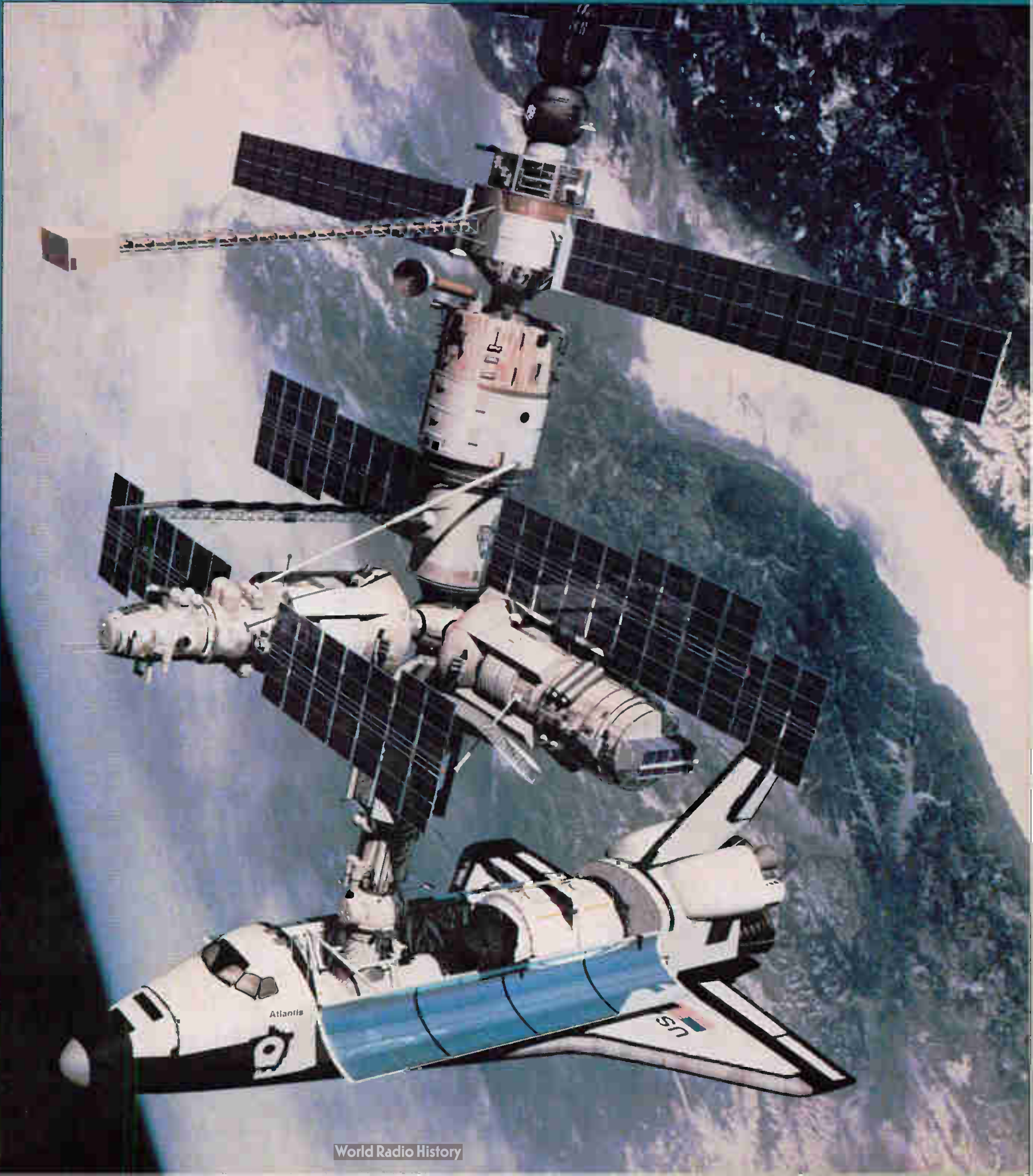
$3.50 US
$5.75 CAN

Satellite Times®

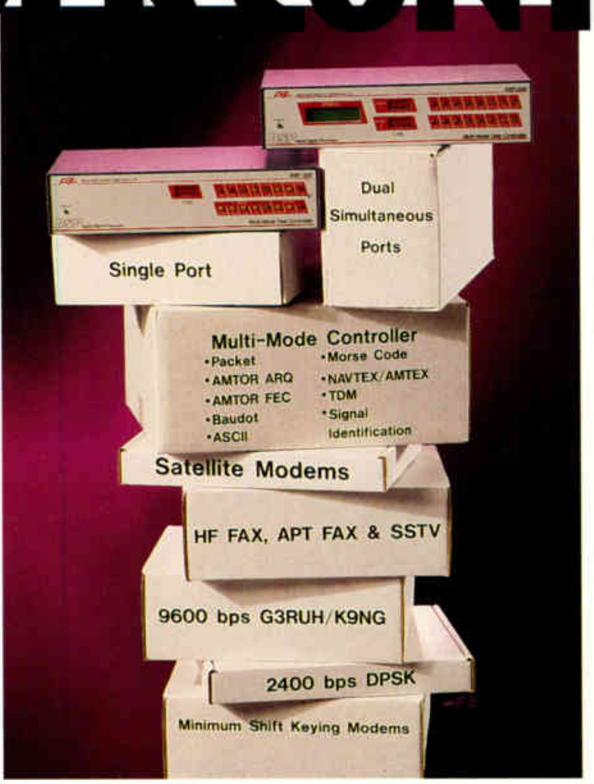
Volume 1, Number 5
May/June 1995

SHUTTLING TO MIR



WE'VE GOT EVERYTHING UNDER CONTROL

FREE "GET STARTED In PACKET" book with purchase of any AEA packet controller!



In the world of multi-mode contollers, nothing tops the DSP-2232 or DSP-1232 from AEA. When you choose either the dual port DSP-2232 or single port DSP-1232, you'll have just what you need to couple HF or VHF/UHF (or both) transceivers with a personal computer or computer terminal. Each converts incoming analog signals into digital data by means of a 12-bit, high speed converter.

Developed by AEA — with over 10 years of multi-mode controller development experience — the DSP-2232/1232 are the most advanced and versatile controllers available anywhere. They give you the capability to control all legal Amateur digital modes popular on both HF and VHF. New modems only require new software which can be installed with an EPROM chip, or downloaded from a telephone BBS binary file into the DSP's RAM. You won't need to replace your DSP-2232 or DSP-1232 as no new hardware or modifications will be needed as new modes become available.

Whatever you've thought about doing in Amatuer radio, it's here in the DSP-2232 /1232. All PK-232 MBX modems (Packet, AMTOR, etc.). All satellite modems (PSK, 4800 bps PACSAT, G3RUH 9600 bps, U022 equalized, 400 bps OSCAR-13). Analog modems for HF FAX, FAX APT, and SSTV. 9600 bps K9NG/G3RUH for terrestrial and satellite use. Each also offers internal RAM for uploading modems, up to 36 simultaneous packet connections, EPROM up to 2 Mbits, software selectable radio ports, Mailbox accessible through both ports, dedicated printer port, RTTY digital noise gate, ARQ tolerance command, etc.

The DSP-2232 adds even more control with its dual port gateway, front panel LCD showing connect and packets status, retrieval, call sign connected to, last call monitored and "marquee" display of received RTTY signals.

Get control of your digital operating position with the DSP-2232 or DSP-1232 from AEA. You'll be on top of the Amatuer radio world, too.

To connect with the AEA dealer nearest you or for product sheets, call (800) 432-8873.

Advanced Electronic Applications, Inc.
PO Box C2160, 2006 - 196th St. SW, Lynnwood, WA 98036 Sales: (206) 774-5554

AEA
Connect with us

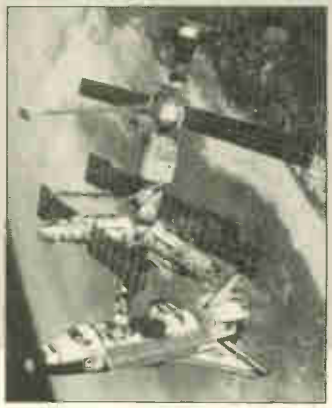
Satellite Times

Cover Story

Cover Photo: Artist rendition of the U.S. space shuttle Atlantis and Russian Mir space station docked together in space. (Photo courtesy of NASA)

Shuttling to Mir

By Keith Stein



On June 9, 1995 the space shuttle Atlantis will be launched on a historic mission into space. Atlantis will perform the first docking with a Russian spacecraft since the Apollo-Soyuz mission in 1975. *ST* columnist Keith Stein takes an in-depth look at the STS-71 mission including the spacecraft frequencies that will be used, amateur radio space operations and much more in this issue's cover story on page 10.

Vol. 1, No. 5

CONTENTS

May/June 1995

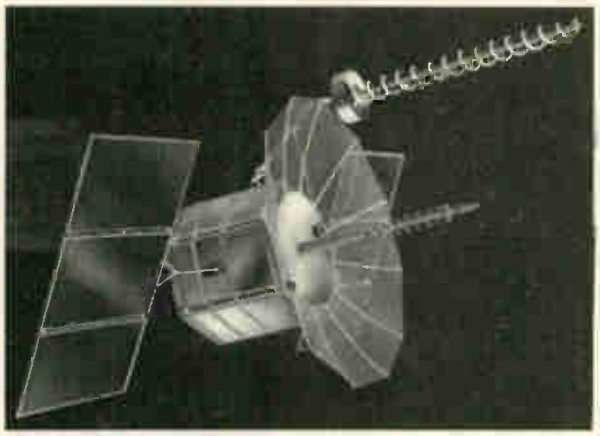
It's a Wonderful World, Bob Cooper

By Tim Olin

How did it get started? Who were the players? Coops' Digest, illegal descrambling chips, LNAs, and Captain Midnight — just some of the colorful history of the TVRO industry. Tim Olin's look back starts on page 16.

Fleet Satellite Communications —

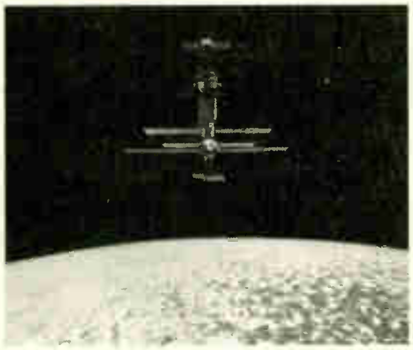
Service to the Fleet



By Larry Van Horn

Looking for some easy satellites to monitor with your programmable scanner? Then look no further than the 225-400 MHz UHF military aircraft frequencies. *ST* profiles the Fleet Satellite Communications (FLTSATCOM) constellation of satellites in the second of a four part series on UHF military satellite systems. Story begins on page 22.

Eyeballing the Big Link-up



The space shuttle Atlantis and Mir will dock in space next month and offer visual observers a wonderful celestial treat. Get a few pointers from Computer and Satellite columnist TS Kelso starting on page 80.

DEPARTMENTS

ST

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

Address: P.O. Box 98, 300 S. Highway 64 West,
Brasstown, NC 28902-0098
Telephone: (704) 837-9200
Fax: (704) 837-2216 (24 hours)
BBS: (704) 837-9200 (M-F 6:30 pm-8 am; 24 hours on weekends)

Internet Address: grove@mercury.interpath.net
Subscription Rates: $19.95 in US and $23.95 in Canada. Call for air mail rates for other countries.

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

Owners
Bob and Judy Grove
Publisher
Bob Grove, WA4PYQ
Managing Editor
Larry Van Horn, N5FPW
Art Director
John Bailey
Design Assistant
Melody Adams
Editorial Assistant
Terry Brooks
Advertising Services
Debbie Davis
(704) 389-6412
Dealerships
Belinda McDonald
Business Manager
Kelly T. Davis, KE4TAM

Editorial Staff

Satellite Services Guide Manager .... Robert Smathers
SSG Monitoring Team .... Robert Smathers
.... Larry Van Horn, N5FPW
Amateur Radio Satellites .... John A. Magliacane, KD2BD
Ask Larry .... Larry Van Horn, N5FPW
Beginners Column .... Ken Reitz, KC4GQA
Computers and Satellites .... Dr. TS Kelso
Domestic TVRO .... Dr. Frank Baylin
International TVRO .... George Wood, SM0IIN/KA6BIN
Navigation Satellites .... Todd Dokey
On the Air .... Steve Handler
Personal Com.Satellites .... Donald Dickerson, N9CUE
Radio Astronomy .... Jeff Lichtman
Satellite Launch Report .... Phillip Clark
Satellite Launch Schedules .... Keith Stein
Satellite Monitor .... Wayne Mishler, KG5BI
Satellite Times Tests .... Larry Van Horn, N5FPW
The Satellite Sleuth .... Dr. Theo Pappan
Weather Satellites .... Dr. Jeff Wallach, N5ITU
What's New .... Wayne Mishler, KG5BI

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

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.

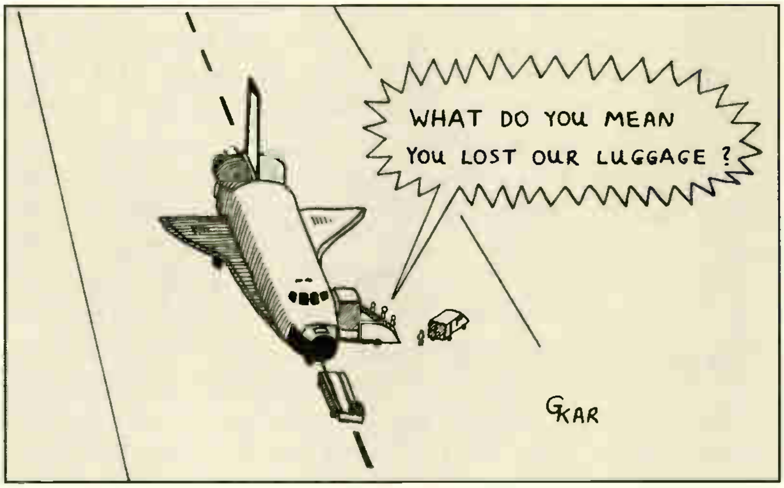
SWAGUR-HOODS. Our camera hoods allow you to photograph your computer or television screen without the usual problems. These hoods give the camera a steady base and focusing becomes very easy. The hoods block stray light and glare from reflecting into the camera lens. These hoods work with your 35mm camera 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.

DOWNLINK

By Larry Van Horn
Managing Editor

From the Editor...



The big news story in this issue of *Satellite Times* is the impending launch of the space shuttle Atlantis early next month. I'm really looking forward to the launch of STS-71, the first U.S.-Russian space docking mission since Apollo-Soyuz in 1975. My personal goal for this mission is not only to monitor some of the communications from the two spacecraft, but also to observe both objects visually as they streak across the dark, open skies here in Brasstown.

This issue's cover story, "Shuttling to Mir" by Keith Stein, should help the radio-equipped monitor listen in on some of the action during the flight. Keith has uncovered some new shuttle-Mir frequencies that will probably be used for the first time ever during this mission.

Amateur radio operators and scanner listeners can even participate in this historic event. Another Shuttle Amateur Radio Experiment (SAREX) will fly on the STS-71 mission. Hams wanting to try their hand at communicating with the shuttle or Mir during the flight should read the story on page 14 in this issue of *ST*. The American Radio Relay League (ARRL) in Newington, Conn. has notified us that uplink and downlink SAREX frequencies have been changed from those used on previous missions.

Of course, with a mission this complicated, anything can go wrong and it probably will. The launch is currently scheduled for June 9, 1995. That date is not firm and could slip for a number of reasons.

I know first hand how unpredictable the weather is in Florida this time of the year. With an extremely narrow launch window of only 5 minutes, weather conditions could easily delay the launch of space shuttle Atlantis.

Another more obscure delay could originate on board the Mir space station. U.S. astronaut Norm Thagard is currently conducting experiments on the Mir space station. He was launched into space from the Baikonur cosmosdrome on March 14, 1995 as part of the Soyuz TM-21 (Mir-18) crew. Thagard will be working on a large array of experiments during his visit including some that must be brought to the station by the new Spektr space module. Work in Russia to ready this critical Mir space station module for launch is running behind schedule. At presstime, any delay does not appear serious enough to disrupt plans for the June shuttle-Mir docking flight. However, any significant additional slip in the launch of Spektr would delay the Atlantis liftoff, and extend Thagard's planned three-month stay aboard the Mir.

An interesting footnote to all of this is that if all goes well, Thagard will set a new U.S. space endurance record during his stay in orbit, beating the old Skylab mark of 84 days by nearly 21 days.

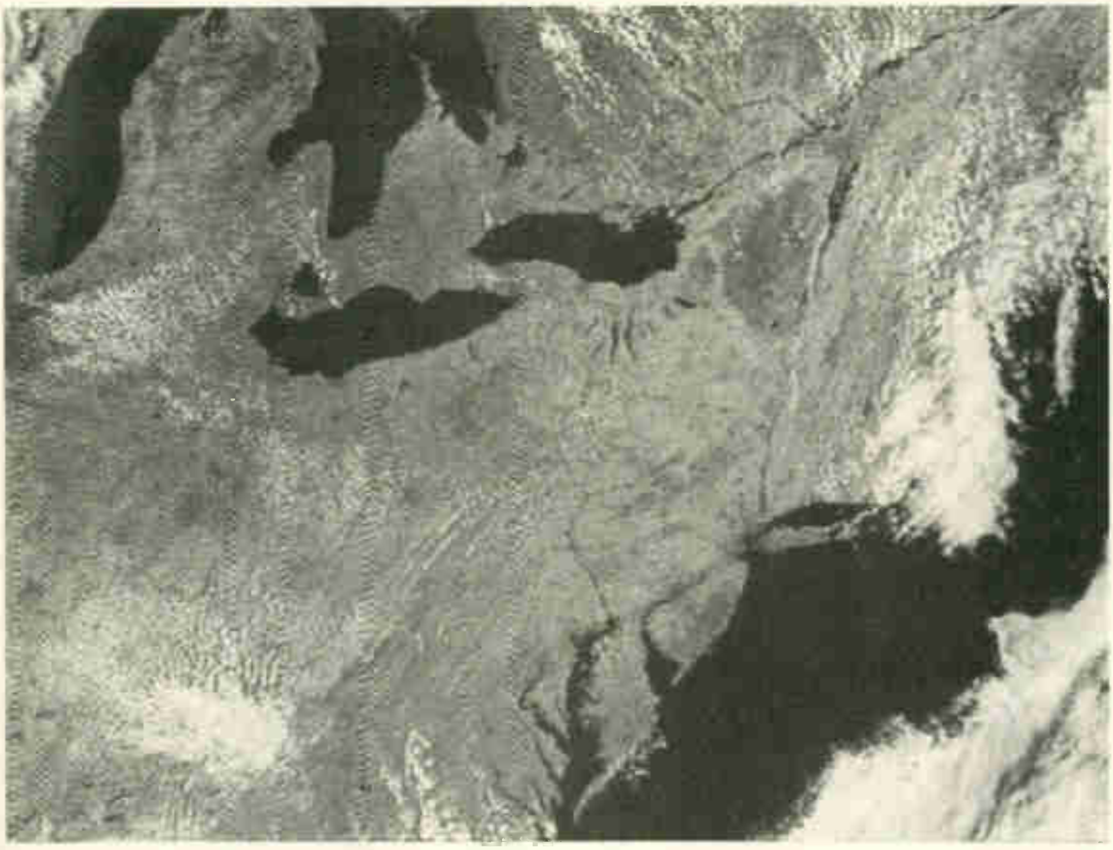
Another good reason to look forward to this shuttle-Mir mission will be the opportunity of observing the entire shuttle-Mir complex visually from here on earth. In this issue's *Computer and Satellite* column, TS Kelso provides some tips on how to get in on the action. We have also included in this issue's *SSG* some preliminary Keplerian elements for the STS-71 mission provided by NASA. These elements are based on a June 9 launch and should only be considered as a starting point in any attempt to hear or visually observe the shuttle-Mir complex. Electronic bulletin boards and Internet news groups will have the latest element sets for both spacecraft after the launch of Atlantis and these should be used in computing accurate observing opportunities.

If you plan on observing this celestial event, make sure to invite some friends to enjoy the fun. The view of these two giant spacecraft orbiting overhead from the ground should be spectacular and this should be a great show that the entire family will enjoy.

Finally, an old wise man once told me a little humor never hurt anyone. We all can use some humor in ours lives and the readers of *ST* are no exception. Starting with this issue, cartoonist George J. Kavayannopoulos N2OWO, will join me with his art and wit in each issue on the *Downlink* page. Check out this issue's submission, I'm sure you will enjoy it as much as I did.

This issue is packed with a lot of great stories and columns that are entertaining and informative. Time to turn the page and enjoy some *Satellite Times*. Till next month — 73 de N5FPW SK. ST

ANNOUNCING THE NEW MULTIFAX VERSION 7 SOFTWARE WITH BUILT-IN SATELLITE TRACKING!



Section of Magnified (zoomed 4X) NOAA 11 APT Image of North East US. Unretouched Photo Directly from SVGA Display.

Log onto the MultiFAX BBS (716-425-8759) and download this image (NE4X.GIF) and dozens of others as well as software, demos, and up-to-date orbital elements.

There is no charge to use the MultiFAX BBS, it is in operation 24 hours a day and supports up to 14.4KB modems.

MultiFAX offers **two** fully featured weather satellite demodulators: One model plugs directly into the expansion slot of your IBM compatible desktop PC, the other model interfaces to your PC (laptop, notebook, or desktop) through the parallel port-perfect for "crowded" computers or **portable** applications.

Both versions offer the same powerful capabilities-PLL circuitry for perfectly straight edges on NOAA, GOES, and Meteosat images. 4800 8-bit samples per second-capture ALL the high APT resolution the NOAA satellites can provide (2-3 miles) in visible and infrared (simultaneously) with a full 12 minute recording.

NEW Version 7 Software Features Include: NEW! Integrated Satellite Tracking including World Map, Schedule Output, and Kansas City Tracker Support • Direct Write to Disk (Extended or Expanded Memory **not** Required but can be used) • NEW! Graphic "Oscilloscope" Tuning/Level Display • PLL Sampling (Satellite Images Have Straight Edges-Even from Audio Tape Recordings!) • NOAA, Meteor, GOES, Meteosat, HF Fax • "Point & Shoot" User Interface with full Mouse Support • 1024 by 768 resolution with 256 Colors/64 Shades of Gray with SVGA-VESA Video Cards Supported • Zoom up to 8X • NEW! Easy Image Enhancement with Cursor Keys • Animate GOES and Meteosat Images (looping) • 10 User Definable Enhancement Palettes • Easy to Use False Colorization • NEW! Enhanced Multiple Unattended Timer Recording • Visible and IR pictures Recorded Simultaneously • Calibrated IR Temperature Readout and Calibrated Temperature Colorization • "3D" Enhancement • Binary or GIF Image File Output-Use Your Images with Hundreds of Other Programs • Dot Matrix and Laser Printer Output • Same High Resolution with Both Systems: 2-3 Miles with NOAA • Stores 3.5 Million 8 Bit Pixels for one 12 Minute NOAA Recording • Latitude/Longitude and Map Overlay (US included) • "Split & Join" Image File Utility-Copy Your Raw Picture Data to Floppies • Reference Audio tape of actual NOAA, Meteosat, and HF FAX Transmissions • Clear, Complete 85+ page Illustrated User's Manual • More...

Minimum requirements: IBM Compatible Computer with 640 KB Memory and either 1) An 8 or 16 bit slot for the internal card **OR** 2) A parallel port (LPT1, LPT2, or LPT3) for the external unit • VGA Card and Monitor • Hard Drive or RAM Disk with 4MB Available Space • Receiver and Simple Antenna (dish not required for high resolution polar orbiting satellites)

Please write or call for more details on MultiFAX Demodulators, receivers, antennas and the new MultiFAX GOES/Meteosat 1691-137.5 MHz downconverter. Internal demodulator with software: $289 plus S&H.

MultiFAX • Route 1, Box 27 • Peachland, NC 28133 • 704-272-9028
MasterCard/Visa FAX: 704-272-9036, BBS: 716-425-8759

SATELLITE MONITOR

By Wayne Mishler, KG5BI

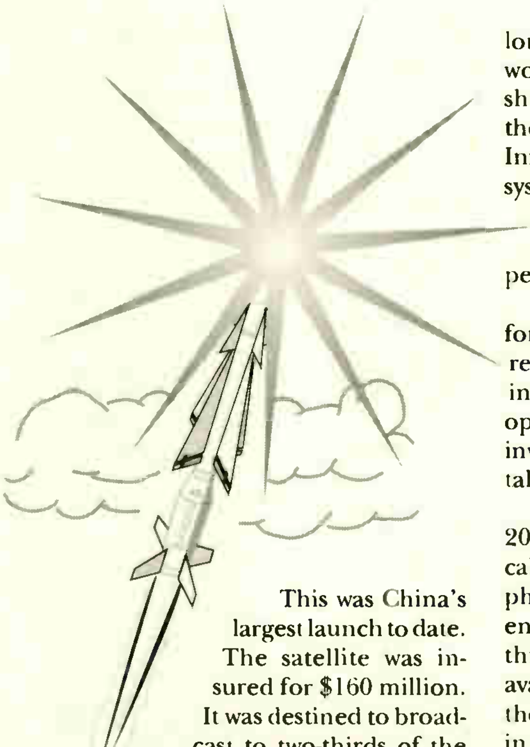
Mystery explosion destroys Apstar 2 bird

For the second time in as many months, a major communications satellite has been destroyed in the launch process.

Fifty-one seconds after lift-off aboard a Chinese Long March 2E rocket at 2:40 p.m. on January 25 (PST), the multimillion dollar Hughes-built Apstar 2 communications satellite riding in the rocket's nose cone was blown apart in a mysterious explosion.

Six residents were reported killed and 23 others injured by fragments of the rocket and satellite that fell in a populated mountainous area seven kilometers launch site.

Some say the launch was shrouded in controversy. The Thai government reportedly had complained to United Nations officials that the satellite would occupy an orbital slot too close to its own. Investigators have not made any allegations.



This was China's largest launch to date. The satellite was insured for $160 million. It was destined to broadcast to two-thirds of the world's population.

The rocket had lifted off at sunrise in the chilly foothill country of southwestern China, carrying in its 9.2-ton payload elaborate dreams of the pan-Asian media industry.

Apstar 2 was to ride in the rocket's nose for 20 minutes to a parking orbit, from which the satellite's own solid and liquid fuel rocket motors were to move it into orbit 22,300 miles above the equator.

From that vantage point, it was to broadcast mostly television programming to a footprint reaching from China and Japan southward to Australia, westward to the Middle East and eastern Europe, and northward to parts of Russia.

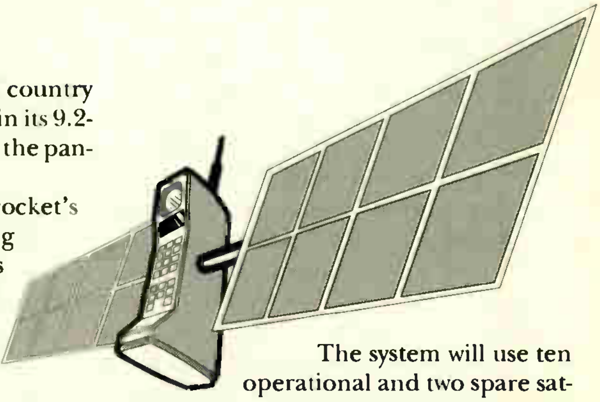
Its life span was to be 14 years. Instead the satellite and the dreams it carried lived for less than a minute before being ripped apart in a cloud of smoke that drifted away in the morning sky.

Star-trek communicator not so far-fetched

You won't want to use it for those hour-long chats with Mom and you probably won't be using it to beam up to your space ship (not yet anyway), but by the end of the decade you may very well be using Inmarsat's global handheld satellite phone system for urgent business and emergency communications when conventional telephone service fails to reach the person you are calling.

The Inmarsat-P affiliate company, formed to implement the system, has already exceeded its initial $1 billion funding target for putting the project into operation by 1999, raising $1.4 billion in investment commitments toward the total estimated price tag of $2.6 billion.

A typical Inmarsat-P user in the year 2000 will carry a pocket telephone identical in appearance to a handheld cellular phone. But that's where the similarity ends. The satellite phone will operate through terrestrial links when they are available and through satellite links when they are not. The difference will show up in price, too. The handset likely will retail for about $1000 and the cost for using it will be about $2 a minute.



The system will use ten operational and two spare satellites in two intermediate circular orbit planes. The satellites will relay telephone calls to Earth-bound access nodes located within the satellites' view. These nodes will be interconnected in a terrestrial network known as the P-net. The network will be linked to public terrestrial and cellular networks through "gateways" owned and operated by third parties.

Development of the system so far has involved four years of collaborative work with leading telecommunications, aerospace and equipment manufacturers, consultants, researchers and other experts. Actual construction of the system's satellites and Earth stations is to begin with the awarding of contracts by the affiliate's board of directors about mid-year.

"Inmarsat has stolen the march on the global handheld satellite phone race," says the company's director general, Olof Lundberg. "The number and prominence of the investors demonstrates overwhelming support of and confidence in the program and will allow implementation to go forward with speed and urgency."

Thirty-eight investors from nations in six continents are supporting the project, Inmarsat says. They include some of the world's leading telecommunications operators who provide mobile services. Inmarsat itself has invested $150 million, giving it two seats on the affiliate company's board of 13 directors.

Established in 1979, Inmarsat is an international cooperative organization with a membership of 76 nations. Its satellite communications system provides mobile communications at sea, in the air, and on land. Its geostationary satellites serve more than 40,000 voice and data terminals worldwide.

SATELLITE MONITOR

Hughes satellites to provide handheld phone service for 54 countries

Hughes Aircraft Company and Afro-Asian Satellite Communications Ltd. have signed a contract to launch two satellites that will link users with handheld telephones on two continents in three years.

The satellites are enhanced versions of Hughes' HS 601 model spacecraft, capable of handling 16,000 phone calls simultaneously. The first satellite is to be launched by the end of 1997. The second is to be launched six months later. Hughes is to deliver the satellites in orbit.

Together, the satellites will serve mobile users in 54 countries in a footprint reaching from Singapore northwest to Moscow, and south to Africa, including India and the Middle East.

Northwestel offers telecommunications in northern Canada

Northwestel Inc. this year becomes Canada's first telephone company to provide MSAT satellite telecommunications services to customers in that nation's northern provinces.

The new service affects everyone without access to regular telephone service including those needing temporary communications at remote sites, such as seasonal camps or other remote work sites such as mines and exploration camps.

Mobile users have access to satellite voice and data communications through an MSAT Communicator that allows switching between cellular and satellite services, depending on location and availability.

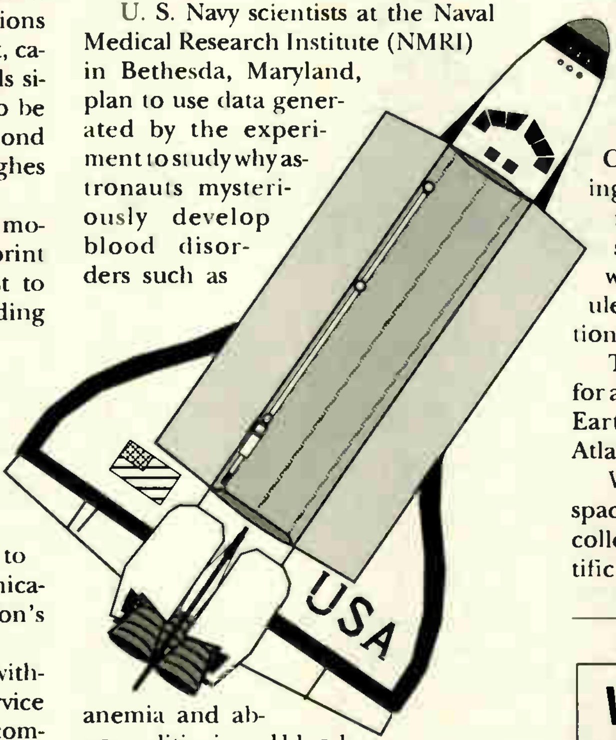
"The possibilities for its use in the north are limitless," says Northwestel president and CEO Bill Dunbar.

With headquarters in Whitehorse, Northwestel is a member of the Stentor group of companies and provides telecommunications services to a population of 100,000 people in northern British Columbia, Yukon, and the northwest territories of Canada.

Space shuttle serves as lab for medical research

Unknown to the world below, the space shuttle Discovery earlier this year launched a mystic and perhaps medically significant experiment that may, among other benefits, reduce health risks of future space travel.

U. S. Navy scientists at the Naval Medical Research Institute (NMRI) in Bethesda, Maryland, plan to use data generated by the experiment to study why astronauts mysteriously develop blood disorders such as anemia and abnormalities in red blood cells when exposed to long periods of weightlessness.



"The causes are presently unclear, and must be known for future missions like the space station," Dr. Kelvin Lee of NMRI noted in a report recently released by the Navy. "If there is ever a Mars mission, with astronauts in microgravity for 18 months or more, we must know what's going to happen."

The institute's experiment seeks to explain how microgravity affects the generation of cellular components of blood by bone marrow.

To find out, the space shuttle crew under the direction of NMRI scientists deployed three sets of human bone marrow cell cultures in low Earth orbit. They will later be retrieved and compared to identical cultures preserved on Earth. Scientists hope the study will lead to development of new therapies.

U. S. astronaut welcomed aboard Russian spacecraft

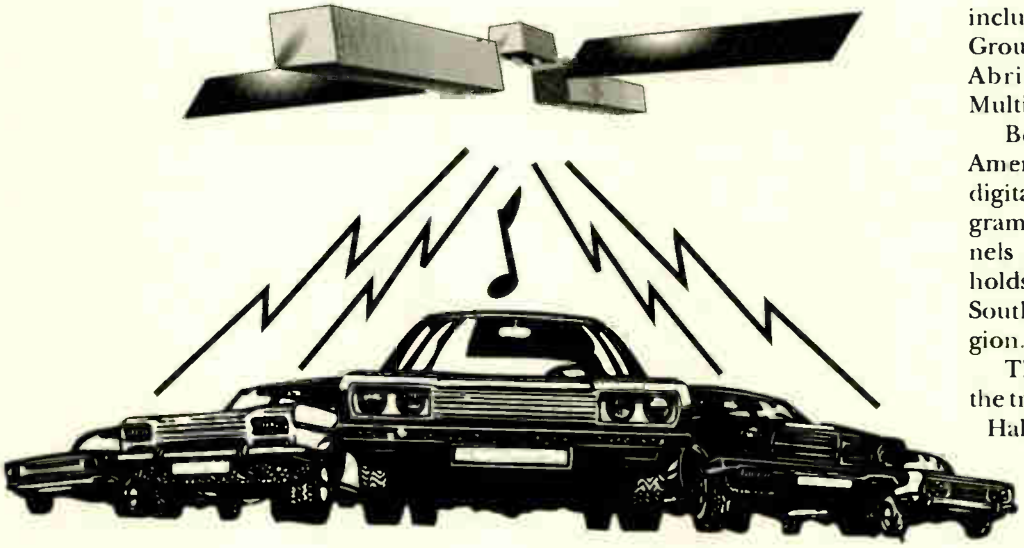
At 9:11 a.m. on March 14, Moscow time, U. S. astronaut Norman Thagard became the first American ever to ride aboard a Russian spaceship.

The launch took place at the Russian-operated Baikonur Cosmodrome located in the neighboring country of Kazakhstan. About nine minutes later, Thagard and his Russian colleagues rendezvoused in space with a Soyuz TM space vehicle, scheduled to dock with the MIR 1 space station on March 16.

Thagard is to be a guest aboard MIR 1 for about three months and will return to Earth aboard the U.S. space shuttle Atlantis in May.

While in orbit aboard the Russian space station, Thagard will work with his colleagues in medical and other scientific experiments.

SATELLITE MONITOR



Car radio satellite service moves toward reality

Fading stations on your car radio may soon be history.

A proposal for a new radio service, transmitted by satellite, would give motorists continuous, digital-quality audio from their car radio no matter where they drive.

The broadcast radio industry opposes the plan, arguing that it would drive local stations out of business. But in January the proposed service cleared its first hurdle with the Federal Communications Commission, who gave it a frequency allocation in the S-band. The plan continues moving through the approval process, and may have a green light by mid-year, according to the FCC.

Subscribers would need a radio and antenna capable of receiving frequencies in the S-band and pay a monthly fee for a package of channels which they would receive via satellite downlink, much like direct broadcast service (DBS) TV.

Local broadcasting companies are objecting to the competition, expressing fear that satellite radio would lure their listening audiences and reduce advertising sales.

Proponents of the service argue that the local broadcasting industry historically tries to block new technology with predictions of financial doom. "They made the same argument with cable and DBS," says an attorney for one satellite firm promoting the plan. "The courts, the FCC, and the marketplace agree with us."

DIRECTV service spreads to Latin America

Media firms in Brazil, Venezuela and Mexico have joined with Hughes Communications, Inc., in a partnership to establish the first all-digital direct-to-home satellite television service in Latin America.

In addition to Hughes, the partnership, operating under the name Galaxy Latin America, includes the Venezuela-based Cisneros Group of Companies, Brazil's Televisao Abril (TVA), and Mexico's MVS Multivision.

Beginning in 1996, Galaxy Latin America plans to package and deliver digital video and CD-quality audio programming through 144 television channels and 60 music channels to households throughout Mexico, Central and South America, and the Caribbean region.

The package will be presented under the trade name DIRECTV Latin America. Half of the 144 DIRECTV Latin America channels will carry Spanish language programming. The other half will provide programming in Portuguese.

Hughes plans to build a primary broadcast center for Galaxy Latin America in Long Beach, California.

DIRECTV Latin America is to use the same digital broadcast satellite technology as its U. S. namesake, featuring small, low-cost dish antennas that are easy to install. Latin Americans currently have few television channels from which to choose. The arrival of DIRECTV Latin America will give them a smorgasbord of viewing options.

"Much of the Latin American region, which includes nearly 77 million homes with TVs, is experiencing unprecedented economic growth," says Hughes Communications executive vice president Jerry Farrell. "We are conservatively projecting a business of five million customers, and we believe the customer base could grow to ten million," he says.

DIRECTV™

INTELSAT insurance purchase sets new record

How would you like to be the salesman who sold INTELSAT the insurance policy covering its planned launch of ten satellites over the next two years?

Face value of the policy was nearly $2 billion. The premium is almost $185 million. This was the largest placement for satellite launch insurance ever undertaken in the industry, according to INTELSAT officials.

The record-setting placement provides insurance for the launch phase before separation of the satellite from the launch vehicle. Seven of the insured launches will be for spacecraft launched by Arianespace, and three will be for launches by Martin Marietta Commercial Launch Services.

"We have an obligation to our investors and customers to make sure our campaign to put new capacity in orbit is protected," says director general Irving Goldstein. "This placement sends a message to both our investors and our customers that INTELSAT is ready, willing and able to guarantee its commitments."

Who won the Super Bowl? Guess again!

If you think a football team won the last Super Bowl, think again. Money and statistics say the real winners were advertisers. For example, take a wild guess at the price tag of a 30-second Super Bowl commercial. Would you believe...a million dollars?

And statistics say the corporations footing the bill for the seven figure ads were getting a bargain. According to a recent survey by Satellite DIRECT magazine, a whopping 48.9 percent of viewers say they'll watch an ad airing during the Super Bowl, compared to 35.9 percent who say they'll watch commercials during a regular TV program.

For advertisers, that 13 percent difference means that people are 36.2 percent more likely to watch a commercial during the Super Bowl than any other program on TV. Don't ask how they came up with that figure. That's why statisticians get paid the big bucks.

Who fired that shot anyway?

"For sale: one satellite in orbit. Slightly used. You catch it."

That may be one solution for the dilemma facing Turkey president Turgut Ozal these days. According to a recent news report in the Turkish Daily News, he seems to be stuck with a satellite that Turkey doesn't need. The newspaper says he launched Turksat-1B to spy on central Asia. (Not in those exact words.) But with the disintegration of the Soviet Union, that steak has lost some of its sizzle.

So what else can Turksat do? No one knows. But they're scrambling for ideas.

Turkey paid about $400 million to put Turksat in orbit. It has an expected life span of about 13 years. And the clock is ticking.

Surely Turksat has some use. Some say intercity telecommunications could use the satellite's transponders. Now there's an idea. But Turkey doesn't have problems with city to city telephone calls. They need help in managing calls within cities, but that's out of Turksat's line.

Besides, it would be more cost effective to lease a transponder on another satellite than to maintain a whole satellite to manage a few phone calls. That would be like booking a hotel and asking for a single bed.

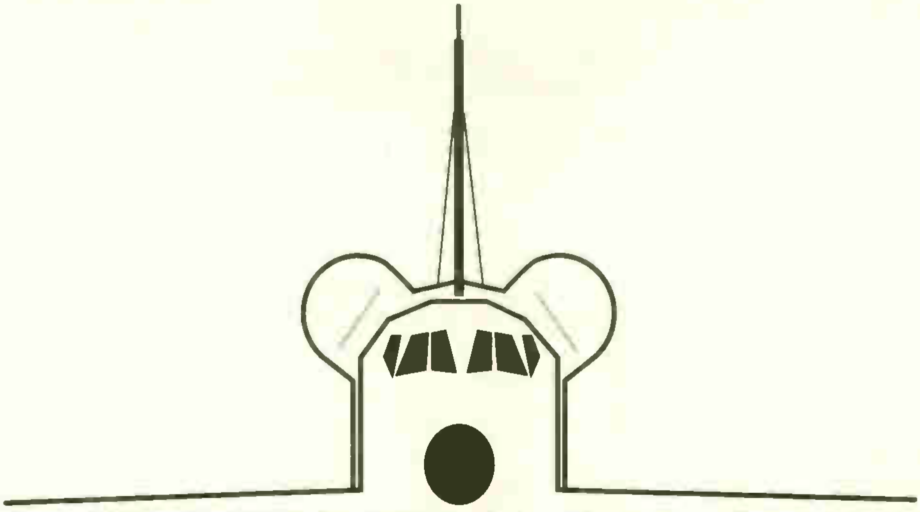
The bottom line seems to be: if you don't have a satellite dish, and if you don't own a mobile phone, and if you don't subscribe to cable TV (and most Turks do not) then you don't need Turksat.

The biggest return on Turkey's investment seems to be the prestige of owning its very own satellite. But $400 million is a steep price for vanity.

Keep an eye on the want ads. You might pick up a bargain. Then again, what would you do with it? ST

Sources:

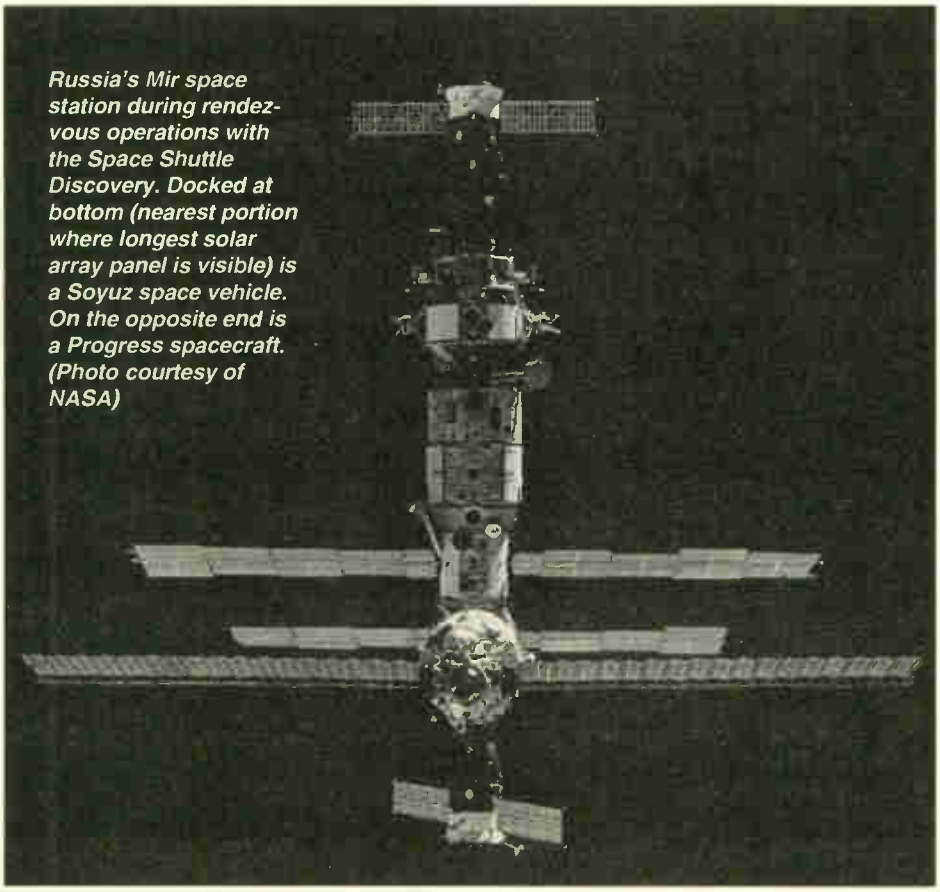
Associated Press, BBC Summary of World Broadcasts, Dave Alpert NY, DIRECTV Inc., Energia Ltd., Federal Communications Commission, Hughes Aircraft Company, Hughes Space and Communications Company, Inmarsat, INTELSAT, Lockheed Missiles & Space Company, PanAmSat, TMI Communications and Company, and United States Navy.



SHUTTLING TO MIR

"We are bringing our spaceships closer together; we are bringing our nations closer together. The next time we approach, we will shake your hand and together we will lead our worlds into the next millennium"

—Space Shuttle Commander, James Wetherbee,
February 6, 1995, orbiting 1.1 m (37 feet)
from the Mir space station.



Russia's Mir space station during rendezvous operations with the Space Shuttle Discovery. Docked at bottom (nearest portion where longest solar array panel is visible) is a Soyuz space vehicle. On the opposite end is a Progress spacecraft. (Photo courtesy of NASA)

By Keith Stein

Two spaceships, hurtling through the darkness of space at 10,850 km/h (17,500 miles per hour) will treat the world below to a spectacular celestial ballet next month as the U.S. space shuttle Atlantis (STS-71) docks with the Russian space station Mir.

With the blue, cloud-shrouded Earth looming in the distance, the two crews will launch a new era in international manned spaceflight, providing dramatic video footage as both vehicles draw closer and closer together filling their spacecraft windows with waving arms and smiling faces. Atlantis commander, veteran astronaut, Robert L. Gibson (who also flew on shuttle missions STS-41-B, STS-61-C, STS-27, and STS-47) will maneuver the shuttle toward Mir during NASA's 69th shuttle mission.

This docking, which will mark the first space meeting between the former Cold War rivals since the 1975 Apollo-Soyuz mission (also known as Soyuz-Apollo in Russia), will be the first of seven shuttle-to-MIR station dockings. These dockings are intended to merge the space programs of the two countries, enabling the United States and Russia to lead Europe, Japan, and Canada in the assembly of a $40-billion, global space station by late 1997.

Next month's docking will require some of the most precise space maneuvering in the history of the shuttle program, which began flying 14 years ago. This will be the first time a docking has been done with such massive vehicles.

At presstime, the launch of STS-71 is scheduled for June 9, 1995. When Atlantis launches from the Kennedy Space Center in Florida, the vehicle will only have a five-minute window of opportunity to align itself with the flight path of the 9-year-old Russian space complex, which has completed over 51,000 orbits of the Earth.

If you live on the east coast of the United States, step outside right after liftoff and look to eastern horizon. The shuttle will be visible to the naked-eye from cloud-free locations and appear to be a fast moving bright star. During past launches traveling this same trajectory, observers have reported seeing shuttle main engine cut-off and sometimes dim flashes that signal external tank separation seconds later. I myself have seen several of these events and highly recommend everyone to attempt this viewing. (See this month's Computer and Satellite column-Editor)

Once in orbit, the shuttle will chase after the MIR space station to accomplish it's historic rendezvous. As the shuttle approaches to within 60 m (2,000 feet) of Mir, Gibson will take manual control of Atlantis, synchronizing it with Mir's velocity, a maneuver known as the "V-Bar" (an imaginary line drawn along the station's direction of travel). At 30 m (1,000 feet), using steering jets, Gibson will slowly draw closer to Mir. He will monitor his progress not only by looking out the shuttle windows at Mir, but also by watching computer screens on the flight deck. Pilot Charles J. Precourt (who also flew on mission STS-55), will be assisting Gibson by calling out distances and other data, keeping track of various navigation systems and making sure he is keeping within the normal limits. Atlantis will approach Mir at a rate of 3 cm/s (0.1 feet per second).

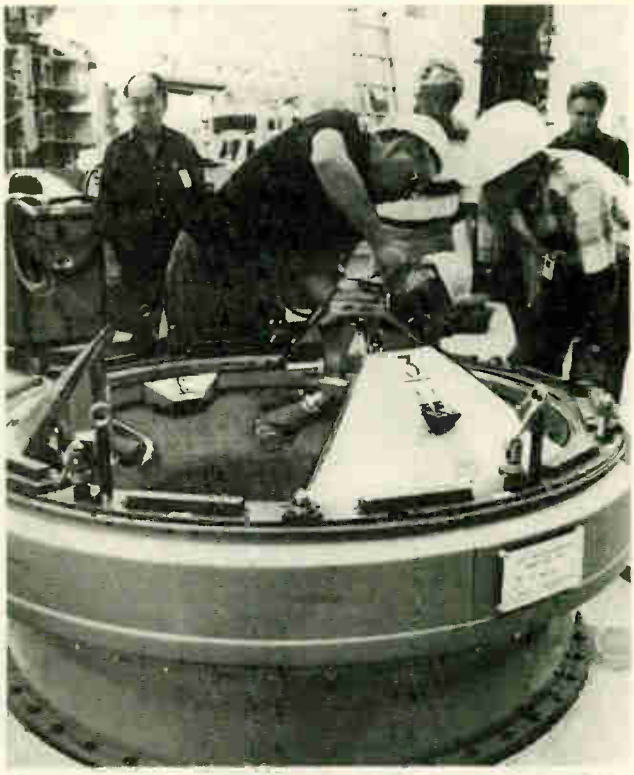
Cameras mounted on both Mir and Atlantis should be able to beam back images of the two vehicles gliding in formation about 387 km (242 miles) above Earth.

Mir, with its blue-green solar wings and spindly construction, will resemble a space-faring dragonfly.

Is there anyone aboard Mir currently?

When Atlantis maneuvers to within 304 km (190 miles) from Mir, shuttle crew members should have sight of the complex with the aid of binoculars. Looking back at them from Mir will be Russian cosmonauts, Vladimir N. Dezhurov, Gennadi M. Strekalov, and U.S. astronaut Norman E. Thagard. All three were launched to Mir in March 1995 aboard the Soyuz TM-21 spacecraft.

Dr. Thagard, a physician, is the first American astronaut to fly atop a Russian rocket, traveling to Mir for a three-month stay. During his mission aboard MIR, he will be conducting life-science experiments to understand the effects of long duration spaceflight on humans. Most of these experiments will be performed with 755kg of equipment packed in the new module known as Spektr. The Spektr module contains a centrifuge, freezer, bicycle exerciser and a metabolic gas analyzer.



Technicians inspect the Russian-built spacecraft docking mechanism, called the Androgynous Peripheral Docking Assembly, that will enable Space Shuttle Atlantis to join up with the orbiting Russian Mir space station next month.

At presstime, problems at Russian customs have delayed the equipment's delivery, and Spektr's launch. Spektr was scheduled for launch on May 10, 1995, with docking on May 17, and checkout completed on June 9, 1995. With this schedule in place, it would only give Dr. Thagard a few days access to the experiments and equipment. His mission will end when Atlantis links up with Mir.

What will they do after docking?

The Mir crew will position the station so that its red docking target will face the approaching shuttle, flying with its open cargo bay toward the MIR space station. Atlantis will use the Androgynous Peripheral Docking Assembly, originally developed for the Russian space shuttle-Buran. Two days after launch, with ten astronauts chattering away in English and Russian, the shuttle will dock with the Russian space outpost.

Special arrangements may be made when the shuttle and Mir crews open the hatch to meet each other. In Russia, they think it's impolite to shake hands over the threshold of somebody's home, and Mir is their home. So what will probably happen when the two ships dock will be a handshake conducted inside Mir and then one conducted inside the shuttle.

Astronauts will bring their Russian counterparts aboard Mir a basket of goodies containing flowers, fruit and salt. Meanwhile, the Russians keep saying they have a big surprise for the shuttle crew, but won't say what that surprise is. After docking, the ships will swap crews and hold work sessions to do scientific experiments, and perform space and Earth observations.

The Atlantis will remain docked with Mir for five days before returning home with Dr. Thagard, and Russian crew members, Dezhurov and Strekalov. Solovyov, and Budarin carried up by Atlantis will remain aboard Mir.

These Shuttle/Mir docking missions have four primary objectives:

- Learning how to work together in space.
- Reducing technical risks for building and operating the international space station.

- Advancing studies of long-duration human space flight.
- Conducting scientific research.

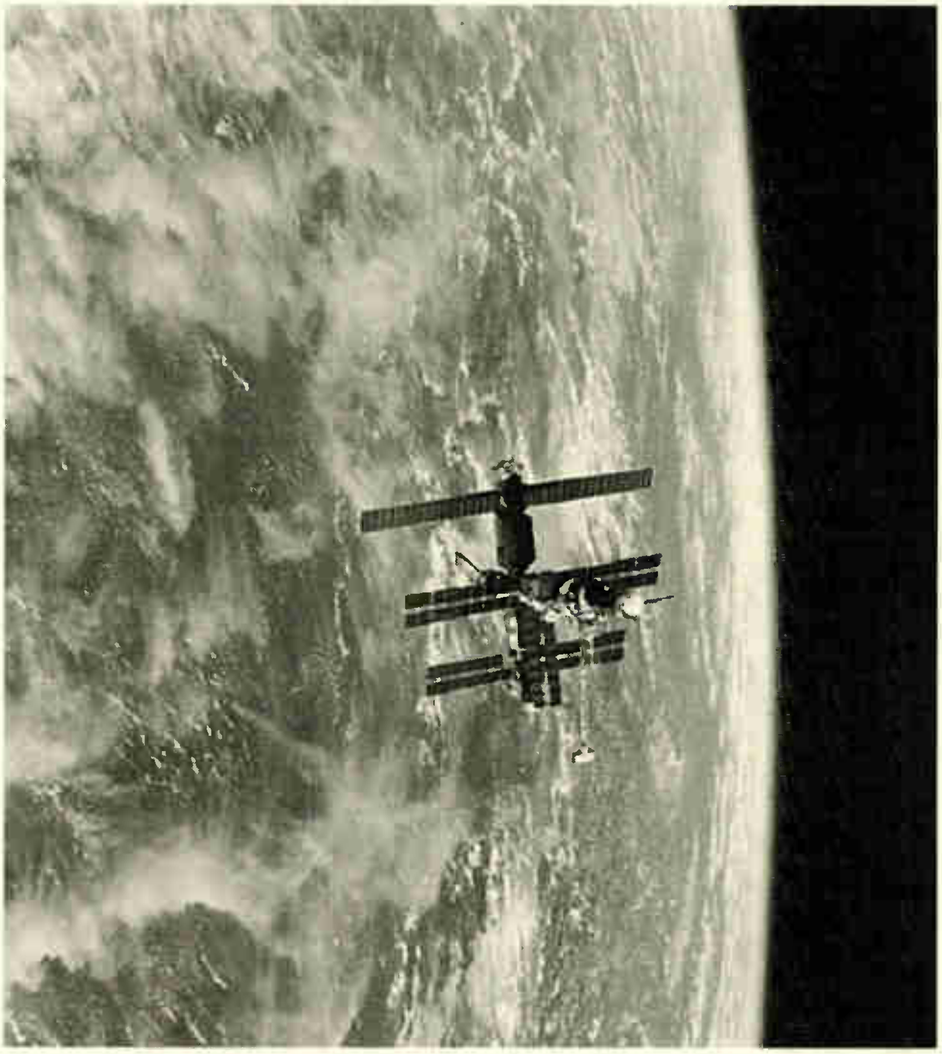
Important hardware, such as jointly developed experimental solar panels will be delivered on a later flight, along with vital supplies. There are 28 investigations in seven science disciplines scheduled for the Shuttle/Mir missions. At least, three extravehicular activities (EVA's) will be conducted during these joint U.S./Russian missions, including one that will set a record, the first four-person spacewalk.

What is life like aboard the Mir space station?

Since it's first element was launched in 1986, over 50 cosmonauts and researchers have worked onboard Mir and more than 40 EVA's have been carried out. Mir is bigger and roomier inside than the shuttle, structured with 10 windows and it has a smell of "wet towels" described by cosmonauts living on the station. The word "Mir" is Russian and translates into English as peace, commune or world.

The base core module of the station is 13.13 m (43.3 feet) long and 4.15 m (13.7 feet) in diameter, a little bit larger than a commuter bus. It contains living quarters, piloting station, main engine and fuel systems. Carpeting on the floor and lights on ceiling, help make the cosmonauts feel at home.

Attached along the same plane at one end of the base module is the Kvant 1 module used for astronomy observations. Attached at the other end of the station, at 90-degree angles to the main module, is the Earth observation and biology module and the materials and biotechnology module. Two more modules are expected to be added this year to the Mir station. The overall Mir complex is about the same size as a DC-9 airliner.



Cumulus and other clouds over the ocean form the backdrop for this scene of Russia's Mir space station during rendezvous operations by the Space Shuttle Discovery (STS-63) and Mir. (Photo courtesy of NASA)

U.S./Russian Crewmembers for first Shuttle/Mir docking mission

STS-71 Crew Members

Commander: Robert L. Gibson
Pilot: Charles J. Precourt Jr
Mission Specialist: Ellen S. Baker
Mission Specialist: Bonnie J. Dunbar
Mission Specialist: Gregory J. Harbaugh
Mir-19: Nikolai Budarin (Russia) (U)
Mir-19: Anatoly Solovyev (Russia) (U)

Mir-18 Crew Members

Commander: Vladimir Dezhurov (Russia) (D)
Flight Engineer: Gennadiy Strekalov (Russia) (D)
Guest: Dr. Norman E. Thagard (D)

On the outside of Mir is positioned at least four sets of solar power panels and docking ports for Progress and Soyuz capsules to bring supplies and men back and forth from Earth.

A typical day aboard the station begins at 0500 UTC and ends at 2000 UTC. Two hours a day are set aside for exercise, and weekends have lighter work loads. Mir is equipped with a shower, but cosmonauts generally towel clean. They talk to their families on the ground periodically through video links. Music and videotapes are the most readily available source of entertainment. Cosmonauts have even commented that the toilet system is simpler and better then the famously expensive, sometimes clogged shuttle commode.

What is the current status of both space programs?

Despite significant financial, political and technical hurdles, the U.S. and Russia are pressing forward with their plans.

In January 1995, during meetings in held in Russia, Russian space officials declared that underfinancing during the last two years has already resulted in curtailing of several space programs and discharge of over 7,500 space specialists. Yuriy Koptev, chief of the Russian Space Agency, reported that there are currently

177 operational Russian spacecraft in orbit, 104 of them are working way past their design lifetime and could fail at any moment.

Commander of the Military Space Forces, Vladimir Ivanov underscored that the 72 space launches planned for 1995 are unreal due to the shortage of boosters and spacecraft. In the best scenario, Russia will be able to launch half of them. In 1994, Russia managed to launch only 49 of a planned 102 spacecraft. Leaders of the Russian space branch declared that if purposed financing is not precisely defined in the budget soon, they will be forced to start curtailing the manned space program in May 1995.

A mirror image is being projected from the United States. NASA has cut its space shuttle launch rate from eight to seven flights a year as a cost cutting measure, and does not plan to outfit a second shuttle to dock with Russia's Mir space station as originally planned. The painful budget cuts at NASA got much worse in March of 1995 as senior officials announced the agency wanted to eliminate 5,900 technicians, engineers, managers and administrative personnel at Kennedy Space Center in the next few years. These cuts would save $318 million, and could begin late this year.

It has been repeated over and over, advanced human spaceflight to Mars, or back to the Moon, and possibly beyond, will not be achieved by one single country, international cooperation must be developed. These Shuttle/Mir missions will study the effects of long stays in near-zero gravity in preparation for building a permanently staffed multi-billion dollar orbiting space station called Alpha.

Construction of the space station, due to be completed by June 2002, will bring Russia, the United States, Canada, Europe and Japan together in this international effort.

In his 1984 State of the Union Address, when then President Ronald Reagan directed NASA to develop a permanently manned space station, he also stressed international participation. "NASA will invite other countries to participate," he declared, "so we can strengthen peace, build prosperity and expand freedom for all who share our goals."

The launch of STS-71 to the Mir space station next month is the first trip into space toward meeting those goals. ST

Mir Space Station configuration for first Shuttle/Mir docking mission

Mir Space Station Base Block

Launched: February 19, 1986
Length: 13.13 m (43.3 feet)
Maximum Diameter: 4.15 m (13.7 feet)
Weight: 20,400 kg (44,880 lb) at launch
Number of main engines: 2

Kvant 1

Launched: March 31, 1987
Principal Application: Manned/automatic astronomical observatory
Length: 5.8 m (19.14 feet)
Maximum diameter: 4.2 m (13.9 feet)
Weight: 11,050 kg (24,310 lb) docked to Mir

Kvant 2

Launched: November 26, 1989
Principal Application: EVA activities support
Length: 12.4 m (41 feet)
Maximum Diameter: 4.4 m (14.5 feet)
Weight: 18,500 kg (40,700 lb) at launch

Kristall

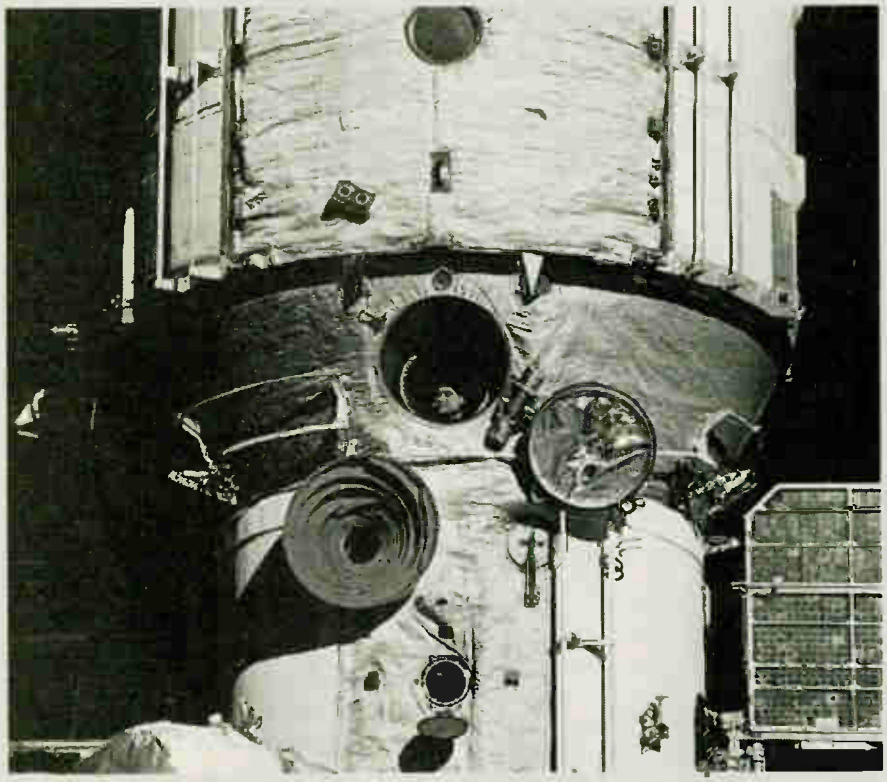
Launched: May 31, 1990
Principal Application: Materials processing unit
Length: 11.9 m (39.2 feet)
Maximum Diameter: 4.4 m (14.5 feet)
Weight: 19.64 t in orbit

Spektr

Launched: May 1995
Principal Application: Remote sensing, emphasizing atmospheric studies
Length: 13 m (42.9 feet)
Maximum Diameter: 4.35 m (14.4 feet)
Weight: 19.64 t in orbit

Soyuz-TM spacecraft

Principal Application: Ferry spacecraft for manned flight
Length: 7 m (23.1 feet)
Maximum Diamater: 2.7 m (8.9 feet)



STS-63 onboard view of Cosmonaut Valeriy V. Polyakov, who boarded Russia's Mir space station on January 8, 1994, looks out Mir's window during rendezvous operations with the Space Shuttle Discovery. (Photo courtesy of NASA)

U.S.-Russian Spacecraft Frequency List

Buran shuttle, Soyuz spacecraft

VHF/UHF :	121.75/130.167 MHz (FM voice) 121.75/121.125 MHz (FM voice) 139.208/143.625 MHz (FM voice) 166.0 MHz (FM wideband telemetry-PAM) 231/233 MHz (FM wideband telemetry) 247/249 MHz (FM wideband telemetry) 417/463 MHz (Telemetry) 922.750/926.050 MHz (Telemetry)
S-band :	2025-2100 MHz (PSK telemetry) 2200-2290 MHz (PSK telemetry)
Ku-band :	13/15 GHz (PSK/video)

Progress supply spacecraft

VHF/UHF:	166.0 MHz (PPM-AM/FM wideband telemetry-PAM) 922.750/926.050/929.070 MHz (Telemetry)
S-band:	2025-2100 MHz (PSK telemetry) 2200-2290 MHz (PSK telemetry)

MIR Space Station

VHF/UHF:	121.75/130.167 MHz (FM voice) 121.75/121.125 MHz (FM voice) 139.208/143.625 MHz (FM voice) 231/233 MHz (FM wideband telemetry) 247/249 MHz (FM wideband telemetry) 417/463 MHz (Telemetry)
S-band:	2025-2290 MHz (PSK telemetry) 2200-2290 MHz (PSK telemetry)
Ku-band:	13/15 GHz (PSK/video)

Space shuttle downlink frequencies

UHF voice:	259.7 MHz (AM-Primary) 296.8 MHz (AM-Secondary) 279.0 MHz (AM-EVA comms) 243.0 MHz (AM-Emergency use only)
S-band tracking:	2106.4 MHz
Orbiter OI transmitter:	2205.0 MHz (FM-Video/Data)
TT&C and voice:	2217.5 MHz (PM Secondary)
Orbiter DFI transmitter:	2250.0 MHz (FM-Video/Data)
TT&C and voice:	2287.5 MHz (PM Primary)
Ku-band telemetry:	15003.4 GHz

Mir and Atlantis may also use 139.3 MHz and 143.6 MHz FM for voice communications during docking operations, but these frequencies have not been approved at presstime.

Late Announcement: New Frequencies Chosen for STS-71 SAREX

The upcoming STS-71 space shuttle flight, tentatively scheduled for June 9, 1995 will be the first Shuttle/Mir docking mission. Since both SAREX (Shuttle Amateur Radio Experiment) and the Mir amateur radio station are expected to be operational throughout this flight and since the two vehicles share the same ham radio downlink frequency (145.550 MHz), downlink frequency conflict between the Mir radio station and SAREX would be expected.

In light of this, and in light of the lessons learned from using the current complement of SAREX frequencies, the SAREX working group have made frequency changes for the amateur radio frequencies that will be used during the STS-71 mission. These frequencies were chosen after much deliberation to minimize conflict between SAREX, MIR and terrestrial-based 2-meter users. In addition, these frequencies are being strongly considered for future SAREX missions.

Most SAREX operations are split-frequency. One frequency is used for "downlink" (the astronauts transmit to Earth stations) and a separate frequency is used for the "uplink" (Earth stations transmit to the astronauts).

At least two of the astronauts aboard Atlantis are licensed and will be available to operate the SAREX experiment. They are Charles J. Precourt Jr, pilot (KB5YSQ) and Mission Specialist Ellen S. Baker (KB5SIX).

SAREX Voice Frequencies

The following frequencies are used for two-way voice communications with the shuttle astronauts.

Downlink:	145.840 MHzWorldwide
Uplink:	144.450, 144.470

Note: *The crew will not favor any specific uplink frequency, so your ability to communicate with SAREX will be the "luck of the draw"*

Mir Amateur Radio Station

Astronaut Norman E. Thagard aboard the Mir has been heard at presstime conducting amateur radio operations using the callsign R0MIR. Look for quite a bit of ham activity in the near future and especially during the STS-71 mission from the Mir amateur station. Mir does not use split frequencies like the shuttle SAREX experiments. Instead one 2-meter simplex channel is used for both voice (FM) and packet operations, 145.550 MHz. ST

SKYVISION INC.®

ORBITRON

Known the world over for their superior reception and picture quality, the Orbitron satellite dish features an exclusive Spinclination mount, which allows declination to be set by rotating the antenna to correct the latitude setting on the scale. Their compact shipping cartons allow these antennas to be shipped very economically to any point in the world. Let Orbitron help you expand your viewing choices.

1514001	6.7'	SX-7	Polar/Spin	$45 (S&H)	$259
1514002	8.3'	SX-8.5	Polar/Spin	49 (S&H)	319
1514004	10.0'	SX-10	Polar/Spin	63 (S&H)	449
1514005	11.7'	SX-12	Polar/Spin	84 (S&H)	649

and many more...

Pico Peaker

You can now accurately aim your satellite dish to receive *all* the satellites using a tool the experts use. Whether installing a new system, moving your dish, or realigning your dish due to wind or frost, the Pico Peaker will save you both time and money. This unit can be used on any receiver system with block down-converted frequencies between 400 and 1450 MHz. It will also eliminate the need for those expensive service calls. The unit includes everything you need—even the cables. A *"must"* for every satellite enthusiast.

900038 Pico Peaker S&H $5 $89.95

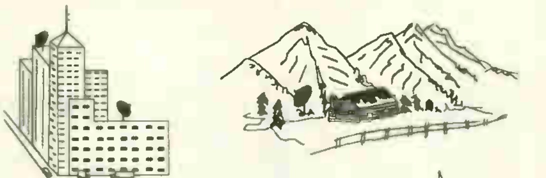
Superjack Actuators

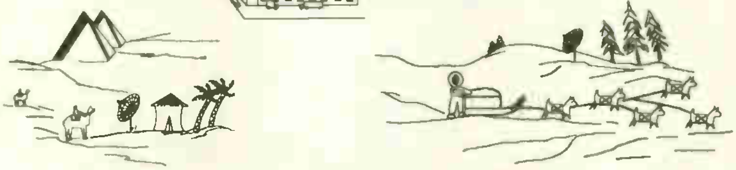
Is your actuator no longer doing its job because of wear and tear? As the hardest working part of your satellite system, the actuator must move your dish from east to west across the entire satellite belt. Each time you change satellites, your actuator sends pulses to the receiver telling the receiver when to stop moving the dish. Most older actuators sent only 10-16 pulses for each inch of travel, which may not be enough to stop the dish at the maximum signal strength. Today's new heavy duty actuators with high resolution reed sensors send 48 pulses per inch of arm travel.So if your old actuator is getting tired, let a new SuperJack insure the finest picture possible.

18" arm	1019018	S&H $15	$ 84
24" arm	1019026	S&H $16	139

Satellite Television

Wherever You Live . . .





. . . at down to earth prices!!!

uniden®

Ultra

The Ultra is Uniden's newest, smallest fully-integrated C/KU receiver ever. This unit includes the ability to control dish movement and is ready for an optional internal program decoder. The Ultra comes preprogrammed for 49 satellite positions and allows you to add satellites as they are launched. Move directly to the satellite by entering the abbreviation from the included infrared remote control. Forty programmable favorite channels can be accessed immediately from your easy chair. Run across something you don't want your kids to see? Just touch a button and eliminate that channel from their access. A complete variety of color menus allow you to control everything from your remote control. The Uniden Ultra is an ideal receiver to get you started in Direct-To-Home Satellite TV.

4527008 Ultra S&H $22 $379.00

The UST 4600 sets a standard in value and performance for home satellite receivers. This unit features automatic satellite programming, 160 favorite channels can be instantly recalled for easy access. All 160 can be changed or updated at any time. This IRD features a stereo processor, enabling you to tune both left and right channels for a full stereo effect from over 100 radio stations found in satellite. The QuikTune feature quickly optimizes the satellite picture for the sharpest image. The 4600 offers other features including IR/UHF remote, 55 satellite position memory and direct satellite access. The versatility makes this an excellent choice.

4527009 UST4600 S&H $22 $499.00

UST 4600

UST 4900

The Uniden UST 4900 is one of the most sophisticated satellite television receiver systems available today. This receiver will open your home to the universe of satellite viewing and is designed to be one of the most user-friendly IRDs available anywhere. Sophisticated microcomputer technology brings in crystal clear audio and video broadcasts with a minimum of user effort. The UST 4900 front display features easy-to-read icons that show you vital information including satellite, channel, polarity, timer status, antenna position and much more. This receiver is capable of storing the positions of the satellites, as well as the tuning details for each channel. The picture-in-picture feature allows you to view two video sources at the same time. You can have it all, including advanced technology and lasting quality, with the UST 4900.

4527010 UST4900 S&H $22 $689.00

All Major Credit Cards Accepted

Skyvision Inc.®

1080 Frontier Drive, Fergus Falls, MN 56537 – Toll Free 800-334-6455

Mail in coupon or call today for the SKYVISION Satellite TV Product Catalog/Buyers Guide Delivered free to your mail box in U.S. and its possessions.

☐ **Send Free Domestic Satellite TV Products Catalog**

☐ **Send International Satellite Catalog** (For Int'l Catalog add $8.00 for S&H)

Name ______________________ **Phone (   )** __________

Address ______________________________________

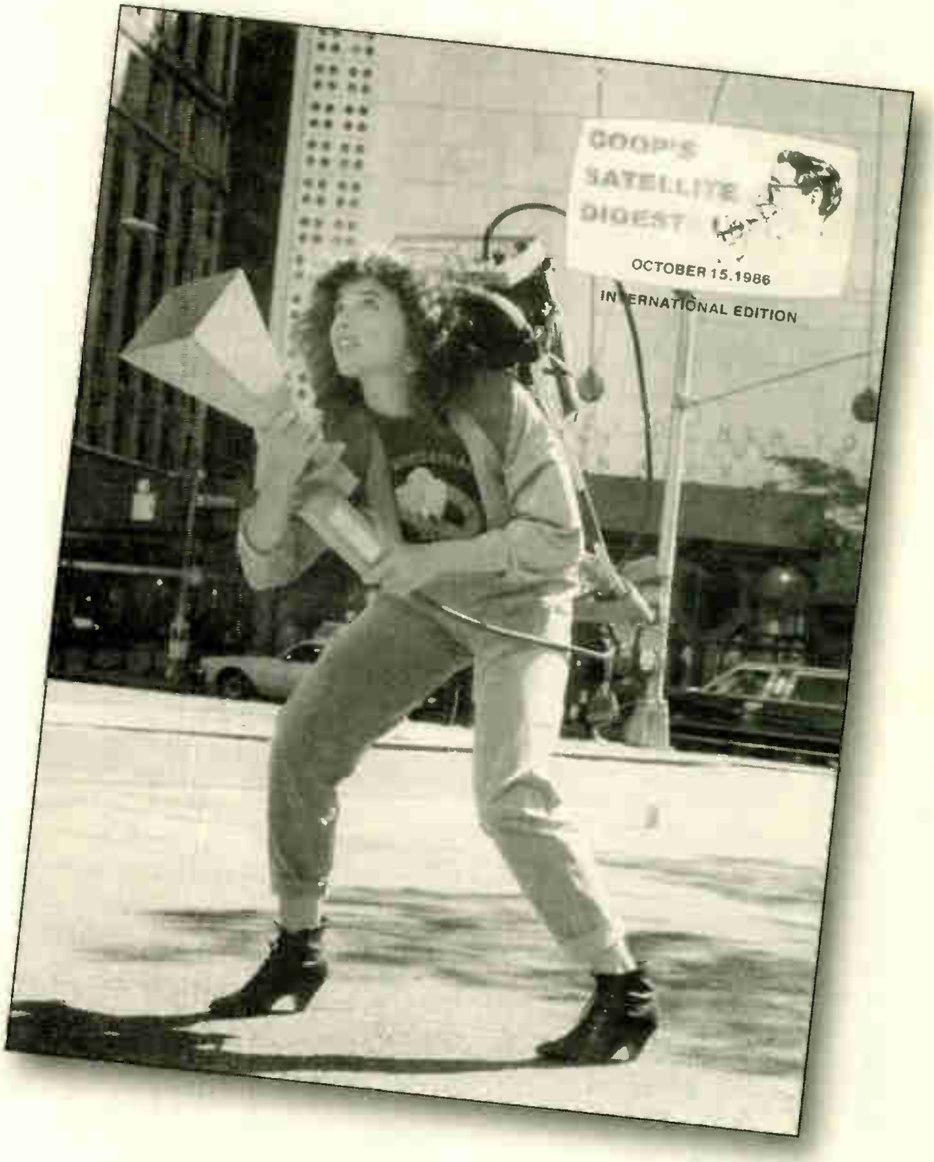
City ____________________ **State** ________ **Zip** __________

Install A System, Upgrade & Repair Yourself And Save $$$$

Call Toll Free 800-334-6455 • International 1-218-739-5231 • Fax 218-739-4879

It's a Wonderful World, Bob Cooper

A brief history of home TVRO



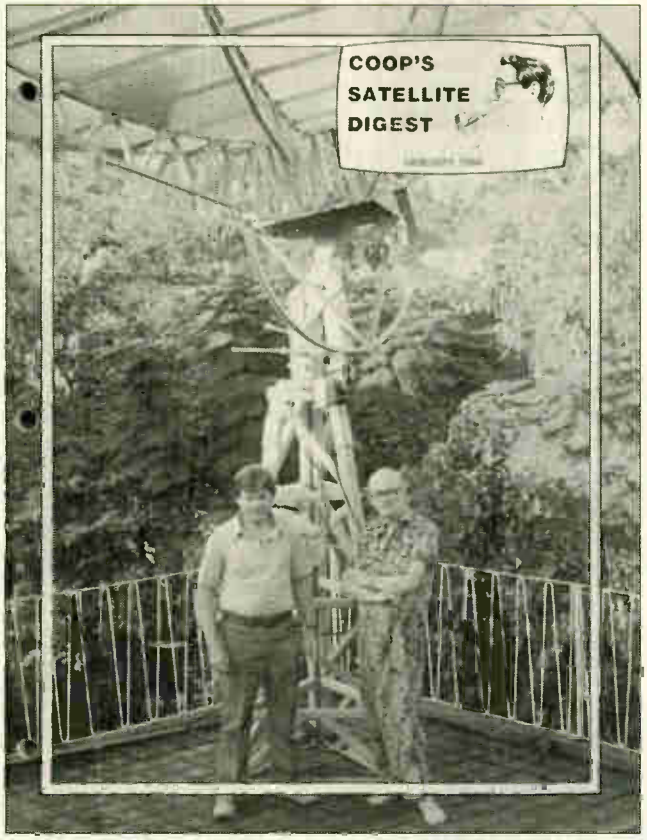
By Tim Olin

The history of satellite communications will hit fifty years of age in 1995. It's had a varied, colorful and interesting history. Satellite communications has changed the way we think, communicate, entertain and do business. There's no way short of a book to cover all the events and people who brought us to this point.

One major part of this history is the saga of home TVRO reception. It's a saga because it has many of the elements: suspense, big money, colorful characters, grand stories of success and sad chronicles of miscalculations. It's a tale of people with vision. There's a refrain in a Grateful Dead song that goes like this: "What a long, strange trip it's been." That could easily refer to the history of home TVRO. What follows is but an overview of that history.

In 1945, the famous science-fiction writer Arthur C. Clark, proposed a way to overcome the problem of unstable, terrestrial television signals. He envisioned an orbiting satellite a hundred miles above the earth that would allow TV signals to be broadcast in a wide area. However, the satellite would take ninety minutes to orbit the earth thus limiting its usefulness because the signal would fade in and out as the satellite would spin past. He went on to point out that a better idea would be to send the satellite into an orbit 22,300 miles above the earth. That way it would take 24-hours to make its way around the earth, the same time as it takes the earth to turn on its axis. Then the signal could be received by a fixed antenna.

Twelve years later, Russia stunned the world with the launch of Sputnik 1. That event kicked off an explosion of activity aimed at launching satellites into space. In 1962, the world's first intercontinental TV broadcast occurred. The broadcast consisted of a picture of the American flag waving over the AT&T earth station in Maine, but it was also seen in England and France. Two years later, the 1964 Olympics were held in Tokyo and they came to American TV sets via Syncom II. Canada was the first country to really begin utilizing satellites on a widespread basis. They began using them for phone service and broadcast communications to reach remote areas where earthbound services wouldn't work.



The father of geostationay satellites, Dr. Arthur Clarke (right) is joined by 1983 TVRO Industry Man of the Year David P. Johnson of Paradigm Manufacturing in this January 1984 cover photo.

Westar 1 Launched

The first multi-use satellite was launched in 1974 for Western Union and was called Westar I. In the fall of 1975, Home Box Office began using Westar 1 to distribute programming to their cable affiliates around the country. Before that time they had to send videotapes to each affiliate which was cumbersome, costly and prevented them from offering live events. Cable subscribers in Mississippi and Florida were the first to benefit from this new technology when the George Frazier-Muhammad Ali prize fight was transmitted live from the Philippines. Fifteen thousand HBO cable subscribers in those two states watched the "Thrilla in Manila" live.

HBO took quite a gamble with this strategy. Cable operators who wanted this service had to fork out as much as $125,000 for an earth station capable of receiving the signal. The FCC required the dish (antenna) to be almost 30-feet in diameter to ensure a good picture for cable viewers. The following year they relaxed the requirement and costs fell like the Black Friday stock market, but a typical cable satellite system still cost $15,000 in the summer of 1977.

Experimenters try Their Hand at TVRO Reception

All of this did not go unnoticed by people outside the cable industry. Steven J. Birkill, an Englishman, began to experiment with receiving the signals only cable operators had been getting. Not far behind were two other men, Bob (Coop) Cooper Jr. and H. Taylor Howard.

Taylor Howard, of later Chaparral feedhorn fame and fortune, was a professor of electrical engineering at Stanford University. He took a surplus military dish and mated it with electronic components that he had to build from scratch. The results of this mating bore fruit on a September day in 1976 when he received his first transmission from the orbiting Westar 1 satellite. A display card read, "Attention All Earth stations." It was from HBO, but of course it wasn't meant for him, it was meant for all those cable operators.

Bob Cooper Jr., was then editor of a cable-TV trade magazine and his first successful reception in September of 1977, came from one of the early Canadian satellites. The signal was received on a 20-foot, 3,000-pound "monster" dish. It was a 30-minute newscast originating from Vancouver, British Columbia. Cooper noted that Rod Wheeler, who lived in the Yukon, had a home system up and running a month or so earlier than his.

The pace of satellite-related broadcast activity began to pick up as did the interest in figuring out how to build home systems to receive it. Interest really started to increase as more and more programming began to appear on the satellites. Three of the early program entries were religious broadcasters. CBN (Christian Broadcast Network) began to beam their signal in the summer of 1977. PTL (remember Jim and Tammy Baker) uplinked their programming in the spring of 1978 as did religious broadcaster, Trinity Broadcasting. Other services available in 1978 included: Showtime, WTBN (now TBS) and sports programming from Madison Square Garden.

Coop Exposes all in TV Guide

In October of 1978, Cooper wrote an article for *TV Guide* revealing that he could pick up *The Tonight Show* as NBC was sending it from Burbank, California to New York for taping and adding of commercials. It was sent entirely uncensored, without commercials, in its raw form. And raw it could be at times. NBC soon stopped using satellite to send Johnny Carson's show back to New York, but Cooper received a ton of mail asking him about this new way of watching television. Later that month, Walter Cronkite and the *CBS Evening News* even did a piece on the advantages of home TVRO reception.

Although NBC stopped sending the *Tonight Show* by satellite there was plenty of other raw feed material that offered interesting viewing for home dish owners. *Monday Night Football* showcased announcer Howard Cossell and his colorful remarks made during commercial breaks (when no one, but dish owners were watching). His comments were rather blunt and provocative to say the least. The same could be said for ABC's Max Robinson, a black anchor on the *ABC Evening News.* Max would be seen waiting on camera in Chicago before the program actually went on the air. Dish owners could watch him get his hair trimmed or listen to his cutting comments made mainly to his white studio assistants. Viewers could also ponder about the glass of tomato juice that was constantly within Robinson's reach. Watching Max had become a minor cult hit with the TVRO crowd and it's said that some bars even offered Max Robinson Bloody Mary specials while patrons peeked in on his news broadcast preparations.

In 1979, Taylor Howard offered a booklet called the *Howard Terminal Manual* which gave many backyard dish wannabes the blueprints to build their own systems. August of 1979 also brought the first public gathering of people who wanted to learn more about this new technology. Bob Cooper conducted the first Satellite Private-Terminal Seminar (SPST) in Oklahoma City, Oklahoma. A group of 505 people showed up, even though Cooper just about didn't. He had to spend a few hours in federal court. At that time, the FCC said it was illegal for anyone to receive private microwave broadcasts without a license. Cooper did happen to have such a license, the day was saved and the seminar did go on. This would not be the last time though that Cooper would have dealings with the U.S. legal system in regard to the home satellite arena.

Two months later, on October 18, 1979, the FCC did away with the license requirement. However, in the eyes of some programmers, the ordinary backyard dish user wasn't supposed to be watching *their* broadcasts. In addition, the Communications Act of 1934 still cast its shadow over the growing homebrew crowd. But that didn't stop those who began to really develop the equipment that would bring down the price of home satellite systems.

Individuals like Robert Coleman, began work on new LNAs or low noise amplifiers (eventually LNAs evolved into LNBs). LNAs were expensive in those early days. One 1977 story stated that RCA ordered two 75-degree Kelvin LNAs for $7,500 apiece. It was difficult to get hold of low temperature LNAs in the early days. The lower the temperature, the more powerful the LNA and the better the reception. Most home TVRO users at that time had 180-degree-and-above LNAs on their systems. The LNA was bi-polar and required two connections, one for the signal and one for power. Today's LNBs use one line and one connection. Dexcel's Art Kawai and Yozo Satoda were at that first Cooper SPST with an LNA for the home market. It didn't do very well, but it plowed ground for Avantek to begin supplying LNAs to the home market. They offered a 120-degree LNA for $795 in lots of 10 back in 1979.

Other Home TVRO Pioneers

Other home TVRO pioneers were Oliver Swan, the man who created the spherical antenna for TVRO and Jim Vines who built the "Paraframe" antenna. He used laminated oak-wood struts mounted to a large ring and aluminum panels to form 12- to 15-foot dishes. Prodelin 10-foot dishes were the first mass produced dish on the market. Soon dish makers appeared from all sorts of places. Hastings Irrigation in Hastings, Nebraska introduced a 12-foot aluminum antenna that came in sections. Price for that dish was $1,395. Huge fiberglass dishes appeared from another irrigation manufacturer in Valley, Nebraska. At one point in time, there were 11 dish manufacturers in Nebraska alone. Randall Odom from Pocahontas, Arkansas was one of the first successful fiberglass dish manufacturers. The first big name company to offer home users not only antennas, but whole systems was Channel Master.

Taylor Howard was working on a feedhorn that didn't cost $200.00 like the commercial versions, and wasn't rectangular. He saw that the feedhorn was the real "antenna" in the TVRO system. It funneled the signals that the dish reflected to a small probe or antenna that is housed inside the feed. The probe then sends the signal to the LNA and from there it travels on to the receiver.

Even though the first satellites had 24-transponders (channels), early on signals were only sent on the horizontal polarization side (12 channels). It was 1978 before anything came up on the vertical polarization. Horizontal and vertical translates into odd and even channel numbers on a system's receiver. Initially, the whole feed system was turned by a television antenna rotor in order to pick up horizontal and vertical signals. Taylor offered a unit with a probe that rotated inside the feed, thus eliminating the cumbersome television rotor. However, his company, Chapparal had to do battle with another feed manufacturer, Boman before it was all over. That in itself is another story.

The cover story on the August 24, 1981 issue of *Newsweek* was *Cable TV, Coming of Age.* It didn't mention anything about home TVRO systems, but it did devote some space to the future of how television could be delivered in the years to come.

> "However the war of the wires turns out, cable will have to contend with a distant, but ominous threat from the same electronic technology that spawned it. Within the decade, it will be possible to beam programs directly from a satellite to the TV set at home. A dozen companies, including CBS, RCA and the Communications Satellite Corp., have applied to the FCC for permission to operate direct-broadcast satellite (DBS) systems."

The article went on to say "DBS does have several disadvantages: it can carry far fewer channels than cable, it lacks the capacity for two-way communications, and the rooftop dish antennas it requires are considerably more expensive than cable boxes." It took three years beyond *Newsweek's* prediction of 1991 for DBS to finally arrive in mass.

Meanwhile, the inventors, the experimenters and the entrepreneurs continued improving TVRO systems. The February 1982 issue of amateur radio's *CQ* magazine featured two ham radio operators putting the finishing touches on a home satellite dish installation. An article inside told about satellite television while a second article in the magazine covered selection of an appropriate site for a dish. There was enough in that article to whet one's appetite, but it was only the forerunner of information more to come. There would soon be an explosion of magazines devoted to TVRO.

Coop's Satellite Digest: The Bible

The TVRO bible was *Coop's Satellite Digest.* It was a wonderful, informative, insightful publication written in Bob Cooper's straight-ahead style. There was always an exotic touch that permeated the *Digest.* For example, in the February 1983 issue we find this statement.

> "Off on a 12 day 'around the world jaunt' starting off with a private TVRO installation for the President of the Philippines, Behar did something perhaps nobody has every done before. By circling the globe, stopping several times to watch television on 6 meter terminals manufactured by his Florida concern, Behar actually saw and recorded television transmissions from each of the world's operating 4 GHz satellites!"

Behar was Bob Behar of Hero Communications. His company made massive 15-22 foot dishes that were being used round the world.

If you have the January/February 1983 issue of *Satellite TV* magazine you would have seen who was selling equipment to the growing home market. Telecom, Vidare, Amplica, KLM, Gillaspie, Kaul-Tronics, Chaparral, Wilson, Jensen, Dexcel, and Earth Terminals were just a few of the many companies who were jumping into the home dish game. Companies came and went as the industry matured. Fortunes were made and lost within a matter of two years. It seemed as if everyone wanted a piece of the action.

The electronics on a home system continued to improve. Motor drives were added to systems so that a dish could be moved from one satellite to another. Receivers were slowly transformed from unreliable boxes that drifted "off tune" to acceptable, semi-reliable boxes. The downconverter used to be outside on the pole the dish sat on and early receivers had little buttons that you had to push to change the polarity from odd to even transponders. Andy Hatfield, Clyde Washburn, John Ramsey, Sat-Tec, KLM, and Anderson Scientific were a few early electronics pioneers that made TVRO systems work better. However, the topic that clouded an otherwise sunny sky was still the one about the legal aspects of the common man watching those signals from the sky that fell in "his backyard."

The November 5th, 1984 issue of *Forbes* magazine talked about the dish "problem" from the standpoint of a new law that President Reagan was expected to sign shortly — HR4103 the cable deregulation bill. The high points of HR4103 were:

> "manufacture, sale and use of earth stations was officially made legal; dish owners must pay for programming; programming pirates were subject to fines and jail time."

Installations for home systems were estimated at 800,000 for the year 1984 and sales of 1.5 million were predicted for 1985.

About the same time, *Popular Science's* December 1984 cover story read, "PS buyer's guide: $1,000 to $4,000, 39 satellite antennas you can buy now." The article for the most part was positive, but one interesting paragraph stood out: "These TV signals are free, but is it legal to tune them in? Yes, says the satellite TV industry. Piracy, say major programmers such as HBO. Bills before Congress may soon resolve the question in favor of the consumer." By the end of the year dish owners were no longer pirates-sort of, because on the horizon was SCRAMBLING!

Who would scramble and what would it mean?

The year 1985 in the home satellite TV world was a tense one. Who would scramble? What would it mean? Would it mean the death of home TVRO systems?

The industry continued to experience growth even though installations didn't hit a million. It was a year that saw Magic Johnson in ads for PenTec TVRO systems, mesh dishes became more popular, Pico brought out their odd shaped 4' x 7' antenna, dishes were becoming smaller, Drake and Panasonic were offering systems, Birdview introduced their elliptical "Spoon" antenna and STS gave the TVRO world a strange looking rectangular, honey-combed, mesh antenna. A cover story for *Sight & Sound* magazine was *Satellite TV: Video's Rising Star.* Other elements from "offshore" landed on the scene from Japan (Uniden and DX) and from Sweden (Luxor). The potential for something really big was there, but the scrambling question was still one that needed an answer.

The scrambling issue spawned a mini-industry around trying to break the system that would encode programming signals. Several issues of *Coop's Digest* featured something on scrambling and the monopoly of the M/A-Com LINKABIT strategy. Coop even began a scramble-fax hotline. M/A-Com, HBO and scrambling were all spoken and came in on the same breath.

When 1986 rolled around the TVRO industry went on the offensive in regard to scrambling. Two personalities stood out in the satellite TV medium. Shaun Kenny's *Boresight* was an open forum used to discuss the problems relating to scrambling. Kenny caused more than one commotion during trade shows with his head-on approach to the evils of the VC2000 decoder.

The other "hot" TVRO show was Keith Lamonica's *FM America*. In the April issue of *Coop's Digest*, Lamonica's followers were described as "bordering on fanatical, not unlike the Iranian death squads dedicated to the Ayatollah." It went on to say, "They have their own bumper sticker: 'What one man can scramble, another man can unscramble.'" The attitude towards scrambling was down right hostile. The September issue of *Coop's Digest* featured a story with the headline, "Oak Orion Broken/ Who's Next?" Every day brought a new rumor about someone that had broke the Videocipher code.

Captain Midnight strikes HBO at midnight!

April 27, 1986 had an event that will be long remembered in the history of satellite TVRO. Captain Midnight struck a little after midnight. The HBO movie, *The Falcon and the Snowman* was interrupted by a message flashed on TV screens around the country that said, "GOODEVENING HBO FROM CAPTAIN MIDNIGHT, $12.95/ MONTH? NO WAY! (SHOWTIME MOVIE CHANNEL BEWARE)."

Needless to say that little act caused quite a stir. It was news that made all the major networks and CNN. Bob Cooper speculated how it was done in the September 1986 issue of *Home Satellite TV*. He felt it wasn't an ordinary "hacker" at all. It had to be someone who was using the "best professional equipment" available. Cooper trotted out a list of other clues that "left a trail as wide as Sherman's advance on Atlanta." It wasn't long before that trail led to John McDoughall. McDoughall was a television engineer who ended up receiving a one-year suspended prison sentence, was fined $5,000 and had his amateur radio license taken away. Thus ended another interesting chapter in the home satellite story.

Illegal chips debut

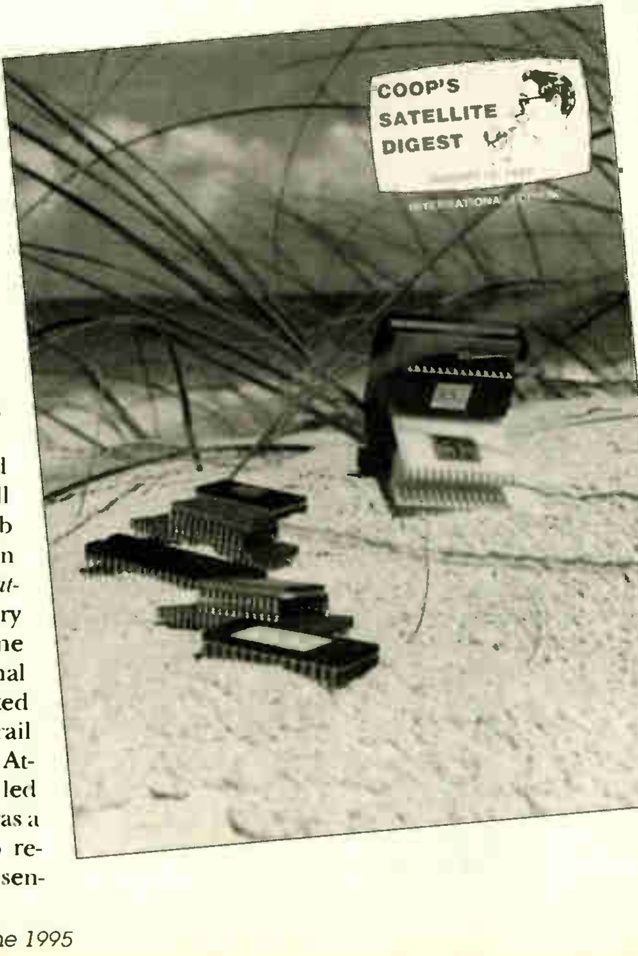
On the January 15, 1987 cover of *Coop's Digest*, was photograph of a "parade" of Videocipher-busting, descrambling chips basking on the beach. These new chips were called the "Musketeer" chips. It was the beginning of big problems for Bob Cooper, Jr. and *Coop's Digest*. The December 4, 1986 episode of *Boresight* invited parties interested in the illegal chips to attend a gathering at Cooper's home in the Turks & Caicos Islands. The purpose was to teach attendees how VCII decoders worked and as part of the $1,500 attendance fee they would receive four computer chips. These chips would enable a person to receive most scrambled signals once they were installed in a Videocipher II decoder.

Three sessions were held in January of 1987 and the first group returned to U.S. soil unmolested, however, the second group didn't fair as well as they encountered Customs agents with a mission. Customs wanted those illegal chips and got several hundred. The third group, including John "Captain Midnight" McDoughall, now aware of the fate of the second group, returned without any of those nasty chips. Shaun Kenny was part of the second group, but held no chips. Several of his videotapes were detained by Customs agents.

Kenny had been banned from the industry's trade show in Las Vegas because of his overt stand on breaking the scrambling code. He outlined a plan to make some money out of all this on his December 4, 1986 *Boresight* show. For $39, Kenny would remove the U-30 chip of a VideoCipher II module and insert a socket, which would allow the easy insertion of a bootleg chip. On his attorney's advice, Kenny quit the socket install business after his trip to Turks and Caicos.

After the second group's encounter with Customs, Coop decided to hold all conferee's chips, notes and videotapes. Then at a later date he would mail them to the attendees. Customs foiled this plan by telling the group that anything entering the U.S. from the Turks and Caicos would be watched with increased scrutiny. On January 29, 1987, Cooper decided not to ship any of the chips as long as Customs had an interest in this matter. This didn't sit too well with some of the attendees. Cooper decided it wasn't a good idea to set foot back on the shores of America and it's reported that he now resides in New Zealand and is working on a book about the satellite industry.

But the momentum towards "Blackbox" fixes to the scrambling issue couldn't be stopped. Scrambling piracy soon became a big business, much to the chagrin of the legitimate TVRO industry. It was feared that home TVRO business would soon die because of the confusion and apprehension surround piracy. Bad press followed the controversy and dish owners were painted as "freeloaders" and "thieves." More problems followed when M/



A-Com sold the Videocipher technology along with various other assets to General Instruments (GI) for $220,000,000. GI set out to make scrambling secure because if they couldn't programmers would be reluctant to continue to lose money to piracy.

General Instruments intensified the fight against illegal reception of signals. They ran ads picturing a policeman loading a handcuffed man into a car. The ad issued this warning: "Sell an illegally modified satellite descrambler and you'll win a free trip. A trip that could last up to 10 years. And cost you $50,000 or more." Unfortunately all this overshadowed a maturing industry. Respected manufacturers like Drake, Panasonic, Uniden and Toshiba continued to offer product that actually worked first time out of the box. Echosphere, Odom, Chaparral, Winegard and others stayed the course.

The headline on the cover story of the October 1991 *TVRO magazine* stated: "Goodbye Mr. Chips." The industry continued to struggle to gain legitimacy by condemning illegal chippers and board "cloners." General Instruments was working hard to provide a secure signal because they knew if they didn't that (unlikely as it seemed) programmers would seek someone who could. But illegal descramblers numbered in the thousands and GI and the FBI pressed charges against suspected illegal satellite operations in Texas, Louisiana as well as other states. The fight for a secure signal was slow going and GI decided to try another route.

General Instruments agreed to upgrade all legal VideoCipher II decoders in 1992. There were questions about GI's ability to produce enough units and about how much it would cost the consumer. Most of the programmers who were using the VideoCipher II signal agreed to terminate its use in 1992. They would switch to a Renewable Security system in hopes that this tactic would work. As GI began to use their new VideoCipher Plus technology, illegal viewing of programming fell dramatically. However, they still left a loophole. The old Videocipher II signal continued to be sent to cable companies that still had their old decoders. Some employees would copy the "seed keys" from one of those decoders and would sell them to someone outside. This "Wizard Code" would then be punched into a modified descrambler and the customer could receive programming for free.

The next step for GI was the introduction of a 44-digit code that changed almost everyday. An article entitled *Satellite Pirates* in the August 1994 issue of *Wired* magazine describes the next countermeasure pirates used: "The VMS subassembly could be mounted on the old VCII boards and could enable a board to receive its 'wizard codes' automatically from a local dealership, by phone." In 1993 US Customs agents raided the headquarters of the VMS innovators. For the most part the piracy era of TVRO has ended. There will always be someone out there trying to break the code, if for no other reason than just for the challenge of it. A pirate, quoted in the *Wired* article put it this way: "Among the end users, there's maybe 10 percent who are die-hards and won't go legal no matter what."

Now we have DirecTv, Primestar, USSB, digital technology, the 18" dish, and on the horizon, interactive television. Somehow it won't ever be the same. It's big, big business and in some ways just isn't quite as fun as it used to be. But without many of those pioneers it wouldn't have happened at all. In passing, some of you may recognize some names of people, companies, publications and events that were not mentioned above, but were important to that "Long, strange trip." There isn't room enough to name them all, but here are a few:

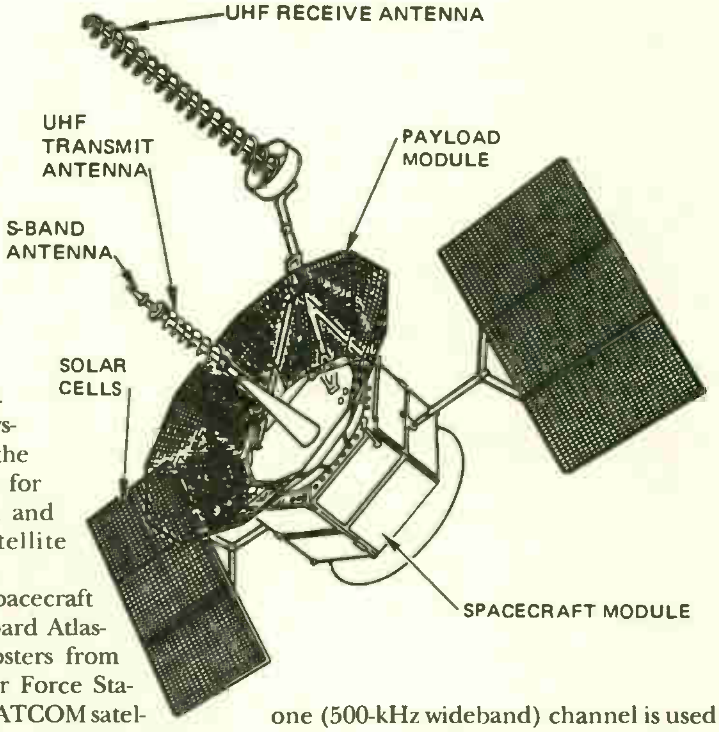
Hayden McCullough; Bob Luly: Intersat; Jamie Gowen: National Microtech: Satfinder; SPACE; Amplica; Arunta; STS; Norm Gillaspie; LOCOM; David Brough; AVCOM; Ted Turner; The Bell Ranch in New Mexico (home of the first TVRO system at a cost of $22,000); Richard Campbell; Paraclipse; Peter Sutro; Titan Satellite Systems Corp; Cal Amp; Cincinnati Microwave; Automation Techniques; Houston Tracker; Satellite Business; Satellite Today; Satellite Dish Magazine; TV Satellite Videoworld Magazine; Satellite TV Opportunities; Signals from Space; and on and on...

Fleet Satellite Communications

Service to the Fleet

"I take great pleasure in inaugurating...the first satellite of the fleet satellite communications system. The gap is filled."

—Navy message from Admiral James L. Holloway
Chief of Navy Operations, 1978



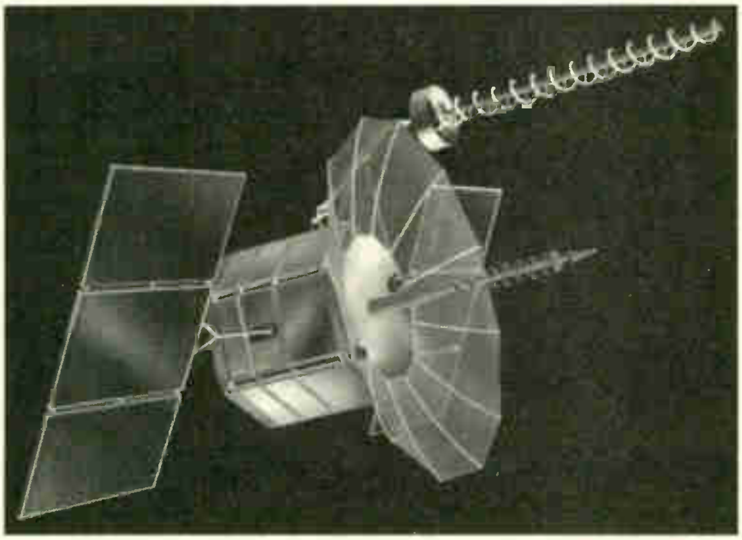
By Larry Van Horn

The above Navy message sent by Admiral James L. Holloway III, then Chief of Naval Operations in 1978, heralded the first day of operation for the Navy's Fleet Satellite Communications (FLTSATCOM) system.

The FLTSATCOM system provides ultra high frequency (UHF) communications for U.S. armed forces around the world. The on-orbit portion of the system, the TRW-built FLTSATCOM spacecraft, was designed to communicate with small, inexpensive terminals used by troops in the field and aboard mobile platforms such as aircraft, ships, and submarines.

The U.S. Navy manages the overall program. The U.S. Air Force Space Systems Division was the contracting agency for the space segment and TRW was the satellite prime contractor.

FLTSATCOM spacecraft were launched aboard Atlas-Centaur space boosters from Cape Canaveral Air Force Station, Fla. The FLTSATCOM satellites are three-axis, body stabilized spacecraft that operate in geosynchronous orbit 35,680 km (22,300 miles) above the Earth. A minimum of three are required in orbit to provide global coverage. FLTSATCOM's 23 channels carry a large volume of UHF communications. Twelve of the UHF channels (5-kHz bandwidth) are used by the U.S. Air Force (part of the AFSATCOM or Air Force Satellite Communications system), one (500-kHz wideband) channel is used by the National Command Authority, and the remaining ten (25-kHz fleet relay and fleet broadcast) channels are used by the fleet. These satellites are hardened against the effects of radiation to improve the system's survivability and its continued high performance during times of critical use.



A total of eight FLTSATCOM satellites were built and launched. Two were lost as a result of launch-related accidents. Four are now operating in-orbit. Flights 1 through 6 are virtually identical. Flights 7 and 8 carry an experimental extremely high frequency (EHF) package being used as a test bed for terminals being developed for future generation communications systems such as Milstar. This package, furnished by the government, is housed in a 14-inch extension module on the aft portion of the satellite.

The EHF package, built by the MIT Lincoln Laboratories, operates on 20 watts of power with an uplink at 40 GHz and a downlink at 20 GHz to accommodate low and high rate frequency hopping.

The FLTSATCOM satellite, weighing an estimated 1,860 kg (4,092 lb) at launch, is considerably larger and heavier than the Gapfiller satellite (See March-April 95 *ST*- "And the Gap was Filled"). It consists of two major parts: a payload module that includes the antennas, and a spacecraft module with a solar array. The payload module contains the UHF, SHF, and S-band communications equipment antennas. The communications equipment is mounted internally on side panels that cover this section of the spacecraft. The spacecraft module contains nearly all other subsystem equipment, including the earth sensors, attitude and velocity control, telemetry, tracking and command, and the electrical power distribution. The spacecraft is stabilized on three axes, and the body-fixed antennas are kept pointed at the center of the Earth. The solar array is kept pointed at the sun by a clocked drive.

TABLE 1

FLTSATCOM Frequency Plan Downlinks (all frequencies in MHz)

	Alpha	Bravo	Charlie
Channel 1:Fleet Broadcast			
	250.450	250.550	250.650
Channel 2: 500 kHz wideband			
	260.350-260.850	262.450-261.950	262.050-262.550
Channels 3-11: Navy relay channels			
ch.3	251.950	252.050	252.150
ch.4	253.650	253.750	253.850
ch.5	255.350	255.450	255.550
ch.6	256.950	257.050	257.150
ch.7	258.450	258.550	258.650
ch.8	265.350	265.450	265.550
ch.9	266.850	266.950	267.050
ch.10	268.250	268.350	268.450
ch.11	269.750	269.850	269.950
Channels 12-23: AFSATCOM narrow band channels			
ch.12	243.945	244.045	244.145
ch.13	243.955	244.055	244.155
ch.14	243.960	244.060	244.160
ch.15	243.965	244.065	244.165
ch.16	243.970	244.070	244.170
ch.17	243.975	244.075	244.175
ch.18	243.980	244.080	244.180
ch.19	243.985	244.085	244.185
ch.20	243.990	244.090	244.190
ch.21	243.995	244.095	244.195
ch.22	244.000	244.100	244.200
ch.23	244.010	244.110	244.210

TABLE 2: FLTSATCOM Spacecraft

Satellit Designator/ Status	Intl Desig	Launch Date	Orbital Location	Frequency Plan
F1/Atlantic relay (res.)	1978-16A	Feb 9, 1978	14.5 deg West	Alpha
F2/Inactive	1979-38A	May 4, 1979	-----	Retired from service
F3/Inactive	1980-04A	Jan 17, 1980	-----	Retired from service
F4/Pacific W. (reserve)	1980-87A	Oct 30, 1980	172 deg East	Bravo
F5/Inoperative*	1981-73A	Aug 6, 1981	-----	Launch failure
F6/Destroyed	-----	Mar 26, 1987	Satellite lost, booster failure	
F7/CONUS (primary)	1986-96A	Dec 4, 1986	100 deg West	Bravo
F8/Atlantic (primary)	1989-77A	Sep 25, 1989	23.1 deg West	Charlie

* Satellite inoperative. The Atlas Centaur nose cone shroud collapsed during launch destroying the primary antenna.

Communications Subsystem

Each FLTSATCOM satellite has the capability to relay communications on 23 separate RF channels. Each of the 23 RF channels has three different frequency plans in which the uplink or downlink may be transmitted. This capability precludes interference at points in which earth satellite coverage overlaps the coverage of the adjacent satellite. Six operational FLTSATCOM satellites currently in near-equatorial orbit are located near 100 degrees West, 23 degrees West, 172 degrees East, and 72 degrees East.

The 25-kHz UHF downlink channels have a separate transmitter for each channel. Channel one, used in primary mode for Fleet Broadcast transmissions, incorporates signal processing within the satellite; the SHF uplink RF signal is translated to UHF for downlink transmission.

Electrical Power Subsystem

Primary electrical power for the spacecraft is provided by a solar array mounted on the wings that extend from the spacecraft module. These solar array wings contains 22,920 solar cells, with an estimated power capacity of 1,435 watts after five years of use. Additionally, the power subsystem includes three nickel-cadmium batteries. Each battery consists of 24 sealed nickel-cadmium 24-ampere-hour cells connected so as to deliver 20 volts even with two cells failed in each battery.

Four antennas are mounted on the payload module. A .48 m (16-foot) paraboloid UHF transmit antenna consists of an 203 cm (80-inch) solid core center section of honeycomb with twelve deployable ribs supporting a silver-filled stainless steel mesh. The UHF receive antenna is an 18-turn helical that uses spring-loaded hinges for deployment of the aluminum ribbon helix and its carbon graphite structure. An SHF horn antenna is mounted on the spacecraft body and looks through a square hole in the paraboloid mesh of the UHF antenna. The hole is covered with a coarse mesh that is transparent at SHF and reflective at UHF. The tracking, telemetry, and command S-band antenna is a log conical spiral mounted on the end of the UHF transmit antenna mast. This antenna functions on 2202.5, 2252.5 and 2262.5 MHz.

Table 1 is a complete rundown of the frequencies, broken down by frequency plans, used by the FLTSATCOM spacecraft. Table 2 gives the current location and operational status of each of the eight FLTSATCOM satellites. Reports on active military satellite frequencies are welcomed.

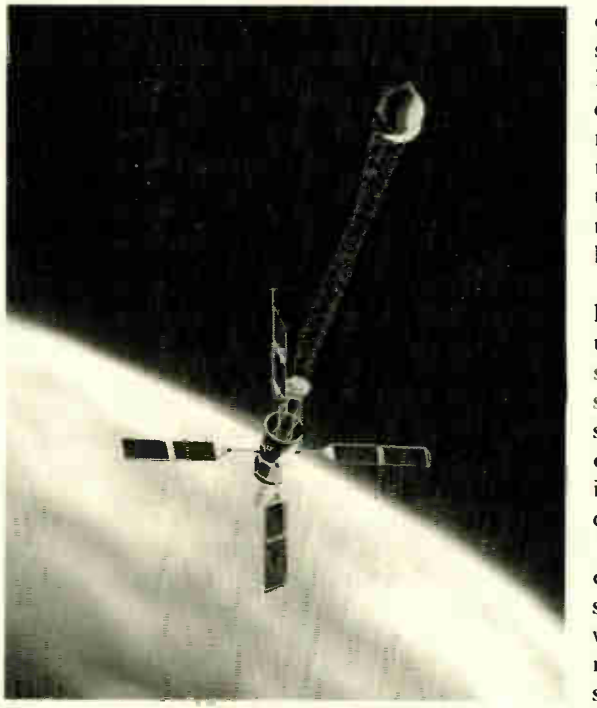
This is the second of a four part series in *ST* on the various UHF military satellite systems currently in operation. In the next issue of *ST* (July/August 1995), we will take an in-depth look at the third generation of UHF satellites — LEASAT. ST

Larry Van Horn is the Managing Editor of Satellite Times and a military consultant/columnist for both Monitoring Times/Satellite Times magazine.

THE SATELLITE SLEUTH

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

Monitoring the 'Pioneers' (Navsats)

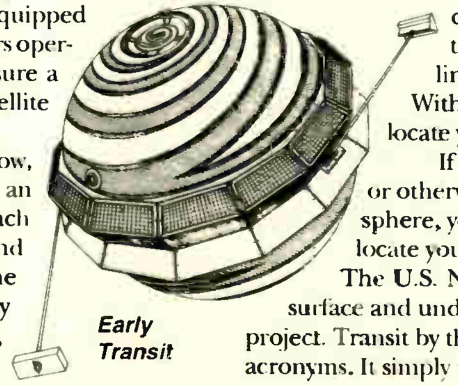


Artist's conception of Nova satellite.

The Transit series of spacecraft offer many varied challenges and rewards for those who choose to monitor these satellite transmissions. The Transit series is a navigational satellite, a real pioneer in the history of the space programs of both the U.S. and Russia.

With the first successful launches of artificial satellites, the military began taking note of this new technology. When they asked the scientists what these new-fanged satellites could do, one of the first responses was that they could provide a very accurate system for navigation on the surface of the Earth, on its oceans and in the air. At the time, Polaris submarines with the ability to launch IRBM (intermediate range ballistic missiles, later called SLBMs or submarine launched ballistic missiles) from relative safety submerged somewhere in an ocean, desperately needed a quick way to pinpoint their location prior to firing those missiles. Low frequency radio fixes and long range navigation (LORAN) were not reliable enough for the task. The Polaris missiles used an accurate inertial navigation system, but an accurate starting point was required. By the time the first Polaris SLBM was launched from the submerged USS George Washington in 1960, a workable system was underway.

It became obvious to even a casual listener of the first artificial satellites that the apparent change in frequency of radio signals transmitted from satellites (the Doppler effect), would allow a simple system of navigation to be employed using a series (or constellation) of such satellites. Such a system could consist of six satellites circling the Earth in polar orbit at an altitude of 900-1000 km (about 558-620 miles) and with an orbital period of about 108 minutes. These satellites would be equipped with extremely accurate and stable transmitters operated in two different frequency bands to insure a usable signal anywhere within range of the satellite regardless of atmospheric conditions.



Early Transit

Regular listeners of ImHoTep satellites know, transmitter frequencies can change during an orbit and sometimes fluctuate wildly twice each revolution of the Earth when they enter and leave solar eclipse. To determine accurately the relative motion of a satellite toward or away from you by monitoring the received frequency, you must know the actual transmitted frequency (to determine the Doppler shift). This could be done by the satellite telling you about any frequency changes (a very difficult and expensive method), or simply by locking down the frequency of the satellite transmitters so that they are ultra stable and then doing your calculations from those known values.

The U.S. Navy chose the Johns Hopkins University to build a system using the later means. A Dewar flask (a specially constructed temperature resistant container) was included on the spacecraft to keep the two ultra-stable oscillators at a constant temperature insuring a consistent transmitted frequency.

The second thing you need to know, once you know the Doppler shift of a satellite's transmitter, is just exactly where the satellite is at the time you are receiving it. Orbital mechanics for a spacecraft in a 1,000 km (about 620 miles) circular orbit around the Earth is a fairly simple and straightforward thing. The orbit is small enough not to be moved around very much by solar pressure and high enough not to encounter any significant air resistance. A satellite's location can be reasonably predicted 24-hours in advance. If the satellite is told every 12-hours exactly where it will be for the next 12-hours (this is called "uploading an Ephemeris"), it can pass along an extremely accurate location for itself over the Earth's surface with every transmission. (Transit's data was stored in magnetic core memory.)

Now if a satellite tells you exactly where it is and you measure its received frequency difference from its transmitted frequency (Doppler shift) you can immediately know your location along a line related to the satellites' ground track (also called the SSP or subsatellite point). Triangulation with another satellite will produce another line and where the two cross — there you are! With everything working right you could expect to locate yourself to within 60 meters (about 198 feet).

If you are not a member of the Flat Earth Society or otherwise have reason to believe you are living on a sphere, you may, with aid of some fancy mathematics, locate yourself in three dimensions.

The U.S. Navy had the more urgent need to locate its surface and undersea fleet, so it took the lead for the Transit project. Transit by the way is not one of the military's' ubiquitous acronyms. It simply refers to a surveyor's transit.

Transmitter frequencies can change during an orbit and sometimes fluctuate wildly twice each revolution of the Earth when they enter and leave solar eclipse. To determine accurately the relative motion of a satellite toward or away from you by monitoring the received frequency, you must know the actual transmitted frequency.

Table 1 - Transit Series Spacecraft

International Designator	Common Names	Catalog Number	Launch Date
1960 Gamma 2	Transit 1B	31	13 Apr 60
1960 Eta 1	Transit 2A	45	22 Jun 60
1961 Eta 1	Transit 3B	87	22 Feb 61
1961 Omicron 1	Transit 4A	116	29 Jun 61
1961 Alpha Eta 1	Transit 4B	202	15 Nov 61
1962 Beta Psi 1	Transit 5A	509	19 Dec 62
1963 022A	Transit 5A3 Transit 7	594	16 Jun 63
1963 038B	Transit 5B1	670	28 Sep 63
1963 049B	Transit 5B2	704	05 Dec 63
1964 026A	Transit 9	801	04 Jun 64
1964 063B	Transit 5B4	897	06 Oct 64
1964 083D	Transit 5B5	965	13 Dec 64
1965 048A	Transit 5B6 NNSS30040	1420	24 Jun 65
1965 065F	Transit 5B7	1514	13 Aug 65
1965 109A	Transit 10 NNSS30060	1864	22 Dec 65
1966 005A	Transit 11 NNSS30070	1952	28 Jan 66
1966 024A	Transit 12 NNSS30080	2119	26 Mar 66
1966 041A	Transit 13 NNSS30090	2176	19 May 66
1966 076A	Transit 14 NNSS30100	2401	18 Aug 66
1967 034A	Transit 15 NNSS30120	2754	14 Apr 67
1967 048A	Transit 16 NNSS30130	2807	18 May 67
1967 092A	Transit 17 NNSS30140	2965	25 Sep 67
1968 012A	Transit 18 NNSS30180	3133	02 Mar 68
1970 067A	Transit 19 NNSS30190	4507	27 Aug 70
1973 081A	Transit 20 NNSS30200 Oscar 20	6909	30 Oct 73
1977 106A	Transit nn NNSS30110	10457	28 Oct 77
1985 066A	Transit 29 NNSS30300 Oscar 24	15935	03 Aug 85
1985 066B	Transit 30 NNSS30240 Oscar 25	15936	03 Aug 85
1987 080A	Transit 21 NNSS30270 Oscar 27	18361	16 Sep 87
1987 080B	Transit 22 NNSS30290 Oscar 29	18362	16 Sep 87
1988 033A	Transit 23 NNSS30230 Oscar 23	19070	26 Apr 88
1988 033B	Transit 24 NNSS30320 Oscar 32	19071	26 Apr 88
1988 074A	Transit 25 NNSS30250 Oscar 25	19419	25 Aug 88
1988 074B	Transit 26 NNSS30130 Oscar 31	19420	25 Aug 88

The first Transit was launched September 17, 1959, but didn't make it into orbit when the upper stage failed to function properly. The second one fared a little better and on April 13, 1960, it did get into a orbit, although not the one desired, of 748 x 373 km (about 464 x 231 miles), inclined 51.3 degrees with a period of about 96 minutes. Early Transit missions were launched from Cape Canaveral, Fla. into low inclination orbits. Later, the operational series satellites were launched into polar orbits from Vandenberg Air Force Base, Calif.

Single Payloads

The announced mission for Transit 1B (International Designator: 1960 Gamma 2, Catalog Number: 31) launched April 13, 1960 was:

- To develop a basis for navigational trials and demonstrations of the Transit concept in elementary form.
- To gain an improved understanding of the effects of ionospheric refraction of radio waves.
- To achieve an increased accuracy in geodetic measurements.
- To obtain improved orbital tracking.

The first of these experimental navigation satellites were spheres about .9 meter (2.97 feet) in diameter with a strip of solar cells around the middle. On the Earth they weighed about 100 kg (220 lb) each. Later versions were an octagonal cylinder a quarter meter by a half meter (and weighing about 50-60 kg (110-132 lb).

The electronics on board consisted of two ultra-stable transmitters (one operated on 54 and 324 MHz, the other on 162 and 216 MHz). The latter transmitter provided more precise data for the study on refraction effects of the ionosphere. This satellite also carried two receivers and two telemetry systems for gathering and sending spacecraft "housekeeping" data.

Broad band logarithmic, spiral stripes of silver painted on outside of the shell served as the antennas. In addition to the transmitters used for navigation studies, Transit 1B also carried a telemetry transmitter which operated on 108.03 MHz. It was used to send back data from a sensor that measured the Earth's albedo in the infrared and other scientific instrumentation information. The main navigation transmitters transmitted on two frequencies at 1 minute intervals. Power was provided primarily by internal batteries and was supplemented by the solar cells. One set of oscillators (54 and 324 MHz) was powered by the solar cells while the other set of oscillators (162 and 216 MHz) was powered by nickel/cadmium batteries.

Transit 1B finally reentered after orbiting the Earth for 2731 days (nearly 6 1/2 years).

Expected satellite lifetime of the early Transits was intended to be about 3 months, but transmissions from one of the early flights have been monitored as late as early 1995 on at least one of the fore mentioned frequencies.

Multiple payloads

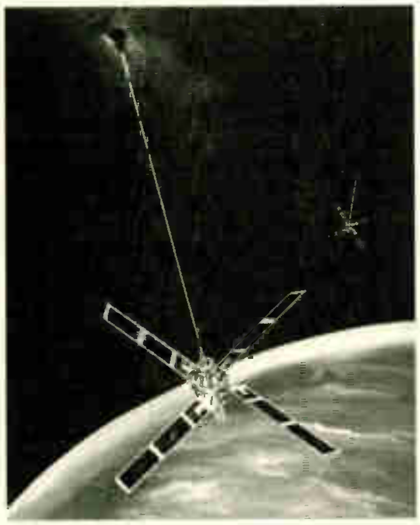
Transit 4A (International Designator: 1961 Omicron 001, Catalog Number: 116) was an interesting mission for several reasons. It was the first triple payload launch ever attempted and was successful in achieving orbit, except that the Injun (a DoD radiation research satellite) and Greb 3 satellites failed to separate. Another satellite payload on this launch, SolRad 3 (DoD solar radiation satellite), did separate.

That mission also marked the first use of a SNAP-3 nuclear reactor in space. That small nuclear package caused part of widespread hysteria when the press began calling them "atomic bombs in orbit". The SNAP-3 reactor carried just 2 kg (4.4 lb) of Plutonium-238 and produced electricity from the heat created by the natural decay of a radioactive isotope.

When Transit 5BN3 was launched on April 22, 1964 and failed to orbit, the spacecraft and its Radioisotope Thermoelectric Generator (RTG) reentered the atmosphere. The public outcry over the RTG and its fuel put a chill on the Transit program and the subsequent Transit 5C series would be launched with solar cells and no SNAP RTGs.

Several other satellites would be launched along with these Transit missions. These satellites provides monitors with signals from platforms in the same orbits as the Transits. In addition to the previously mentioned Injun, Greb and SolRad payloads, there was the low frequency trans-ionospheric satellite (Lofti), SunRay, calibration spheres (Calspheres), and the Navy space surveillance rod (NavSpaSur Rod).

Now if a satellite tells you exactly where it is and you measure its received frequency difference from its transmitted frequency (Doppler shift) you can immediately know your location along a line related to the satellites' ground track (also called the SSP or subsatellite point). Triangulation with another satellite will produce another line and where the two cross —there you are!



OSCAR-class transit satellites.

Another interesting point regarding this mission was the explosion of the Transit 4A upperstage. It occurred shortly afterr placing its payloads in orbit. This was common occurrence for many years as the unused fuel and oxidizer would quickly freeze in the tanks and tubing and uneven heating would cause a leak and/or explosion which would rip apart the relatively large final booster stage. This explosion created approximately 298 debris objects were tracked in orbit. Their international designtators are 1961 Omicron 3 to Omicron 301. Approximately 81 fragments were blown in a "retro" direction and have since come down.

Information about the launches of Transit satellites and their piggyback subsatellites were classified by the Department of Defense beginning in 1963. The program was sometimes refered to by the name Oscar (as in a proper name, not the acronym OSCAR as used by the ham satellite series).

The Transit program proved the usefulness of satellites as extremely accurate navigation aids for ships in particular. It soon became the primary tool by merchant shipping fleets replacing the LORAN system. Transit became operational in 1964. It was followed by similar satellites using such names as the Navy Navigation Satellite System (NNSS), the Transit Improvement Program (TIP), the U.S. NAVSTAR global positioning system (GPS)., and the Global Navigation Satellite System (GLONASS) launched by Russia.

Timation/TRIAD Series

A series of U.S. Navy navigational spacecraft, the Timation (Time Navigation) program, followed the Transit satellites and preceded the NAVSTAR satellites. Along with the TRIAD navigational satellites, Timation was integrated into the GPS, with Timation 3 also designated as Navigation Technology Satellite 1 (NTS-1). Multiple spacecraft were placed in orbit during at least two Timation launches. TIP 1 (aka TRIAD 1 and TRIAD OI-1X, International Designator: 1972 069A, Catalog Number: 6173) was the first TIP satellite and it carried an RTG.

Table 2 — Timation Series Spacecraft

International Designator	Common Names	Catalog Number	Launch Date
1967 053F	Timation 1	2872	31 May 67
1969 082B	Timation 2	4256	30 Sep 69
1974 054A	Timation 3 NTS 1	7369	14 Jul 74

Table 3 — TIP/TRIAD Series Spacecraft

International Designator	Common Names	Catalog Number	Launch Date
1972 069A	TIP 1 TRIAD 1 OI-1X	6173	02 Sep 72
1976 089A	TIP 2	9403	01 Sep 76

The NAVSTAR/GPS

NAVSTAR, short for navigation system using time and ranging, is the satellite portion of the U.S. Department of Defense global positioning system. This is the current U.S. operational satellite navigation system.

The former Soviet Union has also launched several series of navigation satellites, both civilian and military. Their current navigation satellite series GLONASS, is quite similar to the U.S. GPS system and many receivers are being made to receive data from both.

ST reader, John Franke from Yorktown, Va, has been actively monitoring the Russian navigation spacecraft. In recent correspondance, he mentioned his listening activities and also noted that he is working on constructing a unit to receive and decode the Russian civilian navigation satellites. As updates become available, I'll pass along the details to those of you interested in trying your hand at such a project. That's it for this issue. Keep listening out there and let me know what you hear. ST

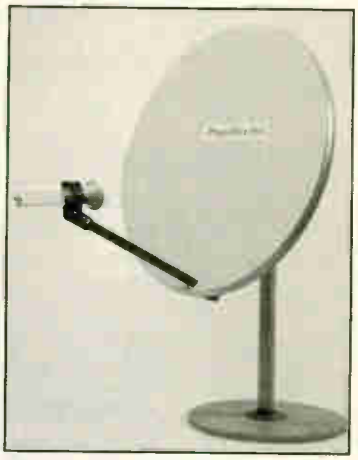
Table 4 — Transit Series Frequencies

54.0 Mhz	Navigation (Early)	A-pair
162.0 MHz	Navigation (Early)	B-pair
216.0 MHz	Navigation (Early)	B-pair
324.0 MHz	Navigation (Early)	A-pair
108.03 MHz	Telemetry (Early)	
136.655 Mhz	Scientific Data Channel (Early)	
136.800 MHz	Scientific Data Channel (Early)	
150.0 MHz	Navigation (operational)	
400.0 MHz	Navigation (operational)	

SNAP (an acronym for Systems for Nuclear Auxiliary Power) is a U.S. research program to develop small nuclear sources to power scientific equipment. This scientific equipment could be destined for use in remote areas on Earth or on other planets. SNAP packages were used on some Earth-orbiting satellites and space probes operating too far from the Sun to use solar cells for power. The Atomic Energy Commission started the SNAP program in the 1960s (the program is now part of the Department of Energy).

SNAP units used in space are encased in containers that can survive reentry or a launch disaster. SNAP units were used in the Nimbus and Transit satellite programs.

145 10FE95 11E-4MB 4593 46631 ECO
RECEIVED ON
10.862
RWC1/
RTC1
$24.95
Order Yours
today
RTB1
$49.95
Easy to use
Software Included

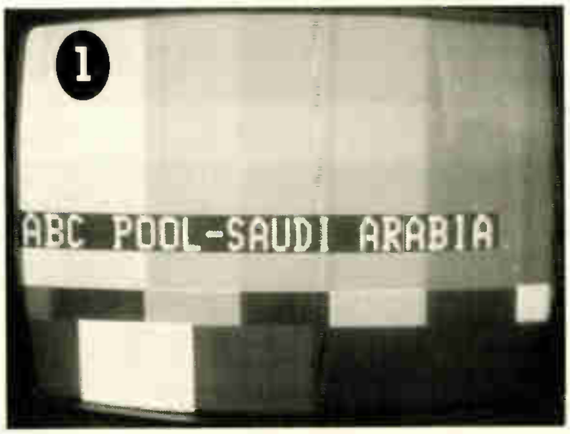


DOMESTIC TVRO

By Ken Reitz
KC4GQA

Create Your Own TVRO Photo Gallery

For the past fifteen years, satellite TV enthusiasts have enjoyed a privileged view of American broadcast television. Scanning the Clarke Belt for "wild feeds" and "backhauls", TVRO hobbyists have seen it all. Satellite TV viewing has quickly became the video equivalent of shortwave listening or monitoring the public service radio bands for some enthusiast.



The bulk of today's TVRO viewers only seem interested in entertainment programming. They bought their TVRO systems to enjoy the American right of a nightly entertainment feast, and you would be amazed at how many satellite dishes only travel between the popular cable birds and nothing else.

There are, however, dozens of C- and Ku-band channels which present an inside glimpse of news and sports and it doesn't take much to find them. Check out the C-band video gride on pages 46-47 in this issue's Satellite Services Guide. Look for those transponders marked 'o/v' or occasional video. This is the target you are looking for to watch some great behind the scenes wild feeds.

Shortwave radio listeners have extended their enjoyment of their hobby far past the listening stage and even go as far as to document their recepetion for historical purposes and enjoyment. They prepare a detailed report of reception that is sent to the shortwave station in the hopes of getting that station verified (a card or letter from the station to the listener confirming that listeners reception). TVRO viewers can create their own verification of reception by simply taking pictures of what they see.

Lights, Camera, Action!

There's no special training needed to take good pictures of your TV screen, but a few tips will help insure your photos come out right the first time. I use normal color film in my camera, usually ASA 200 and a typical roll of film has the usual birthdays, relatives and pet shots along with various shots of the TV screen. I'm sure the film developers get a kick out of seeing these shots come through the machine! The point is that you don't need a separate camera with special film to get some great satellite TV shots. As you surf the Clarke Belt and come across an interesting test patterns, color bars, billboards or wild feeds, grab your camera and take pictures of what you see.

If you have one of the newer automatic shutter cameras, put it into the manual mode and set the shutter speed to 1/60th of a second. This allows the camera shutter speed to sync with the frame speed of the TV screen. A faster speed will show a dark band through the center of the printed picture.

It's best to use a tripod with your camera because 1/60th of a second is a slow shutter speed. Any movement of the camera at this speed will blur the picture. I don't have a tripod, but I have improvised on using the back of a chair or a stack of books on the seat of a chair. Anything will do as long as the camera remains still during the shutter release.

Probably the most difficult thing to do is center the screen in the camera frame. As you look through your camera's viewfinder make sure there is a good bit of border around the screen. If you take the picture too close to the screen a good bit of the top or bottom may be chopped off. I'm always amazed at how much of a picture visible on the negative doesn't show up in the processed prints. To be on the safe side, allow plenty of border around the screen.

Douse Those Lights!

When I take screen pictures I always shut off all the lights and during the daytime, close the curtains. Since the TV screen is putting out plenty of light, there's no need for other external light sources. **Do not use your flash attachment**. Turn off table lamps and overhead room lights as their light may show up as reflections on the screen. Sunlight pouring in from a window may wash out the screen or cause the camera to get a faulty light reading. Use your camera's light meter and follow the directions in your camera's manual on how to use your light meter. It may take some practice before you get perfect pictures.

And, finally, be sure the camera is focused. When you take pictures of ID slides there will usually be a certain amount of lettering on the screen and you should focus on that lettering. If there is only a picture image, focus on the center of the screen. Another caution is sometimes when watching a backhaul or wild feed, the TV cameraman will be adjusting the focus. Be sure to wait until he gets done to do your focusing. Try shooting a static image. At 1/60th of a second any movement on-screen will show up as a blur on your photo.

There are dozens of C- and Ku-band channels which present an inside glimpse of news and sports and it doesn't take much to find them. Check out the C-band video gride on pages 46-47 in this issue's Satellite Services Guide. Look for those transponders marked 'o/v' or occasional video. This is the target you are looking for to watch some great behind the scenes wild feeds.

A Clarke Belt Photo Tour

I've assembled a number of photos for this article which represent various aspects of photographing your satellite TV screen. Here is a brief photo tour to illustrate what can be seen and photographed from the Clarke Belt satellites:

1) This is the typical color bars test pattern. The ID shows that it was ABC network's uplink from Saudi Arabia during the Gulf War in 1992. Whenever there's an event of international significance you can be sure that there will be more than a few channels from various sources standing by to backhaul footage of the event to the various networks. During events such as national elections or Olympics, there will be a flurry of activity from a host of international sources. Don't forget to check both C- and Ku-bands for such feeds.

2) Another set of color bars heralds the arrival of a new channel. This time it's Sports Channel Bay Area (now Sports Channel Pacific on Satcom C1 at 137 degrees west). Note that when this channel premiered, it was carried on Westar 5, long since out of service.

3) Caribbean Super Station was a great idea for a channel which tried several times to make a go of it, but never found the financial support. Transmitting a mix of live bands playing Afro-Carib music and old Kung-Fu movies this channel come and went three times in the last eight years. Note that the top of the screen is chopped off: Not enough border!

4) The Shipboard Satellite Network was a very short-lived project from the late 80's. The idea was to retransmit network news and regular programming to cruise ships at sea via Spacenet 2. SSN broadcast only late night for a few hours and the service only lasted about six months never to return again.

5) A French TV football commentator keeps warm while awaiting the start of a sports feed via Europe's Telecom 1C. These feeds are great places to see sports and news celebrities "off camera" just being themselves. I remember seeing Peter Jennings once during a U.S. election returns broadcast with his feet up on the desk, cradling a phone against his shoulder and speaking to someone on the other end in French.

(Photos 1-4 provided by Ken Reitz. Photo 5 is by John Locker.)

The Videotape Alternative

The proliferation of video cassette recorders has given this video photography idea a new twist. It's always a good idea to have a "working" video tape near your VCR when you're scanning the skies. If something interesting comes up hit the record button and let the tape roll. It's best to be recording on the fastest speed possible in order to get a high resolution tape. This way, if there is something worth photographing you can run and re-run the tape until you get just the right shot. Doing a "freeze" frame photo is not as good as letting the tape roll. Too many video artifacts show up in most freeze frame images and will not prove as good a shot as having the tape run at speed. Videotaping also insures that the image you want won't disappear by the time you've set up your camera. I've missed more great shots because I did not have my camera set up before the billboard or a color bars left the screen.

Now, It's Your Turn

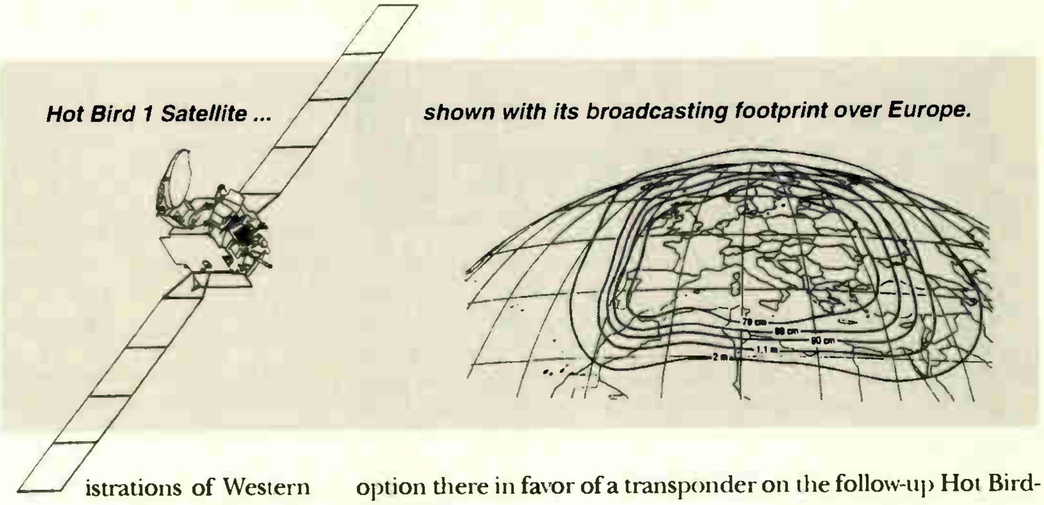
OK, now that you know how to do it, show us your stuff! Dust off those cameras and start snapping away. Start building your own scrapbook of satellite TV experiences. Your C- and Ku-band photos will be a real eye openers for your DSS or cable-bound friends who may have always wondered why your dish is constantly on the move! And, who knows, maybe some of your interesting photographs just might wind up in the pages of *Satellite Times* someday! ST

Frank Baylin, our regular Domestic TVRO columnist, is on special assignment in London, England and Johannesburg, South Africa at presstime. He is working on a special story that impacts U.S. DSS dish owners. He will return in the next issue of ST with that exclusive story.

INTERNATIONAL TVRO

By George Wood
(SMOIIN/KA6BIN)

Hot Bird in the Cat Bird Seat?


Hot Bird 1 Satellite ...
shown with its broadcasting footprint over Europe.

Astra look out! Eutelsat's Hot Bird-1 satellite finally went into orbit in March, delayed several months following the Ariane failure on December 1, 1994.

Hot Bird is being co-located with Eutelsat II-F1 at 13 degrees East, in an effort to compete with the (currently) four Astra satellites at 19.2 degrees West. The co-locating of satellites at one position marks a new direction for Eutelsat, which is made up of the public telecommunications administrations of Western Europe. Originally Eutelsat did not pay any attention to direct-to-home satellite broadcasting. That was to taken care of by individual countries' DBS satellites, each carrying 3 to 5 high-powered transponders.

That concept of European DBS has largely failed, as viewers have turned instead to the first 16, then 32, 48, and now 64 medium-powered Astra transponders. all at one location. Eutelsat originally spread its satellites across the horizon, and offered mixtures of entertainment and feeds in varying languages on each.

But now, to compete with Astra, 13 degrees East has been set aside for purely entertainment programming. However, with a couple of exceptions, the line-up there is not something that will make Astra's owners stay awake all night.

The hottest station on Eutelsat II-F1 is NBC Super Channel, which is now broadcasting in parallel on the new Astra 1D. Super Channel was to have moved over to Hot Bird-1, but NBC has given up its option there in favor of a transponder on the follow-up Hot Bird-2 satellite.

The most exciting new station on Eutelsat II-F1 is BBC World, the new name for BBC World Service Television's 24 hour news channel. It appeared on 11.619 GHz on schedule on January 26. It certainly is quite a contrast from the fast-paced competition, CNN International and British Sky Broadcasting's Sky News on Astra. Initially CNN was accused of being too American, but the channel has broadened its coverage in recent years. Fortunately for we expatriots, American sports are still covered well.

Sky News is terribly British and increasingly tabloid. I remember watching Sky News at the conference hotel during the 1991 European DX Council conference in Barcelona. Tuning in at the top of the hour one day I had to sit through 20 minutes of coverage of pit bull terriers (the current big story in Britain) before Sky News got around to mentioned that the dictatorship in Ethiopia had fled the country.

The next day I only had to wait through 10 minutes of more pit bull terrier coverage before Sky decided to tell the world that Rajiv Gandhi had been assassinated.

BBC World, on the other hand, covers the world, deeply and perhaps a bit ploddingly. Much of the first 30 minutes of the hour is devoted to news, the second half hour to features. Andy Sennitt, editor of the "World Radio TV Handbook", has complained on the Usenet alt.satellite.tv.europe newsgroup about the features being uncut material from BBC domestic television, filled with references to things British that may be quite inexplicable to much of the global audience.

Back when BBC World Service Television first launched, my favorite programs were regular BBC domestic TV newscast, "The News at Six", "The Nine O'Clock News", and especially the morning "Breakfast News" programming. Watching in the morning before work felt like being a tourist in London, it was great!

arianespace inc.

CUSTOMER : EUTELSAT (Paris - France)

MISSION : TV and radio broadcasting throughout Europe and the Mediterranean Basin

PRIME CONTRACTOR : AEROSPATIALE (Cannes - France)

MASS :	
- Total mass (at lift-off)	1.800 kg
- Mass in geostationary orbit (begining of life)	1 050 kg
- Dry mass	840 kg
DIMENSIONS :	
- Central body :	2.8 x 2.2 x 2.5 m
- Height at launch :	3.1 m
- Operational configuration (deployed) span	22.40 m
STABILIZATION :	3 axis
ON-BOARD POWER :	3 kilowatts (end of life)
LIFE TIME:	11 years
PAYLOAD :	16 simultaneously operational transponders in Ku-band (36 Mhz bandwidth per transponder)
ORBITAL LOCATION :	13° East, which means over Africa

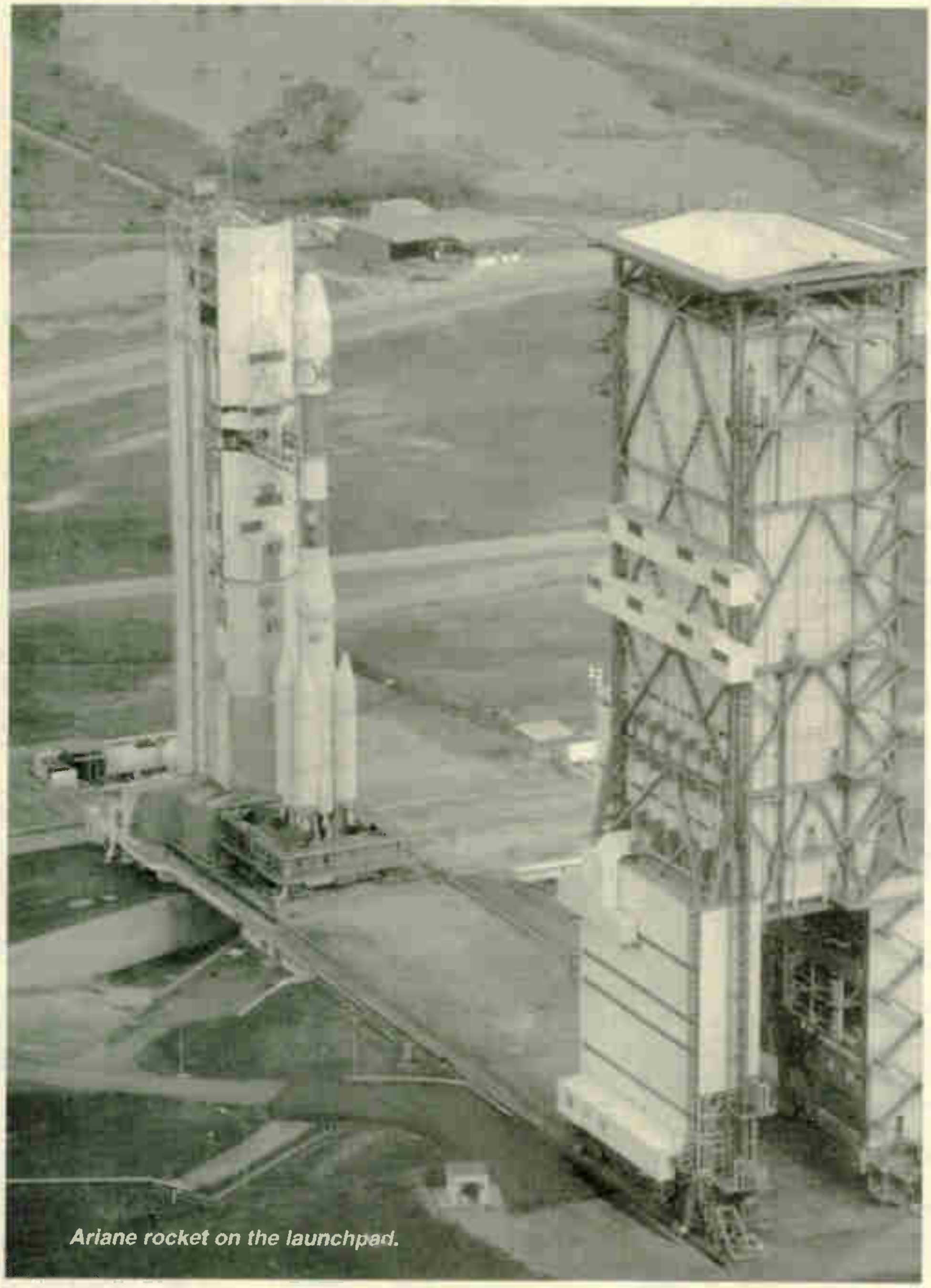
The most exciting new station on Eutelsat II-F1 is BBC World, the new name for BBC World Service Television's 24 hour news channel. It appeared on 11.619 GHz on schedule on January 26. It certainly is quite a contrast from the fast-paced competition, CNN International and British Sky Broadcasting's Sky News on Astra.

But somewhere along the way all of those programs got taken away, the evening newscasts to make room originally for entertainment programming. Now, with the launch of BBC World, the two news shows are still out of the line-up and "Breakfast News" has vanished as well.

The former BBC World Service Television channel on the Intelsat 601 satellite at 27.5 degrees West became the all-entertainment channel BBC Prime on January 26, and on that day "Breakfast News" disappeared from its schedule as well. Unlike BBC World, which is paid for by commercials and broadcasts in clear PAL, BBC Prime is coded in D2-MAC, and is available by subscription.

The BBC Prime line-up of classic British entertainment shows is virtually identical with that of another station, UK Gold, on Astra. UK Gold is a joint venture by the BBC and the former London commercial broadcaster Thames Television. As part of Ruper y Multichannels package, it is only available to viewers in Britain and Ireland. But there is surely a lot of waste here, with two channels with almost exactly the same programming.

Moreover, the subscription cost for BBC Prime, around 10 dollars a month, is about the same as what cable viewers in this part of the world pay for 8 to 10 channel packages that include BBC Prime, and only slightly less than the Multichannels package for Britain which offers UK Gold and 10 other channels.



Ariane rocket on the launchpad.

Other Eutelsat Outlets

The rest of the Eutelsat II-F1 line-up is less inspiring. There's Euronews, a news channel operated by the European Broadcasting Union, which has no on-screen presenters, and has separate soundtracks in English, German, French, Spanish, and Italian. It relies on film from member stations, who seem to send their left-overs. The channel's problems in making ends meet is illustrated by the lengthy blocks of news film accompanied by music, with a "No Comment" caption on the screen, apparently reflecting a shortage of personnel to dub in various languages.

Eurosport is one of Europe's few sports channels, having merged with rival Screensport a few years ago. It offers separate soundtracks in English, German, and Dutch, something which works well with sports. It's remaining competition is Ruper Murdoch's very British (and coded) Sky Sports and Sky Sports II, and the German DSF, both of which are on Astra. Eurosport also broadcasts in parallel on Astra, as well as to Scandinavia on Norway's Thor, and to France on the Telecom IIA satellite.

My main quarrel with Eurosport is that when they merged with Screensport, all the American baseball and football came off the air. They seem to spend most of their time broadcasting boxing, wrestling, and races between motor vehicles.

Other Eutelsat II-F1 broadcasters with

A few broadcasters have moved to Hot Bird from Eutelsat II-F1: MTV, Emirates Dubai Television (which is largely in Arabic, but features some news programming and games shows in English), and Spain's TVE Internacional. Two Italian channels and a Polish channel have been gathered to Hot Bird from other Eutelsat positions, and there are new channels in German and Polish.

programming in English include Deutsche Welle TV, which shares a transponder with the US Information Agency's Worldnet (although that will be coming to an end when Deutsche Welle goes 24 hours), and Turkey's TRT International Avrasya, which has English and German newscasts on every night, presented by announcers from the shortwave Voice of Turkey.

The rest of the II-F1 line-up is decidedly less interesting for English-speakers. The Landscape Channel is coded for British cable systems only, and features pastoral scenes and soothing music. Middle East Broadcasting Company broadcasts in Arabic only, RTL Television and RTL 2 are in German (and also found on Astra), Der Kabelkanal is in German and coded D2-MAC, but has also appeared in clear PAL on Astra 1D. Viva TV is a German counterpart to MTV, with heavy investments from four record companies that recently sued MTV for not playing more of their music. Polonia 1 is in Polish.

Hot Bird

The most exciting arrival coming to Hot Bird is the Science Fiction Channel, which unfortunately isn't scheduled to appear until the Fall. It's still unknown if this will be in the clear or not, but since most Eutelsat broadcasters are in the clear, and pan-European subscription systems have been ineffective and under-promoted, chances are the Sci-Fi Channel will also be in the clear.

Dow Jones' European Business News was scheduled to launch on Hot Bird on February 27. Since the satellite was still on the ground on that date, EBN started on Intelsat 601, before moving to Hot Bird.

A few broadcasters have moved to Hot Bird from Eutelsat II-F1: MTV, Emirates Dubai Television (which is largely in Arabic, but features some news programming and games shows in English), and Spain's TVE Internacional. Two Italian channels and a Polish channel have been gathered to Hot Bird from other Eutelsat positions, and there are new channels in German and Polish.

This is not a line-up to threaten Astra. The main advantages is that virtually all programming is in the clear, and that the Eutelsat and Hot Bird beams also cover Eastern Europe, which Astra does not. Eutelsat transponders have wider bandwidth than Astra, and there is room alongside each regular analog signal for a digital TV transmission.

This may give Eutelsat the jump in introducing digital television to Europe. The new Astra 1D carries four experimental digital transponders, and the upcoming Astra 1E and 1F satellites will be digital. But Eutelsat has an advantage here, but only until Astra 1E launches later this year.

Hot Bird-2 is scheduled to join the 13 degrees east position in August, 1996 with 20 DBS transponders capable of digital transmission. Eutelsat signed an agreement with Matra Marconi Space in November, for the Hot Bird-3 satellite. It too will have 20 Ku-band DBS transponders, and will be positioned at 13 degrees East as well, after launch with Ariane in early 1997.

Astra broadcaster TV Asia has dealt with its first serious potential competitor by merging with it. Last December Zee-TV, broadcast to India over Rupert Murdoch's Star-TV, and partly owned by Star, announced it would start a European channel this March. TV Asia has responded by merging with Zee-TV, which is now the name of the channel on Astra.

Problems in Asia

The new frontier of Asian satellite broadcasting suffered a setback on January 26, when a Chinese Long March rocket failed to put the Apstar-2 satellite into orbit. Six local residents (including an entire family) were killed in the crash, and 23 people were injured, when fragments of the rocket and satellite fell in a mountainous area seven km from the launch site.

Apstar-2 was built to carry 100 digitally compressed TV channels, and would have enabled broadcasters to reach two-thirds of the world's population. It carried 26 C-band and 8 Ku-band transponders. The crash has sent broadcasters scrambling to find new Asian outlets.

The list includes Turner Broadcasting, ESPN, Home Box Office, the Discovery Channel, and Hong Kong's TVB.

Despite the Apstar failure, MTV Asia has gone ahead with plans to launch new channels, using current capacity on four existing satellites. Meanwhile, another Apstar broadcaster, Asian Business

Japan's public broadcaster NHK says it is to launch a global TV service via satellite. According to Radio Japan: "By using the TV Japan services for North America and Europe, this will mean a five hour program to North America and three hours to Europe, free of charge." From 1996 onwards, NHK's plans include expanding broadcasting hours, and launching a similar service to Asia.

News, has now booked a transponder on PAS-4, due to be launched in mid-1995. ABN, owned jointly by Television New Zealand, Dow Jones, Singapore's SIM, and cable giant TCI, is currently on Indonesia's Palapa P2 satellite. Ted Turner's TNT and Cartoon Network, scheduled for Apstar-2, continue to broadcast on Apstar-1.

The Discovery Channel Asia has announced a one year deal with Singapore Telecom to uplink its Chinese language version to Apstar-1. Singapore Telecom is already uplinking Discovery to the Palapa B2P satellite.

Some 25 private Indian television channels were due to launch on Apstar-2. Program-makers, who had invested heavily in projects, now face postponing operations and seeking new vehicles. India may lease channels on its existing Insat 2B and the Insat 2C satellite due to be launched in September. Both India's state-broadcaster Doordarshan and Rupert Murdoch's Star-TV are said by observers to be benefiting from the delay in new competition.

Portugal's RTP was another broadcasters who had leased capacity on Apstar-2. RTP has now made a provisional reservation to use the upcoming Asiasat-2.

One interesting result of the Apstar-crash has been that NBC has dropped a petition with the Federal Communications Commission over the ownership of Rupert Murdoch's Fox TV network. NBC had been challenging Murdoch's ownership of Fox under foreign ownership regulations. The Australian-born Murdoch became an American citizen to qualify under the regulations. NBC said Murdoch's Australian-based News Corporation had exceeded foreign ownership limits on broadcast outlets, and complained News Corp had unfairly been allowed to directly own more stations than NBC, ABC, and CBS.

NBC apparently withdrew its petition because following the loss of Apstar it needs a distribution outlet for its two Asian channels, NBC Super Channel Asia and the Asian News and Business Channel. NBC now says that Star will carry the two channels on Asiasat-2.

ANBC has been running 8 hours a day on Indonesia's Palapa B2P. The channel has now begun 24 hour operations on PAS-2. The new ANBC service also launched nationwide in Australia on January 26, via the Australis pay-TV network.

There's been more fun and games over attaching the blame for the Apstar crash. A Chinese controlled newspaper in Hong Kong has blamed the US-made Hughes satellite and not the Chinese rocket for the failure, but not after another attempt to fix blame elsewhere. Twelve days after the launch, the newspaper "Ta Kung Pao" claimed foreign rivals tracking the launch had sabotaged the rocket.

When that claim was ridiculed, the newspaper switched to blaming Hughes instead. The Chinese also blamed the failure of the launch of the Optus B1 satellite in 1992 on the Australian satellite, rather than the Chinese Long March rocket.

Asian Broadcasters to the World

Britain's media group Pearson has bought 10 percent of Hong Kong's Television Broadcasts, TVB, the world's leading producer of Chinese language drama, and a potential rival to Rupert Murdoch's Star-TV. TVB's plans to expand into South Asia have been temporarily halted by the failure of the Apstar-2 satellite, but Pearson has also secured an agreement with a local broadcaster in that region to start a TV channel soon.

Japan's public broadcaster NHK says it is to launch a global TV service via satellite. According to Radio Japan: "By using the TV Japan services for North America and Europe, this will mean a five hour program to North America and three hours to Europe, free of charge." From 1996 onwards, NHK's plans include expanding broadcasting hours, and launching a similar service to Asia and the Pacific in 1998.

The TV Japan reference makes no sense as far as Europe is concerned. The only Japanese service here is JSTV on Astra, which is hardly free, except for immediately after the Kobe earthquake when JSTV commendably dropped its coding.

China's state broadcaster China Central Television has contracted to use PanAmSat's PAS-2 and PAS-3 satellites to forge the first global television service in Chinese. The deal enables CCTV to use PanAmSat's global television system to broadcast across Asia, the Americas, Europe, and Africa, reaching an overseas Chinese audience of 40 million. CCTV quietly began broadcasting to Asia and parts of North America in December over PaAmSat's Pacific orbiter, PAS-2. Its Mandarin Chinese broadcasts will be widened to all of the Americas, Europe, and Africa when PAS-3 is launched over the Atlantic late this year.

Despite plans to broadcast to satellite viewers in other countries, China itself is very restrictive about letting its own people watch satellite television. There's a similar attitude in Iran, where the Council of Guardians, a body responsible for endorsing the approvals of the Majlis, on February 15 endorsed a law banning the use of satellite dishes and equipment. Satellite dish owners were given one month to turn in their equipment or pay fines of up to $740.

Over the past few years, hundreds of thousands of Iranian households, bored by state television, have installed satellite dishes, which are smuggled into the country. Supporters of the ban say satellite dishes are the spearhead of a "Western cultural invasion".

If you'd like to contribute to the International TVRO column, the fastest way is by email to: wood@stab.sr.se. And if you have access to the World Wide Web on the Internet, check out the new Swedish Radio section, featuring the thrilling Radio Sweden pages: http://www.sr.se ST

ON THE AIR

By Steve Handler

Yersterday USA Brings Old Time Radio to the 21st Century

Does your pet bird have his own fax? No you say, well he would if he belonged to Bill Bragg, the owner and operator of the Yesterday USA Satellite Superstation. The bird's name is Big Bird Bragg, the talking parrot, and he is the mascot and one of the on-the-air personalities of the Yesterday USA network. Big Bird's personal fax machine is located in the station's studios and control room.

What makes this all that much more unusual is the fax, bird, studio and control room are all located in a spare bedroom in Bill's suburban home in Richardson, Tex. From that bedroom, Bill originates all the broadcasts of the popular Yesterday USA old time radio satellite network.

How did all of this wind up in the owner's spare bedroom? For Bill, it was the result of a long evolutionary process.

Bill Bragg, The Man With a Million Friends, and Yesterday USA Mascot Big Bird Bragg. Photo courtesy of the Dallas-Herald and Bill Bragg.

Bill Bragg started with a dream. He wanted to start a museum for the preservation of broadcast history and memorabilia. In January of 1979, he founded the National Museum of Communications with "$25 and a Good Idea". He started gathering artifacts and memorabilia from around the country from the radio and television broadcasting industry.

In late 1983, the Nostalgia Channel approached the museum with an interesting offer. The Nostalgia Channel needed some video transfer equipment that Bill had. They needed to transfer their film library to video cartridges in order to make it more usable for broadcasting. An agreement was struck, and in return for the use of the museum's equipment, Bill received the use of one of the Nostalgia Channel's satellite audio subcarriers, and Yesterday USA was born.

Yesterday USA's first home was in a closet at the Nostalgia Channel which was located in the Dallas Communications Complex (also known as the "Movie Studio"). The Nostalgia Channel's offices were conveniently located in the same building complex as the broadcast museum and the Dallas-Fort Worth satellite uplink facility.

Bill Bragg started with a dream. He wanted to start a museum for the preservation of broadcast history and memorabilia. In January of 1979, he founded the National Museum of Communications with "$25 and a Good Idea". He started gathering artifacts and memorabilia from around the country from the radio and television broadcasting industry.

On the top shelf of a closet at the Nostalgia Channel, Bill Bragg placed a Norelco tape recorder. The recorder had a feeder system that held six 90 minute cassette tapes. First, the feeder would play all six "A" sides of the cassettes, feeding them in one at a time, then flip them over and play all six "B" sides. Audio from the tape recorder was then fed into an audio amplifier. From the closet, a cable carried the audio signal upstairs to the Dallas-Fort Worth satellite uplink facility office where it was then sent to the satellite.

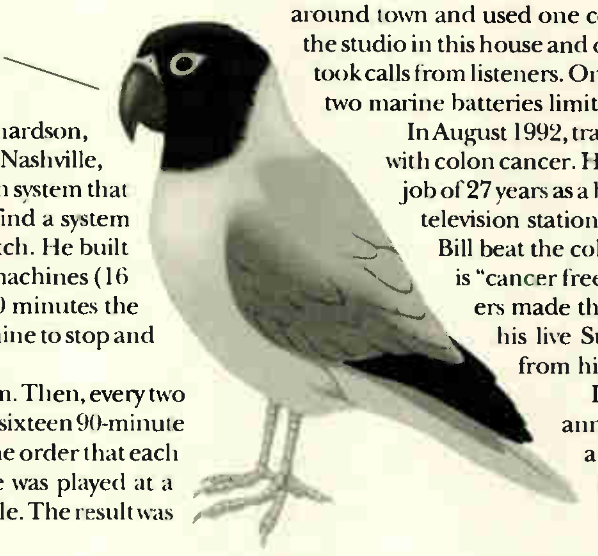
After a year of operation, Bill wantied to improve his program delivery system. He constructed a new system using a twin cassette deck which required the operators at the Nostalgia Channel to change the tapes.

This operation went along fine for about two years then some bad news hit that almost caused Yersterday USA to fold. The Nostalgia Channel was sold and the new owners gave Bill the option of paying for the use of their audio subcarrier or finding a new home. Given his then current state of finances, he chose the latter.

Using a satellite dish, Bill "scanned the skies" for a new home for his radio station. He needed an unused audio subcarrier channel. When he got to the Shop-At-Home (SAH) channel he found exactly what he had been looking for. SAH was broadcasting their audio in mono and not using a stereo pair of audio subcarriers as most satellite broadcasters do. It was then that he also made a rather interesting and astute observation that would ultimately work in his favor. Not only did Shop-at-Home verbally describe the items they were sellling, but they displayed the item number and written descriptions of the merchandise being sold on screen (as well as their toll free order number).

He contacted the Shop-At-Home channel, asked for and received free use of their other unused audio subcarrier. His selling point was a win/win relationship for both Shop-at-Home and Yesterday USA. People at home could listen to old time radio shows and still watch the shop at home items being displayed on screen and order them.

Once the Shop-At-Home agreement was reached, Bill realized that he could not afford a long distance telephone line to feed the programs from Richardson, Tex., to the SAH studios and uplink facility in Nashville, Tenn. Thus, he set about devising an automation system that didn't need human hands to feed. Unable to find a system that used cassettes, Bill designed one from scratch. He built a system that used eight twin deck cassette tape machines (16 decks total) controlled by a computer. Every 90 minutes the computer gave the command for one tape machine to stop and another to start.



Bill drove to Nashville and installed the system. Then, every two weeks he would ship the Shop-at-Home channel sixteen 90-minute tapes. The computer was programed to rotate the order that each tape deck played its material so that each tape was played at a different time during the 14-day rotation schedule. The result was that a listener tuning in at the same time each day would never hear the same program twice.

Some of Yesterday USA's listeners ended up on-the-air as disk jockeys, and soon 25 volunteers made tapes and prepared shows for the radio network. Bill's only rules were "No cussing, and no talking about religion and politics". As time went along, Bill's on the air role shifted. He recorded the introduction to each on-air personality's program and also did one of the 90-minute tape programs.

The arrangement with Shop-At-Home worked out well, even for SAH. One night, one of the listeners to Yesterday USA called Shop-At-Home and bought $7,000 worth of trading cards. "That went along way," Bill indicated, "to convince the executives at Shop-At-Home of the benefits of their relationship."

About four years ago, Bill reached an agreement with satellite Superstation KTVT in Fort Worth, Tex. for the use of one of their audio subcarriers. Out of Bill's spare bedroom studio programming was sent by telephone to the Dallas-Fort Worth Satellite Teleport. From there it was uplinked on one of KTVT's audio subcarriers. A satellite receiver was installed at the Shop-at-Home studio and uplink facility in Nashville. The satellite receiver plucked KTVT's audio subcarrier with the Yesterday USA programming off-the-air, turned it around and uplinked it on to Shop-At-Home's audio subcarrier. The tape recorders at SAH were finally retired.

Bill was not content with only two satellites carrying his radio network, so he entered into an agreement with the Family Network. A satellite receiver similar to the one at SAH was installed at the Family Channel uplink facility in Fort Worth. This receiver also picked up Yesterday USA's programming off of KTVT's audio subcarrier and uplinked it on the Family Network channel audio subcarrier.

In an effort to raise money for the National Museum of Communications, Bill may have been the first person to be heard over three satellite channels while broadcasting from a bicycle. Bill located a four wheel surrey bicycle, outfitted it with tape recorders, broadcast equipment, and two cellular phones. He then peddled around town and used one cellular phone to link him with the studio in this house and on the other cellular phone, he took calls from listeners. Only the four hour life span of the two marine batteries limited his broadcast ability.

In August 1992, tragedy struck! Bill was diagnosed with colon cancer. He was unable to continue in his job of 27 years as a broadcast technician for a local television station. After surgery and treatment, Bill beat the colon cancer, and today states he is "cancer free". While he was sick, his listeners made the broadcast tapes for him and his live Sunday night shows originated from his hospital bed.

In September of 1994, KTVT announced it would soon become a CBS affiliate and Bill knew that the station would stop uplinking on satellite. For

What does the future hold? Bill indicates that he is working with some of the biggest names in the cable business. His goal is to have Yesterday USA carried on every cable television system in the country as background audio for the cable systems program guide or local access channels.

Yesterday USA to continue, one option was to switch the phone line from KTVT to the Family Channel in Fort Worth. Since the Family Channel uplink was a narrow band audio subcarrier, that would limit any redistribution audio quality.

Bill finally found a home for his station at the uplink facility of WGN TV, Chicago's Superstation. There was one small problem with this arrangement. Once again he could not afford the cost of a continuous long distance telephone line to connect his Texas studio with WGN in Chicago. Help to solve this problem was once again, right in his own back yard.

Unable to work full time after his bout with cancer, Bill had been working part time in an engineering position. His employer had a Ku-band satellite uplink facility in the Dallas-Fort Worth area. Bill went to his employer and explained his dilemma about KTVT leaving the air and the loss Yesterday USA's uplink capability. That's when he won another win/win agreement. This time his employer would allow Bill to use an audio subcarrier on his Ku-band satellite uplink channel. In return, the employer was allowed to broadcast Yesterday USA's programming of old radio shows over their Ku-band channel which also distributed training seminars to nursing homes. Now not only would Bill's employer providie training seminars for nursing home staffs, but the nursing home residents could also enjoy some old time radio programs.

On January 1, 1995, Yesterday USA programming ended on KTVT and began on WGN. The programming now goes from Bill's bedroom studio by telephone to his employer's offices near Dallas and is then scrambled, digitized and uplinked on his employer's Ku-band satellite channel. WGN in Chicago receives the Ku-band signal, unscrambles the transmission and uplinks it to their transponder on Galaxy 5.

Recently, the Family Channel stopped carrying Yesterday USA on its narrow band subcarrier. Bill wants Yesterday USA to be on at least two C-band transponders at all times, with one of those transponders in the clear (a transponder whose video program is not scrambled). A search is now underway to locate a second transponder and if past performance is any indicator, Yesterday USA will have a home on a second transponder shortly.

Yesterday USA broadcast are only available on one satellite audio subcarrier at present, Galaxy 5 (G-5), channel 7 (6.8 MHz wideband audio subcarrier). It is also carried on about 15 cable television systems nationwide, as well as 4 hours on Saturday and Sunday nights on KKEY-AM in Portland, Oregon. The station can also be heard from 6:00 p.m. to mdnight daily on WNKE-FM, a low powered station located in Wynot, Mississippi (near Meridian, Mississippi).

What does the future hold? Bill indicates that he is working with some of the biggest names in the cable business. His goal is to have Yesterday USA carried on every cable television system in the country as background audio for the cable systems program guide or local access channels.

Also, Bill indicates that he would love to receive a letter from President Clinton and hopes that he listens to Yesterday USA. After all, Yesterday USA is carried on Fairfax cable system which serves the White House.

Bill Bragg from his converted bedroom studio on the air with Guests. Photo courtesy of Bill Bragg.

Bill describes himself as "The Man With a Million Friends". It certainly seems like he is a man who has been both skilled and lucky enough in life to fulfill his dreams. He has had the ability to overcome life's obstacles and to triumph. After all, how many people do you know control a satellite channel from their spare bedroom?

Yesterday USA gets its support from Bill and the donations from the station's listeners. Contributions for the station are often received in Big Bird's name. In fact, you can even find a telephone listing for Big Bird in the local telephone directory.

Oh, before we forget to give it to you, here is Big Bird's fax number— (214) 6 Hi-Bird. If you send a fax to Big Bird Bragg, Bill requests that you include several blank pages at the end of the fax. Bill uses them for Big Bird Bragg's bird cage.

Yesterday USA Satellite Superstation and Bill Bragg is just another example of what's "On The Air".

On-the-Air Update

The sounds of the outdoors can now be heard more true to life. As of the end of March, the Outdoor Channel is broadcasting selected programs in stereo. Watch this column for other new developments on the Outdoor Channel in the future. ST

SATELLITE SERVICES GUIDE

INTRODUCTION

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

How to Use the Satellite Service Guide

The various sections of the SSG include:

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

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

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

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

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

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

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

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

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

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

Satellite Radio Guide

By Robert Smathers

CLASSICAL

Classical music	E1, 9	6.28 (N)
KUCV-FM 90.9, Lincoln, Neb. (Nebraska Public Radio)	S3,2/4	5.76/5.94 (DS)
SuperAudio — Classical Collections	G5,21	6.30/6.48 (DS)
WFMT-FM 98.7, Chicago, Ill.	G5, 7	6.30/6.48 (DS)
WQXR-FM 96.3, New York, N.Y.	C4,15	6.30/6.48 (DS)

SATELLITE COMPUTER SERVICES

Planet Connect, Planet Systems, Inc (19.2 kbps)	G4, 6 (Ku)	7.40
Planet Connect, Planet Systems, Inc (100 kbps)	G1, 9	7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
	G1,14	7.265

CONTEMPORARY

Adult contemporary, unidenified Canadian networkE	1, 9	7.52
CHFI-FM 98.1, Toronto, Ontario, Canada (soft adult contemporary), ID — "FM 98"	E1, 8	5.41/5.58 (DS)
	E1,6/10/12/14	6.80
CHIN-AM/FM 1540/100.7 Toronto, Ontario, Canada (multilingual)	E1, 2	7.89
CKRW-AM 610, Whitehorse, Yukon, Canada (adult contemporary/oldies)	E1,18	5.41, 6.80
Safeway In-Store Radio (contemporary)	S3,18	5.78, 5.96, 6.48
SuperAudio — Light and Lively Rock	G5,21	5.96, 6.12 (DS)
VOCM-AM 590, St. Johns, Newfoundland, Canada (adult contemporary)	E1,12	6.20
WVTY-FM 96.1, Pittsburgh, Pa. (adult contemporary/Penguins NHL radio network)	C3,22	7.28

COUNTRY

CINC-FM 96.3, Thompson, Manitoba	E1,2	6.40
CISN-FM 103.9, Edmonton, Alberta, Canada, ID —"Country 104"	E1,18	7.48/7.56 (DS)
Safeway In-Store Radio (country)	S3,18	6.12
SuperAudio — American Country Favorites	G5,21	5.04/7.74 (DS)
Transtar III radio network	S3, 9	5.76/5.94 (DS)
WOKI-FM 100.3, Oak Ridge-Knoxville, Tenn., ID — "The Hit Kicker"	G3,13	6.20
WSM-AM 650, Nashville, Tenn.	G5,18	7.38, 7.56
WSM-FM 95.5, Nashville, Tenn.	C4,24	7.38 (DS)

EASY LISTENING

Easy listening music, unidentified station	G4,6	7.69
Horizon	E1,22	7.56 (N)
Safeway In-Store Radio (easy listening)	S3,18	6.32, 7.22, 7.40
SuperAudio — Soft Sounds	G5,21	5.58/5.76 (DS)
United Video easy listening music	F4, 8	5.895 (N)

FOREIGN LANGUAGE

Antenna FM (Greek)	G3, 9	5.88
Arabic, unidentified station	E1,22	7.67
CBC Radio-French (East)	E1,20	5.38/5.58 (DS)
	E1,20	7.36
CFGL-FM 105.7, Laval, Quebec (French, adult contemporary)	E2, 5	7.62
CITE-FM 107.3, Montreal, Quebec Canada (French, soft adult contemporary)	E2, 5	5.78
	E2,9	7.58
	E1,21(Ku)	6.12, 6.20
CKAC-AM 730, Montreal, Quebec Canada (French, adult contemporary)	E2, 5	6.44
	E1,21(Ku)	6.43
Cosmos FM, Hellenic Public Radio, New York, N.Y.	S2,11	8.20
DZMM-Radyo Patrol (from Philippines)	G4,24 (Ku)	6.80
French Canadian audio information service	E2,21	6.46 (N)
French language audio service	E1,24(Ku)	6.55
French language, unidentified station	E2,21	5.40, 6.10
Indian Sangeet Sager	E1,15(Ku)	6.12
Irish music (Sat 1430-0000 UTC)	S3, 3	6.20
Northern Native Radio	E1,26 (Ku)	6.43/6.53 (DS)
Possible Cuban clandestine station (occ audio), ID — La Voz de Resistancia	S2,4	5.80
RAI Satelradio (Italian)	C1,15	7.38
Radio Canada (French)	E1,15	5.40/5.58 (DS)
	E1,15	5.76/7.56 (DS)
Radio Dubai (Arabic)	G7,10	7.48
Radio Energie	E1,24(Ku)	6.12/6.30 (DS)
Radio Maria	G7,10	5.80
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
WCMQ-FM 92.3, Hialeah, Fla. (Spanish — contemporary hit radio)	S2, 4	7.74, 7.92
WLIR-AM 1300, Spring Valley, N.Y. (Ethnic)	S2, 1	7.60
WNTL-AM 1030, Indian Head, Md.(Arabic)	G6,10	6.80, 6.20
WNWK-FM 105.9, Newark, N.J.(Ethnic)	S2,11	8.30
XEL-AM 1260, Mexico City, Mexico, ID — "Radio ACIR" (Spanish)	M2,22	7.38
XEW-FM 96.9, Mexico City, Mexico, ID — "W-FM 96.9" (Spanish)	SD1,7	7.38
XEW-AM 900, Mexico City, Mexico, ID — "La Voz de la America Latina (Spanish)	M2, 8	6.80
XEWA-AM 540, Monterrey, Mexico, ID — "Super Estelar" (Spanish)	M2, 8	7.38
XEVZ-AM 1490, Acayucan, Mexico, ID — "Radio Sensacion" (Spanish-Rock)	M2,22	6.80
XEX-FM 101.7, Mexico City, Mexico, ID — "La Super" (Spanish)	M2,14	7.38
XEX-AM 730, Mexico City, Mexico, ID — "Frecuencia Libre" (Spanish)	M2,14	6.80

JAZZ

KJAZ-FM 92.7, Alameda, Calif, ID — "K-Jazz"	C1, 4	7.78/7.96 (DS)
KLON-FM 88.1, Long Beach, Calif., ID — "Jazz-88"	G5, 2	5.58/5.76 (DS)
Superaudio — New Age of Jazz	G5,21	7.38/7.56 (DS)
WQCD-FM 101.9, New York City, N.Y., ID — "CD-101.9, Cool FM"	C4, 6	6.20

NEWS AND INFORMATION

Arkansas State radio network	G4, 6	6.20

Satellite Radio Guide

Business Radio Network	C4,10	8.06 (N)
C-SPAN ASAP (program schedule)	C3, 7	5.58
C-SPAN II ASAP (program schedule)	C4,19	5.58
CNN Headline News	G5,22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
Standard News	G5,11	5.96
WCBS-AM 880, New York, N.Y. (news)	G4,20	7.38
	G7,19	7.38
WCCO-AM 830, Minneapolis, Minn.	G6,15	6.20
WGN-AM 720, Chicago, Ill. (talk)	E1,2	5.22

RELIGIOUS

Ambassasor Inspirational Radio	S3,15	5.96, 6.48
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
Heaven's Radio	G1,17	7.92
International Broadcasters Network (occ audio)	E1, 2	7.64
KILA-FM 90.5, Las Vegas, Nev. (SOS radio network)	C4, 8	7.38/7.56 (DS)
Religous music with DJ speaking a foreign language	G7,10	8.03
Salem Radio Network	S3,17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
Trinity Broadcasting radio service (Spanish, SAP)	G5, 3	5.96
WCRP-FM 88.1, Guyama, P.R. (Spanish)	G4, 6	6.53
WHME-FM 103.1, South Bend, Ind, ID — "Harvest FM"	G4,15	5.58/5.78
WROL-AM 950, Boston, Mass. (occ Spanish)	S3, 3	6.20

ROCK

CFMI-FM 101.1, New Westminister, British Columbia, Canada, ID — "Rock 101" (album rock)	E1,22	6.80
CHOZ-FM 94.7, St. John's, Newfoundland, Canada, ID — "Oz FM"	E2,20	5.76/5.96 (DS)
CILQ-FM 107.1, Toronto, Ontario, Canada, ID — "Q-107"	E1, 2	5.76/5.94 (DS)
CIRK-FM 97.3, Edmonton, Alberta, Canada, ID — "K-97"	E1,18	7.75 (N)
SuperAudio — Prime Demo	G5,21	5.22/5.40 (DS)

SPECIALITY FORMATS

CFRN-AM 1260, Edmonton, Alberta, Canada (oldies)	E1,18	6.435
Colorado Talking Book Network	C1, 2	5.58
Georgia Radio Reading Service	T401,14(Ku)	5.76
Safeway In-Store (oldies)	S3,18	5.20, 5.40, 7.58
In Touch (reading service)	C5,24	6.48
	C4,10	7.87
Nebraska Talking Book Network	S3, 2	6.48
SuperAudio — Big Bands (Sun 0200-0600 UTC)	G5,21	5.58/5.76 (DS)
SuperAudio — Classic Hits (oldies)	G5,21	8.10/8.30 (DS)
Voice Print (reading service)	E1,16	7.44 (N)
Yesterday USA (nostalgia radio)	G5, 7	6.80

VARIETY

AEN Michael Reagan (0100-0700 UTC)	C3, 1	6.20
American Urban Radio (news/features/sports)	S3, 9	6.30/6.48 (DS)
Cable Radio Network	C3,23	7.24 (N)
CBC Radio	E1,16	5.40, 5.58, 7.38, 7.53
CBC Radio (occ audio)	E1,20	5.78
CBC-FM, Atlantic	E1,16	6.12/6.30 (DS)
CBC-FM, Eastern	E1,16	5.76/5.94 (DS)
CBKA-FM 105.9, La Ronge, Saskatchewan, Canada (CBC — multilingual)	E1,18	7.66 (N)
CBM-AM/FM 940/93.5, Montreal, Quebec, Canada (fine arts/variety)	E1,20	6.12
CBU-AM 690, Vancouver, British Columbia, Canada	E1,22	7.42
CBU-FM 105.7, Vancouver, British Columbia, Canada (variety)	E1,22	5.76/5.94 (DS)
CFWE-FM 89.9, Lac Le Biche, Alberta Canada (variety — country/ethnic)	E1,18	7.875 (N)
CHON-FM 98.1, Whitehorse, Yukon, Canada (country music/contemporary hits)	E1,12	5.40
CJRT-FM 91.1, Toronto, Ontario, Canada (fine arts/jazz-nights)	E1,26(Ku)	5.76/5.94 (DS)
CKER-AM 1480, Edmonton, Alberta, Canada (adult standard, ethnic-night)	E1,18	7.38 (N)
CKLB-FM 101.9, Yellowknife, NWT, Canada (country/ethnic)	E1,14	5.41
	E2,19	6.80
CKUA-AM/FM 580/94.9, Edmonton, Alberta, Canada (variety)	E1, 9(Ku)	5.76/5.94 (DS)
For the People radio network (talk, information)	C1, 2	7.50
Independent Broadcasting Network (talk)	C1,20	7.38
Interstate Radio Network (truck news/ information/news)	E1, 2	5.22
KBVA-FM 106.5, Bella Vista, Ark.	G4, 6	5.58/5.76 (DS)
KNOW-FM 91.1, St Paul, Minn. (Minnesota Public Radio — news/talk)	C4,10	8.26 (N)
KSKA-FM 91.1, Anchorage, Alaska (variety/fine arts)	C5,24	7.38/7.56 (DS)
KSL-AM 1160, Salt Lake City, Utah (news/talk/country)	C1, 6	5.58
Mutual Broadcasting Network (talk show feeds)	E1, 2	7.48
Omega radio network	T2,21	5.80
One on One Sports radio network (sports talk)	E1, 2	7.40
Peach State Public Radio (Georgia PBS)	T401,14(Ku)	5.40/5.58 (DS)
Prime Sports Radio (sports information, talk)	C1,10	7.20
Seltech Radio Syndicated service	E1, 2	5.40/5.58 (DS)
Startalk Radio Network (talk/nostalgia music)	G3,11	7.58
Sun Radio Network feeds (talk programs)	C1,15	7.58
Talk America	S3, 9	6.80
Talk Radio Network	T2,15	6.20
	G4,23	5.80
The Weather Channel (occ audio)	C3,13	6.80
The Weather Channel (background music)	C3,13	7.78
USA Radio Network (news, talk, information)	S3,13	5.01(Ch 1), 5.20(Ch 2)
WINB — Main Street Radio	G3,11	6.20
XETRA-AM 690, Tijuana, Sonora, Mexico, ID — "Newsradio 6-90"/LA Kings NHL	C1, 7	7.38

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

Spacenet 2 Transponder 12 (C-band)

1202.300	U.S.Information Agency "Radio Marti" (ISWBC), Spanish language broadcast service to Cuba

Galaxy 6 Transponder 3 (C-band)

1405.600	KIRO-AM (710), Seattle, Wash — news, talk, and sports talk radio/Seattle Mariners MLB radio network
1405.400	Sports Byline USA (occ audio) — sports talk KQED-FM (88.5), San Francisco, Calif — NPR affiliate (occ audio)
1404.600	Talk America radio network
1403.800	Occ audio
1403.200	Motor Racing Network (occ audio)
1398.300	WGN-AM (720), Chicago, Ill — talk radio/Chicago Cubs MLB radio network
1398.000	Michigan News Network
1397.800	Florida's Radio Network/Orlando Magic NBA radio network
1397.600	Florida's Radio Network/Univ of Florida sports radio network
1397.200	WTMJ-AM (620), Milwaukee, Wis — talk radio/Milwaukee Brewers MLB network/Univ of Wisconsin sports radio networks/Milwaukee Bucks NBA radio network
1394.700	Sun Radio Network
1394.500	WSB-AM (750), Atlanta, Ga — talk radio/Univ of Georgia sports radio networks
1393.600	Florida's Radio Network
1393.400	WGN-AM (720), Chicago, Ill — talk radio/Chicago Cubs MLB radio network/Interstate Radio Network/Other occ audio
1393.200	Wisconsin Radio Network
1393.000	USA Radio Network
1392.700	WGN-AM (720), Chicago, Ill — talk radio/Chicago Cubs MLB radio network/Interstate Radio Network
1391.600	XEPRS-AM (1090), Tijuana, Mexico — Spanish language programming, ID - "Radio Express"
1391.200	Florida's Radio Network/Miami Heat NBA radio network/ Florida Marlins MLB radio network
1390.600	KABC-AM (790) Los Angeles, Calif. — talk radio/Los Angeles Dodgers MLB radio network (English)
1390.400	KWKW-AM (1330) Los Angeles, Calif. — Spanish language programming, Spanish Information Service, ID - "Radio Lobo"/Los Angeles Dodgers MLB radio network (Spanish)
1389.700	Occ audio/data transmissions (burst)
1389.500	Data transmissions (burst)
1388.900	Florida's Radio Network
1387.800	Florida's Radio Network/Univ of Florida sports radio network
1387.500	KWKW-AM (1330), Los Angeles, Calif — Spanish language programming, Spanish Information Service, ID - "Radio Lobo"
1387.100	Michigan News Network
1386.700	Michigan News Network
1386.500	WJR-AM (760), Detroit, Mich — talk radio/Detroit Pistons NBA radio network/Detroit Tigers MLB radio network
1386.300	Illinois News Network
1385.800	WMAQ-AM (670), Chicago, Ill — news/Chicago Bulls NBA radio network
1385.100	For the People radio network
1384.200	KMPC-AM (710), Los Angeles, Calif — talk radio/L.A. Clippers NBA radio network/California Angles MLB radio network
1383.800	KJR-AM (950), Seattle, Wash — sports talk/Seattle Supersonics NBA radio network
1383.400	KFRC-AM (610), San Francisco, Calif. — adult pop music/Oakland A's MLB radio network
1383.200	KDKA-AM (1020), Pittsburgh, Penn. — talk radio/Pittsburgh Pirates MLB radio network
1382.800	Independent Broadcasters Network
1377.900	Los Angeles Lakers NBA radio network
1376.700	Radio Labio Network — Spanish language programming
1375.400	USA Radio Network
1374.100	Northwest Direct — news and talk/Oregon State sports radio network/Portland Trailblazers NBA radio network

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, Tex — spanish language religious, Nuevo Radio Christiana Network
1204.250	Wisconsin Voice of Christian Youth (VCY) America 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)

1445.000	WBIG-FM (100.3), Washington, D.C.—oldies, ID - "Oldies 100"
1444.450	Data transmissions
1443.800	Voice of Free China (ISWBC), Taipei, Taiwan
1443.600	WYFR (ISWBC), Oakland, Calif. — religious programming and talk, ID - "Family Radio Network"
1443.400	Voice of Free China (ISWBC), Taipei, Taiwan
1438.300	WWRV-AM (1330), New York, N.Y. — Spanish religious programming and music, ID - "Radio Vision Christiana de Internacional"
1436.000	KUSC-FM (91.5), Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1435.700	KUSC-FM (91.5), Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1428.100	National Public Radio (NPR) feeds

Galaxy 4 Transponder 2 (C-band)

1402.600	WVAQ-FM (101.9), Morgantown, W Va — West Virginia Metro News
1402.000	WVAQ-FM (101.9), Morgantown, W Va — West Virginia Metro News
1399.000	Oklahoma State sports radio network/San Antonio Spurs NBA radio network
1398.800	Progressive Farmers Network
1398.200	Occ audio/Iowa State sports radio network
1398.000	Oklahoma News Network/Univ of Oklahoma sports radio network
1397.200	Occ audio/Oklahoma State sports radio network

Galaxy 4 Transponder 3 (C-band)

1405.000	Mutual Broadcasting System
1404.800	KOA-AM (850)/KTLK-AM (760), Denver, Colo — news and talk/Univ of Colorado radio network/Denver Nuggets NBA radio network
1404.600	Penn State sports radio network
1404.400	Occ audio
1404.000	South Carolina Radio Network
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, Minn — fine arts, Minnesota Public Radio (occ audio)
1402.100	KNOW-FM (95.3), St. Paul, Minn — fine arts, Minnesota Public Radio
1401.800	BBC World Service (ISWBC)
1398.500	KLIF-AM (570), Ft. Worth, Tex — talk radio/Dallas Mavericks NBA radio network
1398.000	ABC Direction Network
1397.800	Texas Ranger MLB radio network
1397.500	Minnesota Talking Book network
1397.300	WFBC-AM/FM (1330/93.7), Greenville, S.C. — news, talk and oldies music/Clemson University sports radio network
1397.100	Houston Astros MLB radio network
1396.900	Spanish Information Service (SIS) radio network (Spanish)
1396.700	Occ audio/Vanderbilt sports radio network
1396.400	Georgia Network News/Univ of Georgia sports radio network
1396.200	WCNN-AM (680), Atlanta, GA — sports talk
1396.000	WHO-AM (1040), Des Moines, Iowa — talk/Iowa News Network
1395.800	Kentucky News Network
1395.500	American Public Radio (APR)—Monitor Radio programming
1395.100	National Public Radio (NPR) channel 12
1394.600	WHAS-AM (840), Louisville, Ky — adult contemporary music/Univ of Louisville sports radio network
1394.400	National Public Radio (NPR) channel 11
1394.000	National Public Radio (NPR) channel 10/American Public Radio (APR) carrying Monitor Radio programming
1393.500	Atlanta Braves MLB radio network
1392.900	Minnesota Twins radio network
1392.600	National Public Radio (NPR) channel 9/American Public Radio (APR)
1392.300	National Public Radio (NPR) channel 8
1392.000	Minnesota Public Radio
1391.700	National Public Radio (NPR) channel 7
1388.900	Data transmissions (burst)
1388.400	KSJV-FM (91.5), Fresno, Calif — spanish

Single Channel Per Carrier (SCPC) Services Guide

	programming, ID - "Radio Bilingue" (network serves Spanish stations in several western states)
1388.100	National Public Radio NPR channel 6
1387.800	Data transmissions (constant)
1387.500	National Public Radio (NPR) channel 5
1387.200	National Public Radio channel 4
1386.800	National Public Radio (NPR) feeds
1386.200	KSJV-FM (91.5), Fresno, Calif — Spanish programming, ID - "Radio Bilingue" (network serves Spanish stations in several western states)
1385.800	National Public Radio (NPR) channel 3
1385.400	U.S. Naval Observatory Master Clock and National Public Radio (NPR) channel 2
1384.700	National Public Radio (NPR) channel 1
1384.400	KOA-AM (850)/KTLK-AM (760), Denver, Colo — talk/Univ of Colorado sportd radio network/ Denver Nuggets NBA radio network/Colorado Rockies MLB radio network
1383.700	Mutual Broadcasting Network/Independent Network News (INN)
1383.400	KRLD-AM (1080), Dallas, Tex — talk radio/ Texas State News network
1383.100	Mutual Broadcasting System/VSA Radio Network — Ag news
1382.900	Minnesota Radio Network/Univ of Minnesota sports radio network/Minnesota Timberwolves NBA radio network
1382.600	Soldiers Radio Satellite (SRS) network — U.S. Army information and entertainment/Army sports radio network
1382.300	Motor Racing Network (occ audio)
1382.000	WFAE-FM (90.7), Charlotte, N.C. — NPR affiliate
1381.800	WHO-AM (1040), Des Moines, Iowa — talk radio/Univ of Iowa sports radio network/Iowa News Network
1381.600	Alabama Radio Network
1381.400	ABC Direction network/Baylor sports radio network
1377.400	Data transmission (packet burst/tones)
1377.100	In-Touch — reading service for blind
1376.000	Kansas Audio Reader Network

Galaxy 4 Transponder 4 (C-band)

1387.500	Dakota Sports network/Dakota News network
1387.100	ABC Information Network/Mid-America Network
1381.800	Data transmissions
1379.000	Louisiana Network
1378.800	WLAC-AM (1510), Nashville, Tenn. — news and talk/Road Gang truck driver radio network (overnight)
1378.600	Arkansas Radio Network/Univ of Arkansas sports radio network
1378.100	Data transmissions
1377.300	WLAC-AM (1510), Nashville, Tenn. — news and talk/Road Gang truck driver radio network (overnight)
1376.000	Data transmissions
1375.600	KISN-AM (570), Salt Lake City, Utah — sports talk/Utah Jazz NBA radio network

Galaxy 4 Transponder 6 (C-band)

1346.900	WCRP-FM (88.1), Guayama, P.R. — religous/ educational (Spanish)

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
959.200	ABC Satellite Music Network — country and western "Real Country"
959.000	ABC Satellite Music Network — country and western "Real Country"
958.800	Data transmissions
958.000	Data transmissions
957.500	Russian-American Radio Network — Russian language audio service

Anik E2 Transponder 19 (C-band)

1086.000	TV Northen Canada network program audio

Anik E1 Transponder 11 (C-band)

1246.000	Radio Canada International (ISWBC)
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 15 (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 and Labrador service

Anik E1 Transponder 19 (C-band)

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

Anik E1 Transponder 21 (C-band)

1024.300	Canadian weather conditions and warnings
1019.000	CKRW-AM (610), Whitehorse, Yukon Territory — adult contemporary and oldies music Note:This transponder also has 62 data transmissions carriers and six blank audio carriers.

SBS5 Transponder 2 (Ku-band)

1000.600	Wal-Mart in-store network (English)
1001.000	Wal-Mart in-store network (English and Spanish ads)
1001.400	Wal-Mart in-store network (English)
1009.800	Sam's Wholesale Club in-store network (English)
1010.200	Wal-Mart in-store network (English)
1010.600	Wal-Mart in-store network (English)

RCA C5 Transponder 3 (C-band)

1404.800	RFD Radio Service
1404.600	Wyoming News Network/Univ of Wyoming sports radio network
1400.600	Indiana Radio Network
1400.400	Brownfield Network plus other occ audio
1400.200	Occ audio
1400.000	Indiana Radio Network
1396.600	Kansas Information Network/Kansas Agnet
1396.400	Nebraska Ag Network
1396.200	KMOX-AM (1120), St. Louis, Mo — news and talk/Missouri Network/St. Louis Cardinals MLB radio network
1395.700	WIBW-AM (580), Topeka, Kan — news and talk/Missouri Net/Kansas City Royals MLB radio network
1390.000	Occ audio
1387.300	WPTF-AM (680), Raleigh, N.C. — news and talk/North Carolina News Network
1386.900	Brownfield Network — Farm and Ag news/Univ of Kansas sports radio network
1386.200	Radio Iowa
1386.000	People's Radio Network
1384.600	North Carolina News Network/Capitol Sports Network
1384.400	Washington Bullets NBA radio network/Capitol Sports Network
1384.200	Charlotte Hornets NBA radio network/Capitol Sports Network
1384.000	Occ audio/ABC Direction Network
1383.800	Occ audio
1383.600	Occ audio
1383.400	Capitol Sports Network
1382.900	Missouri Network
1382.600	North Carolina News Network
1382.300	Virginia News Network
1378.700	Radio Pennsylvania Network
1378.500	Radio Pennsylvania Network/Philadelphia 76ers NBA radio network
1378.300	Radio Pennsylvania Network/Philadelphia Phillies radio network
1374.600	National Association of Broadcasters (NAB) — misc 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	KABC-AM (790), Los Angeles, Calif. — news and talk/Los Angeles Dodgers MLB radio network (English)
1044.000	Occ audio
1043.600	Unistar Music Radio — Today's Hits, Yesterday's Favorites
1043.400	CNN Radio Network
1043.200	Unistar Music Radio — Today's Hits, Yesterday's Favorites
1042.800	Unistar Music Radio — Original Hits
1042.600	Unistar Music Radio — Original Hits
1042.400	Unistar Music Radio — Good Times and Great Oldies
1042.200	Data transmissions
1042.000	Unistar Music Radio — Good Times and Great Oldies
1041.800	CNN Radio Network
1034.800	Unistar Music Radio — Country and Western
1034.600	Unistar Music Radio — Country and Western
1034.400	Unistar Music Radio — Hits from 60s, 70s, 80s, and Today
1034.200	Data transmissions
1034.000	Unistar Music Radio — Hits from 60s, 70s, 80s, and Today
1033.700	Occ audio
1033.200	Unistar Music Radio — Country and Western
1032.800	Data transmissions
1032.400	Unistar Music Radio — Country and Western

International Shortwave Broadcasters via Satellite

By Larry Van Horn
and Robert Smathers

WORLD RADIO NETWORK ONE SCHEDULE

North American Service Schedule

Galaxy 5, Transponder 6 (WTBS), 3.820 GHz. — vertical polarization, audio subcarrier 6.80 MHz. and via cable systems - contact WRN for details. All broadcast are daily unless otherwise indicated. WRN program information can be heard daily on North American service at 0525, 1125 and 1825 UTC.

* indicates program also carried by C-SPAN 1 audio service Monday-Friday.
\+ indicates program also carried by C-SPAN 1 audio service Saturday-Sunday.

UTC	SERVICE/PROGRAM	EST/PST
0000	Polish Radio - Warsaw	1900/1600
0030	Radio Netherlands - Hilversum	1930/1630
0130	Radio Sweden - Stockholm	2030/1730
0200	YLE Radio Finland - Helsinki	2100/1800*+
0230	KBS Radio Korea International - Seoul	2130/1830
0300	Radio Prague (Slovakia)	2200/1900
0330	Radio Budapest (Hungary)	2230/1930
0400	Vatican Radio - Vatican City	2300/2000
0430	Radio Netherlands - Hilversum	2330/2030
0530	BBC Europe Today (Mon-Sat)	0030/2130
	BBC International Call (Sun)	0030/2130
0600	Deutsche Welle - Cologne	0100/2200
0700	Radio Canada International - Montreal	0200/2300
0730	Swiss Radio International - Berne	0230/2330
0800	ABC Radio Australia - Melbourne	0300/0000*+
0900	KBS Radio Korea International - Seoul	0400/0100*+
1000	Voice of Russia - Moscow	0500/0200*
1030	Radio Netherlands - Hilversum	0530/0230
1130	Central Europe Today from Budapest (Mon-Fri)	0630/0330
	Radio Swiss International - Berne (Sat-Sun)	0630/0330
1200	Radio Australia - Melbourne	0700/0400*+
1300	Radio Telefis Eireann (RTE) - Dublin, Ireland	0800/0500+
1400	Radio France International - Paris	0900/0600*
1500	YLE Radio Finland - Helsinki	1000/0700*
1530	Radio Vlaanderen International - Brussels Calling	1030/0730*
1600	ABC Radio Australia - Melbourne	1100/0800*
1700	Voice of Russia - Moscow	1200/0900*
1730	Radio Netherlands - Hilversum	1230/0930*
1830	Radio Telefis Eireann (RTE) - Dublin, Ireland	1330/1030*
1900	Radio Australia - Melbourne	1400/1100*
2000	Blue Danube Radio - Vienna (Mon-Fri)	1500/1200
	Glen Hauser's World of Radio (Sat)	1500/1200
	UN Radio and BBC Europe Now (Sun)	1500/1200
2030	Radio Vlaanderen International - Brussels Calling	1530/1230
2100	Radio Sweden - Stockholm	1600/1300
2130	BBC Europe Today (Sun-Fri)	1630/1330
	BBC International (Sat)	1630/1330
2200	Radio Telefis Eireann (RTE) - Dublin, Ireland News and Both Sides Now	1700/1400

European Service Schedule

Astra-1B, Transponder 22 (VH-1 TV), 11.538 GHz. — vertical polarization, audio subcarrier 7.38 MHz. and via cable systems — contact WRN for details. All broadcast are daily unless otherwise indicated, time zone is Central European Time (CET).

UTC	SERVICE/PROGRAM	CET
0000	Hugarian Radio - Budapest	0100
0030	Radio Sweden - Stockholm	0130
0100	National Public Radio (US) All Things Considered	0200
0230	Israel Radio - Jerusalem	0330
0300	Vatican Radio - Vatican City	0400
0330	Radio Netherlands (Mon-Sat) - Hilversum	0430
	C-SPAN Weekly Radio Journal (Sun)	0430
0430	Radio Canada International - Montreal	0530
0500	Central Europe Today from Budapest (Mon-Fri)	0600
	Glen Hauser's World of Radio (Sat)	0600
	UN Radio (Sun)	0600
0530	BBC Europe Today (Mon-Sat)	0630
	BBC International Call (Sun)	0630
0600	National Public Radio (US) All Things Considered	0700
0730	PRI Market Place (Tue-Sat)	0830
	PRI Dialogue (Mon)	0830
	National Public Radio (US) Horizons (Sun)	0830
0800	ABC Radio Australia - Melbourne	0900
0900	KBS Radio Korea International - Seoul	1000
1000	Radio Prague (Slovakia)	1100
1030	Radio Netherlands - Hilversum	1130
1130	Radio Canada International - Montreal (Mon-Fri)	1230
	International Money Program and Health Watch (Sat)	1230
	BBC Science Magazine (Sun)	1230
1200	National Public Radio (US) Morning Edition (Mon-Fri)	1300
	National Public Radio (US) Fresh Air (Sat-Sun)	1300
1300	National Public Radio (US) Morning Edition (Mon-Fri)	1400
	National Public Radio (US) Weekend Edition (Sat-Sun)	1400
1400	Radio France International - Paris	1500
1500	YLE Radio Finland - Helsinki	1600
1530	Radio Vlaanderen International - Brussels Calling	1630
1600	ABC Radio Australia - Melbourne	1700
1700	ORF Blue Danube Radio (Mon-Fri)	1800
	Glen Hauser's World of Radio (Sat)	1800
	UN Radio (Sun)	1800
1730	Radio Netherlands - Hilversum	1830
1830	Radio Telefis Eireann (RTE) - Dublin, Ireland	1930
1900	National Public Radio (US) (Mon-Fri)	
	Talk of the Nation, Part 1	2000
	PRI Monitor Radio Weekend (Sat-Sun)	2000
2000	National Public Radio (US) (Mon-Fri)	
	Talk of the Nation, Part 2	2100
	National Public Radio (US) Afropop Worldwide (Sat)	2100
	National Public Radio (US) Piano Jazz (Sun)	2100
2100	Radio Sweden - Stockholm	2200
2130	Polish Radio - Warsaw	2230
2200	PRI Market Place (Mon-Fri)	2300
	PRI Dialogue (Sat)	2300
	National Public Radio (US) Horizons (Sun)	2300
2230	National Public Radio (US) All Things Considered	2330

WRN One schedules are subject to change. Program information is available on Astra 1B VH-1 text page 222/MTV text 535. All programs in English unless otherwise noted. WRN network information can be heard on the European service daily at 0525, 1225 and 1925 CET. For more information about WRN: Telephone: +44 71 896 9000, Via Internet: wrn@cityscape.co.uk or via Compuserve 100041,3344. WRN can also be heard live on the Internet to users with high speed connections to the World Wide Web at: http://town.hall.org/radio/wrn.html

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 live feeds unless otherwise indicated.

UTC	SERVICE/PROGRAM	EST/PST
0100	Radio Havana Cuba - Havana	2000/1700
0200	YLE Radio Finland - Helsinki	2100/1800
0230	Classical Music (taped)	2130/1830
0300	Deutsche Welle - Cologne	2200/1900
0400	Classical Music (taped)	2300/2000
0500	China Radio International - Beijing	0000/2100
0600	Radio Austria - Vienna	0100/2200
0700	Classical Music (taped)	0200/2300
0800	ABC Radio Australia - Melbourne	0300/0000
0900	KBS Radio Korea International - Seoul	0400/0100
1000	Radio Msscow International -Moscow (Mon-Fri)	0500/0200
	Classical Music (taped) (Sat-Sun)	0500/0200

International Shortwave Broadcasters via Satellite

1030	Classical Music (taped)	0530/0230
1100	Radio Japan - Tokyo	0600/0300
1200	Radio Australia - Melbourne	0700/0400
1300	Open House (Mon)	0800/0500
	Canadian Broadcasting Compnay (CBC)	
	As It Happens (Mon-Fri)	0800/0500
	Radio Telefis Eireann (RTE) - Dublin, Ireland	0800/0500
1400	Radio France International - Paris (Mon-Fri)	0900/0600
	Radio France International - Paris (Sat)	
	Rendezvous (taped)	0900/0600
	Canadian Broadcasting Company (Sun)	
	Sunday Morning	0900/0600
1430	Radio France International - Paris (Mon-Fri)	0930/0630
	Radio Sweden - Stockholm (Sat) Sweden Today (taped)	0930/0630
	Canadian Broadcasting Company (Sun)	
	Sunday Morning	0930/0630
1500	YLE Radio Finland - Helsinki (Mon-Fri)	1000/0700
	Classical Music (Sat) (taped)	1000/0700
	Canadian Broadcasting Company (Sun)	
	Sunday Morning	1000/0700
1530	Radio Vlaanderen International - Brussels	
	Calling (Mon-Fri)	1030/0730
	Classical Music (Sat) (taped)	1030/0730
	Canadian Broadcasting Company (Sun)	
	Sunday Morning	1030/0730
1600	Radio Australia - Melbourne)Mon-Sat)	1100/0800
	Canadian Broadcasting Company (Sun)	
	Sunday Morning	1100/0800
1700	Radio Moscow International - Moscow (Mon-Fri)	1200/0900
	C-SPAN Weekly Radio Journal (Sat) (taped)	1200/0900
	Classical Music (Sun) (taped)	1200/0900
1730	Radio Netherlands - Hilversum (Mon-Fri)	1230/0930
	C-SPAN Weekly Radio Journal (Sat) (taped)	1230/0930
	Classical Music (Sun) (taped)	1230/0930
1800	Radio Netherlands - Hilversum (Mon-Fri)	1300/1000
	Classical Music (Sat-Sun) (taped)	1300/1000
1830	Radio Telefis Eireann (RTE) - Dublin, Ireland (Mon_Fri)	1330/1030
	Classical Music (Sat-Sun) (taped)	1330/1030
1900	Voice of America (VOA) - Washington, D.C.	1400/1100
	(Broadcast last 6 hours until 0100 UTC)	

C-SPAN AUDIO 2

Satcom C3 (F3), Transponder 7 (C-SPAN 2), 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. For more information about C-SPAN audio services , write or call: Tom Patton, C-SPAN Audio Networks, 400 North Capitol Street, NW, Suite 650, Washington, D.C. 20001, Telephone: (202) 626-4649

DEUTSCHE WELLE (DW)

Satcom C4 (F4), Transponder 5 (Deutsche Welle TV), 3.800 GHz. — vertical polarization.
Deutsche Welle programming in German and 39 other languages has been noted on the following audio subcarriers on this transponder: 7.02, 7.22, 7.42, 7.58, 7.78, 7.95 and 8.30 MHz.
For more information about Deutsche Welle satellite services, write: Deutsche Welle, Radio & TV International, D-50588 Cologne, Germany.

RADIO FRANCE INTERNATIONAL (RFI)

Spacenet 2, Transponder 4 (Sur), 3.780 GHz. — vertical polarization, audio subcarrier 7.40 MHz.
Telstar 303, Transponder 22 (SCOLA), 4.140 GHz. — horizontal polariztion, audio subcarrier 6.20 MHz.
Anik E2, Transponder 21 (TV 5), 4.120 Ghz.—horizontal polarization, audio subcarriers 5.4 and 6.12 MHz.

RFI broadcast can be heard in a variety of languages throughout a 24 hour period. For more information on RFI satellite broadcast write to: Radio France International, B.P. 9516, F-75016, Paris, France.

VOICE OF AMERICA (United States Information Agency)

The Voice of America (VOA) transmits a variety of audio programs in various 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 deg east Transponder 27 11.163 GHz. PAL system
Intelsat 510 66.0 deg east Transponder 38 4.1775 GHz. PAL system
Intelsat 601 27.5 deg west Transponder 14 3.995 GHz. PAL system
Intelsat 601 27.5 deg west Transponder 21 3.742 GHz. PAL system
Spacenet 2 69.0 deg west Transponder 2H 3.760 GHz. NTSC system
Intelsat 508 180 deg west Transponder 14 3.974 GHz. PAL system

For more information on the VOA write to: Voice of America, Washington, D.C. 20547

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)

Spacenet 2, Transponder 20 (AFRTS), 4.100 GHz.—vertical polarization, audio subcarrier 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. For more information on AFRTS write: AFTRS-BC, 10888 La Tuna Canyon Road, Sun Valley, CA 91352-2098

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:

7.46/7.55 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.
For more information on WHRI qrite to: P.O. Box 12, South Bend, IN 46624.

DBS/Primestar Channel Guide

By Robert Smathers

DirecTV™ Channel Guide

DirecTV
2230 East Imperial Highway
El Segundo, Calif. 90245
1-800-DIRECTV (347-3288)

100	DirecTV Previews	Previews
102-190	Direct Ticket Pay Per View	PPV
200	DTV Previews	Previews
201	DTV Special Events Calendar	Promo
202	CNN	News
203	Court TV	Speciality
204	CNN Headline News	News
206	ESPN 1	Sports
208	ESPN 2	Sports
210	The Golf Channel	Sports
211	NFL Sunday Ticket Offer	Promo
212	TNT	TV programming
215	E! Entertainment TV	Speciality
216	MuchMusic	Music Videos
220	Turner Classic Movies (TCM)	Movies
222	The Disney Channel (East)	Movies/Kids
224	The Disney Channel (West)	Movies/Kids
225	The Discovery Channel	Science/TV documentary
226	The Learning Channel (TLC)	Science/TV documentary
227	Cartoon Network	Cartoons
229	USA Network	TV
230	Trio	TV
232	The Family Channel	TV
233	WTBS-Ind, Atlanta, Ga.(TBS)	Superstation
235	The Nashville Network (TNN)	Country/Outdoors
236	Country Music TV (CMT)	Country Music Videos
240	The Sci-Fi Channel	Science Fiction
242	C-Span 1	Congress-House
243	C-Span 2	Congress-Senate
245	Bloomberg Direct	News
246	CNBC	Financial/Talk
247	America's Talking	Talk
248	The Weather Channel (TWC)	Weather
250	Newsworld International	News
252	CNN International	News
254	The Travel Channel (TTC)	Travel Shows
256	Arts & Entertainment	TV
268	STARZ!	Movies
270	Previews	Previews
271	Encore	Movies
272	Encore-Love	Movies
273	Encore-Westerns	Movies
274	Encore-Mystery	Movies
275	Encore-Action	Movies
276	Encore-True Stories	Movies
277	Encore-WAM!	Movies
282	WRAL-CBS, Raleigh, N.C.	Network TV
284	WXIA-NBC, Atlanta, Ga.	Network TV
286	PBS	Network TV
287	WABC-ABC, New York, N.Y.	Network TV
289	WFLG-FOX, Chicago, Ill.	Network TV
298	TV Asia	Ethnic Programming
299	In-store dealer info channel	Retailers only
300-399	Regional and PPV Sports	Sports
301	DTV Special Events Calendar	Promo
305	Prime Sports	Sports
306	Prime Sports	Sports
308	Prime Sports	Sports
309	Prime Sports	Sports
310	Prime Sports Pittsburgh	Sports
311	Home Team Sports (HTS)	Sports
312	SportsSouth	Sports
314	Sunshine	Sports
316	Pro AM Sports (PASS)	Sports
317	Prime Sports	Sports
319	Prime Sports	Sports
322	Prime Sports Southwest	Sports
323	Prime Sports	Sports
325	Prime Sports West	Sports
326	Prime Sports	Sports
330-348	NFL Sunday Ticket	Sports
335	NFL Sunday Ticket Offer	Promo
350	NFL Sunday Ticket/NBA League Pass	Sports
356	NFL Sunday Ticket/NBA League Pass	Sports
402	Playboy	Adult
501	Music Choice — Hit List	Audio
502	Music Choice — Dance	Audio
503	Music Choice — Hip Hop	Audio
504	Music Choice — Urban Beat	Audio
505	Music Choice — Reggae	Audio
506	Music Choice — Blues	Audio
507	Music Choice —Jazz	Audio
508	Music Choice —Jazz Plus	Audio
509	Music Choice — Contemporary Jazz	Audio
510	Music Choice — New Age	Audio
511	Music Choice — Electric Rock	Audio
512	Music Choice — Modern Rock	Audio
513	Music Choice — Classic Rock	Audio
514	Music Choice — Rock Plus	Audio
515	Music Choice — Metal	Audio
516	Music Choice — Solid Gold Oldies	Audio
517	Music Choice — Soft Rock	Audio
518	Music Choice — Love Songs	Audio
519	Music Choice — Progressive Country	Audio
520	Music Choice — Contemporary Country	Audio
521	Music Choice — Country Gold	Audio
522	Music Choice — Singers & Standards	Audio
523	Music Choice — Easy Listening	Audio
524	Music Choice — Classic Favorites	Audio
525	Music Choice — Classics in Concerts	Audio
526	Music Choice — Contemporary Christian	Audio
527	Music Choice — Gospel	Audio
528	Music Choice — For Kids Only	Audio

DIRECTV™ and DSS™ are official trademarks of DIRECTV, Inc., a unit of GM Hughes Electronics.

DBS/Primestar Channel Guide

USSB Channel Guide

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

963	All New Channel (ANC)	News
965	Video Hits One (VH-1)	Rock Music Videos
967	Lifetime	TV
968	Nickelodeon (Nick)	TV/Kids
970	Flix	Movies
973	Cinemax (East)	Movies
974	Cinemax 2	Movies
975	Cinemax (West)	Movies
977	The Movie Channel (East)	Movies
978	The Movie Channel (West)	Movies
980	HBO (East)	Movies
981	HBO 2 (East)	Movies
982	HBO 3	Movies
983	HBO (West)	Movies
984	HBO 2 (West)	Movies
985	Showtime (East)	Movies
986	Showtime 2	Movies
987	Showtime (West)	Movies
989	MTV	Rock Music Videos
990	Comedy Central	Comedy
999	USSB Background	Enviromental sounds audio/Information

Primestar Channel Guide

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

1	HBO (East)	Movies
2	HBO 2 (East)	Movies
3	HBO 3	Movies
7	Cinemax (East)	Movies
8	Cinemax 2	Movies
13	TV Japan (English)	Not included in $50 a month package
14	TV Japan (Japanese)	Not included in $50 a month package
15	Future service	
17	Future service	
19	Future service	
27	Starz!	Movies
30	Encore 2-Love Stories	Movies
31	Encore 3-Westerns	Movies
32	Encore 4-Mystery	Movies
33	Encore	Movies
34	The Disney Channel (East)	Movies/Kids
35	The Disney Channel (West)	Movies/Kids
40	The Golf Channel	Sports
47	C-SPAN	Congress
48	CNBC — occ service	Financial/Talk
49	The Weather Channel (TWC)	Weather
50	CNN International	News
51	Cable Network News (CNN)	News
52	CNN Headline News	News
55	PreVue Channel	Program Guide
56	Future service	
58	Turner Network Television (TNT)	TV
59	Turner Classic Movies (TCM)	Movies
63	WTBS-Ind, Atlanta, Ga. (TBS)	Superstation
65	The Discovery Channel (TDC)	Science/TV documentary
66	The Learning Channel (TLC)	Science/TV documentary
68	Arts & Entertainment (A&E)	TV
70	USA Network	TV
71	The Sci-Fi Channel	Science Fiction
72	The Family Channel	TV
73	The Cartoon Channel	Cartoons
74	Future service	
77	The Nashville Network (TNN)	Country/Outdoors
78	Country Music TV (CMT)	Country music videos
84	QVC — occ service	Home Shopping
111	WHDH-NBC, Boston, Mass.	Network TV
114	WPLG-ABC, Miami/Ft. Lauderdale, Fla	Network TV
117	WUSA-CBS, Washington, D.C.	Network TV
120	KTVU-FOX, Oakland/San Francisco, Calif	Network TV
124	WHYY-Philadelphia, Penn.	Network TV
131	ESPN	Sports
132	Future service	
141	New England Sports Network (NESN)	Sports
142	Madison Square Garden Network (MSG)	Sports
143	Empire Sports Network	Sports
144	KBL Sports Network (KBL)	Sports
145	Home Team Sports (HTS)	Sports
146	SportSouth	Sports
147	Sunshine	Sports
148	Pro American Sports (PASS)	Sports
149	Future service	
151	Prime Sports Net-Upper Midwest	Sports
152	Prime Sports Net-Midwest	Sports
153	Prime Sports Net-Rocky Mountain	Sports
154	Home Sports Entertainment (HSE)	Sports
155	Prime Sports Net-Inter-Mountain West	Sports
156	Prime Sports Net-Northwest	Sports
157	Future service	
158	Prime Ticket	Sports
201	Viewer's Choice	PPV
202	Request 1	PPV
203	Request 5	PPV
204	Hot Choice	PPV
205	Continuous Hits 1	PPV
206	Continuous Hits 2	PPV
207	Continuous Hits 3	PPV
208	Request 2	PPV
209	Request 3	PPV
210	Request 4	PPV
221	Playboy — occ service	Adult
301	Superadio — Classical Hits	Audio
302	Superadio — America's Country Favorites	Audio
303	Superadio — Lite 'n' Lively Rock	Audio
304	Superadio — Soft Sounds	Audio
305	Superadio — Classic Collections	Audio
306	Superadio — New Age of Jazz	Audio

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69 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 E2 (A1) 107.3 deg
1	SC New York [V2+]	o/v	o/v	SCPC/FM2 (AP) services	Sega Channel [interactive digital]	o/v	Exxxtasy (Adult) [V2+]/VTC/	SCPC services	Data Transmissions	Spice (adult) [V
2	GEMS TV (Spanish) [V2+]	o/v	Virginia EdNet/o/v	Nebraska Educational TV (NETV)	CBS West [VC1]	CBU feeds/o/v	(none)	SCPC services	WHDH-NBC Boston (Atlantic 3) [V2+]	Adam and Eve (adult) [V2+]
3	USIA Worldnet TV	SCPC services	Syndicated show feeds/o/v	WSBK-Ind Boston [V2+]	Action PPV [V2+]	o/v	Parmount Syndication feeds/o/v	SCPC services	Data Transmissions	o/v
4	Canal de Canales SUR (Spanish)	o/v	o/v	Nebraska Educational TV (NETV)	fX East	o/v	FOX feeds	SCPC services	WUSA-CBS Washington (Atlantic 3) [V2+]	TVN Cable Vide Store [V2+]
5	NASA Contract Channel [Leitch]	NHK New York feeds	Ostrich Emu/Superior Livestock/o/v	Univision [V2+]	fX West	Fox News Feeds/o/v	4MC Syndicated feeds/NC Open Net/o/v	o/v	Data Transmissions	CFTM-Montrea (French)
6	Data Transmissions	Univision feeds [SA MPEG-DVC]/o/v	o/v	(none)	Game Show Channel [V2+]	American Independent Network	Buena Vista TV feeds	National Christian Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	(none)
7	(none)	o/v	Syndicated show feeds/o/v	Data Transmissions	The Golf Channel [V2+]	RAI/o/v	FOX feeds East	ABC West [Leitch]	Data Transmissions	ABC East [Leitc
8	Data Transmissions	o/v	Syndicated show feeds/o/v	Data Transmissions	HBO East 2 [V2+]	(none)	PBS X	Telemundo [GI Digicipher]	KOMO-ABC Seattle (PT24W) [V2+]	Global TV [Leitch]/Global fe
9	NASA TV	MuchMusic U.S. [V2+]	RTPI Eurovideo	WPIX-Ind New York [V2+]	o/v	Antenna Satellite TV [V2+]/High Tech Channel	FOX SNG feeds	BBC Breakfast News/o/v	Data Transmissions	Empire Sports Network [V2+]
10	Data Transmissions	Arab Network of America (ANA)	ABC West [Leitch]	Data Transmissions	UAE TV Dubai	ESPN International [B-MAC]	FOX SNG feeds	WABC-ABC New York (PT24E) [V2+]	WFLD-Fox Chicago (PT24E) [V2+]	o/v
11	SC Philadelphia [V2+]	Data Transmissions	Syndicated show feeds/o/v	CNN feeds	Estacion Montellano (Spanish rel)/o/v	Keystone International (Rel)	ABC feeds	o/v	STARZ! Encore 8 [V2+]	o/v
12	Data Transmissions	TV Asia [V2+]	The Outdoor Channel	Data Transmissions	Home Shopping Club Spree	(none)	ABC NewsOne feeds East	o/v	Data Transmissions	CTV (Blue)/o/v
13	Data Transmissions	Independent Film Channel [V2+]	o/v	SCPC/FM2 services	Phoenix Greyhound Racing/o/v [B-MAC]	Video Catalog Channel (VCC)	FOX feeds East	o/v	Data Transmissions	WUHF-Fox Roches (Cancom)
14	Data Transmissions	Cornerstone TV WPCB-TV (Rel)	NPS Promo Channel	CNN [Leitch]	HBO West 2 [V2+]	o/v	FOX feeds West	WRAL-CBS Raleigh (PT24E) [V2+]	Data Transmissions	o/v
15	HERO Teleport [Digicipher]	Midwest Sports Channel [V2+]	Exxxtreme TV Promos (adult) [V2+]	KTLA-Ind Los Angeles [V2+]	TV! [V2+]	o/v	o/v	World Harvest TV (Rel)	Data Transmissions	Global feeds/o/v/Exxxta promos
16	Data Transmissions	o/v	Syndicated show feeds/Wv EdNet/o/v	CNN International [Leitch]	Access TV/o/v [B-MAC]	ESPN International [B-MAC]	o/v	CBS West [VC1]	Data Transmissions	CTV (Green)
17	Data Transmissions	Tokyo BS New York feeds	o/v	FM2/WEFAX services	Via TV Home Shopping	Shop at Home (SAH)	o/v	CBS East [VC1]/o/v	Data Transmissions	Climaxxx (adul [V2+]
18	(none)	Merchandise and Entertainment TV (MET)	o/v	Shop-at-Home/In-store radio net	CBS feeds/o/v	o/v	o/v	CBS feeds [VC1]/o/v	WPLG-ABC Miami (Atlantic 3) [V2+]	Exxxtasy II (adul [V2+]
19	Data Transmissions	University Network/Dr. Gene Scott (Rel)	o/v	SSN Sportsouth [V2+]/ American Infochannel (AIC)	CBS East [VC1]	o/v	United Paramount Network/o/v	CBS East [VC1]/o/v	Data Transmissions	TV Northern Cana (TVNC)
20	Armed Forces Radio & Television Service [B-MAC]	CNN Headline News Clean Feed [V2+]	ABC East (contingency channel) [Leitch]	Shop-at-Home	Natl Empowerment TV (NET)	o/v	ABC East [Leitch]	CBS East [VC1]	Data Transmissions	Newfoundland T (NTV)
21	New England Cable News (NECN)	Channel America	Skyvision Shopping Channel	SSN Pro Am Sports (Pass) [V2+]	La Cadena de Milagro (Spanish rel)	America's Collectables Network (ACN)	ABC East [Leitch]	Warner Brothers Syndication/CBS feeds/o/v	Data Transmissions	TV 5 (French)
22	Newsport [V2+]	Belmont Park Horse Racing [B-MAC]/o/v	Syndicated show feeds/o/v	Data Transmissions	NewsTalk Television	o/v	ABC West [Leitch]	WXIA-NBC Atlanta (PT24E) [V2+]	Data Transmissions	3 Angels Broadcasting (R
23	SC New England [V2+]	Worship TV (Rel)	o/v	SSN Home Teams Sports (HTS) [V2+]	fX Movies	o/v	ABC East [Leitch]	Familynet	Data Transmissions	Exxxtreme TV/Th Cupid Network (adult) [V2+]
24	SC New York Plus-o/v [V2+]	Pimlico Track Horse Racing [Leitch]/o/v	o/v	America One	HBO East 3 [V2+]	Las Vegas TV Net/Around the World After Dark (adult) [V2+]	Best of NASA TV/o/v	CBS Newspath feeds	KPIX-CBS San Francisco (PT24W) [V2+]	CTV (Red)

Satellite Transponder Guide

By Robert Smathers

Solidaridad 1 (SD1) 109.2 deg	Telesat E1 (A2) 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	
(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+]	NHK feeds/SC HI-Chi/o/v	1
(none)	The Sports Network [Oak]	Data Transmissions	TVN 2 PPV [V2+]	Playboy (Adult) [V2+]	The Learning Channel	Spanish language networks [SA MPEG]	Request TV PPV [GI Digicipher]	KUSA-ABC Denver [V2+]	2
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
(none)	Data SCPC	Data Transmissions	TVN 4 PPV [V2+]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food Network [GI Digicipher]	Lifetime East [V2+]	SC Pacific [V2+]	4
(none)	Data SCPC	Data Transmissions	TVN 5 PPV [V2+]	CNN [V2+]	VISN/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	5
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
XEQ-TV canal 9	Data SCPC	Data Transmissions	TVN 7 PPV [V2+]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	Prime Sports West [V2+]	7
(none)	CHCH-Ind Hamilton [Oak]	XHGC canal 5/Q-CVC	TVN 8 PPV [V2+]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
o/v	The Weather Network	(none)	TVN 9 PPV/CVS [V2+]	ESPN [V2+]	Music Choice [digital audio]	ESPN2 Blackout [V2+]/SAH	QVC Network	o/v	9
Mexican Parliament	WXYZ-ABC Detroit [Oak]	SEP	o/v	MOR Music	Home Shopping Club 2	America's Talking	Home Shopping Club 1	Prime Sports SW [V2+]	10
(none)	CBC-North Pacific feed	XEIPN canal 11	Data Transmissions	Family Channel East [V2+]	Prime Network [V2+]	Eternal Word TV Network (Rel)	(none)	Network One 'N1'	11
Data Transmissions	WTOL-CBS Toledo [Oak]	Data Transmissions	Data Transmissions	Discovery West [V2+]	History Channel [V2+]	Valuevision	Nustar (Promo Channel)	SC Florida Alt/o/v	12
(none)	CBC feeds/o/v	(none)	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+]	CNN International [V2+]	WWOR-Ind New York [V2+]	SC Cincinnati/Florida/Ohio [V2+]	15
Data Transmissiosn	CBC Newsworld [Oak]	TV Unam	Flix [V2+]	Cinemax West [V2+]	MTV West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Newsport [V2+]	16
(none)	CBC feeds/o/v	o/v	PandaAmerica-Home Shopping	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN Prime Network Rocky Mtn [V2+]/Cal-Span/o/v	17
(none)	CITV-Ind Edmonton [Oak]	Clara Vision (rel)	Showtime 2 [V2+]	TNN [V2+]	Nickelodeon West [V2+]	HBO Multiplex [GI Digicipher]	Viewer's Choice [GI Digicipher]	SSN Prime Network Upper Midwest [V2+]/STEP/o/v	18
Multivision [GI Digicipher]	CBC feeds//o.v	Cuarenta	(none)	USA East [V2+]	Showtime/MTV [GI Digicipher]	Cinemax East [V2+]	C-SPAN 2	FoxNet	19
(none)	CBMT-CBC (English)	Data Transmissions	Spice/TVN 10 PPV (Adult) [V2+]	BET	Jones Intercable [GI Digicipher]	Home and Garden Network	Showtime West [V2+]	International Channel [V2+]	20
(none)	SCPC/Data Transmissions	(none)	(none)	MEU	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Prime Sports West [GI Digicipher]	21
Caliente Jai Alai Caliente greyhound racing	BCTV-CTV Vancouver [Oak]	XHIMT canal 7	SCOLA	CNN/HN [V2+]	Prime Sports Showcase	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 [V2+]	Cinemax East 2 [V2+]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
(none)	Superchannel [Oak]	XHDF canal 13	TVN Preview/TVN PPV o/v [V2+]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio [Digital Audio]	(none)	CMT [V2+]	SSN Sunshine [V2+]	24

☐ Unscrambled/non-video

▨ Subscription

■ Not available in U.S.

o/v = occasional video

Ku-band Satellite Transponder Services Guide

By Robert Smathers

Spacenet 2 (S2) 69 deg

20	11820	Occ video
21	11900	TV ASAHI [Leitch]
23	12060	Kentucky Educational Television (half-transponders)

SBS 2 (SBS2) 71 deg (Inclined Orbit)

(No observed video)

SBS 3 (SBS3) 74 deg (Inclined Orbit)

2	11780	Occ video (NBC affiliates/ network)
3	11823	Occ video (NBC affiliates/ network)
5	11921	Occ video (NBC affiliates/ network)
6	11970	Occ video (NBC affiliates/ network)
7	12019	Occ video (NBC affiliates/ network)
9	12117	Occ video (NBC affiliates/ network)

SBS 4 (SBS4) 77 deg (Inclined orbit)

1	11725	Data transmissions
10	12166	Data transmissions

Satcom K2 (K2) 81 deg

1	11729	NBC-Eastern time zone
2	11758.5	Data transmissions/Pagesat computer service
3	11788	NBC-Pacific time zone (Spot beam-west coast)
4	11817.5	Cyclesat/occ video
5	11847	NBC contract channel
6	11876.5	Occ video
7	11906	NBC contract channel (network feeds)
8	11935.5	North American Chinese TV Network [Oak]
9	11965	NBC-Mountain time zone
10	11994.5	Data transmissions
11	12024	NBC contract channel (network feeds)
12	12053.5	FM^2 services
13	12083	NBC NewsChannel
14	12112.5	NHK NY - secondary feeds channel
15	12142	Data transmissions
16	12171.5	Data transmissions

Satcom K1 (K1) 85 deg

1	11729	Data transmissions
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]
15	12142	Primestar DBS [Digicipher]
16	12171.5	Primestar DBS [Digicipher]

Note: Complete channel guide in DBS section of SSG.

Spacenet 3R (S3) 87 deg

23	12060	Oregon Educational Network (Spot beam-west coast)
24	12140	NYNET (SUNY) Ed Net/NY Lottery feeds (Spot beam-east coast)

Galaxy 7 (K7) 91 deg

1	11720	Occ video/G.O.P. TV (occasional)
3	11750	Compressed Video (Indiana Higher Education)
4	11780	Occ video
6	11810	Occ video
7	11840	Occ video
10	11900	Occ video/The People's Network (TPN)
12	11930	Asian American TV Network
13	11960	Occ video
15	11990	Occ video/The Asian Network (TAN)
16	12020	Occ video/Microsoft TV (occasional)
17	12050	Westcott Communications ASTN [B-MAC]
18	12050	Occ video
19	12080	Occ video/The People's Network
21	12110	TCI Promo Channel [B-MAC]
22	12140	Occ video/BBC 9PM News (PAL)
24	12170	Occ video/Real Estate TV Network

GSTAR-3 (GST3) 93 deg (Incl. Orbit)

1	11730	SCPC transmissions
3	11852	Occ video
4	11913	Occ video
5	11974	Data transmissions
7	12096	ID Channel
9	11744	Data transmissions
13	11988	Data transmissions
15	12110	Gstar 3 ID Channel

SBS 6 (SBS6) 95 deg

1	11717	Occ video
2	11749.5	SCPC transmissions
3	11774	Occ video
4	11798.5	Occ video
5	11823	Occ video
6	11847.5	Occ video
7	11872	Occ video
8	11896.5	Occ video
9	11921	Occ video
10	11945.5	Occ video
11	11963	CONUS Communications (half-transponders)
12	11994.5	CONUS Communications (half-transponders)/Megabingo
13	12019	CONUS Communications (half-transponders)/CTNA/AsiaNet
14	12043.5	CONUS Communications (half-transponders)
15	12075	Occ video
16	12092.5	Ovv video/Massachusetts Educational Network
17	12110	Occ video
18	12141.5	Occ video
19	12174	Occ 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 network and affiliate 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 [Digicipher] and VSATs
10	11980.75	Louisiana Public TV feeds [Digicipher]
11	12040	Occ video (half-transponders common)
12	12046	CLI Spectrumsaver compression
13	12095	CLI Spectrumsaver compression
14	12108	Georgia Public TV (upper half)/ Peachstar Educational Network (lower half)
15	12147	ABC network and affillate feeds (half-transponders)
16	12167	ABC network and affiliate feeds (half-transponders)

Galaxy 4 (K4) 99 deg

1	11720	SCPC services
2	11750	Data transmissions
3	11750	FM^2 services/MUZAK
4	11780	FM^2 services/Planet Connect computer service (19.2 kbps)
6	11810	Occ video
7	11840	Occ video National Weather Networks
8	11870	Occ video
9	11870	Occ video
10	11900	Occ video
11	11930	Occ video (half-transponders common)
12	11930	Occ video/Channel One
13	11960	Occ video/WMNB (Russian)
14	11990	Occ video (half-transponders common)
15	11990	Occ video
16	12020	FM^2 services
17	12050	CBS Newsnet and affiliate feeds (half-transponders)
18	12050	TVB Jade Channel — Chinese (scrambled)
19	12080	Data transmissions
20	12110	Occ video (half-transponders common)
21	12110	Occ video/Muslim TV (occasional)
22	12140	Occ video
23	12170	CBS Newsnet and affiliate feeds (half-transponders)
24	12170	The Filipino Channel (TRW scrambling system)

Spacenet 4 (S4) 101 deg

20	11820	Occ video
22	11980	Occ video
24	12140	Occ video/Texas education feeds

GSTAR-1 (GST1) 103 deg

1	11730	Data transmissions
3	11852	Occ video
5	11974	O.J. TV (CourtTV)
7	12096	Healthcare Satellite [B-MAC]/ video compression
9	11744	Data transmissions
11	11866	Data transmissions
12	11927	Data transmissions
13	11988	Occ video/Old Dominion Univ. EdNet
16	12171	Data transmissions

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	Occ video
5	11974	Occ video/O.J. TV (CNN/ABC/ others)
6	12035	Occ video
7	12096	Occ video/CNN feeds
8	12157	Occ video
9	11744	Data transmissions
11	11866	Occ video
12	11927	Occ video
13	11988	Occ video/CNN feeds
15	12110	CNN Newsource (secondary)

Anik E2 (A1) 107.3 deg

1	11717	Data transmissions
2	11743	Data transmissions
3	11778	Future home of Expressvu
4	11804	Future home of Expressvu
5	11839	Occ video (continental beam)
6	11865	Occ video (continental beam)
7	11900	Future home of Expressvu
8	11926	Future home of Expressvu
9	11961	Digital transmissions
10	11987	Digital transmissions
11	12022	Showcase TV (West)
12	12048	Woman's Television Network (WTN) (West)
15	12144	Telesat Canada stationkeeping
16	12170	MovieMax! — movies
17	11730	Discovery Channel Canada [Oak]
18	11756	New Country Network (NCN)
19	11791	Bravo! Canada
20	11817	Life Network
21	11852	TeleLatino (TLN) — Spanish-language variety
22	11878	The Weather Network (no audio channel)
23	11913	Showcase TV (East)
24	11939	Woman's Television Network (East)
25	11974	Digital transmissions
26	12000	Digital tranmsissions
27	12035	MoviePix — movies
28	12061	Canal D — French arts channel
29	12096	Telesat Canada stationkeeping
30	12122	Telesat Canada stationkeeping
31	12157	Data transmissions

Solidaridad 1 SD1 109.2 deg

(No video has been seen on any Ku transponder)

Anik E1 (A2) 111 deg

1	11717	Data Transmissions
2	11743	Telesat Services
3	11778	Partial Channel Services
4	11804	Partial Channel Services
5	11839	MuchMusic simulcast
6	11865	NovaNet FM^2 Services
7	11900	Video compression services
8	11926	Occ video
9	11961	Access Network of Alberta
10	11987	Canadian Parliamentary Channel
11	12022	The Family Channel [Oak]
12	12048	R'eseau de l'information (RDI)
13	12083	CBC Newsworld feeds (occasional)
14	12109	RDI feeds (occasional)
15	12144	Knowledge Network
16	12170	Saskatchewan CommunicaNetwork
17	11730	Data transmissions
18	11756	Data transmissions
19	11791	SCPC/Data transmissions
20	11817	SCPC/Data transmissions
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	Comsat Video in-room movies [B-MAC] (half transponders)
2	11780	SCPC services
4	11872	Comsat Video IBM FTN [B-MAC] (half transponders)
6	11970	Data transmissions
8	12068	Comsat Video in-room movies [B-MAC] (half transponders)
9	12117	Comsat Video in-room movies [B-MAC] (half transponders)
10	12166	Occ video/ID Channel
11	11748	Data transmissions
12	11898	Occ video
13	11994	Occ video
14	12141	Occ video

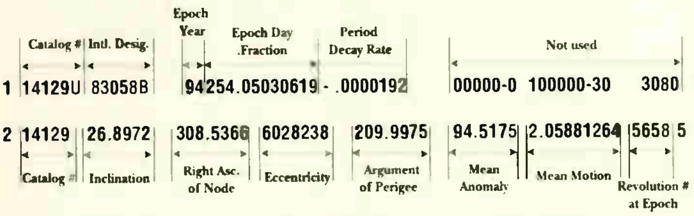
GSTAR-2 (GST2) 125 deg

1	11730	Data transmissions
2	11791	Data transmissions
3	11852	Data transmissions
4	11913	Occ video
5	11974	Occ video
6	12035	Airport Network/CNN International[SA MPEG]
7	12096	Occ video
9	11744	Data transmissions
10	11805	Bluffs Run Greyhound racing (occasional)
11	11866	Occ video/GSTAR-2 ID slate
12	11927	Occ video
13	11988	Occ video
14	12049	Occ video
15	12110	Occ video
16	12171	Occ 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   95085.67894959 -.00000174  00000-0  10000-3 0  3435
2 14129  26.5113 276.3261 6015931 263.2779  28.9850  2.05881301 60630
UOSAT 2 (UO-11 or UoSAT 11
1 14781U 84021B   95088.03321573  .00000166  00000-0  35880-4 0  7854
2 14781  97.7818  94.3375 0013019  78.6670 281.5997 14.69322475592136
COSMOS 1861 (Carries RS-10/11 or Radio Sputnik 10/11)
1 18129U 87054A   95088.50857438  .00000020  00000-0  57981-5 0   421
2 18129  82.9221 117.9700 0010767 320.1442  39.8924 13.72349831389049
OSCAR 13(AO-13)
1 19216U 88051B   95088.38845552 -.00000561  00000-0  10000-4 0   248
2 19216  57.5609 196.0098 7276764   5.2704 359.3130  2.09725996 20491
OSCAR 14 (UO-14 or UoSAT 14)
1 20437U 90005B   95086.77087399  .00000036  00000-0  30884-4 0   849
2 20437  98.5705 172.4449 0011911  76.9481 283.3029 14.29879980270116
OSCAR 16 (AO-16 or Pacsat)
1 20439U 90005D   95086.18596375  .00000016  00000-0  23008-4 0  8829
2 20439  98.5818 173.4308 0012232  79.9117 280.3447 14.29933805270044
OSCAR 17 (DO-17 or Dove 17)
1 20440U 90005E   95086.25250159  .00000032  00000-0  29128-4 0  8823
2 20440  98.5834 173.9260 0012275  78.6108 281.6448 14.30074631270072
OSCAR 18 (WO-18 or Webersat)
1 20441U 90005F   95085.25359691  .00000002  00000-0  17772-4 0  8867
2 20441  98.5829 172.9198 0012865  81.8131 278.4506 14.30046184269937
OSCAR 19 (LU-19 or Lusat)
1 20442U 90005G   95086.19183649  .00000038  00000-0  31334-4 0  8825
2 20442  98.5823 174.1776 0013228  78.1315 282.1356 14.30147720270086
JAS 1-B (FO-20 or Fuji Oscar 20)
1 20480U 90013C   95087.24758390 -.00000010  00000-0  44872-4 0  7791
2 20480  99.0680 190.9050 0541071  56.4572 308.7017 12.83229560240560
COSMOS 2123 (Carries RS-12/13 or Radio Sputnik 12/13)
1 21089U 91007A   95088.17689777  .00000053  00000-0  39834-4 0  7862
2 21089  82.9245 160.1133 0030617  37.4394 322.8883 13.74055828207785
UOSAT-F (UO-22 or UoSat 22)
1 21575U 91050B   95086.19174575 -.00000033  00000-0  33988-5 0  5889
2 21575  98.4047 159.5164 0007522 158.0820 202.0586 14.36965665193721
KITSAT A (KO-23)
1 22077U 92052B   95086.87493178 -.00000037  00000-0  10000-3 0  4801
2 22077  66.0804  46.0128 0010877 220.7519 139.2682 12.86290329123272
EYESAT 1 (AO-27)
1 22825U 93061C   95087.22263709  .00000018  00000-0  25097-4 0  3796
2 22825  98.6230 164.7543 0009323  95.1276 265.0965 14.27656256 78211
ITAMSAT (IO-27)
1 22826U 93061D   95084.79994395 -.00000042  00000-0  57300-6 0  3778
2 22826  98.6229 162.4456 0009789 103.3607 256.8600 14.27762324 77873
POSAT 1 (PO-28)
1 22829U 93061G   95086.15729216  .00000031  00000-0  29918-4 0  3703
2 22829  98.6172 163.8411 0011037  87.6526 272.5920 14.28070182 78081
Radio Sputnik 15 (RS-15)
1 23439U 94085A   95087.16994341 -.00000039  00000-0  10000-3 0   384
2 23439  64.8217  26.0109 0168017 276.2293  81.9510 11.27526316 10383
```

WEATHER SATELLITES

```
NOAA-14
1 23455U 94089A   95089.77311130  .00000083  00000-0  70188-4 0  1185
2 23455  98.8953  32.9348 0010641  57.9885 302.2304 14.11500557 12754
ELEKTRO
1 23327U 94069A   95089.85144609 -.00000125  00000-0  10000-3 0   560
2 23327   0.9350 264.6723 0006048 168.2917 137.7108  1.00269963  1541
DMSP B5D2-7
1 23233U 94057A   95088.85380798  .00000075  00000-0  64194-4 0  2809
2 23233  98.8894 147.6341 0013049   7.3832 352.7530 14.12589794 29957
GOES-8
1 23051U 94022A   95090.16894069 -.00000274  00000-0  00000+0 0  2855
2 23051   0.1506 264.6791 0000196  95.0031 174.5435  1.00280855  3173
Meteor 3-6
1 22969U 94003A   95086.81748498  .00000051  00000-0  10000-3 0  1566
2 22969  82.5546 216.1205 0014595 277.8398  82.1047 13.16727682 56179
METEOSAT 6
1 22912U 93073B   95090.13781190 -.00000104  00000-0  10000-3 0  2747
2 22912   0.2595 270.0962 0000257 158.6357 159.0212  1.00270758  3401
Meteor 2-21
1 22782U 93055A   95087.18225732  .00000007  00000-0 -77053-5 0  3890
2 22782  82.5524 341.3934 0022943 145.7805 214.4841 13.83028654 79343
DMSP B5D2-6
1 21798U 91082A   95088.92473965  .00000058  00000-0  54242-4 0  7815
2 21798  98.9614 100.4890 0013991  51.0397 309.2043 14.13873634172007
Meteor 3-5
1 21655U 91056A   95087.98115210  .00000051  00000-0  10000-3 0  7893
2 21655  82.5498 275.5983 0012393 205.9465 154.1020 13.16838408173944
NOAA 12
1 21263U 91032A   95089.76098751  .00000094  00000-0  61140-4 0  4267
2 21263  98.5919 115.8180 0013665 121.9411 238.3098 14.22503053201271
Meteor 3-4
1 21232U 91030A   95089.08612107  .00000050  00000-0  10000-3 0  7918
2 21232  82.5431 327.4756 0012577 187.5188 172.5762 13.16466781188975
MOP-2
1 21140U 91015B   95089.62003472 -.00000030  00000-0  10000-3 0  9256
2 21140   0.1540  91.5436 0002566 322.4778 356.2370  1.00279454 17152
DMSP B5D2-5
1 20978U 90105A   95088.91727428  .00000100  00000-0  51430-4 0  1373
2 20978  98.6458 157.3941 0080303  43.5859 317.1632 14.32528671225962
Meteor 2-20
1 20826U 90086A   95090.04338931  .00000024  00000-0  86652-5 0  8936
2 20826  82.5220 277.7348 0013370 330.9675  29.0735 13.83604149227426
Feng Yun 1-2
1 20788U 90081A   95089.49872060 -.00000028  00000-0  10000-4 0  3057
2 20788  98.8165 105.2163 0013828 294.8920  65.0938 14.01349832233811
Meteor 2-19
1 20670U 90057A   95086.15819666 -.00000063  00000-0 -70360-4 0  8828
2 20670  82.5497 343.7224 0017656  72.4410 287.8680 13.84164545239767
Meteor 3-3
1 20305U 89086A   95089.02523220  .00000044  00000-0  10000-3 0  2803
2 20305  82.5411  72.3579 0005342 328.8817  31.2042 13.04414346260164
GMS 4
1 20217U 89070A   95087.71078936 -.00000307  00000-0  10000-3 0  1724
2 20217   0.8714  75.5577 0000580  95.1892  50.9184  1.00277719 20943
MOP-1
1 19876U 89020B   95085.68804920 -.00000096  00000-0  10000-3 0  1053
2 19876   1.0511  71.1022 0000378 280.5405  71.7977  1.00270755  2182
Meteor 2-18
1 19851U 89018A   95090.01087048  .00000042  00000-0  24017-4 0  3821
2 19851  82.5160 275.2314 0014861 137.0262 223.2065 13.84386661307379
NOAA 11
1 19531U 88089A   95089.84871591  .00000024  00000-0  38175-4 0    69
2 19531  99.1928  91.1011 0012845  50.1526 310.0771 14.13043995335695
Meteor 3-2
1 19336U 88064A   95089.57719191  .00000051  00000-0  10000-3 0  3814
2 19336  82.5409 121.0508 0015485 269.0503  90.8849 13.16972421320950
METEOSAT 3
1 19215U 88051A   95088.36677281 -.00000295  00000-0  10000-3 0  1038
2 19215   2.3400  70.3745 0000831  45.2117 133.7067  1.00281388 12772
DMSP B5D2-4
1 18822U 88006A   95088.58755404  .00000018  00000-0  26200-4 0  9028
2 18822  98.4112 296.2978 0005434 223.0914 136.9839 14.23147044371198
Meteor 2-17
1 18820U 88005A   95089.37734337  .00000058  00000-0  37816-4 0  5783
2 18820  82.5410  40.9355 0018138  93.9551 266.3683 13.84734181361969
Meteor 2-16
1 18312U 87068A   95085.24488681  .00000093  00000-0  70173-4 0  3833
2 18312  82.5591 348.1619 0013982  43.6433 316.5829 13.84053258384070
DMSP B5D2-3
1 18123U 87053A   95088.96048603  .00000029  00000-0  36946-4 0  8907
2 18123  98.7821 281.3497 0015321  83.9465 276.3456 14.15396006401512
GOES 7
1 17561U 87022A   95089.20456656  .00000072  00000-0  10000-3 0  3137
2 17561   2.1669  73.1559 0004257 348.5668  62.1431  1.00272190 12848
NOAA 10
1 16969U 86073A   95089.86461435  .00000062  00000-0  44635-4 0  1023
2 16969  98.5106  95.1150 0012394 209.0959 150.9531 14.24928642443328
NOAA 9
1 15427U 84123A   95089.82131997  .00000076  00000-0  64015-4 0  1937
2 15427  99.0047 148.0431 0015745 127.5952 232.6652 14.13694841530841
GOES 6
1 14050U 83041A   95085.30775141  .00000023  00000-0  10000-3 0  3703
2 14050   6.1851  58.0683 0005085 343.5262 123.5136  1.00303945101699
GOES 5
1 12472U 81049A   95088.83275091 -.00000288  00000-0  10000-3 0  8478
2 12472   7.3746  54.9112 0005370  14.6437 345.4288  1.00304184  8639
Nimbus 7
1 11080U 78098A   95086.17982513 -.00000073  00000-0 -28005-4 0  4880
2 11080  99.0141 323.6474 0009772  91.4237 268.8035 13.83714002829219
GOES 3
1 10953U 78062A   95088.33321306  .00000052  00000-0  10000-3 0  4695
2 10953  10.6518  45.0777 0003138 101.4026 344.7079  1.00285321 14584
GOES 2
1 10061U 77048A   95086.31163690  .00000072  00000-0  10000-3 0  5091
2 10061  11.6766  42.3385 0012866  99.6136 347.9778  1.00158838  9951
```

STS-71 Estimated Pre-Launch TLEs

```
1 99971U   95160.19121193  .00171834  00000-0  27545-3 0  17
2 99971  51.6417 198.7841 0040351 359.5716  5264 16.01466981  29
```

STS-71, the MIR Docking Mission, is currently scheduled for launch on June 9,1995 at 0310 UTC. Estimated pre-launch 2-line elements courtesy Gil Carman, Johnson Space Center.

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. We are particularly grateful to the following for providing satellite background information: Molniya Space Consultancy — Mr. Phillip Clark; Kaman Sciences Corporation — Dr. Nicholas Johnson; NASA NSSDC/WDC-A, Goddard Space Flight Center; GFSC Oribtal Info Group — Mr. Adam Johnson; University of New Brunswick - Mr. Richard B. Langley; U.S. Air Force Space Command/Public Affairs — Major Planalp; U.S. Naval Space Command/Public Affairs - Gary Wagner and Mr. Keith E. Stein, Satellite Times Staff.

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
"d" indicates the satellite is drifting, moving into a new position or at end of life.

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (OEG)	TYPE SATELLITE
18952	1988-018B Telecom 1C (France)	3.1E	Dom/Gov/Mil (C/Ku)
19919	1989-027A Tele X (Sweden)	4.9E	Reg BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.3E	Reg BSS (Ku)
22921	1993-076A USA 98 (NATO 4B)	6.0E/i	Mil (C)
22028	1992-041B Eutelsat II F4	7.2E	Reg (Ku)
21056	1991-003B Eutelsat II F2	10.1E	Reg (Ku)
19596	1988-095A Raduga 22 (Russia)	11.8E/i	Gov/Mil (C)
20777	1990-079B Eutelsat II F1	12.4E	Reg (Ku)
22269	1992-088A Cosmos 2224 (Russia)	12.5E	Mil-Early Warning
22557	1993-013A Raduga 29 (Russia)	12.5E	Gov/Mil (C)
21055	1991-003A Italsat 1 (Italy)	13.2E	Dom-Telephone (S/Ku/Ka)
21803	1991-083A Eutelsat II F3	16.0E	Reg (Ku)
19688	1988-109B Astra 1A	19.3E	Reg BSS (Ku)
21139	1991-015A Astra 1B	19.3E	Reg BSS (Ku)
22653	1993-031A Astra 1C	19.3E	Reg BSS (Ku)
23331	1994-070A Astra 1D	19.3E	Reg BSS (Ku)
15383	1984-113B Arabsat 1D (Anik D2)	19.8E	Reg FSS/BSS (C)
14234	1983-077A Telstar 3A (301) (USA)	20.3E	Dom (C)
19331	1988-063B Eutelsat 1 F5	21.5E	Reg (Ku)
13010	1981-122A Marecs 1 (ESA)	22.9E/i	Intl Mar (L/C)
22175	1992-066A DFS 3 (Germany)	23.9E	Dom BSS (Ku/Ka)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.5E	Reg (Ku)
20706	1990-063B DFS 2 (Germany)	28.4E	Dom BSS (Ku/Ka)
21894	1992-010B Arabsat 1C	31.4E	Reg FSS/BSS (S/C)
20041	1989-041B DFS 1 (Germany)	33.9E	Dom BSS (Ku/Ka)
21821	1991-087A Raduga 28 (Russia)	34.2E	Gov/Mil (C)
20953	1990-102A Gorizont 22 (Russia)	40.2E/i	Dom/Gov (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	42.5E	Reg FSS (Ku)
23010	1994-012A Raduga 31 (Russia)	44.9E	Gov/Mil (C)
22981	1994-008A Raduga 1-3 (Russia)	48.8E	Gov/Mil (C)
21038	1990-116A Raduga 1-2 (Russia)	49.3E/i	Gov/Mil (C)
22245	1992-082A Gorizont 27 (Russia)	52.5E	Dom/Gov (C/Ku)
19687	1988-109A Skynet 4B (UK)	53.4E/i	Mil (P/C/Millimeter)
14421	1983-105A Intelsat 507	57.2E/i	Int FSS/Mar (L/C/Ku)
14675	1984-009A DSCS III A2 (USA)	60.0E/i	Mil-IOR primary (P/C)
20667	1990-056A Intelsat 604	60.3E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	62.8E	Int FSS (C/Ku)
20918	1990-093A Inmarsat 2 F1	64.4E	Intl Mar (L/C)
13595	1982-097A Intelsat 505	64.8E/i	Int FSS/Mar (L/C/Ku)
13636	1982-106A DSCS II F16 (USA)	65.2E/i	Mil-IOR reserve (C)
23461	1995-001A Intelsat 704	65.6E	Intl FSS (C/Ku)
15629	1985-025A Intelsat 510	66.1E/i	Int FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	69.2E	Gov/Mil (C)
20499	1990-016A Raduga 25 (Russia)	69.7E/i	Gov/Mil (C)
20083	1989-048A Raduga 1-1 (Russia)	69.8E/i	Gov/Mil (C)
22963	1993-002A Gals 1 (Russia)	70.9E	Dom BSS (Ku)
22787	1993-056A USA 95 (UFO-2)	71.1E/i	Mil-IOR primary (P)
20410	1990-002B Leasat 5 (USA)	71.5E/i	Mil-IOR reserve (P)
08882	1976-053A Marisat 2	72.2E/i	Intl Mar (P/L)
22027	1992-041A Insat 2A (India)	74.0E	Dom (S/C)
23327	1994-069A Elektro 1 (Russia)	76.6E	Met (L)
20693	1990-061A Cosmos 2085 (Russia)	77.8E/i	Data Relay (C)
23314	1994-065B Thaicom 2 (Thailand)	78.2E	Reg (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.4E	Reg (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	79.7E	Data Relay (C)
21759	1991-074A Gorizont 24 (Russia)	79.6E	Dom/Gov (C/Ku)
21111	1991-010A Cosmos 2133 (Russia)	80.0E	Mil-Early Warning
20643	1990-051A Insat 1D (India)	82.8E	Dom BSS/Met (S/C)
11622	1979-098B DSCS II E15 (USA)	84.1E/i	Mil-IOR reserve (C)
22836	1993-062A Raduga 30 (Russia)	84.5E	Gov/Mil (C)
13969	1983-026B TDRS 1 (USA)	84.5E/i	Gov (C/Ku)
21016	1990-112A Raduga 26 (Russia)	87.0E/i	Gov/Mil (C)
18922	1988-014A PRC 22 (China)	87.4E	Dom (C)
22880	1993-069A Gorizont 28 (Russia)	90.2E	Dom/Gov (C/Ku)
12474	1981-050A Intelsat 501	91.4E/i	Int FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.3E	Dom BSS/Met (S/C)
23426	1994-082A Luch 1 (Russia)	95.1E/i	Tracking/Relay CSDRN (Ku)
20263	1989-081A Gorizont 19 (Russia)	96.2E/i	Dom/Gov (C/Ku)
20473	1990-011A PRC 26 (China)	98.1E	Dom (C)
19765	1989-004A Gorizont 17 (Russia)	98.4E/i/d	Dom/Gov (C/Ku) Leased to Rimsat
22210	1992-074A Ekran 20 (Russia)	98.5E	Dom BSS (P)
19683	1988-108A Ekran 19 (Russia)	98.8E/i	Dom BSS (P)
21922	1992-017A Gorizont 25 (Russia)	103.1E	Dom/Gov (C/Ku)
20558	1990-030A Asiasat 1	105.5E	Reg (C/Ku)
20570	1990-034A Palapa B2R	107.9E	Reg (C)
23176	1994-040B BS-3N (Japan)	109.4E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.7E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.8E	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.5E	Dom (C)
17706	1987-029A Palapa B-2P	112.5E	Reg (C)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.5E	Dom (C/Ku)
21964	1992-027A Palapa B4	117.8E	Reg (C)
15152	1984-080A GMS-3 (Himawari 3) (Japan)	119.4E/i	Met (P/L) Reserve spacecraft
21132	1991-014A Raduga 27 (Russia)	128.0E/i	Gov/Mil (C/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	130.0E	Dom/Gov (C/Ku)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.8E	Dom (C/Ka)
14134	1983-059C Palapa B1 (Indonesia)	133.9E/i	Regional (C)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	136.0E	Dom (C/Ka)
23185	1994-043A Apstar A1 (China)	137.9E	Reg FSS (C)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
20107	1989-052A Gorizont 18 (Russia)	140.1E/i	Dom/Gov (C/Ku)
20217	1989-070A GMS 4 (Himawari 4)	140.1E	Met (P/L)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.6E	Reg (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	144.8E/i	Dom/Gov (C/Ku)
19874	1989-020A JCSAT 1 (Japan)	149.9E	Dom (Ku)
18316	1987-070A ETS V (Japan)	150.3E/i	Reg (L/C)
23227	1994-055A Optus B3 (Australia)	151.9E	Dom/Mob (l/Ku)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom (Ku)
18350	1987-078A Optus A3 (Aussat K3)	156.0E	Dom (Ku)
22253	1992-084A Superbird A (Japan)	157.9E	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)
23175	1994-040A PanAmSat 2 (PAS-2)	168.9E	Reg (C/Ku)
12046	1980-087A OPS 6394 (Fltsatcom F4) (USA)	171.9E/i	Mil-POR reserve (P-Bravo)
22871	1993-066A Intelsat 701	173.9E	Int FSS (C/Ku)
20202	1989-069A DSCS III B9 (USA)	175.0E/i	Mil-WPAC primary (P/C)
23305	1994-064A Intelsat 703	177.2E	Intl FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	178.0E	Mob-POR (L/C)
15873	1985-055A Intelsat 511	180.0E	Int FSS (C/Ku)
16117	1985-092C DSCS III B5 (USA)	180.0E	Mil-WPAC reserve (P/C)
15236	1984-093C Leasat 2 (USA)	177.1W/i	Mil-POR primary (P)
12994	1981-119A Intelsat 503	176.8W/i	Int FSS (C/Ku)
21639	1991-054B TDRS F5 (USA)	174.4W	Gov (C/Ku)
09478	1976-101A Marisat 3	172.3W/i	Intl Mar-POR (P/L/C)
19548	1988-091B TDRS F3 (USA)	171.5W	Gov (C/Ku)
23467	1995-003A USA 108 (UFO-4) (USA)	170.6W/i	Mil-POR (L/C/K)
18631	1987-100A Raduga 21	170.2W/i	Gov/Mil (C)
21392	1991-037A Satcom C5 (Aurora II)(USA)	139.0W	Dom (C)
20945	1990-100A Satcom C1 (USA)	137.0W	Dom (C)
17561	1987-022A GOES 7 (USA)	136.3W/i	Met (L)
22096	1992-057A Satcom C4 (USA)	135.1W	Dom (C)
22915	1993-074A DSCS III B14 (USA)	135.0W/i	Mil-EPAC primary (P/C)
23016	1994-013A Galaxy 1R (USA)	133.0W	Dom (C)
22117	1992-060B Satcom C3 (USA)	131.0W	Dom (C)
13637	1982-106B DSCS III A1 (USA)	130.1W/i	Mil-EPAC reserve (P/C)
21906	1992-013A Galaxy 5 (USA)	125.0W	Dom (C)
16649	1986-026A Gstar 2 (USA)	124.9W	Dom (Ku)
15826	1985-048D Telestar 3D (USA)	123.0W	Dom (C)
19484	1988-081B SBS 5 (USA)	122.9W	Dom (Ku)
16274	1985-109B Morelos B (Mexico)	116.9W	Dom (C/Ku)
13652	1982-110C Anik C3 (Canada)	114.9W/i	Dom (Ku)
23313	1994-065A Solidardad 2 (Mexico)	113.0W	Dom (C/Ku)
21726	1991-067A Anik E1 (Canada)	111.1W	Dom (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.2W	Dom (C/Ku)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom (C/Ku)
08697	1976-017A Marisat 1	106.3W/i	Intl Mar-AOR (P/L)
03029	1967-111A ATS 3 (USA)	106.2W/i	Exp
20946	1990-100B Gstar 4 (USA)	105.1W	Dom (Ku)
15643	1985-028C Leasat 3 (USA)	104.9W/i	Mil-CONUS reserve (P)
08747	1976-023B LES 9 (USA)	104.0W/i	Mil (P/C)
15677	1985-035A Gstar 1 (USA)	103.0W	Dom (Ku)
22930	1993-078A DBS 1 (USA)	101.3W	Dom BSS (Ku)
21227	1991-028A Spacenet 4 (USA)	101.1W	Dom (C)
23192	1994-047A DBS 2 (USA)	100.8W	Dom BSS (Ku)
22796	1993-058B ACTS (USA)	100.1W	Exp (Ka)
17181	1986-096A USA 20 (Fltsatcom F7)(USA)	100.0W	Mil-CONUS primary (P/C)
22694	1993-039A Galaxy 4 (USA)	99.3W	Dom (C/Ku)
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)	93.6W	Dom (C)
19483	1988-081A Gstar 3 (USA)	93.1W/i	Dom (Ku)
08746	1976-023A LES 8 (USA)	93.0W/i	Mil (P/C)
22205	1992-072A Galaxy 7 (USA)	91.0W	Dom (C/Ku)
22988	1994-009A USA 99 (Milstar 1)	90.0W	Mil (P/K)
18951	1988-018A Spacenet 3R (USA)	87.1W	Dom (L/C/Ku)
15237	1984-093D Telestar 3C (302) (USA)	85.1W	Dom (C)
16482	1986-003B Satcom K-1 (USA)	85.0W	Dom (Ku)
16276	1985-109D Satcom K-2 (USA)	81.1W	Dom (Ku)
15235	1984-093B SBS 4 (USA)	77.1W	Dom (Ku)
12309	1981-018A Comstar D4 (USA)	76.3W/i	Dom (C)
14133	1983-059B Anik C2 (Argentina)	75.9W/i	Dom (Ku)
23051	1994-022A GOES 8 (USA)	75.8W	Met (L)
13651	1982-110B SBS 3 (USA)	74.2W/i	Dom (Ku)
20873	1990-091B Galaxy 6 (USA)	74.1W	Dom (C)
15642	1985-028B Anik C1 (Argentina)	71.8W	Dom (Ku)
12855	1981-096A SBS 2 (USA)	71.3W/i	Dom (Ku)
19215	1988-051A Meteosat P2 (ESA)	70.5W/i	Met (L)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom (C)
15385	1984-114A Spacenet 2 (USA)	69.1W	Dom (C/Ku)
16650	1986-026B SBTS 2 (Brazil)	65.1W	Dom (C)
15561	1985-015B SBTS 1 (Brazil)	63.1W	Dom (C)
21940	1992-021B Inmarsat 2 F4	54.3W/i	Intl Mob-AOR-W (L/C)
19121	1988-040A Intelsat 513	53.0W	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/i	Int FSS (C/Ku)
22314	1993-003B TDRS F6 (USA)	46.7W	Gov (C/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.0W	Reg (C/Ku)
16116	1985-092B DSCS III B4 (USA)	42.5W	Mil-ATL reserve (P/C)
19883	1989-021B TDRS F4 (USA)	41.0W	Gov (C/Ku)
12089	1980-098A Intelsat 502	40.4W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (USA)	37.6W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.5W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.0W	Mil (P/C)
13083	1982-017A Intelsat 504	31.6W/i	Int FSS (C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.2W	Dom (Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	Dom (Ku)
21765	1991-075A Intelsat 601	27.6W	Int FSS (C/Ku)
16101	1985-087A Intelsat 512	26.2W	Int FSS (C/Ku)
19928	1989-030A Raduga 23 (Russia)	25.3W/i	Gov/Mil (C)
21653	1991-055A Intelsat 605	24.5W	Int FSS (C/Ku)
23168	1994-038A Cosmos 2282 (Russia)	24.2W	Mil-Early Warning
22112	1992-059A Cosmos 2209 (Russia)	23.6W	Mil-Early Warning
20253	1989-077A USA 46 (Fltsatcom 8)	23.1W/i	Mil-AOR primary (P-Charlie/K)
21989	1992-032A Intelsat K	21.5W	Int FSS (Ku)
15391	1984-115A NATO III D	21.1W/i	Mil (P/C)
19621	1988-098A TDF 1 (France)	18.8W	Dom BSS (Ku)
20705	1990-063A TDF 2 (France)	18.8W	Dom BSS (Ku)
19772	1989-006A Intelsat 515	18.0W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W/i	Mil (P/C)
20391	1989-101A Cosmos 2054 (Russia)	16.0W/i	Tracking Relay WSDRN (Ku)
21149	1991-018A Inmarsat 2 F2	15.5W/i	Intl Mob-AOR-E (L/C)
15386	1984-114B Marecs B2	15.0W/i	Intl Mar (L)
18384	1987-084A Cosmos 1888 (Russia)	14.8W/i	Data Relay (C)
10669	1978-016A Ops 6391 (FltSatCom 1) (USA)	14.5W/i	Mil-AOR reserve (P-Alpha)
20659	1990-054A Gorizont 20 (Russia)	14.4W/i	Dom/Gov (C/Ku)
23132	1994-035A USA-104 (UFO-3)(USA)	14.3W/i	Mil-AOR primary (P)
21789	1991-079A Cosmos 2172 (Russia)	13.8W	Data Relay (C)
23319	1994-067A Express 1 (Russia)	13.8W	Regional (C/Ku)
22009	1992-037A DSCS III B12 (USA)	12.0W	Mil-ELANT primary (P/C)
22041	1992-043A Gorizont 26 (Russia)	11.0W	Dom/Gov (C/Ku)
22912	1993-073B Meteosat 6 (ESA)	9.7W	Met (L)
21813	1991-084A Telecom 2A (France)	8.1W	Dom/Gov/Mil (C/Ku)
19876	1989-020B Meteosat 4 (MOP 1)(ESA)	7.6W	Met (L)
20168	1989-062A TV Sat 2 (Germany)	6.2W/d	Dom BSS (Ku)
21939	1992-021A Telecom 2B (France)	5.0W	Dom/Gov/Mil (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.1W	Mil (P/C)
21140	1991-015B Meteosat 5 (MOP 2)	1.0W	Met (L)
23124	1994-034A Intelsat 702	0.9W	Int FSS (C/Ku)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.8W	Reg BSS (Ku)

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					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					21.129						
	Bcn		29.408															
RS-15	A (v/a)	Dn	29.354	29.364	29.374	28.384	29.394											
		Up	145.858	145.868	145.878	145.888	145.898											
UoSat 11 (UO-II)	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												

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. Letters in [ ] represent digital formats, as follows:
    [a] 1200 bps PSK AX-25
    [b] 1200 bps AFSK AX-25
    [c] 9600 bps FSK
    [d] Digitized voice (Notes 8 & 9)
12. PO-28 is available to amateurs on an intermittent, unscheduled basis.

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode					Frequencies							
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						
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									

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

Satellite Launch Schedules

By Keith Stein

Space Transportation System (STS-NASA)

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

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-71	June 1995/ Atlantis*	51.6/160	10 days	S/MM-01
STS-70	June 1995/ Discovery**	28.4/160	8 days	TDRS-G

*Crew Assignment: CDR-Robert L. Gibson, PLT-Charles L. Precourt Jr, MS-Ellen S. Baker, MS-Bonnie J. Dunbar, MS-Gregory J. Harbaugh, M19-Nikolai Budarin (Russia) (U), M19-Anatoly Solovyev (Russia) (U), M18-Vladimir Dezhuroz (Russia) (D), M18-Gennadiy Strekalov (Russia) (D), M18-Norman E. Thagard (D).

**Crew Assignment: CDR-Terence T. Henricks, PLT-Kevin R. Kregel, MS-Nancy J. Sherlock, MS-Donald A. Thomas, MS-Mary Ellen Weber.

STS Downlink Frequency Assignment: VHF Voice 259.7 and 296.8 MHz, S-band TRK 2041.9 MHz, S-band TLM 2106.4 MHz, TTC&V (TDRSS) 2217.5 and 2287.5, K-band TLM (TDRSS) 15003.4 GHz.

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
May 1995	Proton	Baikonur	SPEKTR
June 1995	Soyuz	Baikonur	PROGRESS M-28
June 1995	Molniya	Plesetsk	PROGNOZ M2 & MAGION
June 1995	Zenit		Baikonur SAFIR
June 1995	Proton	Baikonur	RIMSAT 4
June 1995	Zenit		Baikonur COSMOS
July 1995	Soyuz	Baikonur	PROGRESS M-29
July 1995	Molniya	Plesetsk	OFEQ 3
July 1995	Cyclone	Plesetsk	SICH-1 & FASAT-ALFA

MAGION 3 Downlink Frequency Assignment: 137 MHz and 400 MHz.

SAFIR Downlink Frequency Assignment: users 401 MHz, and TT&C 137 MHz.

PROGRESS Downlink Frequency Assignment: 165.000 MHz, 166.000 MHz, and 922.755 MHz.

FASAT-ALFA Downlink Frequency Assignment: 400-401 MHz.

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
May 1995	DC-X	WSTF	none
May 1995	Atlas I	CCAS	GOES-J
May 1995	Conestoga	WFF	COMET 1
May 1995	Delta II	CCAS	MSX
May 1995	LLV-1	VAFB	VITASAT 1
June 1995	Delta II	CCAS	KOREASAT-I
June 1995	Pegasus XL	VAFB	TOMS-1
June 1995	Delta II	CCAS	NAVSTAR GPS 2-25
July 1995	Atlas 2AS	CCAS	JCSAT 3
July 1995	Pegasus XL	WFF	SWAS
July 1995	Pegasus	VAFB	MSTI-3

GOES Downlink Frequency Assignments: S-band TLM 2208.586 MHz, and TRK 2209.086 MHz.

COMET 1 Downlink Frequency Assignments: L-band 1613.800 MHz, S-band 2315.000 MHz and 2491.750 MHz, and C-band 5765.000 MHz.

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

MSX Downlink Frequency Assignments: S-band 2282.500 MHz, and X-band 8475.000 MHz.

VITASAT 1 Downlink Frequency Assignments: UHF-band 400.505-400.595 MHz.

PEGASUS Downlink Frequency Assignments: Telemetry 2288.500 MHz, Tracking Transponder (transmit/downlink) 5765.000 MHz.

TOMS Downlink Frequency Assignments: S-band TLM 2273.500 MHz

SWAS Downlink Frequency Assignments: 2215.0 MHz

Chinese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
June 1995	Long March	Xichang	ASIASAT 2

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload

At presstime, a complete launch schedule for European flights was not available.

Satellite Launch Schedules

List of Abbreviations and Acronyms

ASIASAT	Chinese telecommunications satellite
CCAS	Cape Canaveral Air Station, Florida
CDR	Commander
COMET	Commercial Experiment Transporter, designed to provide experimenters access to a low earth orbit with several years of orbital lifetime.
DC-X	Delta Clipper-X experimental single-stage-to-orbit vehicle
FASAT	FASAT-ALFA will become the first Chilean satellite. The main mission objective is ozone layer monitoring, remote sensing, and data transfer.
GHz	Gigahertz
GOES	Geostationary Operational Environmental Satellite (GOES), U.S. weather monitoring system
GPS	U.S. Air Force Global Positioning System used to provide navigation data to military and civilian users.
JCSAT	Japanese telecommunications satellite
K-band	10.90 to 17.15 GHz
M18	Three crew members returning to earth from MIR space station.
M19	Two Russian crew members going up to MIR space station.
Magion	A Czechoslovakia sub-satellite designed to work with the Prognoz-M2 satellite mission under the Interball program.
MHz	Megahertz
MS	Mission Specialist
MSTI	Miniature Seeker Technology Intregation satellite will be launched into the same orbit as MSTI-2 to conduct dynamic stereo observations of tactical missile launches and Earth backgrounds.
MSX	Midcourse Space Experiment is designed to detect, acquire, and track targets and to discriminate lethal from nonlethal objects.
OFEQ 3	An Israeli spacecraft designed to demonstrate technology for their future Amos telecommunications satellite.
PLT	Pilot
Prognoz M	This spacecraft will study the magnetosphere and plasmasphere under a 14-nation co-operation project called Interball.
Progress	Resupply cargo ship bringing food, water, air and equipment to the manned Mir space station.
RIMSAT	RIMSAT provides Pacific telecommunications services via satellites leased from Russia's Informcosmos consortium.
RNG	Ranging
SAFIR	The Satellite for Information Relay is planned as a 2-way data collection & distribution system, a German project.
S-band	2000 to 2300 MHz
SICH-1	Designed to take ocean and atmospheric measurements for environmental monitoring.
S/MM-01	Shuttle MIR Mission-01 is a flight to the Russian Space Station MIR, to support design and assembly of the international space station.
SPEKTR	A new module to be added to the Russian MIR space station. The module's remote sensing instruments are particularly aimed at atmospheric studies.
SWAS	Submillimeter Wave Astronomy Satellite will study how molecular clouds collapse to form stars and planetary systems.
TDRS-G	Tracking & Data Relay Satellite-G is part of a series of NASA tracking, data and communication satellites to replace the NASA ground based network.
TDRSS	Tracking & Data Relay Satellite System
TLM	Telemetry
TOMS	Total Ozone Mapping Spectrometer will study the stratospheric ozone.
TRK	Tracking
TT&C	Tracking, Telemetry and Command
TTC&V	Tracking, Telemetry, Commanding and Voice
VAFB	Vandenberg Air Force Base, California
VHF	Very High Frequency (30 to 300 MHz)
VITASAT	Volunteers In Technical Assistance satellite will provide an Internet electric mail capability to the areas of Earth with poor telecommunications infrastructure, along with other data transfer services.
WFF	Wallops Flight Facility, Virginia
WTSF	White Sands Test Facility, New Mexico

ST Satellite Profile

Total Ozone Mapping Spectrometer-Earth Probe (TOMS-EP)

Mission Ouration: 2-3 years

Organization: Goddard Space Flight Center (GSFC)

Mission: The primary science objectives of the TOMS-EP mission is to supplement and continue the ongoing measurements of the Earth's atmospheric ozone currently being performed by the USSR-US Meteor-3/TOMS cooperative mission and the NASA Nimbus-7 mission.

Flight Plan: The spacecraft will be put into a 955-km circular Sun-synchronous orbit inclined 99.28 degrees with an equator crossing between 11:00 a.m. and 12:00 p.m. local time.

Tracking Operations: The Deep Space Network will support the launch and early orbit phases of the mission. Stations in Goldstone, Calif., Canberra, Australia, and Madrid, Spain will use their 26-m, and 9-m antennas. NASA's Wallops Orbital Tracking Station, and Air Force Satellite Control Network will also support the mission. The Nimbus-7;TOMS/M3;TOMS/EP TOMS Mission Operations Center (TMOC) at GSFC will handle all operations.

Downlink Frequency Assignments: S-band: 2273.500 MHz (Telemetry)

Data Rate (kbps):

Real Time	Playback	Format
1.125	50.625 202.50	NRZ-PCM/PM

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

ST SATELLITE LAUNCH REPORT

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

How to Use the Satellite Launch Report

The "Satellite Launch Report" is a complete list of satellite launches which took place during January and February 1995. The format of the listing is as follows:

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

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

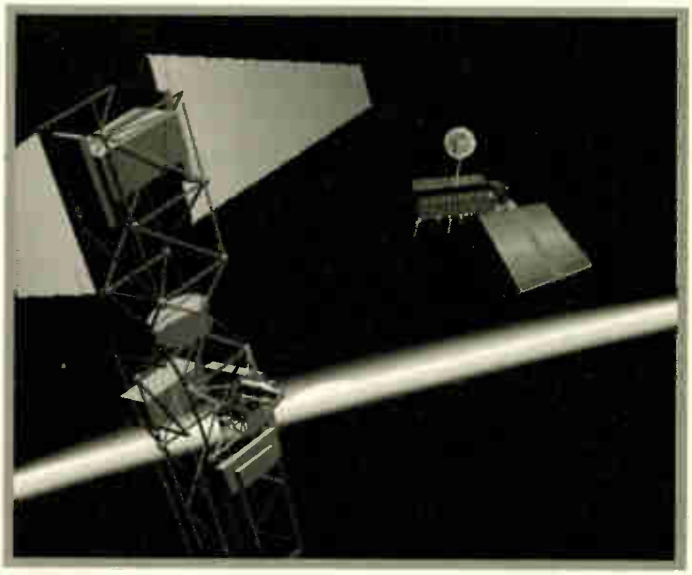
The *Satellite Times* "Satellite Launch Report" is extracted from more detailed monthly listings, "Worldwide Satellite Launches", compiled by Phillip S. Clark and published by Molniya Space Consultancy, 30 Sonia Gardens, Heston Middx TW5 0LZ United Kingdom

Launch Date/Time	Int Des	Satellite		Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Jan 10/0618	1995-001A	INTELSAT 704		3,661 kg
1995 Jan 11.56	23.37 deg	786.48 min	1,353 km	42,339 km
1995 Jan 16.87	0.01 deg	1,436.87 min	35,794 km	35,810 km

Communications satellite, built by Space Systems/Loral for INTELSAT. Mass of the satellite quoted above is at launch: the dry mass of the satellite is approximately 1,500 kg. Expected operational lifetime is 15-18 years. Located over 66 deg E. Launched from Cape Canaveral by and Atlas 2AS, the second stage of which was left in a 26.50 deg, 730.33 minutes, 166-40,806 km orbit.

1995 Jan 15/1345	None	EXPRESS 1		765 kg
1995 Jan 15.6	31deg	88.09 min	110 km	250 km

EXPRESS ("EXPeriment REuseable Space System") is a joint Japanese-German programme (ISAS in Japan), using a re-entry vehicle supplied by Khrunichev in Moscow and based upon one of their Salyut re-entry capsules (possibly also related to the 1960s-1970s FOBS re-entry vehicles). Satellite carried six experiments (total mass 153 kg): three from Germany and three from Japan. A launch vehicle second stage attitude control problem prevented the planned orbit (31.07 deg, 210-398 km) from being attained and the spacecraft and kick motor reached a low orbit from which they quickly decayed: the satellite burned up in the atmosphere at 1631 UTC.



It had been planned to recover the re-entry module in Woomera, Australia after 5.5 days in orbit. Launch was from Uchinoura and used the M-3S-2 vehicle.

USSPACECOM has not issued any catalogue numbers or international designations for this launch (it should be catalogued as 1995-002) because it is claimed (probably incorrectly) that none of the sensors used by USSPACECOM tracked the launch. As a result of this bureaucratic decision by USSPACECOM the counting of the remaining launches for 1995 (which is used here) is currently in error by one. The orbit listed above is an approximate one, quoted by the Japanese.

Launch Date/Time	Int Des	Satellite		Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Jan 24/0345	1995-002A	Tsikada 1		825 kg *
1995 Jan 25.71	82.97 deg	104.97 min	965 km	1,021 km
1995 Jan 24/0345	1995-002B	Astrid		28 kg
1995 Jan 25.71	82.93 deg	105.02 min	965 km	1,026 km
1995 Jan 24/0345	1995-002C	FAISAT		114 kg
1995 Jan 26.85	82.93 deg	104.99 min	968 km	1,021 km

Primary payload is a civilian navigation satellite in the "Tsikada" system: previously launches have been within the Cosmos programme, apart from a few satellites starting in 1989 which carried international search-and-rescue transponders which were named Nadezhda: Tsikada 1 is co-planar with Cosmos 2123. Astrid is a magnetospheric research microsatellite, launched for the Swedish Space Corporation. Satellite carries a neutral particle imager, a miniature UV imaging system and an electron spectrometer. FAISAT is a store-forward communications satellite, modified by and launched for Final Analysis Inc in Greenbelt, Maryland. Second stage of the Intermediate Cosmos launch vehicle is in an orbit similar to that for the three satellites. Launched from Plesetsk.

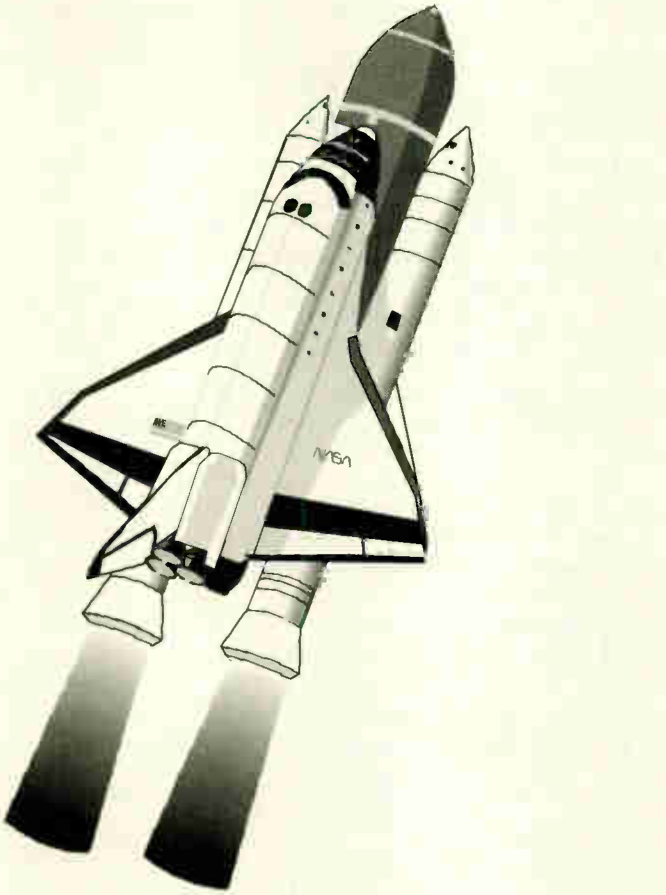
1995 Jan 25/2240 APStar 2 3,000 kg *
Failed to reach orbit

APStar 2 was a Hughes HS-601 satellite, launched for APT Satellite Co Ltd: planned for deployment over 76.5 deg E. In an apparent near-repetition of the Optus-B 2 failure (in December 1992), the satellite exploded 51 seconds after launch from Xi Chang violently enough to destroy CZ-2E vehicle (in the case of Optus-B 2 part of the satellite was placed in orbit, attached to its STAR-63F perigee kick motor): six people were killed and 23 were injured by debris from the explosion. It was later reported that the explosion of APStar 2 was due to a propellant leak.

Launch Date/Time	**Int Des**		**Satellite**	**Mass**
Epoch	**Incl**	**Period**	**Perigee**	**Apogee**
1995 Jan 29/0130	1995-003A		UFO 4 (USA 108)	2,800 kg *
1995 Jan 30.28	26.96 deg	479.43 min	301 km	27,525 km
1995 Feb 7.38	5.13 deg	1,436.23 min	35,645 km	35,933 km

"UHF Follow-On" satellite is based on the Hughes HS-601 satellite. Mass of satellite on station is 1,360 kg. First UFO satellite to carry the EHF ("extremely high frequency") communications payload, to be carried on all future UFO satellites. To be operated over 183 deg E but initially stationed over 189 deg E. Launched from Cape Canaveral using an Atlas 2.

1995 Feb 3/0522	1995-004A		Discovery (STS-63)	95,853 kg
1995 Feb 3.47	51.64 deg	91.07 min	312 km	342 km
1995 Feb 6.85	51.65 deg	92.35 min	387 km	392 km
1995 Feb 7.25	51.65 deg	92.75 min	408 km	410 km
1995 Feb 3/0522	1995-004B		SPARTAN 204	1,167 kg
1995 Feb 8.06	51.65 deg	92.32 min	388 km	388 km
1995 Feb 3/0522	1995-004C		ODERACS 2A	5 kg
1995 Feb 6.52	51.64 deg	91.33 min	329 km	351 km
1995 Feb 3/0522	1995-004D		ODERACS 2B	4.25 kg
1995 Feb 7.53	51.65 deg	91.25 min	323 km	349 km
1995 Feb 3/0522	1995-004E		ODERACS 2C	0.53 kg
No orbital data issued				
1995 Feb 3/0522	1995-004F		ODERACS 2D	1.5 grams
1995 Feb 11.07	51.64 deg	91.06 min	317 km	336 km
1995 Feb 3/0522	1995-004G		ODERACS 2E	1.5 grams
1995 Feb 11.07	51.64 deg	91.12 min	320 km	339 km
1995 Feb 3 05.22	1995-005H		ODERACS 2F	0.5 grams
No orbital data issued				



Shuttle mission carrying six astronauts: J D Wetherbee (commander), E M Collins (pilot - first woman to pilot a shuttle), B A Harris Jr (payload commander, mission specialist MS-1, EVA crewman EV-2), C M Foale (MS-2, EV-1), J Voss (MS-3) and V G Titov (MS-4, second Russian to fly on a shuttle). Shuttle performed a rendezvous with Mir Complex Feb 6, manoeuvring to a distance of 10 metres from the station at 1921 UTC. Shuttle "parked" over the longitudinal docking port of the Kristall module which is docked radially with the Mir core module, this port being planned to be used for the Atlantis (STS-71) docking mission with Mir in June 1995 (by this time Kristall will have been re-located to the front longitudinal port of the Mir core). Fixed payload in the shuttle's payload bay was SPACEHAB-3, mass 3,976 kg, used to permit easy access to space for commercial and other microgravity experiments. Launched from and landed
at Kennedy Space Center, the latter coming Feb 11 at 1151 UTC.

SPARTAN 204 ("Shuttle Pointed Autonomous Research Tool for Astronomy") was initially deployed while remaining attached to the shuttle's remote manipulator arm during Feb 4: during this period it was pointed at the shuttle's tail to observe its surface glow: it was also pointed at one of the shuttle's reaction control thrusters (RCS) to obtain far-ultraviolet spectrographs of the thruster firing. Second part of SPARTAN operations were in free-flight. It was deployed from the shuttle Feb 7 at 1226 UTC and re-captured Feb 9 at 1133 UTC: during the period of free-flight ultraviolet-region astronomical observations were conducted.

Second flight of ODERACS ("Orbital Debris Radar Calibration System") satellites, the first being aboard Discovery/STS-60 in February 1994. The small satellites are to be used to test the tracking capabilities of ground-based radar and optical sensors, allowing those measurements to be calibrated with small objects of a known size and composition. Three ODERACS-2 satellites are spheres and the other three are dipoles of platinum alloys.

Launch Date/Time		Int Des	Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Feb 15/1648		1995-005A	Progress-M 26	7,250 kg *
1995 Feb 15.75	51.61 deg	88.61 min	188 km	224 km
1995 Feb 18.01	51.65 deg	92.45 min	391 km	397 km

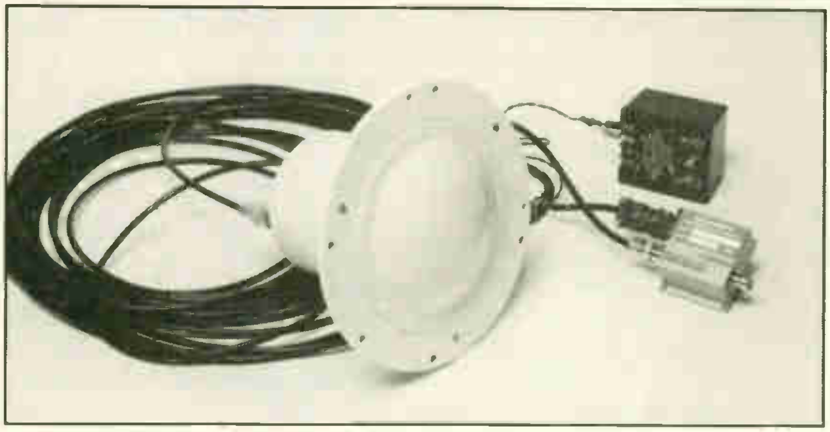
Unmanned cargo freighter, carrying supplies to the Mir cosmonauts as well as 100 kg of equipment to be used by United States astronaut Norman Thagard during his visit to Mir. Spacecraft docked with the rear port on the Kvant 1 module at the rear of the Mir Complex Feb 17 at 1822 UTC. Launched from Tyuratam using a Soyuz launch vehicle: third stage of Soyuz was in an orbit siliar to the first listed above for the spacecraft.

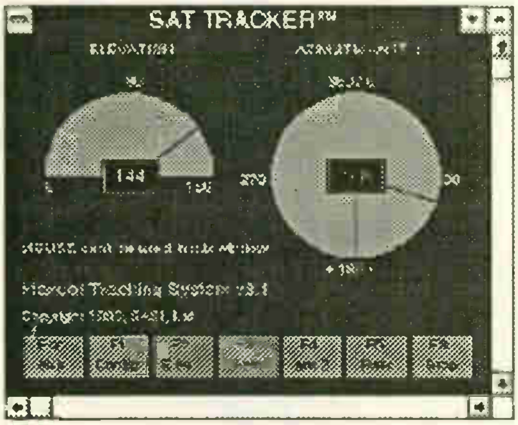
Launch Date/Time		Int Des	Satellite	Mass
1995 Feb 16/1740		1995-006A	Foton 7 (Flight 10)	6,200 kg *
1995 Feb 16.85	62.81 deg	90.40 min	220 km	369 km

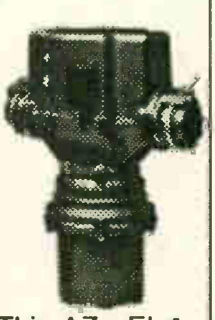
Tenth Foton satellite to be launched (the launch announcements referred to it as "Foton 10"), although only the seventh satellite to carry the Foton name: first three flights were within the Cosmos programme. Spacecraft launched to undertake materials processing experiments, permitting the manufacture of high-quality semi-conductors and variable-refraction lenses. Also carries the ESA Biobox-2 incubator with experiments from Belgium, France, the Netherlands, Spain and Russia concerning the cells responsible for bone mineralisation and on small living organisms (algae and fruit flies), as well as the French Ibis equipment (for CNES) which carries shrimps and urchin larvae to be used for studies into the effects of gravity on the formation of the nervous, vision, hearing and muscular systems. The mission is scheduled to last for 15 days. Launched from Plesetsk using a Soyuz vehicle, leaving a third stage in an orbit similar to that for the satellite.

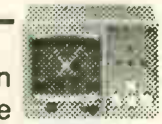
Updates from previous launches.

1977-048A	GOES 2 was boosted off-station over 224 deg E during 1995 Jan 19-28.
1983-073A	Molniya-1 58 decayed from orbit 1995 Feb 23.
1983-077A	Telstar 301 was manoeuvred off-station over 252-253 deg E during 1994 Aug 3-Aug 6 and finally stabilised its orbit over 20 deg E during February 1995.
1984-023A	INTELSAT 508 was boosted off-station over 179-180 deg E approximately 1994 Dec 17-18: it was still drifting at the end of January 1995.
1985-004A	Molniya-3 23 decayed from orbit 1994 Dec 5.
1987-022A	GOES 7 was boosted off-station over 246-247 deg E during 1994 Dec 20-30: it was still drifting at the end of January 1995.
1988-066A	Cosmos 1961 drifted off-station in summer 1993 and is no longer operational.
1989-004A	Gorizont 17 was boosted off-station over 133-134 deg E approximately 1995 Jan 17: this satellite has been leased to the RIMSAT Corporation.
1989-062A	TVSat 2 was manoeuvred off-station over 340-341 deg E approximately 1995 Feb 10-11.
1990-016A	Raduga 25 was manoeuvred off-station over 69-70 deg E during 1995 Feb 26-27.
1993-029A	Cosmos 2244 was manoeuvred off-station during 1995 Feb 13-14 and has been retired. Add the following orbital data (the first is the operational orbit): 1995 Feb 13.10, 65.02 deg, 92.78 minutes, 402 km, 419 km, 296 deg 1995 Feb 14.46, 65.02 deg, 91.85 minutes, 315 km, 415 km, 260 deg 1995 Feb 14.61, 65.02 deg, 90.98 minutes, 229 km, 416 km, 273 deg The satellite is now decaying from orbit. This leaves Cosmos 2258 (1993-44A), Cosmos 2264 (1993-060A) and Cosmos 2293 (1994-072A) as the operational EORSAT constellation.
1994-006G	ODERACS F decayed from orbit 1995 Feb 24.
1994-006H	BREMSAT decayed from orbit 1995 Feb 12.
1994-022A	GOES 8 was manoeuvred off-station over 268-269 deg E approximately 1995 Feb 2.
1994-035A	The first sets of orbital data for UFO 4 (USA 104) appeared in January 1995. Add the following orbital data: 1995 Jan 18.52, 4.87 deg, 1,436.01 minutes, 35,772 km, 35,797 km, 298 deg
1994-055A	The initial mass of Optus-B 3 should be "3,000 ?" kg.
1994-063A	Soyuz-TM 20 with Mir cosmonauts Viktorenko, Kondakova and Polyakov undocked from the Mir Complex 1995 Jan 18 at 0857 UTC, retreated to a distance of 160 metres and re-docked with the Complex at the same port (front longitudinal) at 0923 UTC: the exercise was to check the automatic docking system which had failed during the spacecraft's docking in October 1994 (that docking had to be performed manually).
1994-067A	Ekspress 1 was boosted off-station over 70 deg E during 1995 Jan 4-5 and it was relocated over 345-346 deg E approximately Feb 11.
1994-075A	Progress-M 25 undocked from the Mir Complex and was later de-orbited 1995 Feb 16. No Russian announcements giving the undocking and de-orbit details have appeared through to the end of February, and the fate of the recoverable Raduga capsule is unknown.
1994-079A	Add the following geosynchronous orbit for Orion 1: 1995 Jan 7.90, 0.06 deg, 1,436.16 minutes, 35,775 km, 35,801 km The satellite is deployed over 321-322 deg E.
1994-087A	Add the following orbital data for Raduga 32: 1995 Jan 11.01, 1.45 deg, 1,436.17 minutes, 35,784 km, 35,792 km This orbit has the satellite located over 70 deg E.




SAT TRACKER™





Hubble Monitors Weather on Neighboring Planets

"The weather on Mars: another cool and clear day. Low morning haze will give way to a mostly sunny afternoon with high clouds. The forecast for Venus: hot, overcast, sulfuric acid showers will continue. Air quality is slightly improved as smog levels subside."

NASA's Hubble Space Telescope is serving as an interplanetary weather satellite for studying the climate on Earth's neighboring worlds, Mars and Venus.

Mars: A Cooler, Clearer World

Four years, (or two Mars years') worth of Hubble observations show that the Red Planet's climate has changed since the mid-1970's. "The Hubble results show us that the Viking years are not the rule, and perhaps not typical. Our early assumptions about the Martian climate were wrong," said Philip James of the University of Toledo.

"There has been a global drop in temperature. The planet is cooler and the atmosphere clearer than seen before," said Steven Lee of the University of Colorado in Boulder. "This shows the need for continuous monitoring of Mars. Space probes provided a close-up look, but it's difficult to extrapolate to long-term conditions based upon these brief encounters."

The researchers attribute the cooling of the Martian atmosphere to diminished dust storm activity, which was rampant when a pair of NASA Viking orbiter and lander spacecraft arrived at Mars in 1976. Two major dust storms occurred during the first year of the Viking visits, which left fine dust particles suspended in the Martian atmosphere for longer than normal. Warmed by the Sun, these dust particles (some only a micron in diameter, about the size of smoke particles) are the primary source of heat in the Martian atmosphere.

"Hubble is showing that our early understanding based on these visits is wrong. We just happened to visit Mars when it was dusty, and now the dust has settled out," Lee said. "We are going to have to look at Mars for many years to truly understand the workings of the climate," said Todd Clancy, of the Space Science Institute, Boulder, Colorado.

Knowledge about the Martian climate has been limited by the fact that ground-based telescopes can only see weather details when Earth and Mars are closest — an event called opposition — that happens only once every two years. Though Hubble has observed Mars only for four years, the observations are equivalent to 15 years of ground- based observing because Hubble can follow seasonal changes through most of Mars' orbit.

Though the Mariner and Viking series of flyby, orbiter and lander spacecraft that visited Mars in the late 60's and 70's provided a close-up look at Martian weather, these were snapshots of the planet's complex climate. Hubble provides the advantage of a global view - much like the satellites that monitor Earth's weather, and can follow martian seasonal changes over many years. When Mars is closest to Earth, Hubble returns near-weather satellite resolution.

Mars: No Lack of Ozone

Although there has been concern about a lack of ozone (a form of molecular oxygen created by the effects of sunlight on an atmosphere), dubbed the "ozone hole" over Earth's poles, there are no ozone holes on Mars. By contrast, the planet has a surplus of ozone over its northern polar cap, as first identified by the Mariner 9 spacecraft in 1971. (However the Martian atmosphere is different enough from Earth's that few parallels can be drawn about processes controlling the production and destruction of ozone.) Hubble's ultraviolet sensitivity is ideal for monitoring ozone levels on a global scale. The Martian ozone is yet another indication the planet has grown drier, because the water in the atmosphere that normally destroys ozone has frozen-out to become ice-crystal clouds. Spectroscopic observations made with the Faint Object Spectrograph (FOS) show that ozone now extends down from Mars' north pole to mid and lower latitudes. However, the Martian atmosphere is so thin, even this added ozone would offer future human explorers little protection from the Sun's harmful ultraviolet rays.

Seasons on Mars

The fourth planet from the Sun, Mars is one of the most intensely scrutinized worlds because of its Earth-like characteristics. Mars is tilted on its axis by about the same amount Earth is, hence Mars goes through seasonal changes. However, because Mars' atmosphere is much thinner than Earth's, it is far more sensitive to minor changes in the amount of light and heat received from

Mars at opposition, February, 1995. This image and all others on pp. 60-61 were photographed by the Hubble Space Telescope.

the Sun. This is intensified by Mars' orbit that is more elliptical than Earth's, so it's range of distance from the Sun is greater during the Martian year. Mars is now so distant, the sun is nearly 25% dimmer than average. This chills Mars' average temperature by 36 degrees Fahrenheit (20 degrees Kelvin). At these cold temperatures, water vapor at low altitudes freezes out to form ice-crystal clouds now seen in abundance by Hubble.

"Clouds weren't considered to be very important to the Martian climate during the Viking visits because they were so scarce," says Clancy. "Now we can see where they may play a role in transporting water between the north and south poles during the Martian year." Seasonal winds also play a major role is transporting dust across Mars' surface, and rapidly changing the appearance of a region. This gave early astronomers the misperception that Mars' shifting surface color was evidence of vegetation following a season cycle.

As clearly seen in the Hubble images, past dust storms in Mars' southern hemisphere have scoured the plains of fine light dust and transported the dust northward. This leaves behind a relatively coarser, less reflective sand in the southern hemisphere.

Venus: No Evidence for New Volcanic Eruptions

Hubble spectroscopic observations of Venus taken with the Goddard High Resolution Spectrograph provide a new opportunity to look for evidence of volcanic activity on the planet's surface. Though radar maps of the Venusian surface taken by the Magellan orbiter revealed numerous volcanoes, Magellan did not find clear cut evidence for active volcanoes.

Hubble can trace atmospheric changes that might be driven by volcanism. An abundance of sulfur dioxide in the atmosphere could be a tell-tale sign of an active volcanos. Sulfur dioxide was first detected by the Venus Pioneer probe in the late 1970s and has been declining ever since. The Hubble observations show that sulfur dioxide levels continue to decline. This means there is no evidence for the recurrence of large scale volcanic eruptions in the last few years.

Ejected high into Venus' murky atmosphere, this sulfur dioxide is broken apart by sunlight to make an acid rain of concentrated sulfuric acid. This is similar to what happens on Earth above coal-burning power plants - but on a much larger and more intense scale.

Future Plans

More Hubble observations of Mars and Venus are critical to planning visits by future space probes. In particular, both robotic and human missions to Mars will need to be targeted for times during the Martian year when there is a minimal chance of getting caught in a dust storm. Knowing whether the atmosphere is relatively hot or cold is crucial to planning aerobraking maneuvers, where spacecraft use the aerodynamic drag of an atmosphere to slow down and enter an orbit around the planet. This reduces the amount of propellant needed for the journey.

"If the atmosphere is more extended than expected the added friction could burn up an aerobraking spacecraft, just as Earth's atmosphere incinerates infalling meteors," says James.

Ultimately, knowing the Martian climate will be an fundamental prerequisite for any future plans to establish a permanent human outpost on the Red Planet.

Hubble photographed Venus in ultraviolet light in this January, 1995 image.

By John A. Magliacane, KD2BD

SUNSAT—An Amateur Radio Satellite for Educators

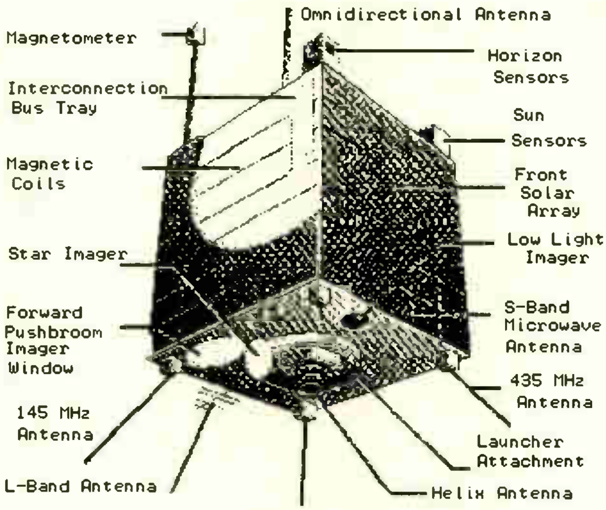


FIGURE 1

A new experimental satellite (SUNSAT) is currently under construction by students at the University of Stellenbosch, in South Africa. Stellenbosch is the second oldest town in South Africa, not far from the southern tip of the African continent. It is located about 50 kilometers east of Cape Town. The University of Stellenbosch has about 14,000 students, is one of the oldest universities in Africa, and has an excellent academic record.

SUNSAT is being built by students and lecturers, some of whom studied at the Universities of Surrey, Stanford and MIT. It is therefore not surprising to find the satellite is very similar to the famous ham UoSATs built at Surrey.

The new satellite is a microsatellite-class spacecraft. A sketch of the spacecraft appears in Figure 1. The satellite measures 45 cm x 45 cm x 40 cm in size, and has a mass of approximately 50 kilograms. It will be launched in January 1996 by NASA from Vandenberg Air Force, California on a U.S. Air Force Delta II as a replacement counterweight for the Danish Oersted microsatellite. SUNSAT will be carried into an elliptical polar orbit with an altitude ranging from 400 km to 840 km. This will guarantee a 15 minute access time to any groundstation on the globe, and yield an orbital period of approximately 100 minutes.

SUNSAT's primary payload is an amateur radio communications system that will support VHF, UHF, and S/L-band links, a 9600 baud packet radio bulletin board system, a high-resolution imager, and some innovative communication packages and experiments that are sure to attract the attention of educators.

Some of the experimental packages being flown on SUNSAT include:

- Parrot system on the 2-meter band that will relay approximately 8 seconds of speech.
- 2-meter analog channel for voice storage and transponder use.
- 24-cm/13-cm linear transponder that will be available for experimenters and repeating television signals.
- Bulletin board system that will enable the satellite to store files and other information in a "mailbox".
- 2-meter 1200 baud AFSK-FM packet radio transponder compatible with terrestrial VHF-FM packet radio stations.
- 2-meter/70-cm 9600 FSK (frequency shift keying) baud digital store-and-forward transponder.
- CCD Star Camera for accurately determining the satellite's attitude relative to the stars. The stellar coordinates can then

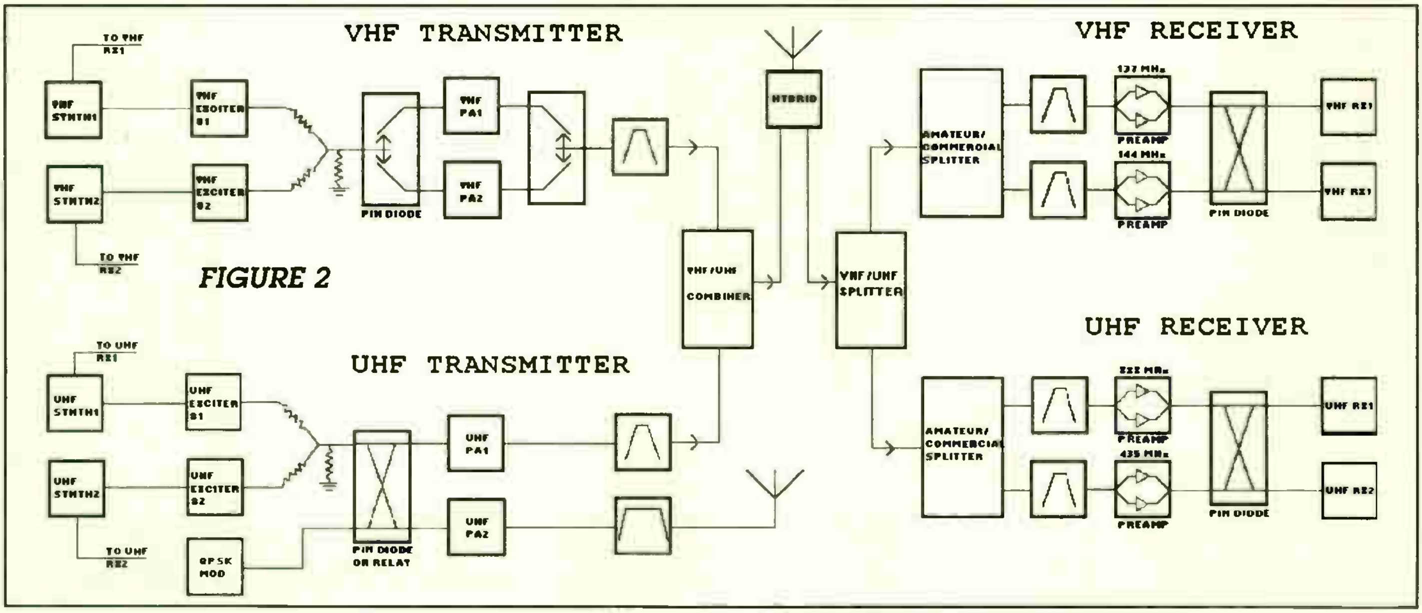
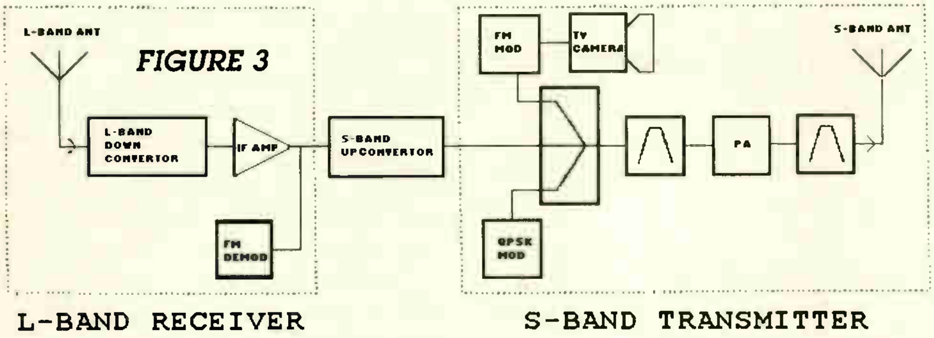


FIGURE 2

FIGURE 3



be converted to an attitude relative to the earth.

- Tri-band (color) CCD imager with a resolution of 15-meters per pixel.

SUNSAT Communications Payload

Figure 2 shows a block diagram of the VHF/UHF communications package. The VHF receiver front ends (137/144 MHz) consist of a narrowband helical bandpass filter followed by a dual (pin diode switched) low noise two stage transistor preamplifier with a noise figure of 1.3dB. Either of these two signals, amateur or commercial, can then be routed via pin diode switching to receiver 1 (RX1) or receiver 2 (RX2). Both receivers are of double superheterodyne design with IFs (intermediate frequencies) of 10.7 MHz and 455 kHz. The default receiver, RX1, is a single channel receiver, and is connected to a dedicated 1200 baud telecommand modem. It also has an extra IF output for use by a digital signal processing (DSP) modem. RX2 is a four channel receiver used for normal operation. The UHF receiver system is similar to the VHF system.

On the transmission side, the desired audio and digital signals are routed by the onboard computer system to the modem's tray and then to the selected exciter. The exciters use a 20 MHz voltage controlled oscillator (VCO), which is then mixed up to 137 MHz and 145.825 MHz by onboard local oscillators. Provisions for an extra synthesizer input are also provided. In an effort to minimize weight on the spacecraft, one exciter and one receiver use the same synthesizer unit. The synthesizer has a 20 MHz frequency span from 110 MHz to 130 MHz in 5 kHz steps.

The exciter's output is summed and fed to one of two Class C power amplifiers. The power amplifiers have a 1 watt (default) mode of operation to conserve battery power, and a 10 watt supplementary mode.

The only difference between the VHF and the UHF transmit system is the addition of an extra quadrature phase shift keying (QPSK) modulator to the UHF hardware for transmitting high speed data from the DSP modem. The QPSK modulated signal can be routed to any of the Class C power amplifiers, which will then place the output signal on either a wideband antenna or the UHF/VHF combiner unit.

Figure 3 shows a block diagram of the S/L-Band communications system. The main purpose of the S-band transponder is to downlink high-speed data from the imager at a rate of 2 megabits per second. The transponder has provisions for downlinking camera video in an analog format using frequency modulation.

The L-band receiver will most likely be used to receive software uploads from the command station, and act as a backup receiver for telecommand of the spacecraft. This data link will operate at a rate of 40 megabits per second.

SUNSAT Star Camera

Figure 4 shows a block diagram of the SUNSAT star camera hardware. A charge coupled device (CCD) imaging camera will be used to photograph the stars, and compare these images with known star catalogs in an effort to determine the satellite's attitude relative to the stars. The stellar coordinates obtained from the SUNSAT star camera can then be converted to determine the specraft attitude relative to the earth.

The CCD camera photographs all stars within a 10 x 10 degree field-of-view (FOV), which is then digitized by the analog-to-digital converter (ADC) to a resolution of 64 scales of gray, and stored in random access memory (RAM) for processing. The raw image is first run through a threshold function, which decides whether a pixel represents a star, a dark space, or a space contaminated by noise or irregularities. The software then records the coordinates of significant pixels, such as those representing brighter than magnitude 6 stars, for use by the constellation recognition algorithm. The recognition algorithm then attempts to find a constellation from the onboard star catalogue which best matches the observed star field. If a match is found, then the stellar coordinates of the guide constellation are used to determine the satellites attitude.

The recognition algorithm is very accurate, but it subject to failure due to a lack of bright stars in the camera's field of view, planets, noise exceeding threshold detection, or other satellites appearing in the field of view of the camera. The impact of such errors will be minimized by waiting a short period of time after taking the initial image and taking another star field image, or by cross checking the derived attitude against the onboard sun sensor and array currents.

FIGURE 4 **Star Camera Block Diagram**

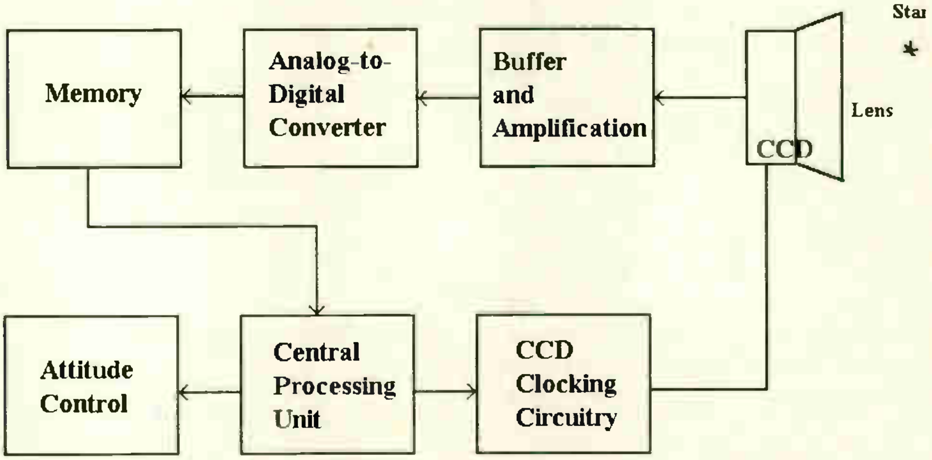
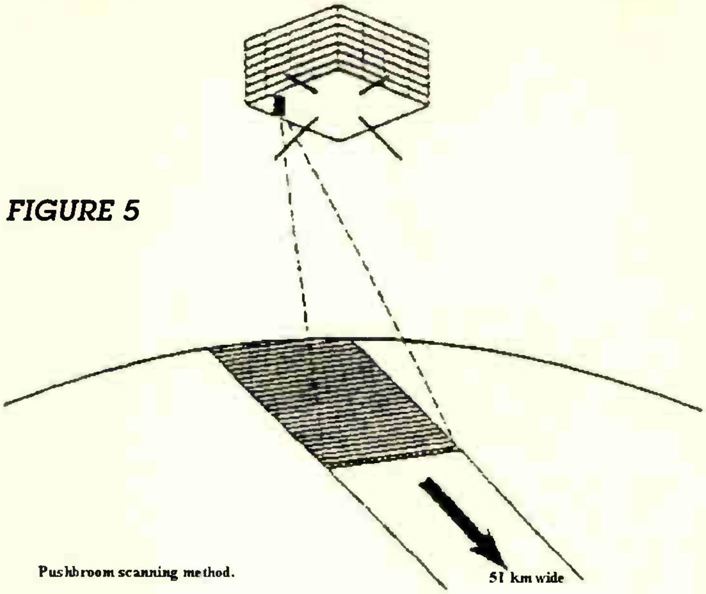


FIGURE 5



Pushbroom scanning method.

SUNSAT High Resolution Imager

The SUNSAT high resolution imager (HRI) will be capable of taking monochrome, tri-color, and stereo images of the earth with a resolution of 15 kilometers. The imager will use the pushbroom scanning method (see Figure 5), whereby a linear (3456 x 1 pixel) charged coupled device will be exposed many times per second to create an image 52 km x 96 km in size. The imager's single tube assembly (Figure 6) contains a 45 degree mirror, reflective lens system, pentaprism with dichroic color splitter, three linear CCD imagers, drivers, and output conditioning electronics. The tube is diagonally mounted in the lower tray of the spacecraft, and can be rotated by a stepper motor to alter the view direction.

The three conditioned video signals will each be digitized by an 8-bit flash analog-to-digital converter and stored in a portion of the 64 megabyte static random access memory array on-board the spacecraft. Any one or all three CCD channels may be stored. Each image requires 11.5 megabytes of RAM per color. SUNSAT can store an entire 34.5 megabyte tri-color image in just 14 seconds.

Images taken by SUNSAT may be converted to a standard image format (GIF, JPEG, etc.) by the on-board computer and kept as 100 kilobyte files on the satellite's bulletin board system and be available for download using packet radio techniques in a single pass, or directed to a high-speed modem for transmission to ground stations via the S-band downlink in real-time.

SUNSAT Bulletin Board

The SUNSAT micro-satellite bulletin board system (BBS) is designed to be usable by groundstations with low-cost equipment. The BBS will utilize data rates of 1200 and 9600 baud and modulation techniques compatible with existing terrestrial packet radio systems and Pacsat satellites. In addition to the standard data and modulation rates, SUNSAT will carry a DSP modem interface for experimentation, research, and development in new digital modulation techniques.

SUNSAT will maintain compatibility with terrstrial packet radio stations by flying with 1200 baud audio frequency shift keying (AFSK) modems. It will also carry 9600 baud frequency shift keing (FSK) G3RUH-type modems to maintain compatibility with existing Pacsat groundstations.

The SUNSAT BBS will operate under control of two on-board computers (OBCs). One computer is designed around an Intel 80188 microprocessor, while the second will utilize a more robust 80386SL. These dual redundant computer systems will run the software implementing the BBS. Both OBCs will have access to 64 megabytes of static random access memory that will act as a RAM disk for BBS message storage. Data compression techniques will yield an effective storage area of about twice the 64 megabyte figure.

The OBCs will run the BBS software along with an AX.25 version 2 protocol driver for compliance with the Pacsat protocol standard. This will allow compatibility with existing Pacsat groundstations, groundstation hardware, and groundstation software, such as PB, PG, WiSP, and MGSS.

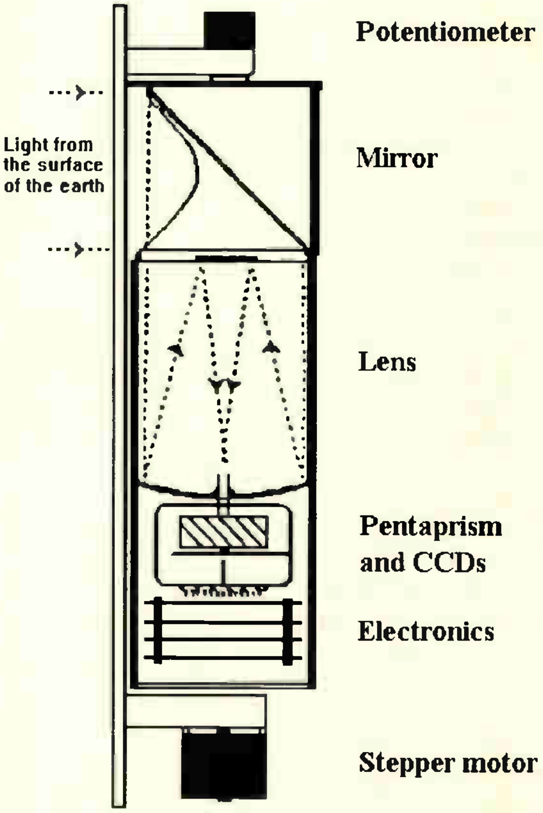
Easypack Transponder

While efforts to maintain compatibility with existing packet radio and Pacsat communication protocols have been made by SUNSAT designers, the satellite will carry additional features not found in current microsatellites. In an effort to involve schools in the SUNSAT project, the satellite will carry an "EasyPack" digital transponder that will allow communication with the satellite using a very low-cost, do-it-yourself groundstation. The transponder will operate in simplex mode on a single uplink and downlink frequency. It is hoped that the "EasyPack" transponder will stimulate interest in technology and facilitate communication between schools of southern Africa. Special software is being developed to make the "EasyPack" transponder easy to use.

SUNSAT News

The latest SUNSAT news will be available on the SUNSAT BBS through the posting of regular bulletins by the SUNSAT command station. The SUNSAT team wants the amateur radio community to particpate in the SUNSAT project, and will be making use of the SUNSAT BBS to provide a medium for the exchange of ideas and information with the community of amateur satellite enthusiasts.

FIGURE 6



Parrot-Radio Interface

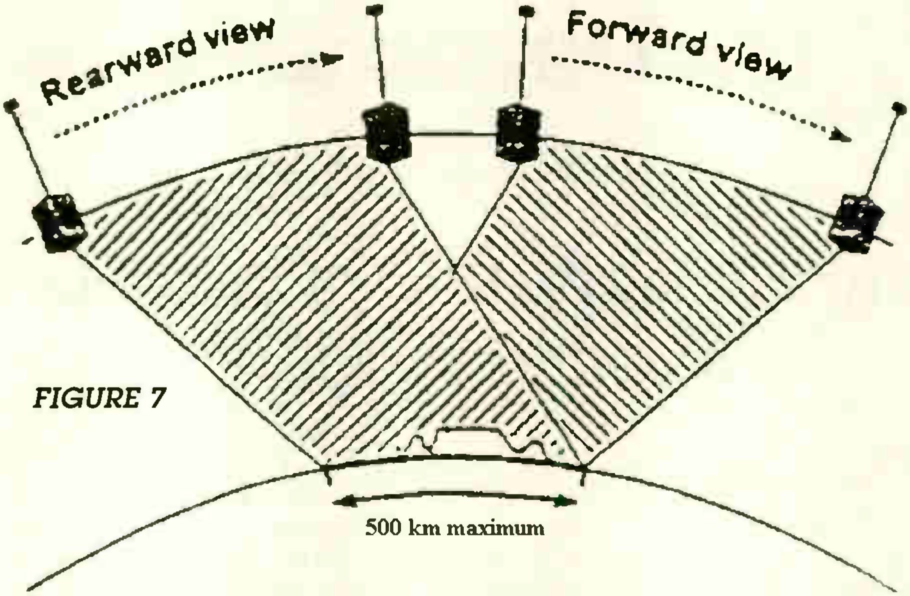
SUNSAT will have the ability to play back 8-seconds of a stored audio signal through its radio channels. Sound files uploaded to the BBS can be played back under OBC control. The Parrot will operate in the 2-meter band, and will allow communication with distant amateurs who do not have packet radio equipment.

The SUNSAT BBS may also be used to mirror messages and files stored on other Pacsat satellites and function as a "one-stop shopping" satellite for all the latest Pacsat files. SUNSAT may also be used to function as a gateway to certain USENET newsgroups carried on the Internet, and TCP/IP electronic mail relays through SUNSAT are also under active consideration by SUNSAT system designers.

LOS

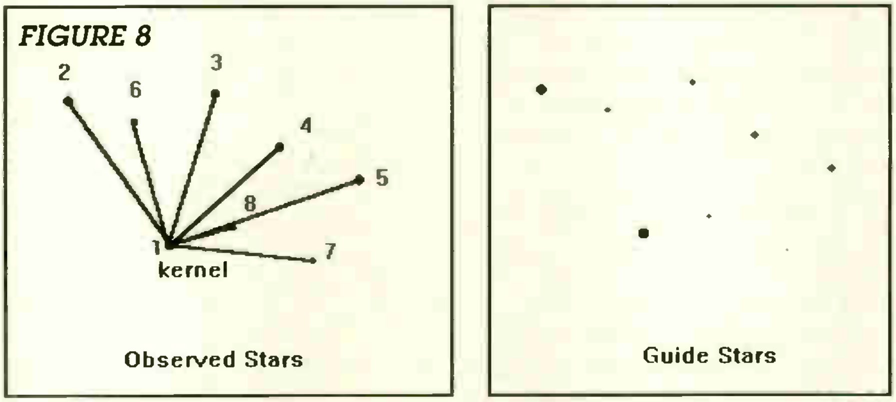
Software for both the ground and space components of SUNSAT are currently being developed on engineering models using JPI Modula-2. As work continues and progress is made in preparing SUNSAT for a launch into low-earth orbit next year, we all wish the designers at the University of Stellenbosch the best in their development and construction of a truly unique microsatellite that will serve the amateur radio community in ways that no other satellites have done before. ST

FIGURE 7



SUNSAT's single pass stereo imaging procedure.

FIGURE 8



Observed Stars

Guide Stars

TABLE 1

Summary of SUNSAT imager characteristics when at an altitude of 800 km.

Linear CCD Sensor:	3 Texas Instruments model TC104-1 imagers
Filter, 50% transmission:	520 - 610 nm, 610 - 700 nm, 700 - 900 nm
Sensor pixel size:	10.7 x 10.7 um
Number of pixels:	3456
Optical focal length:	570 mm
Aperture diameter:	100 mm
F number:	1:5.7
Ground pixel size:	15m x 15m
Image swath width:	51.8 km
Quantization:	8 bit
Bit rate:	37 Mbit/s
Power consumption:	15 W
Mass:	3 kg

ST THE VIEW FROM ABOVE

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

The "Black-World" of Weather Satellite Imagery

Over the past month, there have been a number of calls to the Dallas Remote Imaging Group (DRIG) office inquiring about the significance of the merger of the National Oceanographic and Atmospheric Administration/ National Enviromental Satellite, Data and Information Service (NOAA/NESDIS) and the Department of Defense (DoD) weather satellite programs mandated by the Clinton Administration. This merger of civilian and military weather satellites (tried eight times in the past twenty-two years, and none successful thus far!) is an important part of the Administrations plans to streamline government in general, and space programs, specifically. Under the Presidential order, NOAA, NASA, and Department of Defense setup the Integrated Program Office late in 1994. This office is charged with making the civilian and military agencies work smoothly together to bring about an integrated meteorological satellite program.

Actually, both NOAA and the U.S. Air Force have maintained and operated separate polar orbiting weather satellites since the early 1960's. While most weather satellite enthusiasts are familiar with the NOAA/ NESDIS Advanced TIROS series of weather satellites (NOAA 14, most recent in the series, was launched in Dec. 1994), the U.S. Air Force Defense Meteorological Satellite Program (DMSP) is less well-known. In fact, the DMSP program was for some time classified as one of those 'black' programs......for government eyes only.....similar to the Keyhole KH-11 series of spy reconnaissance satellites! This column will introduce the DMSP program, its history, mission, and future plans to provide direct readout imagery to civilian and military users world-wide.

The Defense Meteorological Satellite Program provides meteorological and environmental data for the U.S. Air Force (and military allies) around the world. The purpose of DMSP is to provide high-quality weather data in a timely fashion from polar-orbiting spacecraft operated by the U.S. Air Force. The DMSP system consist of the ground, launch, and space segments. The program is managed by the Air Force Material Systems Command Space Division at Los Angeles Air Force Base, Calif.

FIGURE 1

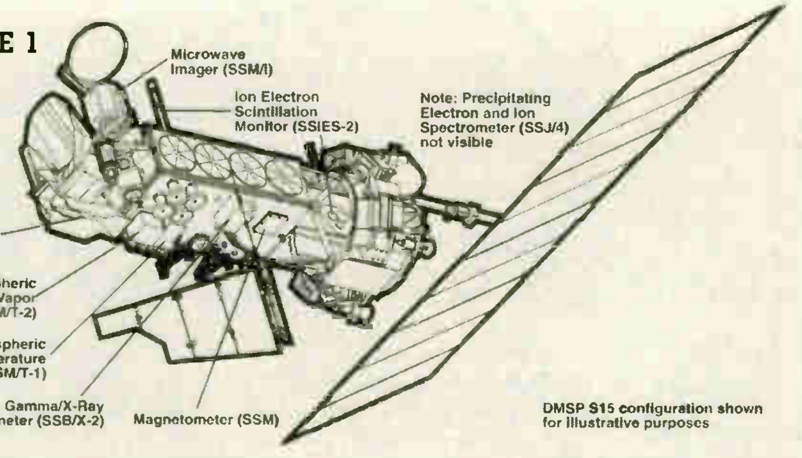


TABLE 1

DMSP Technical Specifications

Launch Configuration	
First Stage	Atlas E/F, Titan II (refurbished ICBMs)
Second Stage	Star 37S AKM
Weight at Liftoff	1500kg (3,300 lb)
Size	3.7 m (12.21 feet) long by 1.2 m (3.96 feet) diameter
Payload weight	227 kg (500 lb)
Orbit	Circular, Sun-synchronous, Polar
Altitude	849 km (526 miles)
Period	101 minutes
Inclination	98.7 degrees
Attitude Determination	Zero Momentum, 3 -Axis stabilized
Primary system accuracy	0.01 degrees Pointing
Control mechanism	Momentum wheels, Magnetic coils
Design Life	48 months
Contractor	Lockheed Martin
Communications Payload	
Uplink	1792 Mhz
Payload Data Links	2207.5 Mhz (imagery), 2252.5 Mhz, 2267.5 Mhz
Telemetry downlinks	2237.5 Mhz

The ground segment provides command and control functions, receives sensor data, and processes and disseminates the data to the user community. Stored data is transmitted from the U.S. Air Force weather central at Offut Air Force Base, Neb., through commercial communication links. The real-time day and night visible and infrared (IR) imagery is digitally encrypted and transmitted directly from the satellite to ground user terminals and Navy aircraft carriers. The DMSP satellites are launched on either the Atlas E/F booster or Titan II launched from the Western Test Range, Vandenberg Air Force Base, Calif.

The space segment consist of the DSMP satellite, and has been in existence since 1966. the current Block V-D satellite carries a variety of sensors, including visible (0.5 km.), infrared , passive microwave temperature sounder and infrared sounders, that measure temperature and moisture content as a function of altitude above sea level. A microwave imager provides data on sea ice, soil, and cloud moisture. Charged particle sensors measure activity around the spacecraft, the Earth's Aurora, and limb,

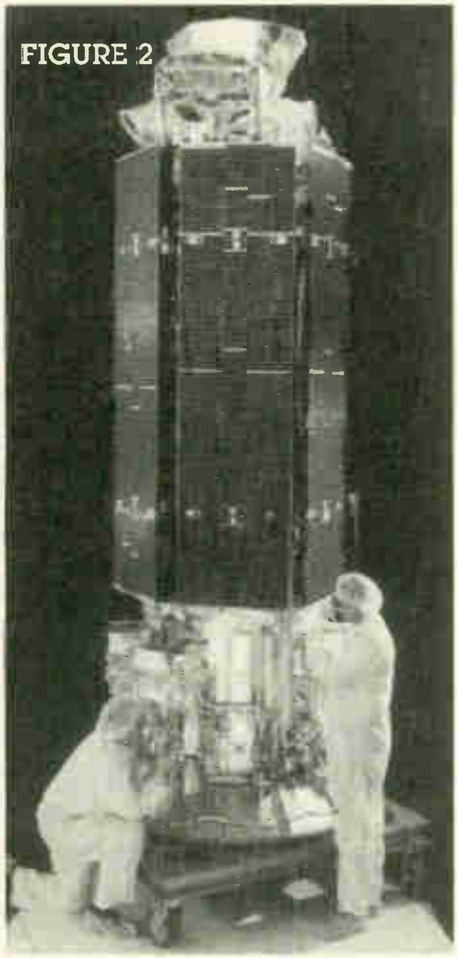


FIGURE 2

and are used to characterize the ionosphere to make low frequency radio wave propagation predictions for the U.S. military command. A low light sensor can image lights from cities, reflections of the moon off of cloud tops, and the Aurora Borealis. The low light sensors have been used in the analysis of the strength and character of solar storms (again, with concern for communication disruptions by Sun).

TABLE 2

DMSP/NOAA Platform Differences

Advanced TIROS NOAA spacecraft	**DMSP**
Analog APT Image	4.0 Km. visibleNone Analog APT Product
Digital HRPT	1.0 KM. visible imageDigital 0.5 km. visible image
HRPT Frequencies	1702.5 Mhz2207.5 Mhz
Access to Imagery	Non-Encrypted, Public AccessDigital Encryption, Military access only

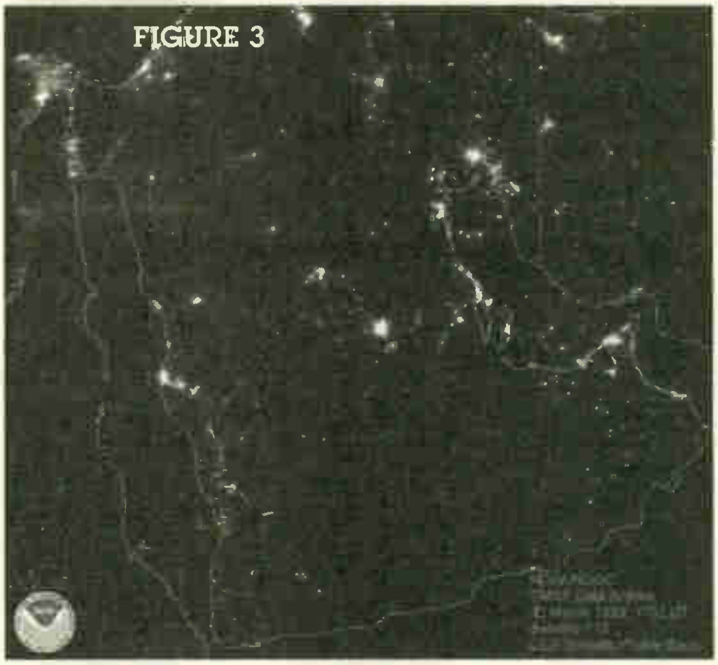


FIGURE 3

Figure 1. is a schematic diagram of the DMSP Block V-D platform. The Advanced TIROS series spacecraft that NOAA/NESDIS operates is actually a derivative of this platform. Some of the technical specifications for DMSP program are included in Table 1.

Figure 2. is a picture of the DMSP Block 5D-2 satellite removed from storage for testing at Vandenberg Air Force Base.

In Table 2, note some of the differences between the DMSP platform and the NOAA platform data capabilities for the amateur user of the direct readout systems.

The question is often asked, "can I receive the DMSP images just like I do from the NOAA polar orbiters?" Unfortunately, the answer is no. Unless you have the digital encryption key used in encrypt the imagery data stream, it is not possible to receive the high resolution images (0.5 km in visible band), even if you have the equipment similar to the HRPT setups used on the NOAA platforms. This *may* possibly change sometime in the future, post NOAA M launch early next century. For now, the military policy remains in force, this is classified data of military intelligence value, and will remain encrypted (other than some brief times when testing is conducted with digital encryption turned off, usually over the U.S. mainland).

We have included several interesting images taken from the DMSP satellites that have been released to the public in this column.

Figure 3. is an actual image taken by the low light sensors onboard the spacecraft at night. This image show the Mideast, with the Red Sea to the left, and Saudi Arabia lit up by lights of the cities and oil wells burning.

Figure 4 is a similar image of the US at night, with Route 66 superimposed on the

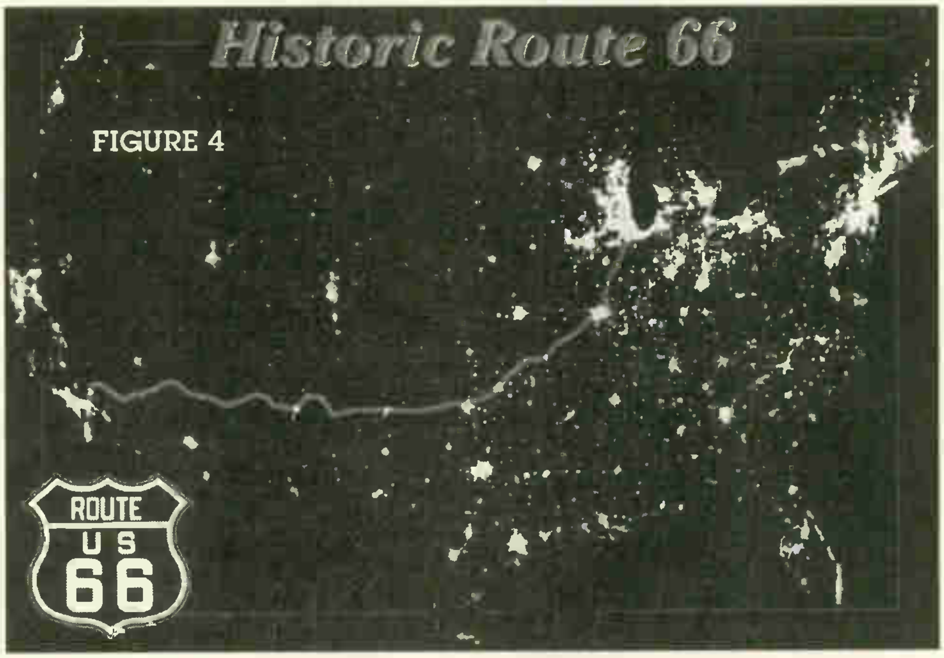


FIGURE 4


FIGURE 5

lights to show this historic route (postcard that may be purchased from USGS-EROS Data Center).

Figure 5. is an image of the Earth's Aurora, again, taken by the low light sensors on the DMSP satellite. This image was taken at the North pole, and the polar project of the Earth is superimposed on the image for latitude registration.

Figure 6. is a montage of images taken of the Blizzard of 1993 by the DMSP F-10 satellite. The distribution of clouds in the InfraRed are shown in the upper left, with the low light sensor in upper right, and microwave image in lower left. This montage was provided by courtesy of the NOAA/NGDC DMSP Digital Archive Center (303-497-6126).

Lastly, Figure 7 is an artist's conception of a DMSP Block 5-D satellite imaging at 870 km. above the Earth.

The current plans for the Integrated Office is to keep the spacecraft separate (NOAA and DSMP) through the NOAA-M launch set for early next century, when a plan to combine sensors and payloads on one type of spacecraft will be implemented. NOAA will have the actual responsibility of operating the spacecraft and offices.

As more information on the merger of the NOAA and DMSP programs becomes available, we will keep you apprised as to new and changing capabilities that amateur satellite sleuths will have to image these high resolution data products! ST


FIGURE 7

TABLE 3

Current Status of Active Polar Orbiting Weather Satellites

NOAA-9	137.620 Mhz
NOAA-10	137.500 Mhz
NOAA 12	137.500 Mhz
NOAA-14	137.620 Mhz
Meteor 3-5	137.850 Mhz

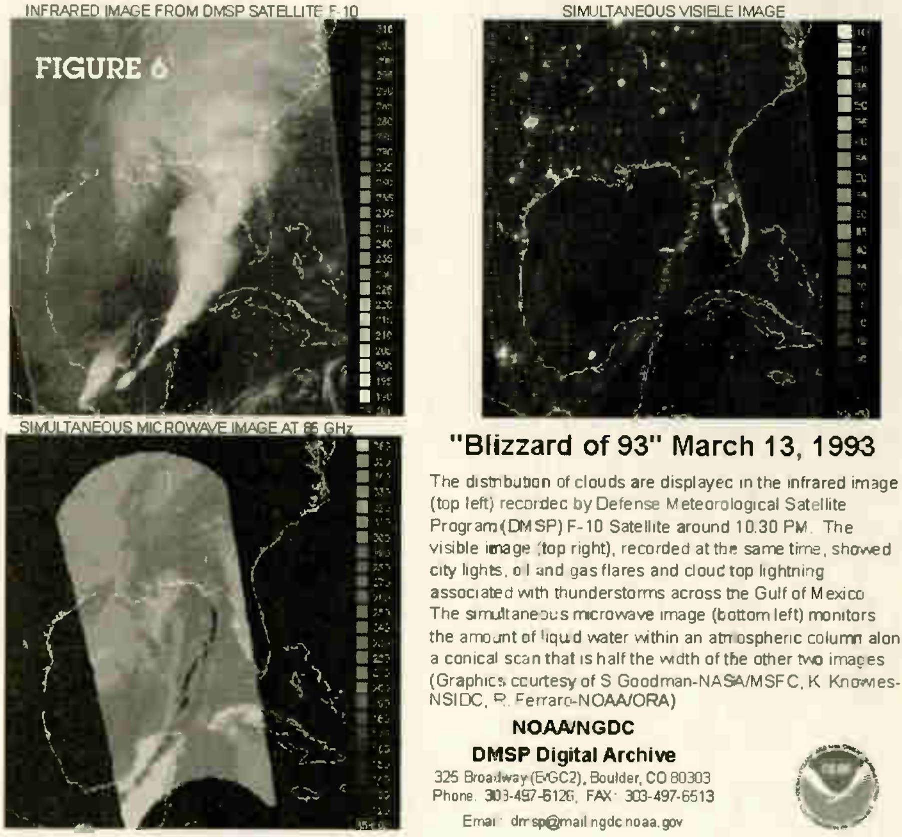


FIGURE 6

INFRARED IMAGE FROM DMSP SATELLITE F-10

SIMULTANEOUS VISIBLE IMAGE

SIMULTANEOUS MICROWAVE IMAGE AT 85 GHz

"Blizzard of 93" March 13, 1993

The distribution of clouds are displayed in the infrared image (top left) recorded by Defense Meteorological Satellite Program (DMSP) F-10 Satellite around 10:30 PM. The visible image (top right), recorded at the same time, showed city lights, oil and gas flares and cloud top lightning associated with thunderstorms across the Gulf of Mexico. The simultaneous microwave image (bottom left) monitors the amount of liquid water within an atmospheric column along a conical scan that is half the width of the other two images. (Graphics courtesy of S Goodman-NASA/MSFC, K Knowles-NSIDC, R. Ferraro-NOAA/ORA)

NOAA/NGDC
DMSP Digital Archive
325 Broadway (E/GC2), Boulder, CO 80303
Phone: 303-497-6126, FAX: 303-497-6513
Email: dmsp@mail.ngdc.noaa.gov

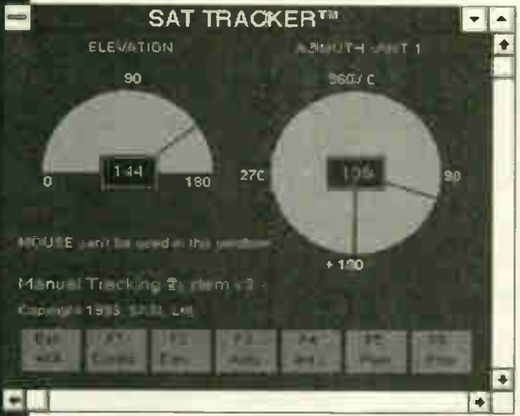
Last Atlas E/DMSP Stack Launched

The last Atlas E/DMSP stack was launched on March 24, 1995 from Space Launch Complex-3 West at Vandenberg Air Force Base, Calif. The Atlas E launch vehicles are refurbished intercontinental ballistic missiles which were built in the early 1960s. Atlas 45E carried this Air Force DMSP satellite into space. The DMSP's Star 37S solid motor inserted the satellite into a 101.9 minute, 854 x 846 km (530 x 825 mile), 98.8 degree inclination orbit.

The satellite launched on March 24 is one of the DMSP Block 5D-2 series of spacecraft. All the DMSP were built by RCA Astro Space, which is now Lockheed Martin Astro Space. This payload carries the Operational Linescan System (OLS) weather imager, and a set of microwave sounders and particle detectors. The satellite has been identified as 5D F-13 (the 13th flight satellite of the Block 5D class), and is also designated DMSP 24547. The 24547 designation indicates that this is the 24th Block 5 satellite to be launched, and is spacecraft construction number 47 (these last two digits do not necessarily reflect the launch order).

SAT TRACKER™

The **SAT TRACKER™** antenna controller is a feature-rich, low-cost system of hardware and software that can be used to accurately track any satellite or celestial object from horizon to horizon—including rapidly moving low orbit satellites like military "LEO" satellites, weather satellites, and amateur radio "MICROSAT" Satellites.



Minimum requirements: DOS compatible 286 and parallel interface. Laptop operation recommended for true portable operation. All cables, documentation and software included.

Unique SAT TRACKER™ Features

- Operates all YAESU AND EMOTO Azimuth & Elevation rotor systems.
- High-speed bidirectional communications through parallel interface.
- Mature, field proven design with high-reliability.
- Manages antenna control system even when obstructions block full antenna movement.
- Compatible with REALTRAK™, Instant Track™ & other satellite trackers.

Frequency Manager for SAT TRACKER™

- Usable on any serial port without conflicts.
- Supports all ICOM transceivers (including the new 820) and receivers.
- Supports mixing of transmitters and receivers.
- Supports for KENWOOD-790 and YAESU-736.
- 10Hz Tuning steps for all radios.

For the name of your local dealer please contact EDCO at 703 938-8105. Dealer applications accepted.

SYSTEMS & SOFTWARE
INTERNATIONAL LTD
Designed and manufactured in the USA

4639 Timber Ridge Drive • Dumfries • Virginia • 22026-1059 • USA
(703) 680-3559 • fax (703) 878-1460
EMail Internet 74065.1140@compuserve.com

NEW!

Universal SCPC-100 Satellite Audio Receiver

Receive Hundreds of Great SCPC Radio Channels and Services On Your Standard TVRO Home Dish Satellite System!

Years ago most radio networks — ABC, CBS, Mutual, NBC, NPR and others distributed their programming by telephone lines or microwave systems. Single Channel Per Carrier (SCPC) technology has allowed these networks to use satellite transmissions to their affiliates and users. **Now you can expand your home satellite system to receive all of these "hidden signals" and programs with the Universal SCPC-100 Satellite SCPC Audio Receiver.** The new SCPC-100 receiver is the first high quality unit that is affordable, rivaling many commercial SCPC receivers costing thousands of dollars. Some of the SCPC-100 features include:

- Stable microprocessor-controlled tuning with two buttons. No knobs; frequency agile.
- 50-channel program memory with instant one-button recall. Non-volatile; holds memory when power is off.
- Receives entire 950-1450 MHz LNB frequency range from your satellite system.
- Easy-to-read 1/2" LED's; 4 digits, 7 segment numbers.
- Receives high quality music from hundreds of stations; can be used with your HI-FI system.
- Simple 3-minute hook-up; easy to use; no user fees or subscriptions required for reception.
- Receives all C- and Ku-band SCPC signals and programming.
- Unit made and assembled in the U.S.A.

Order RCV27
Only 439^{95}
Plus $5 shipping and handling (UPS)

Order Today from Grove Enterprises P.O. Box 98, Brasstown, NC 28902
(800) 438-8155; (704)837-9200

World Radio History

Donald E. Dickerson, N9CUE

Iridium—Plugging Into the Future

"The Iridium project heralds a new age in personal wireless communications."

—Motorola Chairman George Fisher

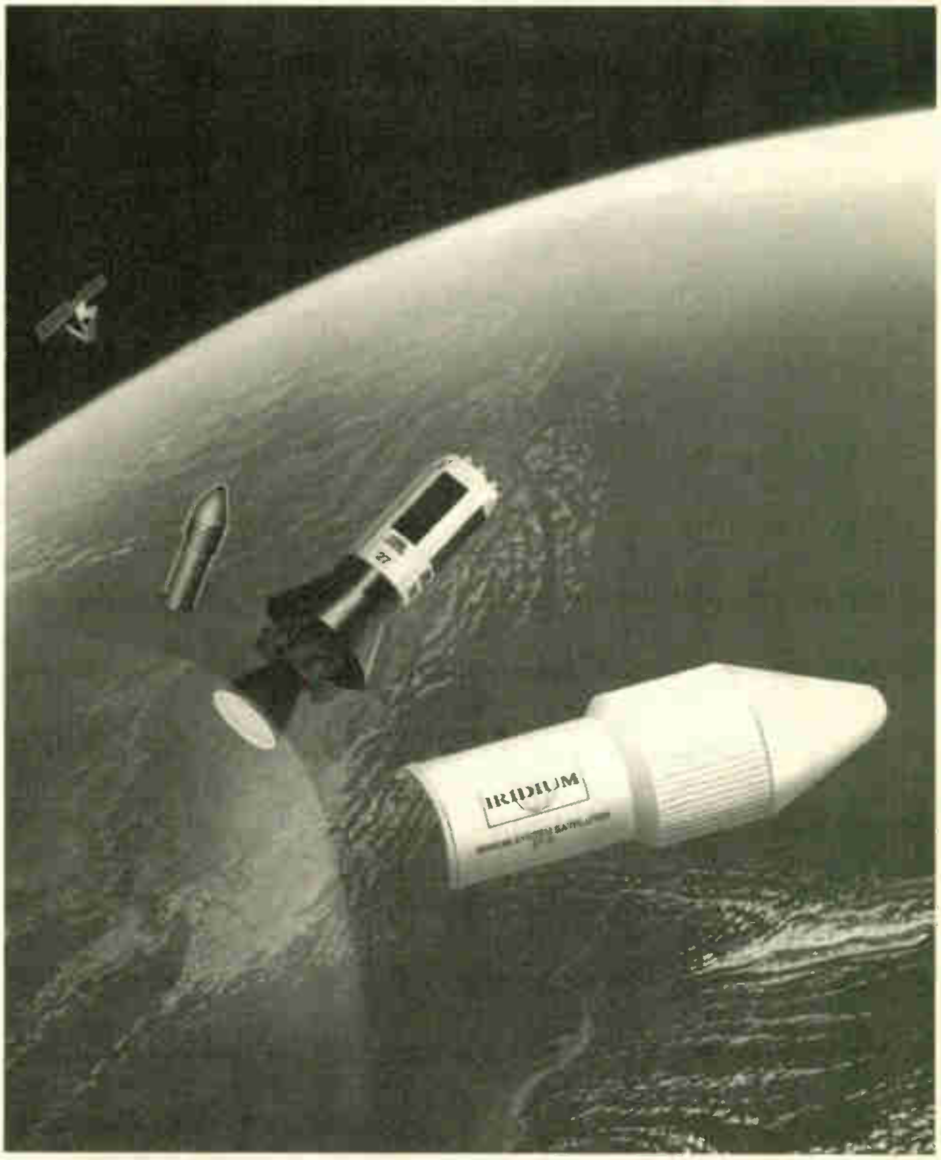
The promise of Motorola's Iridium system is to make instant global communications a reality and bring the world closer to your finger tips. As we near the end of this century we will watch the dawn of a whole new era in personal communications. Space-based systems such as Motorola's Iridium, will make instantaneous, world-wide voice communications from a personal communications device a reality.

Two developments will make the Iridium personal communications system possible. They are both due to successful engineering designs of a reliable pocket personal telephone and a space-based network of satellites. In fact, the Iridium dual-mode hand-held telephone will be so easy to operate, the average consumer will not even realize that they are talking via satellites in space.

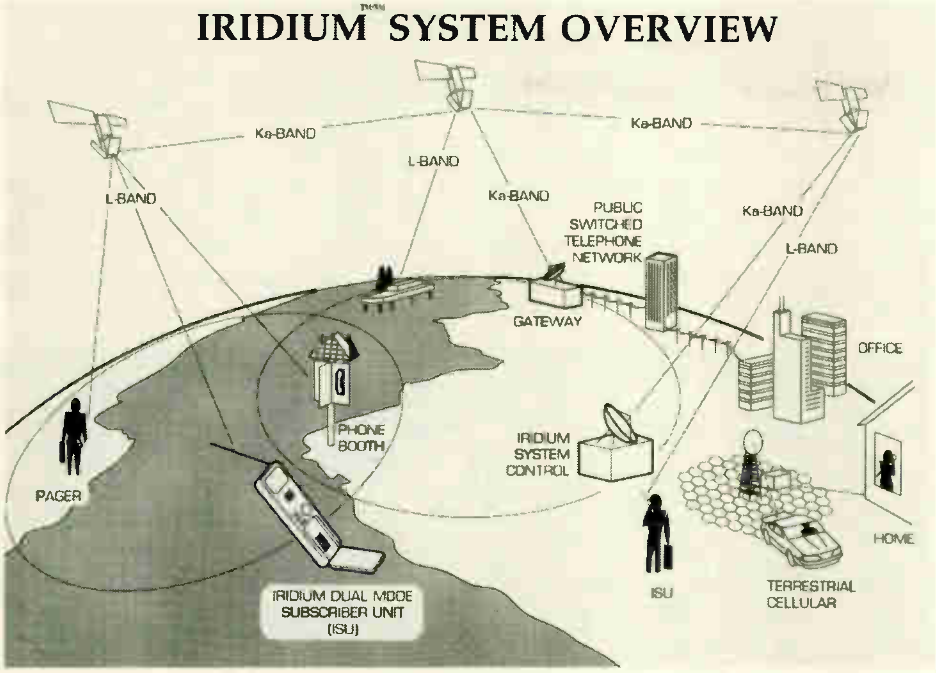
Motorola's entry into the personal communications market will operate on both terrestrial and space-based cellular systems. It will switch systems automatically as needed without any disruption of service, barring regulatory restrictions. The phone itself is approximately seven inches tall and 1/2 inch thick and has a large LCD display. Proposed production models have a six inch rubber duck type antenna which pulls out of the top of the case and rests at a 30 degree angle.

Telephones used in the Iridium network will be able to provide subscribers with a variety of transmission capability including voice, data, fax or paging. The Iridium dual-mode subscriber unit (ISU) will transmit digital voice at 4.8 kbps and data at 2400 baud. The phone will use QPSK modulation with frequency division/time division multiple access (FDMA/TDMA) formatting.

Unlike conventional cellular networks, this satellite-based system will track the location of the Iridium telephone electronically. Once the Iridium telephone is activated, the nearest satellite will interrogate the nearest Iridium ground station and automatically determine account validity and the location of the user. The subscriber's telephone call will be routed through a terrestrial cellular or the satellite system depending on capability and system availability to make the telephone call. If the subscriber's local cellular system is not available, the telephone will communicate directly with a satellite overhead and transfer the call from satellite to satellite through the network to its destination, either an-



Iridium satellites launched into orbit.



other Iridium telephone or Iridium Gateway ground station. The Iridium Gateway ground stations then connect to the local phone system of land-based telephone lines.

Satellite Systems

The satellite-based network that will make all this possible will consists of 66 satellites in six polar orbit planes. Each of these orbital planes have 11 satellites with one of the satellites in each plane a standby spacecraft. The spacecraft will be phased, so that odd numbered planes have satellites in corresponding locations, with satellites in the even numbered planes staggered approximately midway between.

The spacecraft will be traveling in co-rotating planes, up one side of the earth and down the other. The area between the first and last planes the satellites will counter-rotate. This area is called the seem of the network. The planes are separated by 31.6 degrees while the planes that form the seam will be 22 degrees apart. The satellites will maintain a nominal orbit of 780 km (about 483 miles) high. This is high enough to keep them out of the earth's atmospheric drag and to provide world-wide coverage with the minimum number of spacecraft.

From this altitude, the spacecraft of the Iridium system will point three antennas toward Earth. Each antenna will have 16 spot beams aimed at its target area. This means the user will be handed-off to one of 48 spot beams as he travels between Iridium coverage areas. The user can be handed-off to another beam of the same satellite or to the beam of a second satellites as needed. Unlike terrestrial cellular service. the service cells will move as each spacecraft orbits the earth. This motion more than the movement of the user will be the primary factor in hand-offs to other cells or spot beam areas.

As the spacecraft of this system approach the poles. there will be a heavy overlap of spot beam coverage and very few users. Iridium satellites will be programmed to shutoff during this portion of their orbit.

These satellites will also be networked together to relay calls. They will use the 23 GHz band which is allocated for satellite cross-link communications. The Ka-band (with it's 17 to 21 GHz downlink and 27 to 31 GHz uplink) will be used to communicate with ground stations. Iridium's dual mode phones will use frequencies in the L-band (1.5 to 1.6 GHz) to communicate with the individual spacecraft.

Iridium Ground Stations

The Iridium network will require two types of ground stations. The first to be built and put into operation are the system control or telemetry, tracking and control (TT&C) stations. TT&C stations will be used to transmit control signals to position, monitor and maintain the orbits and spacecraft systems of the satellites in the Iridium system.

Motorola has already signed a contract with Telesat Canada for the construction and operation of three TT&C ground stations for use by the Iridium system. Telesat's work on the program will occur in two phases. Phase one is the actual TT&C antenna and ground station construction, which is underway. In phase two, Telesat will provide the manpower necessary to operate and maintain these ground stations once they are completed.

Two ground stations will be located in Canada, one at Yellowknife and the second at Iqaluit in the Northwest Territories. A third TT&C station will be located in Hawaii. These TT&C stations are expected to be operational before the first Iridium satellites are launched in 1997.

A contract for ground station equipment has been let to Viasat of Carlsbad, Calif. Under this contract, Viasat will design the equipment for Iridium's TT&C stations. Visat is one of the largest suppliers of government satellite equipment and networks.

The second type of Iridium ground station is called a Gateway. These stations will interface with the Public Switched Telephone Network (PSTN). This will allow the Iridium user to call any phone in the world. Whether you are calling a phone attached to a standard landline, cellular phone or another Iridium dual-mode phone, you will be able to stay in touch via Iridium Gateway stations.

Gateway stations will receive signals from the Iridium satellites in the Ka-band just like the TT&C ground stations. In current design, the Gateway stations will use three 3.3 meter (10.9 feet) dish antennas for tracking. These Gateway stations will be separated by at least 20 miles geographically. This will assure rain attenuation is not a problem as most rain storm cells are less then 20 miles across. At Ka-band frequencies, rain can cause loss of signal and introduce noise to the system.

Launcher Systems

If you are a student of foreign affairs or world politics you may find, as I did, that the Iridium launch providers are interesting and ironic, almost to an extreme. Ironic in that arguably, the world's three greatest adversaries during the cold war—Russia, China and the U.S. each have contracts to launch Iridium satellites. This is the new world order at its best.

McDonnell Douglas will be the U.S. provider of launch services using the Delta 2 rocket. Each Delta 2 is expected to carry five of the relatively small Iridium satellites into orbit. Russia's entrant for Iridium launches is the dependable Proton rocket which will be used to carry seven satellites into orbit each launch. The Proton launchers are manufacturered by Russia's Khrunichev Machine Building Plant. The final launch participant, is from China's Great Wall Industry Corporation with their Long March IIc rocket. The Long March will carry two Iridium satellites per launch into orbit.

The hook that makes the Iridium system so attractive to international investors is that all Iridium services will be administered through Gateway stations located in each investor country. These Gateway station will be owned by the investors in the respective countries in which they are located. Local marketing, products and services to the Iridium users in the investor country will provide a return on the investment that should prove very attractive to investors around the world.

Russia for example, even in Moscow, has an antiquated phone system. In a country of 250 million there are estimated to be less then 10 million phones. Developing countries without a telephone infra-structure could have subsidized, solar-powered, centrally-located telephone booths in every village. Many other countries would find a substantial market for Iridium which would complement their existing phone systems, both cellular and land based.

Subscribers to the Iridium service should be widespread and varied. An international business person with a portable unit in a coat pocket would have easy access to the home office. The head of a large multinational corporation could quickly call any colleagues, whether they are at home or traveling, on the earth's surface or in the air, anywhere in the world. The mountain climber, skier, or recreational sailor could continue to communicate with family, friends, or business associates. Land and sea mining operations could have continuous worldwide service. And, areas experiencing natural disasters could maintain a reliable communications link with the rest of the world.

The Iridium system is a vision—a realizable vision for a worldwide portable, personal communications system—a vision whose greatest realization, like the telephone of a century ago, extends beyond today's imagination.

Motorola Vice Chairman John Mitchell said, "Iridium is a milestone allowing us to clearly see the beginning of a new class of global wireless communications before the 21st century." ST

Iridium is a Trademark and Servicemark of Motorola, Inc.

Iridium Dual-mode portable telephone model.

GROVE COMMUNICATIONS EXPO '95

Formerly the Monitoring Times Convention

Atlanta, Ga., Airport Hilton

Oct. 13-15, 1995

Pre-register by 9-13-95 and receive a special gift at the Expo!

Preliminary Schedule

FRIDAY, October 13, 1995

12-4 pm	Special interest groups, public education demonstrations, clubs, tours
1-2 pm	Scanning Atlanta—Roger Cravens
2 - 4 pm	International Broadcaster's Forum, Ian McFarland, moderator
7-7-:30	Opening ceremony; greet VIPs (espec. int'l broadcasters) w/Bob Grove host
7:30-8:30	MT expert panel hosted by Rachel Baughn
8:45-9:45	ST expert panel hosted by Larry Van Horn

SATURDAY, October 14, 1995

	SW Ute/BC	**Scanner**	**Satellite**
9:00-10:00	Utility DX ***L.Van Horn***	Public Serv. ***Bob Kay***	Satellite Monit. ***K. Stein***
10:15-11:15	BC Develop. ***G.Hauser***	Listen. Law ***J.Rodriguez***	Weather Sats ***J.Wallach***
11:15-1:00	Lunch		
1:00-2:00	Begin SW ***L. Magne***	Mil. VHF/UHF ***TBA***	TBA ***TBA***
2:15-3:15	SWBC Prog. ***J.Frimmel***	Federal Mon ***J.Fulford***	Begin Sats ***K. Reitz***
3:15-4:15	HF Aero ***B.Evans***	Scan Equip ***TBA***	Domestic TVRO ***K. Reitz***
4:30	Bug Hunt (outdoors)		
5:15	Prize dawing		
7:00	Banquet		

Post banquet bug hunt, listening post, special interest groups

SUNDAY, October 15, 1995

9:00-10:00	AM DXing ***G.Hauser***	Begin Scan. ***B.Grove***	Monitor NASA ***L. Van Horn***
10:15-11:15	HF Digital ***B.Evans***	Trunking ***Doug Graham***	Amateur Sats ***K.Baker***
11:30-12:30	Pirate/Cland ***G.Zeller***	VHF Aero ***J.Baker***	Radio Astronomy ***J Lichtman***
12:45	Closing, hosted by Bob Grove		

LOOK FOR EXHIBITS FROM:

AMSAT, BEARCAT RADIO CLUB, R.L. DRAKE & CO., ICOM, OPTOELECTRONICS, SONY, SWAGUR AND MANY MORE TOP COMPANIES!

Pre-Registration Form

☐ Enclosed is my $55 registration fee

☐ Enclosed is my $23.95 Banquet fee

Name ______________________________

Address ____________________________

City________________State______Zip ____

Phone ______________________________

Card#____________________Exp. date _____

Send pre-registration form to:
Grove Enterprises, P.O. Box 98,
Brasstown, NC 28902, or call
(800) 438-8155; (704) 837-9200

By Jeffery M. Lichtman

Radio Astronomy and Technology

A few years ago, while attending a SARA (Society of Amateur Radio Astronomers) conference at NRAO (National Radio Astronomy Observatory), I ran across a group of research papers that started me thinking about technology developments.

Have you ever wondered who developed the amplifier or receiver your using? Why did they design certain features into the equipment or how did they know the user would find helpful?

I guess many of us sit at our desks using our computers or amateur gear and don't even give the above questions a bit of thought.

Through the years, the human race has had its live made easier through the efforts of inventors and their inventions. In other word, ask and you will receive! This has been the driving force in technology development. The need creates a solution.

Radio astronomy is a branch of science driven by the pace of technological improvements to its research instrumentation. The need has created solutions.

The field of radio astronomy really took off right after World War II, due to the new designs in the field of radar technology. As time went on, the communications industry had specific needs which were similar to those needed by radio astronomers. Radio astronomers have always had special requirements in the area of high gain antennas and highly sensitive receivers and software.

Hardware and software developments have contributed to the success of radio astronomy in five specific areas of technology. They are as follows:

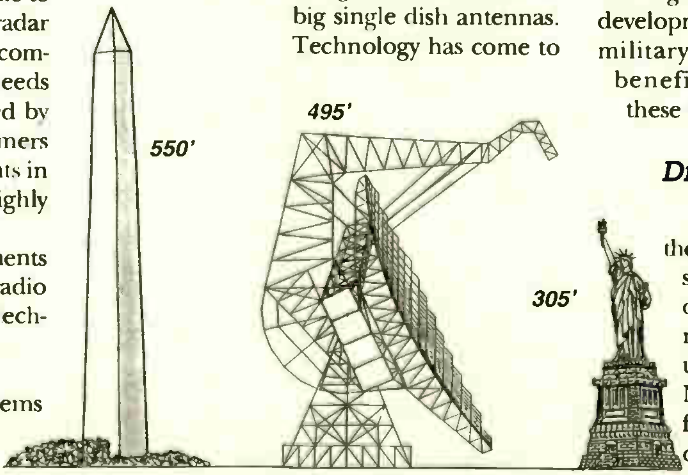
- Highly sensitive receiving systems which include:
  - High Gain Antennas
  - Low Noise Receivers
  - Solid-State Oscillators and Frequency
  - Multipliers and Cryogenics
- Data Correlation and Recording Technology
- Image Restoration Techniques
- Time and Frequency Standards
- Remote Sensing, Navigation and Geodesy

Antennas

In the area of high gain antennas, radio astronomers design and build antennas of the largest possible size and highest quality because celestial signals are extremely weak. Take for instance the new GBT (Green Bank Telescope), which will be completed in late 1995 or early 1996.

Within the design of large antennas is the study of Homology. S. von Hoerner published in a research paper in 1967. It dealt with the principle of parabolic deformation under the gravitational stress. This principle points out how to minimize changing focal lengths due to this gravitational stress in big single dish antennas. Technology has come to the rescue with the development of Very Long Baseline Array (VLBA) antenna systems. Instead of one large antenna to get high gain, radio astronomers can link smaller antennas distributed over a wide area to achieve the same results.

FIGURE 1



Another area of major development is Holographic Antenna Metrology. This principle uses fourier transform in the area of aperture illumination and diffraction patterns of antennas allowing for study of surface dish accuracy. This method was first used by Scott and Ryle at the Cambridge 5-km array. A sample Holographic plot is shown in Figure 2.

In addition to antennas, great strides have been made in the areas of feed horn design, and sub-reflector correction.

Receivers

Receiver technology has moved light years in development in the area of sensitivity. Maser amplifiers were first used in the 1950s by the communication industry and radio astronomers for the reception of weak signals. Airborne Instruments Laboratory (AIL) built several versions of maser amplifiers for use in the military, commercial and radio astronomy applications. Maser systems were installed on the Parkes Radio Observatory antenna in Australia. A maser system was used to help retrieve data from the Giotto satellite during the approach of Halley's comet in the 1980s.

Amplifiers

Parametric amplifiers, manufactured by, AIL, LNR, Comtech, etc. (all on Long Island in New York) in the late 1950s were strongly supported by the radio astronomy field. The radio astronomy community in its pursuit for lower noise, wider bandwidth and higher sensitivity helped push for the development of these amplifiers. Both the military and commercial companies benefitted from the development of these amplifiers.

Discrete Components

Most of us are all familiar with the gallium-arsenide field effect transistor (GasAsFET) amplifiers. These devices replaced the lder parametric amplifiers and have been widely used in the communications field. NRAO and the University of California at Berkley pioneered the development of cryogenically

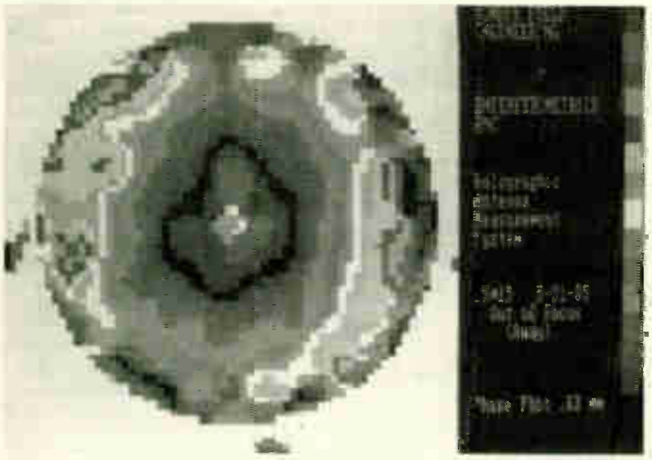


FIGURE 2: Holographic antenna plot (courtesy of Microwave System News 2/86)

cooled GasAsFET amplifiers for use in sensitive low noise receiving systems. Berkshire Technologies was formed by former radio astronomers to meet the needs of NASA and other industries in the area of cryogenic GaAsFETs.

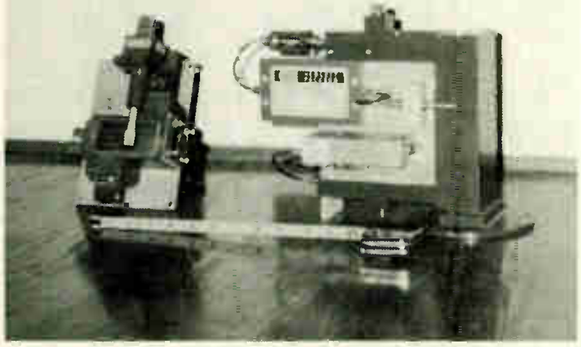
Another device used throughout the communications and computer industry is the high electron mobility transistors (HEMT). NRAO, NASA, and the Jet Propulsion Laboratory has been very supportive in the development of these devices. HEMTs were used in to replace Maser amplifiers and have been widely used at the Very Large Array (VLA) radio astronomy installation.

A few other items that have been developed for use in the radio astronomy field include: Schottky mixers, superconducting-insulating-superconducting (SIS) mixers, solid-state oscillators and multipliers and cryogenics.

Data Recording

Wideband tape recorders are used for Very Long Baseline Interferometry (VLBI). Simultaneous observations are made at several radio telescopes usually separated by great distances. This principle of recording allows for recorded data to be cross correlated at a central location. In the early beginnings of recording (actually quite recent in terms of time), radio astronomers relied on cassette recording techniques. The huge density tapes, usually one million bits per square inch generated great interest during the mid 1980s. In more recent years, analog to digital (A/D) converters have replaced bulky tape units which feeds information to high density disks and large computer storage capabilities.

FIGURE 3: Parametric amplifier



Time and Frequency Standards

Originally used in the communication and navigation area, time and frequency standards have been recently put to greater use in radio astronomy observations. As mentioned in an earlier paragraph, VLBI which is used for cross-correlating information requires that each radio telescope maintain extremely high frequency stability. The Hydrogen maser can provide this stability.

Hydrogen masers produce a 1,420 MHz hyperfine transition of atomic hydrogen as their fundamental output. This technique was developed by the NBS (National Bureau of Standards). NASA and the Department of Defense have played a dominate role in the use of this standard. A Hydrogen maser is used on the NAVSTAR global positioning satellites.

Remote Sensing, Navigation and Geodesy

Observations of cosmic sources of radio radiation made with radio telescopes are basically measuring the temperature of those objects. The medical field uses a similar method called microwave thermography. This method has been used primarily for tumor and vascular investigation.

Ozone monitoring has become very popular over the past few years. As we have heard, the depletion of this protective layer will allow greater ultra-violet (UV) radiation to pass through our atmosphere, thus causing a greater number of skin cancer cases.

Radio telescopes can directly measure and monitor the stratospheric abundance of ozone and its variations at the frequencies of 204 and 278 GHz.

One of the most economical and significant applications of radio astronomy techniques has been on instruments carried aboard remote sensing satellites. These satellites carry passive imaging microwave spectrometers operating at the centimeters to millimeters wavelengths. These satellites are used for mapping atmospheric temperature and humidity, polar ice and other important geophysical parameters. The National Oceanic and Atmospheric Administration (NOAA) and the Department of Defense have used these instruments quite extensively in their orbiting satellites. In addition, spacecraft navigation, geodetic studies and crustal dynamics have all used the VLBI principal commonly used in radio astronomy today.

Technology is changing constantly. Not many of us have the luxury of spending many hours reading the latest technical journals and trade magazines. However, I will continue to keep *ST* readers informed of anything new in areas of related technology and radio astronomy.

For those of you interested in radio astronomy, the Society of Amateur Radio Astronomers offers a universe of knowledge. If you are interested in finding out more of our activities and conferences, contact: Vincent Caracci, SARA membership services, 247 N. Linden St., Massapequa, N.Y. 11758.

I would like to thank NRAO, Jack Browne and Dawn Prior of *Microwaves and RF* magazine for their help and information in developing this article. ST

ST NAVIGATION SATELLITES

By Todd D. Dokey

Terminal Node Controllers

As time marches onward further into the information age, more information and maps are becoming digitized, and displayed upon a computer. In fact, the days of pin-maps are rapidly fading into the past. Now we can faithfully overlay the positions of emergency service vehicles and other information right onto a computerized map layout of the town, county, or even the entire state. This information can be coupled and displayed with map data on pipelines, chemicals and other potentially dangerous areas.

The software and technology for this is not entirely new and there are a few "standard" formats afoot. However when we discuss using computers for the GPS plotting of vehicles, personnel and the disaster areas themselves in near real time, within a price range affordable to the general public, this is new.

Such high tech, information collection and management used to be the realm of the super sophisticated (and super expensive) computerized management system. But not anymore. Now you and I can afford to plot GPS information onto a map overlay on our own computer screens in real time! People, cars, and locations, can simultaneously (and if you use the right equipment) near instantaneously be updated onto a map of your local area.

Advanced Electronics Applications (AEA) of Lynnwood, Wash. has recently introduced a Packet radio terminal node controller (TNC) which has a GPS interface so I contacted AEA about this new release, the PK-12 TNC.

This new packet controller is designed with mobile operation in mind. It has low power consumption, which also makes it a good candidate for emergency use. The PK-12 can also be used as a desktop TNC that can be used in conjunction with AEA's PCPAKRAT for Windows software. It has a built in RAM for its system mailbox which is backed up by batteries and the RAM can be expanded up to 100k. The Maildrop feature allows you to receive and forward messages as well as control third party traffic. The PK-12 also supports node hopping and permits you to restrict who uses your node.

The big plus for this TNC is its ability to interface into navigation systems. The PK-12 is compatible with GPS, LORAN, ULTIMETER-II and ARNAV navigational data. Software and computers are not needed to transmit GPS information with the PK-12. The system is capable of operating as a stand alone tracking device. It can obtain the necessary GPS data from an attached receiver and send it into the packet network via a transceiver.

For example, a car with the PK-12, a transceiver and a GPS receiver can transmit position data that can be read by other members of the packet network and displayed using APRS (Automatic Packet Reporting System) software. APRS software (shareware for the PC and there is a MAC version) was written by Bob Bruninga (WB4APR) and Keith Sproul (WU2Z).

APRS takes the GPS data and reformats it to the APRS standard. Then the software takes control of the TNC and transmits the position data of your station into the packet network. The display from the APRS software converts the TNC/packet data into a map overlay of information as well as the positions of other packet users. Additional information (such as the locations of non system users) can be added to the map display and transmitted into the network for display.

AEA PK-12
Manufacturer Specifications

Demodulator:	Texas Instruments TCM-3105 1200
Modulator:	Phase continuous AFSK
CPU:	Motorola MC68HC11DOP
RAM:	32k expandable to 128k.
ROM:	64k maximum.
Power:	+12 to 16 volts DC @ less than 80 mA.
Radio interface:	5-pin DIN
Terminal interface:	RS-232C (DB-25 connector)
Terminal Data rates:	Autobaud settings at 300, 600, 1200, 2400, 4800, and 9600 bps.
GPS interface:	NMEA-0183.
Dimensions:	5.78" W x 5.275" D x 1.35" H
Weight:	11.9 oz.

APRS capability has some interesting implications for Radio Amateur Civil Emergency Services (RACES) members, amateur radio operators, and others who are involved in emergency services as their profession.

Here locally, the Mokelumne Rural Fire District is preparing to establish amateur radio emergency communications system with the installation of fixed, and mobile equipment. This will include packet radio, and no doubt will involve the PK-12 (I should know, I am helping design the system!)

The obvious needs of the emergency services are ruggedness and portability. This was solved by deciding to package all the equipment in water proof, air tight, portable containers so that it can be packed and moved quickly into position for use. Two duplicate setups will be used at the fixed locations, so they will always be ready to go mobile. This particular fire district has two stations that cover several hundred square miles of jurisdiction (not to mention all the mutual aid with nearby cities and counties). They hope to install at least 2 fixed, and 2 mobile stations.

In addition to passing messages in time of emergency, the mobile stations in time of natural disaster will be set up at predetermined "command post" locations in their area of responsibility and work with the department and other emergency service personnel to provide information, food, medical aid, etc. The local Office of Emergency Services has amateur radio equipment set up in its command center, (we would hope that some kind of county wide pilot program can be developed to interface the whole region for better disaster management).

With the addition of a GPS compatible TNC system, it will be easy to keep track of all the mobile-remote

At 1342 using IDIFcity.map

Move cursor to your QTH with (shift)arrows, NumLok off and (ctrl) PgDn. Then press I & H

Track Memory is 0 % full.

packet users and their locations. As the demands of the situation change, the mobile units can simply pack up and move with the need of the moment. If they are operating mobile they will show up on the map as they move from place to place. If they are not operating mobile they will show up the minute they log back into the system. Since the PK-12 can display mapping information it will also be useful in mapping locations of possible concern.

It is easy to see the value of volunteers in such a situation. If the local amateur radio clubs get involved, it is not inconceivable (with handfuls of people roaming around reporting in information) that the entire county and major portions of the state could be coordinated through an emergency packet network. The "online" information regarding the concentrations of the disaster itself as well as personnel and equipment available and its progress staggers the mind. It can become a reality.

It is hoped that by the efforts of amateur radio and professional personnel that in future disasters the information needed by incident commanders and disaster managers can be circulated and coordinated with greater speed and with a higher degree of accuracy in a near time environment that will permit faster and more effective recovery. It is also hoped that the amateur radio community as a whole, and those communities in which the radio operators live, can have a higher degree of safety due to these efforts.

I would like to thank the friendly staff at AEA for forwarding to me information regarding the PK-12 for use in this issue, and to the tireless men and women of Mokelumne Rural Fire District for their help.

U.S.-Russian Navsat Agreement

The United States and Russia have worked out agreements to limit interference problems to radio astronomy from the mixing of transmissions between the Russian GLONASS navigational satellites and low earth orbiting satellites. During the next few years the Russian satellites will be moved down in frequency in order to limit interference.

It is expected that during the move there exists the possibility of further interference. Although Russian President Boris Yeltsin has urged the appropriate branches of his government to deliver a fully operational 24 satellite constellation by the end of 1995, there are some who doubt the economic priority of doing so.

New Mapping Software

Klynas Engineering of Simi Valley, California has been offering their mapping software package, "Streets on a Disk" for a time now. Lately, the company has introduced a GPS interface that can "easily display moving vehicles on the map." Streets on a Disk even permits the user to create custom maps, display the shortest route between sites, and calculate the mileage. For further information contact Klynas Engineering at (805) 583-1133. ST

For more unformation on the products mentioned in this column, contact the following companies and individuals. Be sure to tell them that Satellite Times sent you.

AEA
P.O. Box C2160
2006 196 Street SW
Lynnwood, WA 98036
Main Office: (206) 774-5554
Customer Service: (206) 775-7373
Upgrade Hotline: (206) 774-1722
Literature Request Line: (800) 432-8873
Fax: (206) 775-2340
Compuserve: 76702,1013

APRS software
Information on PC version, send a SASE to:
Bob Bruninga WB4APR
115 Old Farm Ct.
Glen Burnie, MD 21060

Information on MAC version, send SASE to:
Keith Sproul WU2Z
698 Magnolia Rd.
North Brunswick, NJ 08902

ST WHAT'S NEW

by Wayne Mishler, KG5BI

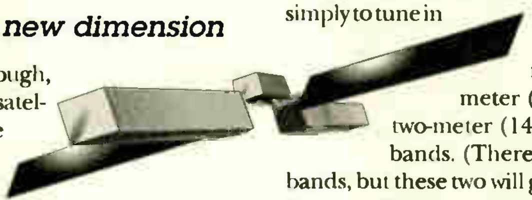
Springtime Discoveries:

Amateur radio, satellites, field day, and new goodies for the ham shack!

The lure of amateur radio is more than the mystery and triumph of sending your own unique signal into the unknown. It is more than the suspense of wondering who might answer your signal: a king, a movie-star, an astronaut, an airline pilot, a ship radio operator, or your buddy down the street. It is more than the great equalizer that puts everyone on the same social plane. It is more than the excitement of speaking through a microphone or telegraph key to global neighbors with diverse and fascinating nationalities, cultures and customs. It is more than the rush of knowing that thousands of people might be listening to your every word on the air. It is more than pride in achieving knowledge and in attaining rank and privilege bestowed by the FCC. It is more than the warm fuzzy feeling of freedom and power you sense while sitting in command of a radio station that opens a window to the world at the flip of a switch and turn of a knob. It is more than knowing that at any moment you and your station could become a vital link to victims of natural disaster or war. It is more than membership by association with a worldwide community of common interest. It is all of these things, combined into a synergetic whole that captivates.

Satellites add new dimension

If that weren't enough, amateur radio via satellite lifts the whole concept into another dimension, spearing your signal through the ionosphere into space to be snared and re-broadcast by satellite transponders to thousands of hams somewhere over the horizon. With this higher dimension comes new technology involving orbital mechanics, polarization, satellite tracking, full duplex (like telephone) conversations, and the like. Of course, that's part of its appeal. But here's another benefit: most amateur radio satellites operate in the VHF/UHF bands. Higher frequencies mean smaller antennas that fit in apartment windows or small attics and go on the road. That makes satellite amateur radio accessible to more people who may have been deterred by the need for large HF antennas.



Amateur radio goes afield

Ah, yes. Satellite and terrestrial amateur radio reach their apogee in the springtime. There are antennas and coax to be checked. Rigs to be cleaned and tweaked. Ham shacks to be shoveled out. But most of all there is field day, which happens every year in June, when hams everywhere take their equipment outdoors to make as many contacts as possible using portable power and makeshift antennas – as they might have to do in emergency situations.

Non-hams can test the waters

Springtime is a good time for non-ham satellite enthusiasts to sample the waters of amateur radio. One of the easiest ways is simply to tune in the action. All you need is a radio that receives the ten-meter (28 to 29.7 MHz) or two-meter (144 to 148 MHz) ham bands. (There are other downlink bands, but these two will get you started.) You can hear ham downlinks on single sideband and FM in both of those bands.

Of course it helps to know the frequencies, times and modes. Check with your local amateur radio club, if one exists. There are several ways to do this. Set your scanner on search mode in the 144 to 148 MHz region. You'll hear local ham repeaters in this range. As field day nears, the repeaters will be abuzz with talk of preparations and club meetings. Another way to find a local ham club is to look it up in the American Radio Relay League (ARRL) Repeater Directory. Most clubs operate a two-meter repeater. If yours does, its frequency and club name will be listed in the directory. You can usually buy a current directory at most ham stores. Or you can order it, along with a list of clubs in your area, from the ARRL, Newington CT 06111. You should also get in touch with the Amateur Satellite Corporation (AMSAT), P. O. Box 27, Washington DC 20044, telephone (301) 589-6062. AMSAT (whose logo is shown at left) is a nonprofit organization of amateur radio operators who contribute their expertise and time to support and expand satellite amateur radio. After you become a member, you will probably be flooded with more information than you ever dreamed existed.

After reviewing your newfound library, you're ready to go in search of satellite amateur radio downlinks. But beware: you'll be exposed to that irresistible lure of amateur radio, that mystic "gravitational" pull toward setting up a station and getting on the air.

Get ready to grab your Grove catalog

Uh huh. You'll find yourself up to your eyeballs in the new Grove Catalog and Buyer's Guide, drooling over the new Icom IC-820H dual-band, all-mode transceiver for terrestrial and satellite communications. Then of course Grove offers the Icom GP-22 hand-held Global Positioning System that'll pinpoint your location on field day. You'll raise eyebrows around the world when you impress them with your exact latitude and longitude on the air.

Reach for the AEA 1995 catalog

And from that location (or any location for that matter) it just a short reach to the eye-catching Advanced Electronics Applications (AEA), Inc., 1995 catalog which parades an impressive lineup of amateur radio peripherals and software before your longing eyes.

You'll love AEA's new ST-1 Antenna Tracker, with suggested retail price of $399, which includes all the hardware and software you need to track amateur and other satellites from horizon to horizon.

Why you need a tracker

As satellites move across the sky, antennas must be adjusted to follow their path. Because of Doppler shift, transponder frequencies

change as the satellite passes overhead, requiring adjustments in the tuning of your transceiver. AEA's new ST-1 system automatically makes these adjustments for you. As the satellite approaches the horizon, the ST-1 points your antennas in the proper direction, and tunes your transceiver (if it is compatible) to the correct uplink and downlink frequencies. Then, as the satellite rises overhead, the ST-1 corrects antenna direction and transceiver tuning continuously throughout the pass. The ST-1 works with the FT-736, TS-790, IC-970, and IC-475/275 combination transceivers. An external RS-232 adapter is not required.

If you like computers, you'll love Pacsat

As you wade deeper into satellite amateur radio, you'll eventually want to send and receive packet messages. These are messages you compose on your computer and send through an interface to your transceiver which transmits them as digital data to Pacsat satellites for re-broadcast back to earth.

Pacsats were profiled in the March/April edition of Satellite Times. You'll find them in the Amateur Radio Satellites column, along with a description of the hardware and software you'll need to operate a satellite packet station. You need a minimum of three pieces of hardware: a computer, a TNC (terminal node controller), and a two-meter ham transceiver. The TNC serves as an interface between your computer and your transceiver.

AEA's new PK-12 packet controller offers simplicity and ease of operation for newcomers, with high-end features and portability for appeal to experienced packet users. It has a suggested retail price of $129 and was designed to make operation easy for beginners. You don't need to memorize a list of commands to get started; just plug it in and get on the air. Then, as you become more at ease with packet, switch to the "expert" mode and discover advanced commands for high-performance.

The PK-12 includes KISS, PERSISTENCE, and SLOTTIME modes along with AEA's well-known Gateway feature. Portability is one of its greatest features. It's light weight, compact size, and low power requirement are ideal for traveling.

For information on AEA's products, check with local dealers if possible. That's where you'll find the best prices. But if you can't find a local AEA dealer, you can get in touch with the company sales department by dialing (800) 432-8873.

New C-band satellite receiver announced

The Tracker Premier 20, a new C-band satellite receiver from the Colorado-based EchoStar Group, combines low cost, competitive features and high performance to appeal to first-time satellite system buyers.

The new receiver, introduced by Houston Tracker Systems Inc. (HTS), a subsidiary of EchoStar, features the same cosmetics and software that made the company's Premier 50 and Premier 70 receivers so popular.

Standard features of the Premier 20 include satellite channel locks, digital stereo on VideoCipher channels, C- and Ku-band satellite position storage across the arc, custom parameter storage for favorite satellites, and last-channel recall.

Remote control, UHF module, antenna, installation guide and operations manual are available in an optional UHF upgrade kit.

Additional information regarding features and price is available from HTS, telephone (303) 790-4445. Be sure to tell them ST sent you.

Universal's new receiver has broadcast-quality audio

Universal Electronics, Inc., has introduced a new state of the art microprocessor-controlled audio broadcast receiver rich in features needed for broad-cast quality reception of all single carrier per channel (SCPC) audio networks.

Universal stresses that its new SCPC XE-1000 audio receiver is frequency agile, transponder agile, capable of receiving all SCPC channels on any satellite without frequency boards. It is, they attest, compatible with all C- and Ku-band channels.

"Our engineers have developed (in the XE-1000) a fully agile SCPC audio broadcast receiver that fulfills all the requirements for the largest or smallest station," Universal says. "The XE-1000 will tune to any SCPC programming carried on many satellites. This receiver is all your station needs to pick up all of the popular programming on one high-quality SCPC receiver. One dish and one receiver will do it all at a low cost that will amaze you."

The receiver's audio section produces high-quality, low distortion, broadcast quality audio with two 600-ohm line outputs, one 4-ohm speaker output, and a front panel headphone monitoring jack.

An LCD readout displays transponder, frequency, bandwidth, de-emphasis, companding, channel name and memory channel. All companding boards (1:1, 2:1, 3:1) are built in as standard features and are selectable. De-emphasis is also selectable.

The XE-1000 has 50 channel non-volatile memories. You can recall each channel and all related parameters with the touch of a button. Frequency, transponder, and parameters are entered via key pad on the front on the set.

It employs two phase locked loop synthesized frequency converters to achieve stable reception.

Additional information is available from Universal, 4555 Groves Road Suite 12, Columbus OH 43232, phone (614) 866-4605. ST

If you have a new product, book, or service to announce in Satellite Times, send it to What's New, % Wayne Mishler, P.O. Box 41, Beaver, Arkansas 72613-0041.

By Dr. T.S. Kelso

Orbital Estimation

On the morning of February 9, 1995, I awoke a bit earlier than usual. Not that I was any more anxious than usual to get to work that day. Instead, I realized that I had a rare opportunity to watch a celestial event of historical import. What made this event even more exciting was that I was able to predict just when it would be visible from my new home in Montgomery, Alabama.

For several days, I had been watching the television coverage of the first rendezvous of the U.S. space shuttle (STS-63) with the Russian Mir space station. As amazing as it was to watch these two large spacecraft maneuver around each other on television, I was anxious to have the opportunity to watch this celestial ballet live. After all, this is where "the rubber meets the road" for orbital mechanics. With a fresh set of NORAD two-line orbital elements for both Mir and the space shuttle and my trusty TrakStar prediction software using the NORAD SGP4 orbital model, I began calculating when I might have my chance.

Of course, a number of conditions have to be met for you to be able to visually observe an low-earth-orbiting satellite. First, the satellite must pass over your location. That means that the satellite's orbit must have an inclination greater than or (approximately) equal to your latitude (north or south). For many space shuttle launches, the inclination is only 28.5 degrees (the latitude of the Kennedy Space Center where the space shuttle is launched from) and only a small percentage of the southern United States will even "see" the space shuttle pop above the horizon. On this mission, however, the space shuttle was launched into a 51.6-degree inclination in order to rendezvous with the Mir space station. That meant that our first condition would be met for a large percentage of the Earth's populated landmasses.

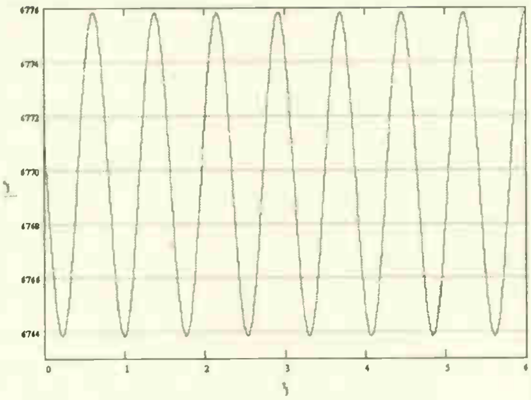


FIGURE 1: *Semi-Major Axis (km) vs. Time (hr), as discussed on following page.*

The next condition which must be met is for the satellite to pass over your location *at the right time of day*. This condition is very important. Basically, the observer must be in darkness and the satellite must be illuminated by sunlight to be visible. For the observer to be in darkness, the Sun must be six degrees or more below the horizon. For a satellite at the altitude of Mir or the space shuttle, it must be passing near the Earth's terminator (the line on the Earth's surface dividing day and night) within an hour or so after the onset of nightfall or before daybreak. If the satellite passes over at some other time of day, it simply will not be visible to the naked eye.

As luck would have it, the conditions were met for this mission, although they wouldn't come together for me until after the rendezvous was over. Nonetheless, both spacecraft, with their crews of astronauts and cosmonauts, would be chasing each other across the Alabama morning sky. Now, all that was needed was good weather.

My calculations had shown that STS-63 would pop up out of the Earth's shadow at 1154 UTC at 14 degrees above the horizon, just north of west. Two minutes later, the Mir space station would appear at the same location. Two minutes might not seem like much of a separation, but at 7.5 km/sec, that's a distance of almost 1,000 km. Both spacecraft would rise to just over 45 degrees above the horizon before heading back to the horizon to the southeast. Once again, luck was on my side since I had a nice unobstructed view in this direction.

As I walked outside, it was a brisk -3 degrees Celsius (okay, brisk for Montgomery), but the sky was crystal clear. I started the car and began looking for STS-63. I didn't have to wait long, with space shuttle popping into view exactly when and where TrakStar had said it would. Suddenly, it didn't seem as cold any more. I watched as it arced up toward the apex of its trajectory and then looked back down to the horizon. Again, just as expected, there was the Mir space station at the same place I'd first seen the space shuttle. Wow!

I was actually seeing both the space shuttle and the Mir space station in the sky at the same time! And, they were right on schedule according to my program (that always makes me feel a lot better). I couldn't have asked for a better view, either. With both Venus and Jupiter in the morning sky, it was easy to use them as benchmarks to determine the brightness of the two spacecraft — each was about as bright as Jupiter and pretty tough to miss. It really was wonderful to experience the excitement of calculating a visual satellite pass and watching it unfold, as predicted. It sure brings those numbers to life.

Since this will not be the last time these two spacecraft will meet in space, you will have the opportunity to go out and watch these events for yourself. In fact, the Space Shuttle is scheduled to dock with Mir next month. (See this month's cover story-Editor). So, what do you need to do to prepare to observe?

As was pointed out in my previous columns, the first two things you'll need will be current element sets and the appropriate orbital model. The most widely-available source of orbital data for Mir is the NORAD two-line element sets. These elements are available via Internet at archive.afit.af.mil in the directory pub/space and via dial-up modem on the Celestial BBS at (334) 409-9280 in the satellite directory of the files section. These elements are updated every weekday (except holidays). The Mir elements can be found in the file MIR.TLE. These elements are also echoed to many other Internet sites, VANs (Value-Added Networks such as CompuServe and America

Online), and BBSs around the world. For the docking of the space shuttle to the Mir space station next month, your best bet to be prepared is to predict viewing conditions using the Mir orbital elements until the elements for the space shuttle become available (Mir has nowhere near the maneuvering capability of the space shuttle).

Why are timely orbital elements important? For Mir, they are important because the orbit is constantly changing due to the effects of changing atmospheric drag and maneuvers to maintain the space station's orbit. Mir also maneuvers to support rendezvous with the Soyuz and Progress spacecraft which supply it and, now, the space shuttle. We'll see just how important this is in a little bit.

For the orbital model, any package that implements the NORAD SGP4 model should suffice. I use TrakStar because it does one thing many other tracking programs do not: it calculates visible-only passes. That is, it can be set to output data only when the satellite is illuminated and the observer is in darkness. It doesn't output graphically, but the tabular ASCII output can be easily imported into any spreadsheet software or other plotting package of your choice to produce a trajectory. The key ingredient, however, is the use of the SGP4 orbital model.

Here's why. In an ideal orbit, the basic orbital elements are constants. That is, the orbital altitude, eccentricity, inclination, and orientation of the orbit in space are all fixed. In real life, however, perturbations on the orbit due to the nonuniform density of the Earth and atmospheric drag cause fluctuations in a satellite's orbit. Let's look some specifics for Mir on the day of my observation to illustrate these effects. The Mir element set I used for my calculations was:

1 16609U 86017A 95039.25598067 .00011090
00000-0 14726-3 0 9200
2 16609 51.6461 83.8459 0000831 296.4901
63.6005 15.58764259512771

The key fields from this element set are:

Date (year, day of year):	95039.25598067 days
Inclination (Inc):	51.6461 degrees
Right Ascension of Ascending Node (RAAN):	83.8459 degrees
Eccentricity (Ecc):	0.0000831
Argument of Perigee (Arg of Perigee):	296.4901 degrees
Mean Anomaly (MA):	63.6005 degrees
Mean Motion (MM):	15.58764259512771 rev/day

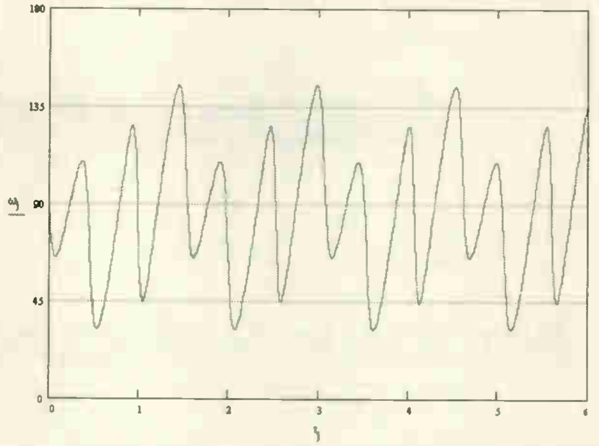


FIGURE 3: ***Argument of Perigee (deg) vs. Time (hr)***

Assuming the mean elements of this element set to be constants (which many non-SGP4 programs do), would yield a semi-major axis (half the distance between the satellite's closest and farthest approaches to the Earth) of 6,769 km. However, an examination of the semi-major axis over a time period of six hours shows it to be far from constant, varying by about 12 km over a single orbit (see Figure 1). And, while not immediately obvious from this plot, the altitude is slowly decaying with time. At this altitude, an error of 1 km in altitude corresponds to just over a 1 sec error *per revolution* in the orbital period — that's about 20 seconds per day. Larger errors in altitude will produce correspondingly larger errors in time for the position of the satellite.

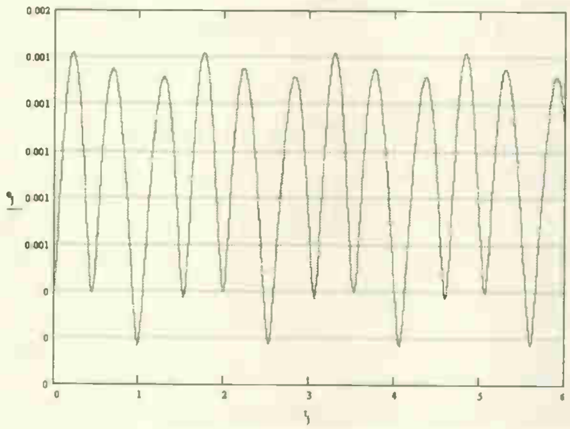


FIGURE 2: ***Right Ascension of the Ascending Node (deg) vs. Time (hr)***

Looking next at the right ascension of the ascending node, the direction in space where the orbit plane crosses the Earth's equator from south to north, we see that this node precesses at a rate of over 4 degrees per day (see Figure 2). At Mir's altitude,that can cause an error of about 500 km per day! Also, notice that while there is a small periodic effect, the secular (trending) effect is quite pronounced.

Finally, to give some idea of the complexity of the fluctuations that can be seen in the orbital elements, let's look at how the argument of perigee for Mir changes over a six-hour period (Figure 3). The argument of perigee is the angle between the right ascension of the ascending node and the direction of the perigee, or closest approach to the Earth's center, measured along the orbit path. As this angle fluctuates, the point where the satellite is lowest also fluctuates, resulting in even more errors. In our example, several periodic effects appear to be present.

When we combine all the effects in the SGP4 model and compare it to a simple two-body propagator, we find an error of 150 km after only six hours and almost 400 km by the end of the day! Given element sets which may be several days old, the errors can be on the order of thousands of kilometers! And using a model which incorporates the perturbations in a manner contradictory to SGP4 can make the errors even worse.

In our next column, we'll look at what criteria are used to determine when an element set needs updating and what mathematical methods are used. Once we're done with that, we'll start exploring some of the basics of taking the output of SGP4 to produce calculations like those in TrakStar. See you next time! ST

The Beginner's Column

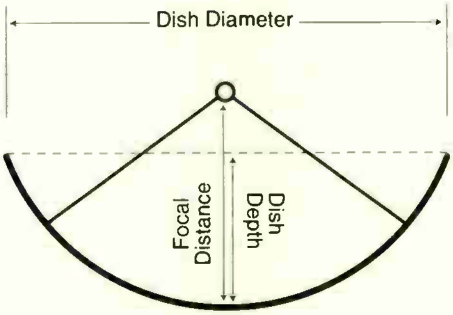
By Ken Reitz, KC4GQA

Parabolic Reflections—Part II

In our last exciting episode of the Beginners Column, the great advantages of the parabolic reflector were explained. This time we'll look at some details concerning this wondrous shape and I'll steer you in the direction of some additional reading for those wanting to do homework for extra credit.

Just to recap, and for those whose attention span is not quite two months, the parabolic curve, with its ability to reflect and focus radio energy, is just the thing to use to capture microwaves. In the shortwave section of the radio spectrum wavelengths are just too long to consider applying the magic of the parabola. Imagine how big a reflector would be for even the 20 meter amateur radio band! So, at those frequencies, we typically use aluminum tubing at a certain distance behind the driven element to increase the gain of the antenna.

But, just how far from the dish surface should a feedhorn (which contains the actual microwave antenna) be? This point, (known as the focal point and when measured, the focal length) is where you want to mount the feedhorn and is determined by the following formula: f=diameter2 / 16 x depth. So, if you have a reflector without a feed support and you want to know how far out to place the feedhorn, measure the diameter and square it. Divide that by 16 times the measured depth of the dish (to measure the depth of the dish stretch a string from lip to lip across the center and measure from the string to the bottom of the dish). Now you can go to the hardware store, buy some aluminum tubing and fashion your own feed support legs. And, say, while your measuring: Stretch another string across the dish exactly across from the first string. Where these two meet is the very center of the dish and your feedhorn should be positioned directly over that point.



Make Mine Deep Dish!

Parabolic reflectors are divided into three basic groups with regard to the aforementioned depth of the dish. There's the shallow, medium and deep dish. This is determined by what's called the f/D ratio, the ratio between the measurements of the focal length to the depth of the dish. Deep dish f/D's are from .25 to .31, medium from .32 to .36 and shallow from .37 to .45.

So, what's the difference? Well, the theory is that the further away from the surface of the dish the feedhorn is mounted the more prone the feedhorn is to noise or interfering signals from the side such as telephone microwave towers. This type of noise, which is found in the C-band, is called Terrestrial Interference (TI). A shallow dish requires the feedhorn to be further away and a deep dish allows the feedhorn to be almost flush with the lip of the dish. This reduces the "ingress" of interfering signals and so the deep dish is most favored in a TI environment.

Antenna manufacturers give you the information you need to determine if a dish is shallow, medium or deep. Here are some examples. The Kaul-Tronics XI-7 has a focal length of 36 1/8" and a diameter of 7 feet. The f/D ratio is .4 which makes it a shallow dish. The Winegard Quadstar 7.5 has a focal length of 31.5 " and a diameter of 7.5 feet. The f/D ratio is .35 and makes it a medium dish. The Paraclipse 8 foot Hydro dish has a focal length of 28 1/8" which gives it a .31 f/D and makes it a deep dish.

What's All The Noise?!

We've talked about noise from point-to-point terrestrial microwave towers getting into the dish, but this is not a problem for most people. Does that mean an end to the noise problem? Wrong again, Hydrazine Breath, noise is the constant enemy of satellite reception and we must fight against it! But, the fact is, it's everywhere. The key to a low noise antenna system is eliminating the noise potential. Surface accuracy, true parabolic construction, and care in assembly are the main ways to reduce noise. Even with the best antenna and careful construction, noise temperature rises as the antenna is pointed closer to the horizon. Noise can vary from 20 degree K to 55 degrees K just going from 45 degrees elevation down to 10 degrees elevation.

The efficiency of a dish is measured in percent and most C-band dishes are from 50 to 70 percent efficient. The gain of a reflector is measured in decibels (dB) which is a logarithmic increase in reception of the desired signal. The gain figure given by antenna manufacturers reflects figures derived from the testing range and may in no way resemble your own experiences. In the three examples given above the KTI- XI-7 has a published gain of 38.2; the Paraclipse 8 is 37.8; and the Winegard 7.5 is 37.5. What we don't get from the manufacturers is the antenna noise figure. This noise figure for the dish is the G/T rating which is a ratio of the Gain of the antenna to the Temperature (noise in degrees Kelvin). This figure is never listed in the ads or other retail information.

Bottom Line

When you get ready to buy an antenna look for the highest gain for the money and, if you are in a TI situation, look for a low f/D ratio. When you do get your antenna, follow the directions explicitly and take great care in putting it together. When you're mounting the feedhorn, make sure it's at the proper focal length, that the feedhorn is set to the proper f/D ratio and centered directly over the center of the dish.

These things having been attended to will insure operations as close to those of the manufacturer's as possible. You'll also go a long way to eliminating unwanted signals which hinder the efficiency of your antenna system.

For an indepth study of parabolic antenna systems see the latest World Satellite Almanac published by Phillips Publications at 800-777-5006. The latest edition of this book should be out by the time you read this. The World Satellite Yearly by Dr. Frank Baylin is also a good source for additional information on parabolic antennas. Write Baylin Publications, 1905 Mariposa, Boulder, CO 80302 or call 303-449-4551. The World Satellite Yearly is also available from Grove Enterprises at 1-800-438-8155.

MAILBAG

Lawrence Dunlap, N9VAG of Bethany, IL writes "...Where can I find info for old satellite receiver circuits plus hints for...TVRO home systems on 'how-to's' for old satellite receivers I have found for $10...?"

One of the great things about the satellite TV hobby is that it's finally getting old enough to have a lot of used equipment find its way to the hamfests and flea markets. However, these receivers may not be in working condition and you'll need the kind of electronic expertise of Lawrence Dunlap to repair them. A new book has just come out which may have information you're looking for. I have not yet seen the book myself, but have seen a favorable review in a trade journal. The book is called Repairing Satellite Equipment (The Insiders Notebook) published by Brich & Associates for $79.95 plus $10 shipping and handling. The order number is 800-532-4655. With over 20 years experience in satellite repairs, the authors list thousands of solutions to actual problems on all makes and models enabling the experienced technician to repair satellite equipment down to the component level.

Jim Brooks of Union, MO writes that he has a Panasonic PS 700EX Satellite system and a Radio Shack scanner and shortwave radio. He asks, "...What is available on satellites besides TV signals?...do I have the equipment and how do I go about receiving these signals.

There are many more signals of the satellites than just those which we can see. There are more than 100 FM radio stations transmitting 24 hours a day on FM audio subcarriers, most in stereo, and at least that many more radio stations and radio networks transmitting at different times throughout the day on single channel per carrier (SCPC). The best way to learn about these and other interesting services is to read Tom Harrington's "Tune to Satellite Radio on Your Satellite System" published by Universal Electronics, Inc., and available from the Grove catalog. This 102 page book is a thorough, easy to read explanation of how all this is done, what's up there, and how you can receive it. Loaded with excellent diagrams and photographs, this book is well worth the price (about $20).

Robert Ribelin of Guatemala City, Guatemala wants to set up a satellite TV system at his home. He asks, "...What differences and/or difficulties will I face compared to setting up a system in North America...?"

Setting up your satellite system in Guatemala will be the same as it is here in the states. Since the satellites are all lined up 23,000 up on the Equator and your latitude is 14 degrees your "look" angle will be almost straight up. Other than that the procedure will be the same. Now, it could be a question of what you'll see. Since you are so far south, getting a good picture from American domestic satellites may require a very large (12 to 16 foot diameter) dish. This is because the loss of full signals will have to be made up by the gain of the dish as we've just seen. A quick look at the footprint charts is not encouraging. Your best bet is to find an operating satellite system (a university would be a good place to start) and start asking questions. How big is their dish, what noise temperature LNB are they using. Before starting out on your own, you need to find out what has been done before. You'll get very good reception from the Mexican Solidaridad birds and probably from a few others, but the U.S. domestic satellites may take quite an investment.

Arnold Duke of Deseronto, Ontario, Canada asks, "...Will a standard TVRO receiver deliver PAL video to a PAL TV set?"

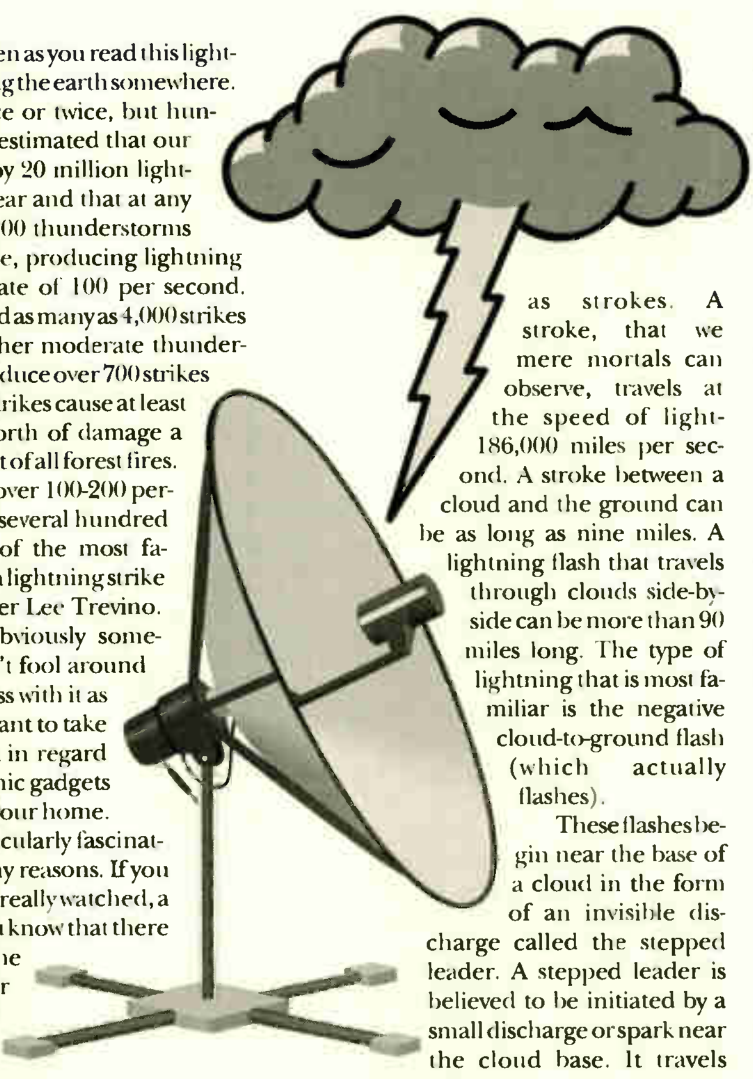
The American industry standard is called NTSC which stands for National Television Standards Committee and is used throughout the American television industry. England uses the PAL (Phase Alternate Line) system and is also widely used in Europe. PAL transmissions when received by an NTSC TV set are out of sync. This is why the image appears in black and white. The image also appears elongated because the PAL system uses 100 more scan lines per frame than NTSC. When the signal is passed to a PAL TV set the sync is correct and the image will be proper.
So, in a word, yes!

Colin Wordley, of Media, PA is "...an avid soccer fan and have been trying to obtain information on satellite services that transmit live games..." He read the January/February ST in which I suggested Primestar offers a certain amount of English soccer. Well, Colin, the problem with live sports events from England and Europe is, as you know, that we are much earlier in the day so that an evening event is five hours earlier here (Eastern) and not in most folks' prime time. This is why the games are taped and replayed at a time when more people will likely watch. The other problem is that soccer is still a sports step-child in this country and has to make way for football, basketball, hockey, baseball (now that the strike has been settled), kick-boxing, horse-back riding, hackey-sak and I think soccer falls just above the lumberjack events. However, I often see live soccer games being "backhauled" on one of the little used contract channels during the day. This requires you to be home during the day and searching all the channels for the unannounced appearance of such a game. It's a little more productive than hunting for a dropped LNB nut in the crabgrass out at the dish, but not much more. ST

Surge Protectors, Lightning and Your Dish

By Tim Olin

Lightning. Even as you read this lightning is striking the earth somewhere. Not just once or twice, but hundreds of times. It's estimated that our planet is touched by 20 million lightning strikes each year and that at any one time about 2,000 thunderstorms may exist worldwide, producing lightning flashes at a total rate of 100 per second. Florida has recorded as many as 4,000 strikes in one hour. A rather moderate thunderstorm can easily produce over 700 strikes in an hour. Those strikes cause at least a billion dollars worth of damage a year, and 70 percent of all forest fires. In an average year over 100-200 persons are killed and several hundred are injured. One of the most famous recipients of a lightning strike is professional golfer Lee Trevino.



Lightning is obviously something that you don't fool around with. You don't mess with it as a person and you want to take precautions with it in regard to all those electronic gadgets that now reside in your home. Lightning is a particularly fascinating subject for many reasons. If you have ever watched, really watched, a lightning storm you know that there is nothing like it. The tremendous power is evident. A typical stroke discharges about 100 million volts of electricity and heats the air in its path to more than 60,000 degrees Fahrenheit. Lightning can be seen for miles and miles. It can be frightening, but it can be beneficial as it does add nitrogen to the soil.

Lightning that strikes the earth consists of one of more electrical discharges known as strokes. A stroke, that we mere mortals can observe, travels at the speed of light-186,000 miles per second. A stroke between a cloud and the ground can be as long as nine miles. A lightning flash that travels through clouds side-by-side can be more than 90 miles long. The type of lightning that is most familiar is the negative cloud-to-ground flash (which actually flashes).

These flashes begin near the base of a cloud in the form of an invisible discharge called the stepped leader. A stepped leader is believed to be initiated by a small discharge or spark near the cloud base. It travels downward in microsecond steps about 50 m (165 feet) long. It pauses for about 50 millionths of a second and then flashes on....pauses again, steps on, pauses and so forth, until it gets about 100 m (330 feet) from the ground. At that point a separate leader jumps up from the ground-especially from tall objects such as buildings or trees-to meet it.

Once the two leaders connect, the stroke becomes a return stroke and this is the actual flash that we see. It happens so fast we really can't discern the direction of the stroke (up or down). Following the return stroke, several other strokes can occur along the original stroke's path in a matter of seconds. These strokes continue until the charge center in the lower part of the cloud is eliminated. The explosive heating and expansion of air along the leader path produces a shock wave that we hear as thunder.

GeoMet Data Services, based in Tucson, Arizona, operates the National Lightning Detection Network, which tracks electromagnetic waves produced by cloud-to-ground lightning strikes. The National Severe Storms Forecast Center in Kansas City, and Global Weather Central at Offutt Air Force Base in Omaha, Nebraska are among 85 Geo-Met customers that rely on information about lightning strikes. Detectors pick up lightning by sensing the electromagnetic waves that lightning creates. A satellite antenna picks up those signals, relays them to a master computer which sends the information off immediately to organizations who want the information. Utility companies rely on the information to spot possible outages and to decide on how many crews may be needed for repairs. The information can save hundreds of dollars.

All this information is interesting in itself. However, for anyone who happens to have a satellite dish or antenna, it's a reminder that lightning doesn't necessarily have to strike your dish or antenna directly to cause a problem. Just hearken back to that part of the story that talks about the 100 million volts of electricity. That's 100 million free floating, unharnessed volts that can wreak havoc on any electrical system or single piece of electronics in a matter of seconds.

So....can you prevent damage to your equipment? Most certainly. There are products on the market specifically aimed at counteracting this electrical bombshell that Mother Nature hurls at us during certain times of the year. The strategy used in protecting something from lightning is pretty basic. Provide a safe path for the lightning to travel that causes little or no harm to objects or people. Lightning will take the path of least resistance and that's the path one wants to make available.

Proper grounding of your dish or antenna is one element in the strategy. This means driving an eight-to-ten foot ground rod into the soil next to the pole that holds attached to the pole by a piece of heavy copper wire. This provides a path for the current that lightning produces to travel along. An electrician or your local satellite dealer should be able to help with this process. Keep in mind though, that grounding isn't the end-all and be-all of your protection. It can divert some of the electrical energy away, but as it has been pointed out, there can be a massive amount of energy in a lightning strike. There is also a large amount of static electricity that emerges from the strike itself. This static electricity can fry your electronic systems. So, the next protective step is a surge suppression device.

There's a wide variety of suppression devices on the market that vary in their ability to prevent electrical surges from harming your electronics. It's a matter of, "you get what you pay for." Inexpensive surge suppressors can handle small surges or spikes, but there are some very good suppressors that allow you to feel more at ease when the big stuff hits. Don't depend on the garden variety of surge suppressors to do the job. When we think of surge suppressors we think of the multiplug kind that says "Surge Suppressor" on it. The ones that you really want to look for are the kind that not only have the multiplug, but they have much more.

In addition to the multiplug outlets, these heavy-duty suppressors also have coaxial cable ports and should even have a strip that you can hook electrical wires to. Those are important differences between the ordinary, dime-store type suppressor and the one that you really want. The current from an electrical storm comes into your home by several means: through electrical wires; phone lines; control wires for your feedhorn and dish mover; and through the coaxial cable that carries the television signal, as well as the off-air antenna cable. A regular multiplug surge suppressor just won't do it. That's why it's

(Continued on Page 86)

No Noise is Good News, or the Solar Transit Effect Shines On

By Tim Olin

Remember the song about that "Lucky old sun that has nothing to do but lay around all day?" It's not true. We all know that it does work pretty hard. It expends a great deal of energy and sends out enormous streams of microwaves, called noise. Most of the time it does its job of keeping us warm and provides us with light, but two times a year it generates noise that interferes with our ability to get our MTV, ESPN or our CNN.

If at some point in the spring or fall you have some problems with reception from your dish, it very well could be because of solar outages caused by the advent of the equinox. The equinox occurs two times during the year when the sun crosses the equator and day and night are of equal length. This event takes place around March 21 in the spring and September 23 in the fall every year. Solar Outages (Solar Transit Effect) begin in the northern hemisphere about 3 1/2 weeks before the spring equinox, and in the fall last about the same amount of time after the equinox.

As mentioned earlier, the sun issues forth a large amount of noise as well as heat and light. This noise overpowers a satellite signal, and in the process completely knocks out the signal or degrades it. It runs in a seven day cycle and takes place about the same time each day. The first day the interference may only last a few minutes, but at the middle of the cycle the effect can last up to 10 minutes. How do you recognize that it's happening? Your picture becomes snowy (a lot of sparkles) and may completely fade from view to be replaced by nothing but snow on your TV screen.

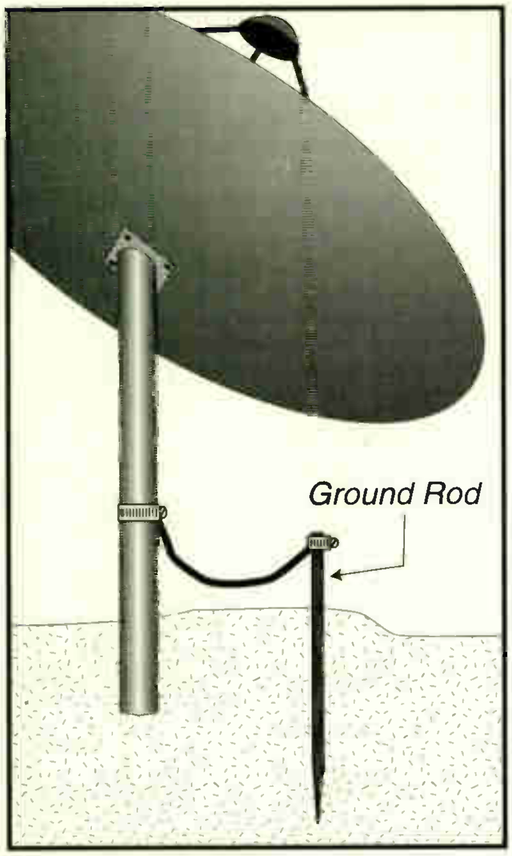
The interference evolves when the sun, a particular satellite, and your dish all line up in straight line. In the spring outage season, the sun works its way from north to south and in the fall season it works its way from south to north. That means it doesn't happen to everyone in the northern hemisphere at exactly the same time. The outages cause problems only with signals coming down from satellites, not those being sent to satellites.

There are a couple of ways to verify that you are experiencing an outage. The first is to simply move your dish to another satellite opposite of the satellite you are presently on. If you get clear reception on some of those satellites, the problem is that "Lucky Old Sun."

A second, but less safe way to do it, is to look at your dish and if the feed is casting a shadow directly in the center, the sun is your problem. The reason I say that it isn't a real safe way to check is that you have to remember that your dish is not only a fine reflector of satellite signals, it also is an efficient solar collector as well. This is especially true of solid, spun dishes. Mesh dishes obviously aren't as bad. The temperatures at the focal point or feed of your dish are extremely hot at the times of these outages. So, avoid standing directly in front of the dish.

Does the Solar Transit Effect interfere with the new 18 inch DSS and Primestar dishes? At the time of this writing it appears that it does, however, how long the effect last is open to speculation. Because the dish is small it has a wider beamwidth (the angle of sky which can be picked up by the dish) than C-band dishes. Some expect the duration of the outages to be twice as long as for C-band. Keep in mind though that DSS broadcast are digital and it is stronger than C- and Ku-band analog signals. As more and more people obtain DSS dishes we will have a better idea before long of the real effects.

The few minutes that the sun messes up your picture is nothing to really worry about. If your dish is properly painted or coated the outage will not harm your electronics. Since most dishes are painted, there is very little to be concerned about. However, it is suggested that you move your dish to another satellite away from the sun until the outage subsides. Better safe than sorry, as they say. Your receiver isn't in any danger either. The whole affair may be a bit annoying, but considering all the benefits we receive from the sun it's a small price to pay, don't you think?



Grounding your dish can be as simple as connecting the support post to a ground rod—but grounding the coax by means of a lightning protector is even better.

important to be able to hook in all your cables and wires.

Technically, suppressors use either metal oxide varistors (MOV), or gas discharge tubes or silicon diode transient suppressors to do the job of protecting electronics. It's probably not real important to go into exactly how each method works, but briefly, the difference in how each one works is how fast it reacts to a surge or spike. Gas discharge tubes can handle fairly high currents, but they do have somewhat of a slow reaction time when a current is introduced. MOVs are at the other end of the scale in regard to reaction time, they react in 10-35 nanoseconds. In between are the silicon diodes. they are somewhat fast and handle somewhat heavy current. One other kind of suppressor uses both diodes and varistors. So, what should we do with all this wonderful information? Well, let's go shopping for a surge suppressor.

- Volt-guard. this unit protects 4 AC receptacles, 8 motor leads, 3 pair of coaxial cables and a PAY-PER-VIEW (PPV) phone line. the models are the VG-SSP4 and the SSP-4-RJ (PPV) and are just 2 of 180 models built by this company. It's backed by a $500,000.00 Product Liability Insurance policy. Call 1-800-237-0769.

- SAT-PRO II PLUS. This unit plugs into grounded AC outlet and offers 5 AC outlets, connections for the motor leads, feedhorn, and multiple LNBs. It also has ports for coaxial cables and PAY-PER-VIEW telephone lines. It comes from Universal Research and Development, Inc, and is backed by a 10 year warranty which is backed by a million dollar product liability insurance policy. Universal also manufactures the PPV Pro which plugs into a grounded three-prong outlet and is built specifically to protect PPV modems and decoder modules. Call 704-298-2926.

- Panamax offers the Coaxmax 2, Coaxmax 4, Coaxmax 6 and the Towermax Sat and the Max 1000. The difference between the models has to do with how many lines that can be handled. The various models do provide protection to AC lines, motor and mover lines, coaxial cable, telephone and audio lines. Call 800-472-5555 in the USA and 800-443-2391 in Canada.

- PolyPhaser Corporation makes the IS-TVRO (protects the LNB and feedhorn motor), the IS-AM36V (for the dish mover) and the IS-PLTVRO-P (which features 4 AC receptacles and coaxial cable protection as well as a power line protector). To completely protect your dish PolyPhaser recommends one TVRO-P be mounted on the ground rod at the dish and the other at the place where the cable enters the house. Phone 800-325-7170.

- The Pay View Master from Electronic Specialists, Inc. covers the PPV, dish controller, up to four signal cables, eight control lines and with commercial models provides signal line filters. 508-655-1532.

Pay particular attention to the warranties as they are not the same for each surge protector. The conditions, claim procedures, limits and recommendations for installation should be ready carefully. No sense in getting struck twice if you don't have to. And be sure to tell all the manufacturers above you heard about them in the pages of *Satellite Times* magazine. ST

Sky-High Receiver, Rock Bottom Price

Grove is slashing prices on a limited number of ICOM R7100-2 scanners. If you have been waiting for a miracle, wait no longer—these are prices that we never believed we could offer! Hurry and take advantage of these rock bottom prices!

Special Limited-Time Offer: $1299.95*

Retail Price: $~~1942.50~~

Last Grove Price: $~~1499.95~~

ICOM *R7100-2,* ICOM's Best VHF/UHF Receiver

With the most popular features of the legendary R7000, plus a few features that listeners wanted, the R7100 is ICOM's best compact receiver.

The R7100 offers 25-800 and 900-2000 MHz frequency coverage on a brilliant LCD readout, selectable tuning steps, USB/LSB/AM/FM modes with wide and narrow selectivity switching.

900 scannable memory locations store frequency, channel number, mode and search steps; ten search banks with memory channel lockout, 5 or 12 channel-per-second scan speed and scan-resume delay are also found on this model.

High sensitivity and stable SSB reception are additional perks, as are sensitive, all-mode squelch and easy pushbutton function selection. Prices subject to change due to yen fluctuations.

Order SCN15-C

$16 UPS
$31 UPS 2nd Day Air
$36 US Priority Mail
$27.50 Canadian UPS;
$43.50 Canadian APP

NOTE: Cellular-capable, full-frequency-coverage model R7100-1 available only to federal, state, county, city and local government agencies and cellular service providers who submit an official purchase order.

SCN15-G R7100-1: .... $\$1539^{95}$
(plus shipping)

*For an additional $55, receive the GRE Super Converter (CVR3)and get full 25-2000 MHz coverage—a $94 value from the factory!

ACCESSORIES:

ACC 36	UT36 Voice Synthesizer	$55.95
ACC 72	TVR7100 Video Adaptor	$274.95
ACC 74	CT17 computer interface	$122.95
BRK 5	MB23 carrying handle	$11.95
BRK 8	MB5 mounting bracket	$42.95
ANT 8N	46" extendable whip antenna	$23.95
CVR 6	Shortwave Scanverter	$99.95
Installation of one or more accessories		$20.00
MAN 4	Service Manual	$50.00
SFT 2	Scancat Pro comp. software	$79.95
(Requires CT-17 Interface kit, ACC 74, above)		
SPK 3	SP20 speaker	$224.95
SPK 13	Grove Sound Enhancer	$249.95
SPL 2	SCPC Splitter	$64.95

GROVE ENTERPRISES

**P.O. BOX 98, 300 S. HYW. 64 W.
BRASSTOWN, NC 28902-0098
1-800-438-8155 (US/CANADA ONLY)
OR 704-837-9200**

VERY LIMITED STOCK!

DON'T MISS THE INCREDIBLE OPPORTUNITY TO OWN THIS FINE ICOM PRODUCT!

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: SARA

Radio astronomy is the observation of radio frequency emissions from distant galaxies, versus the more conventional observation of visible light as seen through an optical telescope. The field of radio astronomy is approximately 60 years old.

If you are interested in radio astronomy and would like to become an amateur radio astronomer, the Society of Amateur Radio Astronomers (SARA) would like to invite you to join their organization.

Amateur radio astronomy groups are relatively new. SARA was organized in 1981 and as of 1992 has approximately 275 members worldwide. Members are involved in Solar Radio Astronomy, Total Power Sky Surveys and Narrow Band SETI experiments. Interest in radio astronomy will allow you to expand your knowledge of general astronomy, radio systems, electronics and personal computers.

SARA holds a yearly conference in June at the National radio Astronomy Observatory in Greenbank, West Virginia. SARA publishes a newsletter on a regular basis called *Radio Astronomy*, which members receive as part of their SARA membership.

If SARA's work sounds interesting to you, you might consider joining their organization. Yearly membership is $20.00 in the U.S., $21.00 (US funds) for Canadian members, and $28.00 (US funds) for foreign members. If you live outside the U.S., do not send checks, please send money orders. It is also important to include a street address, post office boxes are not acceptable for all deliveries. Make all checks and money orders out to "SARA."

The Society of Amateur Radio Astronomers (SARA) can be reached at the following address: Hal Braschwitz, 3623 W. 139th Street, Cleveland, OH 44111.

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

Sky Report — Freehold, NJ
Night sky and bright satellite object information (pre-recorded)
The category for the "Sky Report" is 8888. There is no charge for this service.
(908) 866-8808, (908) 918-1000, (908) 957-8700, (908) 505-8011 and (908) 545-6000.

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.

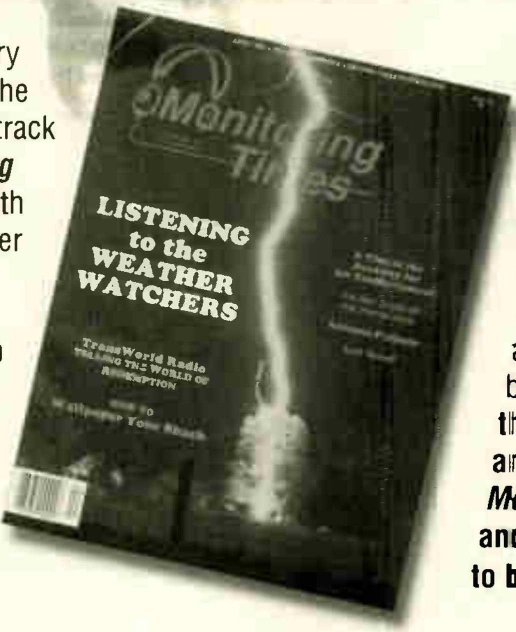
United States Space Foundation
PO Box 1838
Colorado Springs, CO 80901
(719)-550-1000
Membership: Charter $50 ($100 first year), Individual $35, Teacher $29, College student $20, HS/Jr. High $10, Elementary $5, Founder & Life Member $1000+

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).

If it's *on* the Radio, it's *in*

MONITORING TIMES®

World news happens every second, and you need the very best resources to track events as they unfold. ***Monitoring Times*** magazine provides you with the information you need to gather the news and events first hand, without the corrupting influence of news media bias. ***MT* can help you set up your own worldwide monitoring post to hear anything from where the fire trucks are going in your neighborhood to what's going on in other countries.** *MT* provides equipment reviews to help you choose the right equipment; advice to help beginners get started; frequency listings so you know where to tune in; as well as interesting features, stories and tips from the experts. The information in *MT* is both useful and timely— appropriate for beginners and experts alike. **Take the fast lane around the world and in your own community with *Monitoring Times*. Exciting news and events are out there waiting to be heard.**



Monitoring Times

LISTENING to the WEATHER WATCHERS

TransWorld Radio

To subscribe call 1-800-438-8155 **(US and Canada);** (704) 837-9200 **(foreign)** or mail this subscription form to *Monitoring Times*,
P.O. Box 98, Brasstown, NC 28902.

	1 Year	2 Years	3 Years
☐ US 2nd Class Mail	$23.95	$45.95	$67.95
☐ US 1st Class	$49.95	$97.95	$145.95
☐ Canada	$34.95	$67.95	$100.95
☐ Foreign Air Mail	$53.95	$105.95	$157.95

US Funds Only

- ☐ Check/M.O.
- ☐ Mastercard
- ☐ Visa
- ☐ Discover Card

Credit Card# ______________________

Exp. Date ______________________

Name ______________________________

Address ______________________________

City______________**State**______**Zip**______**Country** __________

Signature ______________________________

Monitoring Times

Published by Grove Enterprises

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.

1-3/4" SQUARE DISPLAY AD: $50 per issue. Send camera-ready copy or copy to be typeset. Photo-reduction $5 additional charge. For more information on commercial ads, contact Beth Leinbach, 704-389-4007.

GE Superradio III, custom designed with up to four noise-free SCA Channels. Performance guaranteed. Credit Card orders accepted. (800) 944-0630.

WANTED: Panasonic DR 29, RF 2900, RF 2600. Earle Adams 718 Graisbury Avenue, Haddonfield, NJ, 08033, Phone (609)429-1599.

SATELLITE RADIO BOOK & GUIDE

NEW BOOK covers all Audio Services, SCPC, Subcarriers, FM^2, Facsimile, Press Services, Weather Services. Simple how-to-receive instructions. **Satellite Radio Guide Included.** $16.95 plus $3 Priority Mail ($19.95 total).

UNIVERSAL ELECTRONICS, INC.
4555 Groves Road, Suite 12
Columbus, OH 43232 (614) 866-4605

SUPER SOUND DETECTOR
HEAR THROUGH WALLS

ELECTRONIC STETHOSCOPE
Ultra-sensitive device picks up & amplifies sound through solid objects. Hear through glass, wood, plaster, brick or even 12" concrete. Use wherever audible sound is too faint for the unaided human ear. Picks up voices, machinery, running water, even mice or insects. Can be attached directly to a tape recorder. Includes headphones, sensor and battery. $69.95 check/MO to:

CLE, Box 1913
Sarasota, FL 34230-1913
(813) 922-2633.
Visa/MC accepted.

HUGE 100 PAGE CATALOG

- Shortwave Receivers
- Amateur Radio Gear
- Scanners
- RTTY & FAX Equipment
- Books & Accessories

Send $1 to ☞
Universal Radio
6830 Americana Pkwy. *ST*
Reynoldsburg, OH 43068
Tel. 614 866-4267

YOUR OWN SATELLITE TV BUSINESS!

You can profit from the small-dish revolution in satellite TV! Quality programming, initial investment of less than $600 includes complete satellite system and marketing program.
For info package and video, send $9.95 check or money order to:
S.S.E., P.O. Box 70277
Ft. Bragg, NC 28307-0277

SATELLITE TIMES ADVERTISERS' INDEX

Save Time and Money. . .
Subscribe to ST

To subscribe to *Satellite Times* send subscription form to Grove Enterprises, P.O. Box 98, Brasstown, NC 28902; or Call (800) 438-8155, (704) 837-9200 (outside US & Canada).

	1 Year	2 Years	3 Years
☐ US 2nd Class Mail	$19.95	$38.00	$56.00
☐ US 1st Class	$32.95	$64.00	$95.00
☐ Canada	$26.95	$52.00	$77.00
☐ Foreign Air Mail	$44.95	$88.00	$131.00

US Funds Only

Name____________________________________

Address_________________________________

City____________State______Zip ______ Country________

Phone ___________________________________

CC#________________Exp.date__________________

World Radio History

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

A Taxing Topic

The Direct Broadcasting Satellite (DBS) industry is much too successful–at least this is the substantiable fear of the cable TV industry. Some 60% of satellites' subscribers come from cable-linked communities, and two thirds of those subscribers have switched off their cable.

Predictions show this year's satellite TVRO growth at 5 million subscribers, roughly evenly divided between C and Ku band. Yet more enticement to satellite services is on the way; EchoStar wants to be the low-cost provider, forcing DirecTV and USSB to rethink their pricing. The cable industry sees a bleak future ahead.

Rallying to the cause, the cable industry is trying to impose taxation on the DBS providers. Charles Hewitt, president of the Satellite Broadcasting and Communications Association (SBCA), commented recently on the punitive cable attempt in Maryland, Virginia and Illinois.

In a wide-sweeping attempt to thwart the satellite industry, cable is targeting both C and Ku band networks. Not only would the burden hit the infant small-dish industry, but it could force minor-playing big-dish operators out of competition as well.

Superficially, the proposed tax may seem reasonable, according to Stephen Effros, president of the Cable Telecommunications Association, who says that cable operators already pay a five percent local tax. State legislators, sniffing another source of revenue, are listening intently to cable's proposal.

But Hewitt retorts that satellite providers already pay taxes through agreements with the League of Cities and the Multistate Tax Commission. And satellite TVRO owners had to pay taxes to buy their equipment.

Additionally, as noted by Stephen Hubbard, president of DBS provider United States Satellite Broadcasting (USSB), direct broadcasting doesn't have to run cables across private property, utilize public rights of way or tear up roads like cable does.

The paperwork overload on satellite providers would be staggering, requiring separate filing and payments to tens of thousands of municipalities and other government entities across the country.

The cable industry has belligerently flaunted their independence with some arrogance, often ignoring price regulation efforts, increasing fees with apparent impunity. Competition is welcomed by beleaguered cable subscribers who feel it's well-nigh time for cable to get its come-uppance.

Nor is the satellite consortium sitting still. They are mobilizing now to counter-lobby and even to file a lawsuit against the first state which passes a satellite service fee.

We agree with the satellite front. Broadcasting is broadcasting. Special taxes are not imposed upon terrestrial FM or TV stations, but they are on utilities which intrude into private and public property. Well-financed cable conglomerates have no right to stifle competition by lobbying for punitive restrictions without merit or precedent.

The cable industry would be better advised to seek deregulation in their own monopoly and lobby for lower tax rates. This would create an environment for healthy competition which would generate more attractive program packages and lower rates.

Slip the Surly Bonds of Earth

"Superior performance and features in a compact package"— Satellite Times Test, Sept.-Oct. 1994

With the new ICOM IC-820H dual-band, all mode transceiver for satellite and terrestrial communications!

License required to transmit:
Technician, General, Advanced or Extra

Explore amateur radio's new frontier—satellite communications! Ideal as well for terrestrial contacts. This new, all-mode, dual-band transceiver is both compact and lightweight, offering operating versatility other base stations just can't match: Automatic crossband repeater, normal and reverse satellite communications tracking, independent uplink/downlink doppler-shift compensation, 10 satellite up/downlink management memory channels and more! Frequency coverage is 144-148 MHz VHF/430-450 MHz UHF (can be modified by Grove at time of order to cover 136-174 MHz/420-460 MHz; CAP, MARS or Experimental license required to transmit). See ICOM ad on back cover of this magazine for additional information and specifications.

RECOMMENDED ACCESSORIES:

PWR-4	PS-55 Style-matching power supply	$344.95
PRE-6	AG25 144-148 MHz preamp	$159.95
PRE-7	AG35 420-450 MHz preamp	$164.95
MIC-1	HM-12 Hand microphone	$53.95
MIC-2	SM-20 Desktop microphone	$187.95
ACC-71	SP-20 external speaker	$224.95
ACC-2	SP-3 external speaker	$101.95
ACC-36	UT-36 voice synthesizer	$55.95
ACC-74	CT-17 CI-V level converter	$122.95
ACC-83	MB-5 mobile mounting bracket	$42.95
ACC-138	MB-23 carrying handle	$11.95
MOD-02	136-174/420-460 MHz transmit & receive	$40.00

Order XCVR 01

Only **$1649.95**

Plus $16 UPS shipping (US)

GROVE ENTERPRISES, INC.
P.O. Box 98
Brasstown, NC 28902
(800) 438-8155
Outside the US and Canada call:
(704) 837-9200

The New Leader In Satellite Communications!

and digital

"ONLY THE ...IC-820H showed both transmitter and receiver performance that will result in efficient packet operation at 9600 baud." —*QST*, May 1995

IC-820H FEATURES:

- ☐ Built-in Auto Satellite Functions
- ☐ All Modes in a Compact Case (9.5" W x 2.7" H x 10.0" D)
- ☐ "Plug and Play" 9600 bps Operations
- ☐ Built-in High Stability Crystal (± 3 ppm)
- ☐ Independent Controls with Sub Tuning
- ☐ New DDS for 1 Hz Resolution
- ☐ IF Shift (electronically shifts for effective interference reduction)
- ☐ Satellite Memory and Tracking Function (rev./normal tracking on main/subband)
- ☐ Doppler Compensation Function
- ☐ 10 designated Satellite Memories
- ☐ Data Jack for Packet Ops. (9600 bps)
- ☐ New Modulation Limiter Circuit
- ☐ 2 VFO's each for VHF and UHF Bands
- ☐ 50 Memory Channels
- ☐ Stereo Headphone Jacks
- ☐ 2 Antenna Connectors
- ☐ Noise Blanker
- ☐ RIT Function
- ☐ Memory Allocation Function
- ☐ Attenuator
- ☐ Programmed/Memory/Mode Select Scan
- ☐ CW Semi-Break In and Side Tone
- ☐ AF Speech Compressor (audio)
- ☐ Auto Repeater and One-Touch Functions
- ☐ Separate Main and CW Filters
- ☐ 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
- ☐ Microphone Optional

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 I-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 I-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. **Separate S-Meters** simultaneously indicate each band's 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** electronically shifts the center frequency of the receiver passband 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** prevents you from exceeding the maximum deviation – even with large amounts of data.

For more information about the IC-820H, visit your local ICOM dealer, contact ICOM Technical Support in the Hamnet forum on CompuServe® @ 75540,525 (Internet: 75540.525 @ compuserve.com) or

call ICOM's brochure hotline: (206) 450-6088.

View a video demonstration of this product

VHS

at your participating ICOM dealer today!

Experience the Quality

ICOM®