Volume 1, Number 2
November/December 1994

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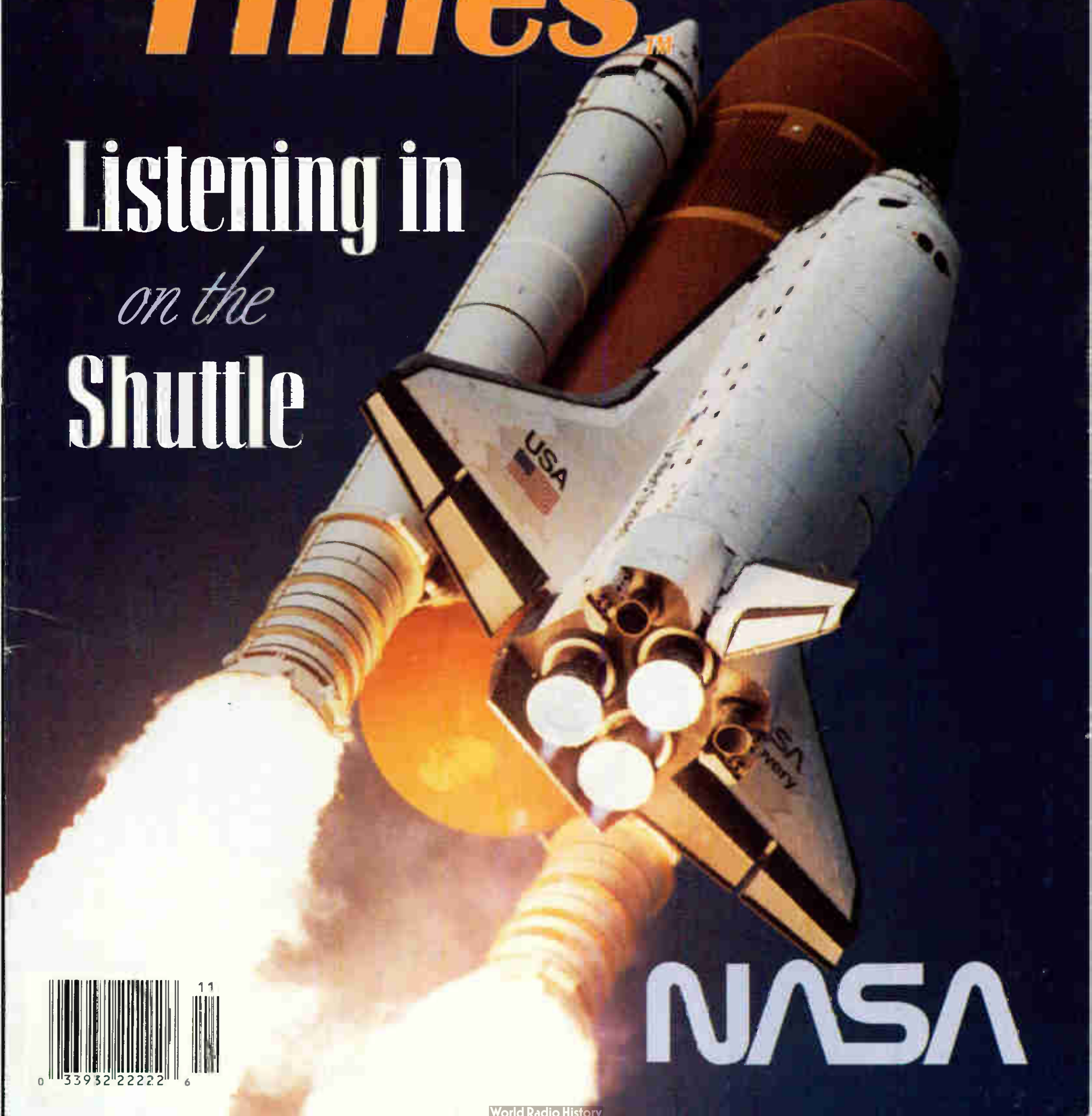
Satellite Times™

Listening in *on the* Shuttle



• TELECOMMUNICATIONS EQUIPMENT •
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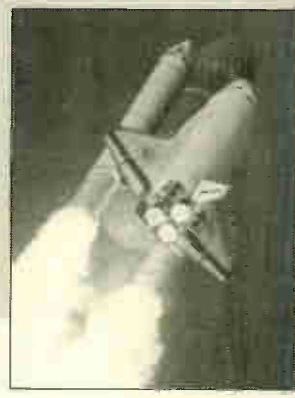
Satellite Times

Cover Story

Space Shuttle Communications

By Kirk Kleinschmidt, NT0Z



Technologically, the shuttle-support communication system comprises one of the most advanced communication systems anywhere. Besides (assuming you're a taxpayer), you pay for it, so you might as well switch off the Nintendo every now and then and see "what's up." Cover photo courtesy of NASA.
See story starting on page 10.

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November/December 1994

Countdown to Liftoff

By Rachel and Harry Baughn

Ever wonder what it would be like to see a shuttle launch for the first time? In this story by Monitoring Times editor Rachel Baughn and husband Harry, you will get a bird's-eye view of the launch of STS-65 last July and some scanner frequencies for your radio that were heard during the launch from Kennedy Space Center. *See story on page 18.*

NASA TV

By Steve Handler

NASA TV provides you with a front row seat to the world of space and space travel. Broadcasting on Spacenet 2, NASA TV offers educational programs and live coverage of space shuttle missions. Tune in to this story starting on page 22 and find out about programs that are "Out of this World."

Asian Satellite Television

By George Wood

Not long ago, if you wanted to watch satellite TV in the Pacific rim and Asia, your choices were limited to the Intelsat satellites. Now, things have changed and are continuing to change at a rapid pace. Check out the International TVRO starting on page 32 for an inside look at Asian Satellite TV.

Test Driving the New Swagursat

In the "Satellite Times Tests" column this issue, Larry Van Horn reviews the Swagur Enterprises "Swagursat" demodulator (pictured above) and the OFS WeatherFAX V5 decoder board and software. Both units are used for weather satellite monitoring.

DEPARTMENTS

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

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DOWNLINK

By Larry Van Horn
Managing Editor

From the Editor . . .

The single most consistent space event that is guaranteed to light up the phones in the editorial offices of *Satellite Times* has always been space shuttle missions. The most consistent question during these calls always revolves around one theme, "How can I hear space shuttle communications?"

This issue's cover story by Kirk Kleinschmidt will help answer your questions about space shuttle communications. Kirk will explore the intricacies of NASA's shuttle communications system and provide you with the frequencies to hear shuttle activity.

Our second story this issue deals with another type of shuttle monitoring, listening to a space shuttle launch from the Kennedy Space Center in Florida on your scanner. MT editor, Rachel Baughn and her husband Harry, will also share with you a unique opportunity to witness a orbiter launch from the eyes of a first time observers.

Most space enthusiasts will agree that the space shuttle is one of humankind's greatest technological achievements. As we watch an orbiter propel into space, it is easy to forget that a successful launch and ensuing mission demands the dedication of thousands of the best and brightest people and somewhere between 350 million and a billion dollars to accomplish.

Have you ever wondered what happens behind the scenes between launches? On Sunday, November 13, from 9:00 - 11:00 pm (EST/PST) and midnight - 2:00 am (EST/PST), The Discovery Channel (TDC) presents a close-up look at just what it does take to send the space shuttle into space and then return it safely to earth with the world premiere of *The Space Shuttle.*

Utilizing rare behind-the-scenes footage, the program travels from the Kennedy Space Center to the Johnson Space Center in Houston, taking you onboard a G2 aircraft as astronauts practice shuttle landings; into Mission Control after a successful launch to observe the unique "bean feast" ritual; and onto the runway 20-minutes after the return of the shuttle *Endeavor* to examine first-hand the effects of space travel on man and machine.

To put a human face on space travel, *The Space Shuttle* offers an intimate look at several celebrated astronauts, including Story Musgrave, one of the oldest active astronauts, and USAF Maj. Eileen Collins, who will be the first female astronaut to pilot a shuttle mission (STS-63 in February, 1995). There will be interviews from those who toil unsung behind the scenes, from Tip Tallone, who is responsible for all aspects of spacecraft preparation before a mission to Rayelle Thomas, who oversees the shuttle's plumbing system.

There will be repeats of the broadcast on Saturday, November 19, from 8:00 - 10:00 pm (EST/PST) and 11:00 pm - 1:00 am (EST/PST), on Sunday, November 20, from noon - 2:00 pm (EST/PST), and on Saturday, November 26, from 4:00 - 6:00 pm (EST/PST). Many cable companies offer the Discovery channel as part of their basic packages and satellite dish owners can catch TDC-East on Galaxy 5, transponder 12 (EST feeds) and TDC-West on RCA Satcom C4, transponder 21 (PST feeds).

I hope each of you as an opportunity to watch this exciting program that captures the excitement of our space shuttle program like no other has ever done.

Finally, I want to include some of your comments, positive and negative on the premiere issue of *Satellite Times.* It would appear that *ST* has been well received.

■ I just received the premiere issue of your new magazine, *Satellite Times.* I am very pleased with what I saw in the magazine. It provides very useful information which was hard to find before. The article on "DBS: It's Here" even answered a question my wife had asked me just a few days ago. She saw a sign in front of a television dealership stating that "DSS is coming soon". My wife asked me what 'DSS" was and after I read your article, I had the answer for her.

I am enclosing a check for my subscription to *ST.* Since the house my wife and I now own has a satellite TV system, your magazine will be a welcome resource of information. I would like to extend my congradulations to you and your staff for such a wonderful magazine. *Monitoring Times* has been and what *Satellite Times* is and will be are two great magazines. *Edward P. Taylor-Virginia*

■ I just received a sample copy of your magazine, *Satellite Times,* and I must confess to being quite disappointed. You mention that the articles should have "broad appeal in a *Reader's Digest* sort of way."

If this is the first issue, I sure hope it doesn't get more complicated later on! I am an Advanced class amateur, a CPA, a computer literate who is definitely not stuck on the shoulder of the Information Superhighway, and a shortwave listener of fifteen years and I can't figure out what the Hell these articles are about! I think I'll spend my money on something else, thank you. *Chris Black-Oregon*

■ Congradulations on getting the newest Grove publication out on time. As a TVRO owner with SCPC capability, I found the center section, "Satellite Services Guide", very useful and informative. I do have one suggestion that I would like you to consider. How about making *Satellite Times* a monthly magazine like *Monitoring Times. Tim Dobbins-Florida*

■ I have read through the first issue of *Satellite Times* and like it very much. My subscription has already been sent in. *Gus Stellwag- New York*

■ I am glad that Bob Grove has the foresight and courage to launch *Satellite Times.* I wish you success. *Armando P. Pasquini-Mexico*

■ Excellent Magazine! *Don Henry-Canada*

ST

SWAGUR Enterprises

Box 620035 - Middleton, WI 53562-0035
Voice - Fax Phone 608-592-7409

The SWAGURSAT allows the owners of ICOM R7000 & R7100 receivers to receive WEFAX images in full resolution (i.e. 40 KHz). The SWAGURSAT is in use all over the world. It has received favorable reports in several magazines. Many feel the SWAGURSAT approach is the more cost effective because you do not have to invest funds in a dedicated receiver which will only listen from 137 to 138 MHz. The SWAGURSAT allows you to use a general coverage receiver which can be used on many other frequencies as well. The cost of the SWAGURSAT is only $220.00 plus $8.75 US ($25.00 foreign) shipping & handling.

SWAGUR-AMP. This is our new Low Noise Amplifier (LNA). It covers the range of from 1500 to 1700 MHz. It has a noise figure of 0.7 dB, a gain of 35 dB and it is powered by 12 volts DC which is supplied to the LNA through its feed line (coax). It is 2-5/8 inches long, 1-7/8 inches wide and 1 inch deep. It is rigidly mounted to our feed horns with an "L" bracket thereby reducing the strain on the "N" connectors. The cost of the SWAGURAMP is only $199.95 plus $8.75 US ($25.00 foreign) shipping & handling.

SWAGUR-HORN. - C. This feed horn was developed to be used with a satellite dish. It receives circularly polarized signals, like those sent by orbiting satellites. It also receives linearly polarized signals. You can attach your own Low Noise Amplifier (LNA) or purchase one from us. The feed horn measures approximately 6-1/8 inches in diameter by 5-1/8 inches long. It has a single "N" connector on its back plane. Why spend a lot of money on a combiner, lossy connectors and matching sections when receiving the polar orbiters or GOES satellites? The cost of the SWAGURHORN - C is only $120.00 plus $8.75 US ($25.00 foreign) shipping & handling.

SWAGUR-DISHES. Our satellite dishes range in size from 2 feet to 10 feet. The dishes are all painted, spun solid aluminum. They can be purchased with or without a mounting ring attached. We also supply polar mounts and struts for mounting feed horns. We can provide complete dish assemblies. These assemblies can include a feed horn and low noise amplifiers. Prices vary according to your requirements. A 2 foot dish without mounting ring is $27.00 while a 10 foot dish with polar mount, feed horn and struts is $715.00. Shipping and handling depends upon dish size.

SWAGUR-HOODS. Our camera hoods allow you to photograph your computer or television screen without the usual problems. These hoods give the camera a steady base and focusing becomes very easy. The hoods block stray light and glare from reflecting into the camera lens. These hoods work with your 35mm camera or we can supply a special Polaroid camera for black & white or color instant pictures. Prices range from $70.00 to $550.00. Our hoods fit most 35mm cameras. Shipping and handling charges depend upon the size of hood you want.

WEFAX SOFTWARE. We can provide OFS WeatherFAX software for use with your image capturing system. The cost of the new PCMCIA (credit card) plug-in card and software for laptop computers is $495.00. This card will also work with desktop computers if you use the buss adapter board. The original WeatherFAX card for desktop computers is still available for only $445.00 which includes the software.

SPECIAL OF THE MONTH

The INMARSAT Special. One feed horn, one LNA, one 4 foot dish with polar mount and feed horn mounting struts. Price $413.95 Plus S&H **This offer expires December 1, 1994**

By Wayne Mishler, KG5BI

TELECOMMUNICATIONS INDUSTRY BOOMING

The world-wide satellite telecommunications industry, fueled by consumer demands for more and better video and audio links, is booming. The number of satellites launched by entertainment and business corporations continues to increase. Many launch services are booked through the remainder of this century. Engineers are developing new technology that promises to boost business communications beyond imagination. Career specialties are emerging in satellite production and ground control. The demand for putting new and better satellites in orbit is creating a growing market for launch services. This trend is expected to increase and set the pace for an industrial space race in the 21st century.

In the U. S., companies to watch include Hughes Aircraft Space and Communications Group, Space Systems/Loral which has European connections, and Martin Marietta Astro Space. Hughes is developing satellite-based tele-imaging for the medical field, video telephone and conferencing for the corporate world, and CAD/CAM data transmission.

Internationally, there are numerous companies pursuing satellite communications projects, including Alenia, Alcatel, Aerospatiale, British Aerospace, Deutsche Aerospace, Matra-and Marconi, and Spar.

NASA STRUGGLING TO LEAD WAY

While the industrial space program is soaring, NASA continues to struggle with stringent funding and political maneuvering by Congress. NASA requested $50 million for development of small spacecraft technology which appears to the be wave of the future in earth imaging and telecommunications. Congress wants to give them only $12 million on the premise that private industry should pick up much of the tab because telecommunications corporations would benefit from the technology.

NASA projects that would be affected include two earth imaging satellites about the size of a console television set that would electronically remove cloud cover while photographing the earth. Perhaps more important, the projects would blaze a trail to new technology, new commercial markets, and new approaches to contracting. The idea is promising but too uncertain for industrial leaders who are looking to the government to bear the financial risks involved in research and development.

LOW ORBIT BIRDS ARE WAVE OF FUTURE

Soon you'll be able to speak with or send computer data to someone on the other side of the world through a satellite using a hand-held mobile phone that fits in your pocket.

Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellite networks will let us enjoy global mobile telephone service with voice and data transmission by 1996, says the U. S. Department of Commerce. These flexible networks will also provide two-way electronic mail using hand-held computers, communications for rescue operations, recovery of stolen vehicles, maritime communications, and more.

There are several LEO/MEO global telephone projects underway today. Motorola will be encircling the earth with 66 such satellites, linking pocket phones, computers, pagers, and fax machines. The Orbital Communications Corporation will be operating a network of 36 LEO satellites and several ground support stations worldwide. TRW plans on placing MEO satellites in orbits that keep them above the horizon and reduce shadows of earth structures.

NEW TECHNOLOGY IMPROVES PHONE SIGNALS

Smart handheld phones automatically selected the best link among several satellites in recent tests by the International Maritime Satellite Organization (Inmarsat). This seems to solve the problem of interference caused by the shadowing effect of trees and buildings.

The Inmarsat system will employs a dozen or so satellites in intermediate circular orbit (ICO). The intent is for two or more of the satellites to be accessible to a user at any given time. Circuitry in the system's handsets combine signals from all available satellites, resulting in stronger, clearer reception.

In the tests, staged at Ipswich, England, two aircraft flew overhead transmitting separate signals generated by special equipment, simulating orbiting satellites. On the ground, a handset operated by researchers automatically switched itself to the best signal. The tests were repeated several times with the handset located in outdoor urban and rural environments and inside buildings with equal success.

Inmarsat plans to use this new technology to provide users worldwide with handheld telephone, fax, computer data, and other services. Set-up cost is expected to be about $2.4 billion.

LONG ARM OF LAW EXTENDS REACH BY SATELLITE

Beware: satellite images may now be used against you in court.

In one recent case, satellite cameras - - capable of zooming in on a spot less than half the size of a city lot – detected land-use violations in Florida. The resulting photographs were used by the South Florida Water Management District to document the case. The defendant settled out of court, repaired damages, and paid a $650,000 fine.

Surveillance by satellite has proven to be less expensive and less time-consuming than conventional types.

FCC APPROVES U. S. COMPANIES FOR DBS SERVICES

The Federal Communications Commission has approved nine U. S. companies to launch and operate direct broadcast satellite (DBS) systems in this country. Local distributors are already advertising this service, which for a monthly fee gives subscribers hundreds of television channels by satellite using an 18-inch antenna dish.

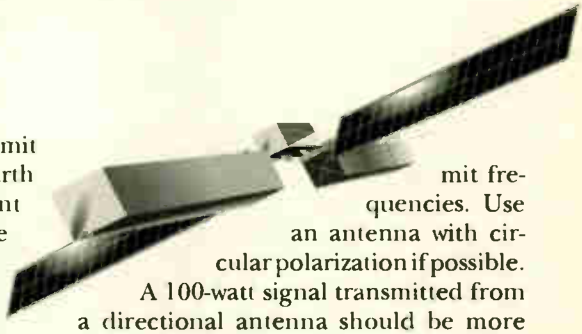
Approved are the Advanced Communications and Direct Broadcast Satellite corporations of Washington, the Continental Satellite and Hughes Communications Galaxy corporations of California, the Directsat corporation of Virginia, the Dominion Video Satellite corporation of Florida, the EchoStar Satellite and Tempo Satellite corporations of Colorado, and the U. S. Satellite Broadcasting Corporation of Minnesota. Numerous other companies are entering the DBS market.

The first DBS satellite, Hughes DBS-1 satellite, went into orbit in late 1993. The second DBS satellite (DBS-2) was launched in August of 1994. There are plans to launch several others by 1996. Three geosynchronous orbital slots are available with a combined capacity of more than 1,000 channels through digital compression technology.

DBS has been in operation in Europe for several years, and is the market is growing in other nations of the world. About 5 million households in Japan have DBS. That nation's Ministry of Posts and Telecommunications says the number will grow to 20 million by 1998.

HAMS HAVE ACCESS TO EARTH IMAGING SATELLITE

NASA will launch South Africa's first satellite with amateur radio capabilities in January of 1966. The Stellenbosch University Satellite (SUNSAT) will transmit high-resolution stereo images of the earth and will carry amateur radio equipment enabling hams to contact the satellite in orbit which will make it a popular educational tool for school children.



UNIQUE QSL CARD AVAILABLE TO HAMS AND SWLS

Amateur radio operators and shortwave listeners may have an opportunity to get QSL cards from the Toronto VHF Society (VE3ONT) which will be transmitting via satellite during the four-day 1994 EME Contest this fall.

Hams who wish to participate in the contest must send an EME contest entry to the ARRL, which is sponsoring the contest. SWLs need only send reception reports to the club which will respond with QSLs. Send ham QSL cards and reception reports with self-addressed envelope to Dennis Mungham, VA3SO, RR 3, Mountain Ontario, Canada KOE 1SO.

VE3ONT will be on the air November 26 and they will transmit on 144.100 MHz and listen for callers between 144.1 to 144.110 from 0538 to 1645 UTC. They'll be operating those same frequencies again November 27 from 0646 to 1713 UTC.

They'll be using the 46m Algonquin Park dish (grid square FN05xw) with a 9-degree lower elevation limit, which may reduce chances for ham stations with fixed antennas in eastern North America.

Hams should call them on a frequency in their listening range, not on their transmit frequencies. Use an antenna with circular polarization if possible.

A 100-watt signal transmitted from a directional antenna should be more than enough to work them on 144 MHz.

KIRTLAND AFB BECOMES SATELLITE CONTROL CENTER

Kirtland Air Force Base at Albuquerque, New Mexico, may soon become a center for controlling U. S. research satellites worldwide. The project has been allocated an annual budget of $120 million. Two new laboratory buildings are being built at Kirtland which is preparing for the arrival of several hundred scientists, researchers, and workers who will operate a control center similar to but smaller than NASA's Johnson Space Center mission control.

Controllers will direct the movements of research satellites around the world from computer terminals at the Kirtland center. Scientists at Phillips Laboratory at Kirtland will work with other teams in developing, testing and evaluating the performance of new satellites. The Rocket Systems Launch Program Office will direct launch services for the military. The Space Test and Small Launch Vehicle Programs Office will manage the Pegasus system of launching satellites on rockets fired from aircraft. The Space Test and Evaluation Directorate will monitor and test satellites in orbit.

OLDEST RADIO STATION GOES SATELLITE

One of the world's oldest radio programs about international broadcasting is now being relayed to Europe by satellite. Weekday broadcasts are at 1615, 1730, 2130 and 2230 UTC. There is also a weekend broadcast at 2030. The broadcasts are being carried by Astra 1B, transponder 26 (Sky Movies Gold), 19.2 degrees east, 11.597 GHz with audio subcarrier

7.74 MHz. You'll also find them on Tele-X and Sirius, 5 degrees east, 12.475 GHz and 11.938 GHz with audio subcarrier 7.38 MHz.

In other European developments, Sky reports changes on its Astra transponder 47. It's going from a preview channel to weekend sports encrypted in videocrypt free to subscribers.

Sky says it's adding more channels effective September 30. Programming may include a travel channel. Expect an increase in subscription fees.

EUTELSAT CARRIES ALGERIAN TV AND RADIO PROGRAMS

Algerian television and radio programs are to be carried by Eutelsat beginning August 20, beamed at North Africa, Europe, Russia and the Middle East. A ground station for the project was being prepared in mid-August, and broadcast negotiations were being completed between Algerian TV and Telecom Holland.

The announcement appeared on television screens tuned to Eutelsat, located at 16 degrees east, with transponder frequency 11680 MHz (horizontal polarization) and subcarriers 6.65, 7.02 and 7.20 MHz.

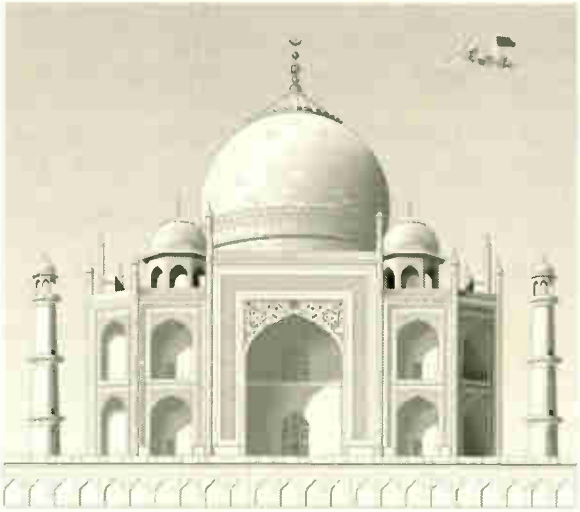
BRAZIL SATELLITE IMPROVES TELECOMMUNICATIONS

Brazil has a new domestic communications satellite. Brasilsat-B1, operated by Embratel, is to improve telephone, television signals and computer data transmission. Another Embratel satellite, Brasilsat-B2 is scheduled to be launched in November.

Brasilsat-B1 replaces an earlier satellite launched in 1985. It has 28 C-band transponders, and an X-band transponder for use by the military.

INDIA INCREASES SATELLITE FOOTPRINT

India plans to lease transponders on three satellites scheduled for launch next year. They are the U.S. PanamSat (PAS-4)



and Hong Kong Apstar-1 and Asiasat-2. The intent, sources say, is to establish a footprint reaching from the Middle-East to China.

PAS-4 is to be positioned over the Atlantic Ocean somewhere between 8 and 72 degrees east and may be linked with three others to establish a service known as the "satellite highway." By leasing a transponder on any of the linked satellites, India could reach all parts of the earth covered by the combined footprint.

Apstar-2, 77 degrees east, and Asiasat-2, 100.5 degrees east, cover a large footprint in Asia.

IRAN: HEAVENLY BIRDS CARRY DEMONIC MESSAGE

While telecommunications shrinks distance, social and cultural barriers for most of the world, Iranian clergy proclaims it as a cultural onslaught against the Islam religion. In a sermon broadcast by the Voice of the Islamic Republic of Iran in mid-August, the Ayatollah Mohammed Emami-Kashani, spokesman for Iran's Guardian Council, warned that telecommunications programming would inflict psychological and spiritual blight on the youth of Iran, draining life from them, and making them mentally unbalanced.

"Just as the West has plotted against us through culture, we must confront the satellite with culture. Let the young people see the treachery parents (who let their children watch satellite television) are committing. What a crime they are committing against their own children!"

Meanwhile, the people of Tehran's Ekbatan district clashed with agents confiscating satellite dishes. Residents battled with agents and encountered police who opened fire and arrested several protestors.

Saudi Arabia earlier this summer banned satellite dishes and gave residents one month to get rid of any they owned. However more recently the *Arab News* reports that Muhammad Ali is urging Islamic entities to support an international Islamic satellite television channel to counter Vatican satellite programming. Stand by for Islamvision.

TAX ON SATELLITE DISHES? SHHH...DON'T TELL CONGRESS!

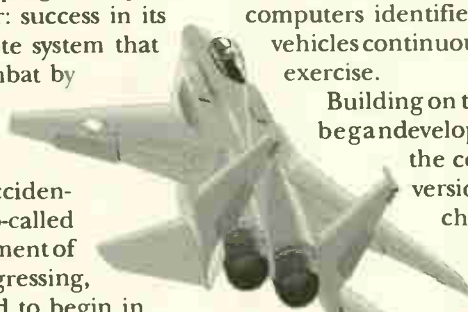
The Moroccan parliament this summer approved a tax on satellite dishes in that country. The tax will be equivalent to about $500 dollars in U. S. currency. Opposition to the tax says it will give the government leverage in controlling programming, claiming that Morrocans with low incomes will no longer be able to receive news from abroad.

SRI RADIO HEARD ON ASTRA BIRD

The new Swiss Radio International continuous broadcast service in English is being heard from the Astra satellite, 19.2 degrees east, transponder frequency 11332 MHz, with subcarrier frequency 7.56 MHz. In addition, the satellite's 7.38 MHz subcarrier continues to carry radio programs in Arabic, English, French, German, Italian, Romansch and Spanish.

SATELLITE SYSTEMS MAY END DANGER OF "FRIENDLY FIRE"

The U. S. Navy is hoping for a special Christmas gift this year: success in its testing of a new satellite system that could save lives in combat by tracking and identifying friendly forces at risk of being mistaken for the enemy and accidentally gunned down by so-called "friendly fire." Development of this technology is progressing, and tests are scheduled to begin in December.



Experts say this technology could have prevented the accidental downing of U. S. helicopters by U. S. F-16 fighters in Iraq. There is hope that it will prevent similar tragedies in the future.

The technology, dubbed SABER, employs special satellite beacons that broadcast two-way positional telemetry to mobile sites on the ground. SABER is a military acronym for Situational Awareness BEacon with Reply.

SABER uses data from existing Low Earth Orbiting (LEO) navigational satellites. It derives positional information from this data, tags this information with unique identification codes, and imposes these codes on unused portions of satellite down-link frequencies, which broadcast the codes to transceivers connected to computer terminals at mobile ground installations.

The transceivers allow commanders to control the beacons by radioing commands back to the transmitting satellites. The beacons can be selectively activated, deactivated, polled, or varied to reduce detection by hostile forces while updating commanders on the positions of their troops. The terminals can be based at mobile command posts on the ground, in the air, and aboard ships. They give commanders continuous real-time pictures of where friendly troops are positioned.

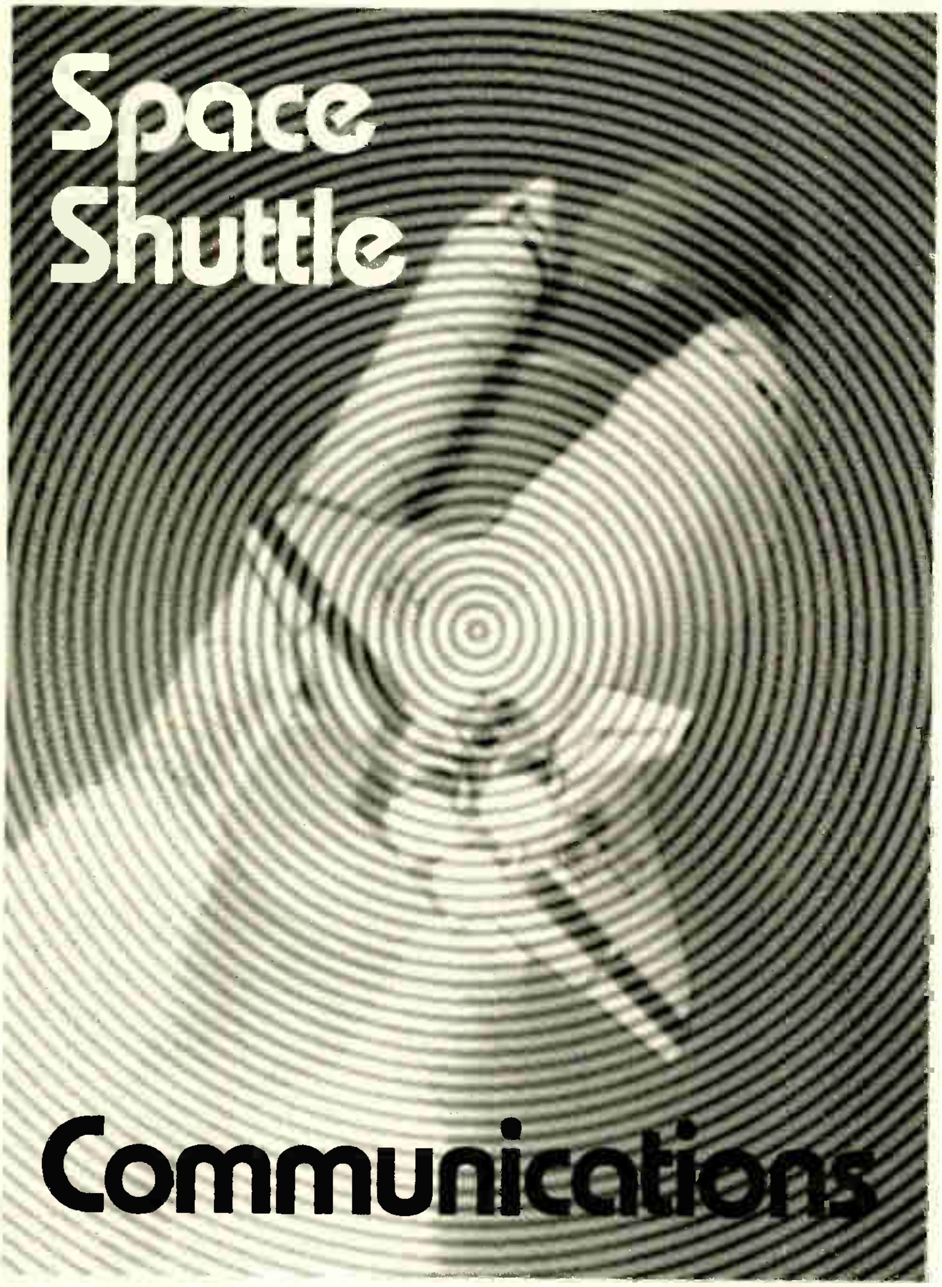
The idea grew out of tests at the U. S. Army Armor School at Fort Knox, Kentucky. In the tests, four beacons were transmitted from mobile ground vehicles to a satellite down-linked to desktop computers in a field tent. The computers identified and tracked the vehicles continuously throughout the exercise.

Building on those tests, the Navy began developing and improving the concept. The Navy's version will use geosynchronous satellites. There are plans to use thousands of beacons to track the large numbers of tanks, ships, aircraft, and other war platforms that would be deployed during a war.

The Naval Air Warfare Center developed a way to transmit beacons under the noise level of satellite transponders. This allows large numbers of beacons to be broadcast without interfering with transponder operation.

Sources: Albuquerque Journal, Aviation Week & Space Technology, Toronto VHF Society, BBC Monitoring Service, U.S. Naval Space Command

Space Shuttle Communications



By Kirk Kleinschmidt, NT0Z

US space shuttles have been lifting off for more than a decade, and unless something akin to the Challenger disaster catches our eye, it's safe to say that shuttle missions are almost becoming routine for the masses. But before you relegate the world's premier orbiter to ho-hum Boeing 747 status, let me remind you that shuttle communications—audio, video and more—are fun and easy to listen in on, and they're unlike any other communications you'll likely intercept.

Technologically, the shuttle-support communications system—including NASA's sophisticated tracking and data relay satellite system—comprises one of the most advanced communication systems anywhere. Besides (assuming you're a taxpayer), you pay for it, so you might as well switch off the Nintendo every now and then and see "what's up!"

When discussing the shuttle electronics and communications systems , it's easy to get in over our heads. An in-depth treatment of the topic could (and does) fill thousands of pages. In this article we'll look at the system from a listening enthusiast's point of view: a system overview, how it work—and how to listen in! And don't worry, techno-junkies, there's plenty for you, too.

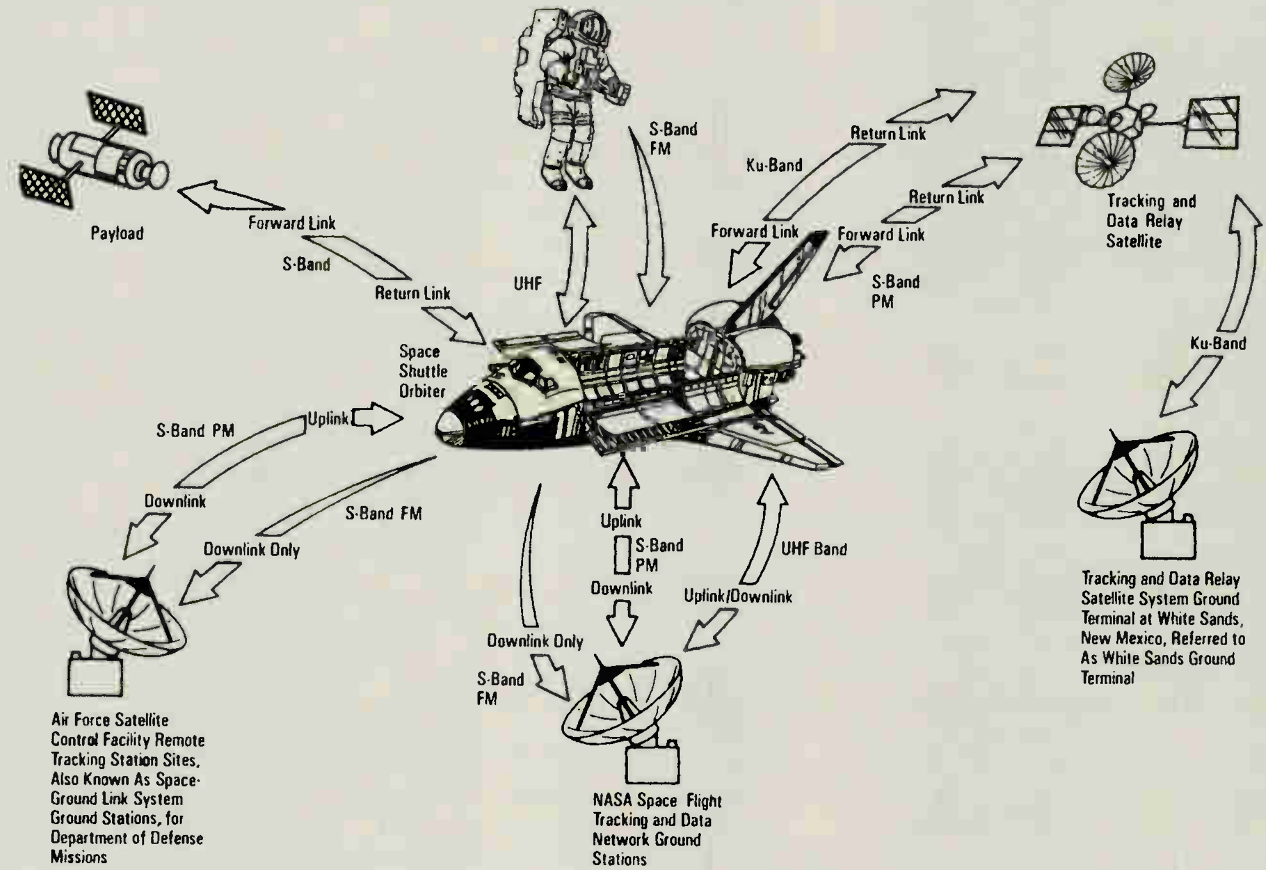
System Overview

Although we'll get into more detail later on, here's a look at the shuttle's main communications systems and requirements:.

Telemetry on the orbiter's conditions, configuration and payloads is a prime contender. The shuttle's 2500 monitored data points add up to a lot of data!; *commands* from ground controllers are sometimes required to reconfigure systems aboard the shuttle or to command various functions; *documentation* and other graphical matter needs to be exchanged with astronauts; and let's not forget about two-way voice traffic between the astronauts and earth! But that's not all: Among other systems, there's a microwave *ranging* system to fix the shuttle's exact position, a ranging system to assist orbital docking or "orbital matching" maneuvers, and a UHF AM system for linking astronauts who are outside the shuttle in spacesuits during extra-vehicular activities (EVA).

NASA uses several radio systems to transfer data back and forth. Exact frequencies are listed in the "Shuttle Frequencies" sidebar. The most basic system is a UHF AM simplex system. The UHF link operates directly between the shuttle and the various

Space Shuttle Orbiter Radio Frequency Links



ground-based tracking stations (or between the shuttle and astronauts who are outside the shuttle or in an open cargo bay). Because the shuttle orbits the earth about once every 90 minutes, direct UHF links to the shuttle are infrequent and fleeting (the UHF system handles a lot of launch and launch-preparation traffic).

The shuttle's S-band microwave data link (a phase-modulated system used for voice, telemetry and computer-to-computer linking) can also talk directly to ground stations, as can the S-band FM downlink. The S-band system can also link directly to Air Force satellite earth stations during military missions so the department of defense can talk to its payloads. The S-band system is also used to talk to payloads that the shuttle astronauts may have just launched, and to the telemetry computers in the spacesuits of astronauts who are EVA. There are about a dozen ground stations worldwide that make up the soon-to-be-obsolete (or consolidated) spaceflight tracking and data network (STDN).

Handling radio traffic while the shuttle is in orbit (ever since STS-9 in 1985) is the responsibility of NASA's orbiting switchboard, the tracking and data relay satellites that make up the tracking data relay satellite system or TDRSS (pronounced "tee-dris").

TDRSS now has five geosynchronous satellites (four working, one spare) that cover about 90% of the shuttle's orbit. These satellites use sophisticated S- and K-band wideband links to relay data (digitized audio, video and data) between the shuttle and the TDRSS ground terminal in White Sands, New Mexico. From White Sands, data is passed to NASA's worldwide telephone, microwave and satellite communications net (NASCOM), which links every involved NASA facility (and many others).

Before we look at each system, let's take a short ride on the shuttle and examine how and when some of the shuttle communication systems are used.

A Quick Ride

Getting the shuttle and its communication systems to orbit is no small feat. At rest on the launch pad at Florida's Kennedy Space Center, a typical space shuttle (mated to its re-usable booster) weighs in at a healthy 4.5 million pounds. Getting things off the ground requires a lot of power—more than 14 million newtons of thrust.

At lift-off (after a typical three-day countdown) from Florida's Kennedy Space Center (the usual launch facility), the shuttle's S-band system talks to ground controllers through the Merritt Island, Ponce de Leon and Bermuda STDN tracking stations ("local" STDN stations that support Kennedy launches). Once the shuttle can no longer be "seen" by the Bermuda station, ground controllers route shuttle communications (S- and K-band) through the nearest TDRSS bird, which relays everything

Listening to Shuttle Communications

Because of the technology involved, you might think that listening to the shuttle is difficult or expensive. In truth, listening in could hardly be easier. NASA and friends provide a variety of ready-made audio and video monitoring opportunities. Hardware requirements range from an inexpensive shortwave or Amateur Radio receiver, to a backyard satellite TV system—even your local cable TV system! Here are the details:

NASA TV

The service that provides the juiciest shuttle coverage is also one of the easiest to receive. NASA TV (formerly called NASA Select) produced its first broadcast on July 1, 1991, and was started as a way to keep journalists and others interested parties supplied with real-time shuttle video and audio.

NASA TV broadcasts live "launch to landing" shuttle communications—video and audio from the shuttle and from various ground-based control centers (it's the juicy stuff that comes down in digital form via TDRSS). Pre-mission briefings and other items of interest to the media are also covered.

When the shuttle is not in orbit, NASA broadcasts a repeating four-hour schedule of "Discovery Channel"-style programs on aeronautics, space exploration and space sciences. Programming gets underway each day at noon Eastern Time. (Okay, I confess: NASA TV *is* interesting. I often have it on in the background in my office.)

To receive NASA TV, tune your C-band satellite TV system to satellite S2, channel 9, 6.8 audio. If you don't have your own dish, chances are fair that your local cable TV company carries NASA TV, especially during shuttle missions (at press time there's at least one cable system in every state that does so).

For more information on NASA TV, write to NASA TV, NASA Headquarters, 300 E St NW, Washington, DC 20546. (Also see the story in this issue on NASA Select TV-editor)

The Goddard ARC

Members of the Goddard Space Flight Center's Amateur Radio Club (the Goddard ARC, WA3NAN) volunteer their time to "rebroadcast" shuttle audio from launch to landing during each shuttle mission (it's the same audio that's broadcast by NASA TV).

If you have a shortwave or ham radio receiver that can tune SSB signals on any HF ham band, you can probably hear the Goddard station, located in Greenbelt, Maryland. During shuttle missions, try these frequencies (upper or lower sideband, as appropriate), listed in MHz: 3.86, 7.185, 14.295, 21.395, 28.65 and 147.45 MHz FM (local).

SAREX

Did you know that most of the astronauts who fly aboard US shuttles are ham radio operators? Yep, it's true. The ham astronaut craze started more than a decade ago with the Shuttle Amateur Radio Experiment (SAREX), sponsored by NASA, the American Radio Relay League (ARRL, the national organization of ham radio operators), and the Radio Amateur Satellite Corporation (AMSAT, an organization of volunteer space scientists and members that designs, builds and orbits Amateur Radio satellites).

The idea was to take a small 144-MHz hand-held Amateur Radio transceiver aboard the shuttle so astronauts (in their free time) could talk to hams on earth—especially those assisting children at designated schools around the world.

The idea was a smashing success, and now, more than 10 years later, shuttle astronauts routinely talk to students and hams all over the globe. It's turned into one of NASA's high-visibility PR programs and it gets kids thinking about space sciences careers. Some missions have even used ham radio visual modes such as slow-scan and fast-scan TV, and all present SAREX-equipped missions maintain a packet (ham radio digital mode) "robot" that works hams automatically "keyboard to keyboard."

When the shuttle is in range, you can listen to the action on the 2-meter ham band. Try these frequencies (in MHz): FM voice uplink channels: 144.91, .93, .95, .97, .99 (if you're a ham and can legally transmit!): FM voice downlink: 145.55. When the packet robot is active, the uplink is on 144.49 MHz, with a downlink on 145.55 MHz (the only 2-meter downlink from the shuttle).

If you hear or work the astronauts from the shuttle, you can send your log information to ARRL and receive a QSL card confirming reception. New cards are often designed for each SAREX mission—they're very collectable!

For more information about SAREX and how you can participate (or to claim your shuttle QSL card), write or call ARRL, Educational Activities Department, 225 Main St, Newington, CT 06111; tel 203-666-1541.

The next scheduled SAREX mission is the 14-day STS-67, scheduled to lift off January 12, 1995, with four ham astronauts aboard. Veteran ham Ron Parise, WA4SIR, will be flying on this lengthy *Endeavour* mission. Why not listen in?

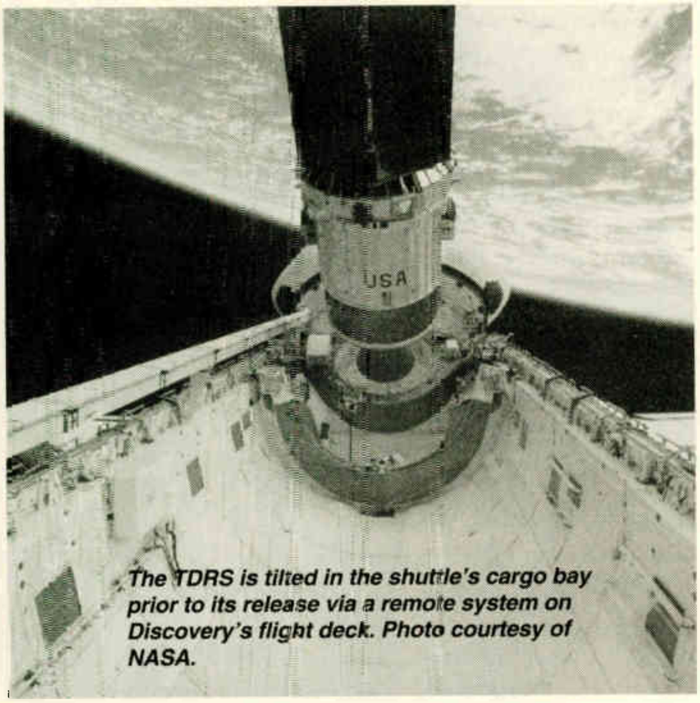
Computer Resources

For information about shuttle launches, missions and SAREX, and satellite (shuttle) tracking software for your desktop PC, try the following computer bulletin boards:

The ARRL maintains a five-line BBS that features satellite tacking software and regularly updated SAREX mission bulletins (in addition to thousands of ham radio-related files). To reach the system, dubbed *Hiram* after the ARRL's founder, have your computer call 203-666-0578 (8N1, up to 14.4 kbits/s).

There's also lots of interesting stuff on NASA's Spacelink BBS. Try it at 205-895-0028.

If you subscribe to *CompuServe, GEnie*, or one of the other popular computer services, you can prowl around their ham radio and satellite TV areas as well.



The TDRS is tilted in the shuttle's cargo bay prior to its release via a remote system on Discovery's flight deck. Photo courtesy of NASA.

to the White Sands ground terminal and on through the NASCOM network. During the switch-over, computers in the orbiter and on the TDRS first adjust their respective antennas to peak the S-band signal. Once that's done and the S-band link is reliable, the cargo bay doors are opened and the computer activates the K-band system, which is harder to "aim" but can transfer more and varied data.

As the shuttle goes round and round the earth, its communications are routed to White Sands via the nearest TDRS . When the shuttle is behind the part of the earth that TDRSS can't see (NASA's "zone of exclusion"), the shuttle orbits "on its own" or relies on quick links with the older ground-based STDN stations. TDRSS is designed to cover at least 90% of the shuttle's orbit, limiting the shuttle's "out of range" time to 15 minutes or less of each 90-minute orbit. Remember: TDRSS orbits at 22,300 miles compared to a typical low-earth-orbit of 160-200 miles for the shuttle. TDRSS can "see around corners" (the curve of the earth as viewed from the shuttle), requiring only two TDRSS birds to support the system.

TDRSS can also relay signals from shuttle-launched payloads to NASA or to the military. If astronauts working outside the shuttle (fixing the Hubble Space Telescope, for example) need to talk directly to scientists on the ground, their UHF communications are relayed to TDRSS via the shuttle. Thanks to extensive computerization, the whole system is virtually seamless.

The landing process works roughly in reverse, except during the dramatic reentry period when radio communications are wiped out. When the shuttle is approaching its landing strip and flying like an airplane, telemetry and voice communications go direct—there's no further need to relay via satellite.

Now that we've taken a quick spin, let's look at the component systems in a bit more detail.

Shuttle Communications Systems

As mentioned earlier, the shuttle communication system handles the formidable tasks of ferrying telemetry, command and control signals, voice, video and other data between the shuttle and its ground controllers.

This system is divided into several subsystems: S-band (FM and PM), K-band, UHF, payload communications, audio and closed-circuit TV. The orbiter's on-board systems distribute audio, video and data signals throughout the craft and its various payloads (to communication panels, headsets, microphones, computers and so on.

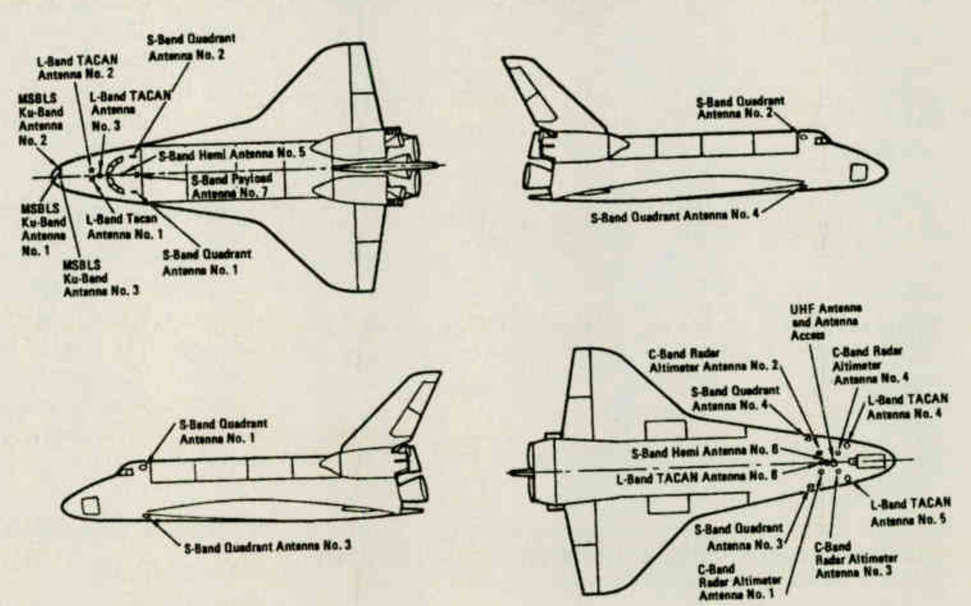
Unless manual control is selected, and to allow the astronauts maximum flexibility, the shuttle's computer system selects and peaks antennas, chooses transmitters and records and processes data. A built-in security system can transmit data "in the clear" or encrypted.

Shuttle Signal Processing

Sending and distributing telemetry data, voice, video and graphics through the shuttle's various radio systems is the job of two network signal processors (NSP). One is primary, the other a backup.

The NSP receives one or two audio voice channels from the shuttle's audio control system (depending on whether the data link is in high- or low-speed mode) and converts them to digital data. Time-division multiplexing is used to mix the digitized

The Shuttle is Loaded with Antennas!



audio with the other telemetry and data streams prior to transmission.

The reverse happens when signals are received from the ground or via TDRSS. Incoming command data is decoded and routed to the shuttle's computer, while "mixed-in" digital voice signals are decoded, converted to audio and routed to the audio distribution system. The system is similar to the second-generation cell phone systems now being tested.

The S-band System

The shuttle's S-band system (two complete systems operating between 1.7 and 2.3 GHz, one using phase-modulated FM [PM], the other using standard FM) is a real workhorse. The PM system transmits and received data from ground controllers (directly or through TDRSS). Each system has redundant backup transmitters and receivers to allow for flexibility and for emergencies.

The S-band forward link frequencies (designating communications going to the shuttle, from the ground or via TDRSS) are 2,106.4 MHz (primary) and 2,041.0 MHz (secondary). Two forward-link frequencies allow two shuttles to orbit simultaneously.

S-band return-link frequencies (designating communications going from the shuttle to the ground, directly or via TDRSS) are 2,287.5 MHz (primary) and 2,217.5 MHz (secondary). Again, two return-link frequencies allow for multiple orbiters.

In high-speed mode, the PM forward link operates at 72 kbits/s (two air-to-ground voice channels at 32 kbits/s each and one 8 kbits/s command channel, plus two-way Doppler and two-way ranging signals). In slow-speed mode, the system operates at 32 kbits/s (one 24-kbits/s two-way voice channel, an 8-kbits/s command channel, plus Doppler and ranging signals). Two-way ranging does not operate through TDRSS.

The S-band PM return link has more horsepower to carry shuttle telemetry:. It's 192-kbits/s system supports two 32-kbits/s voice channels, one 128-kbits/s telemetry link, plus two-way Doppler and two-way ranging signals. A low-speed mode drops one voice channel and halves the telemetry data rate.

The S-band FM system is used only to downlink data (from seven sources, one at a time) directly to STDN ground stations. Redundant transmitters are used; the frequency is 2,250.0 MHz.

Systems downlinked by the S-band FM system include three space-shuttle main-engine interface units (SSME), orbiter video, operations recorders and payload recorders (analog and digital). The system's maximum data rate is 1,024 kbits/s. The S-band FM system does not operate through TDRSS and is used primarily for launch, lift-off, ascent and landing.

Shuttle Frequencies

System	Frequencies
S-band, phase modulated data	
forward link	2,106.4 MHz primary; 2,041.0 MHz secondary
return link	2,287.5 MHz primary; 2,217.5 MHz secondary
S-band, FM data	
return link only	2,250.0 MHz
K-band, FM data, via TDRSS	
forward link	13.775 GHz
return link	15.003 GHz
UHF AM simplex voice	
primary	296.8 MHz
secondary	259.7 MHz
emergency	243.0 MHz
EVA only	279.0 MHz

Note: direct monitoring of the shuttle's UHF simplex channels is possible, but because most shuttle communications go via TDRSS, and because overhead shuttle passes are so short, reception is challenging at best. Receiving (and decoding) the S- and K-band downlinks is probably impossible because of the narrow spot beams used in transmission and because of the high-tech multiplexed encoding.

The K-band System

The shuttle's high-performance K-band system operates from 13 to 17 GHz and is used exclusively to communicate vis TDRSS. The K-band antenna system is housed in the shuttle's cargo bay, limiting its use to periods when the shuttle is in orbit and the payload bay doors are open.

When the K-band antennas are deployed, the shuttle's communications processors use the K-band system (which uses a digital modulation system similar to the S-band system, but can handle much more data) to route signals between the shuttle and the ground via TDRSS. If the K-band link is lost, the system defaults to using the more robust S-band links.

The K-band forward-link frequency is 13.755 GHz; the return-link frequency is 15.003 GHz. As mentioned, the wideband multi-channel data system can handle lots of data. The maximum data rate exceeds 50 Mbits/s, compared to 1 kbits/s for the S-band system.

One interesting feature of the K-band system is its "ejector seat." Because the cargo bay doors must be closed prior to reentry, if the K-band antenna can't be returned to its "stowed" position, a blade chops the cables and releases the antenna mounting clamp, banishing the dish and its electronics to space!

The K-band system can also function as a search radar for finding space-borne objects, closing with them, matching orbits and even docking. Various modes offer radar ranges from 100 feet to 300 miles.

The Payload Communications System

This system transfers information to and from payloads and the shuttle using RF and hardwire links. Payloads need to be activated, checked out and commanded. Primary users are NASA and the DOD. Others users include various satellite consortiums, industry and foreign governments.

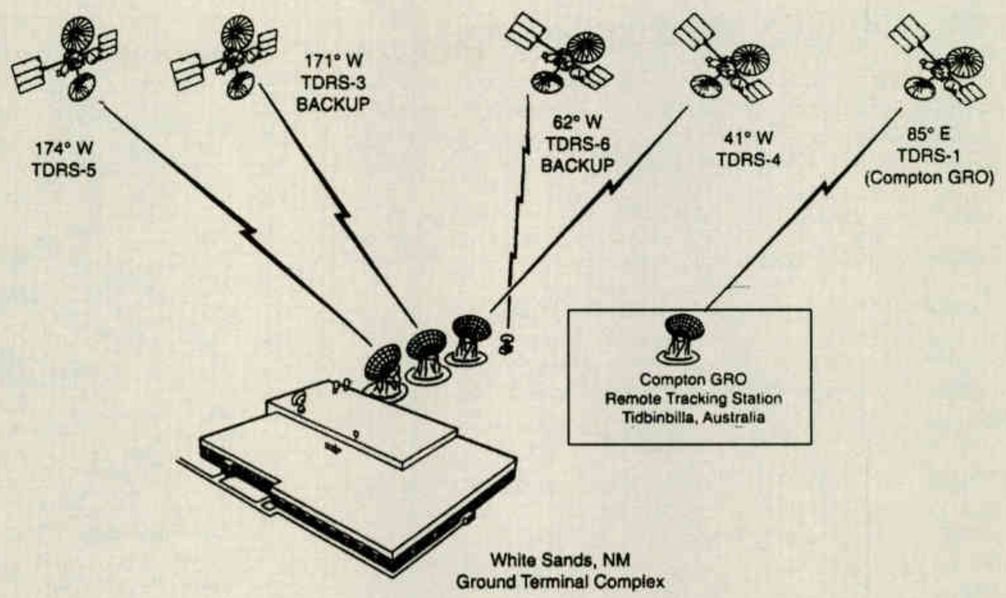
After going through the shuttle's communications processors, payload system signals can be routed to earth via TDRSS or via the S-band system.

The UHF AM System

The shuttle's UHF is mostly a "low-tech" backup system providing audio communications with "outdoor" astronauts and STDN ground stations. It's a simplex system (259.7 MHz primary, 296.8 MHz secondary) that allows only one "person" to transmit at a time. The system can also send and receive on the UHF emergency frequency (243.0 MHz) and has one frequency that only works between the orbiter and EVA astronauts (279.0 MHz).

The Space Flight Tracking and Data Network (STDN)

NASA's STDN was first set up to track and communicate with pre-shuttle spacecraft, including those of the Apollo program. Comprising about a dozen ground-based tracking stations scattered around the globe, the STDN includes a main terminal at White Sands (where the TDRSS terminal is housed) and is administered by NASA's networks division, headquartered at the Goddard Space Flight Center in Greenbelt, Maryland.



TDRSS and its White Sands ground terminal. Note that the older TDRS-1 is parked over the Indian Ocean and is controlled through an auxilliary site in Austrailia.

STDN sites worldwide are connected by NASA's comprehensive NASCOM network, but because STDN sites can cover only about 20% of each shuttle orbit, the STDN is being made obsolete by TDRSS. Eventually, the STDN will be consolidated to a minimum level (it's still required to launch and land shuttles).

In the 1970s, NASA scientists concluded that a satellite-based communication system could better handle space communications (and at a much lower cost compared to enlarging and maintaining the STDN).

A new era in space communications began with the STS-6 launch of TDRS-1 in 1983. The Tracking and Data Relay Satellite System was born!

The Tracking and Data Relay Satellite System (TDRSS)

TDRS is a space-communication network that provides communications, tracking, telemetry, data acquisition and command services for the space shuttle and many other low-earth-orbiting spacecraft. "Customers" other than the shuttle include the Gamma Ray Observatory, the Hubble Space Telescope and, if and when launched, the space station *Freedom.* NASA estimates that more than 70 billion dollars in space missions will depend on TDRSS before the end of the decade.

Functionally, TDRSS consists of a constellation of five satellites (two working, one spare, and two partially functional birds used for special projects) and a ground terminal located at White Sands, New Mexico (a second terminal is being built nearby to eliminate the possibility of a single critical failure).

TDRSS doesn't "process" client communications in either direction;.rather, TDRSS operates as a "bent-pipe" repeater, simply relaying signals to and from client spacecraft and the White Sands terminal. All data and signal processing is done there (for NASA missions) or at an outside client's own facility (linked to the White Sands terminal by NASCOM or a similar network). This eliminates the need for TDRSS to interpret and "handshake" with potentially encrypted client data or to waste time processing proprietary signals.

TDRSS is designed to handle 24 client spacecraft simultaneously, including the space shuttle! Its multiple-band data links can provide service at up to 300 Mbits/s–that's the equivalent of passing the entire contents of 300 14-volume encyclopedias every minute! Compare that to the average 14.4 kbits/s home computer modem!

In addition to providing S- and K-band data links (described earlier), TDRSS can also relay C-band signals in the 4-6 GHz range.

TDRSS Hardware

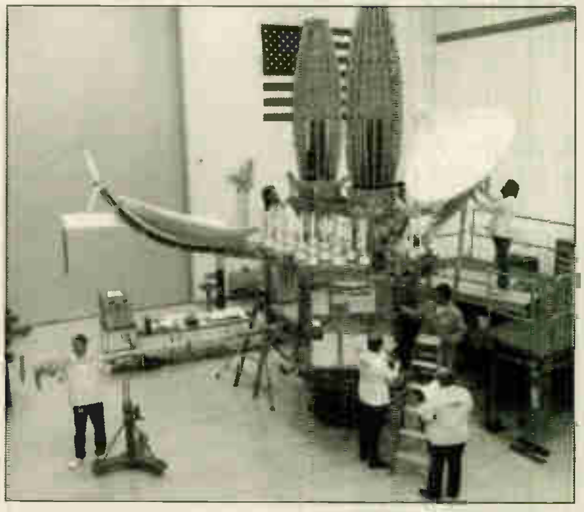
To reduce costs, TDRSs are built around three modules: equipment, communications and antenna. The equipment module houses the components that keep the satellite functioning: attitude and positioning controls, the power supply system (solar, 1850 watts with a 10-year lifespan) and thermal controls (heating and cooling). The payload module handles all communications, and it's loaded with transmitters, receivers and computers. The antenna module features seven complete systems: two single-access dishes; a multiple-access array; a space-to-ground link; C- and K-band antennas and an S-band omnidirectional antenna.

In orbit, a TDRS looks like a giant, double-ended fly swatter with dual, 16-foot parabolic dish antennas (the fly swatters are the solar panels!). These dishes, used by the satellites' single-

TDRS Status Report

Here's a brief look at the deployment history and present status of the five presently orbiting TDRS birds. Although there are five satellites total, only three are fully functional (two main birds and one spare):

Spacecraft	Launch Date	Status	Location
TDRS-1	April 1983	Partially functional	85° east
TDRS-2	January 1986	Destroyed in *Challenger* accident	
TDRS-3	September 1988	Partially functional	171° west
TDRS-4	March 1989	Fully functional	41° west
TDRS-5	August 1991	Fully functional	174° west
TDRS-6	January 1993	Fully functional	62° west



TRW technicians inspect TDRS-6 before it is shipped to NASA for launch on Space Shuttle Endeavor. Photo courtesy of NASA.

access systems, unfurl like giant umbrellas when deployed. They're mounted on flexible gimbals that let them track client spacecraft or aim at ground stations below.

The reflecting surface of the *very expensive* 16-footers is gold-clad, molybdenum wire mesh, woven into a thin cloth and stretched taut by 16 ribs made from fine quartz cords. The entire structure, including the mesh, ribs, a dual-band feed and a deployment mechanism weighs only 50 pounds. Imagine owning a 50-pound, 16-foot dish antenna! (then imagine paying for it....)

A 6.6-foot dish antenna is used for the normal space-to-ground link.

TDRS Tricks

TDRSS's multiple-access systems stretch the limits of modern communication systems. For multiple-access service, the multielement S-band phased array (30 helix antennas per TDRS) is used to multiplex signals between a TDRS and multiple-client spacecraft on a single downlink channel. In other words, TDRS uses most of its helix antennas to talk to its client satellites in orbit. It then takes all of its client signals and uses 12 of its helixes to transmit every client signal in one frequency-division multiplex (FDM) beam to the White Sands terminal.

At White Sands, signals from each helix are received at the same frequency, demultiplexed, and the various data streams are distributed to their proper channels.

This "hands-off" approach by NASA ensures data integrity for the system's many users.

"Most of the demodulation is done at White Sands," says Goddard TDRS Project Manager Charles Vanek, "but the actual data is not decoded there. It goes to the user, and the user takes care of decoding it. It could be encrypted, or it could be in clear text. We don't know, and we really don't care!"

According to Vanek, "TDRSS works very well, and I think our users believe it works very well. TDRSS users have a very high satisfaction level."

The multiplexing happens in real time, for forward and reverse links! Equipment at White Sands can discriminate between 30 sets of simultaneous data signals.

The White Sands Terminal

The first thing you'd notice about the White Sands terminal is a trio of 60-foot K-band dish antennas anchoring a large antenna farm and a sprawling complex of buildings. Located in New Mexico because of the desert's minimal rain and weather conditions (good for trouble-free satellite communications), each TDRSS ground terminal (one is a backup) sports an incredible amount of gear.

Phil Liebrecht, the Associate Chief of NASA's Networks Division, says his people are in the midst of upgrading the facility.

"We're just starting initial operations with a new ground system...we've got somewhere in the neighborhood of 200 racks of transmitters, receivers, computers and other hardware, and about 260 technicians.

"Eventually we'll transfer operations to the new facility and take down the older one to upgrade its technology to match that of the new station. When both stations are upgraded and available, we'll have two to three times the capacity we have today."

The new facility is in the same complex, about three miles up the road.

The Future

Another TDRS (TDRS-7) is set for launch in June of 1995. TDRS Project Manager Vanek acknowledges the project's expense: "The satellite that we're launching in June probably costs 200 to 300 million dollars [in 1994 dollars]. It's expensive because it's quite a complicated spacecraft and it was purchased one at a time. When you buy something one at a time after the main build has been finished, you have new start-up costs and retooling costs for practically everything."

That, Vanek says, is a thing of the past. "We're in the process of procuring three more TDRS satellites, and we expect them to cost considerably less than those purchased one at a time."

Expensive as it is, NASA estimates that TDRSS costs about half of what it would cost to expand and maintain the older STDN, and TDRSS goes off the scale when it comes to capacity and flexibility.

Wrap-Up and Thanks

In addition to those quoted in this article, I'd like to thank NASA for their assistance—especially the "no-nonsense" administrative assistant in Houston who put me right through to "decision makers" while I was bogged down in other "official channels!"

So, armchair enthusiasts, armed with a better perspective on space shuttle communications and a sheaf of frequencies and listening opportunities, the next time you tune across something from NASA, TDRSS or the shuttle—even on the evening news—I trust you'll have a greater appreciation for the technology involved.

Simply writing this article cleaned out some of my shuttle-monitoring cobwebs: For me, the space shuttle is no longer on my "ho-hum" list. How about yours? ST

About the Author: *Kirk Kleinschmidt is a freelance writer and photographer who recently moved from Connecticut back to "Minnesota Lake Country." He's into ham radio (call sign NT0Z), satellites and shortwave listening. Kirk recently was assistant managing editor for* QST *magazine, and regularly writes on technology and business topics.*

Glossary of Terms

The following terms have been simplified, so please allow for some poetic license for the sake of simple answers

Apollo Program: NASA's '60s and '70s program to explore the moon.

C-band: Radio signals in the 4-6 GHz range.

Client Spacecraft: refers to an orbiting spacecraft that is being controlled from White Sands via TDRSS; usually refers to a spacecraft other than the shuttle.

Commands: Control inputs sent to a spacecraft from ground-based control centers or human pilots.

DOD: Department of Defense; relates to shuttle launches of military payloads.

FM: Frequency Modulation (standard).

Forward Link: referring to communications going to the shuttle from the ground (directly or via TDRSS).

K-band: Radio signals in the 13-17 GHz range.

kbits/s: abbreviation for kilobits per second; a measure of data transfer speed between computers.

Mbits/s: abbreviation for megabits per second ("million bits per second"); a measure of data transfer speed between computers.

Microwave: Referring to radio-frequency links above 300 MHz.

Multiple-Access Service: One TDRS antenna array talks to more than one orbiting spacecraft at the same time.

Multiplexing: A modulation technique that allows several information channels to be "mixed together" in one transmitted signal. On the receiving end, demultiplexing recovers each separate information channel; used by TDRSS when sending data to earth.

NASCOM: NASA's worldwide voice, TV and data network that links all involved NASA facilities (and many others).

NSP: Network Signal Processors; used by the shuttle to prepare voice, video and computer data prior to transmission to earth.

Orbiter: a space shuttle.

Payload: The shuttle's "cargo"; typically a satellite to be launched.

PM: Phase modulation: a modulation system similar to standard frequency modulation; used by one of the shuttle's S-band radio systems.

Ranging: A shuttle-mounted K-band radar system used to track orbiting objects; a system used by ground controllers to fix the shuttle exact position as it orbits the earth.

Return Link: Referring to signals going from the shuttle to the ground (directly or via TDRSS).

S-band: Radio signals in the 1.7-2.3 GHz range.

Single-Access Service: One TDRS antenna talks to a single orbiting spacecraft. TDRSs each have two single-access systems.

Spacecraft: any manmade orbiting satellite; space shuttle.

Space Flight Tracking and Data Network (STDN): A dozen-or-so networked land-based tracking and communications sites used to talk to orbiting satellites and space shuttles. The STDN is an older system (once used for Apollo moon shots) that is being consolidated in light of its better-equipped big brother, TDRSS. STDN is mostly used to launch and land shuttles.

TDRS: A single NASA Tracking and Data Relay Satellite

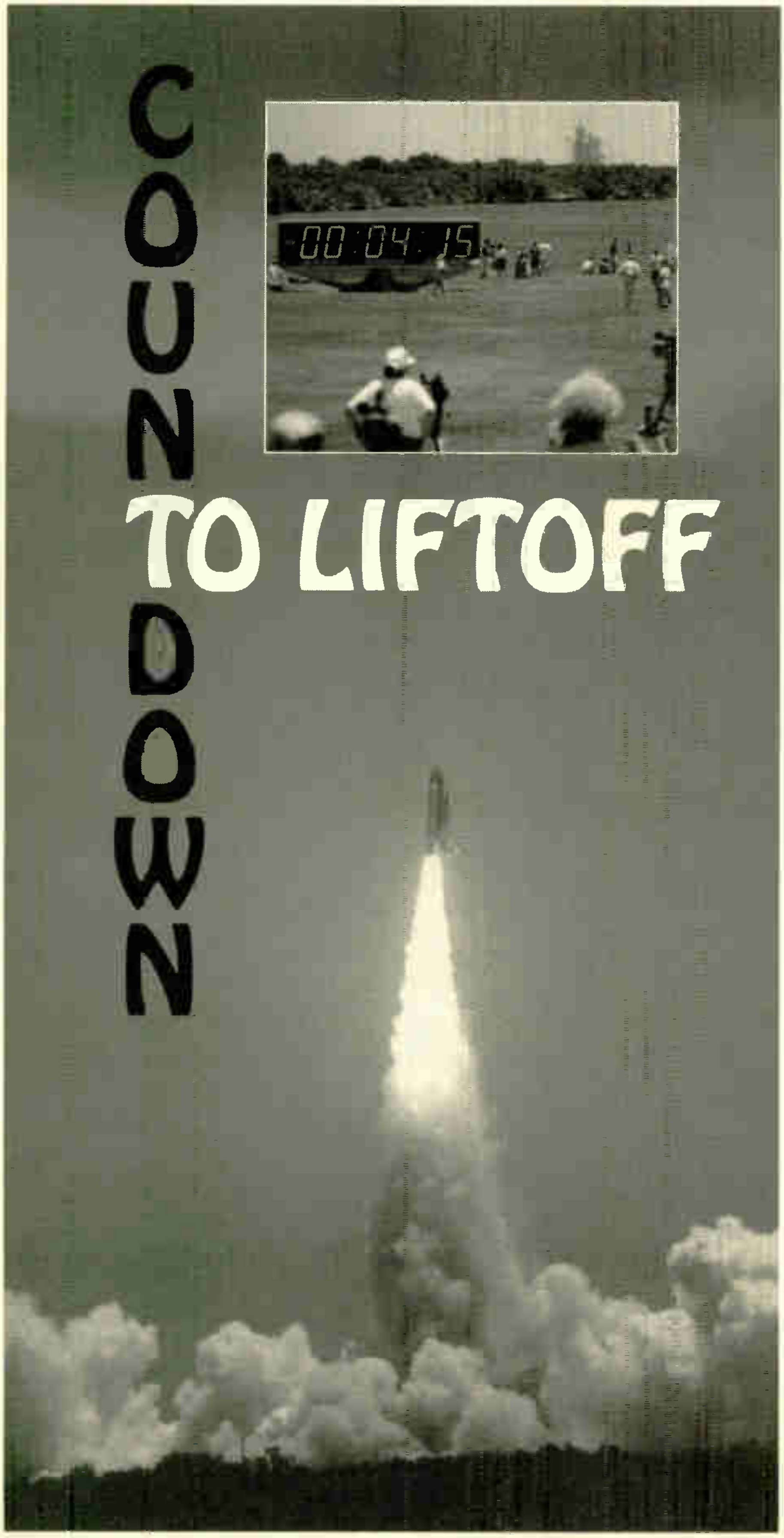
TDRSS: NASA's Tracking and Data Relay Satellite System; used to communicate with orbiting space shuttles and other client spacecraft, now and into the next century.

Telemetry: computer data on the condition of a spacecraft's internal systems.

UHF: Radio signals in the 200-1000 MHz range.

White Sands: Refers to NASA's White Sands, New Mexico, facility that is home to the TDRSS control center and a NASA network and control center, among others.

COUNTDOWN TO LIFTOFF



Inset: Mere minutes remain on the countdown clock; even now the launch could be scrubbed. However—as shown below—it wasn't.

An Eyewitness Account of the Launch of STS-65

By Rachel and Harry Baughn
Photos by Harry Baughn

It was all going too smoothly—too quickly. Surely, something would go wrong at the last second to stop this sudden acceleration of time and excitement. I feel the familiar dread and excitement like the first time on a new amusement park ride the last few seconds before the point of no return. Another part of my awareness is imagining—impossibly—what the individuals encapsulated above that time bomb must be feeling.

In a scant few minutes, if all goes well, the Shuttle astronauts will be well on the way to their adventure—and mine, which began so unexpectedly the day before..

T-3 hours and counting

Early the morning of July 8 at Kennedy Space Center, the count-down clock registers three hours to launch, although more than five hours remain before the scheduled launch at 1:11 pm EDT. The final inspection team is conducting a final survey of launch pad 39A, and the close-out crew arrives to prepare the crew module.

My husband Harry, our friend Steve, and I are just heading south from Ormond Beach, studying maps and wondering what the next few hours are going to bring ... Will we witness our first Space Shuttle launch, or will we join the ranks of those who came, waited, and had to return home with their dream unfulfilled? Knowing the odds are good either way, we try to keep our growing anticipation in bounds, and I busy myself trying out some of the frequencies we entered into the BC-200XLT scanner the night before.

We leave our friend at a picnic shelter at one of the favorite local viewing areas—

Jetty Park in Port Canaveral. Together with his lawn chair and cooler he joins those who came to the Jetty Park's campground to wait for the launch. (Half an hour before launch time, he reported later, there was barely room to sit on the grassy knoll.)

Harry and I head back to the #3 gate to join the growing line of cars. Since Kennedy Space Center is closed to the general public while the shuttle is on the launch pad, the majority of these cars have car passes (obtained by writing: NASA Public Affairs, Car Pass, Kennedy Space Center, FL 32899.) At the intersection, most of them turn east to view the launch from the Causeway. Having Press Passes, we continue north with a smaller line of rental cars and limousines, carrying reporters and observers from all over the world. The scope of this scientific mission is truly international, involving the European, French, German, Canadian, and Japanese space agencies, as well as carrying the first Japanese female astronaut into space.

The drive seems endless as we pass through the gauntlet of security checks, not being able to see our destination in the low-lying Florida marshes. Finally, the towering Vehicle Assembly Building or VAB comes in sight, and a sign points us to the Press Area—a cluster of small buildings off to the side. As we park in the prickly grass lot of the overflow area, it's hard not to feel anxious and inexperienced. We force ourselves to take a deep breath and take stock of what we want to carry, though our first instinct is not to waste another minute.

As we walk up the slight raise to the press area with the major network cubicles perched on the hillside, I have to pinch myself: are we really here?! Was it just yesterday that a casual phone call back to the office in Brasstown to get the NASA shuttle information hotline (407-867-4636) started the ball rolling?

"Oh," Bob Grove had said, "it's a little late to get clearance for the press area, but it can't hurt to try." And now—here we are!

Cameras and crews jocky for position—a process which begins hours before the launch.

T-2 hours and counting

Launch was scheduled for 1:11 pm , but we arrived around 10:30 am, and felt thrilled to be standing next to the enormous countdown clock—which read 1:50—that you see on your TV screen during every televised launch.

After orienting ourselves, I settle into the press viewing stands—practically empty except for photographers jockeying for tripod positions. We introduce ourselves to some former North Carolinians now working in the Florida press, and two reporters from Radio France International, who hammed it up for the camera. But, my job is to check the activity on the scanner. Harry heads off with his camera to find his own action.

HARRY: Well, with Rachel checking the frequencies, my adrenalin is up, and I'm eager to see the network broadcast booths. To the right side of the grandstand where Rachel is are individual buildings occupied by NBC, ABC, CBS, CNN, and trailers belonging to Voice of America and several independents. Walking behind the network buildings reveals an impressive satellite dish farm.

Each building has a set of outside metal steps leading to the second (studio) floor and the roof. The first floor is filled with technicians and broadcast equipment. Climbing to the roof of the CBS building brought into view ongoing news interviews, twin antennas on the cameras for the wireless mikes, the Vehicle Assembly Building to our left, and, straight ahead over the newsman's shoulder, The Columbia, poised on the launch pad. What a thrill!

Engrossed in copying scanner traffic, I don't see the monitor showing NASA Select, or even Harry taking this picture!

On each rooftop is an array of antennas for communications between engineers and camera crews. Some antennas are just for listening; to our surprise as we later reviewed the photos, there was a Grove Enterprises Scanner Beam!

While Harry is exploring the Network booths, I am working the Bearcat Scanner for all it is worth. CBS newsman Bill Harwood—who told us he had been covering the Cape for CBS for 15 years—uses a PRO2006 to hear all the available traffic. If I had had one along, there are electrical outlets and phone lines in the stands.

Although monitors are carrying NASA TV throughout the press area, providing background information and audio from the astronauts, I am soon lost in the world of routine communications crackling from my scanner's speaker. Although all eyes are on the astronauts, this extravagant show is obviously backed up by an enormous supporting cast.

The Security frequencies are extremely active with all they have to do in dealing with the public. There is a minor wreck, and a stalled car. Patrols make an effort to account for the occupants of any parked vehicle that is empty. Security gates that report persons requesting entrance without passes are told: "Find out who they are, what they're doing there, and their need to enter." The message becomes increasingly short and unsympathetic after T-30 minutes.

I soon lock out the Press Public Relations channel, which consists mainly of endless pages for reporters to call their offices. The timing/photo and camera/recording channels are also dispensed with, as TV crews race to resolve wiring, focus, and audio problems to get the perfect shot or link-up. Although their frenzied activity is a new world to me, it's not what I came to hear today.

On the other hand, on such a significant day for so many, it is truly a study in contrasts to listen to the drawling maintenance ("Gator") channel, sending someone down to check hydraulic fuel levels in a piece of equipment, trying to get a truck started, or asking someone the number of hours overtime they worked the night before.

T-1 hour and counting

An hour before the launch, GSA performs a sweep of all the gates. In two minutes, the area is declared clear, and launch support says, "Fall back, (name)." Security reports that at T-55 the Causeway is full—no more spectators will be admitted.

The main concern is still the weather. The NASA weather coordinator reports stratocumulus clouds with no moisture, no bases under 2600 ft., and 110/2 take-off winds. They are worried about some turbulence to the South, toward Patrick AFB. A plane is dispatched to fly into the cloud for a visual assessment.

Convoy Command Launch reports, "Convoy will be deployed momentarily" at T-37. He announces Runway 22 as the slated runway for an abort landing site. Someone reports that GSC and NCC communications had experienced difficulties, so they been linked with KSC. "No problem," comes the reply.

T-22 minutes and counting

On the 173.5625 fire/emergency/rescue channel is heard the order for the close-out crew to fall back. This is followed by a visual verification of the number and configuration of the departing crew.

Range Safety/Emergency Egress reports on 173.6625, "Clearing the pad," at the ten-minute build-in hold at T-20. Even now, launch depends on the awaited weather report.

Fire Chief Bob calls to verify that Site 2 is on the pad. The fire truck had already been called into place earlier. Medical/emergency on 173.6625 performs an EMS radio check and reports that the DOD surgeon is now on duty. The aircraft sent to investigate the clouds to the south reports at T-13 that at the 17,000 level there is no moisture in the cloud.

With an inexorable rush, the countdown continues—Oh no! At T-5 minutes, 173.5625 announces the count will not be holding at T-5. Air Force Security tells Units 2 and 3 to now take cover if they haven't already. I don't feel ready for this . . .

Left: Radio communications were everywhere, especially during set-ups such as Darrall Johnson is doing with the CNN crew.
Below, large photo: Networks broadcast from the roof of their studios, or outdoors in front of the studios, or in air conditioned comfort behind the big glass windows.
Below, left inset: Mark Kramer, special events producer for CBS, takes a call in the calm after the storm.
Below, right inset: Have dish, will travel . . .

Media, Media, Everywhere . . .

T minus 2 seconds

There is no time to savor the moment, as suddenly the clouds begin to billow underneath the Shuttle *Columbia* as the main engines ignite.

T-00 and Liftoff

At T-00, a flash of fire is seen, and as the craft begins to lift silently skyward, the ears finally verify what the eyes have already witnessed: sheer POWER.

After the endless countdown, time finally pauses. The crowd, necks craned and barely breathing again, is still held in suspense. I had expected the physical force of the sound, but it is higher pitched than I had anticipated. Though deep, it does not reverberate in the chest so much as it "breaks" the air with such force the air cannot hold it. The sound holds everyone spellbound.

Then, with the spontaneous release of applause and a few whistles from the gathered crowd, only a graceful white trail remains to mark the tremendous power that broke the bonds of Earth with seven of its most adventurous children.

TABLE 1

Freq	Agency
125.65	Wx
*143.80	Coast Guard
148.485	Timing/photo/status
*165.1125	Command Post
163.4625	Cape Security
162.6125	Launch Support (Alpha)
164.00	Radiation Monitoring
164.75	Cap Nat'l Park Service
165.1875	Visual Surveillance
170.15	Base Comm/Press Support
170.175	Rail/Truck Ops
170.350	NASA PR
170.40	GSA
171.15	Maintenance/Fuel
171.2625	Camera/Recording
171.80	Utility/Parking
*173.025	Air Force Security
*173.125	Air Force Command Post
173.175	Air Force Security
173.4375	Medical/Emergency/Rescue
173.5625	Fire/Emergency/Rescue
173.6625	Range Safety/Emerg.Egress
173.6875	Security/Astronaut Escort
173.7875	Fire/Back-up
407.325	Convoy Command Launch
*407.475	Crane Ops
416.50	Range Safety
*121.50	FAA Traffic, Rerouting

* No activity heard on these frequencies

Aftermath

Five or ten minutes after the launch, Convoy Command Launch asked for permission to travel down the runway. A little later they reported "Control G5 returning to quarters." Fire/back-up asked what equipment was wanted to maintain the runway. Then Range Safety reported it was ready to work inspection; the safety and environmental health team headed out to perform an inspection of the pad.

Fifteen or twenty minutes after the launch, the surgeon reported he was leaving the area, and shortly afterward, so did the fire crew. It was almost time for us to go, too, but first, Harry took me for a tour behind the media scene.

Meet the Press

HARRY: Next to the actual launch was the excitement of being alongside CNN, CBS, NBC, ABC, and so many others, watching and listening to their operations. Having a press pass sort of opened doors to the club-house—once I got up the courage. Wandering in and out of the major network studios wasn't a problem; and communications?! Brother! Every technician with every network carried a Motorola radio. There were more rubber duckies around than at a carnival game booth.

Inside the communications booths each network listens in on the others. Mark Kramer, special events producer at CBS News, sat at a desk flanked by speakers labeled ABC, NBC, CNN, and NASA. At the same time he had an earphone connected to a satellite link to his producer in New York and another in California, so they could react to the competition's moves. In addition to all of the above, his other ear was listening to the direct link between the astronauts and NASA. It is understandable why asking him questions during the heat of the launch was met with a glare—or so his colleagues found out.

After a brief conversation with Steve Sonnenblick, head CNN engineer and well familiar with our sister publication, Monitoring Times, we reluctantly started to leave, needing to pick up our friend at Jetty Park. Leaving the grounds we continued to monitor security as they went through their routines of ensuring all visitors were escorted off the grounds. Passing back through gate #3 brought the surprising view of commandos in black outfits, well armed, wearing flak vests labeled "NASA SWAT TEAM." But they were only directing traffic today.

It was about 2 pm when we finally left the traffic behind, and we suddenly realized we were ravenously hungry. As we sat in the fast-food restaurant, it seemed very odd to be surrounded by other late-lunchers—workmen, mothers and children, retirees—leading their everyday lives. Didn't they notice anything different about us? For several hours we had been lifted out of the ordinary, transported to another world, and we were only slowly coming back to Earth.

For the seven members of Space Shuttle Mission STS-65, already well into their heavy schedule of research for the International Microgravity Laboratory, it would be another 15 days before that happened for them. Then they—as we have—can finally savor all they have been through—the unforgettable sights and sounds that will last a lifetime. ST

It's Programs Are Out of This World

By Steve Handier

It's nearing the last day in the flight of a space shuttle mission and viewers of NASA TV have been able to see and hear the mission live. NASA TV will also be there live when the shuttle returns to earth and lands.

NASA TV (also known as NASA Select) is broadcast by the National Aeronautics and Space Administration and transmits on SPACENET 2, Transponder 5 (TVRO Channel 9) utilizing horizontal polarization with a center frequency of 3880 MHz. Programs that are available range from educational programs to live broadcasts of shuttle missions.

A regular program schedule is broadcast on NASA TV. A complete advance guide to those programs is published by NASA TV and is printed in several of the satellite TV program guides such as *Onsat.*

In addition, throughout the broadcast day, NASA airs billboards with upcoming programs and events list. NASA programming is scheduled during weekdays in four hour blocks and each block is repeated three times a day. The first block is broadcast from 12:00 to 4:00 pm Eastern Time and these programs are repeated starting at 8:00 pm and Midnight Eastern Time. On weekends the schedule is more flexible and is different each weekend.

Typically at 12:00 pm, a 15 minute program called *NASA Today* airs with current news about NASA and on-going programs. The balance of the four hour block consist of a rotation of aeronautics programming, historical and human space flight programming, space shuttle mission highlights, educational programming and management improvement programming.

As mentioned before, NASA TV also broadcasts all space shuttle missions live. Typically they pick up the launch countdown several hours prior to the scheduled launch time and then broadcast the mission live, around the clock, until after the Shuttle lands.

Launch control for the space shuttle is handled by the Kennedy Space Center (KSC) in Florida prior to and during launch sequences. NASA TV broadcasts video of the space shuttle at the launch site and audio of the pre-launch and launch communications, including launch control and shuttle communications.

After the shuttle clears the launch tower, the Mission Control Center or MCC at the Johnson Space Center or JSC in Houston takes control of the space shuttle operations. When the cameras at the Kennedy Space Center loose visual sight of the space shuttle, NASA TV then switches to live video of the MCC at the Johnson Space Center. During this time, NASA broadcasts the audio of the shuttle-to-ground and ground-to-shuttle communications as well as the NASA TV narration of the space flight.

NASA TV also provides you with a front row seat for all of the television video downlinked from the space shuttle. Other activities broadcasted on NASA TV include routine press conferences from space by the shuttle crew, payload experiment coverage, and launch/recovery of satellites from the space shuttle cargo bay.

During the STS-64 Mission on September 16, 1994 viewers were treated to the complete untethered space walk shuttle astronauts Mark Lee and Carl Meade, the first to take place in more than 10 years. This space walk used a new system called SAFER or Simplified Aid For Extravehicular Activity Rescue (which cost approximately seven million dollars. It is less expensive and lighter than the older MMU (Manned Maneuvering Unit) that were used during other shuttle missions.

Specialized activities onboard space shuttles such as satellite launches, spacelab missions, and scientific experiments may be controlled from other NASA facilities, such as the Goddard Space Flight Center (GSFC) in Maryland, the Marshall Space Flight Center (MSFC) in Alabama, or the Dryden Flight Research Center (DFRC) in California. When NASA facilities other than the Mission Control Center take control of these specialized operations, NASA TV broadcasts directly from their facilities rather than the Jonson Space Center.

From time to time, when there are no on-orbit activities in progress (i.e-during sleep periods), the camera at JSC focuses on the mission control world map, which shows the orbital progress of the space shuttle, together with TDRS (Tracking Relay and Data Satellite) and ground station coverage plotted on this world map.

NASA Press conferences are also carried live on NASA TV. Several weeks before and after each shuttle mission a preflight and post-flight press conference is broadcast on NASA TV.

Starting on flight day 2 of a space shuttle mission, mission status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once a day. Reporters gather at NASA centers around the country and are linked via NASA TV to the press conference site at the Johnson Space Center. Reporters located at the other NASA facilities are able to ask questions along with the reporters at the Johnson Space Center.

Members of the media usually assign only one reporter to cover a shuttle mission. It is impossible for that reporter to follow all the activities aboard a space shuttle, 24 hours a day during the mission. NASA TV has a daily program to help the media keep track of the story. Narrated by Ron Navas, NASA's *Mission Update* is broadcast once a day and provides reporters with audio and video excerpts of that day's shuttle's activities.

Like the media, we can't follow a mission for a full 24 hours. A program you might want to watch is called, *Flight Day Highlights* and it will give you a chance to catch up on one whole day of shuttle activities in a narrated, capsule form.

For readers in Hawaii and Alaska, Spacenet 2 doesn't provide the best of signals to your areas for NASA TV. During the STS-68 mission in October, a two-hour package of daily highlights was played each flight day on Galaxy 6, channel 19 at 103 degrees west longitude. This program of daily mission highlights began on launch day and continued through to the shuttle landing. This satellite is worth checking on future missions for this NASA broadcast. You should also consult a current mission TV schedule for specific times and channel for this service. (See below for information on the Comstore mission TV schedule.)

Late last year there was some concern that NASA TV would be removed from the air as part of budget cuts at NASA. A NASA official acknowledged that earlier this year NASA did consider dropping the TV coverage, but after consideration the NASA TV broadcasts will continue for the foreseeable future.

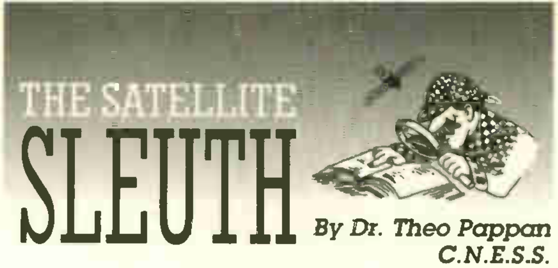
One major change that NASA TV did undergo this year was the switching of it's broadcast from SATCOM F2R to the SPACENET satellite on January 8, 1994. In addition to SPACENET 2, Channel 9, NASA also leases Channel 5 on SPACENET 2 and during the prelaunch, launch, and landing of the space shuttle. Most of the time that video consist of multiplexed video signals rendering it somewhat useless to watch, however some clear video can sometimes be viewed.

If you do watch the NASA TV network and find the programming interesting, you may wish to write to NASA. This is one way that you can see your tax dollars directly at work and let the officials at NASA know that you wish them to continue to provide this service. You can direct your letters to Director, NASA TV, NASA Headquarters, Mail Code P2, Washington, DC 20546. In addition, if you wish to hear the launch status reports prior to the space shuttle launch you may telephone the Johnson Space Center at (713) 483-8600 for a recorded message.

Photos courtesy of NASA

Also the NASA TV schedule of programming is available electronically. If you have a modem check in on Comstore, the mission TV schedule bulletin board service. Call (713) 483-5817 and follow the prompts to access this free service.

Now with your NASA TV schedule in hand, how about moving that dish over to Spacenet 2, channel 9 and catch some great programming that is simply, "out of this world" on NASA TV. ST



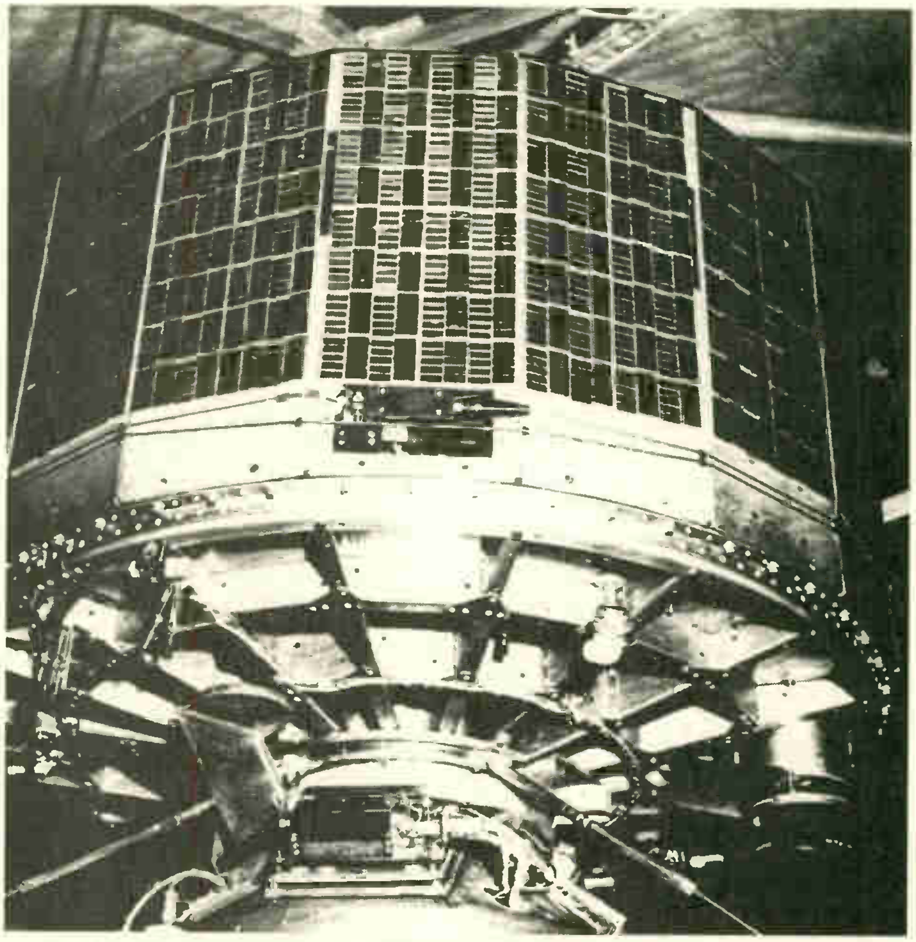
By Dr. Theo Pappan
C.N.E.S.S.

When we go satellite sleuthing we go looking for a known satellite signal or maybe we find one and spend some time trying to figure out what it is. Once we think we know what it is, we can then add it to our list of "satellites monitored", and go on to the next unknown signal. Spending time listening to a signal from AoS (Aquisition of Signal) to LoS (Loss of Signal) can result in a much better understanding of that satellites' condition and capabilities. Monitoring the frequency before AoS and after LoS can also contribute very important clues to a spacecraft's internal state of being. How it sounds when it comes on and what changes in the signal, if any, it makes during the pass can give indications of how it is handling life in space. Paying attention to what happens before, during and after you lose the signal can tell us volumes about that satellite.

For instance, our last column, Gary Davis from Philadelphia asked: "I sometimes hear a satellite that has normal down Doppler suddenly go up in frequency before LoS, and sometimes I lose it before my computer program predicts LoS. How come?"

Good questions Gary, here's how these seemingly impossible things become common place in satellite monitoring.

When we talk about ImHoTeps, we are talking about very old satellites. They may be 15 to 35 years old. That's a long time to stay alive in the hostile environment of near-Earth space. Temperatures can reach 250 degrees below zero on outside parts of the spacecraft in shadow and 250 degrees above zero where the sun hits. And don't forget that this changes in a 90-105 minute cycle every day, year round. Throw in a stream of high energy cosmic particles, a little bit of solar flare stuff, an occasional micro-meteoroid and it's a wonder that anything on an old satellite still works at all.



Incredibly, the 29-year-old satellite TIROS 10 was heard this summer in the northern hemisphere during times of peak sunlight activity. It was deactivated 27 years ago. Photo courtesy of NASA.

The batteries are usually the first to go (just like down here on Earth). They are normally designed to work for 2-5 years, but the constant cycling and nearly equal discharge/charge times would soon kill even the Energizer Bunny.

Without batteries to provide power to the transmitter (and whatever other electronics may still be working), only the sun's energy picked up by the solar cells can supply enough electrical current to start it working. And the sun has to be shining on those solar cells for them to make electricity, right? At some time during it's orbit (not necessarily at night for us listening down here on the ground) the Earth gets between the spacecraft and the sun. That is called an eclipse. When a satellite goes into an eclipse, no sun means no electricity and that means no radio transmissions.

During different times of the day and during different times of the year, these satellites may go into eclipse while they are still within range of your listening station. Once the satellite is eclisped, power is greatly reduced, then there is barely enough voltage to operate the transmitter, the oscillator becomes unstable, and the frequency may change erratically. This is why, for example, you could hear a satellite frequency going up, when it should be going down making it sound like the Doppler has reversed. This time it really is the satellite frequency changing and not the Doppler effect. Often there is a little battery capacity still available or perhaps the solar cells may get fitful bursts of the sun as they are shadowed by other parts of the spacecraft. When this happens the carrier may move around considerably.

Use your computer prediction program to look for passes that are within range of you while going into or coming out of eclipse. If the range circle for the satellite touches the terminator line when it is on the dark side of the terminator then the satellite is in sunlight. Don't forget, the range circle indicates how mush of the earth is seen from the satellite. If the satellite can see the terminator

"When we talk about ImHoTeps, we are talking about very old satellites. They may be 15 to 35 years old. That's a long time to stay alive in the hostile environment of near-Earth space. Temperatures can reach 250 degrees below zero on outside parts of the spacecraft in shadow and 250 degrees above zero where the sun hits."

then it can see the sun and would be in sunlight. (see Figure 1)

The second part of your question Gary, has to do with the same phenomenon. When the satellite goes into eclipse and is still in range of your ground station, the signal will disappear before your predicted LoS. If you notice that AoS is late or LoS is early, you should examine the orbit carefully to see why.

Right now is a good time for those of you located at latitudes greater than 40 degrees (north or south) to notice this aspect of seasonal eclispe.

Transit 5B5 (Intl Designator: 1964-083D, Catalog Number: 965) is a particularly good object to observe these effects during the coming "winter" months. Listen for it on 136.655 MHz. Transit 5B5 transmits signals multiplexed 5,10,15 & 20 kHz above and below the center frequency (see Figure 2). As it loses and regains sunlight, these subcarriers come and go. You can get a feeling for how much sunlight it is getting and the charge on the batteries by how many subcarrriers it is transmitting and how strong they are. Pay careful attention to the different sounds you hear on the different subcarriers as you tune above and below the center frequency. They alternate between what sounds like signaling tones and what sounds like digital data. If you have a spectrum analyzer, this is a very interesting bird to watch! Another interesting satellite to observe for eclipse effects is ISIS-1 (Intl Designator: 1969-009A, Catalog Number: 3669) transmitting on 136.410 MHz. It transmits only a carrier, but the spacecraft exhibits some very unusual behav-

Transit 5B5

Catalog Number: 965
International Designator: 1964-083D

Launched shortly after midnight UTC on December 13, 1964 from Vandenberg Air Force Base, California on an US Air Force Thor missile booster with an Able Star upper stage.

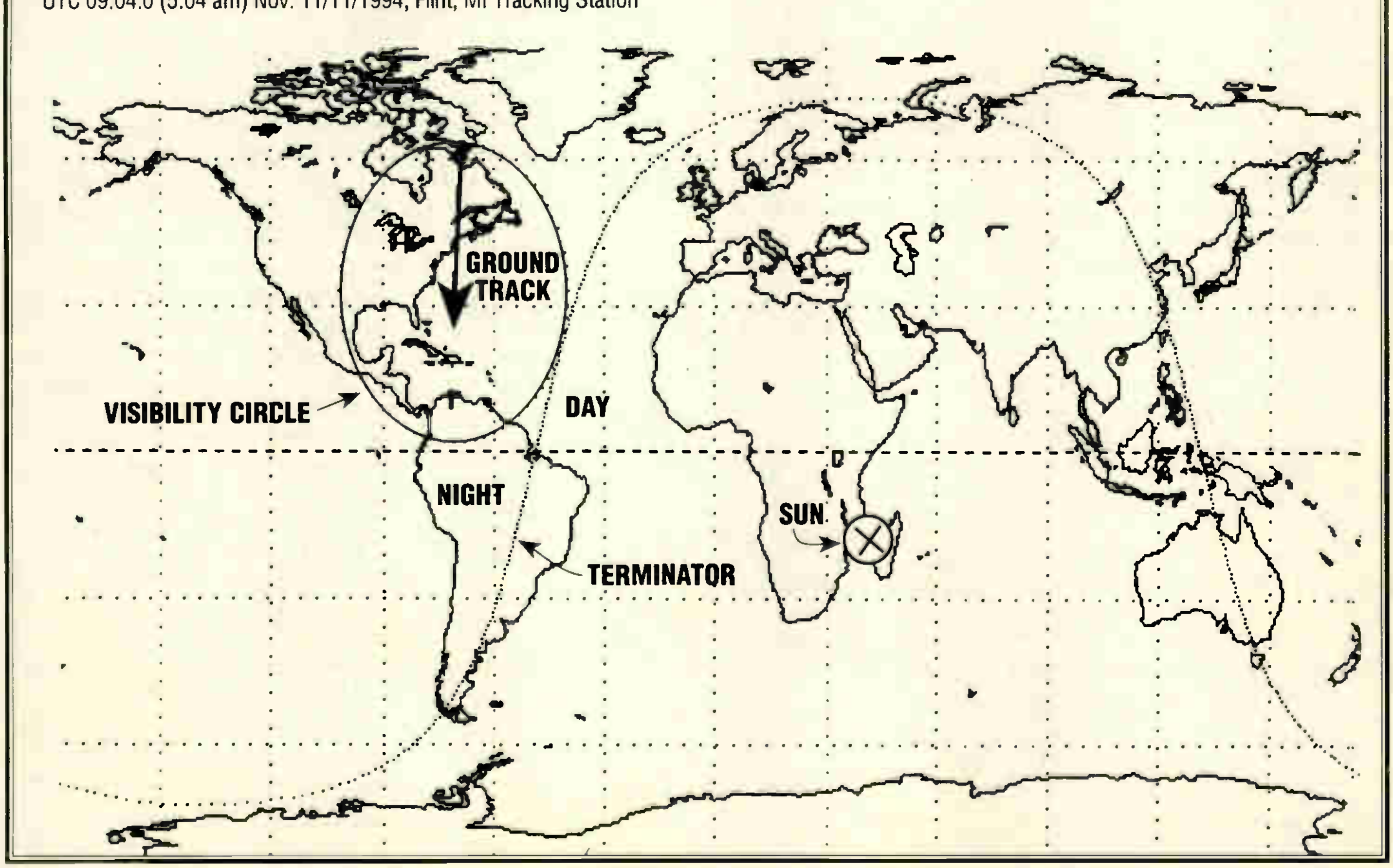
Shape is an octagon (8 sided) approximately a half meter in diameter and a little less than that long. It had a mass, when it was launched, of about 73 kg (163 lbs). The outer surface of the satellite was covered by solar cells.

Mission: to provide a highly accurate navigation system for the new Polaris submarine fleet to locate themselves prior to launching an IRBM. The US Navy named it TRANSIT after the surveyor's aid.

Initial orbit: Period-106.3 minutes, Inclination-89.8 degrees, Apogee- 1084 km, Perigee-1025 km

FIGURE 1: *Satellite Transit 5B5 Tracking Data*

UTC 09:04:0 (5:04 am) Nov. 11/11/1994; Flint, MI Tracking Station



Another interesting satellite to observe for eclipse effects is ISIS-1 . . . It transmits only a carrier, but the spacecraft exhibits some very unusual behavior when going into eclipse. It also does some fascinating things when it comes out of eclipse and first hits the sunlight.

ior when going into eclipse. It also does some fascinating things when it comes out of eclipse and first hits the sunlight. Try listening in and let us know what you think is happening. If we receive a lot of responses with your ideas, maybe we can come to a consensus as to what is happening with ISIS-1. This bird does take a lot of very close monitoring to do a careful analysis of it's current performance. The more detailed observations we make of it, the more we can learn about it. Be sure to let us know what you hear and what you think is happening.

For the opposite effect, namely when the spacecraft has received sufficient sunlight to charge up the batteries to nearly full voltage, dead equipment may return to life. This summer in the northern hemisphere, TIROS 10 (Intl Designator: 1965-051A, Catalog Number: 1430) was heard at times of peak sunlight actually transmitting APT-like signals. This is absolutely amazing for an ancient weather satellite that was launched more than 29 years ago, deactivated over 27 years ago and long forgotten by it's creators. Tiros 10 has now circled the Earth almost 151,000 times! Those of you in the southern hemisphere should listen on 136.235 MHz and you may hear TIROS 10 during your summer solar season. For those of you north of the equator, mark on your calendar for next summer a reminder to look for TIROS 10.

The response I have been getting indicates there are a lot of individuals and groups of 2 or 3 monitoring what you can of satellite transmissions. People like Don in Troy and his buddy Don in Northville. Or Donald in Lancaster and Don in Titusville. Good grief! Are all of you out there named Don? Finally, here is Dan in Hawthorne, Bob in Newport News and... (hm-m-m-m) Don in Huson, Montanna. Definitely some kind of conspiracy here.

All of you said the same thing, that you didn't know there was anyone else out there doing what you have been doing. Well there are. By the way ladies, testosterone is not required for this hobby, only a radio. By the way, we do have a BBS (517 743-5077) for this pursuit thanks to the nice folks at CNESS, but the word was hard to get out.

ISIS-1 (International Satellite for Ionospheric Studies)

Catalog Number: 3669

International Designator: 1969-009A

Launched January 30, 1969 from Vandenberg Air Force Base, California on a TAID (Thrust Augmented Improved Delta) booster.

Shape was a cylinder about 1 meter in diameter and approximately 1 1/4 meters long covered with over 11,000 solar cells. It is spin stabilized and had a mass at launch of about 241 kg (530 lbs).

Mission: to conduct ionospheric studies on behalf of Canada and the US.

Initial orbit: Period-128.4 minutes, Inclination-88.4 degrees, Apogee- 3526 km, Perigee-575 km

TIROS 10 (Television InfraRed Observation Satellite)

Catalog Number: 1430

International Designator: 1965-051A

Launched July 2, 1965 from Cape Canaveral, Florida on an Air Force Thor booster with the Altair upper stage.

Shape was a cylinder approximately .56 meter in diameter and a little over 1 meter long. It had a mass of about 127 kg (280 lbs) before launch.

Mission: to return cloud cover images to aid in weather analysis and prediction. Deactivated on July 3, 1967.

Initial orbit: Period-100.7 minutes, Inclination-98.6 degrees, Apogee- 837 km, Perigee-751 km

Thanks to *Satellite Times* the word is getting out.

Write, modem, fax, (Rene from Edmonton, Alberta, you can use a sled dog) or whatever it takes, and let others know what you are doing and let's compare notes from all those interested in satellite sleuthing. (For those of you residing in cyberspace, you can e-mail to cness@free.org) Just be sure to get it to me so I can get the word out through you column in your magazine!

Some of you are quite experienced in traffic intercepts off the military birds. How about passing along what you have been hearing and where. Others have been successful in decoding some telemetry. Let us know how you do it and what you have found out. There are thousands of satellites up there and they transmit volumes of information each and every day. Take pen or keyboard in hand and send us some of your experiences hearing these satellites. We'll pass them along to the other interested readers here.

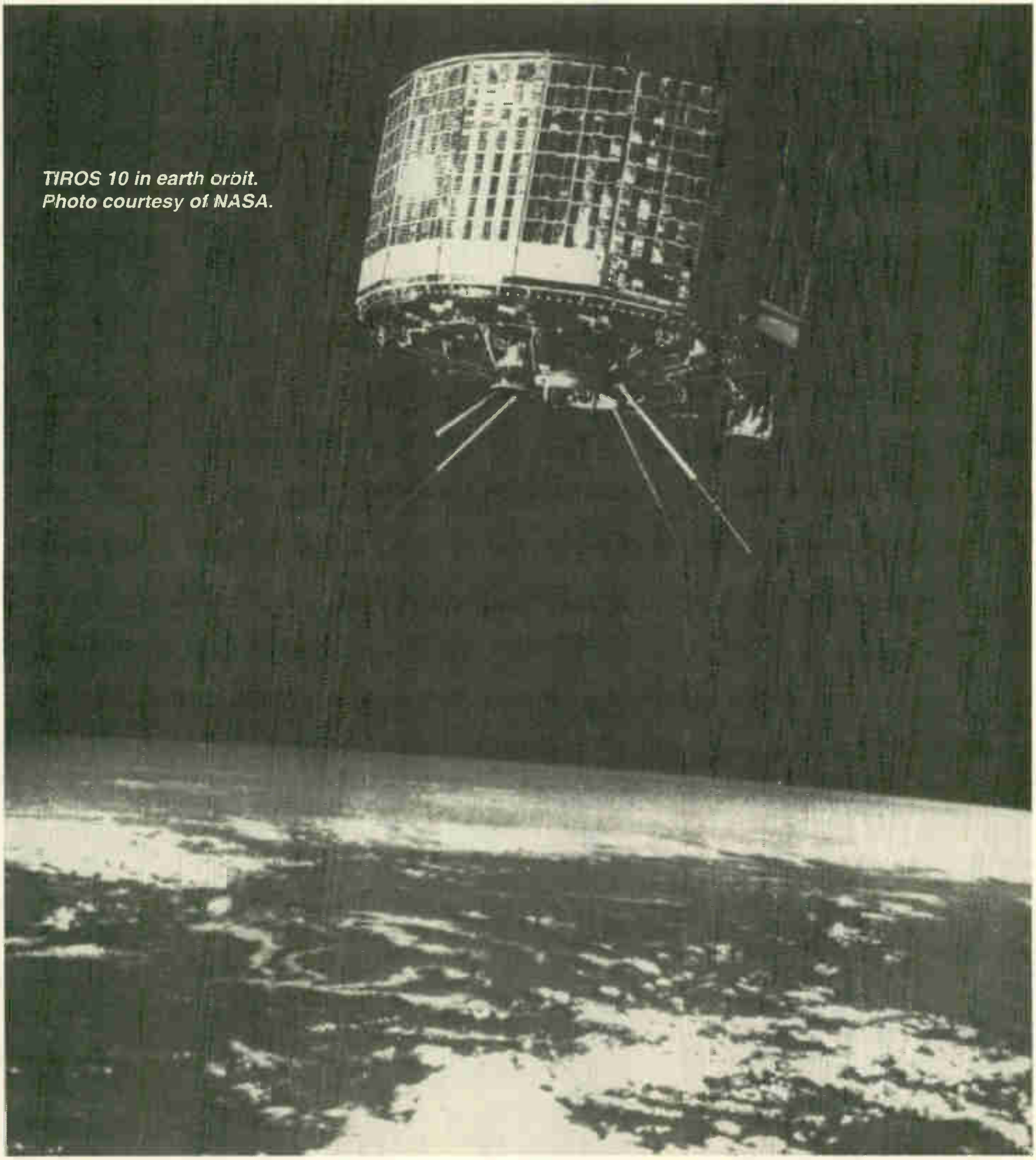
Looking for something in particular? Ask away and if I don't know the answer, I sure know where to ask others for ideas. We finally have a publication dedicated to our favorite pastime and it covers a lot of other fascinating aspects of satellites as well. I don't know about you, but I have been looking for a magazine like this for years. Now that we have one and it's all ours! Let's use it!

Finally, Phil "Rocky" Lewis from New Baltimore, Michigan has checked in with a question. Rocky has been a military and ute listener from his monitoring location off the end of one of the runways of Selfridge ANGB for a lot of years. Rocky says, "You have said that the batteries of most satellites last only a few years. I think I heard a 20+ year old spacecraft transmitting all through the eclipse period when it is supposed to be in darkness. Can the batteries on this bird be that good? If so, what kind are they and where can I get some for my radios?"

It sounds like you have a real puzzler there Rocky, but we are all out of room for this issue. Your question will have to wait until next time.

Hm-m-m-m, I just heard something on 137.720 from my PRO 2004 scanner. A really weird signal. Wonder what was that? ST

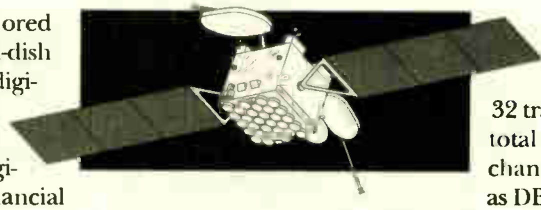
Use your computer prediction program to look for passes that are within range of you while going into or coming out of eclipse. If the range circle for the satellite touches the terminator line when it is on the dark side of the terminator then the satellite is in sunlight.



TIROS 10 in earth orbit. Photo courtesy of NASA.

By Dr. Frank Baylin

The New Digital TV—*The Players*



In the last issue of Satellite Times I explored the new direct-to-home (DTH) small-dish digital broadcasts. These compressed digital video (CDV) signals will forever alter DTH satellite television. While direct broadcast satellite (DBS) services were originally conceived in 1977, neither the financial will or technology was available at that time. Instead, a grass-roots large-dish C-band industry evolved. Now times are changing. Both C-band and the newer Ku-band systems will use CDV technologies.

The birth of DBS has been, at best, fitful. Attempts at creating a commercially successful DBS broadcast venture in the early 1980s by companies like Satellite Television Corporation (STC), a subsidiary of Comsat, United States Communications Inc. (USCI), United States Broadcasting (USSB) and Crimson Satellite Associates failed. The early 1990s saw a re-emergence of new DBS providers. Two ventures, Skypix, a Seattle-based company, and Sky Cable, a partnership of Hughes Communications, NBC, Rupert Murdoch's News Corporation and Cablevision Services, were launched and soon thereafter were aborted. The climate today is quite different.

Current DBS Players in North America

Nine groups have filed for DBS licenses with the Federal Communications Commission, but only six intend to build and operate direct-to-home television broadcast systems. One DBS system is now operational, the DirecTv/USSB venture. PrimeStar Partners also operates a "quasi-DBS" system that operates in the 11.7 to 12.2 GHz FSS (Fixed Satellite Service) range. DBS is defined as transmission of television programming at specifically assigned frequencies, namely the 12.2 to 12.7 GHz DBS band.

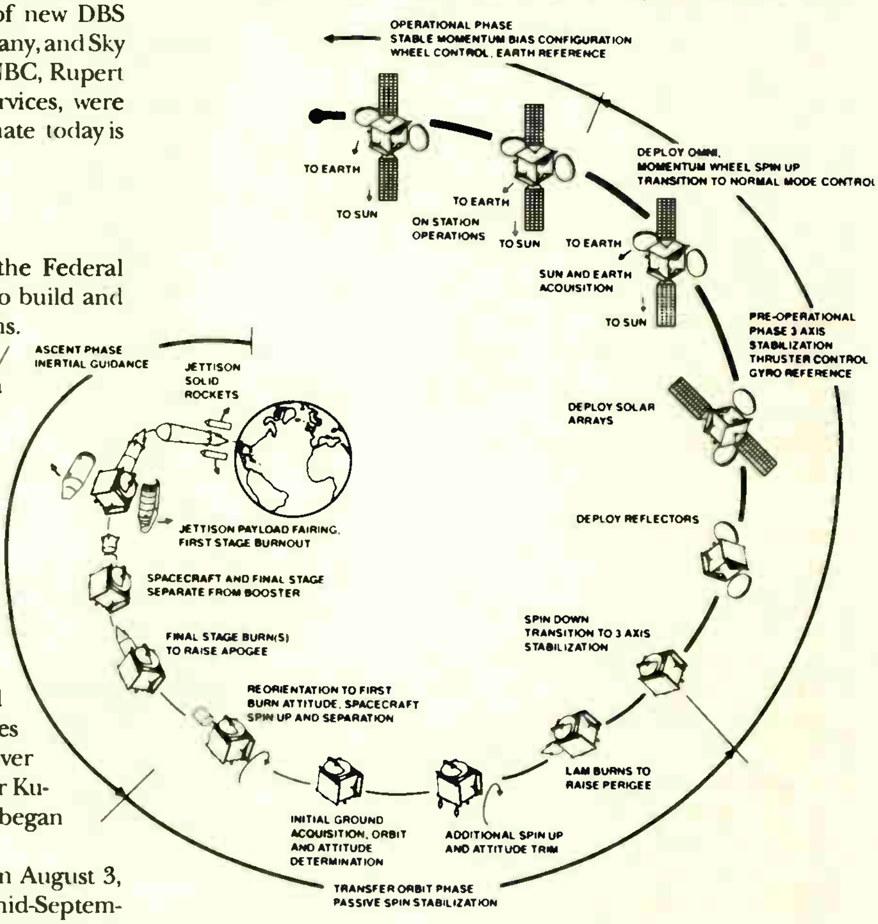
DirecTv and USSB

DirecTv, a Los Angeles based subsidiary of GM Hughes Electronics and USSB (United States Satellite Broadcasting, Inc.), a unit of St. Paul, MN based Hubbard Broadcasting, are both using DBS-1, a Hughes high-powered satellite positioned at 100.8° West to deliver their DBS services. This first 120-watt per transponder Ku-band spacecraft was launched December 17, 1993 and began operations in April, 1994.

The second DBS satellite, DBS-2 was launched on August 3, 1994, placed at 101.2° West, and began operations in mid-September, 1994. DBS-3, which may serve as an in-orbit spare, will be ready for launch in early 1995. A fourth spacecraft, DBS-4, is also in planning stages. DirecTv will use DBS-2, -3 and -4 exclusively.

The DBS-1/2 satellites carry a total of 32 transponders that can potentially transmit a total of up to 200 or more digitally compressed channels. If co-located in the same orbital slots as DBS-1/2, DBS-3 and/or DBS-4 could also be used to effectively increase the power of the signal and either lower dish size or increase the amount of programming transmitted.

These Hughes satellites are designed to be upgraded to deliver high definition television (HDTV) when it is introduced, perhaps as early as 1997. HDTV delivers a much higher resolution, widescreen (16:9 aspect ratio) television picture, closer to the resolution of feature films as seen in movie theaters than to standard TV. To accomplish this technical feat, the twenty four 120 watt tran-



Typical launch sequence of Hughes DBS satellites

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sponders would be run in parallel to produce up to twelve 240 watt circuits. By using this higher wattage, transmissions would allow the use of receive dishes as small as 12 inches in diameter. Another option option of going to a higher wattage downlink would be to keep the dish size constant resulting in greater immunity to rain fade of the downlinked signal.

These DBS state-of-the-art satellites employ a single feed for each downlink dish. It is shaped to deliver a distribution of power throughout the continental United States that permits use of 18 inch receive dishes in all locations. To accomplish this, more power must be delivered to locations such as Florida and other areas where rainfall and thus attenuation of the downlink signal (i.e. rain fade) can sometimes be quite high. If a convention satellite had been employed, receive dish sizes would have had to be larger in Florida and other areas where the satellite footprint would have been weaker or rain fade higher.

USSB purchased five transponders on DBS-1. Both DirecTv and USSB offer pay-per-view movies, sports and educational programs. However, only USSB offers the Time Warner channels HBO and Cinemax, and Viacom's Nick at Nite, MTV and Showtime. Marketing spokesmen for USSB believe that many consumers who subscribe to DirecTv will also purchase some USSB programming. In addition, USSB does offers some subscriber supported channels perceived as complimentary to DirecTv.

RCA's DSS receiver is a sophisticated consumer device with a processing power that rivals a personal computer.

The DSS System

Thomson Consumer Electronics created the digital satellite system (DSS) for both DirecTv and USSB. It is marketed under the RCA brand name and consists of an 18-inch slightly oval dish, feed and menu-driven satellite receiver for $699, not including installation. The standard system, the DS1120RW, consists of a metal dish, a single output LNB and a 30-button remote that can control most televisions. The advanced system, the DS2430RW that retails for $899, features a reinforced plastic dish, a dual-output LNB and a 39-button remote capable of controlling three components as well as the DSS receiver. Polarity is selected by changing a voltage which sent from the receiver to the LNB. LHCP (left-hand circular polarity) is selected when +18 VDC is applied and RHCP (right-hand circular polarity) with +13 VDC.

RCA's DSS receiver is a sophisticated consumer device with a processing power that rivals most personal computers by a factor of ten. It receives, decompresses and decodes a digital signal to deliver laserdisc-quality video and CD-quality audio. Most errors in the input data stream are corrected by a process known as forward error correction. In combination with a smart card, it processes a complex authorization and security control data stream as well as stores details about pay-per-view choices and habits. To facilitate this process the receiver can receive and transmit data via a telephone line. The DSS design incorporates an on-screen listing of programming.

The receiver is designed to decode MPEG1, the current digital compression standard, as well as MPEGII, a new emerging multimedia standard. DirecTv and USSB will upgrade their encoders in late 1994 or early 1995 to effect this change. No consumer modifications in the consumer receiver will be required.

These DSS receivers use "channel mapping," a process whereby uplinkers can move various programs from frequency to frequency as well as statistical multiplexing that assigns less or more

Nine groups have filed for DBS licenses with the Federal Communications Commission, but only six intend to build and operate direct-to-home television broadcast systems. One DBS system is now operational, the DirecTv/USSB venture.

bandwidth to each program without any change being noticed when a subscriber tunes between programs. This "consumer transparent" process thus allows a program such as the Discovery Channel, to remain on the same channel number on the DSS receiver even though its uplink carrier frequency has been changed or it has been assigned less bandwidth because less video compression is needed.

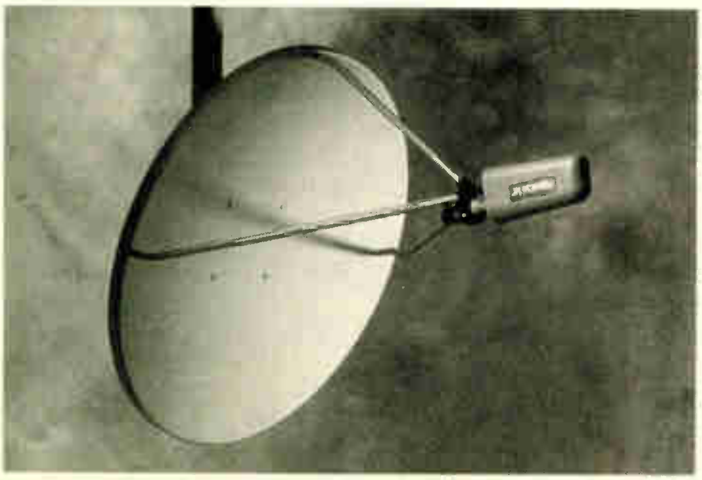
PrimeStar Partners

PrimeStar Partners is a joint venture of satellite operator GE Americom and a consortium of six major cable TV operators including Tele-Communications, Inc., Viacom Cable and Time Warner. This venture transmitted the first quasi-DBS broadcasts consisting of eleven analog video plus six audio channels in the 11.7 to 12.2 GHz FSS band via Satcom K1 orbiting at 85° West. Dishes as small as three feet in diameter receive broadcasts from 14 transponders powered at 47 watts each.

PrimeStar has just completed an upgrade and now provides a 77-channel service, 70 video plus 7 audio programs, using General Instruments (GI) DigiCipher I digital compression technologies. By early 1995, PrimeStar expects to upgrade all its customers to the DigiCipher II, a technology that is compatible with the multimedia MPEGII standard. Subscribers will upgrade to this DigiCipher II by replacing a "side-car" module that contains a new circuit board.

This broadcaster is in a unique position given that it has an option to lease and operate two satellites being created by another DBS operator Tempo. Not surprisingly, one of Primestar's CATV partners, TCI, is also Tempo's parent company. Each of these new satellites will carry thirty two 107-watt, 27 MHz bandwidth, 150 channel capacity transponders that will allow the use of much smaller receive dishes. These new satellites are capable of being switched to sixteen 200-watt transponders, similar to the configuration on Hughes DBS spacecraft. The Tempo DBS satellites will be positioned at either 76° West, 79° West or 75° West and 78° West.

PrimeStar is targeting those households with access to poor quality over-the-air reception and little or no cable TV service. The strategy is clearly not to compete head-on with cable concerns, essentially the parents of PrimeStar, but to fill-in under served areas.



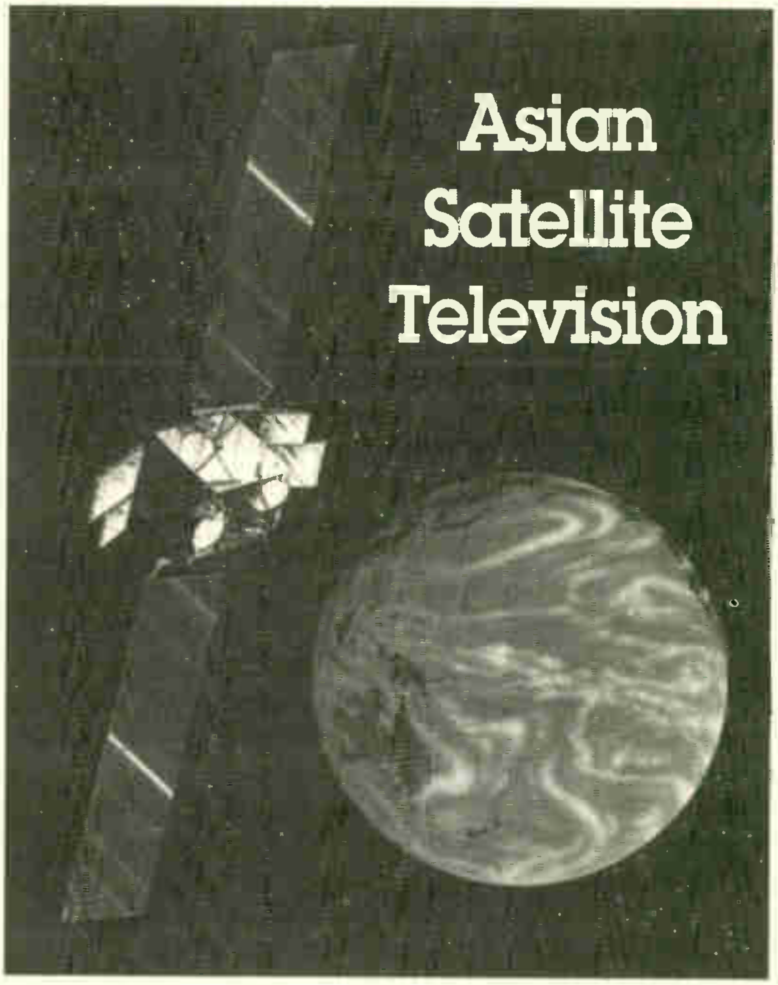
Consumers actually can lease their Primestar dishes and electronics from a local cable TV company. Subscribers wishing to purchase equipment can do so for an installed price of $999. By comparison, the installed price for the advanced DirecTv/USSB FSS system is approximately $950, assuming an installation price of $150.

The PrimeStar Receiving System

The Primestar 300D receiver incorporates DigiCipher I technology and interprets compressed digital video signals received from a 36 to 40 inch offset parabolic dish. Two coax cables from the Ku-band LNB are connected to the receiver, one for vertical and the other for horizontally polarized signals. The 300D is connected to a telephone jack so that subscribers can use the built-in Impulse Pay-Per-View function. A 23-button remote control drives a complete set of on-screen menus that efficiently lead a subscriber through all functions. Like the DSS receiver, it uses both channel mapping and statistical multiplexing to transparently accomplish its task of providing laserdisc-quality video and CD-quality audio signals. The receiver is designed to decode MPEG I compressed digital signals. ST

Dr. Frank Baylin, president of Baylin Publications, has served the industry as author and consultant since the early 1980s. He has authored and co-authored more than ten books as well as software and a video. He has recently published a new book "Miniature Satellite Dishes: The Digital Television Revolution" available for $20 plus 4 s/h. Interested readers can also obtain a free catalog from his company by writing Baylin Publications at 1905 Mariposa, Boulder, CO 80302 or by calling 800-483-2423.

By George Wood (SMOIIN/KA6BIN)



Satellite broadcasting in Asia really got started with the launch of China's Asiasat-1 in 1990. Placed at 105.5 degrees East longitude, this carries 24 C-band transponders, half of them aimed at North Asia (China, Korea, Japan, and Taiwan) using the NTSC video format, and the other half at South Asia (from the Middle East to Indonesia, but centered on India) using the PAL video format.

While many of the transponders on Asiasat carry state-controlled television stations from China, Mongolia, Burma, Thailand, and Pakistan, what created a television revolution in Asia was Star-TV. It started with 5 channels, each with one transponder on each beam. These were Star Sports, MTV Asia, the entertainment channel Star TV Plus, split channels in Mandarin (to China) and Hindi (to India), and BBC World Service Television's 24 hour news channel.

The sudden appearance of uncensored television from the skies came as a shock to conservative Asian governments. The Chinese authorities, unaccustomed to dissent and free speech, complained about unfavorable news coverage on BBC World Service, while parents and religious leaders in India and Moslem countries loudly condemned MTV's sexuality. MTV rapidly became popular with youths in the Far East. With local announcers and Asia pop, MTV managed to break the borders and create for the first time regional stars and celebrities.

Like many Asian countries, India had only a staid state-controlled televison broadcaster when Star-TV made its appearance. Suddenly small entrepreneurs around the country were wiring up neighbors in mini-cable systems, stringing their wires over telephone polls, and adding impromptu film channels by feeding Western and Indian films from VCRs. There were no laws covering cable broadcasting, and the phenomenon spread like wildfire.

India hastily added a collection of new satellite-based channels, but they have largely failed, as viewers continue to prefer the original Star fare.

Star's only competition initially was Indonesia's Palapa B2P satellite at 113 degrees East. This satellite has carried CNN International, ESPN, Home Box Office, Australia TV International from the Australian Broadcasting Corporation, Australia's Nine Network, and Hong Kong's TVB. But Palapa's footprint is concentrated on Indonesia and Southeast Asia, and reception in India and China is far poorer than from Asiasat.

ENTER RUPERT MURDOCH

Such was the new, but fairly stable world of Asian satellite television for two years, until Rupert Murdoch's News Corporation, owners of Fox Television in the US and Europe's number one satellite broadcaster, Britsh Sky Broadcasting, bought Star-TV in 1993 from the wealthy Hong Kong business family that had started the venture.

Murdoch sought to intergrate Star into his emerging global media empire. The first to feel the winds of change was BBC World Service Television. Shortly after Rupert Murdoch gave a speech announcing how satellite television could go past repressive governments to reach viewers directly, China applied pressure on the media baron. The Chinese market was too important, and with China due to take over Star's base in Hong Kong in 1997, Murdoch dropped the BBC broadcast from the northern beam, replacing it with a pay film channel in Mandarin, aimed primarily at Taiwan. Although at the time he claimed the change was for commercial reasons, months later Murdoch finally admitted he had made the move because of Chinese pressure.

Interestingly, Murdoch has just signed a contract with a company called Chinese News Europe, which is broadcasting Chinese programming to Europe during the night on Murdoch's new Sky Sports 2 channel on Astra. This is in competition with the Chinese Channel in Europe, carried overnight on another Astra transponder, which is owned by Hong Kong's TVB, one of Murdoch's rivals in the Far East. Alliances and rivalries in Asia seem to be manifesting themselves in Europe.

One month after dumping the BBC from Star, Murdoch

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chased off MTV, replacing it with his own music video channel, called 'V'.

Murdoch has had other plans, however, involving the upcoming Asisat-2, due to be launched in March, 1995 and located near Asiasat-1 at 100.5 degrees East. This will carry 40 C-band transponders, as well as 9 other transponders in the Ku-band, which so far has seen little used in Asia. The chief executive of Star-TV, Gary Davey, says that Star plans to use digital compression on Asiasat-2 to launch 40 multi-lingual channels over the next 3 years, and another 60 in the long term.

Right now the company says it plans to launch two Mandarin-language entertainment and film channels, an Indian film channel and channels in Bahasa Indonesia, Thai, Tagalog, and Cantonese languages. All would be on a subscription basis, although it is difficult to see how this would work in some parts of Asia, where many hot-wired mini-cable networks function on a pirate basis, and where collecting payment from these systems might be very difficult.

Murdoch's plans to expand his Sky News channel from Europe have been suspended, when the project turned out to be far more expensive than originally thought. A more immediate project is building up a news service for the Fox Network in Europe, Asia would then follow.

There will be some competition for Star as well on the new Asiasat. British Telecom has booked 5 transponders, Australia's Nine Network another 10. Deutsche Welle television also plans to use Asiasat- 2 satellite.

APSTAR AND PAS

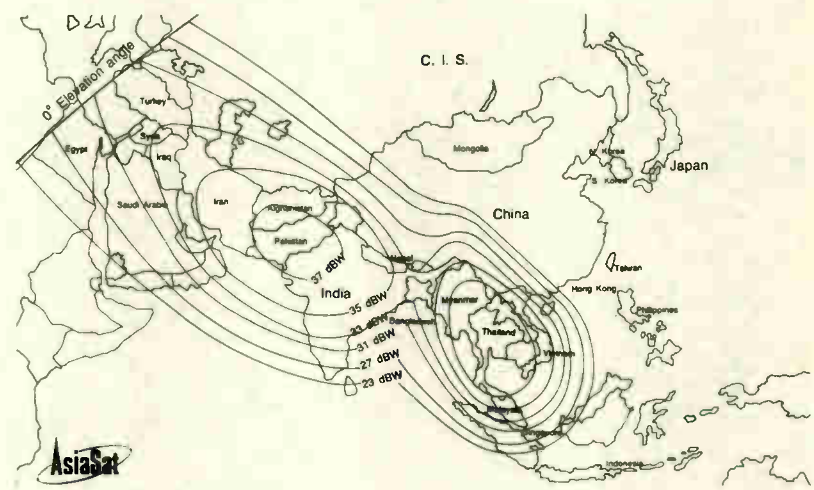
This summer saw the launch of two satellites that will offer programming to compete with Star-TV. On July 21st, a Chinese Long March rocket carried into orbit the Asian-Pacific satellite, Apstar-1. Programmers on Apstar's 24 transponders will include the "Gang of Five" from Palapa—CNN, ESPN, HBO, Australia's Nine Network, and TVB from Hong Kong. Also joining them will be The Discovery Channel, Reuters Television, and MTV Asia. Turner Broadcasting is also launching its joint Cartoon Network/TNT channel (already pioneered in Europe) on Apstar, with extra soundtracks in Thai and Mandarin.

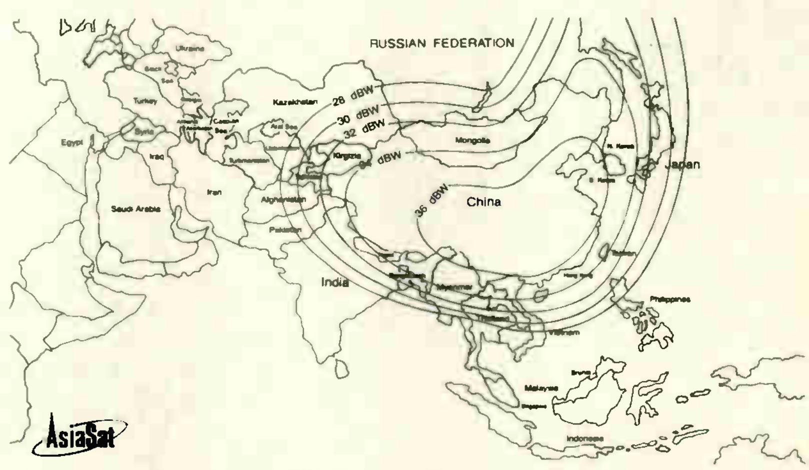
But there's been controversy over Apstar as well. China, which owns the satellite, tried to place it at 131 degees East, without bothering to register the location through the International Telecommunications Union (ITU). The problem is that the US-owned (Tonga-registered and Russian-launched) Pacific satellite Rimsat is at 130 degrees, and Japan's Sakura 3A is at 132 degrees. Most of the world accepts two degrees as the minimum safe spacing between TV satellites to avoid mutual interference.

After much negotiating, the Chinese have finally agreed to move the Apstar-1 satellite to 138 degrees, a position registered by Tonga, but the entire affair has caused a lot of questions to be asked about what kind of a partner China wants to be on the world stage.

There's also concern over the Chinese attitudes towards censorship. It was Chinese protests that drove the BBC off the Star northern beam. The Chinese have introduced severe restrictions on private dish ownership, and they blocked relays of CNN to hotels and those other institutions in China which still had permission to receive satellite television on the anniversary of the Tienamen Square massacre last July. The Apstar programming contract also gives China the right to censor programming transmitted on the satellite.

Consequently, a number of Apstar broadcasters are also booking transponders on the new PAS-2 satellite, which has the advantage of receiving direct uplinks from North America, without having to go through Asian uplinkers.



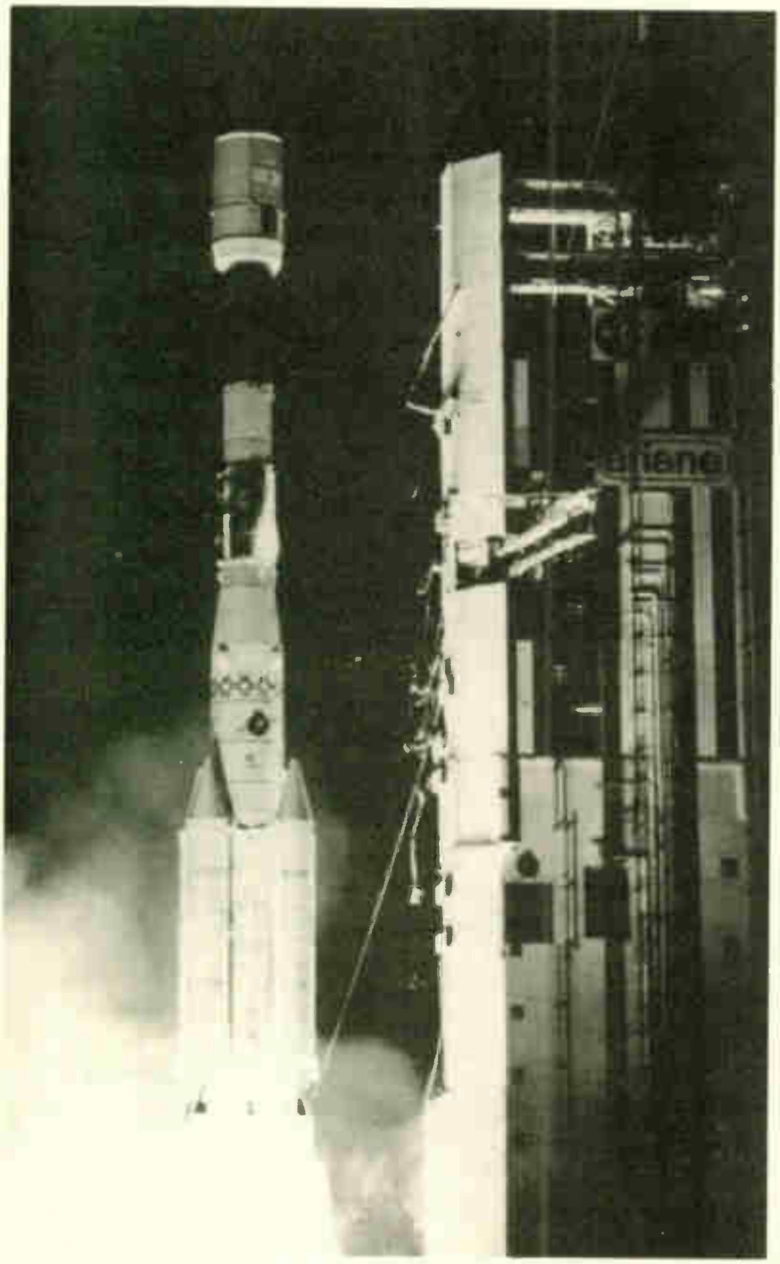


Southern (top) and northern (bottom) footprints for ASIASAT 1

To be fair, China isn't the only country with a one-sided attitude towards satellite broadcasting, restricting reception at home while using satellites to broadcast to other countries. Singapore and Iran have both banned the use of private dishes, and both have announced ambitious plans for their own satellite channels.

PAS-2 was launched on July 8th. It's owned by Panamsat, which is challenging Intelsat's monopoly on intercontinental relay satellites. The company's first satellite, PAS-1, relays a number of broadcasters in both directions across the Atlantic.

The new Pacific satellite started service on August 23rd, and Turner Broadcasting, MTV, Discovery, ESPN, Country Music Television, and Home Box Office have all booked transponders.



Launch from French Guiana of PAS-2. Photo courtesy of Arianespace.

To be fair, China isn't the only country with a one-sided attitude towards satellite broadcasting, restricting reception at home while using satellites to broadcast to other countries. Singapore and Iran have both banned the use of private dishes, and both have announced ambitious plans for their own satellite channels.

NEW SATELLITES

Two new TV satellites were launched into orbit in August by an Ariane rocket from French Guiana. Brazil's Brasilsat B1 will relay 28 C-band transponders to Latin America, from 70 degrees West orbital slot.

Turkey's Turksat 1-B was launched to replace the original Turksat that was lost in a failed Ariane launch in January. It was placed into position at 42 degrees East at the end of September. Hopefully, its 22 transponders will gather together some of the 9 Turkish channels currently carried on 4 different Eutelsats, and the 4 Turkish TRT broadcasts to Central Asia currently carried on Intelsat 604 at 63 degrees East.

According to reports, 10 transponders are aimed directly at Turkey, 2 cover Turkey and Central Asia, 3 reach Europe as well as Turkey, and 1 is focused solely on Europe.

A number of Western European broadcasters are also expected to use Turksat to reach Turkey. CNN had booked a transponder on the original Turksat, and when it failed to reach orbit, CNN hastily began relays on the aged Eutelsat I-F4 at 25.5 degrees East. This service may disappear if CNN moves to Turksat 1-B.

SCANDINAVIAN SATELLITES

Mid-August also saw a major expansion in Scandinavian satellite broadcasting, and a settlement of the Scandinavian Star Wars I wrote about last time, largely in favor of the Swedes. On August 16th, the Kinnevik media empire, which had concentrated its TV3 and TV1000 channels on the Astra satellites, suddenly launched new multi-program packages on Sweden's Sirius direct broadcast satellite (5 degrees east), and the new Nordic Intelsat 702 (1 degree west), which was placed into operation that day.

Kinnevik was one of the original Astra broadcasters, with its initial general entertainment channel TV3. Because of the restrictive Swedish laws on satellite television in the 80's, TV3 initially broadcasts from London, where it was covered under the more tolerant British law. The only exception has been late-night pornography from the pay film channel TV1000, to which the Swedish authorities have no objection, but which is banned in the more puritanical Britain. Those programs are uplinked directly from Sweden, after a short break in transmission.

Kinnevik quickly followed the first channel with separate TV3 services for Denmark and Norway, as well as TV1000, all on Astra, and all using the D2-MAC video standard, man-

Arthur C. Clarke wrote . . . about a popular soft drink company somehow putting its round logo on the surface of the Moon for all to see. It looks like something like that will actually be happening, courtesy of Murdoch and British Sky Broadcasting. They plan to launch a satellite next year which will hover over Europe, the size of a full Moon, and they plan to project the Sky logo onto it.

dated by the European Community, but ignored by virtually every other broadcaster.

Recently, Kinnevik started a low-budget oldies film channel, called FilmMax. Because there was no room left on Astra (which would have cost too much anyway for such a low-budget operation), Kinnevik put FilmMax on Intelsat 601, at 27.5 degrees West. This was followed by a number of cable-only channels to Sweden's largest cities: an MTV clone called Z-TV, the home shopping channel TV-G, and a channel aimed at women called TV6.

On August 16th, the Swedish version of TV3, FilmMax, Z-TV, TV-G, and TV6 all appeared on Sweden's direct broadcast satellite, Sirius at 5 degrees East. This satellite (formerly Britain's Marco Polo 1) shares the orbital slot with Sweden's older DBS bird Tele-X. On the same day another Swedish channel, TV4, which also operates terrestrial transmitters, moved from its fading Tele-X transponder to Sirius. Remaining on Tele-X is another Swedish satellite channel, TV5 Nordic (which is largely owned by ABC through a Luxembourg-based company called SBS).

Because Sirius' footprint is centered on Scandinavia, Kinnevik has largely abandoned D2-MAC on the new satellite. TV3, Z-TV, and TV-G/TV6 (which share a transponder) are all in clear PAL, the most common European TV video standard. FilmMax, as a subscription channel, remains in D2-MAC, as the system is secure and many smart cards are already in use. While TV3 will remain on Astra, FilmMax is leaving Intelsat 601.

Meanwhile, Kinnevik has placed other channels on the new Intelsat 702, which shares 1 degree West with Norway's Thor satellite (the former British Marco Polo 2). TV1000 is now using this satellite, as is TV3 Norway (unfortunately, both are still broadcasting in coded D2-MAC). Even though Intelsat 702 has a wider footprint, TV3 only pays for the right to broadcasts to Scandinavia. Relays of TV3 Denmark and TV3 Sweden will follow soon.

Intelsat 702 is gathering most of the Norwegian channels. The state-owned NRK has moved there from Tele-X, and the private TV2 has moved from Intelsat 515 at 18 degrees West, as have relays of Swedish Television's channels 1 and 2 intended for Norwegian cable networks (coded in D-MAC, and unavailable to private subscribers). Another private station, TV Norge, broadcast from the former Intelsat 512, which occupied 5 degrees West before 702, and it continues on the same frequency.

Meanwhile, the Thor direct broadcast satellite at the same position continues with a package of CNN, MTV, Discovery/ Children's Channel, Eurosport Nordic, and the pay film channel FilmNet. These channels had used the obscure D-MAC standard, but recently switched to D2-MAC. They have also used a very uncommon encryption system, called Eurocrypt S. Subscriptions outside of Norway must have been low. At the end of September, Kinnevik suddenly announced it had taken over the agency for the Thor channels, which were adding coding in the more common D2-MAC scrambling system, Eurocrypt M.

This means that Scandinavians will be able to access the most popular Swedish and Norwegian general entertainment channels, along with the most popular foreign channels, using relatively small dishes (70 centimeters) with twin LNBs to catch both satellite positions, and one single smartcard. With all three versions of TV3, at least 17 stations ought to be available, 7 in the clear.

ASTRA SATELLITE CHANGES

There have been a number of changes on the Astra satellites in the past few weeks. Sky has added three more channels (albeit all sharing the same transponder): Sky Sports 2, Sky Soap, and Sky Travel (the later largely an infotainment channel for Sky's new travel agency). MTV's sister station VH-1 has just arrived on Astra, as part of the Sky package. The Learning Channel has joined The Discovery Channel on its transponder, and Country Music Television (CMT) has moved transponders and expanded hours.

But the rest of the European scene will have to wait until the next issue of *ST*. By then, either Eutelsat's new Hot Bird-1, the new Astra 1D, or both, should be in orbit and possibly operational. Europeans will have at least 40 more channels of satellite television, and a potential new Star Wars developing between Eutelsat at 13 degrees East and Astra at 19 degrees East.

Finally, there is Rupert Murdoch's latest antic. Arthur C. Clarke, the visionary who first proposed communciations satellites, wrote in one of his science fiction stories about a popular soft drink company somehow putting its round logo on the surface of the Moon for all to see. It looks like something like that will actually be happening, courtesy of Murdoch and British Sky Broadcasting. They plan to launch a satellite next year which will hover over Europe, the size of a full Moon, and they plan to project the Sky logo onto it. Fortunately, the 18 million dollar PR stunt would only last for a few days.

The most frustrating thing may be that Murdoch will make everyone in Europe look at his logo, but he continues to refuse to allow his channels to be seen anywhere outside the British Isles, despite European Union (EU) regulations on free access to goods and services in the EU. More about that next time.

I would like to pass along my new Internet address for those readers wanting to contact me on the Information Super Highway: wood@stab.sr.se. This address may change form slightly as Radio Sweden connects to more of the Swedish Radio local network, but it's a lot easier to access than the CompuServe address listed in the last issue.

INTERNATIONAL MAILBAG

I did receive a very interesting letter from Paul Brouillette in Illinois, commenting on my article on international broadcasters on satellite radio in the premier issue in *ST*.

Paul says he has "some qualms about what the new means of delivering international broadcasts may do to the average person's access to them." He says that few people have satellite receivers, that they are costly compared to shortwave receivers, and are not portable.

In addition, he says that so far few local radio stations are relaying international broadcasters, some are available on cable,

I do think there are a number of parallels between satellite monitoring today and the early years of shortwave DXing. Satellite TVRO equipment is NOT any more expensive than some of the quality shortwave receivers you can now purchase.

but cable is expensive, and rebroadcasting means that third parties can censor programs for political or business reasons.

These are all good arguments, and they need to be considered by shortwave broadcasters. I think many shortwave stations have gotten so excited about satellites, possibly afraid to be left behind in the rush to new technology, that they have thrown themselves in and neglected or downplayed shortwave. That's a mistake. Shortwave will remain an important means of reaching listeners, especially in the Third World, for some time to come.

That's probably why *ST's* sister magazine *Monitoring Times* is doing so well. *ST* is a satellite magazine, so naturally we write about satellites here. But shortwave is still alive and well.

That said, I do think there are a number of parallels between satellite monitoring today and the early years of shortwave DXing. Satellite TVRO equipment is **NOT** any more expensive than some of the quality shortwave receivers you can now purchase. You can buy a Galaxy 5-only set-up from Radio Shack for around $500. That'll give you the World Radio Network (and a lot of scrambled TV channels). Twice that will get you a motorized system, with access to a vast array of radio and TV, many in the clear, for just about what a modern DX machine costs. Here in Europe you can buy an Astra system for as little as £200, around $300. Shortwave receivers are even more expensive here than in the US.

Satellite receivers aren't portable, but neither were shortwave receivers until around 20 years ago. I fondly remember my Sony ICF-5900, which was such a break-through in the late 70's, and it wasn't even digital. The modern satellite receiver is no less portable than the shortwave receivers during and after World War Two, when listening to shortwave had its greatest breakthrough. Just as modern technology improved and shrunk shortwave receivers, satellite receivers will be portable within a few years. When the new direct satellite audio services go into operation, our kids or grandkids will probably think that portable receivers to listen to digital satellite radio are about as exotic as Walkmans were to us.

There is a trend among international broadcasters to want to reach "ordinary people" or even "opinion-makers" rather than "hobbyists" as shortwave listeners are considered to be. The problem is that people with satellite receiving equipment use it to watch TV, and it is often only a small number of "hobbyists" who listen to satellite radio. I think it has come as a considerable surprise to the heads of some stations that when they've switched to these new high-tech satellites they are still only reaching those "weirdo hobbyists".

Hence, the importance of rebroadcasting to international broadcasters. Presumeably "ordinary people" listen to local FM stations or subscribe to cable. Rebroadcasting may be limited right now, but it is bound to grow, especially as more and more stations discover the World Radio Network or the availability of BBC World Service radio. In some areas there may be a handful of NPR or other non-commercial outlets. They can't all broadcast "All Things Considered" at the same time. Some of them are going to pick up on carrying some alternative programming, now that it is available.

But it is true that stations can pull the plug. There was a graphic example of this a few months ago. For years the British government banned radio and television stations from carrying the voices of members of the Irish Republican Army or its political wing Sinn Fein. The ban was removed in September. While it was in effect the BBC and other stations got around this by having actors voice the comments of IRA spokespeople.

A similar ban was removed in Ireland some months before the British ban ended, and Ireland's RTE radio then carried an interview with the Sinn Fein leader Gerry Adams. RTE is relayed by the World Radio Network, which is uplinked from London. In order to follow then-British law, WRN bleeped out Gerry Adams' voice. Getting an actor to voice the remarks in a live broadcast would have been impossible. Since WRN relays RTE to North America as well as to Europe, this meant that a broadcast from Ireland to North America, neither of which censor the IRA, was censored anyway.

Since Radio Sweden is also a WRN broadcaster, I find this very disturbing. A few years ago we read sections of the book "Spycatcher", which had been banned in Britain, live over the air. Should a similar incident happen again, we would be censored as well.

That's why broadcasters to Asia are interested in using Rimsat rather than China's Apstar. Dictatorships and closed fundamentalist societies are terribly frightened by the potential of satellite broadcasting to circumvent their control. This has happened in India, and the result has been liberalization. In China, Singapore, Malaysia, Iran, Saudi Arabia, and other countries, the authorities are trying to introduce or enforce dish bans to protect themselves.

I don't think that position will be tenable in the long run, and we are bound to become a global society. That means liberation for some, but possibly irreparable damage to local culture and customs for others. BBC news to China may be liberating, MTV to India or Burma may be cultural imperialism and deeply damaging to the fabric of village society. DirecTV may be a much-needed alternative to the high-price monopolies of the cable companies, or it may be a Deathstar to Canadian culture. Who's to say what's right? Now, there's no turning back. ST

Satellite Launch Schedules

By Larry Van Horn

Space Transportation System (STS-NASA)

Space shuttles are launched from Cape Kennedy, Florida.

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-66	November 1994/ Atlantis*	57.0/164	11	Atlas-03/Crista SPAS-01/ SSBUV A-04/ Escape-11
STS-67	February 1995/ Endeavor**	28.5/190	14+2	Astro-02/GAS(2)
STS-63	February 1995/ Discovery***	51.6/170	8	Spacehab-03/SPTN 204/ CGP/ODERACS-02/ CONCAP II

*Crew Assignment: CDR Lt. Col. Donald R. McMonagle, USAF; PLT Maj. Curtis L. Brown Jr, USAF; MS(PLC) Ellen Ochoa, Ph.D.;
MS Jean-Francis Clervoy (ESA-France); MS Scott E. Parazynski, MD; MS Joseph R. Tanner
**Crew Assignment: CDR Stephan S. Oswald; PLT Maj. William S. Gregory, USAF; MS(PLC) Tamara E. Jernigan; MS John M. Grunsfeld, Ph.D.; MS Lt. Cdr. Wendy B. Lawernce, USN; PS Samuel T. Durrance; PS Ronald A. Parise
***Crew Assignment: CDR Cdr.James D. Wetherbee, USN; PLT Maj. Eileen M. Collins, USAF; MS C. Michael Foale, Ph.D.; MS Bernard A. Harris Jr, MD; MS Col. Vladimir G. Titov (Russian Cosmonaut); MS Janice Voss Ford, Ph.D.

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
November 1994	Delta II	Cape Canaveral AFS, FL	WIND

Arianespace

Ariane rockets are launched from French Guiana.

Launch Number	Launch Date	Launch Vehicle	Payload
Flight 70	November 1994	Ariane 44L	Brasilsat B2 and (Eutelsat II F6 or Telecom 2C)
Flight 71	December 1994	Ariane 42P	Panamsat 3

Note: The Arianespace launch manifest is still very tentative at press time due to the investigation and restart of their launch program following the Ariane Flight 63 mishap.

List of Abbreviations and Acronyms

AFS Air Force Station

Astro-02 Astronomy. Program designed to obtain ultraviolet (UV) data on astronomical objects using a UV telescope flying on Spacelab.

Atlas-03 Atmospheric Laboratory for Applications and Science. Series of Spacelab flights that measure long term visibility in the total energy radiated by the sun and determines the variability in the solar system.

Brasilsat B2 Brazilian geostationary satellite launched for Embratel. Will be located at 70 degrees west when operational.

CDR Commander. Member of the Shuttle flight crew in command of the flight.

CGP Cryo Systems Experiment GLO-II Payload. Cryogenic system for cooling focal plane optics for space-based scientific instruments. GLO-II provides observations of earth's thermosphere, ionosphere, and mesosphere energetics and dynamics and shuttle surface glow.

CONCAP II Consortium for Materials Development in Space (Complex Autonomous Payload)-II. Investigates materials surface reactions to exposure to atomic oxygen flow in earth orbit for high temperature super conducting films and for materials degradation/reaction samples.

Crista-SPAS Cryogenic Infrared Spectrometer Telescope for Atmosphere. A U.S./German joint aeronomy payload intended to explore the variability of the atmosphere and to provide measurements that complement those provide by the UARS spacecraft.

Delta II Medium class expendable launch vehicle

Escape II Experiment of the Sun for Complementing the Atmospheric Laboratory for Applications and Science (ATLAS) Payload and for Education-II. To collect solar data with solar imaging and UV solar irradiance experiments. The data will be correlative with the co-manifested Atlas-03 solar experiments for the understanding of the upper atmosphere photochemistry.

GAS(2) Get Away Special. Alternate name for the Small Self-contained Payload (SSCP) program, providing standard canisters to accommodate low-cost space experimentation.

Eutelsat II F6 Geostationary communications satellite, part of the Eutelsat constellation of satellites. Will be located at 13 degrees east when operational.

ISTP International Solar Terrestrial Project

MS Mission Specialist. A member of the Shuttle flight crew primarily responsible for Orbiter subsystem and payload activities.

NASA National Aeronautics and Space Administration

ODERACS-02 Orbital Debris Radar Calibration Spheres Project. Releases radar dipoles into earth orbit for purposes of calibrating ground-based radar.

Panamsat 3 Geostationary communications satellite launched for Panamsat. Will be located at 43 degrees west when operational.

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 responsibility is to pilot the Orbiter.

Spacehab-03 Dedicated materials processing mission emphasizing research in microgravity conditions.

SPAS-01 German Shuttle Pallet Satellite. Demonstrate the utilization of the MBB platform and systems as a carrier for science experiments.

SPTN 204 Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN). X-ray astronomy. medium energy survey mission, using retrievable free flyer.

SSBUV A-04 Shuttle Solar Backscatter Ultra-Violet Experiment A. Series of flights to measure ozone characteristics of the atmosphere. Platform has avionics and power connection with the orbiter.

STS Space Transportation System (NASA Space Shuttle)

Telecom 2C Geostationary communications satellite launched for France Telecom. Will be located at 3 degrees east when operational.

Thaicom 2 Geostationary communications satellite launched for Shinawatra Satellite Co, Ltd. Will be located at 78.5 degrees east when operational.

UARS Upper Atmosphere Research Satellite. Satellite to study chemical processes acting within and upon the stratosphere, mesosphere, and lower thermosphere.

UV Ultraviolet

WIND Satellite to measure solar wind input to magnetosphere. Part of the ISTP program.

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of active geostationary satellites at publication deadline. Current launch developments can be followed in ST's Space Launch Report column. Satellite location information was supplied to *Satellite Times* by NASA's Goddard Space Flight Center-Orbital Information Group. Satellite background information was supplied by Phillip Clark, Molniya Space Consultascy; Dr. Nichols Johnson, Kaman Sciences Corporation; G. Davidson-UAE; NASA NSSDC/ WDC-A, Goddard Space Flight Center; U.S. Air Force Space Command and the U.S. Naval Space Command.

Radio Frequency Band Key

P band	230 - 1,000 MHz
L-band	1,000 - 2,000 MHz
S band	2,000 - 4,000 MHz
C band	4,000 - 8,000 MHz
X band	8,000 - 12,500 MHz
Ku band	12.5 - 18 GHz
K band	18 - 26.5 GHz
Ka band	26.5 - 40 GHz
Millimeter	> 40 GHz

Service Key

BSS	Broadcasting satellite service
Dom	Domestic
FSS	Fixed satellite service
Gov	Government
Int	International
Mar	Maritime
Met	Meteorology
Mil	Military
Mob	Mobile
Reg	Regional

"i" indicates inclined orbit, orbital inclination greater than 2 degrees

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
18952	1988-018B Telecom 1C (France)	0.0E	Dom/Gov/Mil (C/Ku)
21140	1991-015B Meteosat 5 (MOP 2)	0.1E	Met (L)
19919	1989-027A Tele X (Sweden)	4.9E	Reg BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.0E	Reg BSS (Ku)
22921	1993-076A USA 98 (NATO 4B)	6.3E	iMil (C)
22028	1992-041B Eutelsat II F4	6.9E	Reg (Ku)
21056	1991-003B Eutelsat II F2	11.0E	Reg (Ku)
22557	1993-013A Raduga 29 (Russia)	11.5E	Gov/Mil (C)
22269	1992-088A Cosmos 2224 (Russia)	11.8E	Mil-Early Warning
19596	1988-095A Raduga 22 (Russia)	13.0E	iGov/Mil (C)
21055	1991-003A Italsat 1 (Italy)	13.3E	Dom-Telephone (S/Ku/Ka)
20777	1990-079B Eutelsat II F1	13.7E	Reg (Ku)
21803	1991-083A Eutelsat II F3	16.0E	Reg (Ku)
15383	1984-113B Arabsat 1D (Anik D2)	17.5E	Reg FSS/BSS (C)
21139	1991-015A Astra 1B	19.2E	Reg BSS (Ku)
19688	1988-109B Astra 1A	19.6E	Reg BSS (Ku)
22653	1993-031A Astra 1C	19.9E	Reg BSS (Ku)
22175	1992-066A DFS 3 (Germany)	23.5E	Dom BSS (Ku/Ka)
19331	1988-063B Eutelsat 1 F5	24.7E	Reg (Ku)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	26.3E	Reg (Ku)
21894	1992-010B Arabsat 1C	26.8E	Reg FSS/BSS (S/C)
20706	1990-063B DFS 2 (Germany)	28.5E	Dom BSS (Ku/Ka)
20041	1989-041B DFS 1 (Germany)	33.9E	Dom BSS (Ku/Ka)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
21821	1991-087A Raduga 28 (Russia)	35.0E	Gov/Mil (C)
20953	1990-102A Gorizont 22 (Russia)	39.7E	Dom/Gov (C/Ku)
23010	1994-012A Raduga 31 (Russia)	44.5E	Gov/Mil (C)
21038	1990-116A Raduga 1-2 (Russia)	48.8E	Gov/Mil (C)
22981	1994-008A Raduga 1-3 (Russia)	48.9E	Gov/Mil (C)
22245	1992-082A Gorizont 27 (Russia)	52.6E	Dom/Gov (C/Ku)
19687	1988-109A Skynet 4B (UK)	53.1E	Mil (P/C/Millimeter)
21016	1990-112A Raduga 26 (Russia)	53.7E	Gov/Mil (C)
14421	1983-105A Intelsat 507	56.9E	iInt FSS/Mar (L/C/Ku)
11622	1979-098B DSCS II E15 (USA)	57.0E	Mil-IOR reserve (C)
20667	1990-056A Intelsat 604	59.9E	Int FSS (C/Ku)
14675	1984-009A DSCS III A2 (USA)	60.0E	Mil-IOR primary (P/C)
20315	1989-087A Intelsat 602	62.8E	Int FSS (C/Ku)
20918	1990-093A Inmarsat 2 F1	64.4E	Intl Mar (L/C)
15629	1985-025A Intelsat 510	65.0E	Int FSS (C/Ku)
13636	1982-106A DSCS II F16 (USA)	65.1E	iMil-IOR reserve (C)
13595	1982-097A Intelsat 505	65.6E	iInt FSS/Mar (L/C/Ku)
20499	1990-016A Raduga 25 (Russia)	69.9E	iGov/Mil (C)
20083	1989-048A Raduga 1-1 (Russia)	70.0E	iGov/Mil (C)
22963	1993-002A Gals 1 (Russia)	70.4E	Dom BSS (Ku)
22787	1993-056A USA 95 (UFO-2)	71.2E	iMil-IOR primary (P)
20410	1990-002B Leasat 5 (USA)	71.5E	iMil-IOR reserve (P)
11621	1979-098A DSCS II D14 (USA)	72.0E	iMil-IOR reserve (C)
08882	1976-053A Marisat 2	72.7E	iIntl Mar (P/L)
22027	1992-041A Insat 2A (India)	73.9E	Dom (S/C)
22931	1993-078B Thaicom 1	78.1E	Reg (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	79.5E	Dom/Gov (C/Ku)
20693	1990-061A Cosmos 2085 (Russia)	80.0E	Data Relay (Ku)
21111	1991-010A Cosmos 2133 (Russia)	80.3E	Mil-Early Warning
20643	1990-051A Insat 1D (India)	82.8E	Dom BSS/Met (S/C)
22836	1993-062A Raduga 30 (Russia)	85.0E	Gov/Mil (C)
13969	1983-026B TDRS 1 (USA)	85.3E	iGov (C/Ku)
18922	1988-014A PRC 22 (China)	87.5E	Dom (C)
22880	1993-069A Gorizont 28 (Russia)	90.4E	Dom/Gov (C/Ku)
12474	1981-050A Intelsat 501	91.5E	iInt FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.4E	Dom BSS/Met (S/C)
20263	1989-081A Gorizont 19 (Russia)	96.0E	iDom/Gov (C/Ku)
20473	1990-011A PRC 26 (China)	97.9E	Dom (C)
22210	1992-074A Ekran 20 (Russia)	98.9E	Dom BSS (P)
19683	1988-108A Ekran 19 (Russia)	99.1E	iDom BSS (P)
21922	1992-017A Gorizont 25 (Russia)	103.0E	Dom/Gov (C/Ku)
20558	1990-030A Asiasat 1	105.5E	Reg (C/Ku)
20570	1990-034A Palapa B2R	108.0E	Reg (C)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.4E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.5E	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.5E	Dom (C)
17706	1987-029A Palapa B-2P	112.8E	Reg (C)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.4E	Dom (C/Ku)
21964	1992-027A Palapa B4	117.8E	Reg (C)
23176	1994-040B BS-3N (Japan)	121.0E	Dom BSS (Ku)
21132	1991-014A Raduga 27 (Russia)	128.0E	Gov/Mil (C/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	129.6E	Dom/Gov (C/Ku)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.7E	Dom (C/Ka)
19765	1989-004A Gorizont 17 (Russia)	134.3E	iDom/Gov (C/Ku)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	135.8E	Dom (C/Ka)
23185	1994-043A Apstar A1 (China)	137.9E	Reg FSS (C)
20107	1989-052A Gorizont 18 (Russia)	139.5E	iDom/Gov (C/Ku)
20217	1989-070A GMS 4 (Himawari 4)	140.2E	Met (P/L)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.7E	Reg (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	144.5E	Dom/Gov (C/Ku)
19874	1989-020A JCSAT 1 (Japan)	150.0E	Dom (Ku)
18316	1987-070A ETS V	150.1E	iReg (L/C)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom (Ku)
18350	1987-078A Optus A3 (Aussat K3)	155.9E	Dom (Ku)
22253	1992-084A Superbird A (Japan)	158.0E	Dom (Ku/Ka)
22087	1992-054A Optus B1 (Aussat B1)	160.0E	Dom/Mob (L/Ku)
21893	1992-010A Superbird B (Japan)	162.0E	Dom (Ku/Ka)
16275	1985-109C Optus A2 (Aussat 2)	163.9E	Dom (Ku)
12046	1980-087A OPS 6394 (Fltsatcom F4)(USA)	171.5E	iMil-POR res. (P-Bravo)
22871	1993-066A Intelsat 701	174.0E	Int FSS (C/Ku)
20202	1989-069A DSCS III B9 (USA)	175.0E	iMil-WPAC primary (P/C)
15873	1985-055A Intelsat 511	177.0E	Int FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	178.1E	Mob-POR (L/C)
16117	1985-092C DSCS III B5 (USA)	180.0E	Mil-WPAC reserve (P/C)
14786	1984-023A Intelsat 508	179.9E	iInt FSS/Mar (L/C/Ku)
09478	1976-101A Marisat 3	177.9W	iIntl Mar-POR (P/L/C)
15236	1984-093C Leasat 2 (USA)	177.4W	iMil-POR primary (P)
12994	1981-119A Intelsat 503	177.1W	iInt FSS (C/Ku)
21639	1991-054B TDRS F5 (USA)	174.4W	Gov (C/Ku)
19548	1988-091B TDRS F3 (USA)	171.4W	Gov (C/Ku)
18631	1987-100A Raduga 21	169.9W	iGov/Mil (C)
23175	1994-040A PanAmSat 2 (PAS-2)	164.7W	Reg (C/Ku)
23132	1994-035A USA-104 (UFO-3)(USA)	162.9W	iMil-POR primary (P)
21392	1991-037A Satcom C5 (Aurora II)(USA)	138.9W	Dom (C)
20945	1990-100A Satcom C1 (USA)	135.9W	Dom (C)
22096	1992-057A Satcom C4 (USA)	135.0W	Dom (C)
22915	1993-074A DSCS III B14 (USA)	135.0W	Mil-EPAC primary (P/C)
23016	1994-013A Galaxy 1R (USA)	132.9W	Dom (C)
22117	1992-060B Satcom C3 (USA)	131.4W	Dom (C)
13637	1982-106B DSCS III A1 (USA)	130.0W	iMil-EPAC reserve (P/C)
21906	1992-013A Galaxy 5 (USA)	125.1W	Dom (C)
16649	1986-026A Gstar 2 (USA)	125.0W	Dom (Ku)
15826	1985-048D Telestar 3D (USA)	123.1W	Dom (C)
19484	1988-081B SBS 5 (USA)	123.0W	Dom (Ku)
16274	1985-109B Morelos B (Mexico)	116.8W	Dom (C/Ku)
13652	1982-110C Anik C3 (Canada)	114.9W	iDom (Ku)
17561	1987-022A GOES 7 (USA)	112.7W	Met (L)
21726	1991-067A Anik E1 (Canada)	111.1W	Dom (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.3W	Dom (C/Ku)
14365	1983-098A Galaxy 2 (USA)	107.3W	Dom (C)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom (C/Ku)
14234	1983-077A Telstar 301 (USA)	107.1W	Dom (L/C/Ku)
03029	1967-111A ATS 3 (USA)	105.9W	iExp
08697	1976-017A Marisat 1	105.7W	iIntl Mar-AOR (P/L)
20946	1990-100B Gstar 4 (USA)	105.1W	Dom (Ku)
08747	1976-023B LES 9 (USA)	104.5W	iMil (P/C)
15643	1985-028C Leasat 3 (USA)	104.4W	iMil-CONUS reserve (P)
15677	1985-035A Gstar 1 (USA)	103.1W	Dom (Ku)
22930	1993-078A DBS 1 (USA)	101.3W	Dom BSS (Ku)
21227	1991-028A Spacenet 4 (USA)	101.1W	Dom (C)
17181	1986-096A USA 20 (Fltsatcom F7)(USA)	100.3W	Mil-CONUS primary (P/C)
22796	1993-058B ACTS (USA)	100.0W	Exp (Ka)
22694	1993-039A Galaxy 4 (USA)	99.1W	Dom (C/Ku)
08746	1976-023A LES 8 (USA)	97.6W	i Mil (P/C)
22927	1993-077A Telstar 401 (USA)	97.0W	Dom (C/Ku)
20872	1990-091A SBS 6 (USA)	95.0W	Dom (Ku)
15308	1984-101A Galaxy 3 (USA)	93.5W	Dom (C)
19483	1988-081A Gstar 3 (USA)	92.9W	iDom (Ku)
22205	1992-072A Galaxy 7 (USA)	91.0W	Dom (C/Ku)
23051	1994-022A GOES 8 (USA)	90.1W	Met (L)
22988	1994-009A USA 99 (Milstar 1)	90.0W	Mil (P/K)
18951	1988-018A Spacenet 3R (USA)	86.9W	Dom (L/C/Ku)
15237	1984-093D Telestar 302 (USA)	85.2W	Dom (C)
16482	1986-003B Satcom K-1 (USA)	85.1W	Dom (Ku)
16276	1985-109D Satcom K-2 (USA)	81.0W	Dom (Ku)
15235	1984-093B SBS 4 (USA)	77.1W	Dom (Ku)
14133	1983-059B Anik C2 (Argentina)	76.1W	iDom (Ku)
12309	1981-018A Comstar D4 (USA)	76.1W	iDom (C)
19215	1988-051A Meteosat P2 (ESA)	76.1W	iMet (L)
20873	1990-091B Galaxy 6 (USA)	74.2W	Dom (C)
13651	1982-110B SBS 3 (USA)	74.1W	iDom (Ku)
15642	1985-028B Anik C1 (Argentina)	72.0W	Dom (Ku)
14328	1983-094A Satcom F2R (USA)	72.0W	Dom (C)
16650	1986-026B SBTS 2 (Brazil)	70.0W	Dom (C)
12855	1981-096A SBS 2 (USA)	69.8W	iDom (Ku)
15385	1984-114A Spacenet 2 (USA)	69.3W	Dom (C/Ku)
15561	1985-015B SBTS 1 (Brazil)	65.1W	Dom (C)
21940	1992-021B Inmarsat 2 F4	54.2W	iIntl Mob-AOR-W (L/C)
19121	1988-040A Intelsat 513	53.1W	Int FSS (C/Ku)
20203	1989-069B DSCS III B10 (USA)	52.5W	Mil-WLANT primary (P/C)
14077	1983-047A Intelsat 506	50.1W	iInt FSS (C/Ku)
22314	1993-003B TDRS F6 (USA)	46.3W	Gov (C/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Reg (C/Ku)
16116	1985-092B DSCS III B4 (USA)	42.5W	Mil-ATL reserve (P/C)
19883	1989-021B TDRS F4 (USA)	41.1W	Gov (C/Ku)
23124	1994-034A Intelsat 702	38.1W	Int FSS (C/Ku)
20523	1990-021A Intelsat 603	34.6W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.1W	Mil (P/C)
13083	1982-017A Intelsat 504	31.5W	iInt FSS (C/Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	Dom (Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	Dom (Ku)
21765	1991-075A Intelsat 601	27.5W	Int FSS (C/Ku)
19928	1989-030A Raduga 23 (Russia)	25.6W	iGov/Mil (C)
21653	1991-055A Intelsat 605	24.6W	Int FSS (C/Ku)
23168	1994-038A Cosmos 2282 (Russia)	24.2W	iMil-Early Warning
22112	1992-059A Cosmos 2209 (Russia)	23.8W	Mil-Early Warning
20253	1989-077A USA 46 (Fltsatcom 8)	22.7W	iMil-AOR primary (P-Charlie/K)
21989	1992-032A Intelsat K	21.6W	Int FSS (Ku)
12089	1980-098A Intelsat 502	21.5W	iInt FSS (C/Ku)
15391	1984-115A NATO III D	21.2W	iMil (P/C)
20168	1989-062A TV Sat 2 (Germany)	19.3W	Dom BSS (Ku)
19621	1988-098A TDF 1 (France)	19.0W	Dom BSS (Ku)
20705	1990-063A TDF 2 (France)	18.9W	Dom BSS (Ku)
19772	1989-006A Intelsat 515	18.2W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W	iMil (P/C)
20391	1989-101A Cosmos 2054 (Russia)	15.9W	iTracking & Relay WSDRN (Ku)
21149	1991-018A Inmarsat 2 F2	15.6W	iIntl Mob-AOR-E (L/C)
10669	1978-016A Ops 6391 (FltSatCom 1)(USA)	15.4W	iMil-AOR reserve (P-Alpha)
15386	1984-114B Marecs B2	15.2W	iIntl Mar (L)
20659	1990-054A Gorizont 20 (Russia)	14.4W	iDom/Gov (C/Ku)
18384	1987-084A Cosmos 1888 (Russia)	14.0W	iData Relay
21789	1991-079A Cosmos 2172 (Russia)	13.3W	Data Relay
22009	1992-037A DSCS III B12 (USA)	12.0W	Mil-ELANT primary (P/C)
22041	1992-043A Gorizont 26 (Russia)	10.8W	Dom/Gov (C/Ku)
22912	1993-073B Meteosat 6 (ESA)	9.3W	Met (L)
19876	1989-020B Meteosat 4 (MOP 1)(ESA)	8.3W	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom/Gov (C/Ku)
21939	1992-021A Telecom 2B (France)	5.1W	Dom/Gov (C/Ku)
16101	1985-087A Intelsat 512	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.0W	iMil (P/C)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.8W	Reg BSS (Ku)

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CLASSICAL

Classical Music	E1, 9	6.32 (N)
KUCV-FM, Lincoln, Neb. (Nebraska Public Radio)	S3, 2/4	5.76/5.94 (DS)
Superadio Classical Collections	G5,21	6.30/6.48 (DS)
WFMT-Chicago, Ill.	G5, 7	6.30/6.48 (DS)
WQXR-New York, N.Y.	F4,15	6.30/6.48 (DS)

CONTEMPORARY

CHIN-AM/FM, Toronto, Ontario, Canada (Multilingual)	E2,20	6.83
	E1,13(Ku)	6.83
CKRW-AM, Whitehorse, Yukon, Canada (Adult Contemporary, oldies)	E1,18	5.41, 6.80
In Store Contemporary	S3,18	5.78, 5.96, 6.48
Superadio Light and Lively Rock	G5,21	5.96, 6.12 (DS)
VOCM-AM/FM, St. Johns, Newfoundland, Canada (Adult Contemporary)	E1,12	6.20
WVTY-FM, Pittsburgh, Pa. USA (Adult Contemporary)	F2,16	7.32

COUNTRY

CHON-FM, Whitehorse, Yukon, Canada	E1,12	5.40
CISN-FM, Edmonton, Alberta, Canada (Country 104)	E1,18	7.53/7.62 (DS)
In Store Country	S3,18	6.12
Superadio American Country Favorites	G5,21	5.04/7.74 (DS)
Transtar III Radio Network	S3, 9	5.76/5.94 (DS)
WOKI-FM, Oak Ridge-Knoxville, Tenn.	G3,15	6.20
WSM-AM, Nashville, Tenn.	G5,18	7.38, 7.56
WSM-FM, Nashville, Tenn.	F4,24	7.38

EASY LISTENING

CHFI-FM, Toronto, Ontario, Canada (Soft Adult Contemporary)	E1, 8	5.41/5.58 (DS)
	E1,6/10/12/14)	6.80
Horizon	E1,22	7.62 (N)
In Store Easy Listening	S3,18	6.32, 7.22, 7.40
Superadio Soft Sounds	G5,21	5.58/5.76 (DS)
United Video Easy Listening	F4, 8	5.895 (N)
WZEZ-FM, Nashville, Tenn. (Soft Adult Contemporary, The Wave)	G3,13	6.20

FOREIGN LANGUAGE

Antenna FM (Greek)	G3, 9	5.88, 6.20
CBC Radio-French (East)	E1,20	5.38/5.58 (DS)
	E1,20	7.38/7.58 (DS)
	E1,10(Ku)	5.38/5.58 (DS)
CFGL-FM, Laval, Quebec (French)	E2, 5	7.62
CITE-FM, Montreal, Quebec Canada (French, Soft Adult Contemporary)	E2, 5	5.78
CJMS-AM, Montreal, Quebec Canada (French, Adult Contemporary)	E1, 9	7.58
CJVB-AM, Vancouver, British Columbia, Canada (Ethnic)	E1,15(Ku)	6.12
CKAC-AM, Montreal, Quebec Canada1 (French, Adult Contemporary)	E2, 5	6.44
Foreign language/music	S3,15	5.76
French Canadian audio information service	E2,21	6.46 (N)
French language audio service	E1,21(Ku)	6.55
	E1,24(Ku)	6.55
French language rock station	E2,20	7.72/7.83 (DS)
	E1,13(Ku)	7.72/7.83 (DS)
French music	E1,21(Ku)	6.12/6.20 (DS)
	E1,24(Ku)	6.12/6.30 (DS)
Irish Music (Sat 1430-0000 UTC)	S3, 3	6.20
La Nueva Cadena Radio Christiana (Spanish)	F2, 5	5.96
Los Grandes Groupos-Mexico (Spanish)	SD1,5	6.80
RAI Satelradio (Italian)	F1,15	7.38
Radio Sedeye Iran (Farsi)	S3,15	6.20 (N)
Radio Sonora-Mexico (Spanish)	SD1,6	6.80
Radio Tropical (Haitian Creole)	S2,11	7.60
UPS (Spanish news/music)	F1,20	8.30
WLIR-AM, Spring Valley, N.Y. (Ethnic)	S2, 1	7.60
WNTL-AM, Indian Head, Md. USA (Arabic)	G6,10	6.80, 6.20
WNWK-FM, Newark, N.J. USA (Ethnic)	S2,11	8.30
XEL-AM, Mexico City, Mexico (Spanish)	SD1,5	7.38
XEW-FW, Mexico City, Mexico (W-FM 96.9)	SD1,7	7.38
XEWA-AM, Monterrey, Mexico (Spanish, Super Estelar)	M2, 8	7.38
XEX-AM/FM, Mexico City, Mexico (Spanish, La Super)	M2,14	7.38

JAZZ

KLON-FM, Long Beach, Calif.	G5, 2	5.58/5.76 (DS)
Superaudio New Age of Jazz	G5,21	7.38/7.56 (DS)

NEWS AND INFORMATION

Business Radio Network	F4,10	8.06 (N)
C-SPAN ASAP (Program Schedule)	F3, 7	5.58
C-SPAN II ASAP (Program Schedule)	F4,19	5.58
CJAD-AM, Montreal, Quebec, Canada	E1, 2	6.525 (N)
CNN Headline News	G5,22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
	GST2-2,6(Ku)	6.30
WCBS-AM, New York, N.Y.	G4,20	7.38

RELIGIOUS

Ambassasor Inspirational Radio	S3,15	5.96, 6.48 (DS)
Brother Staire Radio	G5, 6	6.48
CBN Radio Network	G5,11	6.30/6.48 (DS), 6.12
	C3, 1	6.20
Christian Music Service	S2,23	6.20, 7.60
IBN Radio Network	F1,20	7.38
Praise in the Night (occ audio)	S3, 5	6.48
Religious music (easy listening)	G7,14	7.78
KILA-Las Vegas, Nev. (SOS Radio Network)	F4, 8	7.38/7.56 (DS)
Salem Radio Network	S3,15	5.43, 6.34
	S3,17	5.01
Solid Gospel (gospel music)	G7,14	7.58
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
Trinity Broadcasting radio service (Spanish, SAP)	G5, 3	5.96
WROL-AM, Boston, Mass. (occ spanish)	S3, 3	6.20

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ROCK

CFMI-FM, New Westminister, British Colombia, Canada		
(Album Rock, Rock 101)	E1,22	6.80
CFNY-FM, Toronto, Ontario, Canada		
(FM-102)	E1, 2	6.12/6.30 (DS)
CHOZ-FM, St. John's, Newfoundland, Canada		
(OZ-FM)	E2,20	5.76/5.96 (DS)
CILQ-FM, Toronto, Ontario, Canada		
(Q-107)	E1, 2	5.76/5.94 (DS)
CIRK-FM, Edmonton, Alberta, Canada		
(K-97)	E1,18	7.80 (N)
Rock Radio Network	E1,27(Ku)	6.12/6.30 (DS)
Superadio Prime Demo	G5,21	5.22/5.40 (DS)

SPECIALITY FORMATS

CFRN-AM, Edmonton, Alberta, Canada		
(Oldies)	E1,18	6.435
Georgia Radio Reading Service	T401,14(Ku)	5.76
In Store Oldies	S3,18	5.20, 5.40, 7.58
In Touch (reading service)	F5,24	6.48
Nebraska Talking Book Network	S3, 2	6.48
Superaudio Big Bands		
(Sun 0200-0600 UTC)	G5,21	5.58/5.76 (DS)
Superadio Classic Hits (oldies)	G5,21	8.10/8.30 (DS)
Superadio In Touch (reading service)	F4,10	7.87 (N)
Voice Print (reading service)	E1,13	7.44 (N)
Yesterday USA (nostalgia)	G3,17	6.20
	G7,14	5.76
	S3, 5	6.80

VARIETY

AEN Michael Reagan (0100-0700 UTC)	F3, 1	6.20
American Urban Radio	S3, 9	6.30/6.48 (DS)
Cable Radio Network	F3,23	7.24 (N)
CBC Radio	E1,13	5.40, 5.58
CBC Radio (occasional)	E1,20	5.78
CBC-FM, Atlantic	E1,13	6.12/6.30 (DS)
CBC-FM, Eastern	E1,13	5.76/5.94 (DS)
CBM-AM/FM, Montreal, Quebec, Canada		
(Fine Arts/Variety)	E1,20	6.12
CBU-FM, Vancouver, British Columbia, Canada		
(Variety)	E1,22	5.76/5.94 (DS), 7.42
CFWE-FM, Edmonton, Alberta		
(Variety Music)	E1,18	7.875 (N)
E1,14(Ku)	6.45	
CBKA-FM/MBC Radio, La Ronge, Saskatchewan,		
Canada (Multilingual)	E1,18	7.71 (N)
CJRT-FM, Toronto, Ontario, Canada		
(Fine Arts/Jazz-nights)	E1,26(Ku)	5.76/5.94 (DS)
CKER-AM, Edmonton, Alberta, Canada		
(Adult Standard, Ethnic-night)	E1,18	7.42 (N)
CKNM-FM, Yellowknife, NWT, Canada	E1,14	5.41
(Country/Ethnic)	E1,18	7.92
CKUA-AM/FM, Edmonton, Alberta, Canada		
(Variety)	E1, 9(Ku)	5.76/5.94 (DS)
For the People Talk Radio	F1, 2	7.50
Interstate Radio Network	E1, 2	5.22
KBVA-FM, Bella Vista, Ark.	G4, 6	5.58/5.76 (DS)
KNOW-St Paul, Minn. (Minnesota Public		
Radio/BBC overnight)	F4,10	8.26 (N)
KSKA-FM, Anchorage, Alaska		
(Variety/Fine Arts)	F5,24	7.38/7.56 (DS)
KSL-AM, Salt Lake City, Utah	F1, 6	5.58
KUCV-FM, Lincoln, Neb.		
(Nebraska Public Radio)	S3, 2	5.76/5.94 (DS)
Media One (Jazz and World Beat)	T2,15	7.48
Network One radio service	F1,11	7.48
Omega Radio Network	G3,17	5.80
Peach State Public Radio (Georgia)	T401,14(Ku)	5.40/5.58 (DS)
Radio syndicated show feeds	E1, 2	7.54
Seltech Radio Syndicated service	E1, 2	5.40/5.58 (DS)
Skylink Discussion channel	G1,15	5.80
Startalk Radio Network		
(talk/nostalgia music)	G3,11	7.38
Talk America	S3, 9	6.80
The Weather Channel (occasional audio)	C3,13	6.80
The Weather Channel (background music)	C3,13	7.78
USA Radio Network	S3, 5	5.40, 5.76,
5.94,		
6.12		
	S3,13	5.01(Ch 1), 5.20(Ch 2)
United Video background music service	F4, 8	5.90

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Spacenet 2 Transponder 12 (C-band)

1202.300	USIA Radio Marti, Spanish broadcast service to Cuba

Galaxy 6 Transponder 3 (C-band)

1405.600	KIRO-AM (710), Seattle, WA—news/talk/sports talk radio, Seattle Seahawks NFL radio network
1405.400	Sports Byline USA (occ audio)—sports talk/ KQED-FM (88.5), San Francisco, CA--NPR affiliate (ooc audio)/Indy Racing Network (occ audio)
1404.600	Talk America radio network
1404.400	WLW-AM (700), Cincinnati, OH—talk radio, Cincinnati Bengals NFL/Univ of Cincinnati football radio networks
1404.000	American Sports radio network
1403.800	WTMJ-AM (620), Milwaukee, WI—talk radio, Green Bay Packer NFL/Univ of Wisconsin football radio networks
1403.200	Motor Racing Network (occ audio) plus other occ audio
1402.800	Illinois State News Network plus other occ audio
1402.200	Data transmissions
1400.800	WBAL-AM (1090), Baltimore, MD—news/talk radio, Univ of Maryland football radio network
1398.300	WGN-AM (720), Chicago, IL—talk radio, Chicago Bears NFL radio network
1398.000	Detroit Lions NFL/Michigan State football radio networks/occ audio
1397.800	WDBO-AM (580), Orlando, FL—news/talk/ Tampa Bay Buccaneers NFL (occ audio)/Florida State Univ football
1397.600	Univ of Florida football/occ audio
1397.200	WTMJ-AM (620), Milwaukee, WI—talk radio, Green Bay Packers NFL/Univ of Wisconsin football radio networks
1394.700	Sun Radio Network
1394.500	WSB-AM (750), Atlanta, GA—talk radio, Atlanta Falcons NFL/Univ of Georgia football radio networks
1393.600	Florida's Radio Network plus other occ audio
1393.400	WGN-AM (720), Chicago, IL—talk radio, Chicago Bears NFL radio network, Interstate Radio Network plus other occ audio
1393.200	Occ audio
1393.000	James Madison Univ football/Occ audio
1392.700	WGN-AM (720), Chicago, IL—talk radio, Chicago Bears NFL radio network, Interstate Radio Network
1392.300	Occ audio
1391.600	XEPRS-AM (1090), Tijuana, Mexico—spanish language programming, ID-"Radio Express"
1391.200	Miami Dolphins NFL radio network/Occ audio
1390.600	Occ audio
1390.400	Occ audio
1389.700	Occ audio, data transmissions (burst)
1389.500	Data transmissions (burst)
1388.900	One on One Sports Radio Network/WINS-AM (1010), New York City, NY--news (occ audio)/ Florida A & M football
1387.750	Data transmissions
1387.500	KWKW-AM (1330), Los Angeles, CA—spanish language programming, Spanish Information Service, ID-"Radio Lobo"
1386.700	Michigan News Network/Central Michigan football
1386.500	WJR-AM (760), Detroit, MI—talk radio
1385.800	WMAQ-AM (670), Chicago, IL—news
1385.100	For the People radio network
1384.800	KFMB-AM (760), San Diego, CA—news/talk radio
1384.200	KMPC-AM (710), Los Angeles, CA—sports talk radio, L.A. Rams NFL radio network
1383.400	KFRC-AM (610), San Francisco, CA—adult standard
1383.200	KDKA-AM (1020), Pittsburgh, PA—news/talk radio
1383.000	Occ audio
1382.800	Independent Broadcasters Network
1377.900	Occ audio
1377.600	KUSC-FM (91.5), Los Angeles, CA—fine arts, National Public Radio (NPR) affiliate
1377.000	KUSC-FM (91.5), Los Angeles, CA—fine arts, National Public Radio (NPR) affiliate
1376.700	Radio Labio Network—spanish language programming
1375.400	USA Radio Network
1374.100	Northwest Direct—news/talk radio/Oregon State football

Satcom K1 Transponder 12 (Ku-band)

1313.100	Customized IGA spots

Spacenet 3 Transponder 1 (C-band)

1437.200	Associated Press (AP) 3 radio network
1435.000	Associated Press (AP) 2 radio network
1433.400	Associated Press (AP) 1 radio network

Spacenet 3 Transponder 13 (C-band)

1207.900	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.650	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.450	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.200	Good News Radio Network—christian radio
1207.000	Good News Radio Network—christian radio
1206.700	Data Transmission
1206.550	ABC-Satellite Music Network—adult contemporary, Starstation
1206.300	ABC-Satellite Music Network—adult contemporary, Starstation
1206.000	ABC-Satellite Music Network—modern country, Country Coast-to-Coast
1205.850	ABC-Satellite Music Network—modern country, Country Coast-to-Coast
1205.650	ABC-Satellite Music Network—traditional music format, Stardust
1205.400	ABC-Satellite Music Network—traditional music format, Stardust
1204.450	KJAV-FM (104.9), Alamo, TX--Nuevo Radio Christiana Network, Spanish-language religious
1204.250	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1203.550	Salem Radio Network—religious
1203.350	Salem Radio Network—religious
1203.150	Salem Radio Network—religious
1203.000	ABC-Satellite Music Network—urban contemporary, The Touch
1202.800	ABC-Satellite Music Network—urban contemporary, The Touch
1202.250	ABC-Satellite Music Network—golden oldies format, Pure Gold
1202.100	ABC-Satellite Music Network—golden oldies format, Pure Gold
1201.900	ABC-Satellite Music Network—modern rock, The Heat
1201.700	ABC-Satellite Music Network—modern rock, The Heat
1201.500	ABC-Satellite Music Network—Classic Rock
1201.300	ABC-Satellite Music Network—Classic Rock

Galaxy 4 Transponder 1 (C-band)

1444.450	Data transmissions
1443.800	Voice of Free China (ISWBC)
1443.600	WYFR, Oakland, CA "Family Radio Network" (ISWBC)—religious programming/talk
1443.400	Voice of Free China (ISWBC)
1438.300	WWRV-AM (1330), New York, NY—Spanish religious programming/music, ID-"Radio Vision Christiana de Internacional"
1428.100	National Public Radio (NPR) feeds
1427.800	Occ audio
1421.700	Data transmissions
1418.250	Data transmissions
1417.800	Data transmissions
1417.500	Data transmissions

Galaxy 4 Transponder 2 (C-band)

1403.400	Data transmissions
1402.600	WVAQ-FM (101.9), Morgantown, WV—West Virginia Metro News
1402.000	WVAQ-FM (101.9), Morgantown, WV—West Virginia Metro News
1399.000	Occ audio/Texas Tech football/Oklahoma State football
1398.800	Progressive Farmers Network
1398.400	WBNS-FM (97.1), Columbus, OH—oldies, ID - "B-97"/Ohio Network/Ohio State football
1398.200	Occ audio/Iowa State football
1398.000	Oklahoma News Network/Univ of Oklahoma football
1397.600	Ohio Network/Agri Broadcasting Network (Ohio)/WBNS-FM (97.1), Columbus, OH—oldies, ID - "B-97"/Cleveland Browns NFL radio network/Ohio State football
1397.400	Ohio Network/WKNR-AM (1220), Cleveland, OH—sports talk
1397.200	Occ audio/Univ of Tulsa football/Oklahoma State football

Galaxy 4 Transponder 3 (C-band)

1405.000	Mutual Broadcasting System—some syndicated talk shows and news cuts
1404.800	KOA-AM (850)/KTLK-AM (760)—news/talk, Denver Broncos NFL radio network/Univ of Colorado football
1404.600	ABC Information network programming/Penn State football
1404.400	Univ of South Carolina football
1404.000	ABC Information network programming, Tennessee Radio Network farm news
1403.800	WNTL-AM (1030), Indian Head, MD - multicultural programming
1403.500	International Broadcasting Network—Lutheran religious programming, Home Front program (Sat 10a-2p)
1403.000	Minnesota Public Radio Network
1402.400	KNOW-FM (95.3), St. Paul, MN—fine arts, Minnesota Public Radio (occ audio)
1402.100	KNOW-FM (95.3), St. Paul, MN—fine arts, Minnesota Public Radio
1401.800	BBC World Service
1398.500	WBAP-AM (820), Ft Worth, TX--talk radio, ID-"Newstalk 820"
1398.300	KRLD-AM (1080), Dallas, TX—talk radio, Texas Radio Network
1398.000	ABC Radio News (Standard) Occ audio
1397.800	KTRH-AM (740), Houston, TX—news/talk radio, Houston Oilers NFL radio network
1397.500	Minnesota Talking Book Network
1397.300	WFBC-AM/FM (1330/93.7), Greenville, SC—news/talk/oldies, Clemson University sports flagship
1396.900	Spanish Information Service (SIS) radio network (Spanish)
1396.700	ABC Radio News (Standard), Tennessee Radio Network plus other occ audio/Florida States Univ football
1396.400	Georgia Network News/Univ of Georgia football
1396.200	WCNN-AM (680), Atlanta, GA—all sports talk radio
1396.000	WHUR-FM (96.3), Washington, DC—urban contemporary
1395.800	ABC Radio News (Standard), Occ audio/Univ of Kentucky football
1395.500	American Public Radio - Monitor Radio programming
1395.100	National Public Radio (Channel 12)

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1394.600	WHAS-AM (840), Louisville, KY--adult contemporary.Univ of Louisville football
1394.400	National Public Radio (Channel 11)
1394.000	National Public Radio (Channel 10), American Public Radio carrying Monitor Radio programming
1393.000	Univ of Minnesota football
1392.600	National Public Radio (Channel 9), American Public Radio
1392.300	National Public Radio (Channel 8)
1392.000	Occ audio
1391.700	National Public Radio (Channel 7)
1391.400	Weak carrier of Cadena Radio Centro (CRC)—probably a backhaul channel for CRC
1391.100	Associated Press (AP) radio network—news
1388.900	Data transmissions (burst)
1388.400	KSJV-FM (91.5), Fresno, CA—spanish programming, ID - Radio Bilingue (network serving stations in several western states)
1388.100	National Public Radio (Channel 6)
1387.800	Data transmissions (constant)
1387.500	National Public Radio (Channel 5)
1387.200	National Public Radio (Channel 4)
1396.800	National Public Radio feeds
1386.200	KSJV-FM (91.5), Fresno, CA—spanish programming, ID - Radio Bilingue (network serving stations in several western states)
1385.800	National Public Radio (Channel 3) and occ U.S. Naval Observatory Master Clock
1385.400	U.S. Naval Observatory Master Clock and National Public Radio (Channel 2)
1385.000	National Public Radio feeds
1384.700	National Public Radio (Channel 1)
1384.300	KOA-AM (850), Denver, CO/KTLK-AM (760), Denver, CO--news/talk, Denver Broncos NFL radio network/Univ of Colorado football
1383.700	Mutual Broadcasting Network/Independent Network News (INN)
1383.400	KRLD-AM (1080), Dallas, TX—talk radio, Texas State News network
1383.100	Mutual Broadcasting System and VSA Radio Network—Ag news
1382.900	Minnesota Radio Network/Minnesota Viking NFL radio network/Univ of Minnesota football
1382.600	Soldiers Radio Satellite (SRS) network—U.S. Army information and music/Army football
1382.300	Motor Racing Network (Occ audio)
1382.000	Univ of Tennessee football/Occ audio
1381.800	WHO-AM (1040), Des Moines, IA—talk radio/Univ of Iowa football
1381.600	Alabama Radio Network
1381.400	Occ audio/Baylor football
1377.700	Minnesota Public Radio network
1377.400	Data transmission (packet burst/tones)
1377.100	In-Touch—reading service for blind
1376.800	Alabama Information Network (Alanet)/Auburn football
1376.000	Kansas Audio Reader Network

Galaxy 4 Transponder 4 (C-band)

1387.500	Dakota Sports network/Dakota News network
1387.100	Mutual Broadcasting System
1385.100	Mississippi Radio Network auxiliary channel
1384.800	Mississippi Radio Network
1381.800	Data transmissions
1379.000	Louisiana Network/New Orleans Saints NFL radio network/ Louisiana Tech football
1378.800	WWL-AM (870), New Orleans, LA--talk radio/Louisiana Network
1378.600	Arkansas Radio Network/Univ of Arkansas football
1378.100	Data Transmissions
1377.800	Bible Broadcasting Network—religious
1377.500	Bible Broadcasting Network—religious
1377.300	WWL-AM, New Orleans, LA—talk radio, Louisiana Network/Tulane Univ football/S.W. Louisiana football
1376.000	Data Transmissions
1375.600	KISN-AM (570), Salt Lake City, UT—sports talk

Galaxy 4 Transponder 1 (Ku-band)

973.200	Data transmissions
971.100	Data transmissions
969.000	Data transmissions
968.400	Data transmissions
966.900	Data transmissions
959.700	Oldies music
959.500	Oldies music
959.200	Satellite Music Network, Real Country—country and western music
959.000	Satellite Music Network, Real Country—country and western music
958.800	Data transmissions
958.000	Data transmissions
957.900	Occ audio
957.700	Russian-American Radio Network—foreign language audio service
957.500	Russian-American Radio Network—foreign language audio service

Anik E1 Transponder 11 (C-band)

1246.000	Radio Canada International
1245.500	Canadian Broadcasting Company (CBC) Radio - Yukon service
1243.800	Data transmissions

Anik E1 Transponder 13 (C-band)

1206.000	Canadian Broadcasting Company (CBC) Radio - southwestern Northwest Territories service
1205.500	Canadian Broadcasting Company (CBC) Radio - southwestern Northwest Territories service - Occ carrier

Anik E1 Transponder 14 (C-band)

1166.000	Canadian Broadcasting Company (CBC) Radio - eastern Northwest Territories service

Anik E1 Transponder 17 (C-band)

1126.000	Canadian Broadcasting Company (CBC) Radio - northern Northwest Territories service
1125.500	Canadian Broadcasting Company (CBC) Radio - Newfoundland/Labrador service

Anik E1 Transponder 19 (C-band)

1086.000	Canadian Broadcasting Company (CBC) Radio - Quebec/Labrador service
1085.500	Canadian Broadcasting Company (CBC) Radio - CBQ-FM (101.7), Thunder Bay, ON—fine arts/variety

Anik E1 Transponder 21 (C-band)

1024.300	Weather Conditions/Warnings
1019.000	CKRW-AM (610), Whitehorse, Yukon Territory—adult contemporary/oldies.

Note: This transponder also has 62 other carriers consisting of data transmissions and 6 blank audio carriers.

SBS5 Transponder 2 (Ku-band)

1001.000	Wal-Mart In-store Network
1009.800	Sam's Club Office Supplies In-store Network
1010.200	Sam's Club In-store Network
1010.600	Wal-Mart In-store Network

RCA C5 Transponder 3 (C-band)

1404.800	RFD Radio Service
1404.600	Wyoming News Network/Univ of Wyoming football
1404.400	KNHN-AM (1340) Kansas City, KS—news/talk radio, ID - "CNN 1340 Voice of the Heartland"/Kansas State football
1400.600	Brownfield Network plus other occ audio/Indiana Univ football
1400.400	Brownfield Network plus other occ audio
1400.200	Occ audio
1400.000	Brownfield Radio Network plus other occ audio/Purdue Univ football
1396.600	Kansas Information Network/Kansas Agnet/S.W. Missouri State football
1396.400	Nebraska Ag Network/Illinois Univ football/Nebraske football
1396.200	KMOX-AM (1120), St. Louis, MO—news/talk radio, Missouri Network/Univ of Missouri football
1395.700	WIBW-AM (580), Topeka, KS—news/talk radio, Missouri Net/Kansas City Chiefs NFL radio network/Univ of Missouri football
1390.000	Occ audio
1387.300	WPTF-AM (680), Raleigh, NC—news/talk radio
1387.100	KMOX-AM (1120), St. Louis, MO—news/talk radio, Missouri Network (occ audio), Univ of Missouri football
1386.900	Brownfield Network - Farm—Ag news/Kansas football
1386.200	Radio Iowa/Iowa football
1384.600	North Carolina News Network and Capitol Sports Network/Washington Redskins NFL radio network
1384.400	Occ audio/Duke Univ football
1384.200	Occ audio/East Carolina football
1384.000	Occ audio
1383.600	Occ audio
1383.400	Occ audio/North Carolina State football
1382.900	Missouri Network/Univ of Missouri football
1382.600	North Carolina News Network
1382.300	Virginia News Network/Univ of Virginia football
1378.700	Radio Pennsylvania Network/Philadelphia Eagles NFL radio network
1378.500	Radio Pennsylvania Network/Washington Redskins NFL radio network
1378.300	Radio Pennsylvania Network/Villanova football
1374.600	National Association of Broadcasters (NAB)—Occ audio and various sports radio network broadcasts (Occ audio)

RCA C5 Transponder 9 (C-band)

1281.000	Armed Forces Radio and Television Service (AFRTS) 2
1280.700	Armed Forces Radio and Television Service (AFRTS) 1

RCA C5 Transponder 21 (C-band)

1045.000	Occ audio
1043.600	Unistar Radio—Today's Hits, Yesterday's Favorites
1043.400	CNN Radio Network
1043.200	Unistar Radio—Today's Hits, Yesterday's Favorites
1042.800	Unistar Radio—Original Hits
1042.600	Unistar Radio—Original Hits
1042.400	Unistar Radio—Good Times and Great Oldies
1042.200	Data Transmissions
1042.000	Unistar Radio—Good Times and Great Oldies
1041.800	CNN Radio Network
1034.400	Unistar Radio—Hits from 60s, 70s, 80s, and Today
1034.200	Data transmissions
1034.000	Unistar Radio—Hits from 60s, 70s, 80s, and Today
1033.200	Unistar Radio—Country/Western
1032.800	Data Transmissions
1032.400	Unistar Radio—Country/Western
1029.000	Occ audio

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69 deg	Satcom F2R (F2) 72 deg	Galaxy 6 (G6) 74 deg	Telstar 302 (T2) 85 deg	Spacenet 3 (S3) 87 deg	Galaxy 7 (G7) 91 deg	Galaxy 3 (G3) 93.5 deg	Telstar 401 (T1) 97 deg	Galaxy 4 (G4) 99 deg	Spacenet 4 (S4) 101 deg	Anik A1 107.…
1	SC New York [V2+]	Channel America	o/v	Data Transmissions	SCPC/FM2 (AP) services	BBC Breakfast News/o/v	o/v	Exxxtasy (Adult) [V2+]/Movie Greats Network/VTC/o/v	SCPC services	Data Transmissions	Metro I… (Fren…
2	GEMS TV (Spanish) [V2+]	o/v	o/v	VA Education Sat Network/o/v	Nebraska Educational TV (NETV)	CBS West [VC1]	SSN Empire [V2+]	(none)	SCPC services	Data Transmissions	(non…
3	USIA Worldnet TV	Madison Square Garden 2 [V2+]/NHK feeds/o/v	SCPC services	o/v	WSBK Ind Boston [V2+]	Action PPV [V2+]	Data Transmissions	Parmount feeds/o/v	SCPC services	Data Transmissions	Dat… Transmi…
4	Canal de Canales SUR (Spanish)	o/v	o/v	VESN/o/v	Nebraska Educational TV (NETV)	FX East	Data Transmissions	FOX news feeds [occ Leitch]	SCPC services	Data Transmissions	CBC New… Intl [L…
5	NASA Contract Channel [Leitch]	Main Street TV	NHK New York feeds	HBO 2 East [V2+]	KTVT Ind Dallas [V2+]	FX West	RTPI Eurovideo	o/v	o/v	Data Transmissions	CFTM-M… (Fren…
6	Data Transmissions-G	Merchandise Entertainment TV (MET)	Univision feeds [SA MPEG-DVC]	Barry Bargain Home SHopping/VESN/o/v	(none)	o/v	Data Transmissions	Buena Vista TV feeds	National Christian Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	Dat… Transmi…
7	Data Transmissions	Skyvision	o/v	Satellite City Home Shopping/o/v	Data Transmissions	Best of NASA Select/o/v	TV Asia [V2+]	FOX feeds [occ Leitch]	o/v	Data Transmissions	Dat… Transmi…
8	Data Transmissions	WPLG ABC Miami [V2+]	o/v	o/v	Data Transmissions	Phoenix Grayhound Park [Leitch]/o/v	Las Vegas TV Network [V2+]/o/v	PBS X	Telemundo [Digicipher]	KDMD-ABC Seattle (PT24W) [V2+]	Globa… [Leitch]/… fee…
9	NASA Select TV	Unid Svc [BMAC]	MuchMusic U.S. [V2+]	HBO 3 East [V2+]	WPIX Ind New York [V2+]	o/v	Antenna Satellite TV [V2+]/Satellite Market USA	FOX feeds [occ Leitch]	o/v	Data Transmissions	Dat… Transmi…
10	Data Transmissions-G	WUSA CBS Washington [V2+]	Arab Network of America (ANA)	VESN/o/v	Data Transmissions	o/v	ESPN Internationaol [B MAC]	FOX feeds [occ Leitch]	WABC-ABC New York (PT24E) [V2+]	WFLD-Fox Chicago (PT24) [V2+]	Dat… Transmi…
11	SC Philadelphia [V2+]	Home Shopping Club Spree (HSC)	Data Transmissions	o/v	CNN feeds	Estacion Montellano (Spanish rel)/o/v	Keystone International (Rel)	ABC feeds [Leitch]	o/v	o/v	Dat… Transmi…
12	Data Transmissions	o/v	o/v	Data Transmissions	Data Transmissions	VSN/o/v [B MAC]	University Network-Dr Gene Scott (Rel)	ABC Newsone Channel	o/v	KPIX-CBS San Francisco (PT24W) [V2+]	CTV (B…
13	Data Transmissions	Outdoor Channel	Independent Film Channel [V2+]	FLIX [V2+]	SCPC/FM2 services	o/v [B MAC]	Video Catalog Channel (VCC)	FOX feeds East [occ Leitch]	o/v	Data Transmissions	o/…
14	Data Transmissions	WBZ NBC Boston [V2+]	Cornerstone TV WPCB-TV (Rel)	HBO 2 West [V2+]	CNN [Leitch]	Familynet	o/v	FOX feeds West [occ Leitch]	WRAL-CBS Raleigh (PT24E) [V2+]	Data Transmissions	o/…
15	Data Transmissions	NPS Preview Channel	Midwest Sports Channel [V2+]	The Cupid Network (Adult) [V2+]	KTLA Ind Los Angeles [V2+]	TVI [V2+]	Video Catalog Channel (VCC)	Prostar Sports [BMAC]	World Harvest TV (Rel)	Data Transmissions	o/…
16	Data Transmissions	SSN KBL [V2+]	o/v	VESN/o/v/TV Erotica (Adult) [V2+]	CNN International [Leitch]	[B MAC]/o/v	ESPN International [B MAC]	Exxxtasy Promo Channel/ABC feeds/o/v	CBS West [VC1]	Data Transmissions	CTV (G…
17	Data Transmissions	o/v	Tokyo BS New York feeds	All News Channel [V2+]	FM2/WEFAX services	Dubai TV	Shop at Home (SAH)	ABC feeds/o/v	CBS East [VC1]	Data Transmissions	o/…
18	(none)	American Ind. Network	o/v	o/v	3ABN	CBS feeds/o/v	ABC feeds [Leitch]/o/v	N.C. Open Net/ABC feeds/o/v	CBS feeds [VC1]/o/v	Data Transmissions	Exxxtasy…
19	Data Transmissions	NHK New York feeds	o/v	o/v	SSN Sportsouth [V2+]	CBS East [VC1]	Via TV Shopping	o/v	CBS East [VC1]	Data Transmissions	TV Nort… Canada (…
20	Armed Forces Radio & Television Service [B MAC]	NHK Tokyo feeds/o/v	CNN Headline News Clean Feed [V2+]	La Cadena de Milagro (Spanish Rel)	o/v	Natl Empowerment TV (NET)	o/v	ABC feeds [Leitch]	CBS East [VC1]	Data Transmissions	Newfound… (NT…
21	New England Cable News (NECN)	o/v	o/v	Cinemax 2 East [V2+]	SSN Pro Am Sports (Pass) [V2+]	BET Jazz	America's Collectables Network (ACN)	ABC East [Leitch]	Warner Brothers/o/v	Data Transmissions	TV 5 (Fr…
22	Newsport [V2+]	o/v	Belmont Park Horse Racing [B MAC]/o/v	o/v	Data Transmissions	The Talk Channel	o/v	ABC West [Leitch]	WXIA-NBC Atlanta (PT24E) [V2+]	Data Transmissions	5DT…
23	SC New England [V2+]	Data Transmissions	Worship TV (Rel)	Showtime 2 [V2+]	SSN Home Teams Sports (HTS) [V2+]	o/v	Access America/o/v	ABC feeds [Leitch]	Ostrich-Emu TV/RAI/o/v	Data Transmissions	o/v…
24	SC New York Plus-o/v [V2+]	o/v	Pimlico Track Horse Racing [Leitch]/o/v	VESN/o/v	(none)	o/v	World Collectables Network (WCN)	o/v	CBS Newspath/feeds	Data Transmissiosn	CTV (R…

Satellite Transponder Guide

By Robert Smathers

(?2) deg	Solidaridad 1 (SD1) 109.2 deg	Telesat A2 (E1) 111 deg	Morelos 2 (M2) 116.8 deg	Telstar 303 (T3) 123 deg	Galaxy 5 (G5) 125 deg	Satcom C3 (F3) 131 deg	Galaxy 1R (G1) 133 deg	Satcom C4 (F4) 135 deg	Satcom C1 (F1) 137 deg	
ledia ch)	(none)	Data Transmissions	Data Transmissions	TVN 1 PPV [V2+]	Disney East [V2+]	Family Channel West [V2+]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	o/v	1
e)	SCPC services	The Sports Network [Oak]	Data Transmissions	TVN 2 PPV [V2+]	Playboy (Adult) [V2+]	The Learning Channel	Galavision/Univision/Telemundo (Spanish) [SA MPEG]	Request TV PPV [GI Digicipher]	KUSA ABC Denver [V2+]	2
ssions	SCPC services	Data SCPC	Data Transmissions	TVN 3 PPV [V2+]	Trinity Broadcasting (Rel)	Viewer's Choice PPV [V2+]	Encore [V2+]	Nickelodeon East [V2+]	KRMA PBS Denver [V2+]	3
sworld itch]	(none)	Data SCPC	Data Transmissions	TVN 4 PPV [V2+]	Sci Fi [V2+]	Lifetime West [V2+]	TV Food Net/Canal de Noticias	Lifetime East [V2+]	SC Pacific [V2+]	4
ntreal ch)	XHIMT canal 7	Data SCPC	Data Transmissions	TVN 5 PPV [V2+]	CNN [V2+]	VISN/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KOVR Fox Denver [V2+]	5
ssions	Telemax	WDIV NBC Detroit [Oak]	Data Transmissions	TVN 6 PPV [V2+]	WTBS Ind Atlanta [V2+]	Court TV	Z Music	Madison Square Garden 1 [V2+]	KMGH CBS Denver [V2+]	6
ssions	XEQ-TV canal 9	Data SCPC	Data Transmissions	TVN 7 PPV [V2+]	WGN Ind Chicago [V2+]	C SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN Primeticket [V2+]	7
TV Global ls	(none)	CHCH Ind Hamilton [Oak]	XHGC canal 5	TVN 8 PPV [V2+]	HBO West [V2+]	QVC Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC East	8
ssions	o/v	The Weather Network (English)	XHFM Super Canal [B MAC]	TVN 9 PPV/CVS [V2+]	ESPN [V2+]	Music Choice [digital audio]	ESPN2 Blackout [V2+]/SAH	QVC Network	Encore Analog Multiplex (screen in 1/4s)	9
ssions	Mexican Parliament	WXYZ ABC Detroit [Oak]	SEP	(none)	MOR Music	Home Shopping Club 2	America's Talking	Home Shopping Club 1	SSN HSE [V2+]	10
ssions	(none)	CBC-North Pacific feed	CMC [B MAC]	Data Transmissions	Family Channel East [V2+]	Prime Network [V2+]	Eternal Word TV Network (Rel)	The Box	Network One 'N1'	11
lue)	Data Transmissions	WJBK CBS Detroit [Oak]	Data Transmissions	Data Transmissions	Discovery West [V2+]	The History Channel	Valuevision	Nustar (Promo Channel)	o/v	12
	(none)	CBC Newsworld [Oak]	XEIPN canal 11	TVN PPV o/v [V2+]/o/v	CNBC [V2+]	The Weather Channel [V2+]	Encore [GI Digicipher]	Travel Channel [V2+]	SC Chicago [V2+]	13
	Data Transmissions	WTVS PBS Detroit [Oak]	XEW canal 2	o/v	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Blackout [V2+]/SAH	Cable Health Club	KCNC NBC Denver [V2+]	14
	Multivision [GI Digicipher]	CBFT CBC (French)	Data Transmissions	Data Transmissions	HBO East [V2+]	Showtime East [V2+]	Shop at Home SAH/o/v	WWOR Ind New York [V2+]	SC Ohio/Florida/Cincinnati [V2+]	15
een)	Data Transmissiosn	Global TV [Oak]/Global feeds	o/v	(none)	Cinemax West [V2+]	MTV West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Newsport [V2+]	16
	(none)	CBC feeds/o/v	o/v	Adam & Eve (Adult) [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN Prime Network Rocky Mtn [V2+]	17
l [V2+]	(none)	CITV Ind Edmonton [Oak]	Test Pattern	(none)	TNN [V2+]	Nickelodeon West [V2+]	HBO Multiplex [GI Digicipher]	Viewer's Choice [GI Digicipher]	SSN Prime Network Upper Midwest [V2+]/STEP/o/v	18
hern TVNC)	Multivision [GI Digicipher]	SCPC/o.v	CNI News	Spice 2 PPV (Adult) [V2+]	USA East [V2+]	Showtime/MTV [GI Digicipher]	Cinemax East [V2+]	C SPAN 2	FoxNet	19
land TV)	(none)	CBMT CBC (English)	Data Transmissions	Spice/TVN 10 PPV (Adult) [V2+]	BET	Jones Intercable [GI Digicipher]	(none)	Showtime West [V2+]	International Channel [V2+]	20
ench)	(none)	SCPC services	(none)	TVN PPV o/v [V2+]	MEU	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Prime Ticket Networks [GI Digicipher]	21
V	Caliente Jai Alai/Caliente greyhound racing	BCTV CTV Vancouver [Oak]	o/v	SCOLA	CNN/HN [V2+]	Americana TV	Nostalgia Channel	Movie Channel West [V2+]	SSN PSNW [V2+]/STEP/o/v	22
	(none)	CBC-North Atlantic feed	(none)	TVN PPV o/v [V2+]/o/v	A&E [V2+]	E! Entertainment TV	Unid user [digital]	VH 1 [V2+]	KWGN Ind Denver [V2+]	23
ed)	(none)	Superchannel [Oak]	XHOF canal 13	TVN Preview/TVN PPV o/v [V2+]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio [Digital Audio]	Univision (Spanish)	CMT [V2+]	SSN Sunshine [V2+]	24

Unscrambled/non-video

Subscription

Not available in U.S.

o/v = occasional video

International Shortwave Broadcasters via Satellite

By Larry Van Horn

WORLD RADIO NETWORK ONE SCHEDULE

North American Service Schedule

Galaxy 5, Transponder 6 (WTBS), 3.820 GHz.
Vertical Polarization, Audio Subcarrier 6.80 MHz.

All broadcast are daily unless otherwise indicated.

UTC	SERVICE/PROGRAM	EDT/PDT
0000	Radio Sweden - Stockholm	2000/1700
0030	Kol Israel - The Voice of Israel	2030/1730
0100	YLE Radio Finland - Helsinki	2100/1800
0130	Radio Netherlands - Hilversum	2130/1830
0230	Blue Danube Radio - Vienna	2230/1930
0300	YLE Radio Finland - Helsinki	2300/2000
0330	Vatican Radio	2330/2030
0400	Radio Canada International - Montreal	0000/2100
0430	BBC Europe Today (Mon-Sat)	0030/2130
	BBC International Call (Sun)	0030/2130
0500	Deutsche Welle - Germany	0100/2200
0600	Radio Canada International - Montreal	0200/2300
0630	Swiss Radio International - Berne	0230/2330
0700	Radio Australia - Melbourne	0300/0000
0800	Radio Korea - Seoul	0400/0100
0900	Radio Moscow International (Mon-Fri)	0500/0200
	Topical Tapes-Intl Call (Sat)	0500/0200
	BBC Science Magazine (Sun)	0500/0200
0930	Radio Netherlands - Hilversum	0530/0230
1030	Kol Israel - The Voice of Israel	0630/0330
1100	Radio Australia - Melbourne	0700/0400
1200	Radio Telefis Eireann (RTE) - Dublin	0800/0500
1300	Radio France International - Paris	0900/0600
1400	YLE Radio Finland - Helsinki	1000/0700
1430	Radio Vlaanderen - Brussels Calling	1030/0730
1500	ABC Radio Australia	1100/0800
1600	Blue Danube Radio - Vienna (Mon-Sat)	1200/0900
	United Nations Radio (Sun)	1200/0900
1630	Radio Netherlands until 1655 UTC (Mon-Fri)	1230/0930
	Radio Netherlands until 1730 UTC (Sat & Sun)	1230/0930
1700	Radio France International (French) (Mon-Fri)	1300/1000
	RTE - News at 1730 (Sat & Sun)	1300/1000
1800	Radio Australia - Melbourne	1400/1100
1900	Kol Israel - The Voice of Israel	1500/1200
1930	Radio Vlaanderen - Brussels Calling	1530/1230
2000	Radio Sweden - Stockholm	1600/1300
2030	BBC Europe Today (Mon-Fri)	1630/1330
	Topical Tapes - International Call (Sat)	1630/1330
	BBC Europe Today (Sun)	1630/1330
2100	RTE - Both Sides Now (Mon-Fri)	1700/1400
	Radio Telefis Eireann (RTE) (Sat & Sun)	1700/1400
2300	BBC Newsdesk - London	1900/1600
2330	RTE - News from Dublin (Mon-Fri)	1930/1630
	RTE - News & Sport (Sat)	1930/1630
	RTE - News (Sun)	1930/1630

European Service Schedule

Astra-1B, Transponder 22 (MTV Europe), 11.538 GHz
Vertical Polarization, Audio Subcarrier 7.38 MHz

All broadcast are daily unless otherwise indicated, time zone is British Standard Time.

BST	SERVICE/PROGRAM
0000	National Public Radio (NPR) All Things Considered
0130	NPR Rhythm Review (Mon-Fri & Sun)
	NPR Piano Jazz (Sat)
0230	Radio Netherlands - Hilversum
0330	NPR/BBC Topical Tape Features (Mon-Fri)
	NPR Living on Earth (Sat)
	NPR Horizons (Sun)
0400	YLE Radio Finland - Helsinki
0430	Radio Vatican
0500	Central Europe Today - Budapest (Mon-Fri)
	Radio Canada International (Sat & Sun)
0530	BBC Europe Today (Mon-Sat)
	Topical Tapes - International Call (Sun)
0600	NPR All Things Considered
0800	Radio Australia - Melbourne
0900	Radio Korea - Seoul
1000	Radio Moscow International (Mon-Fri)
	Topical Tapes - International Call (Sat)
	Topical Tapes - Science Magazine (Sun)
1030	Radio Netherlands - Hilversum
1130	Kol Israel - The Voice of Israel
1200	NPR Morning Edition Part 1 (Mon-Fri)
	NPR News Features (Sat & Sun)
1300	NPR Morning Edition Part 2 (Mon-Fri)
	NPR Weekend Edition (Sat & Sun)
1400	Radio France International - from Paris
1500	YLE Radio Finland - Helsinki
1530	Radio Vlaaderen International - Brussels
1600	Radio Australia - Melbourne
1700	Blue Danube Radio - Vienna (Mon-Sat)
	United Nations Radio (Sun)
1730	Radio Netherlands - Hilversum
1830	Radio Telefis Eireann (RTE) - Irish news from Dublin (Mon-Fri)
	Radio Telefis Eireann (RTE) - News & Sport from Dublin (Sat & Sun)
1900	NPR Talk of the Nation Part 1 (Mon-Fri)
	C-SPAN Journal - Washington (Sat)
	NPR Living on Earth & Horizons (Sun)
2000	NPR Talk of the Nation Part 2 (Mon-Fri)
	NPR Afropop Worldwide (Sat)
	NPR Piano Jazz (Sun)
2100	Radio Sweden - Stockholm
2130	BBC Europe Today (Mon-Fri & Sun)
	Topical Tapes - International Call (Sat)
2200	NPR All Things Considered

WRN One schedules are subject to change. European listeners should listen to WRN for details, on Astra 1B or turn to page 222 of MTV text. All programs in English unless otherwise noted.

C-SPAN AUDIO SERVICES

C-SPAN Audio 1

Satcom C3 (F3), Transponder 7 (C-SPAN 1), 3.840 GHz
Vertical Polarization, Audio Subcarrier 5.20 MHz

All broadcast are daily and taped unless otherwise indicated.

UTC	SERVICE/PROGRAM	EDT/PDT
0000	Radio Havana Cuba(Live)	2000/1700
0100	Radio Japan (Live)	2100/1800

International Shortwave Broadcasters via Satellite

0200	Classical Music	2200/1900
0300	Deutsche Welle - Germany (Live)	2300/2000
0400	China Radio International (Live)	0000/2100
0500	Classical Music	0100/2200
0530	Radio Austria International (Live)	0130/2230
0600	Voice of America (Live)	0200/2300
0700	Classical Music and schedule information until 1030 except Thursday and Friday 0800 - 0900 UTC	0300/2400
0800	Paris Rendezvous until 0900 UTC (Thu)	0400/0100
	Israel Magazine until 0900 UTC (Fri)	0400/0100
1030	Radio Korea - Seoul (Live)	0630/0330
1100	Radio Japan - Tokyo (Live)	0700/0400
1200	Open House (Mon) (Live)	0800/0500
	As It Happens - Canadian Broadcasting Corp (Tue-Fri) (Live)	0800/0500
	Classical Music (Sat & Sun)	0800/0500
1300	Classical Music and Schedule Information or Historical Speeches Programs (Mon/Thu/Fri until 1600 UTC, Tue-Wed until 1700 UTC	0900/0600
	Paris Rendezvous, Sweden Today, Israel Magazine (Sat until 1500 UTC)	0900/0600
	Radio Canada International - Sunday Morning (Live) (Sun until 1600 UTC)	0900/0600
1500	Classical Music (Sat until 1700 UTC)	1100/0800
1600	Weekly C-SPAN Radio Journal (Mon until 1700 UTC)	1200/0900
	Paris Rendzevous (Thu until 1700 UTC)	1200/0900
	Israel Magazine (Fri until 1700 UTC)	1200/0900
	Classical Music (Sun until 1700 UTC)	1200/0900
1700	Voice of America Worldwide English Service until 0000 UTC (Live)	1300/1000

C-SPAN Audio 2

Satcom C3 (F3), Transponder 7 (C-SPAN 1), 3.840 GHz
Vertical Polarization, Audio Subcarrier 5.40 MHz

BBC World Service in English is broadcast continuously 24 hours a day on this audio subcarrier.

DEUTSCHE WELLE

Satcom C4 (F4), Transponder 5 (Deutsche Welle TV), 3.800 GHz
Vertical Polarization

The following subcarriers carry Deutsche Welle programming and other foreign language programming:

7.02 7.22 7.42 7.58 7.78 7.95 8.30 MHz

RADIO FRANCE INTERNATIONAL

Spacenet 2, Transponder 2 (GEMS TV), 3.740 GHz
Vertical Polarization, Audio Sub-Carrier 5.80 MHz

RFI broadcast can be heard in a variety of languages throughout a 24 hour period.

VOICE OF AMERICA (United States Information Agency)

Voice of America transmits in a variety of languages on the following audio subcarriers and satellites.

NTSC 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 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

Satellites

Eutelsat II F1, 13.3 degrees east, Transponder 27, 11.163 GHz, PAL system
Intelsat 510, 66.0 degrees east, Transponder 38, 4.1775 GHz, PAL system
Intelsat 601, 27.5 degrees west, Transponder 14, 3.995 GHz, PAL system
Intelsat 601, 27.5 degrees west, Transponder 21, 3.742 GHz, PAL system
Spacenet 2, 69.0 degrees west, Transponder 2H, 3.760 GHz, NTSC system
Intelsat 508, 180 degrees west, Transponder 14, 3.974 GHz, PAL system

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)

Spacenet 2, Transponder 20 (AFRTS), 4.100 GHz
Vertical Polarization, Audio Sub-carrier 7.41 MHz

AFRTS Radio Service can be heard on this transponder carrying a variety of radio network news and sports programming for servicemen, their families overseas and sailors aboard Navy ships.

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

Galaxy 4, Transponder 15 (World Harvest TV Network), 4.000 GHz
Horizontal Polarization

Religious broadcaster WHRI/KHWR uses audio subcarriers to feed three shortwave broadcast transmitters as follows:

7.46 and 7.55 MHz WHRI programming relayed to shortwave broadcast transmitters in Indianapolis, Indiana for transmissions beamed to Europe and Americas.
7.64 MHz KHWR programming relayed to a shortwave broadcast transmitter in Naahlehu, Hawaii for transmissions beamed to the Pacific and Asia.

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode		Frequencies
OSCAR 13 (AO-13) (Note 1)	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 … 145.985
	S (u/S)	Dn	2400.711 720 730 740 2400.747
		Up	435.601 610 620 630 435.637
	Bcn		2400.650
OSCAR 10 (AO-10) (Note 2)	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		145.910
RS 10/11 (Notes 3, 4 & 5)	A (v/A)	Dn	29.360 370 380 390 29.400 — Robot 29.403
		Up	145.860 870 880 890 145.900 — Robot 145.820
	Bcn		29.357
RS-12/13 (Notes 3, 6 & 7)	K (h/A)	Dn	29.410 420 430 440 29.450 — Robot 29.454
		Up	21.210 220 230 240 21.250 — Robot 21.129
	Bcn		29.408
UoSat 11 (UO-II)	Bcns	Dn	145.826 435.025 2401.500
		Up	None
PACSAT (AO-16) (Notes 8, 9 & 12)	[a]	Dn	437.025 (Sec) 437.050
		Up	145.900 145.920 145.940 145.960
DOVE (DO-17) (Notes 10 & 12)	[b,c]	Dn	145.825 2401.220
		Up	None
WEBERSAT (WO-18) (Note 12)	[a]	Dn	437.075 437.100 (Sec)
		Up	None
LUSAT (LO-19) (Notes 8 & 12)	[a]	Dn	437.125 437.150 (Sec)
		Up	145.840 145.860 145.880 145.900
JAS-Ib (FO-20) (Note 12)	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
	JD [a] Dgtl	Dn	435.910
		Up	145.850 145.890 145.910

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode		Frequencies									
OSCAR 21 (RS-14) Trans. #1	B (u/V) Linear	Dn	145.852	860	870	880	890	900	910	920	930	145.932
		Up	435.102	094	084	074	064	054	044	034	024	435.022
	Dgtl	Dn								145.983		
(Notes 11 & 12)		Up	435.016	435.155		435.193		435.041				
	Bcns	145.819							145.952		145.983	
Trans. #2	B (u/V)	Dn	145.866	870	880	890	900	910	920	930	940	145.946
		Up	435.123	119	109	099	089	079	069	059	049	435.043
	Bcns	145.800	145.838	145.948								
OSCAR 22 (UO-22)	[c]	Dn		435.120								
		Up	145.900		145.975							
KITSAT A (KO-23)	[c]	Dn		435.173								
		Up	145.850		145.900							
KITSAT B (KO-25)	[c]	Dn	435.175		436.500							
		Up	145.870	145.980								
IT-AMSAT (IO-26)	[a,c]	Dn	435.820 (Sec.)		435.867							
		Up	145.875	145.900	145.925	145.950						
EYESAT /AMRAD (AO-27)	[b,a]	Dn	436.800									
		Up	145.850									
POSAT (PO-28) (Note 13)	[c]	Dn	435.250	435.280								
		Up	145.925	145.975								
MIR	[b]	Up & Dn & FM voice		145.550								
ARSENE (Note 14)												

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

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.

S. 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. The AO-21 RUDAX supports a number of digital modes. Recently, it has been used in a "bent pipe" DSP experiment which permits conventional FM signals to be processed and retransmitted as conventional FM signals. This provides a single channel "repeater-like" capability. This Mode is periodically interrupted for telemetry and other digital transmissions, somtimes including digitized voice.
12. 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)
13. PO-28 is available to amateurs on an intermittent, unscheduled basis.
14. Arsene has experienced failures of both 2 meter and S Band downlinks.

Ku-band Satellite Transponder Services Guide

By Robert Smathers

Spacenet 2 (S2) 69 deg

21	11900	TV ASAHI [Leitch]
22	11980	Occasional video

SBS 2 (SBS2) 71 deg (Inclined Orbit)
(Occasional video on all transponders)

SBS 3 (SBS3) 74 deg (Inclined Orbit)
(Occasional video on all transponders)

SBS 4 (SBS4) 77 deg (Inclined orbit)
(Occasional video on all transponders)

Satcom K2 (K2) 81 deg

1	11729	NBC-East
2	11758.5	Data Transmissions
3	11788	NBC-Pacific (Spot Beamed to West Coast)
4	11817.5	Cyclesat
5	11847	NBC-Contract Channel
6	11876.5	Occasional video
7	11906	NBC-Contract Channel
8	11935.5	North American Chinese TV Network [Oak]
9	11965	NBC-Mountain
10	11994.5	(none)
11	12024	NBC-Contract Channel
12	12053.5	FM2 Services
13	12083	NBC-NBC NewsChannel
14	12112.5	Occasional video
15	12142	NBC-Contract Channel
16	12171.5	(none)

Satcom K1 (K1) 85 deg

1	11729	(none)
2	11758.5	Primestar DBS [Digicipher]
3	11788	Primestar DBS [Digicipher]
4	11817.5	Primestar DBS [Digicipher]
5	11847	Primestar DBS [Digicipher]
6	11876.5	Primestar DBS [Digicipher]
7	11906	Primestar DBS [Digicipher]
8	11935.5	Primestar DBS [Digicipher]
9	11965	Primestar DBS [Digicipher]
10	11994.5	Primestar DBS [Digicipher]
11	12024	Primestar DBS [Digicipher]
12	12053.5	Primestar DBS [Digicipher]
13	12083	Primestar DBS [Digicipher]
14	12112.5	(none)
15	12142	Primestar DBS [Digicipher]
16	12171.5	Primestar DBS [Digicipher]

Spacenet 3R (S3) 87 deg

19	11740	(none)
20	11820	(none)
21	11900	(none)
22	11980	(none)
23	12060	Oregon Educational Network (West Spot Beam)
24	12140	NYNET (SUNY) Ed Net/NY Lottery feeds (East Spot Beam)

Galaxy 7 (K7) 91 deg

1	11720	Occasional video
2	11750	(none)
3	11750	Compressed Video
4	11780	Occasional video
5	11810	(none)
6	11810	(none)
7	11840	FIL SAT - Philipino programming
8	11870	(none)
9	11870	(none)
10	11900	Occasional video
11	11930	Occasional video
12	11930	Asian American TV Network
13	11960	Occasional video
14	11990	Occasional video
15	11990	The Asian Network (TAN)/ Occasional video
16	12020	(none)
17	12050	Westcott Communications/ FETN/ASTN [B-MAC]/ANTN
18	12050	Occasional video
19	12080	Occasional video
20	12110	(none)
21	12110	(none)
22	12140	BBC 9PM News (PAL)/ Occasional video
23	12170	(none)
24	12170	(none)

GSTAR-3 (GST3) 93 deg (Inclined Orbit)

1	11730	SCPC Transmissions
2	11791	(none)
3	11852	Occasional video
4	11913	Occasional video
5	11974	Data Transmissions
6	12035	(none)
7	12096	ID Channel
8	12157	(none)
9	11744	Data Transmissions
10	11805	(none)
11	11866	(none)
12	11927	(none)
13	11988	Data Transmissions
14	12049	(none)
15	12110	ID Channel
16	12171	(none)

SBS 6 (SBS6) 95 deg

1	11717	Occasional video
2	11749.5	SCPC Transmissions
3	11774	Occasional video
4	11798.5	Occasional video
5	11823	Occasional video
6	11847.5	Comsat Video Enterprises [B-MAC] (half-transponders)
7	11872	Occasional video
8	11896.5	Comsat Video Enterprises [B-MAC] (half-transponders)
9	11921	(none)
10	11945.5	Comsat Video Enterprises [B-MAC] (half-transponders)
11	11963	CONUS Communications (half-transponders)
12	11994.5	CONUS Communications (half-transponders)
13	12019	CONUS Communications (half-transponders)
14	12043.5	CONUS Communications (half-transponders)
15	12075	Occasional video
16	12092.5	Massachusetts Educational Network/Occasional video
17	12110	Occasional video
18	12141.5	Comsat Video Enterprises [B-MAC] (half-transponders)
19	12174	Occasional video

Telstar 401 (T401) 97 deg

1	11730	SCPC Transmissions
2	11743	National Tech University (Digital Video)
3	11790	South Carolina Educational TV
4	11798	ABC Affiliate and Network feeds (half-transponders)
5	11845	PBS [Digicipher]
6	11855	SERC/PBS Regionals/ Stations (half-transponders)
7	11902	PBS Educational Services (half-transponders)
8	11915	PBS Stations/Regionals and Backhauls
9	11957.5	PBS Digital Video/SCOLA [Digicipher] and VSATs
10	11980.75	Louisiana Public TV feeds [Digicipher]
11	12040	Occasional video (half-transponders common)
12	12046	(none)
13	12095	(none)
14	12108	Georgia Public TV (half-transponders)
15	12147	ABC Affiliate and Network feeds (half-transponders)
16	12167	ABC Affiliate and Network feeds (half-transponders)

Galaxy 4 (K4) 99 deg

1	11720	SCPC Services
2	11750	Data Transmissions
3	11750	FM2 Services/MUZAK
4	11780	FM2 Services
5	11810	(none)
6	11810	(none)
7	11840	National Weather Networks/ Occasional video
8	11870	Occasional video
9	11870	Occasional video
10	11900	Occasional video
11	11930	Occasional video (half-transponders common)
12	11930	Channel One/Occasional video
13	11960	WMNB (Russian)/Occasional video
14	11990	Occasional video
15	11990	Occasional video
16	12020	FM2 Services
17	12050	CBS Newsnet and Affiliate feeds (half-transponders)
18	12050	Occasional video
19	12080	Occasional video
20	12110	(none)
21	12110	Occasional video
22	12140	Occasional video
23	12170	CBS Newsnet and Affiliate feeds (half-transponders)

Spacenet 4 (S4) 101 deg

19	11740	(none)
20	11820	Occasional video
21	11900	(none)
22	11980	Occasional video
23	12060	(none)
24	12140	Occasional video

GSTAR-1 (GST1) 103 deg

1	11730	Data Transmissions
2	11791	(none)
3	11852	Occasional video/[BMAC Service]
4	11913	(none)
5	11974	Data Transmission
6	12035	(none)
7	12096	Healthcare Satellite [B-MAC]/ Video Compression
8	12157	(none)
9	11744	Data Transmissions
10	11805	(none)
11	11866	Occasional video
12	11927	(none)
13	11988	Occasional video
14	12049	(none)
15	12110	(none)
16	12171	(none)

GSTAR-4 (GST4) 105 deg

1	11730	Data Transmissions
2	11791	Data Transmissions
3	11852	CNN Newsource (Primary) [Leitch]/some feeds in clear
4	11913	Occasional video
5	11974	Sears Teleconference Network [BMAC]
6	12035	Occasional video
7	12096	CNN feeds/Occasional video
8	12157	Occasional video
9	11744	Data Transmissions
10	11805	(none)
11	11866	Occasional video
12	11927	Occasional video
13	11988	Occasional video
14	12049	(none)
15	12110	CNN Newsource (Secondary)
16	12171	(none)

Anik E2 (A1) 107.3 deg
(Data transmissions have been noted on four transponders, all others have no activity except as noted below)

5	11839	Occasional video
6	11865	Occassional video (Continental Beam)

Solidaridad 1 SD1 109.2 deg
(No video has been seen on any Ku transponder)

Anik E1 E1 111 deg

1	11717	Data Transmissions
2	11743	Telesat Services
3	11778	Partial Channel Services
4	11804	Partial Channel Services
5	11839	CBC Newsworld feeds
6	11865	NovaNet FM2 Services
7	11900	Video Compression Services
8	11926	Digital Video Services
9	11961	Alberta Access
10	11987	CBC Parliamentary Channel
11	12022	The Family Channel [Oak]
12	12048	CBC Newsworld
13	12083	MuchMusic
14	12109	SuperChannel [Oak]
15	12144	Knowledge Network
16	12170	Saskatchewan Cable Network
17	11730	(none)
18	11756	(none)
19	11791	(none)
20	11817	(none)
21	11852	Radio Quebec
22	11878	Quatre Saisons
23	11913	Canal Famille (V2+)
24	11939	Musique Plus
25	11974	La Chaine
26	12000	TV Ontario (English)
27	12035	Super Ecran (V2+)
28	12061	Ontario Legislature
29	12096	Reseau des Sports (V2+)
30	12122	The Family Channel (V2+)
31	12157	The Movie Network (V2+)
32	12183	Atlantic Satellite Network

Anik C3 (C3) 114.9 deg (Inclined Orbit)
(This satellite rarely has video transmissions)

Morelos 2 (M2) 116.8 deg
(No video has been seen on any Ku transponder)

SBS 5 (SBS5) 123 deg

1	11725	Occasional video
2	11780	SCPC Services
3	11823	(none)
4	11872	(none)
5	11921	(none)
6	11970	Data Transmissions
7	12019	Occasional video
8	12068	Occasional video
9	12117	Occasional video
10	12166	ID Channel/MegaBingo/ Occasional video
11	11748	Data Transmissions
12	11898	Occasional video
13	11994	Occasional video
14	12141	Cal State Chico/Occasional video

GSTAR-2 (GST2) 125 deg

1	11730	Data Transmissions
2	11791	Data Tranmissions
3	11852	Data Transmissions
4	11913	Occasional video
5	11974	SCPC Transmission
6	12035	CNN International [Leitch]
7	12096	Occasional video
8	12157	(none)
9	11744	Data Transmissions
10	11805	Bluffs Run Greyhound racing/Occasional video
11	11866	Data Tranmissions
12	11927	Occasional video
13	11988	(none)
14	12049	CNN Airport Channel
15	12110	Occasional video
16	12171	Occasional video/CourtTV backhauls (half-transponders)

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 (AO-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
UOSAT 2 (UO-11 or UOSAT 11)
1 14781U 84021B 94259.55664486 .00000118 00000-0 27826-4 0 7312
2 14781 97.7853 270.0022 0011805 343.5640 16.5180 14.69245619563726
COSMOS 1861 (Carries RS-10/11 or Radio Sputnik 10/11)
1 18129U 87054A 94259.06060329 .00000027 00000-0 13079-4 0 9577
2 18129 82.9205 261.6689 0012780 126.3312 233.9016 13.72341388362378
OSCAR 13 (AO-13)
1 19216U 88051B 94255.03141595 -.00000341 00000-0 10000-4 0 9639
2 19216 57.7390 231.5483 7231710 350.0805 0.9547 2.09725791 16330
OSCAR 14 (UO-14)
1 20437U 90005B 94260.24520782 .00000021 00000-0 25048-4 0 314
2 20437 98.5872 343.7577 0010412 283.6457 76.3562 14.29855283242741
OSCAR 16 (AO-16 or PACSAT)
1 20439U 90005D 94261.20697721 .00000006 00000-0 19484-4 0 8296
2 20439 98.5961 346.0402 0010748 281.6298 78.3679 14.29909137242893
OSCAR 17 (DO-17 or Dove)
1 20440U 90005E 94260.73242676 .00000023 00000-0 25767-4 0 8302
2 20440 98.5967 345.9264 0010797 282.1116 77.8842 14.30049101242843
OSCAR 18 (WO-18 or Webersat)
1 20441U 90005F 94260.77940046 .00000008 00000-0 20293-4 0 8327
2 20441 98.5964 345.9670 0011387 282.6574 77.3334 14.30022831242854
OSCAR 19 (LO-19 or Lusat)
1 20442U 90005G 94261.24106417 .00000014 00000-0 22526-4 0 8280
2 20442 98.5972 346.7038 0011669 280.6449 79.3421 14.30120276242933
JAS 1-B (FO-20 or Fuji Oscar 20)
1 20480U 90013C 94261.38526384 -.00000024 00000-0 11456-4 0 7264
2 20480 99.0514 35.6582 0541300 128.3652 236.7383 12.83227663216082
INFORMTR-1 (OSCAR 21, AO-21 or RS-14)
1 21087U 91006A 94260.98935951 .00000094 00000-0 82657-4 0 5131
2 21087 82.9371 74.0296 0034792 183.1054 176.9892 13.74544644182336
COSMOS 2123 (RS-12/13 or Radio Sputnik 12/13)
1 21089U 91007A 94261.15456134 .00000038 00000-0 24598-4 0 7304
2 21089 82.9220 302.5081 0028116 207.6788 152.2863 13.74046397181416
UOSAT-F (UO-22 or Oscar 22)
1 21575U 91050B 94260.74803762 .00000001 00000-0 14773-4 0 5345
2 21575 98.4283 333.3428 0008359 19.5123 340.6381 14.36931313166370
KITSAT A (KO-23)
1 22077U 92052B 94260.60791282 -.00000037 00000-0 10000-3 0 4273
2 22077 66.0822 86.4803 0015420 264.9756 94.9498 12.86287179 98678
ARSENE
1 22654U 93031B 94262.03583661 -.00000123 00000-0 00000+0 0 2809
2 22654 2.0483 94.8577 2912797 191.9219 161.1305 1.42202795 2536
EYESAT 1 (AO-27)
1 22825U 93061C 94261.24026932 -.00000005 00000-0 15790-4 0 3275
2 22825 98.6472 336.0840 0008396 304.1084 55.9297 14.27634336 50963
ITAMSAT A (IO-26)
1 22826U 93061D 94260.72390188 .00000004 00000-0 19414-4 0 3258
2 22826 98.6476 335.6251 0008768 305.0158 55.0188 14.27739247 50893
POSAT 1 (PO-28)
1 22829U 93061G 94261.70111181 -.00000006 00000-0 15528-4 0 3192
2 22829 98.6438 336.6264 0009543 287.0663 72.9463 14.28040464 51040
KITSAT B (KO-25)
1 22830U 93061H 94261.20397519 .00000014 00000-0 22905-4 0 3320
2 22830 98.5472 332.3546 0010765 265.5648 94.4296 14.28063452 50973

WEATHER SATELLITES
GOES 2
1 10061U 77048A 94260.35497615 .00000056 00000-0 00000+0 0 4125
2 10061 11.3663 44.6035 0003347 48.4783 255.3119 1.00263821 8033
METEOSAT 2
1 12544U 81057A 94253.98803825 -.00000120 00000-0 10000-3 0 7832
2 12544 6.9164 57.5984 0028978 74.8703 320.5764 0.98723667 9346
GOES 6
1 14050U 83041A 94258.39095117 .00000027 00000-0 10000-3 0 2715
2 14050 5.8011 60.0089 0004114 4.4268 302.0081 1.00239075 13683
NOAA 9
1 15427U 84123A 94263.01527987 .00000087 00000-0 70556-4 0 9598
2 15427 99.0385 314.5670 0014840 314.8507 45.1457 14.13643521503651
NOAA 10
1 16969U 86073A 94263.02515500 .00000029 00000-0 30645-4 0 8562
2 16969 98.5109 269.1403 0014208 54.2218 306.0280 14.24905526416005
GOES 7
1 17561U 87022A 94262.92727716 -.00000064 00000-0 10000-3 0 214
2 17561 1.7549 74.7860 0003587 6.7953 138.3676 1.00275887 10927
METEOSAT 3
1 19215U 88051A 94262.90075196 -.00000274 00000-0 10000-3 0 9954
2 19215 1.9358 71.7317 0000525 145.3712 31.4602 1.00274198 10860
METEOR 3-2
1 19336U 88064A 94262.97609623 .00000051 00000-0 10000-3 0 3267
2 19336 82.5351 256.6002 0019486 28.5740 331.6422 13.16968727295730
NOAA 11
1 19531U 88089A 94262.95645693 .00000057 00000-0 55597-4 0 7773
2 19531 99.1814 254.2289 0011081 225.9536 134.0727 14.13016606308528
METEOSAT 4
1 19876U 89020B 94254.64862269 -.00000092 00000-0 10000-3 0 646
2 19876 0.6234 66.6103 0001544 80.0363 69.1286 1.00273730 223
GMS-4
1 20217U 89070A 94252.78998623 -.00000304 00000-0 10000-3 0 768
2 20217 0.4234 73.9969 0000796 43.0049 295.7048 1.00260882 18946
METEOR 3-3
1 20305U 89086A 94263.03587926 .00000044 00000-0 10000-3 0 1483
2 20305 82.5526 204.3932 0008185 54.8090 305.3739 13.04413649235264
METEOR 2-20
1 20826U 90086A 94262.53810013 .00000035 00000-0 17796-4 0 8389
2 20826 82.5206 70.9087 0013824 138.2251 221.9964 13.83589113200809
MOP-2
1 21140U 91015B 94259.64119213 -.00000031 00000-0 00000+0 0 7903
2 21140 0.2230 347.6471 0003154 193.4178 45.5836 1.00277521 7963
METEOR 3-4
1 21232U 91030A 94260.58744253 .00000050 00000-0 10000-3 0 7360
2 21232 82.5399 104.2812 0012941 320.4884 39.5272 13.16464714163513
NOAA 12
1 21263U 91032A 94263.01484327 .00000076 00000-0 53443-4 0 1855
2 21263 98.6104 288.6774 0012755 326.3804 33.6561 14.22448320173984
METEOR 3-5
1 21655U 91056A 94259.46092658 .00000051 00000-0 10000-3 0 7414
2 21655 82.5470 52.2714 0013254 334.4993 25.5475 13.16833816148470
METEOR 2-21
1 22782U 93055A 94260.60958337 .00000017 00000-0 22009-5 0 3377
2 22782 82.5444 133.2096 0023099 331.1116 28.8772 13.83014568 52867
METEOR 3
1 22969U 94003A 94260.25680870 .00000051 00000-0 10000-3 0 1016
2 22969 82.5622 351.2943 0016548 38.3204 321.9062 13.16724165 30963
GOES 8
1 23051U 94022A 94262.13484399 -.00000204 00000-0 00000+0 0 1811
2 23051 0.2502 265.8464 0003200 314.3284 95.9962 1.00266921 1230

Information and updated two line orbital element sets for amateur, weather, TVRO and other satellites are also available on-line on several bulletin board systems worldwide or directly from NASA's Goddard Space Flight Center via Internet Telnet at the following address: oig1.gsfc.nasa.gov.

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 July, August, and September 1994. 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 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	Incl	Int Des Period	Satellite Perigee	Mass Apogee
1994 Jul 1/1225	1994-036A		Soyuz TM-19	7,150 kg*
1994 Jul 1.57	51.62 deg	88.46 min	190 km	207 km
1994 Jul 3.70	51.65 deg	92.52 min	396 km	400 km

Two manned spacecraft, carrying Yuri I Malenchenko (commander) and

Talgat A Musabayev (flight engineer) to the Mir Complex: Musabayev is a Kazakh cosmonaut. Docked with the Mir Complex 1994 Jul 3.58 (1355 UTC). Cosmonauts are scheduled to remain in orbit (with V V Polyakov launched aboard Soyuz TM-18) until November 1994. Third stage (Block I) of Soyuz launch vehicle in an orbit similar to the first one quoted above. Launched from Tyuratam.

1994 Jul 3/0800	1994-037A		FSW 2-2	2,600 kg*
1994 Jul 3.56	62.95 deg	89.67 min	174 km	343 km
1994 Jul 9.16	62.96 deg	89.60 min	173 km	337 km

Second flight of second generation Fanhui Shi Weixing ("Recoverable Test Satellite") satellite, launched for remote sensing and microgravity experiments, the latter involving plants (white lotus, rice, watermelon and sesame seeds) and animals. The reentry module was recovered 1994 Jul 18.15 (0335 UTC), after which time the designator 1994-037A was transferred to the equipment module which remained in orbit. Second stage of CZ-2D launch vehicle in an orbit similar to the first one noted above. Launched from Shuang Cheng Tzu.

Launch Date/Time Epoch	Incl	Int Des Period	Satellite Perigee	Mass Apogee
1994 Jul 6/2359	1994-038A		Cosmos 2282	3,000 kg*
1994 Jul 12.86	2.28 deg	1,442.90 min	35,756 km	36,083 km
1994 Jul 22.93	2.29 deg	1,435.96 min	35,755 km	35,813 km

Second generation early warning satellite in the Prognoz series, stationed over 335 deg east. Should remain operational for about 5 years. Third stage of the Proton-4 launch vehicle left in the following orbit: 51.65 deg, 88.28 min, 186-193 km. Fourth stage (Block DM-2) is in an orbit similar to the first one listed above for the satellite. Launched from Tyuratam.

1994 Jul 8/1643	1994-039A		Columbia (STS-65)	103,710 kg
1994 Jul 8.75	28.45 deg	90.55 min	300 km	304 km
1994 Jul 22.56	28.47 deg	89.39 min	241 km	249 km

Carried seven astronauts on IML-2 mission (International Microgravity Lab): Robert D Cabana (commander), James D Halsell (pilot), Richard J Hieb (payload commander, mission specialist, MS-1), Carl E Walz (MS-2),

Leroy Chiao (MS-3), Donald A Thomas (MS-4) and Chiaki Naito-Mukai (payload specialist, first Japanese woman in space). Mass of IML-2 was 9,610 kg (remained in orbiter's payload bay). Mass quoted above is that projected for landing which took place Jul 23 at 1038 UTC. Launched from and landed at Kennedy Space Center.

1994 Jul 8/2305	1994-040A		PANAMSAT 2	2,920 kg
1994 Jul 14.87	0.05 deg	1,436.39 min	35,648 km	35,937 km
1994 Jul 8/2305	1994-040B		BS-3N	1,210 kg
1994 Jul 30.86	0.19 deg	1,436.20 min	35,777 km	35,800 km

PANAMSAT 2 is a communications and video satellite, built by Hughes and operated by PanAmSat in Greenwich, Connecticut (USA). Mass given above is at launch. The nominal lifetime is 15 years. Initially located over 195 deg east, but to be operated over 191 deg east.

BS 3N is a direct broadcasting satellite, built by Martin Marietta Astro Space and operated by MM Astro Space for Nippon Hoso Kyokai and Japan Broadcasting Inc, Tokyo. Mass given above is at launch: on station it is 699 kg and the dry mass is 575 kg, location is 110 deg east. Nominal lifetime is 7 years.

Third stage of Ariane 44L launch vehicle left in the following orbit: 7.49 deg, 653.34 min, 364-36,762 km. Launched from Kourou.

1994 Jul 14/0513	1994-041A		Nadezhda 4	825 kg*
1994 Jul 16.90	82.95 deg	104.68 min	954 km	1,005 km

Civilian navigation satellite, incorporating COSPAS-SARSAT search and rescue transponders, co-planar with Nadezhda 2. Operational lifetime is expected to be about 4 years. Second stage of the Intermediate Cosmos launch vehicle is in an orbit similar to the satellite. Launched from Plesetsk.

Launch Date/Time	Int Des		Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1994 Jul 20.73	1994-042A		Cosmos 2283	6,500 kg*
1994 Jul 20.85	67.11 deg	89.50 min	169 km	330 km

Yantar fourth generation, close look photoreconnaissance satellite, expected to remain in orbit for about two months. Satellite should release data return capsules during its mission, with the main re-reentry module returning to Earth after 60-65 days. Third stage of Soyuz launch vehicle was in an orbit similar to the one listed above. Launched from Plesetsk. Launch time quoted above is in decimals of a day in the absence of an official figure.

1994 Jul 21/1031	1994-043A		APSTAR 1	1,383 kg
1994 Jul 28.19	0.05 deg	1,436.00 min	35,651 km	5,919 km

APSTAR 1 is a Hughes HS-376 satellite bus, launched for the APT Satellite Company Ltd of Hong Kong for communications. Mass quoted above is at launch: design lifetime is 12 years. Initially located over 137 deg east, but to be operated over 131 deg east. Third stage of Chinese CZ-3 launch vehicle was left in the following orbit: 25.92 deg, 771.34 minutes, 529-42,436 km. Launched from Xi Chang.

1994 Jul 29.40	1994-044A		Cosmos 2284	6,500 kg*
1994 Jul 29.45	70.34 deg	88.19 min	195 km	274 km
1994 Jul 30.20	70.38 deg	89.41 min	214 km	277 km

Cometa fourth generation topographic and mapping photoreconnaissance satellite, expected to remain in orbit for 40-45 days with the main re-reentry module returning to Earth. Third stage of Soyuz launch vehicle left in an orbit similar to the first one listed for the satellite. Launched from Tyuratam. Launch time quoted above is in decimals of a day in the absence of an official figure.

1994 Aug 2/2000	1994-045A		Cosmos 2285	825 kg*
1994 Aug 2.89	74.03 deg	104.98 min	974 km	1,013 km

Satellite launched into an orbit typical of the original Parus navigation satellites, except that the orbital inclination of 74 deg has not been used for the series since the early 1970s. Purpose of this flight is therefore unknown. Second stage of Intermediate Cosmos launch vehicle in a similar orbit to the satellite. Launched from Plesetsk.

1994 Aug 3/1439	1994-046A		APEX (P90-6)	261 kg
1994 Aug 5.20	69.97 deg	114.95 min	363 km	2,544 km

Advanced Photovoltaic and Electronics Experiment (APEX) launched to determine long-term effect of harsh radiation and plasma environments.

Planned operating lifetime is 3 years, with the minimum goal of 1 year. Launched by B-52 departing Edwards Air Force Base Aug 3 at 1325 UTC and carrying a three stage Pegasus launch vehicle: third stage of Pegasus is in an orbit similar to the one quoted above for APEX.

Launch Date/Time	Int Des		Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1994 Aug 3/2357	1994-047A		DBS 2	2,860 kg
1994 Aug 12.98	0.04 deg	1,436.50 min	35,775 km	35,813 kg
1994 Aug 4.00			Atlas-2A 2nd stage	1,815 kg
1994 Aug 4.27	26.90 deg	700.24 min	202 km	39,284 km

DBS 2 (Direct Broadcast Service) is a communications satellite, using a Hughes HS-601 satellite bus. Mass of the satellite is that given at launch. Satellite deployed over 258-259 deg east and carries a SpaceArc time capsule. Expected operational lifetime is 12 years. Second stage of Atlas-2A launch vehicle left in the following orbit: 26.90 deg, 700.24 minutes, 202-39,284 km. Launched from Cape Canaveral.

1994 Aug 5.05	1994-048A		Cosmos 2286	1,900 kg*
1994 Aug 6.09	62.89 deg	709.47 min	565 km	39,379 km
1994 Aug 8.55	62.89 deg	717.40 min	569 km	39,767 km

Oko early warning satellite, co-planar with Cosmos 2196. Expected operational lifetime is four years. Third stage of Molniya launch vehicle discarded in an orbit with the following parameters: 62.83 deg, 91.99 minutes, 218-526 km. Molniya fourth stage is in an orbit similar to the first one quoted above for the satellite. Launched from Plesetsk. Launch time quoted above is in decimals of a day in the absence of an official figure.

1994 Aug 10/2305	1994-049A		BRASILSAT B1	1,765 kg
1994 Aug 20.00	0.44 deg	1,436.06 min	35,723 km	35,849 km
1994 Aug 10/2305	1994-049B		TURKSAT 1B	1,779 kg
1994 Aug 21.67	0.09 deg	1,431.67 min	35,619 km	35,781 km

BRASILSAT B1 is a telecommunications satellite, built by Hughes Space and Communications for Embratel in Rio de Janeiro, Brazil. Mass quoted above is that at launch. Expected operational life is 12 years. Satellite initially located over 299 deg east, but the planned operational location is 290 deg east.

TURKSAT 1B is launched for telecommunications, television and data transmissions, built by Aerospatiale Espace & Defence for the Turkish Ministry of Post and Telecommunications. Mass quoted above is at launch. Planned lifetime is 10 years. To be deployed over 42 deg east.

Third stage of Ariane 44LP launch vehicle was left in an orbit with the following parameters: 6.92 deg, 658.22 minutes, 354-37,021 km. Launched from Kourou.

1994 Aug 11/1528	1994-050A		Cosmos 2287	1,300 kg*
1994 Aug 27.02	64.88 deg	675.46 min	19,112 km	19,134 km
1994 Aug 11/1528	1994-050B		Cosmos 2288	1,300 kg*
1994 Aug 28.67	64.82 deg	675.81 min	19,013 km	19,171 km
1994 Aug 11/1528	1994-050C		Cosmos 2289	1,300 kg*
1994 Aug 22.45	64.84 deg	675.58 min	19,113 km	19,139 km*

Three Uragan satellites in the GLONASS navigation series. First launch to use the third orbital plane scheduled for the GLONASS system. Expected operation lifetime is 5 years for each satellite. Proton third stage discarded in the following orbit: 64.80 deg, 87.67 minutes, 135-183 km. Proton fourth stage is in an orbit similar to the satellites. Launched from Tyuratam.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee
1994 Aug 23/1431	1994-051A	Molniya 3-46		1,750 kg*
1994 Aug 23.66	62.79 deg	701.02 min	593 km	38,932 km
1994 Sep 1.99	62.79 deg	717.90 min	605 km	39,756 km

Communications satellite, co-planar with Molniya-3 38. Expected to remain operational for about three years. Third stage of Molniya-M launch vehicle discarded in an orbit with the following parameters: 62.83 deg, 92.37 minutes, 216-566 km. Fourth stage in an orbit similar to the first one quoted above for the satellite. Launched from Plesetsk.

1994 Aug 25/1425	1994-052A	Progress M-24		7,250 kg*
1994 Aug 25.85	51.65 deg	88.54 min	183 km	222 km
1994 Aug 30.80	51.65 deg	92.48 min	394 km	398 km

Unmanned cargo freighter, carrying supplies to the cosmonauts aboard the Mir Complex. Planned docking for August 27 was aborted when the spacecraft was 150 metres from the Mir Complex: a second docking on August 30 also failed. A third docking on September 2, controlled manually by cosmonaut Malenchenko from inside the Soyuz TM-19 spacecraft, was successful. Third stage of Soyuz launch vehicle was in an orbit similar to the first one noted above. Launched from Tyuratam.

1994 Aug 26/1200	1994-053A	Cosmos 2290		13,000 kg*
1994 Aug 26.56	64.81 deg	89.55 min	212 km	293 km
1994 Sep 6.43	64.81 deg	90.09 min	209 km	348 km

First use of Zenit launch vehicle to place a probable photoreconnaissance satellite into orbit. Zenit second stage was discarded in an orbit similar to the first one noted above for the satellite. The rocket stage was seen to be tumbling rapidly in orbit (more than 100 rpm) two weeks after launch, and once might speculate whether such behaviour is connected with the break-ups of the Cosmos 2227 (1992-093B) and Cosmos 2237 (1993-016B). Launched from Tyuratam.

1994 Aug 27/0857	1994-054A	USA 105		4,500 kg*

No orbital data announced (probably geosynchronous). No details of this classified Department of Defense launch. Payload might be an ELINT satellite. Titan-4 third stage might have been left in a geosynchronous transfer orbit or possibly entered geosynchronous orbit before the payload was deployed. Launched from Cape Canaveral.

1994 Aug 27/2310	1994-055A	Optus B-3		1,700 kg*
1994 Sep 6.02	0.87 deg	1,474.96 min	36,666 km	37,422 km

Third launch of Australian Optus-B satellite by the Chinese. Payload is a Hughes HS-601 bus: satellite owned by Optus Communications Pty. Planned design life is 13-14 years. To be located over 156 deg east.

Second stage of CZ-2E launch vehicle discarded in an orbit with the following parameters: 27.85 deg, 97.48 minutes, 190-1,086 km: third stage (US STAR-63F motor) discarded in 24.07 deg, 700.66 minutes, 383-39,124 km orbit. Launched from Xi Chang.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee
1994 Aug 28/0750	1994-56A	Kiku 6 (ETS 6)		3,800 kg*
1994 Aug 28.57	28.43 deg	638.96 min	248 km	36,144 km
1994 Aug 31.69	13.08 deg	845.96 min	7,796 km	38,707 km

Kiku 6 (also called ETS 6, Engineering Test Satellite, before launch) was planned to demonstrate the technology base for a large-scale domestically built geosynchronous orbit satellite, development of advanced satellite communications and technologies and the more general development of the satellite's equipment in orbit. Failure of apogee kick motor prevented planned placement into geosynchronous orbit over 153.8 deg east and the mission had to be abandoned. H-2 second stage discarded in an orbit with the following parameters: 28.55 deg, 562.97 minutes, 150-32,263 km: this orbit has an apogee nearly 4,000 km below the geosynchronous altitude - it is nclear whether this was intentional. Launched from Tanegashima.

1994 Aug 29/1738	1994-057A	DMSP 2-7 (USA 106)		823 kg
1994 Aug 29.78	98.92 deg	101.95 min	843 km	859 km

Block 5D-2 Defense Meteorological Satellite Program satellite. Orbital injection is performed using a Star-37S, built into the satellite. Expected operational lifetime is four years. Launched by an Atlas-E from Vandenburg.

Satellite Launch Report Update (Previous Launches)

1985-025A Orbital data issued for INTELSAT 501 at the end of July indicated that the satellite has been re-located over 64 deg east.

1988-091B TDRS 3 was re-located over 188 deg east during 1994 July 27-29.

1994-001A Soyuz-TM 18 with cosmonauts Afanasyev and Usachyov undocked from the Mir Complex 1994 Jul 9 and landed 1994 Jul 9 at 1013 UTC.

1994-027A SROSS C2 performed a series of manoeuvres to lower its orbit during early July 1994: the following orbital data refers to these manoeuvres (the first orbit is pre-manoeuvre):

1994 Jul 2.09, 46.04 deg, 98.27 minutes, 433 km, 919 km
1994 Jul 2.43, 46.04 deg, 98.20 minutes, 433 km, 912 km
1994 Jul 3.52, 46.04 deg, 97.81 minutes, 433 km, 875 km
1994 Jul 4.80, 46.04 deg, 97.41 minutes, 432 km, 838 km
1994 Jul 5.88, 46.04 deg, 96.87 minutes, 432 km, 785 km
1994 Jul 6.81, 46.04 deg, 96.11 minutes, 433 km, 712 km
1994 Jul 7.01, 46.00 deg, 95.61 minutes, 429 km, 667 km
1994 Jul 7.14, 46.04 deg, 95.19 minutes, 432 km, 623 km

1994-031A Progress-M 23 released a Raduga recoverable capsule which was recovered 1994 Jul 2.

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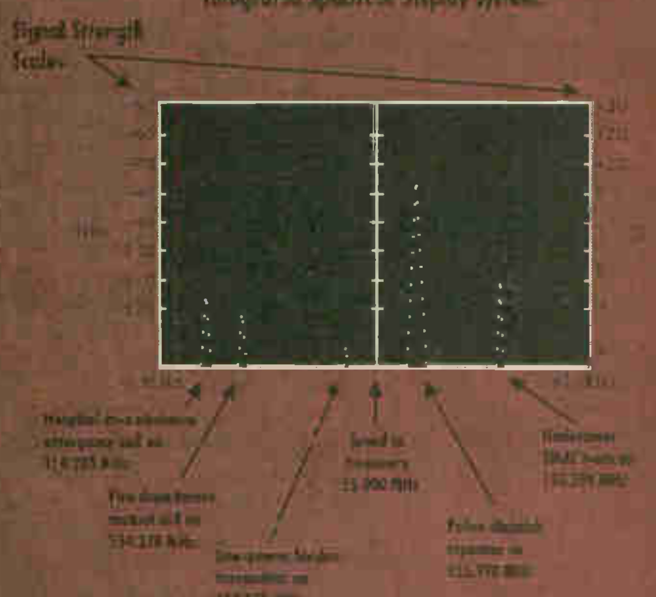

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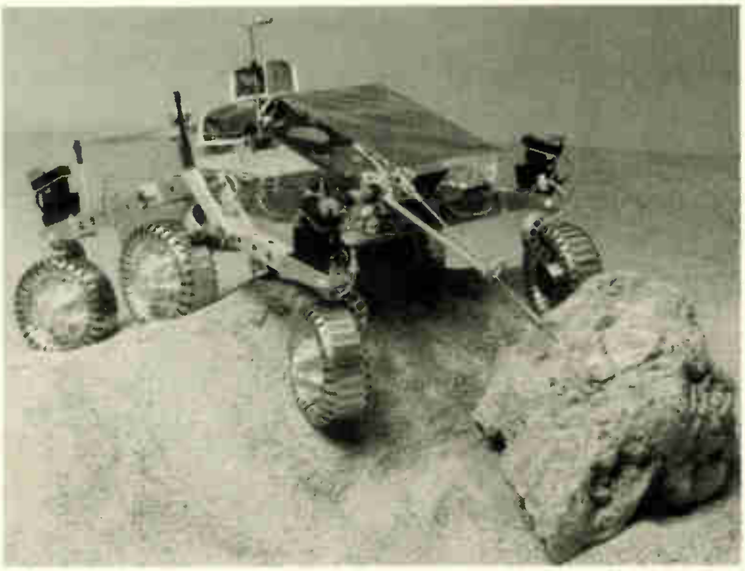
NASA Selects Two Small Explorer Missions for Development

Two new science missions to study the Sun and the evolution of galaxies, both aboard small, relatively inexpensive spacecraft, were unveiled recently by Dr. Wesley T. Huntress, NASA Associate Administrator for Space Science.



The first of the newly selected missions, the Transitional Region and Coronal Explorer, or TRACE, will observe the Sun to study the connection between its magnetic fields and the heating of the Sun's corona. Dr. Alan Title of the Lockheed Palo Alto Research Laboratory, Calif., is the principal investigator. His team will include 13 other scientists from the United States, Sweden, the United Kingdom and the Netherlands. TRACE is scheduled for launch in 1997.

The second spacecraft, the Wide-Field Infrared Explorer, or WIRE, is scheduled for launch in 1998 on a mission to study the evolution of galaxies. WIRE will use a cryogenically-cooled telescope and arrays of highly sensitive infrared detectors for the studies. WIRE was proposed by Dr. Perry B. Hacking of NASA's Jet Propulsion Laboratory, Pasadena, Calif., with co-investigators from the California Institute of Technology, Cornell University, Ball Aerospace Systems Group, and JPL.

The two newly announced missions are part of NASA's Small Explorer (SMEX) Program, which provides frequent flight opportunities for highly focused and relatively inexpensive science missions. Small Explorer spacecraft weigh approximately 500 pounds (227 kilograms). Each mission is expected to cost approximately $50 million for design, development and operations through the first 30 days in orbit.

The missions will be launched by Pegasus, an expendable launch vehicle owned and operated by Orbital Sciences Corp., Loudon, Va., under contract to NASA. The TRACE and WIRE missions join three other Small Explorer missions already in development or operation.

SAMPEX, the Solar, Anomalous and Magnetospheric Particle Explorer, was launched July 3, 1992 and has been successfully investigating the composition of local interstellar matter and solar material, and the transport of magnetospheric charged particles into the Earth's atmosphere.

The Submillimeter Wave Astronomy Satellite, or SWAS, is scheduled for launch in June 1995 on a Pegasus rocket to be released from an L-1011 at NASA Goddard Space Flight Center's Wallops Flight Facility in Virginia. SWAS will for the first time directly measure the amount of water and molecular oxygen in interstellar clouds. SWAS also will measure carbon monoxide and atomic carbon, which are believed to be major reservoirs of carbon in these clouds.

FAST, the Fast Auroral Snapshot Explorer, is scheduled for launch one month after SWAS, in July 1995, from Vandenberg Air Force Base in Lompoc, Calif. FAST will probe the physical processes that produce aurorae, the displays of light that appear in the upper atmosphere at high latitudes.

NASA Selects Mars Pathfinder Landing Site

NASA has selected an ancient flood plain on Mars as the landing site for the 1997 mission of Mars Pathfinder, one of the first in a new generation of small, low cost spacecraft.

Eons ago, when water flowed on Mars, great floods inundated the landing site, located on a rocky plain in an area known today as Ares Vallis. The site is 527 miles (850 kilometers) southeast of the location of Viking Lander 1, which in 1976 became the first spacecraft to land on Mars. Pathfinder will be the first spacecraft to land on Mars since the twin Viking landers arrived almost 20 years ago.

The spacecraft, scheduled to arrive at Mars on July 4, 1997, will parachute down to Ares Vallis at the mouth of an ancient outflow channel chosen for the variety of rock and soil samples it may present.

The purpose of the new Pathfinder mission is to demonstrate an inexpensive system for cruise, entry, descent and landing on Mars, said Project Manager Anthony Spear and Project Scientist Dr. Matthew Golombek of NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.

The lander, carrying a microrover, will aerobrake in the upper Martian atmosphere using an aeroshell and a parachute. Just before impact, airbags will inflate to cushion the landing. The microrover will then roll out to examine the rocks and soil nearby.

Both lander and rover will carry scientific instruments and cameras. The lander will make atmospheric and meteorological observations during descent and function as a weather station on the surface, as well as a radio relay station for the rover.

The constraints on the landing site location have to do with engineering considerations, Spear said. Since the spacecraft are solar-powered, the best site is one with maximum sunshine and in July 1997, the Sun will be directly over the 15 degrees north latitude region of the planet.

The elevation must be as low as possible, Spear added, so the descent parachute has sufficient time to open and slow the lander to the correct terminal velocity. The landing will be within a 60- by 120-mile (100- by 200-kilometer) ellipse around the targeted site due to uncertainties in navigation and atmospheric entry.

Ares Vallis, which meets the engineering constraints, was chosen after a workshop earlier this year that involved the invited participation of the entire Mars scientific community. More than 60 scientists from the United States and Europe attended.

The Ares Vallis site also is a "grab bag" location, according to Golombek, located at the mouth of a large outflow channel in which a wide variety of rocks are potentially within the reach of the rover. Even though the exact origins of the samples would not be known, he said, the chance of sampling a variety of rocks in a small area could reveal a great deal about Mars.

The rocks would have been washed down from highlands at a time when floods moved over the surface of Mars. Several potential sites were listed where ancient flood channels emptied into Chryse Planitia, having cut through crustal units and ridged plains where the water would have picked up material and deposited it on the plain.

Other sites that were considered included Oxia Palus, a dark highlands region that contains highland crust and dark wind-blown deposits; Maja Valles Fan, a delta fan which drained an ancient outflow channel; and the Maja Highlands, just south of Maja Valles. All of the sites were studied using Viking orbiter data.

Both the Pathfinder lander and rover have stereo imaging systems. The rover carries an alpha proton X-ray spectrometer that will enable examination of the composition of the rocks. The imaging system will reveal the mineralogy of surface materials as well as the geologic processes and surface-atmosphere interactions that created and modified the surface. The instrument package also will enable scientists to determine dust particle size and water vapor abundance in the atmosphere.

New Data Brighten Debris Outlook for Space Station

Recent results from powerful radar measurements of orbital debris are good news for the International Space Station.

NASA has just completed the third year of a campaign measuring and monitoring the orbital debris environment using the Haystack Orbital Debris Radar. The Haystack Radar is operated for NASA by the MIT Lincoln Laboratory, Lexington, Mass. This powerful radar can detect debris objects that are as small as a pea (about 1/4 inch in diameter) orbiting 400 miles out in space.

The orbital debris population measured by Haystack has been compared with predictions of the orbital debris environment based on the NASA "Engineering Model". This model was developed using measurements and data on the debris environment collected prior to 1988. The measured orbital debris population differed from NASA's predictions over all altitudes that were studied using the Haystack Radar.

At low altitudes (250-400 miles) the measured debris population was below predicted levels. Thus, this measurement campaign brings good news to the International Space Station. According to George Levin, NASA's Orbital Debris Program Manager, Washington, D.C., engineers and scientists believe there are three major reasons why their earlier predictions overestimated the Space Station debris population.

"The first reason for this improvement in the orbital debris environment is the success of NASA's Orbital Debris Mitigation Program. Since 1987, following the explosion of an orbiting 3rd stage rocket belonging to the European Space Agency (ESA), NASA has made a concerted effort to inform other spacefaring nations of the hazards to spacecraft resulting from these types of explosions. As a result of these efforts ESA, Japan, China and Russia have all joined NASA in modifying the designs of their launch vehicles and their satellites to minimize the possibility of future accidental explosions in space," said Levin.

A second reason for the improvement in the environment in this region of space can be traced to the major economic and political upheaval that occurred here on Earth during the last decade.

The end of the cold war saw a dramatic reduction in Russia's military space program. In previous years many intentional explosions of satellites on orbit were attributed to the Russian military space program.

The testing of anti-satellite weapons by both the United States and Russia is believed to be another military space activity which contributed to the low-Earth orbital debris population during the early to mid-80's. The cessation of these anti-satellite tests by both the United States and Russia has helped to reduce the growth of orbital debris.

A third reason for the improvement in the low-altitude space environment also can be attributed to these same economic and political changes. The world-wide launch rate has fallen almost 40 % in the last nine years (from 129 launches in 1984 to 79 launches in 1993).

Levin explained that, "The forces of nature play a large role in affecting the debris environment in low-Earth orbit. Objects in these low (250-400 mile) orbits are affected by changes in the solar cycle. During the peak of the solar cycle the density of the atmosphere increases at these altitudes. This increased density acts to slow down the orbiting debris objects, causing them to re-enter the atmosphere. Thus, much of the debris injected into the proposed Space Station orbit during the early to mid-80's reentered during the unusually strong peak associated with the last solar cycle."

Of increasing concern to NASA is the orbital debris population measured by the Haystack Orbital Debris Radar at higher altitudes (500-650 miles). In these orbits debris was found to be greater than NASA's predictions. Objects in these orbits are not significantly affected by changes in solar activity. Thus, the lifetime of debris in these orbits can exceed 1000 years. The long orbital life at these high altitudes also means that debris in these orbits will not pose a hazard to the Space Station. However, these orbits are important for scientific, Earth observation, weather and communications satellites.

NASA Administrator Daniel S. Goldin has directed NASA engineers and scientists to focus increased attention on these orbits. NASA must first understand the cause of the increased debris population in the 500-650 mile altitude regime. Only then is it possible to determine the actions required to control the growth of debris in this economically important area of space. ST

By John A. Magliacane, KD2BD

The Gentle Art of Listening

The best way to learn more about a new mode of radio communications is to actively monitor communications taking place via that mode. Some of the best Amateur Radio operators spent many years as SWLs, gaining valuable knowledge and experience through their monitoring activities. The same can be said for those involved Amateur Satellite communications.

One of the common misconceptions about Amateur Satellite monitoring is that the signals generated from Orbiting Satellite Carrying Amateur Radio or OSCAR satellites are too weak to be heard without an elaborate receiving station. While all low-earth orbiting OSCAR satellites operate with transmitter powers below those of commercial Very High Frequency (VHF) satellites such as the NOAA or METEOR series of weather satellites, many frequency modulation (FM) beacon transmitters carried on Amateur satellites can be easily heard on a handheld VHF-FM receiver with a simple antenna.

FIGURE 1

UoSAT-OSCAR-11 on board computer status message transmitted using FSK ASCII at 1200 bps on 145.825 MHz FM.

** UoSAT-OSCAR-11 OBC **

Diary Operating System V3.2
Date: 6 /8 /93 (Friday)
Time: 23 :35 :43 UTC
Auto Mode is selected Spin Period: + 5251
Z Mag firings: 0+
SPIN firings: 0-
SPIN firings: 39 SEU count 24026 RAM
WASH pointer at D028 WOD commenced 6 / 8 /93 at 0 :0 :9 with channels 0 ,10 ,20 ,30
Last Command: 109 to 0 , 0 Attitude control initiated, mode 1

The Technological Paradox

New semiconductor technologies are providing the communications field with quieter and more sensitive receivers every day. It would only seem logical that with "hotter" receiver performance, the effective radiated power levels of OSCAR satellite downlink transmitters should be decreasing. In reality, the opposite has actually occurred. OSCAR satellite downlink signal levels have been increasing as new satellites containing high efficiency, gallium arsenide solar cells and state-of-the-art high density storage batteries are built, launched, and placed into operation. These technological improvements make higher OSCAR satellite output power levels possible while still maintaining an acceptable power budget. Better receivers coupled with stronger satellite signals, and the use of narrowband FM downlinks are making OSCAR satellite monitoring easier than ever before.

Two of the easiest OSCAR satellites to monitor with very simple equipment are DOVE-OSCAR-17 (DO-17) and AMSAT-OSCAR-21 (AO-21). Both satellites transmit 5 kHz deviation narrow-band FM downlink signals that are easily received on low-cost portable or mobile VHF-FM receivers. A 2-meter handheld transceiver or a scanning receiver can be used to receive signals from these satellites even though they orbit many hundreds of miles above the earth's surface.

FIGURE 2

Sample of packet radio transmissions made by DOVE-OSCAR-17 on 145.825 MHz FM.

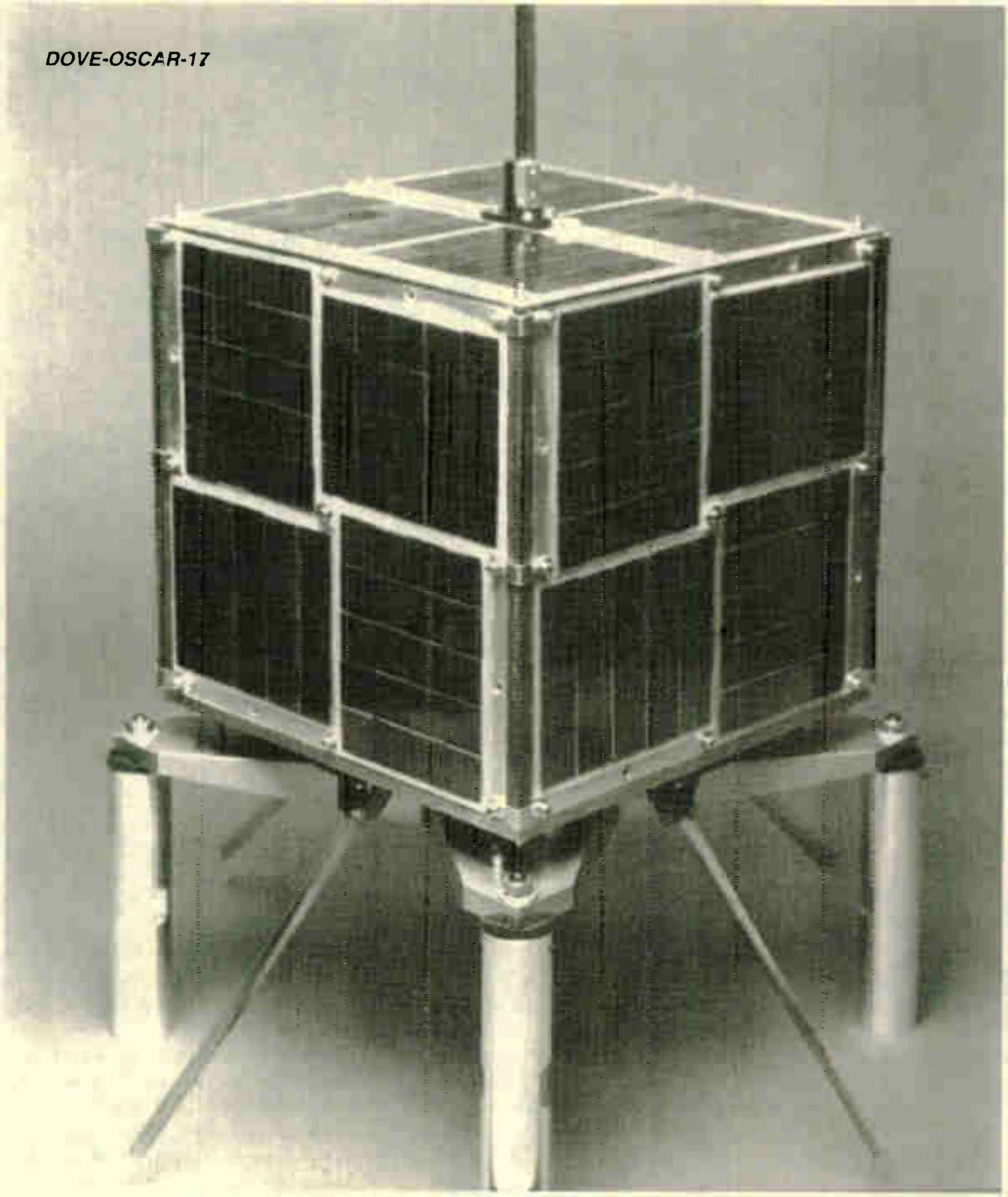
DOVE-1>TIME-1 <UI>:PHT: uptime is 096/12:01:24. Time is Thu Sep 15 02:03:03 1994
DOVE-1>TLM <UI>:00:59 01:57 02:8B 03:2B 04:5F 05:5B 06:6C 07:3A 08:72 09:62 0A:A4 0B:B9 0C:E7 0D:DC 0E:01 0F:28 10:D2 11:78 12:00 13:1C 14:BD 15:AA 16:7F 17:86 18:88 19:8A 1A:87 1B:86 1C:8E 1D:86 1E:FF 1F:6B 20:EB
DOVE-1>TLM <UI>:21:A4 22:1A 23:02 24:01 25:1E 26:03 27:00 28:02 29:00 2A:01 2B:00 2C:00 2D:14 2E:00 2F:A7 30:D6 31:A8 32:01 33:00 34:CA 35:AA 36:B2 37:B1 38:C8
DOVE-1>STATUS <UI>: 80 00 00 1E 3C 18 CC 02 00 90 00 02 0C 0F 3C 05 0F 31 01 0A 52
DOVE-1>BRAMST <UI>:11th September 1994 12:20 UTC Work continues on new software. Voice experiment continues: 90 Secs TLM — DAC Test (8 Tones) — Voice S Band is still off till further notice. 73 Dove Command Team (vk7zbx)

Non-Human Voices from Space

DOVE-OSCAR-17 suffered a hardware malfunction after launch that has made controlling and programming of the spacecraft very difficult. Despite the difficulties controllers have been having with DOVE-OSCAR-17, the satellite has been on the air with as much as 4 watts of power, transmitting telemetry using the AX.25 packet radio communications protocol, and making digitized voice transmissions using FM on a carrier frequency of 145.825 MHz.

If you tune into DOVE's beacon on this frequency, you may be able to hear non-human voices from outer space as well as bursts of packet radio telemetry. You probably won't make the eleven o'clock news or the supermarket tabloids for receiving these voices from the vacuum of space on your receiver, but you can sure impress your friends!

Actually, transmitting stored voice messages is the primary mission objective of the



DOVE-OSCAR-17

Photo courtesy of AMSAT

DOVE-OSCAR-17 satellite. "DOVE", an acronym for Digital Orbiting Voice Encoder, transmits speech using a Votrax SC-02 speech synthesis chip. Voice can also be transmitted by converting a short digital audio program to an analog signal after having been digitized and uploaded to the satellite by a DO-17 control station. The satellite's beacon transmits with as much as 4 watts of output power and has a very strong signal and is easily heard on even the simplest of receivers.

DOVE-OSCAR-17 isn't the only OSCAR satellite transmitting FM mode signals on 145.825 MHz. UoSAT-OSCAR-11 (UO-11) also carries a beacon on this frequency. It transmits data from many of its on-board experiments and sensors using 1200 baud ASCII and audio frequency shift keying (AFSK) modulation. At 300 milliwatts of power, it isn't as strong as DOVE, but it can be heard with a low-cost receiver. UO-11 is often mistaken for DOVE by those just getting their feet wet in Amateur Satellites. UoSAT-OSCAR-11 also carries a digital speech experiment, so you may hear some non-human voices coming from this spacecraft as well.

The UoSAT-OSCAR-11 satellite was designed and built by the Engineering Department at the University of Surrey in England. Its speech is generated by a National Semiconductor "Digitalker" system that contains a pair of ROMs or Read Only Memory chips. One ROM generates speech with an American accent, while the second generates speech with a British accent. It can also simulate both male and female voices.

Human and Not-So-Human Voices

Another satellite that is easily received on narrow-band FM VHF receivers is AMSAT-OSCAR-21. AMSAT-OSCAR-21, also known as Radio Sputnik 14 (RS-14), carries a digital communications experiment called RUDAK that has a downlink on 145.987 MHz. RUDAK is an extremely flexible communications transponder. It is fully programmable through software that is uploaded to the satellite from ground control stations. At press time, the RUDAK transponder on RS-14 was acting as a "bent-pipe" FM transponder, accepting FM uplink signals in the 70-cm Amateur band on 435.016 MHz, and relaying those signals to the 2-meter band on 145.987 MHz.

The RUDAK transponder downlink is also interspersed with telemetry transmissions that use the AX.25 packet radio protocol, as well digitized audio messages and facsimile images in an APT format similar to those generated by NOAA weather satellites. The downlink is normally cycled through FM repeater operation, digitized audio message, telemetry, and WEFAX image over a 10 minute period. A standard, unmodified packet radio terminal node controller (TNC) will enable you to decode satellite telemetry data and get the latest operating schedule from the satellite beacon.

Tuning for Doppler Shift

A short tutorial on the effects of Doppler shift is in order when discussing the reception of radio signals from low earth orbiting satellites such as the ones described in this article.

In the good old days of short wave listening, it was sometimes necessary to keep one hand on the receiver tuning knob to compensate for receiver drift. Well, regardless of how stable your satellite receiver is, and regardless of how stable the transmitted frequency of the satellite is, the laws of physics dictate that downlink signals from DOVE-OSCAR-17, UoSAT-OSCAR-11, or AMSAT-OSCAR-21 will drift. This drift is known as the Doppler effect or shift, and can cause signals from these amateur satellites to shift by as much as 7 KHz as they zoom overhead at speeds close to 15,000 miles per hour.

The 2-meter downlink and beacon transmissions heard from these satellites will first appear about 3.5 KHz higher than their published frequency as the satellite comes over the horizon on an overhead pass. Using an FM receiver with 5 KHz tuning steps, it will be necessary to tune 5 KHz higher than the actual satellite downlink frequency as the satellite comes into range.

The magnitude of this drift is dictated by three factors: the speed of light (which is the same as it is for RF), the relative speed of the satellite in relation to the observer, and the RF carrier frequency of the satellite downlink. The polarity of the shift is dictated by the direction of travel (is it coming or going?).

As the operating frequency is increased, so is the amount of doppler shift. A beacon on a low earth orbiting satellite transmitting on 435 MHz can be expected to drift as much as 20 KHz during a pass, while a signal on 10 GHz can shift as much as 500 KHz.

As the satellite makes its closest approach in the middle of the pass, the distance between the satellite and the observer on earth will slow, and for a brief moment, will stop at the time of closest approach (TCA). At this point, there wil be no doppler shift, and the signal received from the satellite will be exactly equal to its published frequency.

After TCA, the satellite begins to recede and move away from the observer, causing the the satellite downlink frequency to continue its downward drift.

For these reasons, it is best to set your receiver 5 KHz higher than the satellite beacon frequency as the satellite comes into range. The receiver frequency should be shifted down another 5 KHz during the middle of the pass, and down yet another 5 KHz towards the very end of the pass.

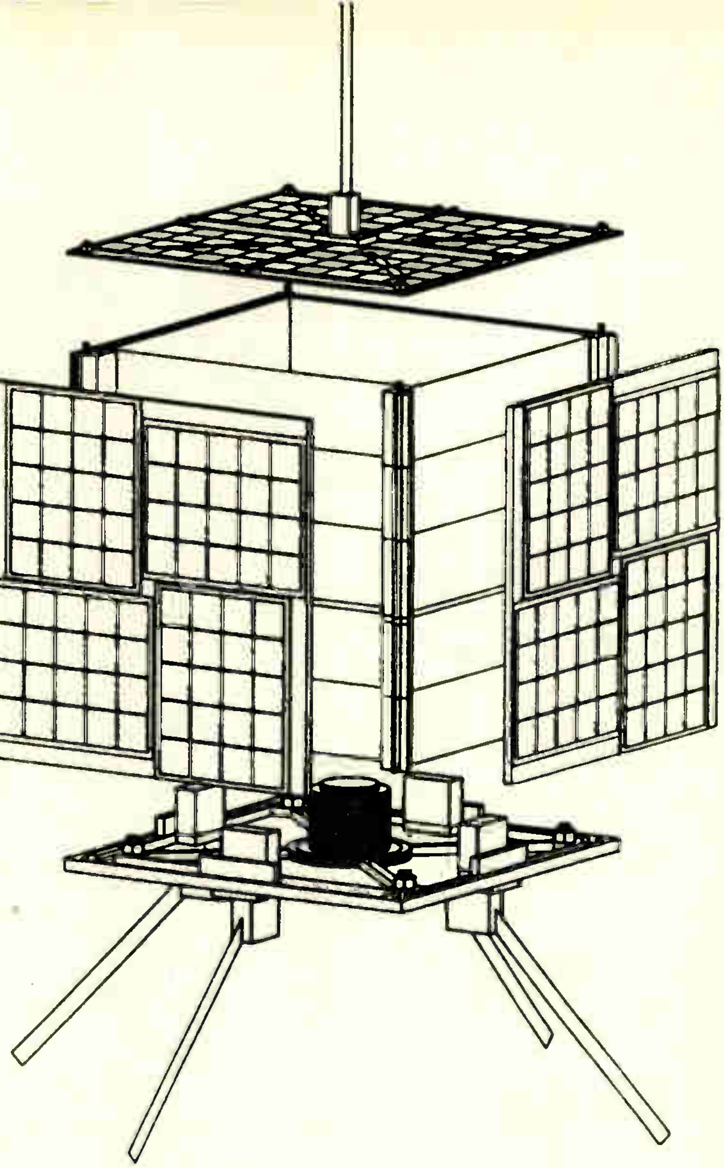


FIGURE 3

Several packet frames generated by the RUDAK transponder on AMSAT-OSCAR-21 on 145.987 MHz FM.

RUDAK2>BEACON <UI C>:++ Hi, this is the RUDAK-II experiment on AMSAT OSCAR 21 ++
RUDAK2>BEACON <UI C>: RUDAK-II Schedule: (down 145.987, up 435.016) min/10 Beacon Mode π 0..3 FM Repeater 4 Digital Audio 5..7 WEFAX Picture π 8..9 AFSK TLM
RUDAK2>WEFAX-1 <UI C>: WEFAX General Info: Mode : MGCS, Subcarrier 2400Hz, DSB max=white, Start 300Hz(3s), Stop 450Hz(5s), Phasing signal (5% bl, 95% wh), Sync (1st 40 Pixels), 800x800 Pixels, 4 lines/sec., module 267

LOS

Well, we've come to the end of another Amateur Satellite column. In the next issue of Satellite Times, we will explore the SSB voice and CW transmissions that can be monitored from the various OSCAR satellites. We will also show how a receiving converter can be used ahead of an HF receiver to monitor VHF and UHF transmissions from these satellites. Happy satellite DXing! ST

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

Getting Equipped to Monitor Weather Satellites

In the last issue of *Satellite Times* we presented an introduction to weather satellite monitoring, a general overview of the United States and Russian meteorological satellite programs, and two excellent tutorials on satellite sleuthing and the basic's of satellite orbital mechanics by Dr. Theo Pappan and Dr. T.S. Kelso, respectively.

This issue of the *View from Above* will focus on the equipment required to start your own monitoring station and begin receiving actual weather satellite images! First, let us whet your appetite with a spectacular image provide by Dallas Remote Imaging Group (DRIG) member Tom Loebl, of Hubbardstown, MA. Figure 1 shows a visible light image of Florida taken by the U.S. polar orbiter National Oceanic and Atmospheric Administration (NOAA) 9 from 870 km in space. This is a High Resolution Picture Transmission or HRPT - 1.0 km per picture element image showing some fine detail of the Florida Everglades.

NOAA 9 orbits the Earth from pole to pole, in a sun-synchronous orbit, approximately fourteen times per day (orbital period of 102 minutes per orbit). This type of satellite orbit contrasts with the Geostationary Operational Environmental Satellite (GOES) geostationary orbit, which is relatively fixed in space for a ground observer (see Figure 2 for a comparison of polar orbiters vs. GOES).

A Frequently Asked Question

Perhaps the most often asked question of the beginner in weather satellite monitoring is '...but what will be needed to hear these signals and display the pictures?...". A fairly simplistic answer may be the following:

1. A method to be able to predict when and where the polar orbiting satellite will be 'in view' of your ground station (i.e. satellite tracking program).
2. A system capable of receiving the 137 MHz (NOAA polar orbiter) or 1691 MHz (GOES) satellite radio signals.
3. An image display system to view and print the visible and infra-red (IR) images obtained from these satellites.

Actually, the answer gets quite a bit more complex if you want to receive the very high resolution HRPT and GEOS Stretched Very high-resolution Infrared Spin Scan Radiometer (VISSR) imagery at 1.0 km per pixel resolution, but we will cover that in another column.

Figure 3 shows the components necessary to receive both the low resolution Automatic Picture Transmission or APT (NOAA 4.0 km per pixel resolution) and GOES WEFAX or Weather Fax (4.0 km or 7.0 km IR imagery from GOES) images. In this issue we will focus on receivers and tracking programs. Details on image display and printing requirements for weather satellite reception will be discussed in future columns.

Satellite Tracking Programs

There are many excellent satellite tracking programs available that utilize the North American Air Defense Command (NORAD) radar observations (Keplerian element sets). These programs predict the location of satellites and display their position relative to the ground observer. Commercial programs such as Instantrack, RealTrack, Quicktrak, WINTRAK, etc, may be purchased from AMSAT (the address for AMSAT is listed in the Space Interest Groups column in this issue of *Satellite Times*-ed) and other vendors at reasonable prices.

These graphically based applications will display an orthographic or mercator map of the world, show your location, and the relative positions of the satellites. It will give you Acquisition of Signal (AOS) and Loss of Signal (LOS) times (remember Dr. Pappan's tutorial in the last issue of *ST*), the

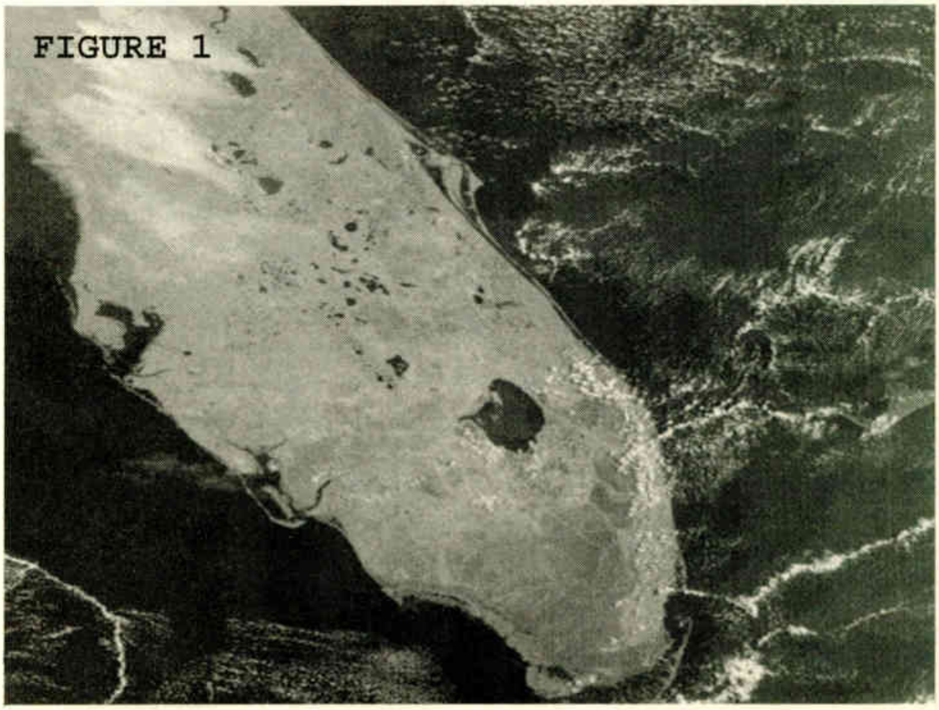


FIGURE 2

SATELLITE COMPARISON

	GOES (Geostationary Operational Environmental Satellite)	POLAR ORBITER
Basic Operation	Two satellite system covers from North to South America, from Pacific to Atlantic locations	Maintains 2 satellites in Polar orbit at all times: N to S (A.M.) S to N (afternoon)
Data Received	Visual (VIS) & Infrared (IR)	Day: VIS & IR, Night: IR
Direct Readout Data	WEFAX Weather Transmission	APT Automatic Picture Transmission
Distance From Earth	22,300 miles	500-900 miles
Image Format	Hemisphere/Quadrants	1,700 Mile Swath
Image Timeliness	Near Real Time	Real Time
Major Missions	1. Earth Imaging & Data Collection 2. Space Environment Monitoring 3. Data Collection 4. WEFAX Transmissions *Major Systems Include:* *VISSR - Visible Infrared Spin Scan Radiometer* *VAS - Atmospheric Sounder* *SEM - Space Environment Monitor* *DCS - Data Collection System*	1. SAR - Search & Rescue 2. ERBE - Earth Radiation Budget Experiment 3. TOVS - Trip Operation at Vertical Sounder 4. AVHRR - Advanced Very High Resolution Radiometer 5. SEM - Space Environment Monitor 6. DCS - Data Collection System 7. SBUV - Solar Backscatter Ultra Violet Radiometer
Orbit Location	Clarke Belt over Equator	Polar 9° - 11° N>S S>N
Pixel Size	8 Km Resolution	4 Km Resolution
Reception	Dish (4 feet+)	Antenna (omni directional)
RF Signal	1691± MHz (to down converter)	137 - 138 MHz
Scan Rate	240 lines/min - 4 lines/second	120 lines/min - 2 lines/second
Schedule	WEFAX Guide	By Prediction
Signal Availability	24 Hours	101 to 102 Minutes
Spacecraft Velocity	6,800 MPH (24 hour period)	17, 000 MPH (101 minute period)

ground track, and print out predictions for the next several weeks. Public domain programs (i.e. - FREE!) may be obtained from the DRIG Bulletin Board System (BBS) at (214) 394-7438 and many other satellite bulletin board systems world-wide. Some of these public domain programs actually rival many of the commercial programs in functionality and performance! These programs are available for a variety of computer platforms including the IBM PC, MAC, Commodore, and even UNIX-based systems.

APT Station Requirements

Some of the general requirements for a polar orbiter APT station include:

- A receiver with frequency coverage of 137-138 MHz. capable of receiving the FM mode.
- Turnstile, Beam, Discone, or quadrifilar helix antenna system.
- Pre-amplifier designed for 137 MHz to boost the receive signal for satellite (best results if mounted on the antenna).
- Low-loss (Belden 9913) coaxial cable connected between the antenna/preamplifier and the receiver.

If you are interested in GOES WEFAX reception at 1691 MHz, a six foot parabolic dish and a downconverter to convert the 1691 MHz signal to a more usable 137 MHz signal would be required.

Receivers

The Polar Orbiter satellite images are downlinked in two major frequency bands. Low resolution APT - 4.0 km per pixel resolution images are transmitted in the VHF range (137 MHz band). High Resolution Picture Transmission or HRPT - 1.0 km per pixel - is a digital signal transmitted at 1702 MHz and 1698 MHz, requiring much more sophisticated receiving equipment. GOES WEFAX is transmitted at 1691 MHz (4.0 km visible imagery and 7.0 km IR imagery resolution), and is typically downconverted to 137 MHz for reception on the same receiver as the APT signals.

There are a number of commercially manufactured receivers designed specifically to receive weather satellite signals. Both crystal controlled and fully synthesized receivers (137-138 MHz) are available at moderate prices in the $100 to $300 range. Some of the technical specifications you should consider include: sensitivity, selectivity and receiver Intermediate Frequency (IF) bandwidth - which will determine the ultimate quality of the received signal and imagery.

An IF bandwidth of 40 kHz is optimal for the APT imagery. Police scanners and VHF/UHF communication receivers (i.e - Icom and Yaesu) will receive the signals just fine, but the built-in IF bandwidth is typically either too wide (150 kHz) or too narrow (15 kHz). To reproduce quality APT images, the IF bandwidth must be wide enough to pass the entire signal waveform (the white and black upper and lower peaks of the signal). A narrow bandwidth will produce a picture with distortion and loss of resolution. Wide bandwidths will result in excessive noise on the signal, producing a snowy picture.

Vanguard, Quorum Communications, Wraase, Hamtronics, all manufacture 137 MHz receivers with the proper 40 kHz IF bandwidth. For a complete listing of vendors, send a 10 x 12 envelope with $ 1.00 postage to: DRIG, PO BOX 117088, Carrollton, TX., 75011-7088, and we will send you a booklet showing you how to get started, with addresses and phone numbers of the various equipment manufacturers.

GOES Downconverters simply sit out by the six foot parabolic dish and take the 1691 MHz signal, convert it to 137.5 MHz, and then feed this VHF signal directly into the antenna plug on the 137 MHz receiver. The rest of the receiving display system will

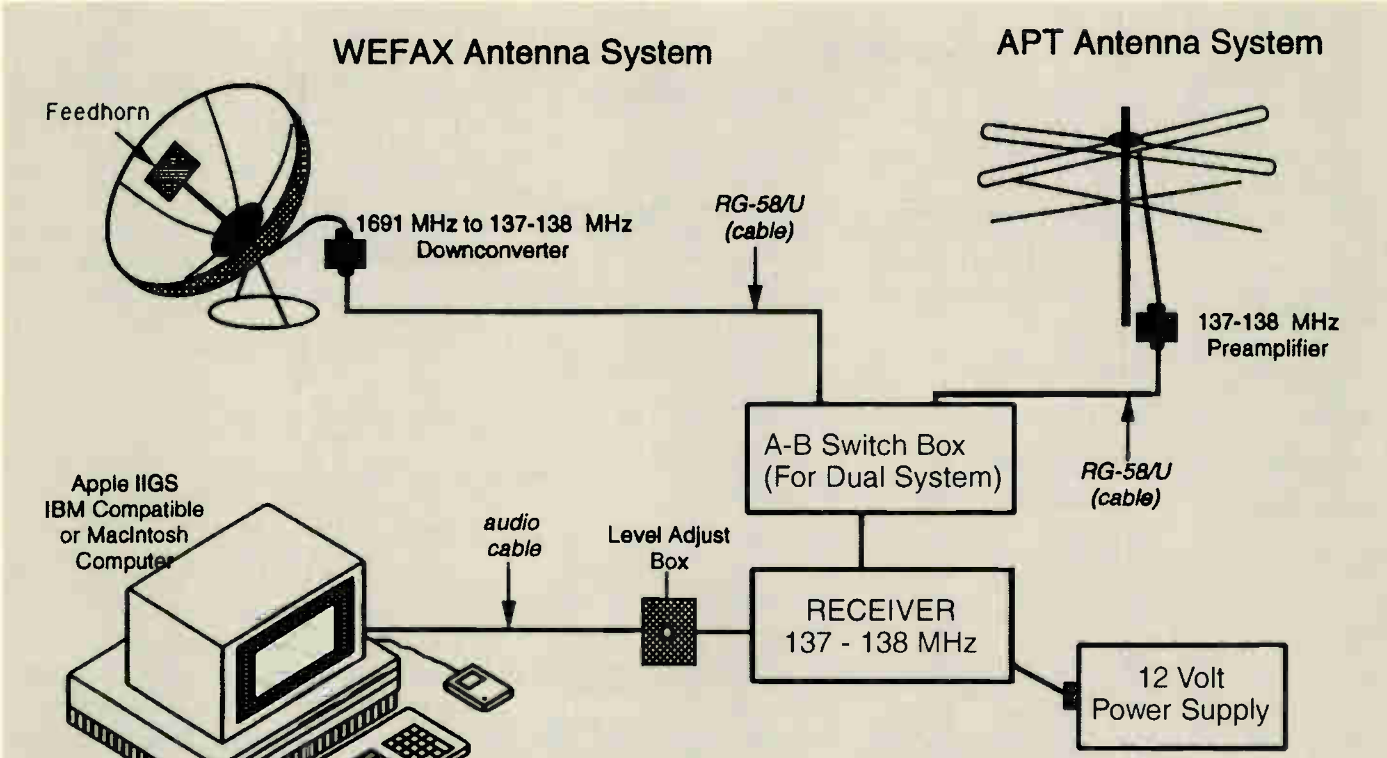


FIGURE 3

Configuration of Components

be identical to the APT imagery (see Figure 4)

If you have a police scanner that covers 137 MHz you can program in 137.500 or 137.620 MHz and monitor those two frequencies for a while. Eventually, you will hear the characteristic 'tick-tock, tick-tock' fax signal which represents a weather satellite image being received by your receiver. You don't have to spend a lot of money to get started in listening for weather satellite signals.

Over the next few columns we will cover, in detail, the antenna system, signal formats, demodulator cards, display systems, and image software needed to receive weather satellites. Finally, Figure 5 is another great weather image by Tom Loebl. It is an HRPT image from the NOAA 10 spacecraft and shows some severe thunderstorms south of Lake Michigan. Note the shadows to the west of the storms indicating it is a morning pass of the satellite, with the sun to the East.

Until next issue, turn on those VHF receivers and get ready to display your own live imagery from the *View from Above*! ST

Donald E. Dickerson, *N9CUE*

Advanced Communications Technology Satellite (ACTS)

In this edition of Personal Communication Satellites we will explore a satellite with the world's most advanced communications technology currently in orbit, NASA's Advanced Communications Technology Satellite or ACTS. ACTS provides for the development and flight test of high-risk, advanced communications satellite technology.

ACTS provides new communications satellite technology for:

- Operating in the Ka-band (30/20 GHz) where there is 2.5 GHz of spectrum space available (five times that available at lower frequency bands).
- Very high-gain, multiple hopping beam antenna systems which permit smaller aperture Earth stations.
- On-board baseband switching which permits interconnectivity between users at an individual circuit level.
- A microwave switch matrix which enables gigabit per second communication between users.

These technologies provide for up to three times the communications capacity for the same weight as today's satellites (more cost effective), much higher rate communications between users (20 times that offered by conventional satellites), greater networking flexibility and on-demand digital services not currently available from communications systems today. The development and flight validation of this advanced space communications technology by NASA's ACTS will allow industry to adapt this technology to their individual commercial requirements at minimal risk. It also will aid the U.S.industry in competing with European and Asian companies which have, in the last decade, developed significant capabilities for producing communication satellites and associated ground equipment.

ACTS technologies, which are applicable for a variety of frequency bands, will potentially lower the cost or technical threshold so that such new services as remote medical image diagnostics, global personal communications, real-time TV transmissions to airliners, direct transmission of reconnaissance image data to battlefield commanders and interconnection of supercomputers will be feasible. Technology spin-off is already occurring.

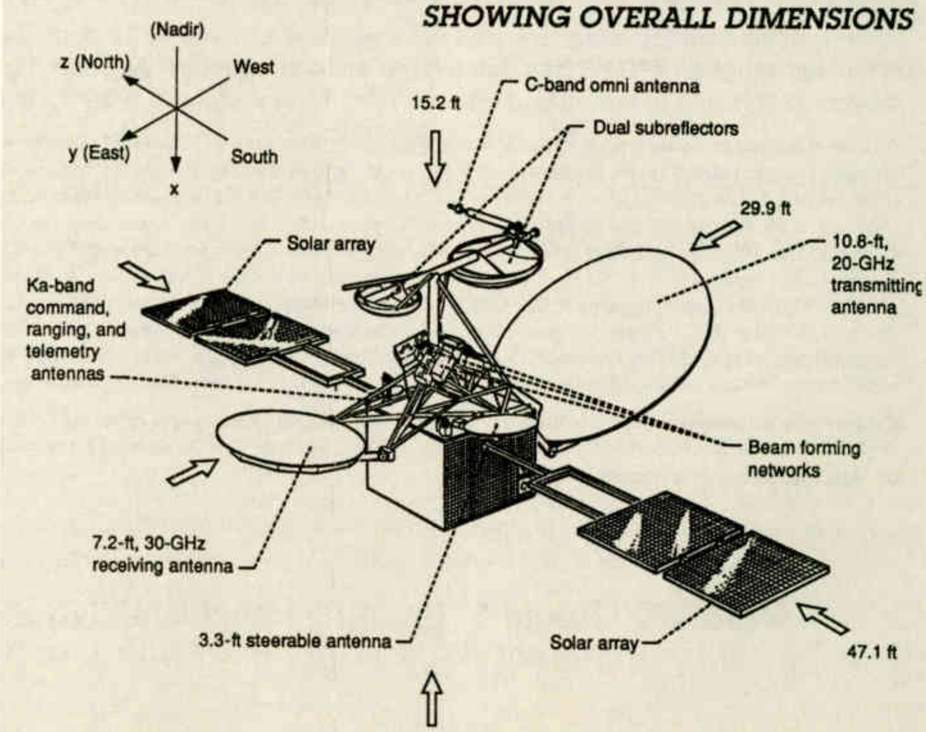
Motorola currently is adapting the ACTS Ka-band and on-board switching technologies for their $3 billion Iridium satellite system, which will provide global voice/data communications services. Norris Communications also is proceeding with a Ka spot beam communications satellite.

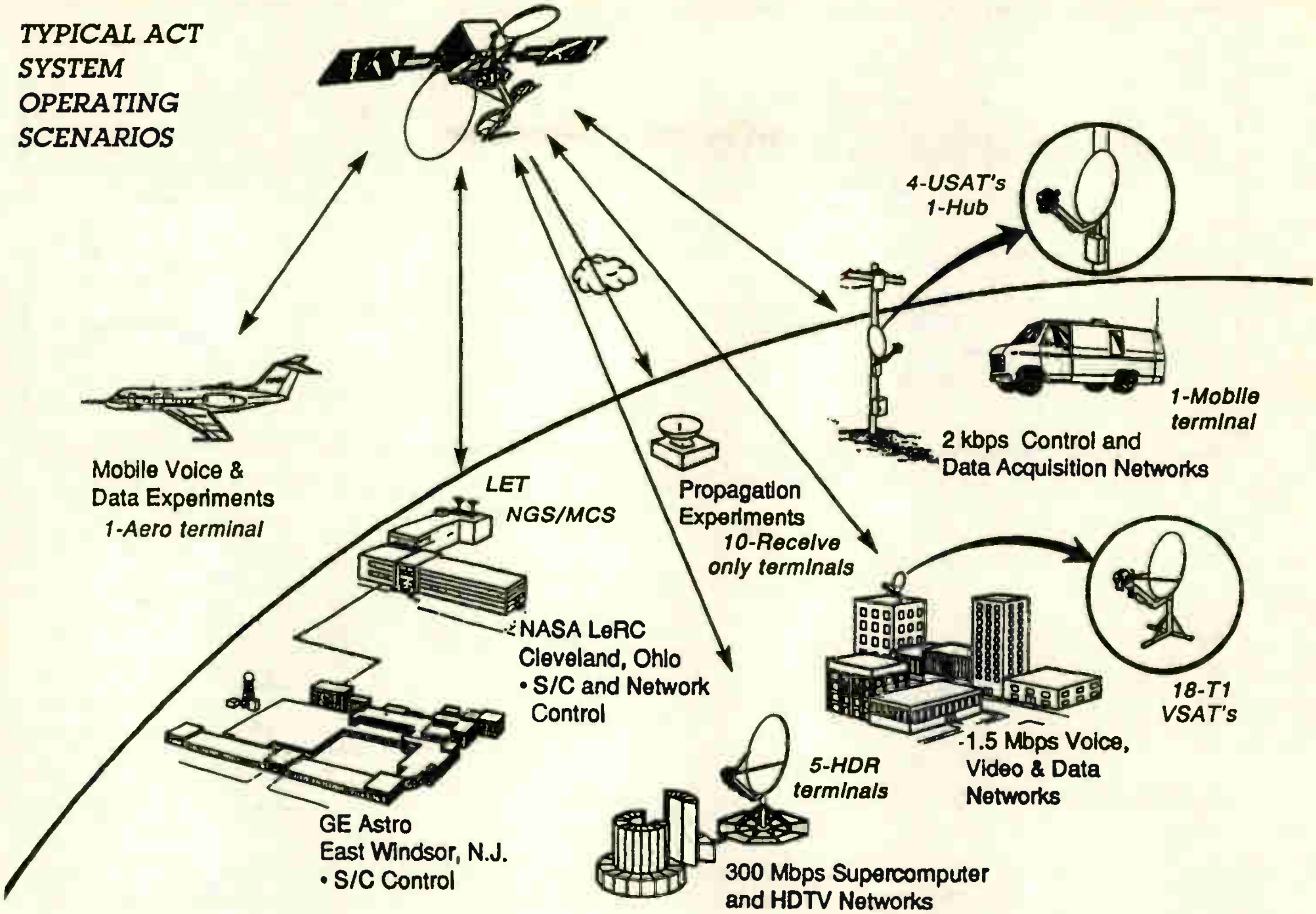
ACTS was launched on the STS-51 mission in July of 1993. It is based on the RCA 4000 series bus satellites, used by some commercial communication satellites. This bus was modified to house the apogee kick motor. ACTS measures 47.1 feet (14 m) from tip to tip of the solar arrays and 29.9 feet (9 m) across the main receiving and transmitting antenna reflectors. The spacecraft is three-axes stabilized and occupies an orbital slot of 100 degrees west in the Clark Belt.

The spacecraft's solar panels rotate once per day to maintain orientation towards the sun. ACTS also carries a battery back-up power supply to maintain spacecraft power during eclipse periods from the sun. During eclipse periods. experimental communication payloads will not be operated.

The side of the spacecraft facing earth is covered with antennas. It has a single 3.3 meter, 20 GHz transmitting antenna; a single 2.2 meter, 30 GHz receiving antenna

SPACECRAFT ON-ORBIT CONFIGURATION SHOWING OVERALL DIMENSIONS





with dual subreflectors; a one meter steerable dish and a set of spot beam feed horns. With this formidable array of antennas new high-gain multiple beam technology is being tested.

Goals for the ACTS satellite program are as follows:

- It will establish a digital network of very small aperture terminals (VSATS) capable of transmitting 1.544 megabits per second (Mbps) in a single satellite hop.
- ACTS will be used to establish a high data rate point-to-point network using microwave switch matrix systems.
- ACTS will be used to develop a low data rate network for personal communications using ultra-small aperture terminals (USAT).
- ACTS will used to develop a mobile network capable of high data rates on Ka-band (20/30 GHz).

To meet these goals, three complex and highly technical systems had to be developed. The first was a Multibeam Antenna (MBA) that can rapidly reconfigure narrow hopping and fixed spot beam patterns. The MBA is used to service traffic needs on a dynamic basis.

The second was the Baseband Processor (BBP), which is a high speed digital system that efficiently uses transponder space for circuit switched messages.

Finally, the Microwave Switch Matrix (MSM) had to be developed. It is hoped that the MSM will be able to route high volume, point-to- multipoint traffic over 900 MHz of bandwidth while rapidly reconfiguring the spot beam antenna on the spacecraft. This will make the multipoint routing of high volume TDMA and DAMA signals possible.

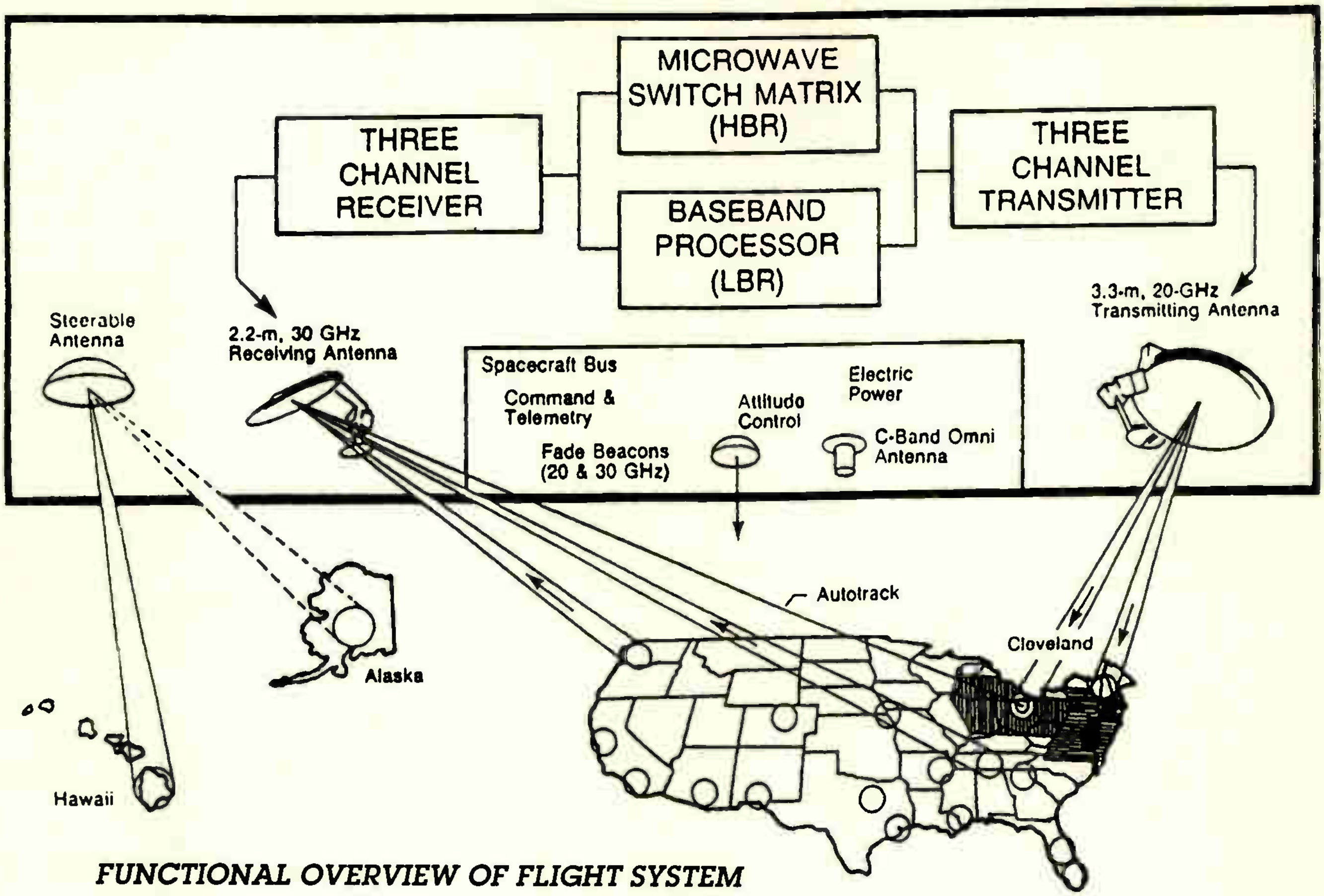
In addition, the contractors and staff at the Lewis Research Center in Cleveland, Ohio hope to use the ACTS to develop advanced algorithms to provide an efficient demand assigned multiple access (DAMA) system.

Advanced research using ACTS is also being done on techniques to correct errors in data due to fading and rain attenuation at 20 and 30 GHz. A forward error correction (FEC) method is being tested. Later test will investigate co-channel interference between two 27.5 Mbps frequency division multiplexed (FDM) channels, high definition television (HDTV) and the mobile equipment that could be used in autos, ships and aircraft.

ACTS has spot beams focused on Cleveland, Atlanta and Tampa. Two additional spot beams will allow for electronic hopping, one for the eastern half of the country and another for the western half. The east and west beams use opposite polarity to help limit interference.

How will ACTS rebroadcast signals from ground stations? The spacecraft collects the 30 GHz uplink and pushes it through a low noise receiver. It amplifies and down-converts the signal to 3 GHz. From here it is routed through the baseband processor (BBP) communications mode or the microwave switch matrix mode.

The baseband processor is a high speed digital data system which uses a time division multiple access (TDMA) format. The transmitter converts the 3 GHz signal to 20 GHz. It is then amplified by a traveling wave tube amplifier (TWTA). The traffic is then downlinked from the satellite in data



FUNCTIONAL OVERVIEW OF FLIGHT SYSTEM

bursts of 110 Mbps. Serial minimum shift keying (SMSK) modulation is used because of its efficient use of frequency space.

Serial minimum shift keying (SMSK) modulation is used because of its narrow characteristics. Traffic is burst to the satellite at 110 or 27.5 Mbps. The length of each TDMA frame interval is 1 millisecond. Uplink and downlink transmissions are synchronized with the hopping spot beam dwells by burst time plans. Burst time plans are generated by the master control station and transmitted to the spacecraft. Changes in TDMA burst time plans take place at the start of a specified 75 millisecond superframe command.

All network message coordination is handled by time multiplexing them into the same traffic bursts used to carry the message. The BBP system can service up to 40 different earth station per TDMA frame. It can simultaneously accept TDMA signals from east and west uplink hopping beam configurations.

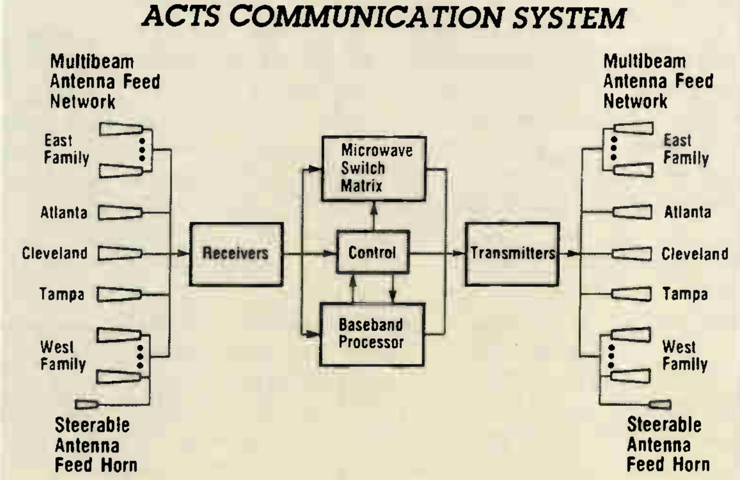
The microwave switch matrix system is the high volume point to point system that can downlink to several stations simultaneously. It downlinks a 20 GHz signal in TDMA, FDMA or several other modulation formats as require. The switch can make all possible connection combinations between the 3 uplink and 3 downlink beam antennas. A scanning method is used in a predetermined sequence of short burst of TDMA. This is accomplished through a GaAsFET with a switching time of 100 nano-seconds.

The NASA master control station for ACTS is located at Lewis Research Center. It is the site of the master baseband processor. The satellite control station or SOC is located Martin Marietta Satellite Operations in East Windsor N.J. This station supports the BBP as well as the Ka-band command, ranging and telemetry.

The NASA master control station interfaces the TDMA signals into the RF terminals for transmission to and from the spacecraft. The NASA station employs a 5.5 meter diameter Cassegrain beam waveguide antenna that operates on both 20 and 30 GHz. It is linearly polarized but cross polarized to each other allowing simultaneous operation of both the transmitter and receiver. The antenna gain is 56.7 dB at 20 GHZ and 60.2 dB at 30 GHz. This antenna is aimed at the Clark Belt and can be pointed anywhere between 80 and 110 degrees west. From Lewis the spacecraft is at approximately 39 degrees in elevation.

The Ka-band command, ranging and telemetry system uses the same antenna. Telemetry and ranging is used to monitor the spacecraft's operation and the command link is used to issue control orders to the spacecraft. The ground station uses 29.975 GHz to uplink commands, and it trans-

ACTS COMMUNICATION SYSTEM



mits a carrier at all times even when no commands are being issued.

ACTS has two downlinks, one vertically polarized on 20.185 GHz and one horizontally polarized on 20.195 GHz. The 20.195 GHz beacon will serve as a back-up to 20.185 GHz. A third beacon is transmitting on 27.5 GHz. This beacon is used exclusively for detecting rain fade on the uplink signals.

Rain-fade compensation equipment is a major system on ACTS. It requires real-time information on attenuations occurring on the uplink and downlink between the spacecraft and each ground terminal. This attenuation is determined by measuring the received signal strength of the beacons transmitted by the spacecraft. For satisfactory operation of the rain-fade-measuring equipment, which measures only the strength of the telemetry carriers, the frequency-modulated telemetry and ranging put onto the carriers must have a constant modulation index to preserve a constant transmitted carrier amplitude.

The horizontal beacon at 20.195 GHz is received in the same low-noise amplifier as the baseband processor signals and is coupled-off and bypass-filtered before double-frequency down conversion to 70 MHz is accomplished. The vertical beacon at 10.185 GHz is received by a separate low-noise amplifier before similar down conversion. Both are power divided at 70 MHz and routed on two paths, one to the telemetry demodulators, and the other to the rain-fade measuring equipment.

Propagation studies will be conducted through NASA's program office. Equipment will be loaned to various research centers and universities for monitoring the beacons, radiometers and low rate data transmissions for determining propagation effects.

The Defense Advanced Research Projects Agency (DARPA) is also involved with this advanced research spacecraft. DARPA is setting up a ultra high data rate ground station . It can support two-155 Mbps communication channels that can communicate independently of each other to other ultra high data rate stations. These stations could be interfaced with existing telephone systems, the synchronous optical network (SONET) or standard optical carriers. These stations support experimentation in supercomputer networks, High Definition Television (HDTV) transmissions and the development of hybrid fiber optic/satellite links.

The Naval Warfare Assessment Center (NWAC) is working with NASA to design a shipboard terminal to transmit and receive data at rates of up to 384kbps. The station involved in this research is located at Corona, California. They are using a 18-inch diameter antenna at the research center and onboard ships.

JPL is working on aeronautical mobile and land mobile systems. Current land mobile experiments employ 2.4, 4.8 and 9.6 kbps compressed voice circuits. The modulation format is differential phase shift keying (DFSK). Aeronautical mobile will use small phased array antennas mounted on the aircraft for both voice and date communications. The antenna consists of multiple stacked aperture-coupled microstrip patch radiating elements. Each element will have 5 dB gain and a transmit power of 1.5 watts. The system will operate at 20 GHz and the aero terminals will operate in duplex voice and data between. ST

RADIO ASTRONOMY

By Jeffery M. Lichtman

Abandoned but not Forgotten

The Rebirth of a Satellite Station

About 10 years ago, AT&T abandoned a satellite antenna site located at Woodbury, Georgia. This site is located about 65 miles south of Atlanta. The antenna site is located in a natural bowl-type valley something similar to the bowl at the National Radio Astronomy Observatory in Green Bank, WV. This peaceful setting offers a natural block to most types of terrestrial interference.

The two 105-foot dishes at Woodbury.

The facility was used by AT&T for satellite uplink/downlink communications. Originally the antennas were operated in the frequency range of 5.925-6.425 GHz for transmitting and 3.700-4.200 GHz for receiving. The 105 foot diameter antennas have a gain of about 60 dB at 4 GHz and 63 dB at 6 GHz.

Parametric Amplifiers, commonly known as paramps, were cooled to about 18 degrees kelvin giving the system the necessary signal-to-noise ratio for operation in the 4/6 Ghz range. The cooling system with this type preamplifier probably cost AT&T around $75,000 dollars then. Compare that to the LNAs (Low Noise Amplifiers) available today that sell in the $200 - $2000 range and have even lower noise figures.

Even more interesting is the drop in power consumption. The older parametric amplifier cooling system used as much power as a home air conditioner. Today's modern LNAs only need about 1 watt to achieve the same or better noise figure. This AT&T facility was probably abandoned for a more economical site closer to Atlanta.

The antenna site has gone unused (except by the local bird population) until it was acquired by GTRC (Georgia Tech Research Corporation) around 1991. Mr. Ron Bell, Vice President of GTRC saw the educational potential of the site and decided to make the old AT&T antenna site part of the Georgia Tech facilities.

When the site was abandoned, AT&T left the site inoperative. They removed DC motors, cables and power connections along with some of the critical motor contractors and relays necessary to move the 105 foot antennas. So for over six years, these two antennas sat quietly looking at the sky and never realizing the full potential of what they could be collecting from space.

Radio Astronomy gives us one more way to view the heavens, electronically. The availability of 105 foot dishes to the amateur radio astronomer is rare. Time for observations at other facilities is booked often years in advance, so it is hoped that the Woodbury Observatory will soon be another radio astronomy tool available for scientists, students and amateurs to use.

The Work Begins

Around 1991, Dr. Whit Smith, KJ4SC, a research engineer and adjunct professor for the School of Electrical Engineering at Georgia Tech and a few of his students began the planning to replace the missing parts of the antennas with the ultimate goal of bringing the site back to life. Additional help would be needed in the way of an on-site maintenance and security. Mr. Tim Gilbert, an independent contractor, was hired for this task. Gilbert has done a great job working at the facility and we witness noticeable changes each time we visit the site.

Over the past three years, a great amount has been accomplished, from refurbishing the upper receiver room (50 feet above the ground) to bringing one antenna back to life. Dr. Whit Smith has guided his students through several special projects at the site. The students have gained real hands-on experience in building position sensors, motor controllers, computer interfaces, LNAs and various receiving equipment.

A regional group from SARA (Society of Amateur Radio Astronomers) was become involved in an advisory capacity in the refurbishment of the Woodbury site. This has been accomplished through the leadership of RF design engineer and SARA member, Charles Osborne, WD4MBK. He is employed by Scientific Atlanta's Satellite Communications Division. Osborne became acquainted with Dr. Smith through the Georgia Tech Amateur Radio Club (W4AQL). Over the past few years, Osborne has constructed many 4 and 6 GHz receiving systems. It was through this experience and his voluntary help that a total power

FIGURE 1

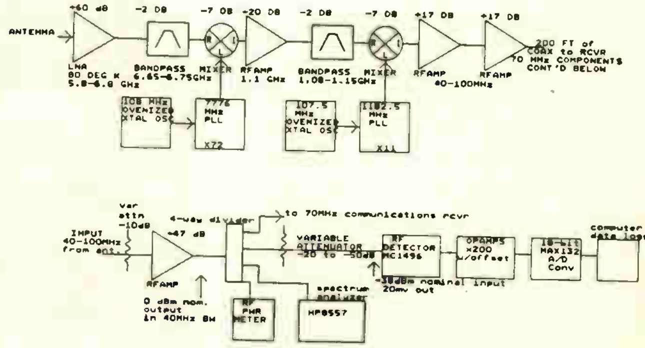


FIGURE 2

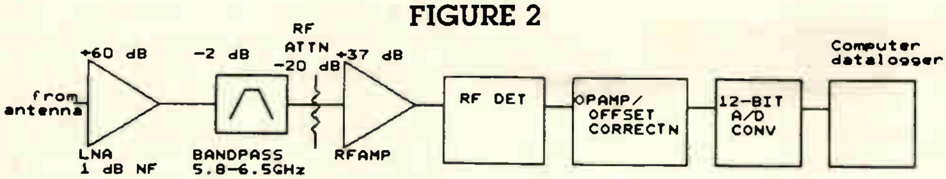
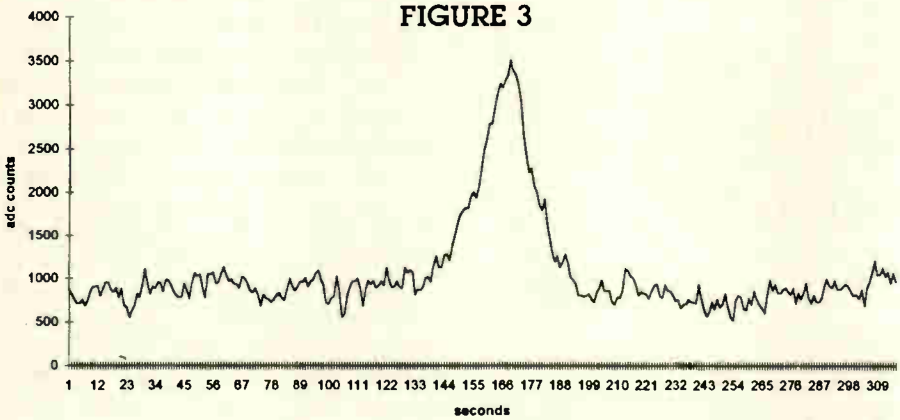


FIGURE 3



receiving system has put in place, for training and observational projects by Georgia Tech students and SARA members.

The Woodbury Total Power Radio Telescope constructed by Charles Osborne consists of a 60 dB LNA with 1.2 dB noise figure at 6.7 GHz; 100 MHz wide bandpass filter; Mixer; 7.7 GHz local oscillator; 20 dB post amplifier; 60 MHz wide bandpass filter; another Mixer; 1.1 GHz local oscillator; 30 dB intermediate frequency amplifier; variable attenuator; 70 MHz amplifier with 47 dB gain; and another variable attenuator. At this point the signal is fed to a square law detector and then to a four way splitter where it is branched out to an Analog to Digital (A/D) converter, digital readout, spectral line receiver, and an extra port for another piggyback receiver or spectrum analyzer. Figure 1 is a block diagram of the telescope.

Some professional work has been done by Dr. Paul Steffes, W8ZI, in the area of planetary work with Venus and the Magellan satellite. Dr Steffes recently completed a TRF (Tuned Radio Frequency) type receiver operating from 5.8 to 6.5 GHz. This receiver consists of the following; a 60 dB LNA at 1.1 dB noise figure, 700 MHz bandpass filter, 15 dB post amplifier, which is fed into a Schottky diode detector and a DC amplifier. The output of the receiver feeds an A/D converter. With 60 dB of gain from the antenna, this system functions very well as an efficient collector of radio astronomy signals. Figure two is a block diagram of Steffes TRF receiver.

Osborne, Dr. David Moore, KC4YFD, a high school physics instructor, and your editor have observed a few radio objects at Woodbury. A typical chart recording reflecting some of these observations is shown in figure 3.

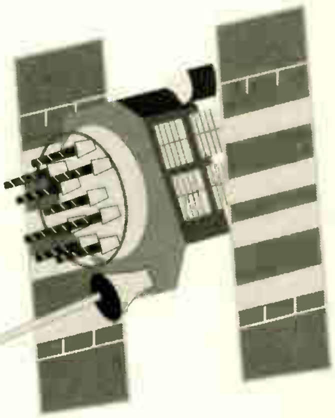
It has always been the dream of Amateur Radio Operators and Amateur Radio Astronomers to work with large antennas. Opportunities for group acquisitions of phased out antenna sites is rare, but they do exist. Many facilities built during the 70s and 80s have been abandoned, This is because of newer more powerful satellites and fiber optics, which have made large antennas unnecessary. 12 GHz satellites make a 10 meter dish equivalent to the much more costly larger diameter dishes. Interested groups should inquire about these sites through your local AT&T or local Bell division office. You never can tell, a site might be available in your area.

I would like to thank Mr. Charles Osborne of Scientific Atlanta and Dr. Whit Smith of Georgia Tech School of Electrical Engineering for their information and help with this article.

For those of you interested in the field of Radio Astronomy, The Society of Amateur Radio Astronomers would be the place to start. The group is dedicated to education and research by amateurs in the field of amateur radio astronomy. Membership dues are $20.00 per year for the U.S. $28.00 for Foreign. SARA may be contacted by writing to: SARA Membership Services, 247 N. Linden St., Massapequa, N.Y. 11758. ST

By Todd D. Dokey

A Look at Some Rockwell/Collins GPS Applications.



Even before the Persian Gulf War, GPS has played an important role in the ability of the United States to project its forces anywhere on the globe. It was in that technological war, that GPS came into it's own as an effective tool in combat.

There is no other vastness on land which compares to the oceans of the world, except a desert. Such desolation can present navigational problems simply due to a lack of reference points. Under noncombat conditions, one can use the stars and other similar methods for navigation across the desert. In combat, things are a bit more urgent, and require the utmost of speed and precision. It is in this arena that GPS permitted the coalition forces to excel over the Iraqis. Iraqi forces were often amazed when US troops walked straight up to their encampments, camps in which they surely felt protected in part by the vastness of the desert.

This hide and seek maneuver was accomplished by the use of portable GPS receivers. The locations of the camps and strong points were taken from information collected by satellites and other means. The GPS receivers were then used to plot a course across the desert to these points.

Intelligence data can be collected from many sources and merged into a coherent "picture" of the threats posed to forces in the field.The overall "map" can be drawn using up to date satellite imagery which can be updated and enhanced by other intelligence information collected by electronic and photographic surveillance aircraft.These combined intelligence data will assist the Pentagon planners by offering near real time updates of field conditions which may influence strategy.

The up to date target location data can then be transferred to thebattlefield personnel where that data can be fed into aircraft and missile guidance systems for precision flight paths to the targets of choice. Infantry and artillery units can be directed toward the enemy without wasting too much time trying to find the enemy, in order to engage him.

It all seems so easy now, but there really was a time when computerized information and GPS did not exist!

In 1974, the Collins Avionics Division was one of four contractorsinvolved in the first phase of the GPS development program. By 1977 GPSwas enhanced so that it could successfully be used during conditions of electronic jamming. In 1983 the first transatlantic flight using satellite navigation was completed using GPS.

In May of 1985, the Collins Government Avionics Division of Rockwell International Corporation was awarded the contract for the full-scale production of military NAVSTAR GPS equipment for the Army, Air Force and Navy.

One of the products Rockwell/Collins now provides for aircraft iscalled the CDNU (Control Display Navigation Unit). The CDNU combines information from communications and navigational sensors (inertial navigation system, doppler, and altitude or heading references) to provide a centralized point of control to the pilot and flight crew. It can compute this information for any use from flying holding patterns to vertical navigation. It is used in aircraft such as the CH-47 and C-160.

The CDNU can be configured with software and Rockwell has developed a large library of software to interface this system for use with a wide variety of aircraft. The software can be loaded into the CDNU system and specially configured (even on the flightline) while the receiver remains in the aircraft, which eliminates the removal of the CDNU for upgrade or software reconfiguration.

The CDNU uses a 16 MHz. Intel 80386 processor in conjunction withan 80387 math coprocessor on a 32-bit data bus. It uses 1 MB of flash EEPROM for the aircraft and mission application software. The "boot"instructions for the 80386 are kept in a 128K UVPROM and uses 256K of RAM. A 64K nonvolatile EEPROM is used for data base variables.

In 1993 the PLGR (Precision Lightweight GPS Receiver) system wasdeveloped for DoD (Department of Defense). The system is a five channel receiver capable of decoding the civilian and military GPS codes. The PLGR is used in vehicles and as a hand-held unit.

The PLGR is capable of operating in spite of SA (SelectiveAvailability) mode and can use DGPS (Differential GPS) in conjunction with enhanced anti-spoofing techniques. The PLGR is produced for all four branches of military service and provides interfaces for SINCGARS and HAVE QUICK time synchronization.

The division of Rockwell which produces this receiver also providesGPS missile guidance system additions for the Navy's Tomahawk Land Attack Missile (TLAM) and Standoff Land Attack Missile (SLAM). The abbreviations are also used for the Rockwell guidance systems employed in these missiles.

The TLAM is a small GPS receiver package which interfaces with themissile's original TERCOM (terrain contour matching enroute navigationalsystem). The TERCOM guidance permits the missile to hug the ground anddetermine its location based upon the terrain it follows into the targetarea. The use of GPS in the Tomahawk missile increases accuracy and reduces targeting errors by relieving the dependence on the precision of the missile's terrain maps. The TLAM naturally has antijamming capability.

The SLAM is used in the Harpoon missile. It is also used toincrease position accuracyraising the probability that the targetwill be within the "seeker field" of view during "terminal phase" of themissile's flight. The SLAM guides the weapon to the target in conjunction with the missile's INS (inertial guidance systems). An inertial guidance system simply stated determines current position based upon direction of travel and speed from point of origin. The SLAM GPS receiver also incorporates antijam technology.

GEM (GPS Embedded Module) is a 7 pound "black box" type GPSreceiver which is part of Rockwell's MAGR (Miniaturized Airborne GPSReceiver) contract. The MAGR receivers are intended for use in aircraftsuch as the F-14D, F/A-18, AV-8B, AH-64 Apache and F-16 ADF (just to name a few).

The GEM can use the NSA certified PPS-SM (Precise PositioningService Security Module). With this feature the receiver is unclassified, that is to say, it does not require the need for specially cleared personnel to deal with its secure encryption systems. GEM systems are modular, and built to be integrated into existing and new aircraft.

Rockwell does not restrict the GPS equipment it makes to strictlymilitary applications. The Collins GEO-NET 2000 is a laptop style terminal which works with mapping software that can graphically track vehicles or ships at sea and display their positions in real time on the map display which is GIS compatible. The GEO-NET system is capable of connecting to VHF, UHF, HF or SATCOM communications systems to transmit precise location data back to the base system or to other systems in a GEO-NET 2000 network. The data system does not interfere with voice communications.

Applications include law enforcement (where it can be used totrack vehicle locations in real time and also like a MODAT terminal),maritime (vessel tracking, harbor management or emergency response), andagriculture (tracking of seed or fertilizer dispersement).

The system supports special remote data collection hardware likethe GNR (GEO-NET Remote) data logger for in field work. The GNR-2000consists of a GPS receiver, a palmtop computer and special loggingsoftware. This permits field personnel to enter specific data regarding a precise location, which will appropriately integrate into the overallGEO-NET display map of information regarding the area.

The GEO-NET 2000 can also transmit manually entered text messages,sensor data or other predetermined information for display and storagethroughout the network.

NavMaster mission planning software runs under Microsoft Windows and can interface to the Trooper or PLGR (Precision Lightweight GPS Receiver) hand-held receivers. Planners can use NavMaster to transferwaypoint and route information libraries into the hand-helds for specific applications in the field.

NavMaster requires at least Windows 3.1, an 80386 processor, 2 MBof RAM (4 is recommended), a VGA display and 5 MB of disk space. Itoptionally will work with DeLorme XMap (tm) and MapExpert (tm).

Earlier mention was given to military application of GPS. However, there are other scenarios for the use of the same technology. For example, a fire and hazardous materials spill in an industrial park. The fire is precisely located because the city map has been included in the communications center computer system and paired with GPS information in the GEO-NET map.

The data regarding the hazardous materials content of the building is fed into a GEO-NET system by using a GNR remote data terminal, if it is not already known. The data is displayed on a GIS map of the city involved and it is determined by known wind pattern data for the city that an evacuation must take place covering a certain area.

The fire department's HAZMAT team arrives on scene and relatescloud drift data to the GEO-NET system. The cloud data is updated into the system and the locations of the responding fire and law enforcement units are displayed in real time on the GEO-NET consoles.

The incident commander requests HAZMAT data on nearby businesses inthe industrial park as the possibility exists that the fires may spread.This data has already been entered into the system and is part of the GIS mapping database which is sent to the commander over the GEO-NET data network. Further catastrophe is avoided because the site specific HAZMAT data was available to the commander.

In law enforcement, individual vehicle locations can be tracked anddisplayed on a master map in the dispatch center. This would permit theautomatic deployment of the nearest patrol unit to a crime scene. Sincethe city is also on a computerized map, the location of the person making this hypothetical 911 call is known because of the ANI (automatic number identification) of the call.

Watch out criminals! Big GPS brother can be used against you! Yourmovements can also be tracked on this mapping system, which couldconceivably reveal patterns of movement or relations to unknown associates. This information could be used to link you to your activity. Crime trends can be examined. This information is useful in convicting all types of criminals from arsonists to car thieves.

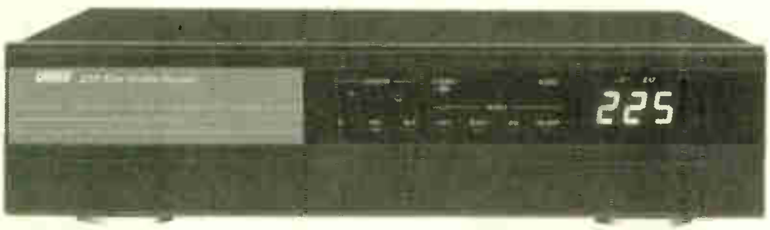
Another example would be in tracking animal or plant species in thewild. Specific locations of certain plants or habitats could be determined and their growth (or lack thereof) could be plotted on a map of the region. Sensor data or field tests on soil samples and water quality could be added to the database. In this way, natural resources from trees to mineral deposits could be cataloged with greater accuracy. Reforestation growth after a forest fire could also be tracked.

Information from natural disasters to man made catastrophes canbe tracked and better understood with the aid of this technology. Thiswill hopefully permit better management of all the issues (strategic, political, social, economic or demographic) that concern us. The possibilities are only limited to your imagination.

Further information regarding GEO-NET and NavMaster can be obtained by writing: Rockwell InternationalCollins DivisionCedar Rapids, Iowa 52498. ST

WHAT'S NEW

by Wayne Mishler, KG5BI



DRAKE RECEIVER FEATURES IMPROVED RECEPTION

The R. L. Drake Company has developed new technology for its ESR300e receiver which improves reception of weak or noisy satellite TV signals. They call it programmable threshold extension. It enables users to adjust and program the receiver's intermediate frequency (IF) bandwidth. This extends the minimum threshold of the receiver, permitting quality reception of marginal signals. Threshold extension reduces noise in the picture and improves picture quality with less video distortion.

Programmable threshold extension can be programmed into memory of desired channels, or it can be adjusted from the normal operating mode. Threshold extension is independently adjustable from one channel to the next. The operator can choose the setting that reduces noise in the picture while maximizing picture quality with the least video distortion for available signal strength. Threshold extension is available for either of two IF bandwidth settings in the receiver: 27 MHz or 18 MHz.

The Drake ESR300e is a programmable 225-channel remote-controlled receiver capable of multi-standard operation. It features less than 4 decibels C/N at maximum threshold extension, and less than 6 decibels C/N with no threshold extension. There is advanced noise reduction for its stereo audio section which employs companding circuitry compatible with Wegener audio transmissions. Other features include a dual input tuner for multiple LNB connections, expanded input frequency range from 950 MHz to 2050 MHz, two SCART connections for multiple decoder operation, a video recorder timer, and a built-in antenna positioner for use in motorized installations.

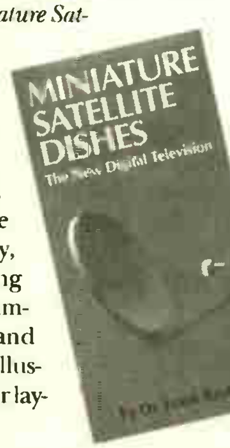
Programming and operation of this sensitive receiver is simplified by a series of selectable, multi-lingual on-screen menus. The receiver also features programmable video invert selection via the remote control, allowing the operator to select and program into memory operating parameters on a channel-by-channel basis.

The ESR300e is just one of a diverse line of products from Drake, a leader in the communications industry since 1943. Their current product line includes consumer satellite television equipment, commercial satellite communications equipment, and radio communications equipment.

For information on Drake products, contact Daniel Albrecht, International Sales Manager, R. L. Drake Company, P. O. Box 3006, Miamisburg OH 45343, telephone (513) 866-2421, fax (513) 866-0806.

NEW BOOK EXPLAINS DBS TV

A new book released by Baylin Publications, entitled *Miniature Satellite Dishes – The Digital Television Revolution*, covers all aspects of the direct broadcast satellite (DBS) industry. Nine chapters delve into DBS technology, corporations offering the service, programming, installation and more. The book is illustrated and written for laymen.



The first three chapters of the book include an overview of this exciting new field. They cover the underlying technology of satellites and receiving systems. The writer, Dr. Frank Baylin, explains such topics as digital video compression, bit error rate, receiver design, and compatibility of large- and small-dish systems.

Chapter four tells about the origin of DBS and looks at the companies offering DBS: DirecTV, EchoStar, PrimeStar, and USSB. It examines and explains in detail about their satellites and other systems. It explains how DBS differs from large-dish satellite TV and from cable television. It examines frequency allocations and other topics.

In subsequent chapters, things like "DigiCipher" and "VideoCrypt" (methods used to protect programming) are explained. The issue of system security and related options are studied. Programs relayed by DirecTV, PrimeStar and USSB are examined. So are program packages and prices offered by the various vendors. You'll study a step-by-step procedure for installing home satellite systems such as the RCA DSS system used by DirecTV and USSB. And you'll find out how to connect home entertainment components such as stereos and VCRs to satellite TV receivers.

This is essential reading for anyone considering DBS and its available now for $20 plus $4 shipping from Baylin Publications, 1905 Mariposa, Boulder, CO 80302. A catalog of Baylin products is free for the asking. Their telephone number is (303)-449-4551, and their fax line is (303) 939-8720.

NEW SATELLITE RECEIVING STATION DEBUTS

GEOSTAR Engineering has introduced a digital high resolution receiving station for geostationary satellites such as geostationary operational environmental satellites (GOES) which continuously photograph the earth and broadcast super sharp images of cloud patterns and other scientific data.

GEOSTAR says their new state of the art imaging system, the VISSRSAT 2000, is easier to use and more flexible than any other system available to date, and that it is easy to install. The system brings sharp pictures of the earth from satellite sensors directly to your desktop computer. It receives, "ingests" and projects on your computer screen GOES data live as satellite cameras scan the earth's surface. GEOSTAR says no licensing or usage fees are required for ingesting data directly from the satellite's instruments, unlike commercially marketed data which is non-digital and rarely received in real-time.

There are numerous commercial, institutional and private applications for the VISSRSAT 2000 in meteorology, oceanography, climatology, forestry, fishing and agriculture.

The system comes complete with a 12-foot diameter mesh dish, steering motor with IR remote controller, an integrated downconverter, computer cards, software, and cables. The price for the entire package is $3995.

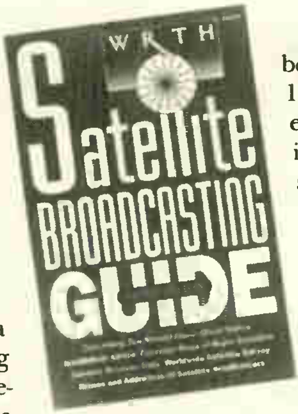
Buyers who already own or have access to an adequate dish antenna can save money by purchasing the system less antenna. The antenna that comes with the package is a 3.6-meter aluminum mesh reflector that provides 41.65 decibels of gain. It employs a 36-inch polar mount and weighs 288 pounds. The antenna positioner is a 24-inch Von Weise with reed position sensing. It operates with the UST 300 pulse controller with infrared remote control, circuit breaker protection, east and west limits and 40 satellite position memory. The preamplifier and downconverter features a noise figure of less than .75 decibel.

The system requires an IBM or compatible PC computer with 386 or greater processor, one megabyte RAM, VESA compliant SVGA adapter and SVGA monitor, one 3 1/2 inch floppy disk drive and a hard disk drive large enough to store high resolution data. For example, a single sector 1024 x 1024 image requires one megabyte of storage space on the hard drive. A full earth disk saved at full resolution requires more than 200 megabytes of hard disk space.

For information about the system, write or fax GEOSTAR Engineering, 103 Downing Place Apex, NC 27502, fax (919)-362-5822 before noon eastern time. Their telephone number is (919) 362-0530.

WRTH LAUNCHES SATELLITE GUIDE

The 1995 edition of the WRTH Satellite Broadcasting Guide (by the publishers of the popular World Radio TV Handbook) will soon be available with helpful information on receiving satellite radio and television broadcasts.



It promises to be even better than the 1994 edition which explained how to buy, install, and operate satellite reception systems and exploded the mysteries of satellite reception with more than 160 maps of satellite tracks and 150 illustrations of satellite hardware.

WRTH Satellite Broadcasting Guide is published by Billboard Books, 1515 Broadway, New York 10036, and list for $24.95. Grove Enterprises is offering a pre-publication discount on the 1995 edition until December 31, 1994 of $23.95 and that price includes free shipping.

GERMAN MAGAZINE COVERS EUROPEAN SATELLITE BROADCASTING

Anyone who enjoys satellite broadcasting and reads German should check out *Tele-Satellit*, a high-quality magazine covering satellite and home entertainment in Europe.

With editorial offices in Munich, Germany, *Tele-Satellit* bills itself as Europe's satellite magazine. It covers every facet of television satellite reception including equipment, tracking, and programming for European audiences.

Tele-Satellit is a world-class magazine with in-depth articles, eye-catching layout and design, and four-color printing which accentuates photographs and illustrations.

Send inquiries to *Tele-Satellit*, Abonnement-Service, Postfach 20, D-80452 Munchen, Germany.

POSTER GIVES HELPFUL SATELLITE INFORMATION

With all the satellites going into orbit these days, you'd think someone would come out with a chart that shows in a glance the satellites people use most. Well, someone has. Keystone Communications is offering to everyone its popular *North American Satellite Guide* poster published annually and previously was available only to Keystone clients.

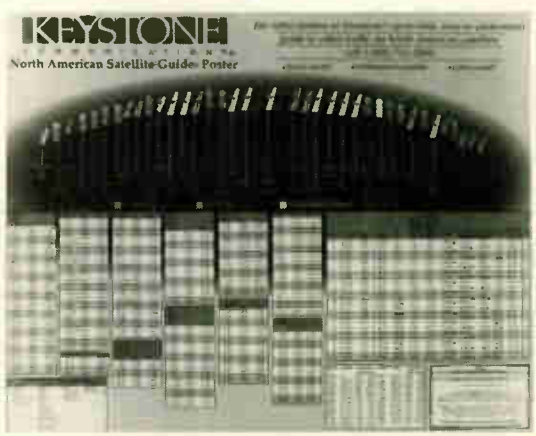
This eye-catching poster measures 22 x 28 inches and is immaculately printed in full color. It features the North American communications satellite arc along with C-band and Ku-band frequencies, half transponder formulas, and UTC time conversion tables.

With this poster on your wall, you'll be in good company. It's displayed in the media room at the White House and the technical operations centers of the PBS and NBC networks. To get one, send $15 (U.S. residents) or $18 (Canada residents) to Keystone Communications Poster Department, P. O. Box 2755, Salt Lake City, UT 84110-2755.

The poster is a companion piece to Keystone's *North American Satellite Guide*, a one-stop reference to North American satellites that carry video traffic. The guide is published six times a year and features one satellite per page, listing all of that satellite's technical information. This includes its position on the arc, down-link polarity, channel number, owner or lessee, and more.

The guide is "primarily for professional broadcasters," says Doug Jessop, publisher of both the guide and the poster. "Our annual poster can be used by professional broadcasters, home satellite dish owners, educators, or anyone on the information super-highway."

Keystone provides television-related services for more than 1,000 U. S. and international clients every year, including news, sports, program distribution, and business clientele. The company uses its own network of owned and leased satellite transponders, microwave and fiber optics through its facilities in New York, Washington D.C., Los Angeles, San Diego and Salt Lake City. ST



SATELLITE TIMES TESTS

By Larry Van Horn, N5FPW

The Swagursat and OFS WeatherFAX V5

When first starting into the hobby of weather satellite monitoring, most beginners use scanning receivers they have on hand in the shack to hear and decode satellite imagery. While there are some excellent scanners and communication receivers in the marketplace that cover the meteorological 137 MHz FM band, most of these receivers do not have the proper bandwidth to give good dynamic range and contrast to the received imagery.

In this issue of *Satellite Times*, *ST Test* will look at the OFS "WeatherFAX V5" decoder and the Swagur Enterprises "Swagursat" demodulator which, in combination, produce excellent weather satellite images and overcome the bandwidth problem for owners of the ICOM R-7000/7100 VHF/UHF communications receivers.

SWAGURSAT

The Swagursat is a special video demodulator unit that attaches to the Icom R-7000/7100 receiver 10.7 MHz intermediate frequency (IF) port on the back of these two receivers. By employing the desired bandwidth for weather satellite reception and connection to a good decoder/ software the Swagursat produces excellent imagery from the polar and geostationary orbiting weather satellites.

The Swagursat comes in a small, compact metal box with a loud speaker enclosed in the unit. There are three external connectors: the 10.7 MHz IF input from the R-7000/7100, the 12-volt power input (transformer supplied), and the output jack to the weather satellite demodulator card. There is a volume control on the front

panel of the unit to control the enclosed speaker's volume. Instructions for installation of the unit are well done, and the installation itself and operation of the unit is extremely simple.

There is one important warning that potential buyers should know about. Since this unit is so easy to install and operate, you might be tempted to pass on reading the instructions prior to installation. If you don't read these instructions, you will miss some very important information that could effect the health of your Icom receiver. Take a few minutes and be sure to read the warning in the instructions prior to installing your Swagursat.

Receiver bandwidth should be thought of as a "window" and it limits the range of frequencies in the IF that the receiver can respond to. This is an extremely important specification when you are trying to meet the 40 kHz IF bandwidth requirement for the polar orbiting weather satellites, or the narrow frequency deviation for Meteor or GOES spacecraft reception.

Weather satellites use a base carrier frequency that is frequency modulated or FM (with an impressed Amplitude Modulated-AM tone). This means that the frequency is shifted to transmit the satellite image and this deviation is different amongst the different satellites. NOAA polar orbiting satellites exhibit around 36 kHz of deviation, plus another 3 kHz (either side) for the Doppler effect giving a total of 45 kHz of frequency swing. The Russian Meteor weather satellites have a total bandwidth of around 30 kHz (deviation plus Doppler effect). GOES weather satellite reception requires around 45 kHz of IF bandwidth. The receiver you pick for weather satellite reception needs about 40-50 kHz of IF bandwidth and this is the heart of the problem.

The more popular scanners (i.e.-ICOM, Uniden, AOR, Radio Shack, etc) are designed for either 15 kHz (FM narrow for public safety monitoring) or 150 kHz (FM wide for broadcasting-FM stations). If the bandwidth is too narrow (15 kHz), clipping of the signal occurs resulting in a loss of dynamic range. If the bandwidth is too wide (150 kHz), it will let in more noise and unwanted signals. Both of these conditions will degrade the signal-to-noise figure and produce poor weather satellite imagery.

The Swagursat Satellite Demodulator overcomes this problem by providing to the decoder card in your PC the proper bandwidth from the ICOM R-7000/R-7100 receivers for weather satellite reception.

OFS WeatherFAX V5

The second half of this ST test involves the OFS Weatherfax V5 decoder card. Once you have the proper bandwidth out of your receiver, then you have to take the tones and convert them into an image. The OFS Weatherfax V5 is a hardware and software package that decodes the audio from your receiver into weather satellite images that you can display on a monitor or capture in a file for storage on a hard disk for further processing later. Shortwave enthusiasts can even use this package to decode HF marine fax on a IBM PC computer from your shortwave receiver.

The OFS package has the capability in real-time to capture, analyze, print, store

Swagur Enterprises
7240 Hwy Y
Lodi, WI 53555
Telephone/Fax: (608) 592-7409

OFS WeatherFAX
6404 Lakerest Court
Raleigh, NC 27612
Telephone/FAX: (919) 847-4545

and animate all of the weather satellite images directly from GOES-WEFAX, METEOSAT-WEFAX, GMS-WEFAX, NOAA APT, Russian Meteor APT, HF-FM Fax and GOES-TAP. The system will capture full pass images at full resolution. A typical NOAA pass displays at 3-4 MB of image resolution. These images can be saved to disk using standard TIFF and GIF file formats. The package allows you to print grey scale images on most printers including: laserjet, bubblejet, inkjet, color-inkjet and 9- and 24-pin dot matrix printers.

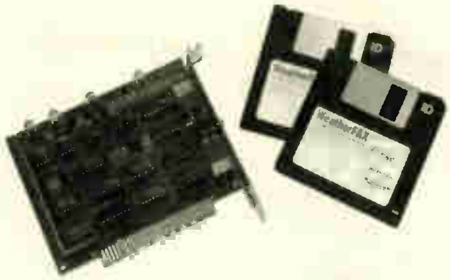
The OFS software has an extensive toolbox package for processing the satellite images you receive. This toolbox has about every tool an amateur or professional meteorologist would ever need or want. Basic tools in this toolbox include: zooms, rotate, reverse, mirror, palette interpolation, histogram, and brightness/contrast to name just a few.

There are some sophisticated advanced tools that include: temperature calibration, geopolitical map and latitude/longitude grid overlays, pixel photometry, cloud cover, distance measuring, filters, 3-D projections, and text annotation.

The software has full interactive mouse support for all menus. There is on screen help by pressing the F1 key and you can even start your favorite tracking program from within WeatherFAX without exiting to DOS. The program has a perpetual 24-hour schedule/timer for unattended image capture. The scheduler/timer works in the background mode to allow normal capture operation. It automatically saves either full or sectored images. For unattended operation, the images are saved to disk using a time stamp as the file name.

This hardware/software package will work on IBM PC/XT/AT or compatible computers with VGA or better graphics and 640 KB of conventional memory. For highest resolution, a 386SX or better is recommended with SVGA graphics (1024 x 768 x 256 color or better), and 4 MB of expanded memory (The higher the graphics resolution, the greater the image area displayed at a time).

The decoder board does use an advanced design to get rid of AGC gain distortion that is common on some other weather decoders. This board has both AM and FM decoders (weather and HF fax capability) and a automatic gain lock (AGL) that statistically sets the optimum signal level. This digital method provides the high linearity needed for precise temperature calibration. The input signal is also controlled by



the keyboard which means there are no knobs to set up or adjust.

The card also provides straight edges for NOAA satellites and maintains frame sync, even in the presence of noise fading and signal dropouts. The card has a self-test feature that verifies correct system operation. The board itself is a compact half-sized card that fits into any computer slot on full sized and on some laptop computers.

In Operation

A very simple test setup was used for this test of the Swagursat and OFS WeatherFAX V5 which consisted of an ICOM R-7100 receiver, no preamplifier and a Antennacraft omni-directional Scantenna. All test runs were conducted using NOAA 137 MHz polar orbiting satellite signals.

I was really impressed with the simplicity of the Swagursat. This unit did its job extremely well and delivered a usable product to the OFS WeatherFAX card and software even under some difficult, high-noise conditions.

The OFS Weatherfax package was also equal to the task of decoding and displaying NOAA APT satellite imagery. The capability of taking the received images and then using the advanced toolbox to analysis the images was particularly impressive.

I also found that having the ability to overlay geopolitical boundaries on the NOAA satellite imagery extremely useful. Unlike GOES-WEFAX imagery which has political boundaries inserted in the picture at transmission, NOAA APT images are raw, straight-from-the-camera pictures. This feature really helped enhance the viewing and study of NOAA satellite images.

Both companies offer excellent product support via fax and voice telephone and 30 day, full money guarantee with no restocking fees.

Criticisms

Hard as I tried, I couldn't really find fault with the installation, operation, or construction of the Swagursat or the OFS WeatherFAX. My biggest criticism looking at both units as a whole (Swagursat and OFS WeatherFAX) was one of economics. Buyers will incur major league "sticker shock" if you put this whole package together from scratch. So let's go inside the numbers...

Complete 137 MHz Weather Satellite Capability (No 1691 MHz WEFAX)

Icom R-7100 (Grove Price)	$1369.95
Swagursat	$228,75
OFS WeatherFAX V5	$451.50
Antennas/Preamps/Misc	$200.00
Total System Cost	$2250.20

What is interesting about the above figures is that we haven't even factored in the cost of a computer (I hope you have one of those), but if you don't have one, do not get the cheapest one around. You are paying top dollar for good resolution and features, don't ruin it by attaching this package to a low end IBM XT or AT computer. To fully use those attributes, a minimum system should consist of a 386SX with SVGA capability and at least 8 MB of RAM. Anything less and you are wasting your money across the board.

My only other criticism is the advanced toolbox feature of the WeatherFAX. It is not with the toolbox itself as much as it is knowing what all those great features are and how to put them to some practical use. Newcomers will find a whole new world of terms in the toolbox menus of the program. For instance, there is no standard reference available for the newcomer to show or explain what any of the 20 NOAA/NESDIS image enhancement curves are or used for. Maybe one of our budding ST writers can do an article on weather satellite imagery analysis and interpretation for a future edition of *Satellite Times.*

Bottom Line

I really had fun playing with the Swagursat and OFS WeatherFAX. Stu Gurske and Jerry Dahl respectively, each have great products they can both proud of. Since I already own a ICOM R-7100, the cost of the two products versus what I got in performance and features really didn't bother me at all. While there are cheaper routes to receiving and decoding weather satellite images, these two products definitely represent the high end in quality, performance, construction, features and operation for weather satellite remote imagery reception and decoding. ST

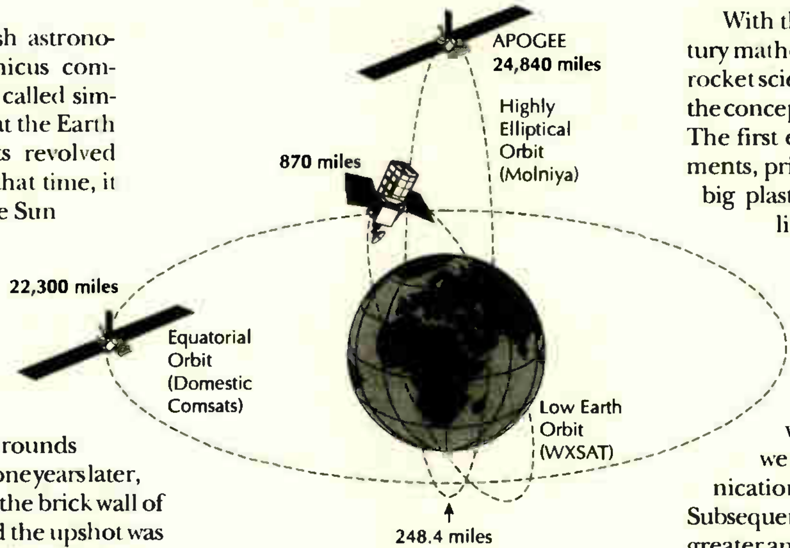
ST THE BEGINNER'S COLUMN

By Ken Reitz, KC4GQA

Circles Within Circles

In the year 1512, Polish astronomer Nicolaus Copernicus commented in a paper he called simply "Commen-tariolus", that the Earth and other known planets revolved around the Sun. Up until that time, it was widely believed that the Sun and planets revolved around the Earth. Copernicus' revelation soon became big news.

There was no Internet on which to post such a finding so this information was slow to make the rounds among the literate. Twenty-one years later, the idea ran headlong into the brick wall of the Spanish Inquisition and the upshot was that Italian astronomer Galileo was forced to denounce Copernicus' theories thus delaying America's space program by who knows how many centuries.



Meanwhile, in 1618 while Pilgrims plotted their course to the New World, Johann Kepler, a German astronomer, published his Third Law of Planetary Motion which helped push things along regarding how orbits are maintained. Sir Isaac Newton would later put the finishing touches on all of this and the foundation for orbital geometry was laid.

I Thought You Said "Beginner's" Column

Well, yes. This is my way of letting you know how orbital mechanics began. It comes down to the inquiring minds of the 17th century to finally figure out what people through the ages had long observed – the movement of the stars through our skies, the existence of our solar system's planets and the unavoidable presence of Earth's very first satellite, the Moon.

In fact, the Moon was actually the earth's first communication satellite of sorts, with the first radio echoes bounced off it's surface and received on earth in the 112 Mhz band on January 10, 1946. The first recorded two-way earth-moon-earth (EME) exchange occurred in the 1.2 GHz band between amateur radio operators W6HB and W1BU on July 21, 1960.

Now, with literally hundreds of satellites in various orbits, the only way to keep track of them or find them in the wide skies above us is by consulting what are referred to as Keplerian Element Sets. We have come full circle, so to speak, with Herr Kepler.

Celestial Dance Partners

Just as the Moon revolves around the Earth and the Earth the Sun, the whole Solar System itself is turning within a long arm of the spiral galaxy we call the Milky Way. Thanks to the early efforts of Earth-bound mathematicians, this whole concept of orbiting has been declared a complete success.

Now, on to the business of metal moons or satellites. As a communications satellite, the Moon leaves a lot to be desired. To begin with, it's too far away (ten times the distance of our geostationary satellites); the surface is not radio frequency friendly (reliable Earth-Moon-Earth communications requires a good bit of power and extensive transmitting and receiving antennas) and besides it always seems to be in the wrong place for our communication needs.

New Moons For An Old Planet

With the combined efforts of 17th century mathematicians, and our 20th century rocket scientists and electronics specialists, the concept of satellite technology was born. The first efforts were, by modern achievements, primitive. They involved launching big plastic, metallic- coated balloons or little metal boxes with built-in tape loops. Not exactly the exotic vision of visionary Arthur C. Clarke who, in 1945, foretold the future of geosynchronous satellite communications.

It wasn't until Syncom 2 was launched in July, 1963, that we finally had in orbit a real communications satellite, by modern standards. Subsequent generations of satellites brought greater and greater technological advances to the point where today, we are pleased to announce the placement of high-powered DBS satellites with the prospect of 150 channels or more, which will probably carry reruns of 60s, 70s and 80s situation comedies.

Geosynchronous & Polar Orbits

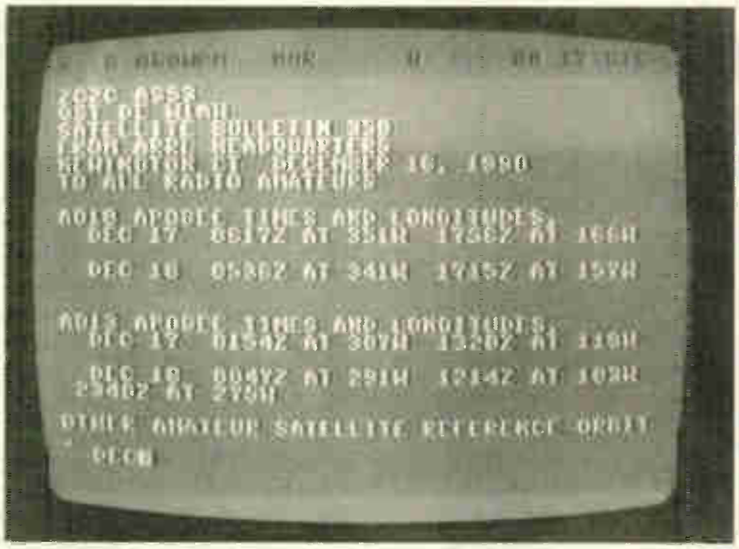
It was discovered early on that, in order to break earth's gravitational-pull, Earth-built objects desiring to have a place in the sky would have to achieve a certain orbital velocity. Using even more fancy math calculations, more exoctic orbits can be achieved.

Satellite orbits usually fall into two categories: orbits around the Equator and polar-type orbits. Geostationary satellites are launched into orbits which scribe the circumference of the Earth at the equator, roughly 22,300 miles above the earth. These satellites, clipping along at a fast pace with the rotational direction of the Earth, appear to be motionless in our sky, hence the term "geosynchronous or geostationary".

Other satellites are launched in a much

lower orbit, one hundred to one thousand miles up. These satellites, with the Earth rotating beneath, appear to travel in continuously changing paths around the planet circling in a small ellipse about the North and South poles, hence the term "polar orbit".

A third, but less common orbit, puts the satellite in a highly elliptical orbit with the low point closest to the Earth (perigee) typically being about 250 miles and the highest point away from the Earth (apogee) being roughly 24,800 miles. This highly elliptical orbit is typical of the former Soviet Union's Molniya (Russian for lightning) series of satellites and is therefore sometimes referred to as a "Molniya orbit".



In order to track low Earth orbit satellites it's helpful to have updated information. This information is transmitted for the amateur radio satellites by W1AW, the headquarters station of the American Radio Relay League (ARRL). This screen, captured off radioteletype, shows apogee times and longitudes for two of the amateur satellites as transmitted by W1AW.

Circular Reasoning

I know what you're thinking: "If these rocket scientists are so smart why don't they just have one type of orbit and be done with it!" Well, there are good reasons for having these different types of orbits. Not the least of these is that it's fun to experiment. Let's face it, if you'd given this much time to the study of higher math wouldn't you at least want to play with it?

Seriously, the basic reason for the different types of orbits has more to do with the mission of the various spacecraft. Our domestic geostationary broadcast satellites are designed to serve the entire country. It's therefore advantageous that the satellite appear stationary over the center of the country. The broadcast beam from the satellite covers the northern hemisphere and network and cable affiliates are happy. If programming were beamed to low orbiting satellites, ground stations would be required to constantly shift their receiving antennas to pick up the signal. Cable reception is already bad enough in most places, imagine how bad it could be with this extra technological requirement!

Polar orbit satellites offer many advantages over stationary satellites. Spy satellites need to travel over forbidden territory and train their sophisticated optics on interesting targets. Weather satellites are doing the same, but with much less ominous overtones. "Ah ha!", you're saying, "But the GOES weather satellites are geostationary. Isn't that a bit redundant? Why have a satellite that just looks at one side of the planet?" Well, for one thing GOES gives us a constant 24 hours a day look at the whole planetary disk in real time. The problem is that it does this from 22,300 miles up and there's only so much resolution at this distance. However, GOES gives us a full-time observation advantage not available with a polar orbitering satellite. The polar orbiters give us higher resolution from a very close range, but these satellites only visit the same area of the planet a few times every 24 hours.

Molniya-type orbits have the best and worst of both worlds. Several of these satellites operating together (sometimes called a constellation) can provide uninterrupted service just like the stationary birds. This type of orbit does require the receiving station to make periodic adjustments to track the satellite's transmitted signal. They have "footprint" patterns on the globe on which their signal falls which can connect the polar regions of earth. This is why they were invented in the mid 60s by the former Soviet Union to allow service in the remote polar regions.

AMSAT or Radio Amateur Satellite Corporation as it is officially known, has launched it's most recent and sophisticated satellites into a Molniya orbit. For the first time ham radio operators will be able to have much longer contacts with more reliable communications. It is a amateur radio operators dream, but ten to one they still only talk about the weather and the size of their antennas.

New Vision For Low Earth Orbiters

Since the dawn of civilization (October, 1957 with the launch of Sputnik 1 to be exact) there has been an urge among the world's population to take phone calls from anywhere on the surface of the planet. Forget that this could mean that junk phone artists could hound you at the most inopportune moments. That your brother-in-law, who still owes you $500, can call you up while you're at the art gallery contemplating why there is a Jackson Pollack. That most of your calls will be wrong numbers from equally bedeviled global villagers who can't operate the little gadgets any better than you can. The fact is that you want these devices or dozens of the biggest international business players, like Motorola, wouldn't be prepared to sink untold billions of dollars into duplicate services.

Here's the scheme: Different companies plan to launch between 6 and several hundred satellites, depending on the company's concept, all of which will travel in (thank God!) the same direction at roughly 16,000 miles per hour and evenly spaced so that a satellite in such a constellation would be in view of any given spot on the planet at any given time. That means that with your little Personal Communications Device (we can't call them telephones anymore), you may call your stock broker and put in an order for more Motorola stock. Think of it as a terrifically complex cellular phone network thousands of times bigger than anything we now have (and you know how well the current system performs).

There are at least a dozen such start-up companies lobbying the FCC, even as you sleep for rights to the spectrum around 1.6 GHz, all together about 50 MHz of our already disappearing frequency spectrum. It should be obvious that this satellite thing has gotten completely out of hand, but none of it would have been possible without our complete understanding of heavenly bodies in motion. ST

By Chuck Morrison,
Chief Engineer, Grove Enterprises

A Helical Antenna for FLTSATCOM Reception

Reception of the FLTSATCOM transmissions in the 240-270 MHz range using an omnidirectional antenna will normally yield signals barely above the noise level on an Icom R-7100 VHF/UHF communications receiver - just barely enough to move the S meter. With the recent international tensions around the world, I wondered how many interesting signals I was missing under the noise level. A gain-type antenna would bring the signals up and let me hear what I was missing. I considered many different types of antennas, but based on the characteristcis of the downlink signal, one design stood out - the Helical Antenna.

FLTSATCOM Characteristics

The minimum effective isotropic radiated power of the FLTSATCOM satellite is 26 dBW. The average downlink frequency is 255 MHz, giving a wavelength (λ) of 300/255, or 1.18 meters. The satellites are in geosynchronous orbit at an altitude (d) of 35680 kilometers. Path loss is given by

$$L\ (dB) = 10\log_{10}(4\pi \times d/\lambda),$$

or 171.6 dB. For an EIRP of 26 dBW, the power at a perfectly omnidirectional 0 dBi antenna would be 26 - 171.6 = -145.6 dBW, or -115.6 dBm. This is .37 microvolts into 50 ohms - a quite weak signal. A receiving antenna with 10 dB gain would increase the received signal to -105.6 dBm, or 1.2 microvolts - a signal that should be readable on most receivers.

Helical Antenna Design

A helical antenna provides a high gain over a wide bandwidth. It is also naturally circularly polarized, which is necessary since FLTSATCOM transmissions are right-hand circularly polarized. It is relatively easy to build and forgiving of mechanical inaccuracies. The following design information is adapted from Chapter 19 of the 16th edition of The ARRL Antenna Book.

The helical antenna is a large coil with one end fed against a ground plane. The diameter of the coil should be λ/π, the spacing between turns should be $\lambda/4$, and the ground plane diameter or side length should be λ. Antenna gain is proportional to the number of turns (n) on the helix. Gain over an isotropic antenna is given by

$$G\ (dBi) = 11.8 + 10\log_{10}(n/4).$$

A four turn helix should yield a gain of 11.8 dBi, which would be adequate.

The input impedance of a helical antenna is 140 ohms. There are several ways to match this to the typical receiver input impedance of 50 ohms. I used one extra turn on the helix, with the first half turn spaced closely to the ground plane. This in effect formed a parallel line transmission line matching section with its characteristic impedance determined by the spacing. I would adjust the spacing experimentally to obtain minimum antenna VSWR.

Construction

I had been looking for the ideal structural material to support VHF wire antennas for a long time. Several years ago, I tried to make a 6-meter quad frame out of PVC pipe. This seemed to be the ideal material, since it is so easy to work with, and so many fittings are available. I would just cut the pipes and put the antenna together like a tinkertoy. But after I had purchased all of the materials and brought them home I made a shocking discovery - that small diameter PVC pipe was not rigid enough to support even its own weight over any distance at all.

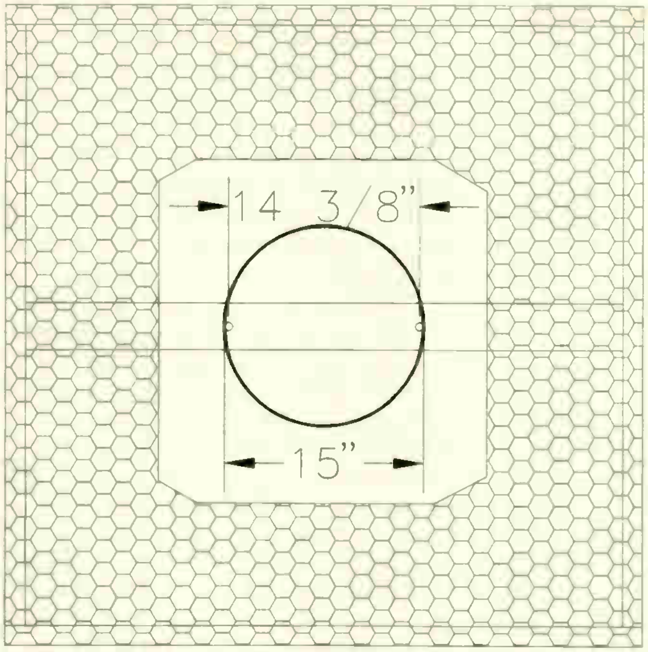
Not long ago, I was in a home supply store thinking about a way to build this antenna. I needed to build a form to support a 15-inch diameter coil, but I wanted it to be cheap. PVC pipe was on my mind again. Then I passed the dowel rods. They were rigid enough, and cheap. But they were only 3 feet long, which was too short. If I could connect them together like PVC pipe, they would work great. I got a few 1/2 inch PVC fittings and went back to the dowel rods. It turns out that 5/8 inch dowel rods make a great fit in 1/2 inch PVC fittings. This would work well for this antenna.

I first built a 4-foot square frame out of 2" by 2" lumber. Four feet is close enough to the wavelength of 46 1/2 inches. I put a 2 by 4 from the midpoint of one side of the frame to the midpoint of the other side. I drilled two 5/8" diameter holes in the 2 by 4 with their outside edges the required coil diameter apart, being very careful to keep the drill bit perpendicular to the frame. Then I covered the frame with chicken wire, and stapled it to the wood. The ground plane frame is shown in Figure 1.

Insert the dowel rod coil form into the holes drilled into the 2 by 4. They should be a snug fit. If they are square to the ground plane, glue them into place. I did not get my holes exactly square, so I reamed out the holes a little bit to allow adjustment of the dowels. When I got them square, I used some automotive body putty to hold them in place. The 3 foot long dowel rods were not long enough, so I spliced 2 more feet onto the form with 1/2-inch PVC unions. At the end of the coil form I put a dowel rod cross piece using 1/2-inch PVC elbows.

When the form was completed, I placed marks on the dowel rods at the places where the wire would touch them per the dimensions shown in Figure 2. These dimensions are for a turn spacing of $\lambda/4$ at 255 MHz, with numbers rounded to the nearest 1/8-inch. I filed a small notch in the dowels at these places to help locate the wire.

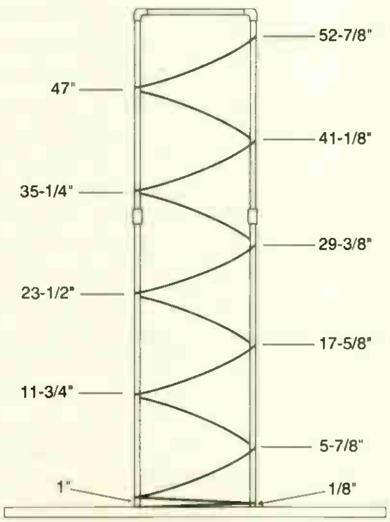
FIGURE 1



I used number 12 copperweld wire that I obtained at a hamfest for the radiator. The wire type should not be too critical, however, the stiff copperweld wire, already coiled into a circular roll, made keeping a circular coil shape easier. For right-hand circular polarization, the helix must spiral away from the ground plane in a clockwise direction. This is very important, as cross polarization can result in a signal loss of over 30 dB. I wound the wire around the form, and secured it at each notch on the dowel rods with a staple.

Underneath the first half turn of the helix, I placed a piece of sheet brass. I secured the brass to the chicken wire ground screen by cutting tabs from the brass sheet and bending them through the chicken wire mesh. At the feed end of the helix, I mounted a BNC connector through the brass sheet, and soldered the center pin to the copperweld wire. The first half turn of the helix was nearly touching the ground screen and shorting, so I wrapped the first half turn with tape. The capacitance between the first half turn of the helix and the ground plane would adjust the VSWR, so I drilled two sets of holes through the sheet brass straddling the first half turn. I would adjust the capacitance by running cable ties through these holes and adjusting the spacing between the wire and the ground plane.

FIGURE 2



Performance

I measured the antenna VSWR with a Hewlett-Packard vector network analyzer. By tightening the cable ties fully, I could obtain a VSWR better than 2:1 from 220 to 280 MHz. Most people do not have access to such test equipment, but for receiving, VSWR is not that important. Adjusting the spacing between the first half turn and the ground plane to less than 1/8-inch should yield an adequate impedance match.

Using an Icom R-7100 receiver, I connected the antenna and began searching the sky with the receiver tuned to 250.45, 250.55, and 250.65 MHz. I found two distinct directions which each yielded signal maximums. Later calculations and measurements with a compass verified that these directions were the headings for the FLTSATCOM satellites at 23° W and 100° W longitude.

Signals received from the 100° W satellite were stronger, probably due to the higher elevation angle of this satellite from my location in North Carolina. With the antenna peaked on the 100° W satellite, I tuned the receiver across the 250 to 270 MHz band. At least ten signals were readable, with S meter readings from S1.5 to S2. I then went back inside and connected the receiver to the omnidirectional antenna on the roof of Grove Enterprises. The same frequencies that had S1.5 to S2 signals with the helical antenna were just above the noise floor, with the S meter barely moving at all. The helical antenna clearly has substantial gain over our omnidirectional antenna.

Conclusions

There is plenty of room for improvement with this antenna. If more antenna gain is desired, more turns may be simply added to the helix. There is no provision for mounting it for remote rotation; I rotated it by hand until a peak was found and then propped it up with a board in that position. It should be fairly easy to build a frame to point the antenna in one direction; configuring it for remote azimuth and elevation selection may be a lot more difficult.

For satellite monitoring, ground-mounting the antenna is fine. If it is used for other applications, height above ground may be important. Also, if the antenna is to remain outside for an extended period, it probably should be ruggedized and painted to protect it from the weather. But for approximately ten dollars worth of materials and an afternoon's construction time, the performance is quite good. It certainly provides a cheap and dirty way to listen to the FLTSATCOMs. ST

Ask Larry

By Larry Van Horn, N5FPW

Questions or tips sent to "Ask Larry" are printed in this column as space permits. If you desire a prompt, personal reply, mail your questions along with a self-addressed, stamped envelope (no telephone calls, please) to Ask ST, c/o Satellite Times, P.O. Box 98, Brasstown, NC 28902.

Q. Could you please give me the addresses and telephone numbers of the companies mentioned in the Direct Broadcast Satellite (DBS)/Digital Satellite System (DSS) article on page 20 of the premiere issue of Satellite Times? Eric Rumbis-Skokie, Illinois

A. The three main companies active in the DBS/DSS market at this time are:

DirecTV
P.O. Box 92424
Los Angeles, CA 90009
Phone: (800) DIRECTV (347-3288)/
(315) 535-5000

Thompson Consumer Electronics
MS 1-36 600 North Sherman Drive
Indianapolis, IN 46201
Phone: (317) 781-4605

US Satellite Broadcasting Company
(USSB)
3415 University Avenue
St. Paul, MN 55114
Phone: (800) 204-USSB (8772)/
(612) 645-4500

Q. I am presently looking for a satellite receiver for my TV. Should I invest into a satellite system with 12 foot dish that I can buy locally or should I purchase the newer Ku band satellite receiver with the 5-foot dish or smaller? David Phillips-Columbia, South Carolina

A. The best all around purchase would be to go for larger dish with a dual feed system (C band/Ku band). You could then get the best of both worlds. While it will be a little more expensive than a single band system, your programming choices will be unlimited.

Q. Is there a schedule of Single Channel Per Carrier (SCPC) stations not operating 24 hours a day and could you print it in Satellite Times? John Cable-Lehigh Acres, Florida

A. At present I know of no schedule for SCPC stations operating less than 24 hours a day. I am sure given the nature and number of these stations that a complete schedule for all of the SCPC stations listed in our Satellite Services Guide in ST would be difficult to put together. One suggestion I could offer is to get a copy of the M-Street Directory from Grove Enterprises which list all the AM/FM radio stations in the US and Canada with addresses and telephone numbers and write the stations you are interested in directly. You should address your query to the Program Manager of the station or network.

Q. Is there a way I can use my Pro-2004 scanner with my satellite receiver to receive SCPC transmissions? Edward P. Taylor-Fisherville, Virginia

A. While using a scanner will not yield as good of results as a dedicated SCPC receiver, you can hear SCPC activity on your scanner if you know where to tap in on your Television Receive Only (TVRO) satellite receiver. The top end frequency limit of the PRO-2004 is 1300 MHz and by splitting the signal at the input to your receiver from the dish Low Noise Block (LNB) downconverter, you will miss quite a few SCPC signals.

Another alternative is to check the back of your receiver (and your instructions) for the 70 MHz loop. Since the beginning of satellite receiver design there has been a 70 MHz loop built-in onto the back of satellite TVRO receivers. Originally designers imagined this feature would be used for the addition of peripheral equipment such as add on descramblers or Terrestrial Interference (TI) filters. This was a great idea before the introduction of the Integrated Receiver Descrambler (IRD). This 70 Mhz loop is simply a secondary intermediate frequency (IF) output.

Since the output of the loop is 70 MHz any tuning device which can tune 10 Mhz either side of 70 MHz can recover the signals on the particular channel to which the satellite is tuned.

A quick check on the back of your receiver or instruction manual may reveal that you do have a loop, but it is not labeled "70 MHz". If you look closely on the back or the receiver or in your owners manual you may find that the output of the loop is at some other frequency. There has never been a "standard" loop out frequency on satellite receivers, consequently you may find anything from 70 MHz up to 465 MHz. Use the frequency only as a reference point.

To set up your PRO-2004 for SCPC using your receiver loop, connect the loop output to the input of a TV splitter. Then on the splitter outputs, connect one leg back to your receiver loop input connection and the other output will go to the BNC antenna connector on your 2004.

One of the most frustrating things which can occur when tuning SCPC signals via the loop is the presence on all frequencies of an annoying buzz or hum in the audio. This is caused by lack of filters in the power supply. it is not a design defect of either receiver, but it is almost impossible to get rid of.

Q. I have an 18 inch actuator on my satellite dish. If a change it to a 24 inch, would I be able to increase the number of satellites I could receive? R. Milligan-Sequim, Washington

A. Since you didn't indicate which satellites you are currently receiving, I would say in most cases, yes. With a 24 inch actuator, your dish would swing through a wider portion of satellite arc giving you more satellites. If you currently receive all of the satellites from Spacenet 2 (east) to RCA Satcom C1 (west) on your 18 inch actuator, you are actually in pretty good shape and probably do not need a 24 inch arm. If you receive the entire domestic arc now and want to watch some of the international birds and are willing to invest in some additional equipment, then a horizon to horizon mount might be a better way to go. As always, a site survey by your local satellite dealer is a must to determine if the additional expense is going to pay off. ST

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SPACE INTEREST GROUPS

ST's Space Interest Groups list those local, national and worldwide groups you can join directly that promote space and space activities. If you belong to a space group and haven't seen it listed in *Satellite Times* write today and ask for a Space Group listing form. Your group will be listed each month, and will be featured in a group profile at least once, as well as receiving a complimentary *ST* subscription for group use. Write to: SIG Editor, c/o Satellite Times, P.O. Box 98, Brasstown, NC 28902-0098.

Space Group Profile: Space Station Future Fighters

In May 1991 NASA's Space Station Freedom was canceled by a subcommittee in the House of Representatives. The six-member subcommittee proposed that the space stations funds go instead to building a parking lot in Florida, to conducting an "office waste" experiment in Michigan, and to other assorted special interest projects. Fortunately the subcommittee's plan was later overturned by a full committee.

Alarmed and outraged by this and other growing attacks upon space and science projects, a group of concerned citizens in Houston, Texas, formed the Space Station *Freedom Fighters* in 1991 to develop and document grassroots support for the space station. The volunteers decided to take the space station message "to the streets" to educate the public which in turn would lead to the public expressing its support to Congress. In addition, the *Freedom Fighters* also focussed on media education in an attempt to curb the negative biased reporting against space and science projects such as the space station.

Who are the *Future Fighters*? Teachers, engineers, students, scientists, writers, salespeople, office workers, astronomers – anyone who does any advocacy for the space station is a *Future Fighter*.

ST readers desiring to take an active role in determining the fate of the space station and the future of the U.S. in space, send a stamped, self-addressed envelope to the Space Station Future Fighters, 16582 Space Center Blvd, Houston, Texas 77058 or fax to 713-488-7903. You will receive free information about the space station and a blank copy of the national petition with which to collect signatures.

Amateur Satellite Corporation (AMSAT)
P.O. Box 27
Washington, DC 20044
(301)-589-6062

ASERA Ltd
PO Box 184
Ryde, NSW, Australia, 2112
email: lindley@syd.dit.csiro.au
Membership $A100 (dual subscription), Subscriptions $A25 (newsletter only) $A50 (journal only).

British Interplanetary Society
27/29 South Lambeth Road
London SW8 1SZ
ENGLAND
Membership: No dues information available at present.

Canadian Space Society
43 Moregate Crescent
Bramalea, Ontario
CANADA L6S 3K9
Answering Machine: (416)-626-0505
CSS BBS: (905)-458-5907 (8N1, up to 2400 buad)
Membership: Annual dues are $25/year ($15/year for full-time students, $100/year for corporate members).

National Space Society
Membership Department
922 Pennsylvania Avenue, S.E.
Washington, DC 20003-2140
(202)-543-1900
Membership: $20 (youth/senior) $35 (regular).

The Planetary Society
65 North Catalina Avenue
Pasadena, CA 91106
(818)-793-5100
email psociety@delphi.com
Membership: $5/year

Space Access Society
4855 E Warner Rd #24-150
Phoenix, AZ 85044
(602)-431-9283 voice/fax
hvanderbilt@bix.com
Membership: $30/year, $1000/lifetime; includes email updates. $50 for email plus mailed hardcopy ($25 extra outside the US).

Space Station Future Fighters
16582 Space Center Blvd
Houston, TX 77058-2039
Fax: (713) 488-7903
Membership: All volunteer, No formal membership or dues. Presently conducting a national petition drive in support of the international space station. Send a stamped self-addressed envelope for free information and a blank copy of the petition.

Space Studies Institute
258 Rosedale Road
PO Box 82
Princeton, NJ 08540
Membership: $25/year. Senior Associates ($100/year and up) fund most SSI research.

Students for the Exploration and Development of Space
MIT Room W20-445
77 Massachusetts Avenue
Cambridge, MA 02139
(617)-253-8897
email: odyssey@athena.mit.edu
Membership: Dues determined by local chapter.

United States Space Foundation
PO Box 1838
Colorado Springs, CO 80901
(719)-550-1000
Membership: Charter $50 ($100 first year), Individual $35, Teacher $29, College student $20, HS/Jr. High $10, Elementary $5, Founder & Life Member $1000+

World Space Foundation
Post Office Box Y
South Pasadena, California 91030-1000
(818)-357-2878
Membership: Contributing Associate, minimum of $15/year (but more money always welcome to support projects).

STOCK EXCHANGE

Satellite Times assumes no responsibility for misrepresented merchandise.

Ads for **Stock Exchange** must be received 45 days prior to publication date. All ads must be paid in advance to *Satellite Times*.
Ad copy must be typed for legibility.

NON-COMMERCIAL SUBSCRIBER RATES: $.25 per word — *Subscribers only!* All merchandise must be personal and radio-related.

COMMERCIAL RATES: $1.00 per word. Commercial line ads printed in bold type.

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R-390-A SALES — SERVICE — PARTS. Information SASE Miltronix, P.O. Box 3541, Toledo, OH 43608.

GE SUPERADIO III, custom designed with up to four noise-free SCA channels. Performance guaranteed. Credit Card orders accepted. (800) 944-0630.

HOME AUTOMATION. Become a dealer in this fast-growing field. Free information. Cll 800-838-4051.(12-93)

POWERFUL, TUNABLE ANTENNA BOOSTER for SWL, 150 kHz to 30 MHz. Send $2.00 for info. (refundable). DARCY ELECTRONIC, RR 2, Burns Lake, BC. Canada, V0J 1E0.

WORLDWIDE PENPAL ADDRESS MAGAZINE! $3 postpaid, ($4 foreign): Golden Quill Penpal Club, P.O. Box 92048, Pasadena, CA 91109.

Rocky Top Satellite Parts. Order or request price list at 1-800-837-6430 or 208 Fleming Street, Murphy, NC 28906. (4/95)

"For Sale: Two Used Uniden UST-5000 Satellite Receivers. $75 each. Bob (217) 864-5427."

Commercial GOES Weather Satellite Receiver FG-701. Copy images from GOES/GMS/METEOSAT ON 1691 & 1694.5. a complete dual frequency, triple conversion microwave reciever with built in LNA and switchable bandwith demodulator. New cost is $3500. One used unit for sale, only $1500 (UPS prepaid in US). T. Pappan, POB 580, Owosso, MI 48867-0580.

WANTED: MOTOROLA Flipphones and EXPO walkie talkies (UHF/DPL preferred). Also looking for Yupiteru handheld receiver. Mark. (301)428-9076 phone/fax.(12-93)

Highest price paid for used scanners! (614)544-5842 (03-95)

Mint AR-3000 receiver. $500. Call W8ISG, (616)731-5600 days or leave message.

FOR SALE: BEARCAT 850XLT with GRE 800 MHz superconverter, 4 mos. old. Searches 100 channels per second. Perfect condition with original boxes. $350. David, (405)436-3755, evenings.

ACOUSTIC GUITAR PICKUPS: quick-mount, low price, high quality, wholesale/retail, money-back guarantee—can also be used as a contact mic.. Sample $20 S&H included. VISA/MC accepted. CLE, Box 1913, Sarasota, FL 34230-1913. Phone/FAX 813-922-2633.

Take heed SHORTWAVE LISTENERS. Are you planning to deal with Mike Papagorgio's coin show "Money Makes Money"? Please contact me before you buy from him. George DiPrinzio 837 E 232 St., Bronx, NY 10466 or call collect (718)231-5638. (01-95)

PC WEATHER HF FACSIMILE 6.0 software (DOS), demodulator, tuning cassette, headset, manual. $49. 810-688-3952.

NRD 525 with Sherwood Filter Mods; 8.0. 4.0, 2.0, 1.0. $750. NVA 319 Speaker with Push Button Filters. $80. All with original boxes and manuals. Call Mike after 0100 UTC (602)497-5852.

Uniden President 2510 with accessories. $250. Uniden 122. mobile SSB CB with accessories, new $150. Emcom T-2000 Touch-Tone Decoder, $90. Newton 7000 noise cancelling speaker, new $20. Astron RS-10S 10 amp. power supply with built in speaker. new $50. K-40 CB mobile mag. mount antenna, $30. 4 amp. power supply, 13.8/16.5 volt selectable, $20. M250 mobile linear, $150. Hiwatt 110 mobile linear $60. Dann. (407)898-4152.

FOR SALE: BEARCAT BC200XLT w/cellular. $205 Shipped. (614)452-3209.

Kenwood R-5000 with voice synthesizer, RDI white paper, mod/review book, manual, service manual. and SP-430 external speaker $700. Bob Lusby, (317)477-1280.

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)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups 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 NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period, inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

UPLINK

By Bob Grove, Publisher

Ku vs. C Band vs. Cable: *The Gauntlet is Down*

Since the early 1980s, C band (3.7-4.2 GHz) has reigned supreme in the satellite TV industry. TVRO (television, receive only) "big, ugly dishes" ("BUDs") pepper the countryside with their four-to-ten-foot parabolas. Videocipher (TM) descramblers dominate the pay-TV marketplace. Billions of dollars have been invested in this part of the spectrum, an enormous asset. But there's a new kid on the block.

Ku band (11.7-12.7 MHz) holds great promise for a new genre of satellite TV, as well as other communications links. With twice as much spectrum and new, high-technology, digital-compression techniques, direct-broadcast satellites (DBS, 12.2-12.7 GHz) offer some awesome advantages over C band to the consumer.

Low cost (hundreds, not thousands, of dollars investment) and small (18-inch, not ten-foot, dishes), DBS appears to have captured the appeal of the nation. Best guesses would have at least 100,000 units now in the hands of the public, with Thomson, the French manufacturer (under the RCA brand name), expecting to produce more than half a million units per month by year's end.

When RCA/Thomson's exclusive arrangement with DirecTV runs out (after 18 months or 1 million units), Sony goes on line as the next major player and, after 24 months, the floodgates open.

The GM Hughes Digital Satellite System (DSS) birds are still not up to full speed, however. While DirecTV hawks 175 channels for the viewer, in fact, there aren't nearly that many activated, and only 22 states even have consumer receiving equipment. DirecTV hopes to offer full, nationwide coverage by the end of the year.

But DirecTV isn't the only player. United States Satellite Broadcasting (USSB) shares the same two Hughes DBS birds, and USSB will offer a high-definition television (HDTV) option when it senses that the marketplace is ready.

Finally, PrimeStar is supplying 70 channels in the lower Ku Fixed Satellite Service (FSS) band to 80,000 American homes. But these numbers are not yet attractive to major national advertisers who are waiting for at least one million subscribers.

Dropouts in Ku band reception are common during the rainy season, and the digital compression smears fast-action video, two major deficits happily reported by cable companies to their prospective customers. Interactive video, also available on cable, is lacking on the satellite services. Many new DBS subscribers are holding on to their cable as well–at least for now.

DSS hopes to overcome the technical problems; a suggestion to strap two 120-watt traveling-wave-tube amplifiers (TWTAs) to double the output power would boost signals by 3 dB.

Ku in the UK is far more prevalent than in the U.S., with some 3 million Brits presently watching British Sky Broadcasting, a product of Rupert Murdoch's media megabucks. The trend is reflected throughout the European community which now boasts some 14 million small-dish owners.

While Europe's direct broadcast birds are still analog, two new Astra satellites are scheduled to carry digital transponders into orbit in 1995 and 1996.

There is a lot of money riding on these Direct Broadcast Satellites, and their time has come. Expect exploding growth in the DBS market in the years ahead. ST

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This third edition gathers the best satellite articles from *QST* to enrich your operating enjoyment. Learn about all the active satellites from OSCAR 10 through OSCAR 27–and beyond!

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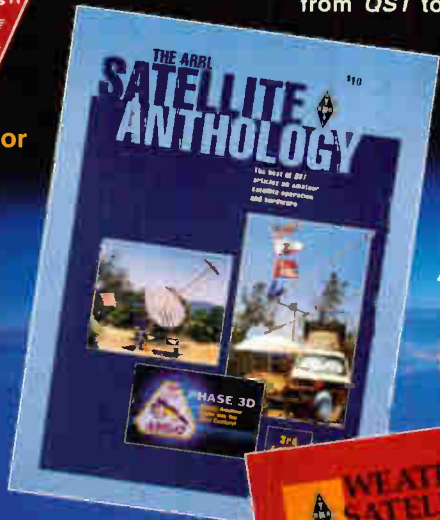
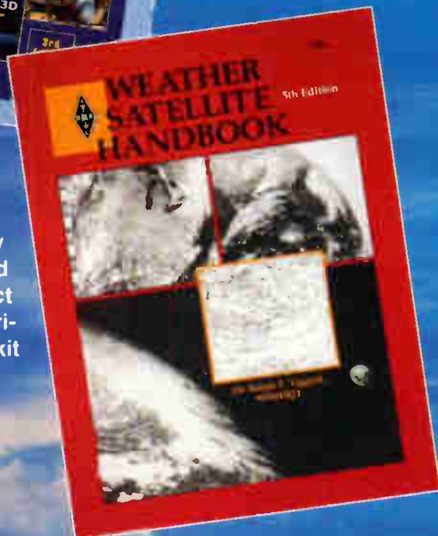


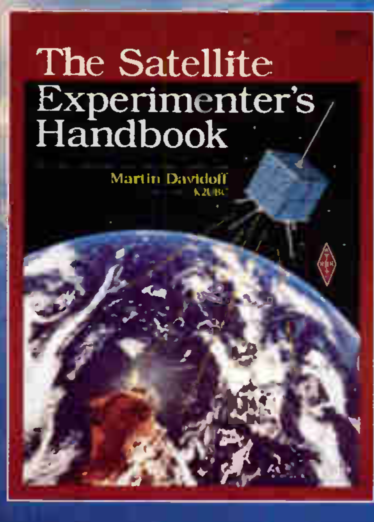
NEW EDITION

Weather Satellite Handbook

by Dr. Ralph E. Taggart, WB8DQT

This revised and expanded 5th edition will teach you how weather satellites function, how to build or modify your own receiving equipment and how to buy or build the right antennas. It also features an interface project that allows you to capture fascinating images from various weather satellites and HF WEFAX broadcasts (a kit is available). ARRL Order No. 4483. Retail $20





The Satellite Experimenter's Handbook

by Martin Davidoff, K2UBC

This title focuses on satellites built by and for the international amateur radio community and will be your guide to using and designing satellites. You'll also get a fascinating look at how you can put orbiting spacecraft to practical use.
ARRL Order No. 3185. Retail $20

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- ☐ RIT Function
- ☐ Memory Allocation Function
- ☐ Attenuator
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- ☐ Auto Repeater and One-Touch Functions
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- ☐ CW Narrow Filter (optional)
- ☐ Tone Scan (optional)
- ☐ 45 W (FM, CW), 35/6 W (SSB) VHF
- ☐ 40 W (FM, CW), 30/6 W (SSB) UHF

IC-820H 2 M/440 MHZ Dual Band All Mode Transceiver

The IC-820H isn't your typical base station transceiver. This all mode dual bander has compact and lightweight dimensions offering operating versatility other base stations just can't match. Mobile and field operations are ideal with this rig. But don't let its size fool you. This is a high performance transceiver with state-of-the-art construction, circuit design and cutting edge features.

ICOM's **Newly Designed 1-loop DDS** (digital direct synthesizer) is employed in the PLL circuit of the IC-820H. Previous PLL circuits for 10 Hz resolution transceivers contained 2-loop circuits. The new 1-loop has a single loop and **Generates a Signal with Superior 1 Hz Resolution**. ICOM's DDS PLL also contains a normal PLL as the main-loop and a DDS as the sub-loop.

Satellite operation with the IC-820H's **Built-In Satellite Functions** has never been this easy. These include **Normal and Reverse Tracking** for different modes of satellite communications; **Independent Uplink/Downlink Control** for Doppler shift compensation; **Separate Satellite VFO** and **10 Dedicated Satellite Memories** provide quick switching from normal to satellite operation as well as easy recall of satellite and downlink frequencies.

With **Independent Controls and Indications for Both Bands**, this dual bander is as easy to operate as most single band transceivers – and exchanging the main and sub bands is just a switch away. In addition, while simultaneously receiving signals on each band, **Separate S-Meters** indicate their respective signal strengths.

The **Sub Tuning Function** can be assigned to the **RIT** or **SHIFT** control and allows you to tune automatically at variable tuning speeds. This is especially useful when searching for signals over a wide frequency range – eliminating the need for excessive rotations of the main dial.

The IC-820H's **Compact Size** enables easy installation in a shack as well as a vehicle. Overall dimensions may be small, but important points such as LCD size and space between switches are more than adequate.

An important consideration in all mode transceivers is the interference reduction circuit. The IC-820H's **IF Shift Circuit** shifts the center frequency of the receiver passband electronically to evade interfering signals.

The IC-820H's **DATA Terminal** (in ACC socket) is connected to its modulator circuit directly. This **Data Jack supports Packet Operation** at up to **9600 bps**

A newly designed **Modulation Limiter Circuit** is employed in the modulator circuit to prevent you from exceeding the maximum deviation – even with large amounts of data.

Call (206) 450-6088 for FREE Product Literature!

View a video demonstration of this product
VHS
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