tell. The antennas are located inside a natural ring of mountains, unusual in middle Georgia, but precisely why the site was chosen by AT&T in the early 70's in the first place. This the same reason Greenbank was chosen for NRAO—because it is shielded by mountains.

Downconverter Ideas

Like most amateur microwave projects, my 6 GHz downconverter is based on using whatever parts I can find at hamfests, so yours may not be exactly the same. It's more food for thought than a cookbook answer. Some basic rules apply:

- Filter at 6 GHz to limit interference's effects
- Use 50-60 dB of LNA gain to overcome feedline losses to D/C
- Filter at each IF to limit noise power
- Mount all gain stages to thick metal bases to slow temperature changes
- Ovenize or temperature compensate where possible
- Use isolators and attenuators in sensitive spots to stop oscillation
- Tighten all coaxial connectors *very* tight.

One idea for a good way to become equipped for multiple bands is to downconvert from 6668 MHz into a 1420 MHz IF. This could be your existing system if you were already observing on 1420 MHz.

For the continuum energy it matters little whether the spectrum is inverted or not, so high side local oscillators work just as well if you have them. Even for spectral line work, high side local oscilators (LO) just mean that you have to be more careful with your math in figuring out where the signal is expected to be. In my case follow the math:

Input Frequency = 6665.0 MHz
LO Frequency = 7776.0 MHz
7776.0-6665.0=1111 MHz*
7776.0-6668.518=1107.482 MHz*
7776.0-6670.0=1106 MHz*

* First IF range (1090-1135 MHz) using 1111 MHz as Fc, etc.
First IF LO=1182.5 MHz

1182.5-1111.0=71.5 MHz**
1182.5-1107.482=75.018 MHz**
1182.5-1106.0=76.5 MHz**

**Second IF range (50-90 MHz)

As you can see, the second LO was chosen to re-invert the spectrum back to normal but it's not really important so long as you know where you are.

Even with a 4 foot dish I was able to see a reasonable amount of voltage deflection for various slices of galactic ridge energy and Cygnus.

A key thing to notice is what small changes in noise power are involved in radio astronomy observations. Those of us working with communications expect sometimes 100 dB of potential signal strength variation. Radio astronomy requires very little dynamic range to be present in the receiver—often less than 6 dB variation, even including sun noise measurements.

A plot of the methanol target Cygnus indicates that my system noise power varied barely 0.024 dB in response to the crossing of the source. This corresponds to about an 8 degree K (Kelvin) increase. Since I use an 18-bit Maxim Max132 analog to digital converter, plotting the data even from a signal that small is still 800 steps, retaining a lot of detail.

The significance to you is that a loose cable connector or a cool breeze on the LNA will easily cause a gain drift exceeding the expected signal from space. Since I can see system gain changes of 0.001 dB, even the bending of the cable shows up.

To counteract some of these problems, I placed the whole 70 MHz backend electronics in an igloo cooler. This helped to stabilize the gain significantly. I don't try to cool everything, just maintain equilibrium. The cooler at present does not use closed loop control, but even running at maximum cooling, the benefits are enormous. Internal temperature is 66 degrees F +/-0.5 degrees, even for a large ambient change over many hours.

The op amp gain and offset circuitry, detector (MC1496), 47 dB gain 70 MHz line amplifier, and the 18-bit analog to digital converter are in the cooler.

Out on the antenna, I found that a good trick was to use a 1/4-inch piece of aluminum plate as the LNA mount. The increased "thermal inertia" reduced gain drift significantly over the use of a finned type heatsink. The finned type couples the ambient temperature changes to the LNA (a bad thing), i.e., the amplifier runs cooler but quickly follows every cool breeze resulting in gain changes. In addition, I have mounted a temperature sensor and heater on the baseplate so that active temperature control can eventually be done.

One item to be aware of is "ground thermal noise." On my 4-foot dish, the antenna pattern is not that clean, so I am instantly aware of getting close to trees while pointing the antenna. This is analogous to the "sky glow" that hampers the visual astronomers.

It is important to know your equipment. This simply means that you must be completely familiar with how your equipment reacts to various conditions, such as signal strength, local interference, and temperature changes. This will help you in identifying real astronomical data and manmade interference. Find a way to measure a known operating point (source) and then come back to it at the start of each measuring cycle. In my system this is -32 dBm into the MC1486 detector. I adjust the system attenuation until the output voltage hits a good midrange operating level (which corresponds to about -32 dBm). This reduces the contributions of detector non-linearity.

Calibrators

Having a noise source of known strength at the feedpoint (ahead of the LNA) allows one to perform useful tests. In my case, I have an 11 degree K amount of noise coupled in. This gives me a weak signal of known, comparable strength and size in plots of desired objects (radio sources).

The calibrator starts at 100,000 degrees K noise source. This corresponds to 25 dB ENR [see ktbs calculations by Kraus]. I place 18 dB of coaxial attenuators after the noise source to reduce noise by a factor of 63 to 1584 degrees K. A 20 dB stripline coupler inserts this inline with the desired signal coming from the feed. An isolator reduces it an additional 0.35 dB, giving a factor of 108 division of the noise down to 15 degrees K. Additional coaxial losses bring this down to an estimated 11 degrees K calibration blip on the receiving record.

Using the 18-bit analog to digital converter, the 11 degree K corresponds to 800 counts out of a possible 262,000+ levels, spread over +/- 11 volts of input range to the analog to digital converter. This proves to be very repeatable number, which I can use for comparison with the observed object.

Bandwidth

I use a 5 MHz noise bandwidth in my final filtering at 70 MHz. This so far has proven to work well. It covers most of the doppler shifted energy in various sources. If I increase my bandwidth to 36 MHz, I can see an obvious reduction in the galactic ridge at 6668 MHz. I assume this means that the continuum energy is less here than at the correct 5 MHz.

One final note on dish size: While a 4-foot dish has barely 1 square meter of collecting area, at 6668 MHz the resolving power is much better than at 1420 MHz. The beamwidth of my 4-foot dish at 6668 MHz is equivalent to a 19-foot dish at 1420 MHz. If you have a 9-foot TVRO dish at 6668 MHz it has more resolving power than the 40-foot antenna (NRAO Greenbank) operating at 1420 MHz. The signals will still be weaker, closer in strength to the noise floor, but with a little attention to gain drift and backend signal processing, some interesting plots can be done.

Those of you with covenant restrictions on antennas may be able to get a waiver (See *Space News*, p.24, 3/4-3/10/96 *U.S. Prohibits Local Rules Against Small Satellite Dishes*) more easily for a 4-foot dish than a 10-foot dish. The foundation requirements are also less stringent. The really difficult parts to obtain are the LNAs. Some amateur designs for 5760 MHz may be modified or retuned to the 6668 MHz frequency, but this is a bit of a task. I look forward to hearing about other amateur radio/radio astronomers trying to detect methanol emission.

In Table 1 you will find a brief grouping of methanol sources along with their locations.

TABLE 1: Methanol Sources

RA	DEC	Strength (Jy) @6668 MHz+/- 3 MHz doppler
06 06	+21 39	495
06 05	-06 22	337
17 17	-35 44	3300
18 03	-20 32	5090
18 10	-18 02	544
18 11	-17 53	317
18 32	-08 03	405
18 43	-02 42	206
18 59	+01 09	560
19 21	+14 25	850

Note: RA=Right Ascension and Dec=Declination

Wrapup

As the editor of ST's *Radio Astronomy* column, I would like to challenge the readers of this magazine to send in any activity reports on any projects you are doing. Don't be shy! Those three prizes we have mentioned in previous columns are still waiting to be handed out!

Our next column will deal with the radio observatory of Dr. David Moore a naval shipboard radar antenna converted for radio astronomy use. ST

What's New

by Wayne Mishler, KG5BI
email: mishler@aol.com

Drake's New Offerings

The R. L. Drake Company's lineup of new satellite equipment drew attention at the Cable and Satellite show in London earlier this year. "Dealers and distributors were interested in the new products and we were pleased with the attendance," says Dan Albrecht, Drake's international sales manager.

Leading the lineup were Drake's new international integrated receiver decoders (ESR800XT and ESR2000XT) and commercial modulators (VM1750e, VM2450e and VM2550e.)

Designed for the motorized system market, the ESR800XT and ESR2000XT were popular attractions. Their features include versatility and integration of card reader modules, such as VideoCrypt and D2MAC/Eurocrypt. The 800 can integrate a front panel card reader, and the 2000 can integrate two such readers. Both units feature built-in antenna positioners for control of motorized antenna systems.

The crowd especially liked the variety of programming and viewing options of Drake's new receivers. The ESR800XT comes equipped with 800 programmable channels, and the ESR2000XT offers a whopping 2000 programmable channels. "We have designed these units with maximum programming options in mind. We want to make it as simple as possible for users of our receivers to get all the channels they want, and be able to access those channels quickly and easily," Albrecht explains, adding that all programmed channels come with video/audio and antenna settings.

Both receivers, with threshold of less than 3 dB, can receive weak signals even with small antennas. Their variable threshold capabilities can yield superior picture quality in less than ideal conditions.

The 2000 offers global operation and versatility, with multi-voltage capability and multi-standard operation. It excels in NTSC and PAL environments.Other advanced features include on-screen displays, six selectable language menus, including Arabic. They also offer programmable event timers. "We have greatly increased the usability of our product in many regions of the world," says Albrecht.

Drake ESR 2000XT

The new modulators interested commercial distributors and cable operators. "They were very receptive," says Bob Jackson, Drake director of marketing. As mentioned above, there are three.

The VM1750e is a heterodyne audio/video modulator providing both a modulated visual output and an aural RF carrier output. It accepts video and audio baseband signals from satellite receivers, TV cameras, video tape recorders, TV demodulators and similar other equipment. The 1750 is intended for use in SMATV or cable applications. It can operate in PAL G, B, D, or I.

The VM2450e is a frequency agile modulator with more power for mid-size cable systems. It is especially at home operating in PAL environments. It operates on frequencies ranging to 450 MHz and uses SAW filtering.

The VM2550e is also a frequency agile modulator, but is designed for professional use in larger CATV systems and crowded cable environments. It comes with more channel capacity, and can operate on higher frequencies to 550 MHz for superior video quality. It also uses SAW filters and uses audio and video selectable AGC. This enables it to maintain nearly constant modulation levels.

More TV Set-Top Box Products on the Way

More television set-top products supporting the growing global demand for digital TV services are on the way, according to a recent announcement by ComStream Corporation, of Calif,

That company has struck an agreement with Matsushita Electric of the UK to begin developing and producing this year a new generation of set-top box that performs as receiver and decoder of digital television satellite, cable and MMDS transmissions.

Several brand names may be on the production agenda. The first units produced will carry the Panasonic name. In previous production, ComStream has already supplied over 1.5 million demodulator subsystems used in set-top boxes marketed under the RCA name. The two companies may also jointly manufacture products under other international brand names for distribution in Europe.

Columbia Audio Video to Sell DISH Network Hardware

Columbia Audio Video consumer electronics stores will soon be selling DISH Network satellite reception equipment, says EchoStar Communications Corp.

EchoStar's DISH system features MPEG-2 hardware along with installation, financing, and leasing services.

Columbia specializes in high-end home entertainment systems, multi-room systems, and home automation products. "Having [Columbia] in our consumer electronics line-up gives DISH Network prestigious status in the satellite television equipment market," says Larry Smith of EchoStar.

DISH Network offers two choices for consumer equipment. The standard system includes an 18-inch dish, a standard digital satellite receiver, and an infrared remote. The premium system includes the same size dish but features a higher-grade receiver and remote. Both packages include accessories and an on-screen program guide and navigator with no additional charge.

Programming is available directly through DISH Network for $19.99. It includes America's Top 40 programming package with upgrades available at additional cost. A total of more than 200 channels of digital video, audio, and data services are to be delivered to homes throughout the U.S. with the launch of EchoStar II later this year.

Football Fans Can Start Packing

Okay football fans. Let's see how serious you really are. Prepare to pack your toothbrush, jersey, and pennant (not necessarily in that order) and hit the road following your favorite NFL team. Your travel and lodging will be paid for and you'll even get some spending money!

The NFL Sunday Ticket Challenge contest, sponsored by the NFL, is a new weekly on-screen trivia contest running during the 1966 regular season. There will be several prizes including a grand prize with travel to eight available NFL games during the 1997 regular season. The contest kicks off in August and continues through December.

You can get the details at any of the 25,000 authorized consumer electronic retail stores and satellite dealers that sell DSS systems in your area. All consumers are eligible regardless of whether or not they are NFL Sunday Ticket subscribers.

To compete, you watch a series of plays from a previous week's games and then answer three questions related to the plays. Piece of cake! Answers can be submitted either by phone or by mail.

A grand prize sweepstakes winner will be chosen to travel with guest to their choice of eight available NFL stadiums during the 1997 season. Airfare, hotel accommodations, game tickets, and spending money will be included, courtesy of NFL Enterprises.

Even if you don't win the big one, there are some other nifty prizes. Three first-prize winners will go on a three-day and 2-night trip to an NFL training camp. Ten second-prize winners will get an official jersey, cap and other apparel. And 500 third-prize winners will get an official NFL Sunday Ticket cap.

"Fans can enter for a chance to win exciting prizes while watching their favorite sport, and retail outlets can bolster sales of satellite systems," says Tola Murphy Baran of NFL Enterprises.

NFL Sunday Ticket is the League's satellite television package consisting of 199 live regional telecasts of NBC and FOX Sunday afternoon games, except where prohibited by local blackout rules.

DIRECTV Just Got Bigger

DIRECTV, of Hughes Electronics Corporation, has added ten cable networks to its Select Programming package at no extra cost to consumers.

The ten new channels include A&E, Black Entertainment Television, CNBC, Discovery Channel, Family Channel, History Channel, Home & Garden Television, Sci Fi Channel, TNN, and the Travel Channel.

The other (previously available) channels are America's Talking, Bloomfield Information Television, Cartoon Network, CNN, Country Music Television, Court TV, C-SPAN, C-SPAN2, E! Entertainment Television, ESPN, ESPN2, Headline News, Home Shopping Network, Learning Channel, MuchMusic, Super Station TBS, TNT, USA Network, Weather Channel, and five commercial-free audio channels from Music Choice. The expanded package is still $19.95 per month.

AEA Announces New "Plug and Play" Integrated Data Radio

Advanced Electronic Applications, Inc., (AEA) has introduced the next progression in packet radio—an integrated data radio which they call the IDR-96.

This is a 9600 bps TNC with full featured mailbox, Gateway node operation, advanced Global Positioning System commands, identification of TCP/IP, TheNet, NetROM stations, and more.

The unit is a self-contained, crystal-controlled, five-watt transceiver. Because the radio is built into the unit, there are none of the compatibility problems normally en-

countered with 9600-baud packet.

Two software programs are included with every IDR-96. PC PakRatt Lite is a DOS communications program that will help operators get on the air quickly. Bob Bruninga's APRS software lets you explore the merging technologies of Packet radio and GPS.

By eliminating the connection hassles and providing the necessary communications software, the IDR-96 offers amateur radio operators a veritable "plug and play" approach to 9600 bps Packet radio.

The IDR-96 is available at amateur radio sales outlets or directly from AEA at (206) 774-5554.

AEA CableMate Spots Coax Problems

All tied up in coaxial cable problems? There's a hand-held device that can help you find them. It may be a bit pricey for the occasional user ($499) but for the regular user it could be a time saver.

The name, CableMate—Time Domain Reflectometer, sounds complex. But in operation the unit simply helps you find problem areas in coax by injecting pulses and measuring the result. There's a small video screen on the unit that displays the severity of the fault, and the distance from the unit to the fault up to 2000 feet. The distance is displayed in feet or meters, and the amplitude of the pulses in decibels.

Battery powered, the unit with its on-screen menus simplifies operation for anyone regardless of their technical experience. There's even an electronic manual built into the unit. You can bring up on-screen answers to most questions of operation and functions that you'll encounter.

Plus there's optional software that lets you link the CableMate to a PC for data storage and printout. Additional information is available from AEA at (206) 774-5554. ST

ST COMPUTERS & SATELLITES

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

Visually Observing Earth Satellites

One of the most satisfying aspects of satellite predictions comes when you get to actually test out your satellite tracking software. Itís one thing to have a slick software interface with lots of bells and whistles, showing where the satellite should be on a world mapóitís quite another to point your antenna at the horizon and pick up your favorite satellite right on schedule.

Of course, humans tend to be visual creatures. We are often told how things work, but we want to see for ourselves. As the old saying goes, ìSeeing is believing.î The same is true for satellite predictions. From the earliest days of the Space Age, observers have looked up in the early evening sky to search for small points of light silently speeding through the heavens. From Echo 1 in the early 1960s to the Mir space station and the U.S. space shuttle today, there is an endless fascination with being able to predict an event in the heavens and then watch it occur like clockwork.

A Bit of History

In fact, many of us have started professional careers from just such a foundationómyself included. I can still clearly remember that day in 1979 when I went out in my backyard to watch for Skylab to pass overhead. Skylab was getting lots of attention then because of the imminent decay of its orbit, and the local television station in Kansas City (70 miles away) reported a particularly good pass would be visible that evening. I called some friends and we drug my Celestron 8 telescope and some binoculars out in the backyard at the appointed hour and waitedówe were not to be disappointed. Just as advertised, a bright light rose out of the western twilight and slowly slipped across the sky.

Of course, I wanted to be able to look at Skylab through the lens of my Celestron 8 and track it across the sky, but it moved too quickly and there was no way to know exactly where to look. After all, the field of view of this telescope is only about half a degreeóthe width of the sun or the moon. Even to have Skylab simply pass through the field of view would take some pretty accurate calculationsóa lot more than we got from the local weatherman.

As Skylab passed from sight, my mind was buzzing with all sorts of questions, not the least of which was: ìCouldnít I do this myself?î After all, I had just bought my first computer a year earlier, a TRS-80 Model I, and by now we had some reasonably sophisticated programming tools (BASIC and FORTRAN) available on that platform. Couldnít I write a program which would tell me where to look to find a given satellite?

My initial impression at the time was that this would be fairly straightforward. After all, I already understood basic two-body Keplerian orbits and had enrolled in an MBA program at the University of Missouri to get access to the IBM 360 so that I could develop some FORTRAN code to predict the positions of the planets (in my spare time), and it worked reasonably well. It shouldnít be too difficult to adapt to this code to tracking Earth satellites. But it seems things are never as easy as they first appear.

The first problem was getting orbital elements. It was one thing back then to go to the library and find a book with orbital elements for the planetsóit was another story entirely to find a source for orbital elements for Earth satellites. It wasnít until 1981 that I discovered that NASA distributed these on paper via the USPS and that you could get on distribution for up to twenty satellites.

Having the element sets before then probably wouldnít have done much good, though. The two-line element set format had a somewhat different set of Keplerian elements than what I was used to andóas many of you have also discoveredówonít produce particularly accurate predictions using a simple two-body orbital model. Thatís because the simple model ignores perturbationsósuch as precession of the nodes or atmospheric drag, in each satelliteís orbit which causes the orbit to vary with time.

Fortunately, I found out about the NASA source for orbital elements when I purchased a BASIC program for the TRS-80 Model I called SAT TRAK. Written by William N. Barker and David G. Cooke, it actually implemented the NORAD SGP orbital model. It wasnít until I attempted to convert their code to use double precision variables that I discovered from my friend, Robert Boren, that the SAT TRAK code was actually a BASIC version of the FORTRAN code used by NORAD, and he got me a copy of Project Spacetrack Report Number 3 which detailed this model. I spent a good part of the next 15 years making these element sets available electronically and getting people to understand that accurate predictions demanded that these element sets be used in conjunction with the SGP4 orbital model.

Today, access to the NORAD two-line orbital element sets and the corresponding SGP4/SDP4 orbital models is easyóall you need to do is point your WWW browser to http://www.grove.net/~tkelso/. Current data, free software, and an Adobe Acrobat version of Project Spacetrack Report Number 3 are all available at this site. In addition, orbital element sets are available at hundreds of sites worldwide, and almost all satellite tracking software includes the NORAD SGP4 modelóall thanks to a visual pass of the Skylab space station.

The Underlying Physics

But knowing where a satellite is going to be is only part of the story. A visual satellite pass requires a number of additional circumstances, without which you wonít be able to see the satellite. These are:

- The satellite must be above the observerís horizon.
- The sun must be far enough below the observerís horizon to darken the sky.
- The satellite must be illuminated by the sun.

We covered how to determine whether a satellite is above the horizon in a series of columns on Orbital Coordinate Systems from the September/October 1995 to the January/February 1996 issues of this magazine. To determine whether a pass satisfies the other requirements means we first need to know where the sun is.

How accurately the position of the sun must be determined depends upon the application. In most cases, the algorithm described in Chapter 24 of Jean Meeusís book Astronomical Algorithms will work quite nicely. The low-accuracy algorithm is accurate to 0.01 degree (a little over one percent of the sunís diameter) and can be calculated fairly quickly. The end result will need to be converted to ECI (Earth-centered inertial) coordinates in the same frame as we use for the satellite and observerís position (this is already done for you in my SGP4 Pascal Library [sgp4-pl2.zip] in the routine solar.pas).

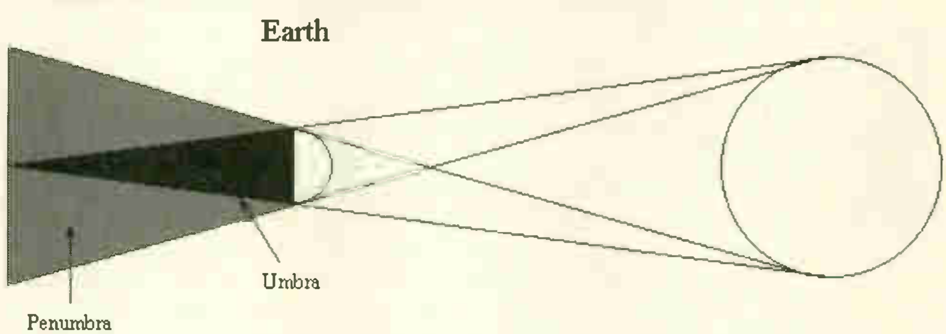
Calculating the position of the sun relative to the observer, once its position in the ECI coordinate system is known, is fairly straightforward. We simply substitute the sunís position for the satelliteís position in the equations we developed in Orbital Coordinate Systems, Part III. In fact, all we really care about is the sunís elevation above (or below) the horizon.

The next question we must answer is: Just how far below the horizon does the sun have to be for the observerís sky to be dark? Well, the sun has to be 50 arcminutes below the horizon for it to be considered to have set (all of these results apply equally to sunrise conditions). Part of this angle is due to the semidiameter of the sun (about 16 arcminutes): Even without the atmosphere, when the center of the sun is on the horizon, half of its disk is still above the horizon.

The rest of this angle (about 34 arcminutes) is due to atmospheric refraction. In fact, when the sunís disk appears to be just touching the horizon, it is actually completely below the horizon. The Earthís atmosphere, however, refracts the sunís image enough to make it appear to still be above the horizon. The point when the sunís center is 50 arcminutes below the horizon is considered to be the official time of sunset (or sunrise) and is the beginning (or end) of civil twilight. As you know, however, the sky is still quite bright at this point and no stars can be seen.

The point when stars (or satellites) begin to become visible marks the beginning of nautical twilightówhen the sunís center is 6 degrees below the observerís horizon. Whenever the sun is more than 6 degrees below the horizon, it should be fairly easy to spot an illuminated Earth satellite. The sunís effect on the night sky continues until the end of astronomical twilight when (if) it reaches 18 degrees below the horizon and the indirect light from the sun is less than the contribution from starlight. Of course, sky brightness and atmospheric refraction are influenced by actual meteorological conditions, so there may be some variance in the actual versus the predicted times.

FIGURE 1: Earth-Sun Shadow Geometry

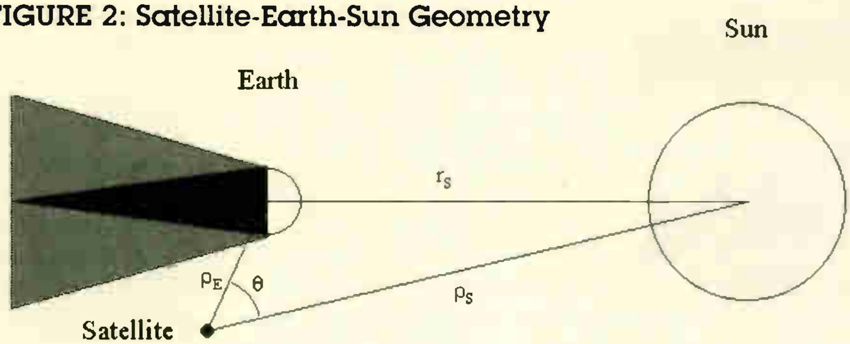


To determine whether a satellite is illuminated is a little trickier. As seen in Figure 1, because the sunís disk is not a point of light, it does not cast a sharp shadow. There are actually two areas of shadow that trail the Earth in the anti-solar direction. That cone where no portion of the sunís surface can be seen is referred to as the umbra. The tail of this cone reaches over a million kilometers beyond the Earth (well past the orbit of the moon, thus giving rise to total lunar eclipses). The angle of this cone is somewhat affected by atmospheric refraction and may vary.

The shadow cone where only part of the sunís disk is obscured by the Earth is referred to as the penumbra. This shadow is not a sharp transition, but rather a gradual transition from full sunlight to full darkness. For near-Earth satellites, the transition across the penumbra occurs fairly quickly due to the smaller size (note that Figure 1 is not drawn to scale) and faster speed of the satellites.

To determine whether a satellite is in umbral or penumbral eclipse requires several simple calculations. First, we must determine the distances from the satellite to the Earth (rE), the satellite to the sun (rS), and the Earth to the sun (rS). These distances are simple vector distances determined from knowing the position of the satellite and the sun in the ECI coordinate system. The geometry is shown in Figure 2 on the following page.

FIGURE 2: Satellite-Earth-Sun Geometry



From these values, we can then determine the semidiameters of the Earth and the sun (ρ_E and ρ_S, respectively) and the angle between the center of the Earth and the sun (R_S), all from the vantage point of the satellite. The semidiameters are calculated as

$$\theta_E = \sin^{-1}(R_E/\rho_E)$$

$$\theta_S = \sin^{-1}(R_S/\rho_S)$$

where RE and RS are the radii of the Earth and the sun, respectively. The angle between the center of the Earth and the sun is calculated as

$$\theta = \sin^{-1}(\rho_E \cdot \rho_s/\rho_E\rho_s)$$

where the numerator is the vector dot product of the two distance vectors.

To have an umbral eclipse, the semidiameter of the Earth must be greater than the semidiameter of the sun (not equal due to atmospheric refraction) and the angle between their centers must be less than the difference in their semidiameters. That is

$$\theta_E > \theta_S$$

$$\theta < \theta_E - \theta_S$$

An example of this geometry is shown on the left-hand side of Figure 3.

For a penumbral eclipse, the angle between the centers of the Earth and the sun must be less than the sum of their semidiameters (the two disks are just touching) and greater than their differences (the beginning of an umbral eclipse). In the penumbral phase, though, there is no requirement that the semidiameter of the Earth be greater than that of the sun. However, since this will be the case for all orbits within the moonís orbit, this condition will be the rule. The requirements for a penumbral eclipse are

$$|\theta_E - \theta_S| < \theta < \theta_E + \theta_S$$

An example of this geometry is shown on the right-hand side of Figure 3. If the semidiameter of the Earth is larger than the sun under these conditions, a partial eclipse occurs. The condition when

$$\theta_S > \theta_E$$

$$\theta < \theta_S - \theta_E$$

however, describes an annular eclipse.

To adapt an existing satellite tracking program to show eclipse conditions becomes a fairly straightforward problem. At each time step, the program must calculate the position of the sun in the ECI coordinate system, the position of the satellite in the ECI coordinate system (this should already be done), and the distance from the satellite to the sun. Then, the semidiameters of the Earth and sun are calculated, together with the angle between their centers. Using the simple boolean conditions above, it is easy to determine whether the satellite is in full sunlight, totally eclipsed, or somewhere in between.

To determine whether a satellite is visible from the ground only requires the additional step of calculating the sunís elevation relative to the observer. If the sun is more than 6 degrees below the observerís horizon and the satellite is above the horizon and illuminated, a visual pass is possible (weather permitting). It should now be possible for you to determine when a satellite pass is visible and even when it will fade into the Earthís shadow!

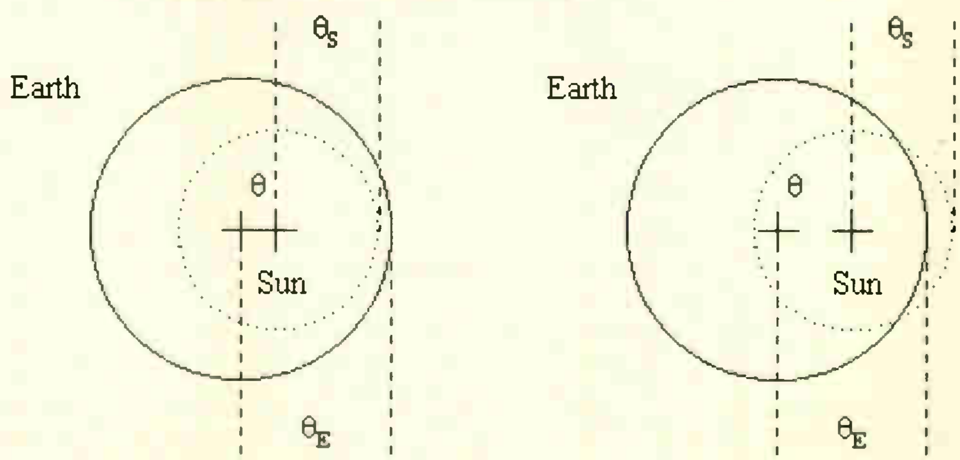
Conclusion

Obviously, there are a number of other factors involved in determining good satellite passes. Size of the satellite and its distance from the observer play an important role. But understanding the fundamentals will not only make it possible to view Earth-orbiting satellites, it will also help you understand things like eclipse seasons for geostationary satellites.

If youíd like more information on this subject, I invite you to attend my session entitled Visually Observing Earth Satellites at the upcoming Grove Expo in Atlanta on 18-20 October. Weíll cover it all from the basics to advanced topics. Hope to see you there!

As always, if you have questions or comments on this column, feel free to send me e-mail at tkelso@grove.net or write care of Satellite Times. Until next time, keep looking up! ST

FIGURE 3: Umbral and Penumbral Eclipse



BOOK REVIEW

The New Russian Space Programme: From Competition To Collaboration

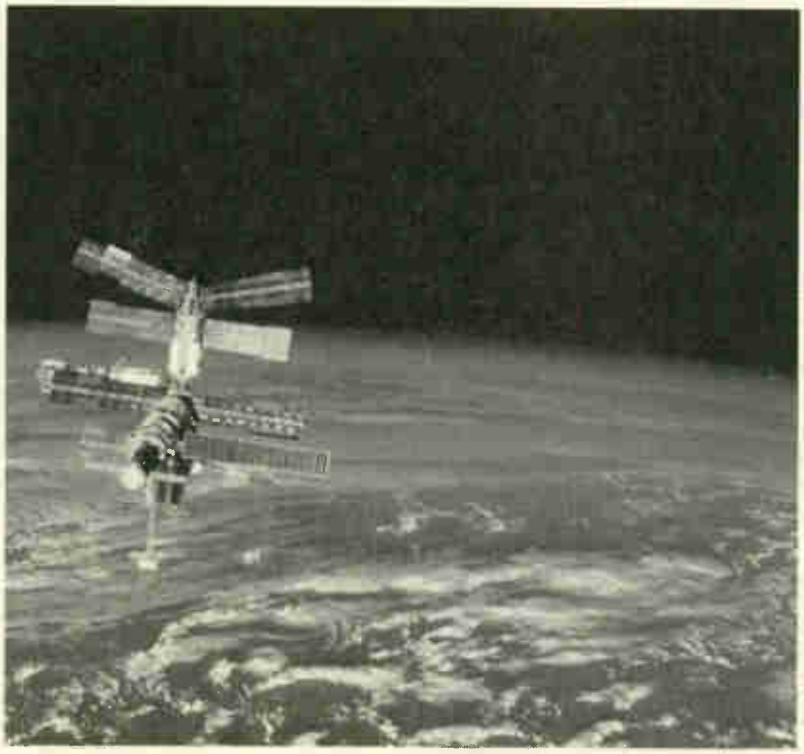
By Brian Harvey

Published by John Wiley and Sons in association with PRAXIS Publishing Ltd., The White House, Eastergate, Chichester, West Sussex, PO20 6UR, UK. 424 pages. ISBN 0-471-96014-4, Price: £24-50 in the UK, $40 in the US.

The original edition of this book was published in 1988 under the title *Race into Space: the Soviet Space Programme*, a year before the first official Russian acknowledgement of their manned lunar program and in the days when the doors on Soviet secrecy were only starting to open.

The new edition of the book rightly takes a new title, because it is a much-expanded and re-written version of the earlier work. Brian Harvey's clear and concise style of writing is a bonus compared to much western literature dealing with the former-Soviet space program.

The book is divided into three main sections. "Part 1: Origins" tells the story of the manned programs through to the demise of the manned lunar program in the mid-1970s. "Part 2: The program" provides a review primarily of the Soviet unmanned space programs, which are usually ignored or glossed over in books reviewing Soviet space activities, and concludes with a review of the various spaceplane programs and the Energiya/Buran system. "Part 3: Space Stations" starts with the first Soviet space station designs and concludes with the current collaboration with the United States in the International Space Station program.



Splitting the book into the three sections can be a little confusing chronologically, but on the other hand the separation of the subjects in Parts 1 and 3 of the book does reflect the various evolutions of the Soviet space effort: first, as it tried to put a man on the Moon, and as that dream faded, the development of the space station program.

In the original book there was still much speculation concerning launch failures and failed missions. Western literature had added so much imaginary detail to what little was known or suspected, that it was difficult to discover the correct story behind the nearly fictionalized accounts. Mr Harvey successfully did this in his earlier book, but in the new edition he is now able to utilizet all of the information now available from official Russian sources in his discussion of failures. Who needs the old largely-fictitious (but often accepted) accounts of some American writers, when you can have the true story?

There are many highlights in this book. Being a "detective" of the former-Soviet space program myself, I found the accounts of the never-flown programs of manned lunar missions and spaceplane projects particularly clear and impressive. With so many abandoned projects from so many design bureaus to discuss from it could have been difficult to maintain a clear discussion of what was going on: Mr Harvey is able to do this with apparent ease.

My one criticism of the book is to question the sources for some of Mr. Harvey's figures on spacecraft and launch vehicle masses. He quotes a mass for the Proton launch vehicle of 1,028,500 kg (page 112) which surely owes its pedigree to the inaccurate speculative work of Charles P Vick in the early 1970s: We have known for about a decade that the actual launch mass of Proton is about 700 tons (700,000 kg). There are some similar payload masses, the origin of which had me scratching my head, since they are not in agreement with what we now know about the payloads (for example, the Molniya-1 mass is 1,600 kg rather than 816 kg quoted on page 197).

Similarly, the comment on page 194 that "The first Resurs O-1 .... was flown on 4 November 1994" is a little misleading: there had been earlier Resurs-O1 flights but they were within the Cosmos program.

Having said this, I maintain the errors in the book are minor compared with amount of information which this book contains. It is an excellent review of the Soviet space program as it is now understood, and I would recommend it to anyone with the slightest interest in the subject. Brian Harvey is to be congratulated on this work. ST

Phillip Clark
Satellite Times staff

By Philip Chien

Women in Space

Onboard the base block module of Russia's Mir space station the visiting STS-76 crew members enjoy Russian food. At right is astronaut Kevin P. Chilton, mission commander, who along with his crewmates docked with Mir on March 23 and remained linked until March 28. Left to right are astronauts Shannon W Lucid, Linda M. Godwin and Michael R. Clifford, all mission specialists, along with Richard A. Searfoss, pilot. The right hand of payload commander Ronald M. Sega is at right edge. Lucid was in the process of transferring from STS-76 to the Mir-21 crew, which thereby grew from two to three members. (NASA)

SASA Administrator Dan Goldin is quick to point out that we don't launch men in to space anymore, we launch people. In July Shannon Lucid surpassed Norm Thagard as the most experienced American in space, and as we go to press she's expected to become the most experienced woman, and non-Russian in space. Her flight plan did not originally call for her to make these records, but when you fly a long duration mission you can't expect everything to go exactly as planned.

The space shuttle design is over two decades old, so it shouldn't come as any surprise that materials used on the shuttle have changed. Some components have been changed to increase safety or reliability, or reduce operating costs. Others have been changed due to companies going out of business or changing federal regulations.

The redesigned solid rocket motor (RSRM) is assembled at the Kennedy Space Center. As the segments are mated an adhesive is applied to seal the two propellant surfaces. Until recently the adhesive was Trichloroethane, but that substance is no longer manufactured because it's an ozone depleting agent.

NASA and Thiokol realized that the critical substance would no longer be available, and set up a program to develop a replacement, Morstik 227, a water-based adhesive. The adhesive was tested in a flight support motor, which simulates the actual solid rocket booster (SRB) burn. The first use of the new adhesive was on the STS-78 mission in June. Inspection of the recovered boosters showed soot in all six of the field joints, where none had been noticed before. The changed adhesive was the obvious and—as it turned out—correct suspect. Fortunately NASA still has about 110 lbs. of the old adhesive in stock, enough for about 10 to 14 shuttle launches.

It should be stressed that even with the additional soot the STS-78 mission was not placed in any additional danger. The situation was anticipated and thoroughly tested as part of the RSRM design. Nevertheless it was soot where soot hadn't been seen before. Since there is no pressing need to launch the next shuttle immediately, and NASA chose to swap out the next mission's boosters with a set assembled with the old adhesive.

The immediate short-range change involves STS-79 getting delayed from July to September, and there are other minor adjustments to the shuttle's manifest. Astronaut Shannon Lucid, aboard the *Mir* space station since March was to return to Earth on STS-79. She will now stay in space for a few additonal weeks.

Due to the delay Shannon will set a new female duration record in space, surpassing Russian cosmonaut Yelena Kondakova's 169 days on September 7, 1996. The current record for any non-Russsian/Soviet in space on a single mission is European Space Agency astronaut Thomas Reiter, with 179 days in space.

Shannon reaches that milestone on September 15, 1996. Less than a score of Russians and former Soviet cosmonauts have spent more time in space. Shannon was asked how she felt about setting a new American record and commented "I just hope that it isn't a record which holds for very long, because I hope that in the next couple of years quite a few Americans will be able to spend a long time in space, and America will be able to gain a lot of experience with long duration spaceflight."

What's not well known is that Shannon also holds the record for the amount of time any person spent aboard the shuttle. Besides her six months in space aboard *Mir* Shannon had flown on four previous shuttle flights—STS 51-G, STS-34, STS-43, and STS-58. From October 1994 to December 1994 her 34 days 22 hours in space was the shuttle duration record.

Shannon was one of the first female astronauts. In 1978, NASA announced the selection of 35 astronaut candidates from over 8000 applications. The other female astronauts selected in 1978 were Sally Ride, Judy Resnik, Kathy Sullivan, Anna Fisher, and Rhea Seddon. Since then an additional twenty five female astronauts have been selected by NASA.

As one of the first six female astronauts Shannon had more than her fair share of publicity. What made her stand out even more was that she was the first astronaut candidate who had given birth.

Female astronauts have flown aboard

the shuttle as mission specialists, payload commanders, pilots, and to *Mir*. To date no female astronaut has commanded the shuttle, but it's likely to happen by the end of the decade. Lieutenant Colonel Eileen Collins became the first female shuttle pilot on the STS-63 mission and is scheduled to fly on the STS-84 flight in 1997. It's likely that her third flight will be as a shuttle commander if she remains with the shuttle program. She commented "It's one of my goals in life, I would certainly like to become a shuttle commander someday."

There's always been a stark contrast between American and Russian female space travelers. It is significant to note that no Soviet / Russian woman has flown in space on her own merits, every Russian female cosmonaut has flown to establish a record or make a political statement.

The first female Soviet cosmonaut was Valentina Tereshkova. Her flight was a plain and simple political statement—a Soviet woman could spend more time in space than all of the American *Mercury* astronauts put together. The only technical requirements was parachuting experience, due to the *Vostok* spacecraft's design. The other three female cosmonaut candidates were quickly and quietly dropped from the program.

There have been persistent rumors that she was chosen because she was *Vostok 3* cosmonaut Andrian Nikolayev's girlfriend. They were married in 1964, with Soviet Premier Khrushchev giving away the bride. Their only daughter was born just eight months later, leading many to speculate that the quick marriage was as much for biological as for political reasons.

It took two decades before the next Russian woman flew in space, Svetlana Savitskaya, shortly before Sally Ride became the first American woman to fly in space. The world saw the event as a not-so-subtle reminder that Soviet women had preceded American women in to space. She flew a second flight to establish two additional records—the first woman to fly twice in space, and the first female spacewalk. The Soviets had planned an all-female crew to visit the *Salyut 7* space station, but managers canceled the mission fearing that there could be an emergency where a man's strength would be required. As before the other female candidates were quietly dropped from the cosmonaut corps.

Yelena Kondakova, the wife of cosmonaut and Energiya NPO deputy chief Valeri Ryumin, was selected as a cosmonaut in 1989. She flew as the flight engineer for the

Astronaut Shannon W. Lucid, STS-76 mission specialist, appears to enjoy her last hours aboard the Space Shuttle Atlantis before becoming a crew member supporting Russia's Mir-21 mission aboard the Mir space station. (NASA)

Mir 17 crew in 1994, spending six months in space. Normally the commander and flight engineer perform several spacewalks during a long duration mission, but none were performed during the *Mir 17* stay. She remains on flight status, but has not received another flight assignment yet.

There have been female cosmonauts from other countries who have trained for short visits to *Mir*. Helen Sharman, a British passenger, was aboard *Mir* for a week. Ryoko Kikuchi was the backup Japanese journalist who did not fly. A French woman, Claudie Andre-Deshays, is expected to visit *Mir* by the time you read this article.

When joint U.S. Russian activities were planned many high level Russian managers did not want American women to fly long duration missions aboard Mir. NASA insisted that female astronauts would have to be accepted in the shuttle-*Mir* program. The first two astronauts to train for *Mir* flights were Norm Thagard and Bonnie Dunbar.

Many people were surprised when they found out that Shannon Lucid would be responsible for much of the cleaning and maintenance aboard *Mir*. But those tasks are always the responsibility for the third crewmember, whether it's a male or female cosmonaut aboard *Mir*.

Before the STS-76 flight carried Shannon Lucid to *Mir* General Yuri Glazkov, the head of the cosmonaut training, made several comments about female cosmonauts. He stated, "The presence of a lady on the *Mir* station helps our crewmembers, they pay more attention to the way they speak and act, and so on. Women generally are hard working and normally if assigned to do any duties they do it very accurately, as opposed to some instances men. By being present for a relatively long period of time [Shannon] will share her culture with our cosmonauts."

He added "[Yelena]'s fellow crewmembers after flying with her were even more cultured than they used to be. We do not expect that there will be curtains on the windows, due to the fact that a woman's on board. But we're pretty sure that the microclimate on board would definitely be improved because there's a woman on board *Mir*. And a side effect we anticipate is that the fans will be taken care of in a more timely manner because we know that women love to clean, and they will take care of the fans to let less dust in to the environment."

He could not explain why so few women have been selected as cosmonauts. He did acknowledge that a new female flight engineer candidate had recently been accepted, and would eventually fly in space.

This view is certainly not held by every Russian, or even every Russian cosmonaut. Cosmonaut Sergei Krikalev is a veteran of two *Mir* flights and one shuttle flight. For his *Mir* missions he flew with the British female passenger and trained to fly with the Japanese female reporter. He flew with NASA mission specialist Jan Davis on his shuttle flight. Sergei commented. "It's obvious if people are qualified for flight, it doesn't matter whether you're a man or a woman."

Male astronauts still outnumber females by a five to one ratio. Less females are selected as mission specialist candidates because of the relatively low numbers of qualified female engineers and scientists who apply. Until recently female military pilots were not allowed to get the qualifications needed to become pilot astronauts, but three have been selected in recent astronaut classes.

Female astronauts are qualified for the same tasks as male astronauts, although there have been some cases where medical scientists have specifically desired all-male subjects. There is one major advantage for many of the female astronauts though. As a rule they're smaller than their male counterparts, and Marhsa Ivins noted that due to her size another couple of experiments could be squeezed on board whenever she flew! ST

THE BEGINNER'S COLUMN

By Ken Reitz, KS4ZR

A Bike Rider's Guide to the Clarke Belt

Satellite TV is all the rage. New companies spring to life every six months to get in on the direct broadcast satellite (DBS) land rush. There's DirecTV, USSB, Primestar, AlphaStar, and now EchoStar (DISH). Little bitty 18 inch dishes, tucked away safely out of the sight of your local subdivision architectural approval committee, quietly pick up a digital data stream which brings you a hundred channels of entertainment. It's truly a technological miracle.

But, let's get this straight: There is information and there is entertainment. There is taking an air-conditioned bus tour of the U.S. and there's riding a bike across the country. Having a DSS system installed at your home is not learning about satellite technology. Signing up for a package of TV shows you've already spent the last 10 years looking at is not about exploring the world you're supposed to be a part of. Zipping along the Interstate at 80 mph on a tour bus and pedaling along at 15 mph, exposed to the elements, are two different experiences.

Look at those cute little dishes. They don't move! In fact, they don't do anything their corporate conglomerate owners don't want them to do. And, by the way, your invoice is past due. Please pay promptly or we'll be forced to discontinue service.

The free flow of information is subversive. The Internet is subversive. Libraries are subversive. Shortwave radios are subversive. Television Receive Only (TVRO) Earth stations—yes, those black mesh dishes trying to melt into the background—are subversive. Why? Because no one can control what you watch with them. But, don't take my word for it: ask the folks who know what it feels like to have the full weight of a government's boot on their neck. Ask the folks from Iran, Saudi Arabia, or China, just to name a few, whose citizens risk jail or financial penalty for wanting what's available to all Americans: an unfettered view of the Clarke Belt.

Take a Deep Breath!

I know what you're thinking: "Got up on the wrong side of the Cosmos, did we?" Well, maybe. I just hate to see people rushing headlong to embrace new technology without stopping to question if it's better technology.

I realize that everything has its place. If you live in a city or any other place that precludes the installation of a full view satellite system, DBS is the answer. If your family is clamoring for entertainment and you have no access to cable, or the service you do have leaves a lot to be desired, DBS is the answer.

However, if space is not a limitation and your curiosity exceeds the warmed-over offerings of DBS, full view satellite TV is the answer. The first thing you have to do is get over the price hurdle. In my area of the country, discount stores are offering DBS systems for $200. One store, which sells big screen TV systems advertises "Buy a big screen TV—get a small dish satellite system free!"

Why? Well, it's because most retailers get a commission for signing up new customers. The more customers they can sign up, the more commissions they'll receive year after year as the cost of watching keeps going up. It's not about selling equipment, it's about selling programming and creating a cash stream through subscription commissions. Most subscription packages include channels you never watch, yet still have to pay for. Only with full view systems do customers have a real choice of how much or how little to spend. In addition, you're free to switch programmers, to go for the provider which gives the best service or lowest prices.

A Radio Analogy

Shortwave broadcasting has been around for the better part of this century and, despite its age and relatively low technology, remains quite popular the world around. Still, if you were to announce to your friends that you were going to buy a $500 shortwave receiver they would question your sanity. "Why?" they would chorus, "reception is so spotty, signals fade, there's all kinds of static and interference, and besides, the fidelity is so, well, un-digital! Why not stick with FM; the signals are drift free, there's no static and the music's in stereo!" "But," you counter, "there's not a station within antenna's reach that's transmitting what I want to hear."

Every year, despite the technological drawbacks, millions of shortwave radios, from $49 palm-sized wonders to expensive table top sets with all manner of buttons and dials, are sold each year. And it isn't because there are that many crazy people in this country or that people aren't aware of the FM option. The programming's the thing!

So it is with full view satellite TV. The system is going to cost more, but you're going to learn something about satellite technology and the various countries you'll be privileged to see via satellite. Popular support is now in favor of DBS, just as popular support in radio is with FM. What's wonderful is that we still have a choice.

The Great Info Hunt

So, my fellow beginners, let's begin at the beginning. The first thing you need to do to research the DBS alternative is to amass as much material (preferably as cheaply as possible) as there is available. You've already taken the most important step by buying this magazine. I'm not just saying that because I write for it: For the money, *Satellite Times* is the greatest single source of satellite information available. If you stick around this hobby long, you'll realize that information is often as expensive as equipment! *ST* provides three critical ingredients for your research: timely, diverse information, at a reasonable price.

The first element, timely information, is particularly important when dealing with satellite related publications. The satellite industry moves so quickly and changes direction so often that year old information is useless, and six-month-old information is of marginal value. The second element, diversity, is vital. There is no other single source for information on all the topics typically covered in any given issue of *ST*. In fact, there are a number of periodicals devoted to each individual subject covered in these pages. And, finally, the cost factor. It's not uncommon for satellite industry magazines to cost from $50 to $75 per year. This makes *ST* a real bargain.

It could be that, as you get further involved with this hobby, you'll want to branch out, to delve a little more deeply in any (or all!) of the various facets of satellite technology covered here. In that case, you'll need access to more information.

Net-wits to the Rescue

If you have access to the Internet, a good place to start is with news groups offered by whatever server or service you use. AOL, Compuserve, Prodigy all have various conferences for learning more about satellites. Directly on the Web there are at least four Web sites started by satellite enthusiasts: The DBS Home Page: **www.dbsdish.com/main.html**; DBS OnLine!: **www.dbs-online.com**; Robert Smathers Satellite WWW Page: **www.nmia.com/-roberts/robert.html**. Satellite Communications Data Exchange: **www.sat-city.com**. After a short while you'll be able to add considerably to this list and before long you'll be swapping industry rumors like a veteran! On the Net you'll find satellite dealers, program packagers, even nefarious DBS pirates who have their own sites. Start compiling your own list.

A Mountain of Information

If your mailbox doesn't see enough activity, your satellite info-search will soon end that. Write or call the following companies for catalogs of interest. The Grove catalog carries 12 satellite related books all priced under $30 (800-438-8155). Baylin Publications claims to be the world's largest supplier of books, videos and software about satellite TV, SMATV and Wireless Cable. Their 16 page catalog covers publications as well as installation aids (303-449-4551). Skyvision sells complete TVRO systems via mail order; call 800-543-3025 for their latest catalog. Direct Buyer's Service (DBS) has a satellite buyer's guide and information packet on TVRO equipment at 800-327-4728. Name Brands Only (NBO) also has complete systems available at 800-604-2222.

There are hundreds of channels of viewing on the full view satellite systems and four publications keep viewers up to date on what's happening. Write or call for sample issues of their guides and subscribe to the one that best fits your needs. Two are weekly guides, two are monthly guides, and both types have their advantages and disadvantages while doing the same job. The weeklies: *Onsat* 800-234-0021 and *Satellite TV Week* 800-345-8876. The monthlies: *Orbit* 800-234-4220 and *Satellite Entertainment Guide* 800-661-3203.

Weather satellites are a fascinating subject. That it's possible to actually set up a system just to watch our weather from above is amazing! The best introduction to weather satellites is Ralph Taggart's *Weather Satellite Handbook*. You'll learn the difference between "polar orbit" and geostationary weather satellites and what you'll need for reception. It's not light reading, but stick with it and you'll be on your way. It's available from the Grove catalog or any of the other usual mail order outlets.

WeatherSat Ink is a quarterly magazine devoted to the subject. Filled with photos and charts, this publication shows just how far you can go in this section of the satellite hobby. You'll learn about sophisticated reception techniques and how to get in touch with the many people who make weather satellites their main focus. Write *WeatherSat Ink* c/o Bluebird Greenhouses, 4821 Jessie Dr., Apex, NC, or use their FAX line: 919-362-5822.

Radio amateurs have been in the forefront of satellite communications since the 1960s. Many amateur satellites are whizzing over your house every day and you can tune in. You don't have to be a ham radio operator just to listen, and in many cases a simple shortwave radio or scanner is all you need to start. You can even hear cosmonauts in the MIR space station or catch the astronauts in the space shuttle as they pass over. The best source for learning about amateur satellites is Keith Baker's book, *How To Use Amateur Radio Satellites* published by AMSAT. AMSAT also publishes the bi-monthly *AMSAT Journal* which chronicles the progress of this part of the hobby. A subscription to *AMSAT Journal* is $30 per year at 850 Sligo Avenue, Silver Spring, MD 20910, or call 301-589-6061, FAX: 301-608-3410. There's a ton of information on their Website, including Keplerian element sets: *http://www.amsat.org* which is linked to all kinds of other pages of interest.

There are several other very esoteric satellites for which not a lot of information is widely available. Luckily, you're reading the one publication that regularly covers all the satellite bases. Military satellites, INMARSAT communications satellites, low earth orbit (LEO), and middle earth orbit (MEO) telecommunications satellites, as well as global positioning satellites (GPS) are all covered in the pages of *Satellite Times*.

Invitation to the Clarke Belt

Now it's your turn. Start exploring the world of satellite communications by putting your phone and computer into action and start understanding what it's all about. Write, call, fax, and surf your way to being an expert. If you think satellite TV is just watching sports and movies, you're in for a big surprise. There are hundreds of radio stations to listen to, data signals to explore, wire services from around the world to read, and an amazing assortment of channels you never knew existed. Watch satellites from Mexico and Canada. Peer over the horizon to satellites bridging Europe over the Atlantic and explore more. Think you can't put in a satellite system yourself? Think again. Manufacturers have taken most of the guesswork out of doing installations and today it's easier than ever. ST

Special Report

Life on Mars?

No "green men," but meteorite yields evidence that primitive organisms may have lived on the red planet

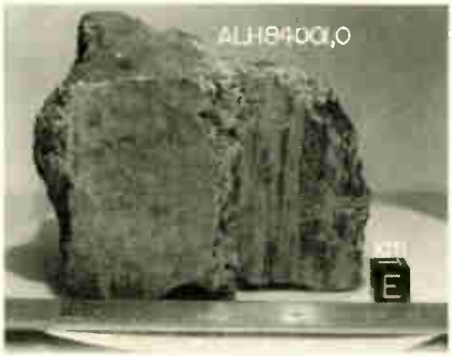
A NASA research team of scientists at the Johnson Space Center (JSC), Houston, TX, and at Stanford University, Palo Alto, CA, has found evidence that strongly suggests primitive life may have existed on Mars more than 3.6 billion years ago.

The NASA-funded team found the first organic molecules thought to be of Martian origin; several mineral features characteristic of biological activity; and possible microscopic fossils of primitive, bacteria-like organisms inside of an ancient Martian rock that fell to Earth as a meteorite. This array of indirect evidence of past life was reported in the August 16, 1996, issue of the journal *Science*, presenting the investigation to the scientific community at large for further study.

The two-year investigation was co-led by JSC planetary scientists Dr. David McKay, Dr. Everett Gibson, and Kathie Thomas-Keprta of Lockheed-Martin, with the major collaboration of a Stanford team headed by Professor of Chemistry Dr. Richard Zare, as well as six other NASA and university research partners.

"There is not any one finding that leads us to believe that this is evidence of past life on Mars. Rather, it is a combination of many things that we have found," McKay said. "They include Stanford's detection of an apparently unique pattern of organic molecules, carbon compounds that are the basis of life. We also found several unusual mineral phases that are known products of primitive microscopic organisms on Earth. Structures that could be microsopic fossils seem to support all of this. The relationship of all of these things in terms of location—within a few hundred thousandths of an inch of one another—is the most compelling evidence."

"It is very difficult to prove life existed 3.6 billion years ago on Earth, let alone on Mars," Zare said. "The existing standard of proof, which we think we have met, includes having an accurately dated sample that contains native microfossils, mineralogical features characteristic of life, and evidence of complex organic chemistry."



This 4.5 billion-year-old rock, labeled meteorite ALH84001, is believed to have once been a part of Mars and to contain fossil evidence that primitive life may have existed on Mars more than 3.6 billion years ago. The rock is a portion of a meteorite that was dislodged from Mars by a huge impact about 16 million years ago and that fell to Earth in Antarctica 13,000 years ago. The meteorite was found in Allan Hills ice field, Antarctica, by an annual expedition of the National Science Foundation's Antarctic Meteorite Program in 1984. It is preserved for study at the Johnson Space Center's Meteorite Processing Laboratory in Houston. (NASA)

"For two years, we have applied state-of-the-art technology to perform these analyses, and we believe we have found quite reasonable evidence of past life on Mars," Gibson added. "We don't claim that we have conclusively proven it. We are putting this evidence out to the scientific community for other investigators to verify, enhance, attack—disprove if they can—as part of the scientific process. Then, within a year or two, we hope to resolve the question one way or the other."

"What we have found to be the most reasonable interpretation is of such radical nature that it will only be accepted or rejected after other groups either confirm our findings or overturn them," McKay added.

The igneous rock in the 4.2-pound, potato-sized meteorite has been age-dated to about 4.5 billion years, the period when the planet Mars formed. The rock is believed to have originated underneath the Martian surface and to have been extensively fractured by impacts as meteorites bombarded the planets in the early inner solar system. Between 3.6 billion and 4 billion years ago, a time when it is generally thought that the planet was warmer and wetter, water is believed to have penetrated fractures in the subsurface rock, possibly forming an underground water system.

Since the water was saturated with carbon dioxide from the Martian atmosphere, carbonate minerals were deposited in the fractures. The team's findings indicate living organisms also may have assisted in the formation of the carbonate, and some remains of the microscopic organisms may have become fossilized, in a fashion similar to the formation of fossils in limestone on Earth. Then, 16 million years ago, a huge comet or asteroid struck Mars, ejecting a piece of the rock from its subsurface location with enough force to escape the planet. For millions of years, the chunk of rock floated through space. It encountered Earth's atmosphere 13,000 years ago and fell in Antarctica as a meteorite.

It is in the tiny globs of carbonate that the researchers found a number of features that can be interpreted as suggesting past life. Stanford researchers found easily detectable amounts of organic molecules called polycyclic aromatic hydrocarbons (PAHs) concentrated in the vicinity of the carbonate. Researchers at JSC found mineral compounds commonly associated with microscopic organisms and the possible microscopic fossil structures.

In the center of this electron microscope image of a small chip from a meteorite are several tiny structures that are possible microscopic fossils of primitive, bacteria-like organisms that may have lived on Mars more than 3.6 billion years ago. A two-year investigation by a NASA research team found organic molecules, mineral features characteristic of biological activity and possible microscopic fossils such as these inside an ancient Martian rock that fell to Earth as a meteorite. The largest, possible fossils are less than 1/100th the diameter of a human hair in size, while most are ten times smaller. (NASA)

The largest of the possible fossils are less than 1/100 the diameter of a human hair, and most are about 1/1000 the diameter of a human hair—small enough that it would take about a thousand laid end-to-end to span the dot at the end of this sentence. Some are egg-shaped while others are tubular. In appearance and size, the structures are strikingly similar to microscopic fossils of the tiniest bacteria found on Earth.

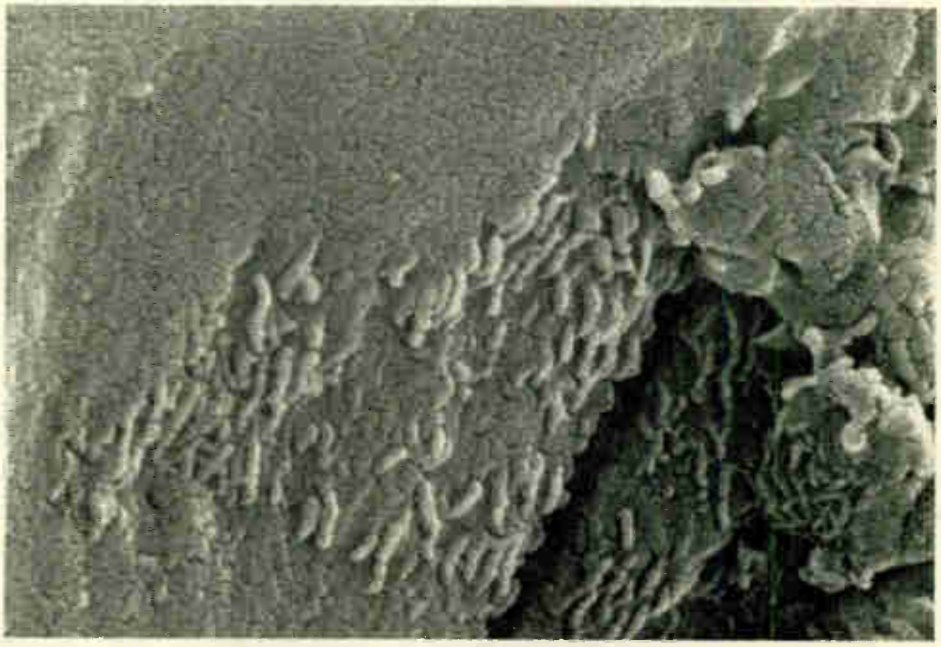
The meteorite, called ALH84001, was found in 1984 in Allan Hills ice field, Antarctica, by an annual expedition of the National Science Foundation's Antarctic Meteorite Program. It was preserved for study in JSC's Meteorite Processing Laboratory and its possible Martian origin was not recognized until 1993. It is one of only 12 meteorites identified so far that match the unique Martian chemistry measured by the Viking spacecraft that landed on Mars in 1976. ALH84001 is by far the oldest of the 12 Martian meteorites, more than three times as old as any other.

Many of the team's findings were made possible only because of very recent technological advances in high-resolution scanning electron microscopy and laser mass spectrometry. Only a few years ago, many of the features that they report were undetectable. Although past studies of this meteorite and others of Martian origin failed to detect evidence of past life, they were generally performed using lower levels of magnification, without the benefit of the technology used in this research. The recent discovery of extremely small bacteria on Earth, called nanobacteria, prompted the team to perform this work at a much finer scale than past efforts.

The nine authors of the *Science* report include McKay, Gibson, and Thomas-Keprta of JSC; Christopher Romanek, formerly a National Research Council post-doctoral fellow at JSC who is now a staff scientist at the Savannah River Ecology Laboratory at the University of Georgia; Hojatollah Vali, a National Research Council post-doctoral fellow at JSC and a staff scientist at McGill University, Montreal, Quebec, Canada; and Zare, graduate students Simon J. Clemett and Claude R. Maechling and post-doctoral student Xavier Chillier of the Stanford University Department of Chemistry.

The team of researchers includes a wide variety of expertise, including microbiology, mineralogy, analytical techniques, geochemistry and organic chemistry, and the analysis crossed all of these disciplines. Further details on the findings presented in the *Science* article include:

Researchers at Stanford University used a dual laser mass spectrometer—the most sensitive instrument of its type in the world—to look for the presence of the common family of organic molecules called PAHs. When microorganisms die, the complex organic molecules that they contain frequently degrade into PAHs. PAHs are often

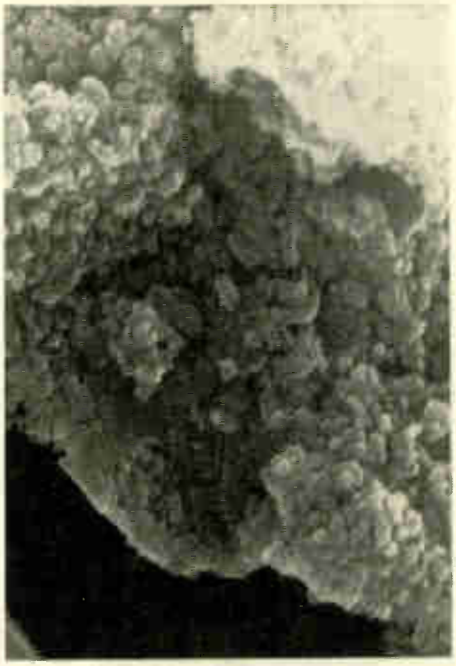


This electron microscope image is a close-up of the center potion part of the photo above. While the exact nature of these tube-like structures is not known, one interpretation is that they may be microscopic fossils of primitive, bacteria-like organisms that may have lived on Mars more than 3.6 billion years ago. (NASA) associated with ancient sedimentary rocks, coals, and petroleum on Earth and can be common air pollutants.

Not only did the scientists find PAHs in easily detectable amounts in ALH84001, but they found that these molecules were concentrated in the vicinity of the carbonate globules. This finding appears consistent with the proposition that they are a result of the fossilization process. In addition, the unique composition of the meteorite's PAHs is consistent with what the scientists expect from the fossilization of very primitive microorganisms.

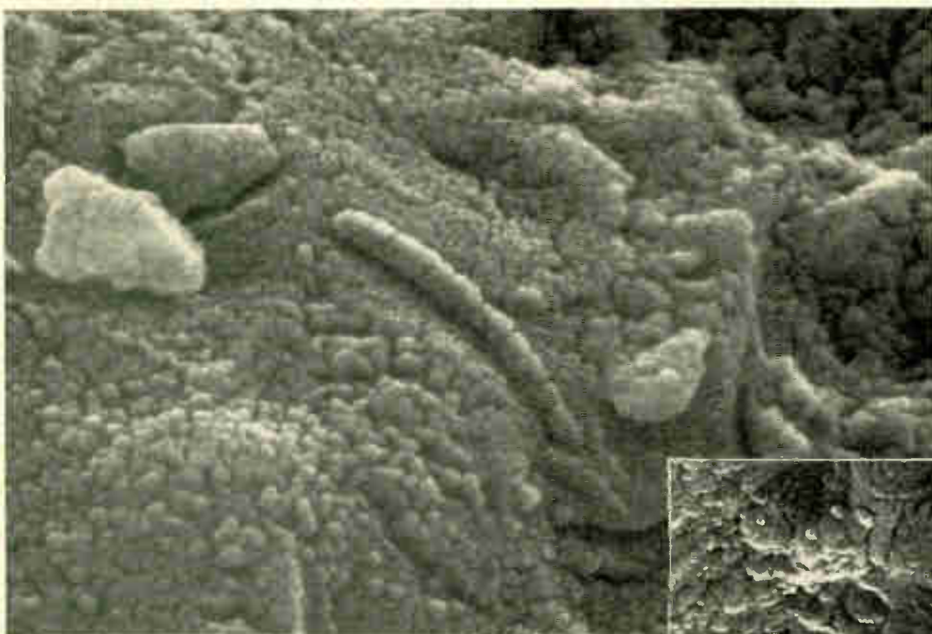
On Earth, PAHs virtually always occur in thousands of forms, but, in the meteorite, they are dominated by only about a half-dozen different compounds. The simplicity of this mixture, combined with the lack of light-weight PAHs like napthalene, also differs substantially from that of PAHs previously measured in non-Martian meteorites.

The team found unusual compounds—iron sulfides and magnetite—that can be produced by anaerobic bacteria and other microscopic organisms on Earth. The compounds were found in locations directly associated with the fossil-like structures and carbonate globules in the meteorite. Extreme conditions—conditions very unlikely to have been encountered by the meteorite—would have been required to produce these compounds in close proximity to one another if life were not involved. The carbonate also contained tiny grains of magnetite that are almost identical to magnetic fossil remnants often left by certain bacteria found on Earth. Other minerals commonly associated with biological activity on Earth were found in the carbonate as well. The formation of the carbonate or fossils by living organisms while the meteorite was in the Antarctic was deemed unlikely for several reasons. The carbonate was age dated using a parent-daughter isotope method and found to be 3.6 billion years old, and the organic molecules were first detected well within the ancient carbonate. In addition, the team analyzed representative samples of other meteorites from Antarctica and found no evidence of fossil-like structures, organic molecules or possible biologically produced compounds and minerals similar to those in the ALH84001 meteorite.



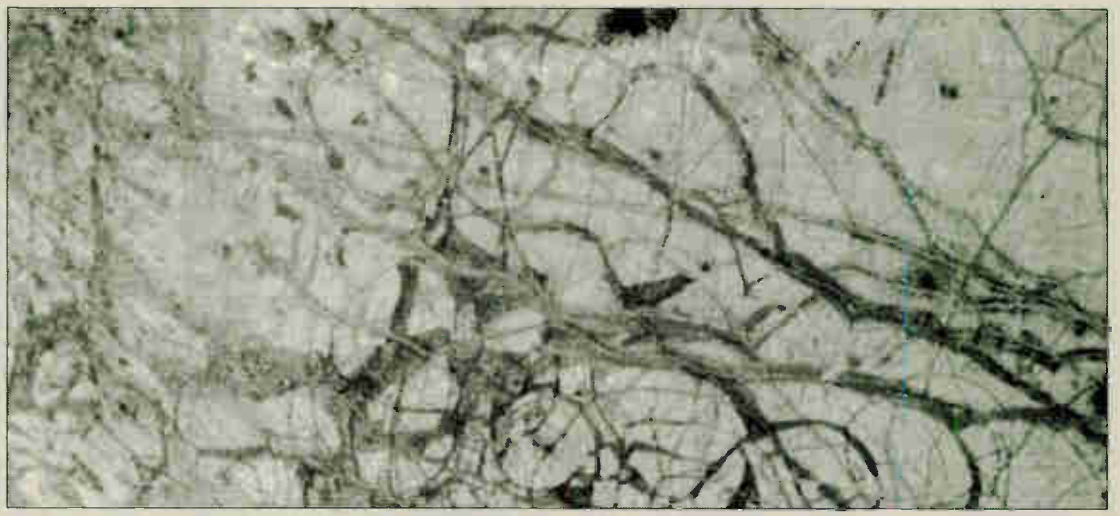
Electron microscope image shows egg-shaped structures, some of which may be possible microscopic fossils of Martian origin as discussed by NASA research published in the Aug. 16, 1996, issue of the journal Science. (NASA)

The composition and location of PAHs organic molecules found in the meteorite also appeared to confirm that the possible evidence of life was extraterrestrial. No PAHs were found in the meteorite's exterior crust, but the concentration of PAHs increased in the meteorite's interior to levels higher than ever found in Antarctica. Higher concentrations of PAHs would have likely been found on the exterior of the meteorite, decreasing toward the interior, if the organic molecules are the result of contamination of the meteorite on Earth. ST



These high-resolution scanning electron microscope images show an unusual tube-like structural form that is less than 1/100th the width of a human hair in size found in meteorite ALH84001n. Although this structure is not part of the research published in the Aug. 16 issue of the journal Science, it is located in a similar carbonate glob in the meteorite. This structure will be the subject of future investigations that could confirm whether or not it is fossil evidence of primitive life on Mars 3.6 billion years ago. (NASA)

Europa Harbors Possible "Warm Ice" or Liquid Water



Galileo image of Europa's broken ice, suggesting a highly active surface. (NASA)

Tantalizing new images of Jupiter's moon Europa from NASA's Galileo spacecraft indicate that "warm ice" or even liquid water may have existed, and perhaps still exists today beneath Europa's cracked icy crust.

The Europa results are one of several new Galileo findings, including an image of a huge erupting geyser-like volcano on Jupiter's moon Io and new information about Jupiter's Great Red Spot, by NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA.

Galileo scientists are poring over images that show places on Europa resembling ice floes in Earth's polar regions, along with suggestions of geyser-like eruptions and details of long dark bands centered with white stripes that stretch like interstate highways across Europa's face.

"This moon is a marvelous place," said Dr. Ronald Greeley, a Galileo imaging team scientist and a geologist at Arizona State University, Tempe, AZ. "We're seeing evidence of a lot of geological activity on Europa."

"In some areas, the ice is broken up into large pieces that have shifted away from one another, but obviously fit together like a jigsaw puzzle," said Greeley. "This shows the ice crust has been or still is lubricated from below by warm ice or maybe even liquid water."

The results bring scientists a step closer to determining whether Europa has environmental "niches" warm enough and wet enough to meet the requirements to host life, Greeley said.

Europa is about the size of Earth's Moon and is covered largely with smooth white and brownish-tinted ice, instead of large craters like so many other bodies in the Solar System. Scientists believe its cracked cue-ball appearance is due to stressing caused by the contorting tidal effects of Jupiter's strong gravity. They speculate that the warmth generated by tidal heating may have been sufficient to soften or even liquefy some portion of Europa's icy covering.

Europa has long been considered by scientists and celebrated in science fiction as one of the handful of places in the Solar System (along with Mars and Saturn's moon Titan) that could possess an environment where primitive forms of life could possibly exist.

"A major goal of Galileo's studies of Europa is to search for signs of current or past activity to help answer the question: Is there a liquid zone on Europa?" said Greeley. "We are interested in identifying the time and places on Europa where liquid water might exist. We want to go back to some of these areas that suggest soft ice or liquid water under the ice and test some of the questions we're asking now."

The current images, taken from a distance of about 95,700 miles (155,000 km), show features about one mile across (1.6 km per pixel resolution). Moon flybys later in the mission will bring the Galileo spacecraft to within 370 miles (600 km) of Europa's surface. During those flybys, the best resolution from the camera will average about 72 to 98 feet (22 to 30 m-per-pixel) and as fine as 36 feet (11 m) per pixel, so that objects the size of buildings on Earth could be discerned, Greeley said.

Galileo's close flybys of Europa will occur Dec. 19, 1996, Feb. 20, 1997 and Nov. 6, 1997. Additional non-flyby observations will be made during this September and November, and in April, June and September of 1997.

Galileo's detailed images are shedding new light on the nearly global, highway-like stripes on Europa that scientists call "triple bands" because of their dark-bright-dark appearance. Originally discovered in data from NASA's Voyager spacecraft in 1979, the cracks are thought to reflect tidal stressing in Europa's icy crust. "The scale of fracture patterns—extending a distance equivalent to the width of the western United States—dwarf the San Andreas fault in length and width," said Greeley.

Planetary geologists have proposed several models that could be responsible for creating the banded roadway look of these features. One set of models calls for combinations of tectonic faulting and flooding caused by liquid water or warm ice mixed with darker silicates that well up through cracks and then freeze over.

Galileo scientists say the new data suggest another model where "dirty geysers" erupt along a line, ejecting a mixture of ice and darker silicate debris along the surface. This event may be followed by a more gentle, continuous flow of cleaner water ice that paints the white stripe down the center of the feature. ST

World Radio Network Schedules

WRN1 - European English Service
Astra 1B (19 degrees east) Transponder 22, (VH-1),11.538 GHz, V-Polarization, Audio Subcarrier 7.38 MHz, All programmes in English. WRN program information can be heard daily at 0125, 1025 and 2050 BST. Program information is also available on VH-1 Text page 222, 223, and 224.

All times BST (For Central European Time add one hour)
0000 - Radio Budapest
0030 - Radio Netherlands
0127 - Earth & Sky (Daily Science Series)
0130 - Radio Prague
0200 - NPR All Things Considered (rpt)
0300 - CBC As It Happens (Mon-Fri)
0300 - CBC tba (Sat)
0300 - CBC tba (Sun)
0400 - Polish Radio Warsaw
0430 - BBC Europe Today (Mon-Fri)
0430 - Glen Hauser's World of Radio (Sat)
0430 - UN Radio From New York (Sun)
0500 - YLE Radio Finland
0530 - Radio Austria International
0600 - NPR All Things Considered (rpt)
0730 - PRI Market Place (Tuesday-Saturday)
0730 - PRI Sound Print (Sunday)
0730 - PRI Dialogue (Monday)
0800 - ABC Radio Australia
0900 - Radio Swiss Int'l (Mon-Sat)
0900 - C-Span Weekly Radio Journal (Sunday)
0930 - Radio Canada Int'l (Mon-Fri)
0930 - UN Radio (Sat)
1000 - Radio Prague
1030 - Radio Netherlands
1127 - Earth & Sky (Daily Science Series)
1130 - Channel Africa, Johannesburg (Mon-Sat)
1130 - Glen Hauser's World of Radio (Sun)
1200 - NPR Morning Edition (Monday-Friday)
1200 - NPR Press Club (Sat)
1200 - NPR Weekly Edition (Sun)
1300 - NPR Morning Edition (Monday-Friday)
1300 - NPR Weekend Edition (Saturday & Sunday)
1400 - Radio France International
1500 - Voice of Russia (Mon-Sat)
1500 - VOA Communications World (Sun)
1530 - Radio Vlaanderen International
1600 - ABC Radio Australia
1700 - ORF Blue Danube Radio (Monday-Friday)
1700 - Glen Hauser's World of Radio (Sat)
1700 - SABC Network Africa (Sun)
1730 - Radio Netherlands
1825 - News in Esparanto from Polish Radio Warsaw
1830 - RTE News at Six
1900 - Radio Austria International
1930 - YLE Radio Finland
2000 - RTHK - News from Hong Kong (Mon-Fri)
2000 - UN Radio from New York (Sat)
2015 - Health Watch (Sat)
2000 - Radio Romania International (Sun)
2030 - KBS Radio Korea International
2100 - Radio Sweden
2130 - Polish Radio Warsaw
2200 - NPR All Things Considered
2300 - PRI The World (Mon-Fri)
2300 - NPR All Things Considered (Sat & Sun)

WRN2 - European Multi-lingual Service
Eutelsat II F-1 (13 degrees East) Tr 25 (NBC), 10.987 GHz, V-Polarization, Audio Subcarrier 7.38 MHz. Please note that at all other times the schedule for WRN1 - Europe is broadcasts.

All times BST (Subtract five hours for Eastern Time)
0309 - Vatican
0745 - Vatican end
0830 - Vatican start (Sunday only)
0930 - Vatican start (Mon-Sat only)
1130 - Vatican end (not Wednesday)
1200 - Vatican end (Wednesday only)
1200 - Radio Studio Delta start (Mon-Fri only)
1300 - Delta end (Mon-Fri only)
1300 - Vatican start
1530 - Vatican end
1530 - Radio Studio Delta start (Mon-Fri only)
1630 - Delta end
1630 - Vatican start
2230 - Vatican end
2230 - Radio Studio Delta start (Mon-Fri only)
2330 - Delta end (Mon-Fri only)

WRN 2 - N. American Multi-lingual Service
Galaxy 5 (125 degrees West) Tr 6 (TBS) 3.820 GHz, V-Polarization, Audio Subcarrier 6.2 MHz. Please note that programmes listed below with an asterisk (*) are subject to pre-emption without notice. WRN programme information is available on TBS Text page 204.

All times Eastern (For UTC add five hours)
0030 - *Radio Netherlands in Dutch
0125 - *WRN Announcements, until....
0600 - YLE Radio Finland, News in Finnish
0625 - YLE, News in Swedish
0630 - YLE, News in English
0700 - *WRN Announcements, until....
0800 - RTE News in Irish
0900 - Radio Prague in Czech
0927 - *WRN Announcements, until....
1000 - YLE Radio Finland, Regional broadcasts in Finnish
1030 - YLE, News in Finnish
1100 - YLE, Features in Finnish
1120 - YLE, Slow speed Finnish
1130 - YLE, News in English
1200 - *WRN Announcements, until....
1400 - *Radio Sweden, News in Swedish
1430 - *WRN Announcements, until....
1500 - *Radio Vlaanderen International in Dutch
1530 - *Radio Netherlands in Dutch
1625 - *WRN Announcements, until....
1645 - YLE, News in French
1700 - *Polish Radio Warsaw in Polish
1800 - Radio Budapest in Hungarian
1830 - YLE Radio Finland, Rock Music & Talk in Finnish (Mon-Fri)
1830 - YLE, Phone-in for children in Finnish (Sat&Sun)
1900 - YLE, News in Swedish
1930 - YLE, News in English
2000 - YLE, Light music in Finnish
2100 - YLE, Documentaries in Finnish (Mon-Thu)
2100 - YLE, Chuch Bells & Concert in Finnish (Sat)
2100 - YLE, New Classical releases in Finnish (Sun)
2130 - YLE, Light Music in Finnish (Fri only)
2200 - YLE, News in English
2230 - YLE, News in Finnish
2300 - YLE, News in Finnish
2310 - YLE, Religious programme in Finnish (Sun-Fri)
2320 - YLE, News in Swedish
2323 - YLE, Programme Preview in Finnish
2330 - Radio Austria International in German

WRN 1 - Africa/Asia-Pacific Service
Intelsat 702 (1 degree West) Tr 23B, 3.9115 GHz, Circular-Polarization, MPEG2 Audio Stream and AsiaSat-2 (100.5 degrees East) Tr 10B, 4.000 GHz, H-Polarization, MPEG2 Audio Stream.

All times UTC. For South African Standard Time add two hours and for Australian Eastern Time add eleven hours.
0030 - Radio Netherlands
0127 - Earth & Sky (Daily Science Series)
0130 - Radio Prague
0200 - Voice of Russia
0230 - Radio Sweden
0300 - NPR All Things Considered (rpt)
0430 - BBC Europe Today (Mon-Fri)
0430 - Glen Hausers' World of Radio (Sat)
0430 - BBC Int'l Call (Sun)
0500 - YLE Radio Finland
0530 - Radio Austria International
0600 - NPR All Things Considered (rpt)
0730 - RTE Dublin
0930 - Radio Canada Int'l (Mon-Fri)
0930 - UN Radio (Sat)
1000 - Radio Prague
1030 - Radio Netherlands
1127 - Earth & Sky (Daily Science Series)
1130 - Channel Africa, Johannesburg (Mon-Fri)
1130 - BBC Science Magazine (Saturday)
1130 - Glen Hausers' World of Radio(Sunday)
1200 - NPR Morning Edition (Monday-Friday)
1200 - NPR Press Club (Sat)
1200 - NPR Weekly Edition (Sun)
1300 - RTE Dublin
1400 - Radio France International
1500 - Voice of Russia (Mon-Sat)
1500 - VOA Communications World (Sun)
1530 - Radio Vlaanderen International
1600 - ABC Radio Australia
1700 - ORF Blue Danube Radio (Monday-Friday)
1700 - Glen Hausers' World of Radio (Sat)
1700 - BBC Int'l Money Prog & Sports Zone (Sun)
1730 - Radio Netherlands
1830 - RTE Dublin
1900 - Voice of America - World News & Mission Bosnia
1930 - YLE Radio Finland
2000 - Radio Deutsche Welle - News from Germany
2050 - Esperanto from Polish Radio
2100 - Radio Sweden
2130 - Polish Radio Warsaw
2200 - RTE Dublin

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$18.50 Canadian UPS
$22.50 Canadian APP

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BRK 2	Mounting bracket w/ cig. power cord	$15.95

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SATELLITE TIMES ADVERTISERS' INDEX

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)

OECAY 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 BRDADCAST 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 polling 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 NOOE (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.

UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

Auctioning off the Spectrum, or, The Emperor Has No Clothes

I continue to be amazed at the success of the Federal Communications Commission's (FCC's) endeavor to sell something it doesn't own, and the willingness of people to spend $20 billion for something they can't buy. Will NOAA next sell the oceans, and NASA the moon?

The FCC is a regulating body, not a merchant; the spectrum is a measurement, not an entity. Even if the Commission sells 1.9 GHz to Motorola, I can generate another 1.9 GHz in my home or office and Motorola can't have it.

The FCC will quickly respond that they don't sell a frequency, only the rights to it, but where do these rights begin—and stop? Just because an orbiting platform is emitting a signal at 1.9 GHz, does this mean that it is regulated to remain within the geographical confines of the International Telecommunications Union's (ITU's) Region 2 (North and South America)? And what if its line-of-sight operations experience interference from, or cause interference to, another terrestrial or space system in Region 1 or 3? Should these non-signatory countries feel responsible for the exclusivity of the Region 2 auction winner as pontificated by the FCC?

It may seem reasonable to reserve a slice of spectrum for a successful bidder if ITU signatories already honor an exclusive right to that chunk of spectrum and the bird is in a geosynchrnous orbit, but what about low-earth-orbiting (LEO) polar (non-geosynchronous) satellites? When they are low on the horizon, the expectation of international interference is great, and even worse when they are flying over other regions.

Fortunately for the winners of the half dozen or so FCC auctions, all but one have been for terrestrial applications; these users should have little problem implementing the exclusivity of their line-of-sight microwave allocations.

So what do spectrum auctions really accomplish? For one thing, they resolve disputes among several contenders for the same privileges, settling once and for all (?) who has the primary, or even exclusive, rights for a particular service—at least in the United States.

Time will tell whether the spectrum auction really works. In the meantime, however, it is a cash cow that won't stop. Ironically, even though the financially-strapped FCC is mandated by Congress to hold the auctions, it isn't the beneficiary. All checks are made out to the U.S. General Treasury. ST

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