Satellite Times

A publication of Grove Enterprises

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Volume 1, Number 6

July/August 1995

GOES THE NEXT GENERATION

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Satellite Times

Cover Story

Cover Photo: A photo of the spectacular May 23, 1995, night launch from Cape Canaveral of the GOES-9 spacecraft, the second spacecraft in the GOES-Next series. (Photo courtesy of NASA)

GOES—The Next Generation

By Philip Chien

Everybody talks about the weather, but nobody does anything about it. However, don't tell that to the folks at the National Oceanographic and Atmospheric Administration (NOAA). They've just launched their second geostationary satellite of the year. In this issue's cover story, Philip Chien takes an in-depth look at the new GOES-Next program and an abbreviated history of weather satellites. Story starting on page 10.

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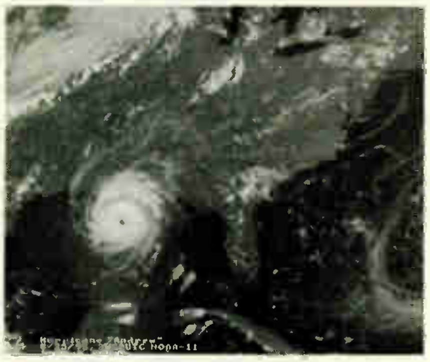


Looking at Earth from Space

By J.S. "Stu" Gurske

From the darkness of space, a battery of weather satellites constantly monitor the changing and dynamic patterns of the world's weather. What does it take to get started in this exciting aspect of satellite monitoring? Stu Gurske provides the basics in his weather satellite reception primer starting on page 14.

A Bird's Eye View of Earth

By Raymond J. Smith

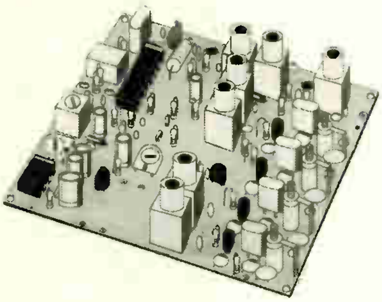
Want to receive APT satellite imagery from the polar orbiting NOAA satellites? Need some ideas on equipment and how to get started? Ray Smith looks in-depth at all of these questions and more in his article titled "A Bird's Eye View of Earth." Ray even includes the plans for a $30 homebrew turnstile antenna for 137 MHz. Story starts on page 18.

Leasat—High Flying Space Frisbees

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 Leaaat constellation of satellites in the third of a four part series on UHF military satellite systems. Story begins on page 22.

The Hamtronics Weather Satellite Receiver



In the *Satellite Times Tests* column this issue, Jeff Wallach and Fred Piering of the Dallas Remote Imaging Group put the Hamtronics R138 137 MHz receiver to the test. As you will see on page 88, it passed with flying colors.

DEPARTMENTS

ST

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

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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.

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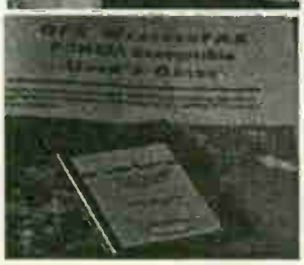


WEFAX SOFTWARE. We can provide OFS WeatherFAX software for use with your image capturing system. The cost of the new PCMCIA (credit card) plug-in card and software for laptop computers is $495.00. This card will also work with desktop computers if you use the buss adapter board. The original WeatherFAX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

DOWNLINK

By Larry Van Horn
Managing Editor

Surveys, We Got Surveys!

As most of you know, we conducted our first *ST* reader survey in the March/April issue. I am very pleased with the response we have received from our readers. In fact, we have received so many replies, we are still compiling some of the information.

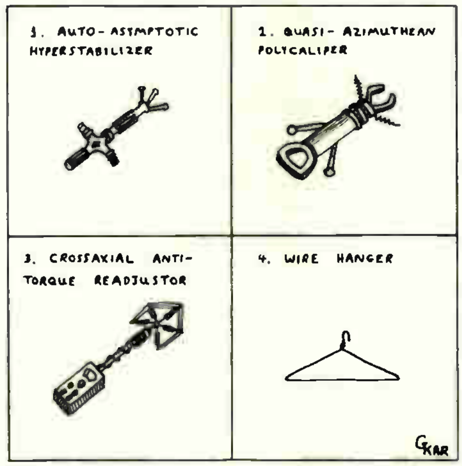
I can report on a few of the more interesting statistics that we have tabulated from the survey so far. A snapshot of the average *ST* reader would show they are between 45-54 years old in age and have an average yearly income of between $50,000-$75,000. That reader owns their own home and lives in the suburbs. Most of our readers have earned either an associate or bachelors degree and are employed in technical/professional fields.

Over 83 percent of our readers own a computer and about 61 percent have CD-ROM capability. Seventy-five percent of *ST* readers said they were interested in astronomy and 39 percent even own a telescope. Almost half of the of the respondents consider themselves beginners and one-quarter say they have an intermediate level of expertise.

We plan to publish some additional details from this survey in the months to come. And no, I haven't forgotten the contest we ran in conjunction with the reader survey. From all the surveys we received we held a drawing and ten lucky winners each won a one year free subscription to *Satellite Times.*

Bob Grove, publisher of *Satellite Times* did the honors and the lucky winners are (drum roll please):

Wayne Bock-Oak Ridge, Missouri; James E. Greenwood-Pelham, New Hampshire; Isidoro Hernandez-Carolina, Puerto Rico; Thomas Lopez-Eagle Pass, Texas; Joseph R. Miller-Batavia, New York; Donald A. Skinrood-Candler, Arizona; Ronald Stone-San Antonio, Texas; Larry Treat-Lowell, Indiana; Ronall Tull-Whitehorse, Yukon, Canada; and Timothy Wingert-Salem, Oregon.



NASA's standard tools for satellite repair in space.

I also selected one entry from all those received for a special "editors award." I really did appreciate all the comments, positive and negative we received and wanted to reward the one person whose comments I found the most useful and constructive.

Congratulations to John Robinson in Nashville, Tennessee who will be receiving a one year extension on his *ST* subscription courtesy of the Managing Editor.

Our readers have indicated a strong interest in the homebrew aspect of satellite listening and I would like to run more construction articles in the pages of *ST.* We plan to present more construction articles, tips, and modifications in future issues of *Satellite Times.* If you have one you would like to share, by all means contact us.

How about a downconverter for the 2 GHz space band? Phase 3D will be launched next year and a whole host of new ham bands will be available via satellite. Transponders carried onboard Phase 3D will have downlink capability in the 2.4, 10.4 and 24 Ghz bands and uplinks in the 1268 Mhz, 2.4 and 5.68 Ghz bands. In order for hams to operate on these new satellite frequencies, homebrew projects will have to be the order of the day. I don't think you are going to see the major ham manufacturers jump on the band wagon right away with equipment for operating on these new satellite frequencies.

The issue of *Satellite Times* you are holding is very special. We have devoted a lot of pages to the fascinating hobby of weather satellite monitoring. There are even a couple of construction articles in this issue. If you like the smell of hot solder in the morning, warm up those irons and turn to pages 18 and 74.

Speaking of special issues, you'd better get that renewal card in the mail right now because you don't want to miss the next exciting issue of *Satellite Times,* our first anniversary issue. We have had a lot of requests to do material on military satellite listening and the September/October issue is going to be chock full of military satellite articles.

We will finish our four part series on UHF military satellites with an in-depth look at the Department of Defense newest satellite—the UHF Follow On constellation. In fact, we even have an *ST* exclusive in conjunction with that article: the new UFO frequency bandplans—November, Oscar, Papa, and Quebec.

We are also planning features on NORAD, U.S. Space Command, the DSP early warning satellites and the Navy's Space Surveillance System. I know this is one issue you won't want to miss so be sure to get that renewal card in the mail today. Till next time, 73 de N5FPW SK. ST

World Radio History

SATELLITE MONITOR

By Wayne Mishler, KG5BI

What? Short-wave on AM via satellite?!

Imagine sitting in your kitchen, in Canada or the U.S., and listening to Radio Australia on a table AM radio.

It's being done through satellite.

World Radio Network (WRN) beams international radio stations via satellite to the Canadian Broadcasting Corporation in Canada, which relays them to radio stations in ten Canadian cities for local broadcast on AM and FM frequencies.

These programs are being heard via ground wave in Canada and some northernmost U.S. regions. The AM broadcasts probably are being heard in other parts of North American by sky wave when terrestrial propagation conditions are right. This should provide some good listening for night-owl AM DXers when propagation improves this winter.

Karl Miosga of WRN says that international stations beamed to CBC include Radio France International from 0100 to 0200, Radio Netherlands 0200-0300, Radio Sweden 0300-0330, BBC Europe Today 0330-0400, Deutche Welle 0400-0500, and Radio Australia 0500-0600. Those are Eastern Standard Times.

These international stations are being broadcast locally in Vancouver on 690 kHz, Calgary 1010 kHz, Edmonton 740 kHz, Regina 540 kHz, Winnipeg 990 kHz, Toronto 740 kHz, Ottawa 91.5 MHz (FM), St. John's 640 kHz, Whitehorse 570 kHz and Yellowknife 1340 kHz.

PAS-2 footprint covers Asia and western U.S.

Asia Business News (ABN), transmitting via PanAmSat's PAS-2 satellite, this Spring was to begin reaching viewers in Asia, Pacific and western U.S. regions with in-depth business news and financial information from Asia. This is the first time ABN has been available in the U.S. since the company began operations in 1993.

"In the six months since PAS-2 began service, we've worked with both regional and international programmers to develop a compelling line-up of TV services on the satellite," says PanAmSat president and chief operating officer Fred Landman.

ABN is owned by a consortium of companies including Dow Jones, TCI, and Television New Zealand. The network covers business and financial news pertinent to Asia. It draws editorial matter from bureaus in Southeast Asia, East Asia, Europe and the U.S.

The satellite has the capacity to reach two billion people, and carries programming in more than five languages.

U.S. planning next year's joint space operations with Russia

The U.S. is already planning its third and fourth docking missions with the Russian space station Mir, scheduled for March and August of next year.

In the fourth docking mission, U. S. Naval Reserve Commander William F. Ready, commander of the Atlantis space shuttle, will be joined by five other U. S. astronauts including a pilot, three mission specialists, and a doctor who is to remain aboard Mir for about four months. The mission will conduct scientific studies and transfer water and supplies to Mir.

As of April 24, this year, U. S. astronaut Norman Thagard had been aboard Mir for 40 days, working with the Russian crew in medical and biological research experiments. They are studying the effects of weightlessness on human metabolism, and measuring radiation in the space station.

On April, the crew launched into orbit the German GFZ-1 microsatellite to study the Earth's gravitational field. Satellite data was to be relayed to Earth stations in England, Australia and Germany.

U. S. developing early-warning satellite system

NO ICBM'S

A team of space and engineering gurus are developing an early-warning satellite system to protect the U.S. from missile attacks. The system will be placed in orbit, and will use infrared technology to sense approaching missiles.

The team of developers will be led by Hughes Electronics Corporation who will provide space elements, and will include engineers and ground crews from TRW Space and Electronics Group.

Each of the two industrial firms brings its own special expertise to the project. TRW is known for design and development of complex space defense systems, including the existing Defense Support Program, and payloads for Milstar. Hughes is a leading producer of communication satellites and infrared sensors.

The system, when completed, will be managed and operated by the U. S. Air Force.

Eye in the sky may track ground vehicles to save money

The power of computers and satellites may soon be used to track movement of ground vehicles.

A New Mexico company is working on an idea that would help public schools improve management of their bus routes, and pay for miles driven rather than miles estimated on paper. The same concept could monitor movement of other ground vehicles as well.

A computer program has been created to store information about school bus routes, mileage, students and bus contractors.

Global positioning system (GPS) receivers would be placed on vehicles. Using signals from the nation's defense GPS satellites, the receivers would gather data on vehicle movement. Computers would analyze data from the receivers, enabling dispatchers to measure rather than estimate real-time mileage of their vehicles.

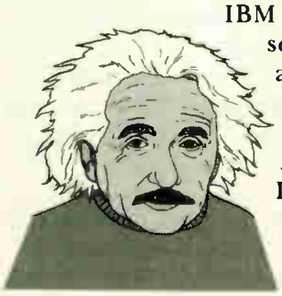
Who was that Einstein guy, anyway?

Scientists wonder why interstellar matter is expelled from certain regions in space and collected in others. This phenomenon creates vast, empty regions of space, known as cosmic voids, and shoves stars and planets and moons together into clusters like driftwood on water. This creates the galaxies of our universe. It also mystifies humanity.

In an article in the May 20, 1995, *Astrophysical Journal*, three scientists present a possible explanation, with help from an 85-year-old theory by Albert Einstein, who laid the foundation for modern-day cosmology nearly a century ago.

Einstein and an associate theorized, in 1910, that when particles are exposed to radiation fields they collide with photons, accelerating the particles to high velocities. In earthbound radiation fields, the Doppler shift retards particle speed and quenches the process. But in space there is a phenomenon known as Zero-Point Fields: seas of energy, resulting from quantum mechanics, possessing an unusual spectrum which would allow space particles to be accelerated without opposition.

In their article, Alfonso Rueda of California State University, Daniel Cole of IBM Watson Research Center, and Bernhard Haish of Lockheed Palo Alto Research Laboratories, propose that Zero-Point Fields provide the mechanism for expelling space particles out of cosmic voids and into galaxies.



Satellite communications firm offers stock

PanAmSat Corporation in April offered $275 million in 12.75% mandatorily exchangeable senior redeemable preferred stock, due 2005.

Investments will go toward the development, construction and launch of the PAS-5 and PAS-6 satellites, to be used primarily for digital direct-to-home (DTH) program services in Latin America.

Morgan Stanley & Company led the offering with co-managers Bear, Stearns & Company, and Donaldson, Lufkin & Jenrette Securities Corporation.

PanAmSat provides satellite-based video and data communications services for more than 110 countries in the Atlantic and Asia-Pacific regions.

PAS-5, scheduled for launch in 1997, will provide C-band and Ku-band coverage of North and South America. PAS-6 is to be launched in late 1996 or early 1997 and will provide an additional 360 digital channels for Latin American viewers.

By mid-1997, based on their current launch schedule, PanAmSat will be providing more than 500 DTH channels to markets in Latin America, the Caribbean and the southwestern U.S.

INTELSAT expands service to Indian Ocean and Latin American regions

INTELSAT 704 went into operation this Spring, providing commercial operations to customers in the Indian Ocean region. Located at 66 degrees east, this is the first of INTELSAT's VII series satellites to be deployed over the Indian Ocean.

The launch in March of INTELSAT 705 promises to expand television and telecommunications services in the C-band and Ku-band for customers in Latin America.

INTELSAT 705 was to settle into orbit at 310° East, and to go into operation in May after in-orbit testing. It's location gives it a footprint covering the western Atlantic region. It is to provide broadcast, VSAT, and domestic telephone services for Argentina, Brazil, Chile, the United Kingdom, the U.S., Bolivia, Colombia, Ecuador, Peru and Venezuela.

INTELSAT

DIRECTV announces new packages

Effective June 1, 1995, DIRECTV is offering two new monthly programming packages to consumers. A new entry-level package entitled "Select Choice" is priced at $19.95 per month and includes programming and receiving equipment. The other package, "Plus DIRECTV", $14.95 per month, gives customers satellite programming while keeping their cable service.

The company's "Total Choice" subscription package remains unchanged. It is priced at $29.95 per month, and includes more than 40 cable television networks with seven channels of movies, the Disney Channel, 28 other channels of commercial-free digital music, and a regional sports network. Total Choice also offers 50 channels of pay per view movies and special events coverage.

DIRECTV in April was to begin covering the new World League of American Football. Subscribers are to receive tape-delay coverage of one game per week during the World League's 10-week schedule at no charge. Every Tuesday during the season, DIRECTV will air one match-up from the previous weekend.

DIRECTV sails with U.S. Navy

Sailors aboard the aircraft carrier USS Abraham Lincoln in April were treated to 150-channel DBS TV viewing while on training maneuvers near the U.S. Pacific coast.

In a demonstration of the service, engineers from Hughes Electronics, as-

sisted by Navy technicians, installed a modified DSS unit on the ship in port at San Diego. The receiving system featured a tracking and stabilization system that kept the unit's tiny antenna dish locked on DIRECTV satellites during sea maneuvers. Programming was routed from the antenna through fiber optics to 600 television sets on the ship.

New weather satellite goes into orbit

Japan's newest weather satellite, GMS-5, will collect and distribute weather data to nine nations in the Asia-Pacific region. It was launched into circular orbit in March at 22,300 miles above the equator.

The satellite was scheduled to undergo three-months of in-orbit testing before being made available for service. It is located at 140º East longitude.

Data from the satellite will contribute to weather forecasts for Australia, China, Indonesia, Korea, Malaysia, New Zealand, the Philippines, Thailand and Vietnam.

GMS-5 was built in Los Angeles by Hughes Space and Communications Company under subcontract to NEC Corporation of Tokyo.

NASA to launch new exploration satellite

A new 633-pound satellite with remote sensing instruments next year is to be placed in a 318-mile, Sun-synchronous, 97.4-degree orbit for NASA to use in studying Earth.

The satellite, named Clark, is to be one of a pair (Lewis and Clark) of relatively low-cost exploration satellites in NASA's new "Small Spacecraft Technology Initiative."

The Lewis and Clark duo are small spacecraft specifically designed and built to fit NASA's dwindling budget.

Cubans defy Castro with home-spun satellite antennas

Cuban citizens, in defiance of their government, are flattening metal cans into home-spun antennas to receive forbidden satellite television programs.

Reports from the BBC explain that the Cuban state-owned television network Cubalsa last year built a satellite reception tower in downtown Havana. The intent was to receive and re-broadcast foreign satellite television programs to Cuban citizens. The price for this service, including an "authorized" antenna dish, was about $100 a month.

"The Cuban government justified the price by claiming high costs for rights to the broadcasts. News reports say the government pirated the signals," BBC says.

To avoid the charges, resourceful viewers began making antennas from metal scraps and scavenged electronic components, which worked.

"With these homemade antennas, Cubans can watch cable channels from the satellite reception antenna located atop the Habana Libre hotel," says short-wave monitor Victor Garcia-Rivera, of Fairfield, Ohio.

"The antenna was erected to broadcast satellite transmissions throughout the island for privileged foreigners who can afford such places," he says. "An unintended outcome was that resourceful Cubans (citizens) tapped into the transmissions to bypass the government's total media control."

"The government has ordered citizens to stop using the antennas or face prosecution," says a report in Cuba's official newspaper Granma. The government scrambled their transmissions, but viewers found decoders.

The article, quoted by the *Miami Herald* newspaper, apparently did not specify what the punishment might be for non-compliance. But it was made clear that any unauthorized equipment used to receive programs from overseas will be confiscated.

USSB offers flexible programming packages

United States Satellite Broadcasting (USSB) emphasizes flexibility in their programming options.

For example, their "Select One Plus" program allows customers to choose among several multi-channel movie options, and then add Lifetime, Comedy Central, Nickelodeon/Nick at Nite, MTV, VH1, and the All News Channel to please everyone in the family.

The package retails for $17.95 per month.

First time DSS buyers get a free month of USSB Entertainment Plus, a $34.95 value that includes the company's entire line-up of 20 networks. When the free month ends, viewers can choose from seven programming packages, including Select One Plus.

For additional information, call the USSB consumer hot line: 800-BETTERTV (800-238-8378).

Watts in a moonbeam?

It was a clear and moonlight night. While America slept, scientists at Arizona State University were out chasing moonbeams with a wattmeter.

Apparently they caught some. In a report published by the *Science* journal, researchers Robert Balling and Randall Cerveny say that sunlight reflecting from a full moon sends to Earth about .0102 watts of power per square meter of ground coverage.

It gives new meaning to the word "moonshine."

At its brightest, moonshine (not the white lightning variety) yields about 1% of a watt.

For comparison, the power in direct sunlight is about 135,000 times greater. The sun produces about 1,376 watts per square meter. There are 746 watts in one horsepower.

So lunar moonshine won't melt your ice cubes. At least on Earth. But at high noon on the lunar surface, temperatures can rise to 200 degrees Fahrenheit, emitting considerable amounts of infrared energy. While much is lost in the 220,000 mile journey to Earth, enough remains to allow weather satellites to measure differences during various phases of the moon.

Even so, say Balling and Cerveny, moonshine has little affect on Earth's weather, even on a clear and moonlit night. But the jury's still out on white lightning. ST

Sources:

DIRECTV, Energia Ltd., Hughes Space and Communications Company, Lockheed Missiles & Space Company, Miami Herald (courtesy of Victor Garcia-Rivera), PanAmSat, Seattle Post-Intelligencer (courtesy of Richard Sklar), U. S. Navy, United States Satellite Broadcasting Company, World Radio Network. If you have seen or heard news about satellites or space related items, Satellite Monitor wants to hear from you. You can send your contributions to: Satellite Monitor, P.O. Box 98, Brasstown, NC 28902-0098 or fax them to (704) 837-2216. Become a Satellite Monitor reporter today.

LATE BREAKING NEWS!

Anti-Castro Broadcasters Discovered on Satellite

For years, their voices have been heard on shortwave radio denouncing Fidel Castro and his government. Their world is one of secrecy and it is shrouded in mystery. Some of these stations have even had ties to the intelligence agencies of the United States government. Others have had their roots buried deep in the Cuban-American community of Miami. Regardless of their lineage, these shortwave voices have two things in common: their hate for Castro and his government, and the name that shortwave listeners call these types of shortwave broadcast stations—clandestine radio stations.

Just what is a clandestine radio station? Noted radio author Gerry Dexter in his book *Clandestine Confidential* describes them this way, "This writer has never seen an entirely acceptable definition. Perhaps the closet was given by Carol Feil in the 1977 edition of the *World Radio TV Handbook* as—a clandestine transmission is a political transmission from a radio station or organization that is considered illegal in the target country."

Now for the first time ever in this hemisphere, some of these Anti-Castro clandestine broadcasters are being heard via satellite. On the evening of June 4, noted *Monitoring Times* shortwave columnist Gayle Van Horn, monitored several clandestine broadcasters transmitting from Spacenet 2, transponder 13U (4) *SUR TV* network, audio subcarrier 5.80 MHz.

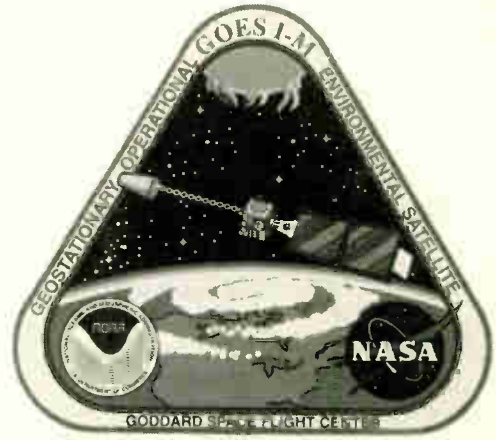
For well over a year now, satellite monitors have been reporting 5.80 MHz as a blank audio carrier on *SUR*'s video transponder, after *Radio France International* quit using it sometime in 1994. Now the transponder appears to have come alive with several of these clandestine stations using the audio subcarrier to broadcast their transmissions.

Some of the broadcasters noted during the evening hours of June 4 include: *La Voz de la Resistencia, La Voz del Cubano Democratico, La Voz de la Federacion Mundial de Expresos a Polticos de Cubanos*, and the longest running Cuban clandestine station—*La Voz de Cuba Independiente y Democratica (CID)*.

Mrs.Van Horn noted that the broadcast appeared to be feeds with a mixture of newscasts and regular programming. It is not known at this time who the intended audience of these broadcasts is. Some of the clandestine stations mentioned above have programs on shortwave broadcaster WHRI in Noblesville, Ind. *ST* contacted Jim Hall of the WHRI station staff and he said that they were definitely not the recipients of any of the broadcasts noted on Spacenet 2, transponder 13U. "We get our programming from the Cuban groups via telephone lines," Hall said.

ST has contacted both *SUR* and the Hero Teleport in Miami, but neither company had answered any of our questions regarding these satellite broadcasts at presstime. We hope to have a full report on this in the next issue of *Satellite Times*.

GOES THE NEXT GENERATION

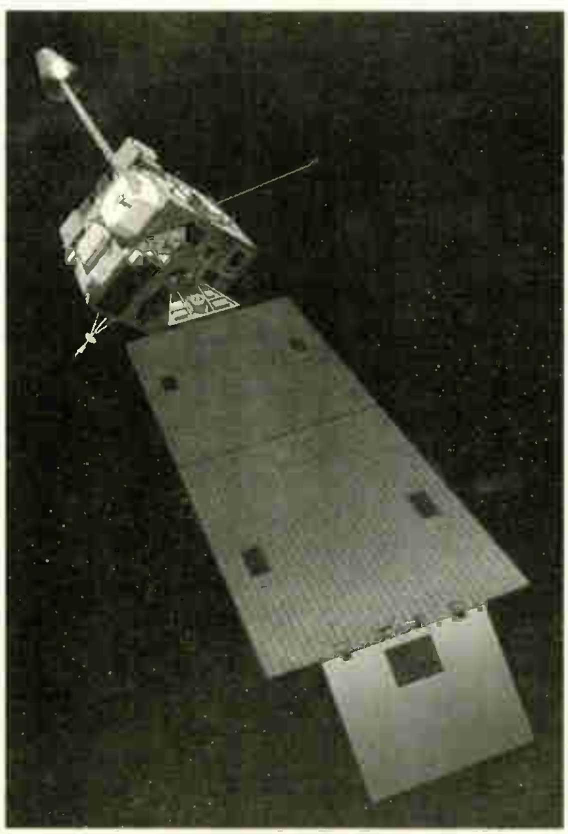


By Philip Chien, Earth News

You may not even realize it, but everybody benefits from weather satellites. For the past decade meteorological satellites in geosynchronous orbit have been observing the world. GOES, the Geosynchronous Operational Environmental Satellite, is so much a part of our daily lives that we take it for granted. The orbital pictures of weather views you see on the news and in newspapers are taken by GOES from their vantage point 35,888 km. (22,300 mi.) above the equator.

GOES-Next, the U.S.'s current generation of weather satellites are reaching fully operational status as you read this article. The first GOES-Next spacecraft, GOES-8 was launched on April 13, 1994 and was recently declared fully operational. GOES-9 was launched on May 23, 1995 and is undergoing on-orbit checkout and calibration. GOES-9 is expected to enter operation this fall.

But for a while it looked like GOES-Next would never occur. The program was originally budgeted for US$276 million when the contract was awarded to Ford Aerospace in 1985. It's now expected to cost over a US$1 billion and the first launch took place 4 years behind schedule. Thermal vacuum tests in 1990 showed that the imager and sounder mirrors were warping beyond specifications, resulting in launch delays and increased testing requirements. NASA and the National Oceanic and Atmospheric Administration (NOAA) seriously considered killing the entire program.



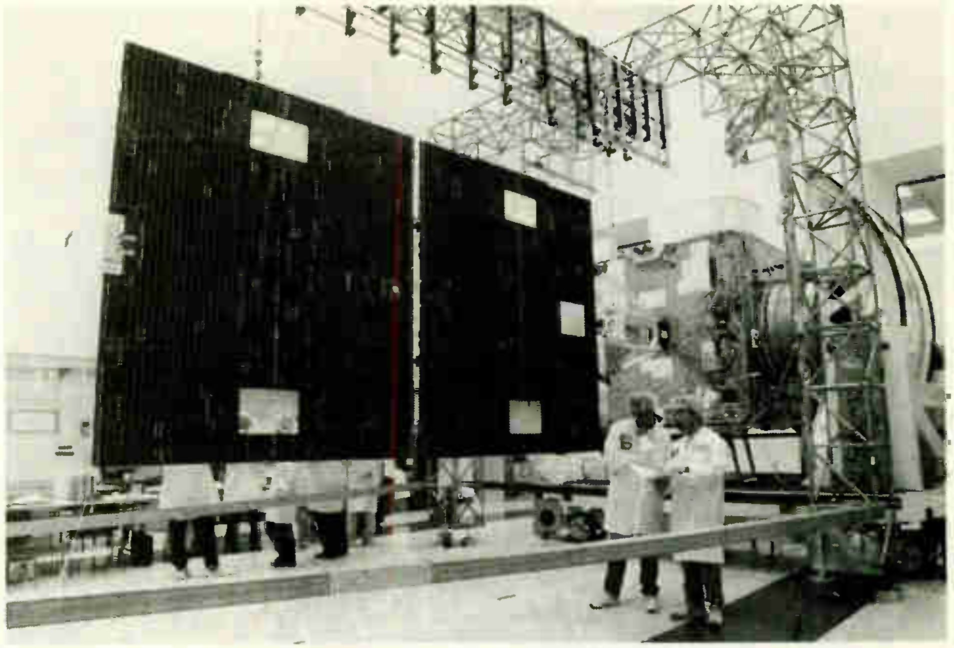
Artist rendition of the GOES-Next spacecraft in orbit. (Courtesy of Space Systems/Loral)

The delays put the National Weather Service into a precarious position. The GOES-G spacecraft was lost in a launch accident in May 1986, and premature failures of sensors on previous spacecraft left the U.S. with only one operational GOES. That spacecraft had to be moved back and forth between two orbital locations, an Eastern location for the Atlantic hurricane season and a Western location for the Western storm season. Any failure in that single spacecraft would have blinded the U.S.'s weather forecasting capabilities. Because of the high cost of the GOES-Next series NASA and NOAA chose not to build a spare spacecraft based on the previous design. Dr. Elbert W. "Joe" Friday of the National Weather Service stated "The decision not to obtain a backup spacecraft was one of the dumbest we ever made."

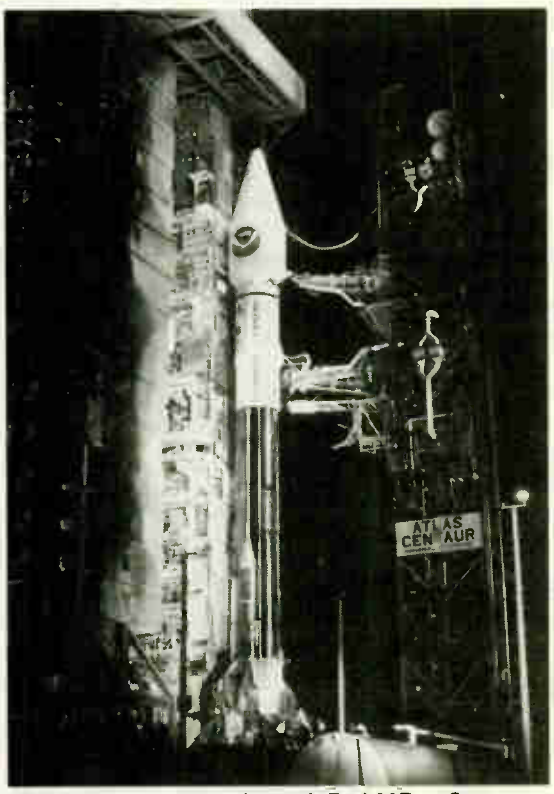
By 1991 a drastic approach was taken. An aging European weather satellite, Meteosat 3, was borrowed from Eumetsat, the European weather forecasting agency. It was positioned where its commands could be sent from Europe, but within view of the Atlantic Ocean and Eastern U.S. With the pressure off, the GOES-Next program could proceed at less of a breakneck pace. An important decision changed the first set of flight instruments into a ground-test set where more intense tests could be performed. The tradeoff was a more expensive program and an additional delay to the first GOES-Next launch, for reduced overall risks. Eventually the delays and cost overruns resulted in a total program cost of US$1.1 billion for the five GOES-Next spacecraft, plus the launch vehicles.

But is GOES-Next worth the extra effort and cost? Absolutely according to NOAA and NWS meteorologists.

Unlike previous GOES spacecraft the GOES-Next series can use the imager and sounder simultaneously. The imager can be used in a high resolution zoomed in mode to view close up storm features, or photograph the entire western hemisphere in one photo.



Space Systems/Loral workers test the solar arrays on the GOES-I spacecraft at the Astrotech processing facility in Titusville, Fla. (Photo courtesy of NASA)



The Atlas 1 rocket on Launch Pad 36B at Cape Canaveral Air Force Station during final countdown of a GOES weather satellite launch. (Photo courtesy of NASA)

The most important GOES-Next feature is its High Resolution Radiometer. Meteorologists observing GOES images of hurricane formations have always wanted more clarity in their images. The Imager has an infrared resolution of 4 km. (2.5 mi.) with 1024 gray scales (10 bits), in comparison with 64 grays (6 bits) on the previous GOES-7 class spacecraft.

Other GOES-Next instruments include a sounder which can plot temperature profiles, and the Space Environment Monitor which measures the Earth's magnetic field and solar disturbances which affect the weather.

One of the biggest spacecraft challenges is the Image Navigation and Registration system. To track storms accurately the spacecraft has to maintain an accurate lock on its location in orbit, and where it's pointed on the earth's surface. The INR continuously steers the instrument scan mirrors to compensate for errors resulting from orbital motion, satellite attitude deviations, and satellite thermal distortions. The flash flood warning function requires the most critical registration and only became operational this June for the GOES-8 spacecraft, 14 months after its launch.

While not a weather forecasting function, recent GOES spacecraft also include Ultra-High Frequency Search and Rescue receivers which can receive signals from downed aircraft or ships in distress. When the GOES-8 Search and Rescue receiver was turned on for testing last year it received an unexpected signal from a downed craft. An operational search and rescue receiver on a lower altitude weather satellite verified that the signal was valid and search and rescue forces were deployed - resulting in a rescue credited to the satellite even before it was officially put into operation!

From an amateur weather satellite enthusiast's perspective there are significant improvements to the spacecraft's capability to retransmit WEFAX data. The WEFAX transponders now have their own dedicated circuits and amplifiers, resulting in a cleaner signal with a higher signal to noise ratio.

GOES-Next is an important hardware improvement, but there have also been significant improvements in ground-based doppler radar systems and international cooperation. The World Weather Watch of the Global Atmospheric Research Program (GARP) coordinates shared data between the world's geosynchronous weather satellites. A nominal constellation consists of five operational satellites: NOAA's GOES East at 75º West and GOES West at 135º West, ESA's Meteosat at 0 degrees East/West, India's Insat at 74º East, and Japan's GMS at 140º East. Together these five satellites provide continuous coverage of the entire world, except the very high latitude arctic regions. The GOES East and West spacecraft view the entire Western hemisphere. Europe's Meteosat series and the Japanese GMS (Geosynchronous Meteorological Satellite) spacecraft view most of the rest of the world, but there's a large gap over Russia, the Middle East, and India. India is willing to share its data for research purposes, but does not want to release the Insat data publicly because it would help rival Pakistan.

Before weather satellites came into existence weather forecasting was a combination of black magic and good guessing. Jokes about meteorologists being the only profession where you can be wrong all of the time and still keep your job are quickly fading from memory, largely due to the improved forecasting capabilities provided by weather satellites.

Phillip Chien is an aerospace writer for Earth News and covers all the space launches from the Kennedy Space Center in Florida. Phil is an active amateur radio satellite hobbyist and holds the ham call KC4YER.

An Abbreviated History of Geosynchronous Weather Satellites

Weather satellites have been part of our lives ever since the first TIROS spacecraft was launched in 1960. It returned thousands of extremely crude coarse images of clouds over its 88 day lifetime and showed the value of weather observations from space.

The primary disadvantage of low altitude weather satellites is their limited field of view. Each TIROS image is about the size of a small state, enough for detailed regional studies, but not enough area for large weather systems which may cover an entire continent.

Meteorologists quickly realized that a geosynchronous weather platform could view an entire hemisphere at once, providing the "big picture" - how large patterns are building into storms which will affect upcoming weather. The geosynchronous weather satellites do not diminish the need for polar weather satellites since lower orbits permit much finer resolution, important for studying storm details. The first Application Technology Satellite (ATS-1), launched in 1966, was the first geosynchronous satellite with an experimental weather observation instrument.

Under the 1973 Basic Agreement between NASA and NOAA, NOAA establishes the observational requirements for both polar and geostationary weather satellites. Acting as NOAA's agent NASA's Goddard Spaceflight Center procures the spacecraft and instruments required to meet NOAA's objectives and the launch services. NOAA takes responsibility after the spacecraft is checked out in orbit. NOAA determines the requirements for replacement spacecraft. Ultimately the data is distributed through the National Weather Service to consumers.

Normally a spacecraft is known by a letter designation while it's being built, and only gets a numeric designation after it's been turned over to NOAA in orbit. For example GOES-B became GOES-2 when it became operational. GOES-G was lost in a launch vehicle accident so it never got a numeric designation, and GOES-H became GOES-7 instead. The same numbering technique is used for the NOAA polar orbiting satellites.

The first dedicated geosynchronous weather platform was the Synchronous Meteorological Satellite (SMS), built by Ford Aerospace. SMS-A was launched in May 1974, followed by SMS-B in February 1975. Those two prototype spacecraft were joint NASA/NOAA projects. SMS-C became the first operational geosynchronous weather satellite and was renamed GOES-A and turned over to NOAA for regular day-to-day operations after its launch in 1975. All together, Ford built five first generation geosynchronous weather platforms, two SMS and three GOES.

During a six month period in 1977 NASA launched three geosynchronous meteorological satellites for three different organizations using Delta launch vehicles. GOES-B was launched on June 16, followed by GMS for Japan on July 14, and Meteosat for ESA on November 22nd.

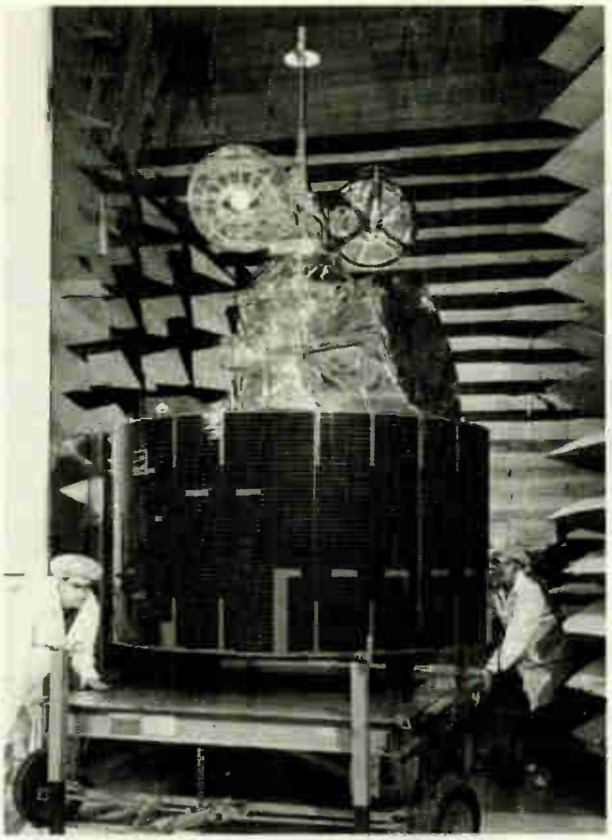
Hughes Aircraft won the contact to build additional GOES spacecraft, and built a total of five spacecraft, GOES D through H. Like the Ford SMS spacecraft the Hughes Aircraft GOES are spinning satellites, viewing the Earth only 5% of the time. The Hughes satellites were literally limited by the lifetime of the tungsten filaments in the light bulb used in the mirror position reading mechanism. In later satellites the bulbs were supplemented by much higher reliability light emitting diodes.

NASA selected Ford Aerospace, which later became Space Systems/Loral, to build the GOES-Next series of three axis stabilized spacecraft. International Telephone and Telegraph (IT&T) was chosen as the subcontractor for the spacecraft's instruments. The GOES-Next series consists of three spacecraft, GOES-I, -J, and -K plus two options GOES-L and -M. The GOES-Next spacecraft weighs 2062 kgs (4,536 lbs). at launch and has a nominal lifetime of five years, but enough propellant to remain in position for a much longer period. When NOAA starts to receive indications that there are problems with one of the GOES-Next spacecraft the GOES-K spacecraft will be prepared for launch. With the decision to go ahead with the GOES-L and -M spacecraft, GOES-Next will be serving this hemisphere's weather forecasting needs well into the 21st century.

GOES-8 is now fully operational in the 75° West position where it observes the Eastern U.S. and Atlantic Ocean. GOES-K was launched on May 23, 1995. Somehow it seemed ironic that the launch was delayed a couple of days due to bad weather at the launch site, with high winds and rain. During the summer GOES-K's orbit was circularized at geosynchronous altitude and the safety checks for the spacecraft's bus were completed. Upon turn-over of the spacecraft's systems to NOAA it was renamed GOES-9, however NASA retained primary responsibility for checking out and verifying the spacecraft's instruments. While GOES-9 is technically not anticipated to start service before this fall it will be returning test images during its checkout period, and those images may be used as part of normal weather forecasting functions. During the checkout the GOES-9 spacecraft will be compared with GOES-8 to evaluate their relative performance.

About the time you read this article the decision will be made as to which of the GOES-Next spacecraft will be placed in which position for nominal operations. The Eastern hurricane watch requires more precise instruments and the decision may be made to move GOES-8 to the Western position and GOES-9 to the East, if necessary. Alternately GOES-8 may stay in the Eastern location with GOES-9 taking up the Western slot.

The Meteosat 3, which has been substituting for GOES is in standby mode, just in case it's needed. Around the end of the year it will be retired and moved out of the geosynchronous belt. GOES-7 will become the spare spacecraft, backing up the two operational GOES-Next spacecraft.



After successfully completing its testing, the GMS-5 weather satellite is wheeled out of an anechoic chamber at Hughes Space and Communications Company facilities in Los Angeles, Calif. (Photo courtesy of Hughes Space and Communications Company)

Four international space organizations also operate geosynchronous meteorological spacecraft, representing Japan, India, Europe, and Russia. The different satellites all perform similar functions, but use different technical approaches. India's Insat is the only one which combines meteorological and communications functions on a single satellite. GOES-7 and the Japanese GMS, based on the same platform, use despun antenna platforms, similar to the spin-stabilized Hughes communications satellites. In comparison Europe's Meteosat uses an electronic antenna which turns the spacecraft's antennae on and off as the spacecraft spins.

Japan chose to purchase weather satellites from Hughes, similar to the spacecraft Hughes was building for NASA. The Geosynchronous Meteorological Satellites (GMS) have been observing the Eastern hemisphere since 1977. After launch they're named Himawari.

Europe's Meteosat has also been in operation since 1977. Two pre-operational satellites were originally planned. Due to delays with the operational Meteosat program a spare qualification unit for the original model was upgraded into a flight unit. Meteosat 3, often referred to as Meteosat P2, was launched in 1988.

The Eumetsat Convention came into force on June 19, 1986. Eumetsat assumed control of the Meteosat Operational Program (MOP) on January 12, 1987. The sixteen Eumetsat members are: Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. Its headquarters are located in Darmstadt, Germany however the spacecraft are still controlled by ESA's ESTEC center in the Netherlands.

Three MOP satellites were authorized, Meteosat 4 through 6. They were launched in 1989, 1991, and 1993. All six Meteosat spacecraft were built by Aerospatiale of France. The operational satellites have a mass of 704 kgs (1549 lbs) at liftoff, and a beginning of life mass of 316 kgs (695 lbs). The cylindrical satellites are 3.1 meters (10.9 feet) high, and the main body is 2.1 meters (6.93 feet) in diameter. The spacecraft spins at 100 RPM, the only European designed spin-stabilized satellites. The nominal lifetime is five years. Communications is through S and UHF transponders.

The primary payload is an imaging radiometer in visible, IR, and water vapor wavelengths and the spacecraft produces a set of three images once every 30 minutes.

Beginning with Meteosat 7 Eumetsat will take responsibility for satellite procurement and operations. Meteosat 7 is currently scheduled for launch in late 1995 or early 1996.

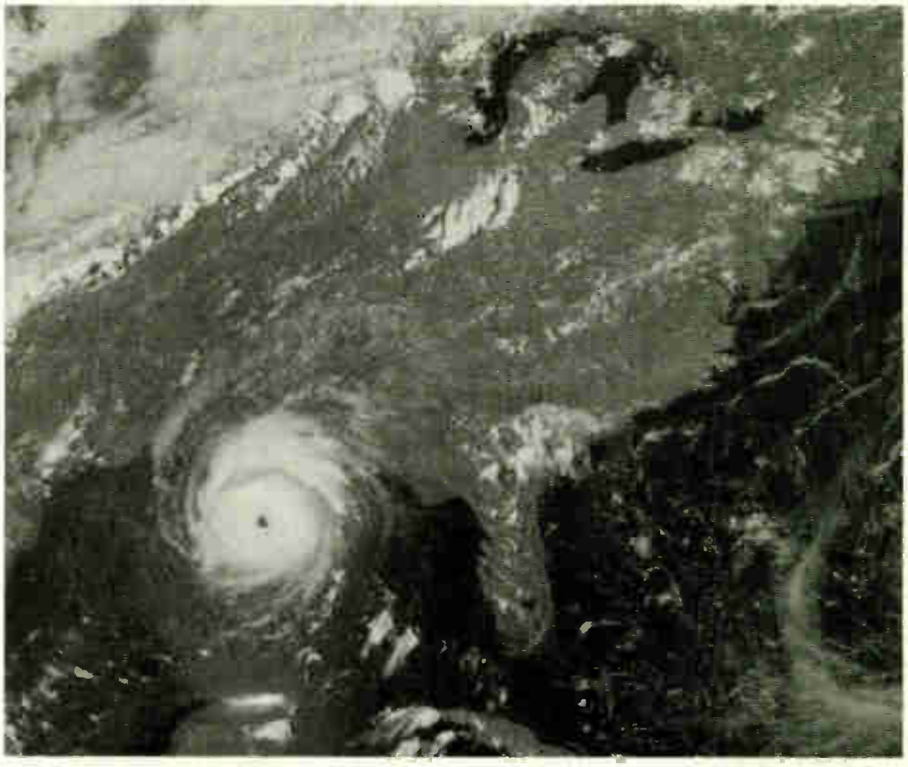
Insat, built by Ford Aerospace for the government of India, was a combination weather and communications spacecraft. It was the first geosynchronous "three axis stabilized" meteorological platform. Four first-generation Insat spacecraft were launched in 1982, 1983, 1988, and 1990 on a variety of launch vehicles with different degrees of success. The second-generation Insat spacecraft are built primarily by Indian aerospace firms with two spacecraft launched so far, Insat IIA in 1992 and Insat IIB in 1993. Insat IIC is currently scheduled for launch at the end of 1995 or early 1996.

A combination of technical and geographical reasons have made geosynchronous spacecraft less important for the former Soviet Union. The Soviet Union has launched over 50 Meteor polar low earth orbit weather satellites, built by the All-Union Research Institute for Electromechanics (VNII Elektromekaniki). These satellites were funded by the USSR State Committee for Hydrometorology (Hydromet). Since the breakup of the Soviet Union funding has come from Russia. Three generations of satellites have been produced, the latest weighing 2,200 kgs (4840 lbs), operating in 1,200 km (774 miles) 82.5° inclined orbits. The Meteor spacecraft carry TV cameras to observe clouds, an Infrared imager for day/night cloud images, a visible imager for daytime clouds, and an infrared sounder for vertical temperature measurements.

In 1975 the Soviet Union announced its own Geostationary Orbit Meteorological Satellite (GOMS/Elektron) program. In 1988 Soviet officials indicated that a GOMS launch would occur around 1991, but the launch didn't occur until this year. It's anticipated that GOMS data will become part of GARP.

China has launched two FengYun polar satellites which have produced good data, but have had premature failures in orbit. So far China has not announced any plans for any geosynchronous weather satellites. ST

Looking at Earth from SPACE



An NOAA 11 APT image of Hurricane Andrew taken on August 25, 1992 while the storm was located just south of Louisiana. (Photo courtesy of the Dallas Remote Imaging Group)

From the darkness of space, electronic sentinels constantly monitor the changing and dynamic patterns of the world's weather. Day and night these satellites continuously observe and measure the many forces of nature which converge on our planet. Photographs are constantly sent to Earth from these orbiting satellites for analysis by meteorologist and scientists. But national government weather agencies aren't the only ones that can receive weather images. You can also receive weather satellite pictures like the pros live and direct from space in your own home.

Environmental satellites, equipped with a variety of sensors, monitor Earth and transmit the information back to Earth electronically. These electronic signals can be received by a ground station (also known as an Earth station), and displayed as images on a computer monitor. The capability to acquire information directly from environmental satellites produced the name direct readout.

A Weather Satellite Primer

By J. S. "Stu" Gurske

Geostationary Orbits

Geostationary spacecraft orbit the Earth at a speed and altitude that allows them to hover continuously over one area of the Earth's surface, providing continuous coverage of that area. U.S. coverage is provided by Geostationary Operational Environmental Satellites (GOES). One of the GOES communications functions is to provide Weather Facsimile (WEFAX) services. WEFAX data, with a resolution of 8 kilometers (4.96 miles), consists of retransmissions of processed GOES images, polar-orbiter data, and other meteorological information. With its seemingly stationary position relative to Earth, a result of its orbit 35,581 km (22,238 miles) above Earth, GOES provides views of almost a third of the Earth's surface. Images from GOES combined with images from Japanese, Russian and European Space Agency geostationary satellites provide a global view of the Earth's environment. These satellite transmit WEFAX services in the area of 1.7 Gigahertz (GHz).

Polar Orbits

Polar-orbiting satellites orbit approximately 960 kilometers (600 miles) above Earth, providing a more detailed look at a smaller area. Their orbital paths cross almost directly over the poles and their sun-synchronous orbits mean that they cross the equator at the same time each day. U.S. polar orbiters, called TIROS satellites, provide low-resolution imagery called Automatic Picture Transmission (APT). APT is real-time data, with a resolution of 4 kilometers (2.48 miles), that can be obtained when the satellite is within the receiving area of a ground station antenna—approximately every 102 minutes. APT transmissions can be received in the 136-138 Megahertz (MHz) range.

High Resolution Picture Transmission

(HRPT) from polar-orbiters has data resolution of 1.1 kilometers (.7 mile), but requires more costly equipment to obtain it. Like the GOES WEFAX, HRPT is transmitted in the 1.7 GHz range.

When APT signals are sent by the orbiting satellite, it is usually in a frequency modulation (FM) format with the picture information sent by amplitude modulation (AM) using a 2400 Hertz (Hz) audio carrier. In other words, the signal is sent by FM. When the signal is detected by an FM receiver, a 2400 Hz signal is heard. This 2400 Hz signal has been AM modulated with the picture information during the transmitting process.

The bandwidth of this FM signal is not the usual 7.5 kilohertz (kHz) that police and fire departments use for communication. Instead the signal is over 30 kHz wide in bandwidth. Since most communications receivers and scanners are not capable of demodulating a signal that wide, some provision or modification to the receiver must be done to properly detect the 30 kHz FM signal. If we are going to receive images from polar orbiting weather satellites, we must also allow for Doppler shift. If Doppler shift is taken into consideration our receiver needs to be able to detect a 40 kHz wide signal. This is not as big a problem as one might first expect, as we shall soon see.

Either WEFAX or APT services enable the user to obtain substantial environmental data. A dual system that accesses both types of data provides a comprehensive and continuous picture of the environment. Continuing technology improvements and cost reduction make that feasible and possible in a low-cost system.

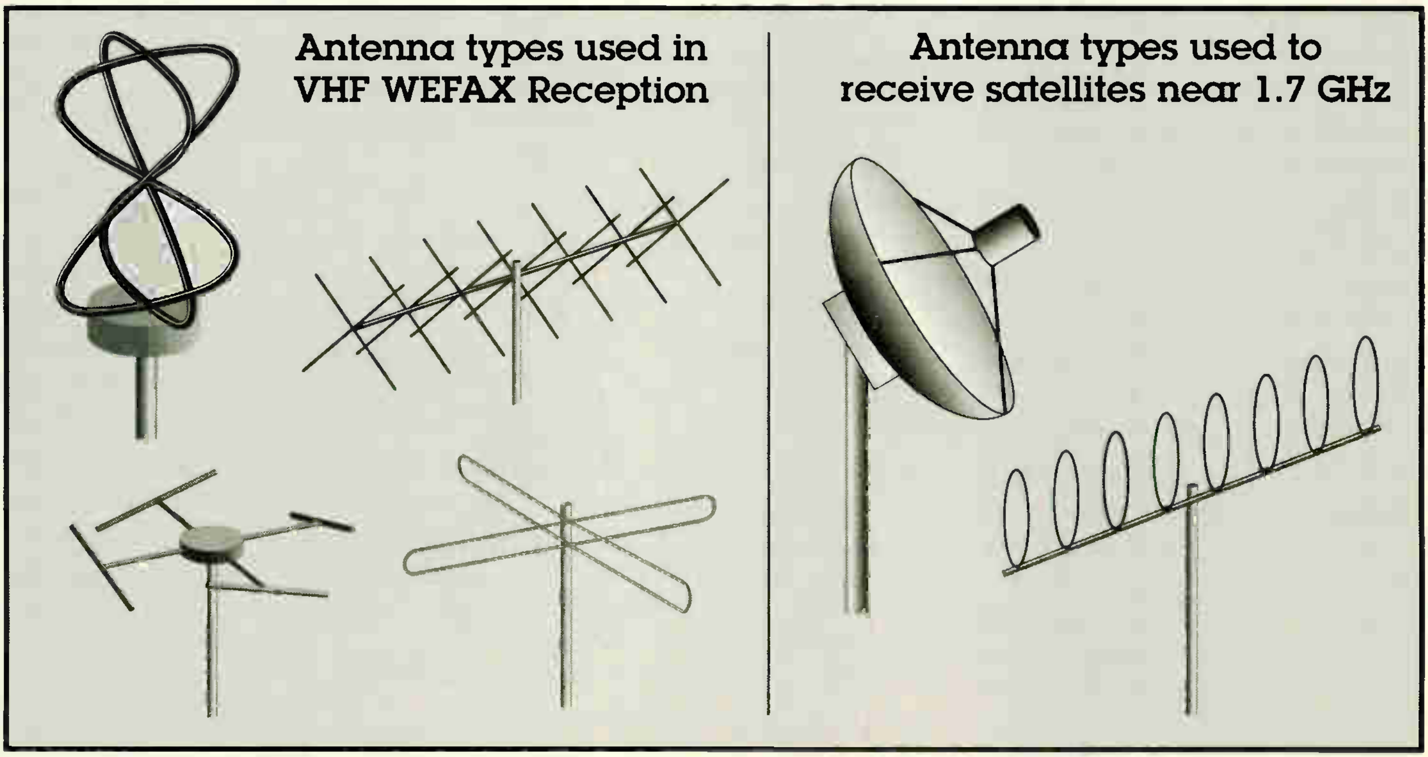
Receiving equipment

Obviously, you need a receiver which is able to demodulate a FM 30 or 40 kHz bandwidth signal. The receiver must be able to tune the 136-138 MHz orbiting satellite band and, ideally, up to 1.7 Gigahertz or so. While few "off the shelf" commercial receivers can demodulate these signals, many special weather satellite receivers are now available today. They range from stand alone receivers to "plug in cards" (containing a complete receiver), to a special device which plugs into the intermediate frequency (IF) port of ICOM R7000 or R7100 VHF/UHF communications receivers. Many feel this special plug in device is the more cost effective approach because it allows a general coverage receiver to serve its usual functions as well as using it as an excellent weather satellite receiver with the addition of this device.

Antennas

When receiving orbiting satellites, you should consider that they revolve (tumble) in space. They also send a circularly polarized signal (right hand circular) and therefore you need an antenna which will optimize this kind of signal. While simple antennas can be used. the best results will be obtained if you use crossed yagis with a phasing harness and an azimuth and elevation rotator system to track the satellite.

Alternatively, one can use turnstile types of antennas, but they almost always suffer dropouts during part of the period the satellite is in view. Typically several "drop outs" with their attendant banding of the picture occur during a satellite pass when marginal antennas are used. As is always the case with radios, the better the antenna, the better the result. Some people use antennas known as Lindenblads. They are good and perhaps better than the turnstile types, but because they are somewhat labor intensive, they do cost a bit more to build (or purchase). Similarly, the Quadrifilar Helix is another type of antenna used to receive circularly polarized signals, but it, too, is very labor intensive to construct, and therefore more costly. For the do-it-yourselfer both the Lindenblad and



Early morning APT photo of the Rocky mountains. (Photo courtesy of the Dallas Remote Imaging Group)

Quadrifilar Helix should be considered.

Antennas used for GOES WEFAX reception on 1691 MHz often consist of ring type yagi's or dishes. Dishes provide much better signals to the receiver, but they require a little more effort and space. Dishes are available from satellite TV dealers as well as from vendors specializing in WEFAX equipment. A dish collects the signal and reflects it to the feed horn located at the focal point of the dish. Feed horns for 1691 MHz can be built from coffee cans or purchased. Coffee cans while effective, tend to rust in several months. So, for a permanent installation, it is best to either purchase an aluminum can and install your own probe(s) or purchase the entire feed horn assembly from a weather satellite dealer.

Down Converters

If your receiver will not tune to 1691 MHz you might want to use a down converter. A down converter takes the higher frequency, 1691 MHz in this case, and converts it to a lower frequency. This lower frequency is usually in the 137 to 138 MHz range. You can then use your polar orbiter receiver to listen to the GOES satellites. Down converters can be built or they can be purchased from several weather satellite vendors.

Preamplifiers

For best results, one should mount some kind of a good preamplifier tuned to 137.5 MHz, at the antenna. If you live in close proximity to an airport or on an aeronautical airway, you might want to consider installing a filter tuned to reject the aircraft band (108 to 136 MHz). This filter might also be helpful if you have Amateur radio operators, or one of their repeaters, located near you (144 to 148 MHz frequency range). Many enthusiasts do not use a preamplifier and manage to receive some images, but for excellent results you need the strongest signal possible. Use a preamplifier.

Computers

Almost any kind of a computer (PC) will work. However, for excellent images, it is necessary to have at least a VGA monitor and video card in your computer. If you have SVGA, your images will reproduce even better. Your software might also allow for a video card with one megabyte (MB) of RAM (Random Access Memory) instead of the usual 512 kilobytes. If your software provides for animation of your images, you may also need several megabytes of computer RAM installed in your machine to handle the larger job of animation. You do not need a large hard drive for image storage unless you want to store a lot of images on your computer.

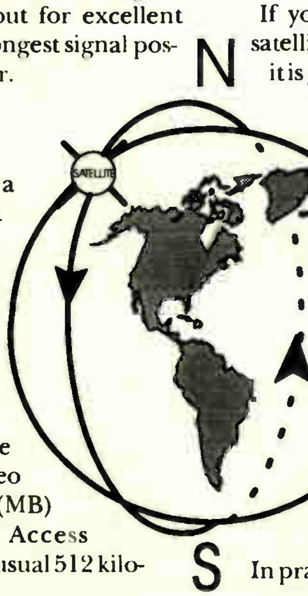
Software

There are a lot of software vendors with excellent products being marketed today. I have used several different types and have been satisfied with all of them. In general, you will have a choice of three basic approaches to software.

1) A "plug-in card" for decoding the already demodulated signal.
2) A decoder which plugs into a serial or parallel (printer) port on your computer. It too, decodes the already demodulated signal.
3) A "plug-in card" which contains the entire radio receiver as well as the decoding hardware.

All three of these systems include the software as a part of the package. Some of these decoders are available in kit form for those who like to build things. Obviously there are advantages and disadvantages to all three approaches. If you are interested in purchasing a decoding system make up a list of the advantages and disadvantages of each of these systems and then make your choice.

Orbital Prediction



If you want to listen to an orbiting satellite, you must, of course, know when it is going to appear over your location and where to look for it in the sky.

The polar-orbiters get their name because they travel from north-to-south or south-to-north depending upon the time of day over the polar regions. This sounds confusing, but if you visualize a satellite rotating above the earth from pole to pole, as the earth rotates under it, the satellite will come from the north at one time and 6 hours later it will come from the south. In practice, the orbiters, come from the

An APT photo of the Rabaul volcano taken by NOAA 12. (Photo courtesy of the Dallas Remote Imaging Group)

north and head south (descending) in the morning and from the south and head north (ascending) in the afternoon. These satellites can usually be heard three times on one day, (once quite far east of your location, then almost directly overhead and once again when they are quite far west of your location). On the next day they will be heard twice, (once to the east and quite high, then west of you and quite high); then the next day three times once again.

Obviously you will need some way of predicting where they will be at any given time. Fortunately, there are a lot of computer programs out there which are very user friendly, which will give you all the information you will need.

The German astronomer and mathematician Johannes Kepler (1571-1630), in 1627 published a treatise which predicted the way natural objects (and now, man-made satellites) rotate around a body, like the earth. This orbital information called Keplerian data (or elements) must be updated in your computer program periodically. Fortunately, this data is readily available in many places including computer bulletin boards and in the SSG here in *Satellite Times*.

WEFAX image from the Goes 8 weather satellite received on 1691 MHz. (Photo courtesy of the Dallas Remote Imaging Group)

Satellite Tracking

When I began tracking satellites in 1969, I had to obtain a TBUS message from the weather bureau, then plot the data on a satellite tracking chart, and then go outside to my garage roof to listen to the satellite using headphones. I tracked the satellite by hand by pointing my antenna where I thought the satellite would appear. When I began receiving it, I followed it by listening for the strongest signal. A helper tended the equipment in the house. I received many excellent pictures using this method, and became quite good at it.

Today, I use a tracking program in the computer which controls the azimuth and elevation rotators to point the antenna and follow the satellite as it passes over my location. There are several tracking programs available and they all seem to function well. Some have more bells and whistles such as warning beeps when the satellite appears or messages which tell the status of your rotators.

Saving Images

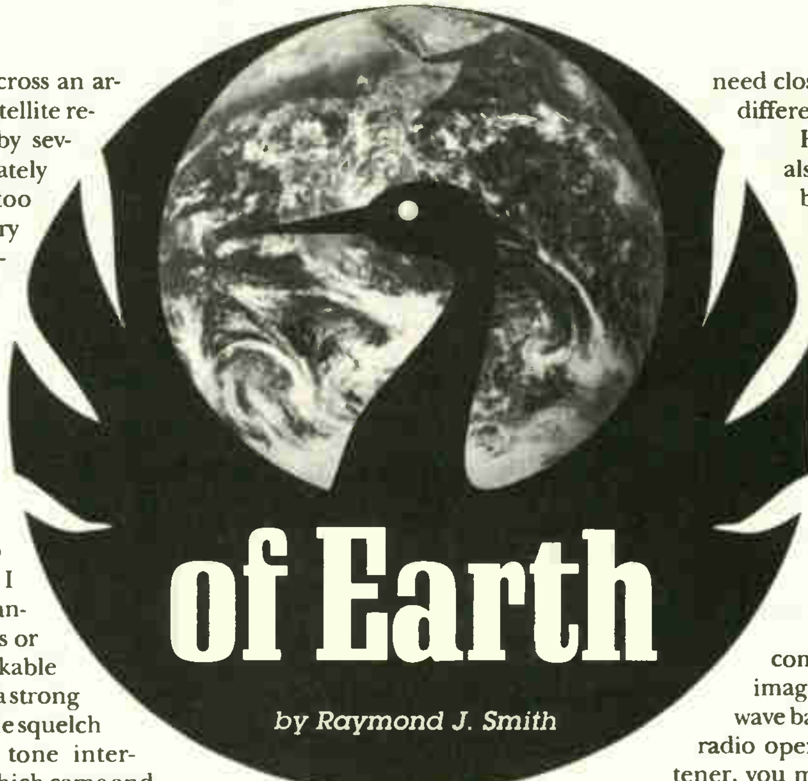
When you start receiving good images (or even the first one) you will want to preserve many of them in some way. There are photographic hoods available which will hold the camera steady, will cut out reflections and allow you to use your 35 mm camera or other film formats to take excellent pictures.

You can save the images to diskettes, but since the orbiter images may use well over a megabyte of space, if you copy a full pass with 2040 bytes per line, a diskette may not be able to save the entire pass. You can, with most programs, save just a screen full which will fit on a diskette. But another approach, and the one I often use, is to save the image on a computer backup tape. I save entire passes on tape and when I want to look at it later I merely use the restore function, then select the part of the image I want to use. I then record that portion to a diskette for processing in my graphics manipulator (to adjust for brightness, contrast, gamma etc). By using backup tape, I always have the full image to work with.

Weather satellite imagery reception can be fun and educational. With the price of weather satellite equipment plummeting why not consider putting up your own APT or WEFAX direct readout station to monitor the Earth from space. ST

Stu Gurske is the president and founder of Swagur Enterprises and an avid weather satellite enthusiasts since 1969. Stu says he is married to the greatest women in the world Lois, WB9YXU. Stu also has a ham call, K9EYY.

A Bird's Eye View... of Earth



by Raymond J. Smith

When I first came across an article on weather satellite reception as a hobby several years ago, I was immediately discouraged. It looked too much like work — drudgery with pocket calculators, logarithm tables soaking up weekends and equipment soaking up bags of cash. I even thought you would need a big satellite dish antenna with motors on it to monitor this kind of thing.

But the article did mention a frequency — 137.5 MHz, so out of curiosity I punched that into my scanner. After a couple of hours or so of monitoring a remarkable thing happened. I received a strong signal that broke through the squelch revealing a high-pitched tone interrupted by a tik-tok sound, which came and went in five minutes (a weather satellite signal).

"Hey, this weather satellite stuff is going to be a snap," I figured. That assumption wasn't quite right.

In this article I hope to give you a rough idea of what it will cost in money and labor to see your own pictures of Earth from space. There is plenty of information to help you get started, and we will even list some of those sources. Since this is a beginner's primer, I'll try and avoid that algebra stuff I mentioned.

There are three main sources for weather satellite images, discounting TV and newspapers. I will present them in order of cost and complexity. What makes all of them directly available to you is the recent emergence of powerful and cheap personal computers (PC). PC clones are on almost every desk in almost every office, and mass-production has really brought the cost of memory and peripherals down to levels of unprecedented economy.

Weather satellite software packages do exist for non-DOS machines, but the selection of software products is much smaller as PC/DOS users outnumber the others by far. An AT-compatible 286 computer is adequate if you are patient, but processing the images you capture is less tiresome if you have a 386/486 or better machine. I bought a math co-processor for my old 286, but it was no help with the processing of images.

Viewing weather images on LCD laptops and cheap CGA (Composite Graphics Adapter) monitor is hopeless. EGA (Enhanced Graphics Adapter) is better, but still not worth the effort. The resolution on an EGA monitor is less than what you'd get by printing the image on a 300 DPI (dots per inch) laser printer. On the other hand, if you already have a VGA (Video Graphics Adapter) monitor, upgrading to super-VGA is not necessary. I have a 640x400 pixel monitor at work, and a 1024x768 pixel monitor at home, and need close-up glasses to really tell the difference between them.

Handling larger-sized images also requires that 1 or 2 megabytes (MB) of extended memory be set aside. Hard drive storage space for your images can also be a problem. One raw hi-res image file can soak up a megabyte of disk space easily. These computer considerations will apply regardless of what front-end apparatus you ultimately pick.

HF Utility Stations

The least expensive and complicated source of satellite images is transmitted on the shortwave bands. So if you are an amateur radio operator or shortwave utility listener, you might be inclined toward HF (high frequency) FAX (facsimile) as a start. There are over a hundred utility shortwave stations that broadcast FAX images. Most send out weather or navigation charts, but some re-broadcasts images from the American Geostationary Operating Environmental Satellites (GOES), the Japanese GMS (Geostationary Meteororlogical Satellite), or European Meteosat geosynchronous weather satellites. If you have a shortwave radio capable of sideband reception, you can identify one of these stations by its sound: scratchy and repetitive like an old 78 rpm record, if they're sending a black and white chart. It will sound like an up-and-down whistle, repeating at half-second intervals, if they are sending a 16-grey scale photo.

The frequency of these tones depicts the color of the pixel being sent; a low 1400-Hz note might be black, with the corresponding high pitch of 2000-Hz representing white. This is fed into an analog-to-digital converter, sampled at intervals,

Satellute enthusiasts Jade Smith shows the completed turnstile antenna. In theory, both pickup/reflector pairs should be equidistant. Putting one pair closer together eliminated an annoying "null" in the pickup pattern when the satellite was directly overhead. (Photo by Raymond Smith)

and the resulting image built up on the monitor screen line by line. left to right, top to bottom, like a slow-motion TV screen.

The cheapest analog-digital peripheral for this task lists for about US$70. A special-purpose plug-in converter board for your PC, plus the software. might be as much as US$400. As is often the case with this hobby, it's possible to trade your own labor for equipment cost. You can homebrew your own audio-digital board, for instance, thanks to commonly available tone decoder chips such as the 567. There are other alternatives as well. Some PCs have game/sound driver boards, such as the SoundBlaster. Some of these come with audio input jacks for digitizing incoming sound into digital files. Plans and shareware software exist for converting an audio capture (.VOC) file into an image.

The package I bought utilizes a simple tone decoder that plugs into the PC's serial port. Most of the signal processing is done through software. The same plug, with different software, can be used to decode Morse or unencrypted radioteletype broadcasts.

An adequate BFO-equipped shortwave radio can be bought for around US$150. One with digital tuning is better (much, much better-Editor), one that can store frequencies is better still, and one that can turn itself on and off and switch to a given frequency at a given time is best. I use the Sony ICF-2010 portable with a Grove antenna preamp. You will need a wire antenna 25-to-40 feet in length, connected to the radio by a shielded coaxial cable. (75 ohm cable works fine.). All this can be purchased for US$20 or less. Your new shortwave antenna should be hung outside and the higher it is the better.

The major drawback with shortwave radio facsimile reception is the interference generated by your PC and its monitor. Trying to get a weak signal from Japan or England with the PC turned on is like trying to listen to a violin solo in a boiler factory. I have spent a lot of beer money on shielded cable, audio isolation transformers, and a dozen or so ferrite RF choke doughnuts to cut down on the computer intereference. I also had to junk my plastic computer keyboard and find a genuine IBM model, which was quieter. If I could have located my antenna farther away from the PC, I doubt that these problems would have been as acute.

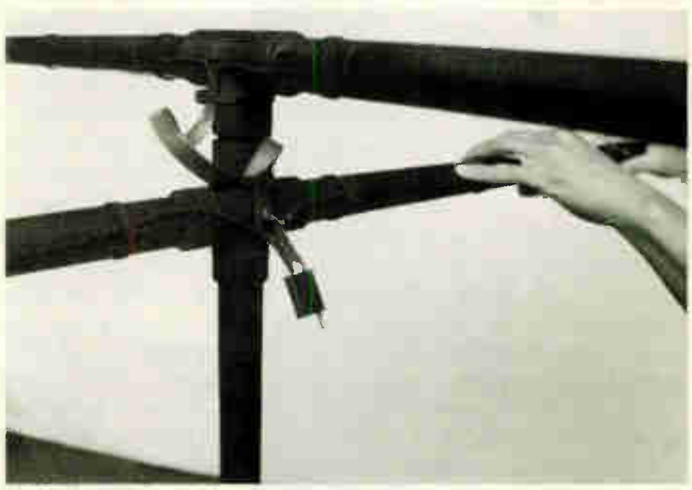
Because it's shortwave, you can pick up stations from the other side of the planet. Some of the fellows at my work place love the FAX charts I receive. They run off the intercepted faxes on a laser printer and displaying them as trophies. As with any shortwave reception, however, conditions vary greatly and so will the quality of the images you capture. A noisy or fading signal that would be acceptable as voice produces unreadable photographic images.

Polar Orbiters

The source for weather images I find most fascinating are the polar orbiting weather satellites. These satellites circle north-to-south, then north again from pole to pole while the Earth spins under them, giving their tracks an inclination of about 98° at the equator. Their altitude is about 980 km (500 miles), and they continuously broadcast black and white images taken in visible and infra-red light spectrums. On a VGA display, these images almost look like photographs.

Their 5-watt FM transmitters continuously broadcast a 2400-Hz audio tone which varies in amplitude, or loudness. Very loud is white, and when the squelch mutes the sound off, the screen shows black. Like the shortwave fax signals, the monitor screen is painted line by line, left to right, top to bottom.

The chief advantage in receiving your photos direct is the excitement of seeing your corner of the planet right now, as the satellite streaks overhead at 27,200 kph (17,000 mph). The resolution is much better than shortwave, particularly from the Russian Meteor weather satellites. Now don't assume that you will be able to see into your neighbor's back yard on these images. The finest single detail I've been able to pick out was the Golden Gate bridge, which appeared as three white pixels on one of my images that extremely enlarged. I've had good luck watching

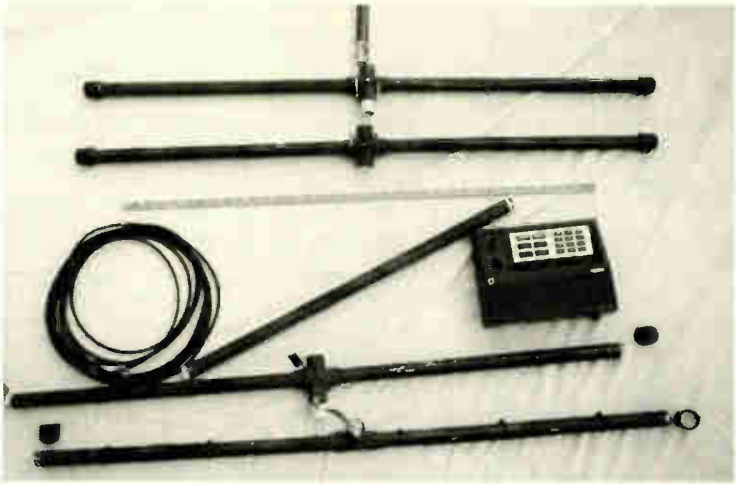


A close-up of the sprinkler "Tee" antenna fittings and the phasing line between the two folded dipoles. Antenna was spray-painted camouflage colors so as not to be notceable to neighbors. You can spray paint yours any color you like, or not at all. (Photo by Raymond Smith)

hurricanes, the Malibu, Calif. fire storms, and I even managed to receive some interesting infra-red shots during the L.A. riots. But basically, you will be looking at very large objects from a long way up in space.

What equipment do you need?

The main components of any weather satellite reception system are the antenna, a preamplifier, the radio, the tone decoder, and the imaging software.



Exploded view of the Turnstile antenna main components. Authors weather satellite receiver, a modified Uniden scanner is also displayed. (Photo by Raymond Smith)

For an antenna I use what's known as a "turnstile" which is a pair of non-moving "X" shaped elements that occupies about a cubic yard of space. I have designed and built my own turnstile (Figure 1) that I can pull it apart and store in a closet. Commercial equivalents of this antenna list for about US$120, but you can construct one of your own for around US$30.

A signal preamplifier between the antenna and the receiver is almost a must. Special-purpose preamps list for US$65-110. I have experimented with cable-TV amplifiers that costs less than US$15 and they work surprisingly well. In fact, I can pick up polar orbiter signals without mounting the antenna outside using a preamp. I live on the top floor of my apartment building and the tile roof overhead is largely radio-transparent at 137 Mhz, although the solar water heaters sometimes throw a moving radio "shadow" on the incoming signals.

In theory, acquisition ranges for the NOAA (National Oceanographic and Atmospheric Administration) polar orbiter should be roughly a 1,600 km (1,000 miles) north to a 1,600 km (1,000 miles) south of your antenna, depending on your antenna's altitude above sea level and surrounding terrain. In fact, using my turnstile antenna, I regularly get reception from just under my local horizon. Using a phenomenon known as "ducting," I have also received 2,400 km (1500 mile) wide views that begin in Saskatchewan and continue south to the tip of Baja, Mexico.

Specially made weather satellite receivers are sold by several firms and start for around US$100 up to over US$400. Some of these systems have the radio and decoder built into a single PC card (US$600). In any case, a regular scanner won't do because the wideband signals from the weather satellites use plus or minus 40 kHz (including Doppler shift) bandwidth, and police and fire transmitters broadcast narrow-band FM—plus or minus 15 kHz from a given center frequency.

I chose to purchase a pre-modified scanner for US$150 from a weather satellite retailer rather than chopping away on my hand-held scanner, which would have certainly voided the warranty. It has 16 memory channels that cover the standard public service bands from 29 to 512 MHz, plus a nifty feature that finds the nearest NOAA VHF voice weather broadcast. I was delighted to find that although modified for the increased FM bandwidth, the scanner still worked fine for local police calls.

The disadvantage of the polar orbiters is that there may not be an operating satellite overhead at the time you want to look—say, when you want to show off your setup to a neighbor who just walked in (a Murphy radio law-Editor). In fact, there may be none for hours and then three satellites will all pass over your location within 30 minutes. Being able to predict passes of these satellites at your location is extremely important then.

A necessary component for any weather satellite enthusiasts is a computer program that predicts the satellite passes for you. I was surprised at the number of shareware programs available to handle these chores. You can purchase them shrink-wrapped, type them in yourself from a hard copy BASIC listing, or download them from a computer bulletin board system. Your choice can be determined by your enthusiasm, leisure time, and credit card balance.

The orbits of the polar weather satellites do decay slightly over time, so you will have to re-enter the satellites orbital parameters—known as Keplerian Elements—every couple of months. These Kep element sets are available from several bulletin boards and also in the SSG section in each issue of *Satellite Times.* Some of the firms that make pre-fab satellite equipment have dial-up bulletin boards they maintain with Kep information updated frequently.

Some enthusiasts use old VCRs to record raw spacecraft or HF fax audio. The video portion of the tape is unimportant since you send the audio signal into the audio input of the VCR. Unlike conventional audio cassette recorders, VCR tape speeds are constant and this is a good thing or the recorded image would resemble a funhouse mirror when displayed. Another plus when using a VCR as a recoding device is that the start times can be preprogrammed, and VCRs don't cause nearly as much radio interference as a running PC computer.

A graphics processing program will be a valuable component of your weather satellite imaging system. Even after rough adjustments to images at capture time, most still need some work. These satellites were designed to show clouds, but most earthbound voyeurs like me want to see some ground detail. The NOAA birds send two images side by side (APT mode), one visible and one infra-red, and if you have one looking good on the monitor the other side will invariably be black or snow white. That means you will probably have to fiddle the brightness and contrast of your received image. If the image was captured during a south-to-north, or ascending pass, the image will also appear upside down, and will have to be flipped to put north back on top.

The commercial software packages for rendering the digitized images are becoming more sophisticated and cost efficient. Some common features found in these packages include: zooming, enlarging, rotation and contrast enhancement. Most of these packages will also allow you to convert, or "export" you pictures to other computer image formats. If you use PC Paintbrush, for example, you would want to process the image as a PCX file or convert it into a GIF format if you intend to share it with others. GIF files have become the standard medium for computer image exchange.

More expensive software options include: detection of ground temperatures from infra-red images; sharpening, softening, artificial colorization of the black-and-white images; and overlaying of latitude and longitude lines. Some programs will even calculate and draw in state or national borderlines on your images for you.

Geostationary Satellites

After you have all your orbiter software and hardware set up, you can feed it from two other sources.

The weather pictures we are most familiar with, those on the evening news, originate from the GOES spacecraft, which are parked over the equator at 35581 km (22,238 miles) above the Earth. Their orbital period is one day long, so they seem stay in the same place in the sky, and provide the same perspective of the globe all the time.

These satellites broadcast in the microwave portion of the spectrum on a frequency of 1691 MHz. This means that you will need a down-frequency converter to change that frequency to 137 MHz used by your existing polar orbiter system (around US$600). You will also need a precisely aimed 120 cm (4 foot) dish or loop-yagi antenna (US$120) to acquire these signals, which are comparatively faint signal strength. You can also fit your backyard TVRO satellite dish with a custom GOES feedhorn (US$120). For working stiffs like me, these are all big-ticket items. Home-brewing your way around them is a serious project. I modified my polar orbiter equipment with a soldering iron and hardware store parts, but superhigh frequency gear does requires more precision.

The advantages: GOES images are of superior quality, they are predictable and have convenient borderlines already overlaid. You also get weather prognosis charts and relayed pictures from the Japanese and European satellites. There are other ways of getting this product, fortunately. Computer bulletin boards using automated equipment capture and place these images into downloadable files for subscribers with telephone modems. A high-speed (14.4 kilobits) modem is a real plus for this job, as the resulting SVGA GIF files vary in length from 300 to 700 kilobytes. My V.42 modem will transfer files at 1.65 kilobytes per second, for a typical transfer time of four minutes, depending on the size and type of the file and task loading of the sending PC.

High Resolution Picture Transmission (HRPT)

The ultimate amateur challenge is the capturing of HRPT images from the American polar orbiters. In addition to the 137-MHz signals previously described, NOAA polar orbiters send High Resolution Picture Transmissions (HRPT) images at 1691 MHz. Actually, the 137 MHz WEFAX images are relatively crude analog samples of the digital, multi-channel, high-bandwidth HRPT transmissions. Several IR wavelengths are being sent at once. The resulting images are about four times as sharp, and breathtaking.

But to capture them, you'll need all of the equipment mentioned above, plus azimuth/elevation rotators to accurately point and track a high-gain antenna. You will also need commercial-grade software to handle the ton of data coming in. The cost for a typical HRPT setup is around US$5,000, but some amateurs do it regardless of the cost.

Summary

The cost for my APT weather satellite system was less than a premium VCR. Some folks even use their systems profitably — pilots, sailors, fishermen, astronomers, prospectors for geothermal sources, etc. My profit has been in the form of knowledge gained. I have learned a great deal about signal processing, image processing, orbital mechanics, radio theory, PCs and their subsystems, and meteorology—all the things you couldn't force me to study for their own sake. It was frustrating at times, but overall it was great fun. And it's not over yet. After a friend suggested I upload some images of an approaching storm to a local BBS, I wound up becoming a co-sysop on that BBS, and learning about Hayes modem protocols and such.

If you want to learn more about this hobby on your own, I would suggest getting a copy of *The Weather Satellite Handbook* by Dr. Ralph Taggart, WB8DQT. It is available from Grove Enterprises for US$19.95 plus $6 UPS shipping. You can get your copy by calling 1-800-438-8155 or writing to Grove Enterprises, P.O. Box 98, Brasstown, NC 28902. Additional sources of weather satellite information can be found elsewhere in this issue of *Satellite Times*. ST

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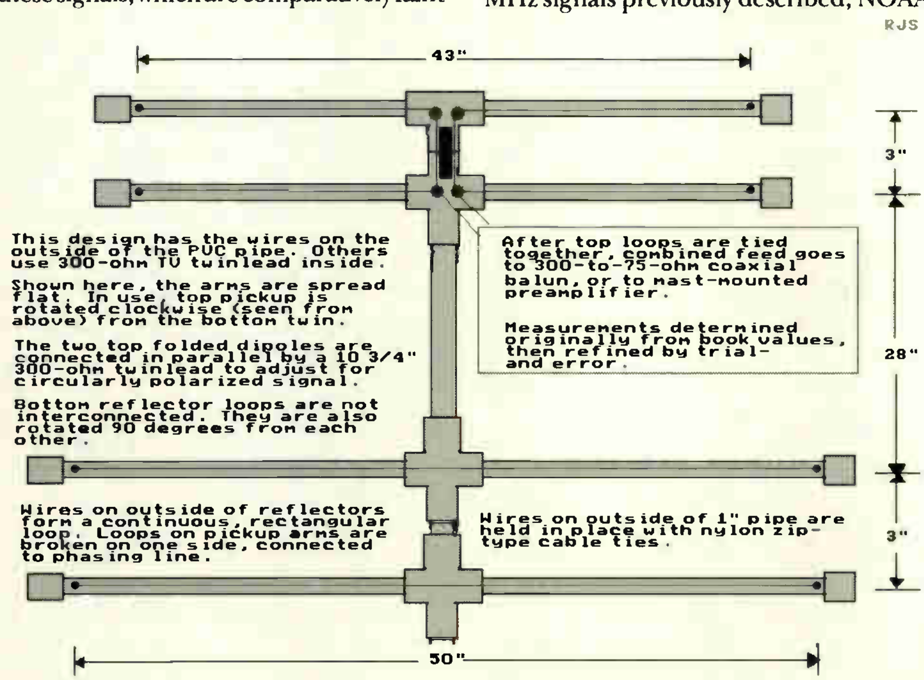
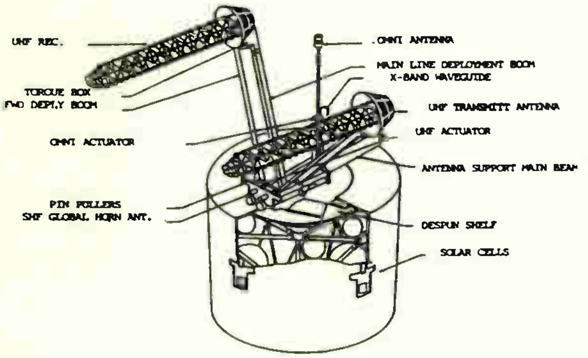


Side view of "Turnstile" weather satellite antenna made from PVC sprinker pipe.

LEASAT



HIGH FLYING SPACE FRISBEES

By Larry Van Horn

It actually was all quite simple. Four locking pins were retracted on the launch cradle. Then an explosive device was fired and that released a spring. The spring would then flip the spacecraft with a spinning motion out into space. That was how the five Leasat (Syncom) spacecraft were launched from the cargo bays of the space shuttles *Discovery* and *Columbia* in 1984, 1985 and 1990.

These satellites looked like giant frisbees being thrown into space. It was rather entertaining to watch on TV as the flying, satellite frisbees rolled out of the shuttle and into the darkness of space.

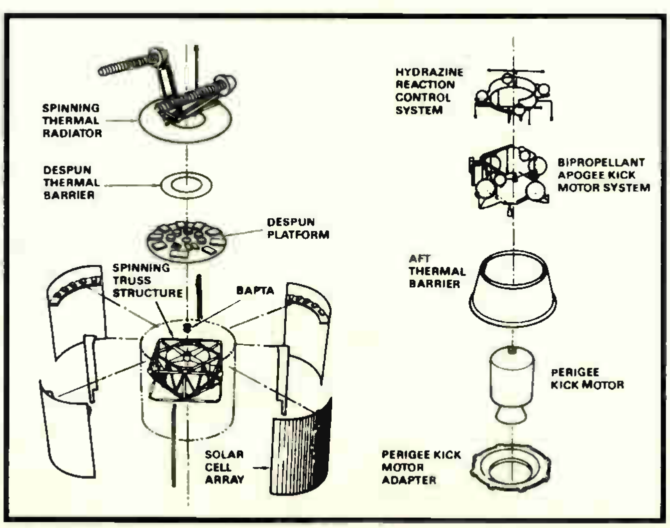
But that simple launch technique was no accident. The Leasat series of satellites was the first type of spacecraft designed to be launched from the space shuttle cargo bay. In fact, the Leasats were unique because they didn't even need a separately purchased upper stage to get them into geosynchronous orbit. Each satellite had its own unique upper stage built inside the spacecraft.

However, the launch method wasn't the only unique thing about these spacecraft. Even more unusual was that the U.S. Navy's Leasats were "leased satellites"; hence, the program was named Leasat.

Assuming that the Fleetsatcom system of satellites would die from old age at the end of their expected five year lifetimes, Congress approved the lease of an interim series of ultra high frequency (UHF) military communication satellites.

In September 1978, the United States Navy announced a contract award for Leasat to Hughes Communications Services, to provide worldwide communications satellite service to the Department of Defense for at least five years at each of four orbital locations. The Navy would act as executive agent on behalf of the Department of Defense. Users of the satellite network would include: mobile, air, surface, subsurface, and fixed earth stations of the Navy, Marine Corps, Air Force, and Army. Hughes Space and Communications Group built each of the satellites.

The agreement called for Hughes to design, build, launch, and operate a complete communications satellite system. Included were five satellites, one of which was a spare, as well as associated ground facilities—an operational control center, a network of four fixed ground stations, and two movable stations. The operational control center is located in El Segundo, Calif., and houses the computing hardware/software and communications equipment that interfaces with the four fixed ground stations in Guam, Hawaii, Stockton, Calif., and Norfolk, Va. These satellites occupy geosynchronous positions over the United States and over the Atlantic, Pacific, and Indian Oceans.



Leasat F1 (Syncom IV-1) was scheduled for launch in June 1984, but the shuttle mission was aborted only seconds before liftoff. Leasat F2 (Syncom IV-2) became the first in the series to be launched, on August 30, 1984. Shortly after launch Leasat F2 suffered a complete failure of the 500 kHz DoD wideband transponder (channel 2). It is now believed this transponder was never recovered.

Leasat F1 followed on a November 8, 1984 launch. Leasat F3 (Syncom IV-3) was launched from the shuttle *Discovery* on April 12, 1985, but did not achieve orbit when the satellite failed to start. Four months later, NASA and Hughes mounted a salvage attempt during the August 27, 1985, shuttle mission on which Leasat F4 (Syncom IV-4) was launched. After attaching special electronic assemblies to Leasat F3 during two days of space walks, astronauts manu-

TABLE 1: Leasat Spacecraft

Satellite	Orbital Location	International Designator	Satellite Catalog Number	Launch Date
Leasat F1	Retired	1984-113C	15384	Nov 10, 1985
Leasat F2	177.6° West	1984-093C	15236	Aug 31, 1984
Leasat F3	105.3° West	1985-028C	15643	Apr 12, 1985
Leasat F4	Failed	985-076D	-----	Aug 29, 1985
Leasat F5	71.5° East	1990-002B	20410	Jan 9, 1990

ally launched the satellite again. The electronics allowed ground controllers to turn on the satellite and, at the end of October, fire its perigee rocket and send Leasat F3 into orbit.

Leasat F4 successfully obtained orbit and was undergoing tests about a week after launch when all of its UHF transponder downlinks failed. The satellite was declared a loss.

The fifth and last Leasat, which was built as a spare, was successfully launched from the space shuttle *Colombia* in January 1990. All previous Leasat launches had been from the *Discovery*.

TABLE 2: Leasat Frequency Downlink Bandplans

(All frequencies listed in MHz)

	Whiskey	X-ray	Yankee	Zulu
Channel 1: Fleet Broadcast Channel				
	250.350	250.450	250.550	250.650
Channel 2: 500 kHz Wideband Channel				
	263.55-264.05	260.35-260.85	261.45-261.95	262.05-262.55
Channels 3-8: 25-kHz Navy Relay Channels				
ch. 3	251.850	251.950	252.050	252.150
ch. 4	253.550	253.650	253.750	253.850
ch. 5	255.250	255.350	255.450	255.550
ch. 6	256.850	256.950	257.050	257.150
ch. 7	258.350	258.450	258.550	258.650
ch. 8	265.250	265.350	265.450	265.550
Channels 9-13: AFSATCOM Narrow Band Channels				
ch. 9	243.855	243.955	244.055	244.155
ch. 10	243.860	243.960	244.060	244.160
ch. 11	243.875	243.975	244.075	244.175
ch. 12	243.900	244.000	244.100	244.200
ch. 13	243.910	244.010	244.110	244.210

Satellite Description

Leasat is 4.26 meters (14 feet) in diameter and 6.17 meters (20 feet, 3 inches) high with its UHF and omnidirectional antennas deployed. With its antennas was stowed in the launch configuration, Leasat was 4.29 meters (14 feet, 1 inch) high. Total payload weight (including launch cradle) in the shuttle was 7,711 kg (17,000 lbs). Weight after separation from the shuttle was 6,895 kg (15,200 lbs), and the satellite's weight on station at the beginning of life was 1,388 kg (3,060 lbs).

These satellites are spin-stabilized, with the spun portion containing the solar array and sun and earth sensors for attitude determination and earth pointing reference, batteries for eclipse operation, and all propulsion and attitude control hardware. The despun platform contains earth-pointing communications antennas, communications repeaters, and the majority of the telemetry, tracking and command (TT&C) equipment.

Power Source

Solar panel output was 1238 watts after seven years in orbit. Three 25A-hr nickel-cadmium batteries for eclipse operation are designed for a normal maximum 45 percent discharge. Redundancy resulting from the three-battery system permits full load support with loss of one of the batteries.

Communications Payload

Two large helical UHF antennas provide receive and transmit capability in the UHF band (240-400 MHz). The Leasat satellite has seven 25-kHz UHF downlink channels, one 500-kHz National Command Authority (NCA) wideband channel, and five 5-kHz Air Force satellite communication (AFSATCOM) channels. One of the seven 25-kHz UHF downlink channels is the downlink for Fleet Satellite Broadcast message traffic. The remaining six 25-kHz channels function as direct relay channels with separate repeaters.

Telemetry, command, and the Fleet Broadcast uplink and beacon are in the "exclusive" portions of the super high frequency (SHF) band (7,250 to 7,500 MHz, and 7,975 to 8,025 MHz). Table 2 lists all of the Leasat bandplans and communications capability.

The principal Navy Fleet Broadcast function includes an SHF uplink, and both SHF and UHF downlinks. The additional antennas for this channel are the SHF uplink and downlink earth coverage horns, which support the uplink and acquisition/timing function, respectively. The UHF downlink for Fleet Broadcast is multiplexed onto the UHF transmit helix.

Leasat spacecraft less 25-kHz channels than the Fleetsatcom UHF military satellites. Even though they serve an expanding Navy satellite communications requirement, the reduction of channels was made possible by applying the ground-based Demand Assigned Multiple Access (DAMA) technique. DAMA lets each satellite use it's radio frequency (RF) channels more efficiently.

This is the third of a four-part series in *ST* on the various UHF military satellite systems currently in operation. In the next issue of *ST* (September/October 1995), we will take an in-depth look at the latest generation of UHF satellites for the 1990s and beyond—the UHF Follow-On or UFO spacecraft. We will also present an *ST* exclusive: the UFO UHF frequency bandplans. ST

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TABLE 3: Leasat Channel Characteristics

Channel Type	No.	Bandwidth, kHz	EIRP*, dBw	G/T*,dB/K
Relay	6	25	26	-18
Wideband	1	500	28	-18
Narrowband	5	5	16.5	-18
Fleet Broadcast	1	Onboard Processing	26	-20

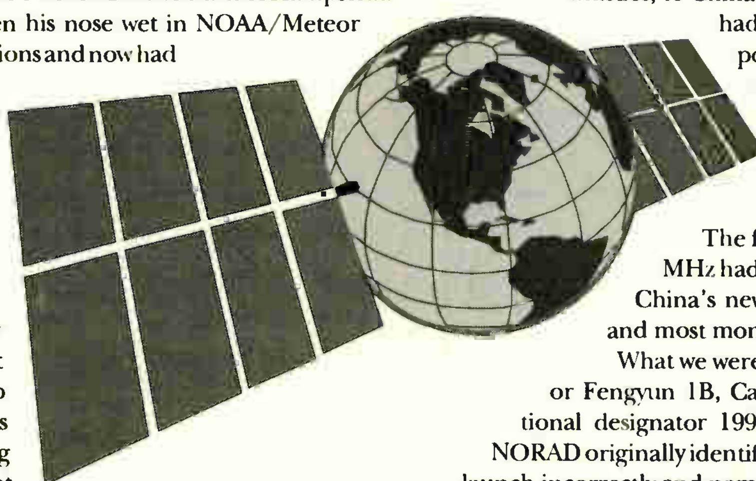
*Specific minimum values over the coverage areas for the full service period.

THE SATELLITE
SLEUTH

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

Charlie's Excellent Adventure

It seems that everyone who listens to the mysterious signals sent out by satellites, comes to it by some unique experience. That certainly was the case for Charlie Davis of Hampstead Md. Charlie had just gotten his nose wet in NOAA/Meteor weather facsimile transmissions and now had began to wonder about those mysterious ImHo-Teps he had heard me refer too.



"Just when is the best time to run into a bunch of them?", he inquired innocently one day on the phone. "Well they can show up anytime," I replied, "but they often seem to show up on holidays when most folks are out of town celebrating something or other." That propitiously worded statement was uttered in all honesty (and in complete ignorance of the future) a few days before Labor Day 1990.

On August 31 (Friday of the Labor day weekend) "Charlie's Excellent Adventure" began. First, transmissions on 137.279 Mhz were heard and copied on APT equipment that presented no ground/cloud images, but a solid synch frame and sequential numbers on the edge of what would be the image frame. This was, of course, Cosmos 1602 (International designator 1984-105A, Catalog number 15331) launched on September 28, 1984 from the Baikonur launch site in the then Soviet Union (now Kazakhstan).

Cosmos 1602 served as a good learning exercise for the several people interested enough to join in on a BBS and phone-call linked search for more information about this interesting satellite. We shared AoS/LoS timings for passes through Saturday and Sunday when I announced the identity of the source of the signals as Cosmos 1602. A good time was had by all. It was an interesting, not an every-day common occurrence and it had a little mystery to it. A perfect weekend effort.

Labor Day was on the 3rd of September that year and Monday started off with a bang that might have been reserved for July 4th. New signals on 137.795 MHz were causing chaos among the APT troupers that had shuffled into the shack that morning before facing a day of national celebration. Those that heard the mystery signal heard it on 137.800 and that made no sense at all. When they looked at the image and saw what was clearly a NOAA scan and not a Meteor scan, they were even more confused. Had the U.S. sent up a new weather satellite and kept it a secret? And what was it doing on this frequency instead of 137.50 or 137.62?

The answer was clear to those who knew that the U.S. had sold the NOAA weather satellite system, complete with all bells and whistles, to China several years before. Indeed China had launched their first attempt at a polar weather satellite two years and three days earlier. China 24 (aka PRC24 or Fengyun 1, Catalog number 19467 and International Designator 1988-080A) had been launched on September 6, 1988. The frequencies of 137.035 and 137.795 MHz had been used then also, but the first of China's new satellites transmitted only briefly and most monitors never heard it at all.

What we were hearing was China 30 (aka PRC 30 or Fengyun 1B, Catalog number 20788 and International designator 1990-081A). It should be noted that NORAD originally identified most objects associated with this launch incorrectly and named the primary spacecraft as "1990-081B". A few days later they corrected their error by quietly reassigning numbers without any comment. The images were excellent and we wondered about the sensors the Chinese were using as compared to the US sensors on the NOAA satellites.

Charlie marched off to the China embassy in Washington, D.C., and came back with the full technical specs for the Fengyun series of weather satellites (in Chinese of course). As he read me the wavelength sensitivities for the various sensors over the phone, I could not help but notice the obvious differences from the US NOAA spacecraft sensor standards. Hm-m-m, I thought. With three channels of HRPT data being transmitted, one could make a real-color image of the Earth from the Chinese weather satellite data. Real color is not an objective for weather satellites. Shades of grey in various spectral ranges provide the data meteorologists want. Sure enough, when the word got out about Fenyun 1B, those with HRPT equipment were printing out true-color weather pictures. Something never possible before or since.

Charlie was overwhelmed with what he had gotten into in just the space of a long weekend. Peg, his wife, was a bit overwhelmed with their phone bill too. She sent me a copy of the last page with the total circled and implied that since I had been the one to get him started in this "madness", I should assume some responsibility for the huge charges. I sent her a copy of -my- phone bill for that month and she never mentioned it again. She still talks to me, but when I call Charlie, she has a tendency to say he's not there.

The result of "Charlie's Excellent Adventure" was that he hasn't left home on a holiday since and has heard a lot of fascinating things in the many intervening years. He knows that anything can happen at anytime and you just have to be listening to catch it. And if you're not... you just missed it.

When the Russians announce s launch they naturally write about it in proper Russian Cyrillic. Now comes the weak link. Someone translates that Russian into American or British English and maybe they do not understand that there are good ways and not so good ways to translate the cyrillic alphabet.

I can't find that satellite!

I often hear people say something like "I can't find that satellite you told me about. There isn't any 'Ocean' listed in the elements". When I tell them to look for 'Okean' they say "Oh ya, I have that". Let's look at the reason for this confusion and maybe explain some other weird names you have tried to deal with in the past.

To start with there is no 'Okean' series of spacecraft. (Oh, I know you have seen them in the TLEs and read about them.) But in truth there is no such series. There is an 'Ocean' series launched by the Russians. "Then what are these 'Okean' satellites?" you ask. They are the Russian Oceanographic satellites called 'Ocean' by the Russians. The problem starts with the Russian alphabet. They use the Russian Cyrillic alphabet (Not the Cyrillic alphabet that we commonly think of as Greek.). Russian Cyrillic has many letters that look like the letters in the American alphabet. However, looking like they are the same doesn't mean they are the same. They aren't. Not by a long shot. When the Russians announce a launch they naturally write about it in proper Russian Cyrillic. Now comes the weak link. Someone translates that Russian into American or British English and maybe they do not understand that there are good ways and not so good ways to translate the cyrillic alphabet. Or maybe they don't know at all. In any event, they look at the Russian letter and say "That looks like a ..." and substitute the English letter. They do this for every letter of the word and when they are finished they say "That's how it should be in English." Well, maybe and maybe not.

Lets look at OKEAN/OCEAN as an example. (By the way, we can't afford to buy a whole set of Russian Cyrillic typefaces for this column yet so refer to Figure 1 for the examples of how they really would look in Pravda.)

First of all the Russian word does look like Okean, but it's not pronounced that way. The 'k' is pronounced like we pronounce 'c'. So if you say Ocean, you will sound just like a Russian saying 'Okean'. The same goes for Kosmos and Cosmos. Some languages change the pronunciation of a letter depending on where in the word it is. 'K' and 'C' are obvious but what are not obvious are some of the other words.

FIGURE 1—Russian Cyrillic translations

Russian Original	Common Translation	Better Translation
Космос	Kosmos	Cosmos
Океаи	Okean	Ocean
Горизонт	Gorizont	Horizon
Тсуклон	Tsyklon	Cyclone

FIGURE 2—More Cyrillic translations

СССР	USSR
США	USA
НАСА	NASA
Москва	Moscow
Мир	Mir
Кваит	Kvant
Восток	Vostok
Союз	Soyuz
Венера	Venera
Вертикаль	Vertical
Спутник	Sputnik
Восход	Voskhod
Восток	Vostok
Метеор	Meteor
Ракета	Rocket
Зонд	Zond
Салют	Salyut
Бчран	Buran
Протон	Proton

Another "for instance"

Take a popular booster used by the Russians commonly called in the American press the Tysklon. (see Figure 1 for how it is written in Russian Cyrillic) Now when you see that in print you will try to say "Tiss - ki - lon" which is unfortunate since it is pronounced 'Cyclone' by a Russian. (If you say 'Cyclone' in American you will sound like a Russian saying 'Tysklon'.) And that's as it should be since that's what they mean. When this big powerful booster is launched, the sound and fury it makes is like a cyclone. Well you sure would never know that by 'Tysklon' would you?

A conspiracy?

So why are these people that use these words doing this. Are they stupid or is this another conspiracy to confuse us all? Neither, I am sure. The thing is, if you have never heard these words pronounced correctly you really are playing 'Russian Roulette' by transliterating letter by letter. After the first person does it poorly, he is quoted by a second source and soon people all over are saying the wrong thing. It's easy to start and hard to set right. Then there are the cases where the wisdom of Solomon might not help.

The thing is, if you have never heard these words pronounced correctly you really are playing 'Russian Roulette' by transliterating letter by letter. After the first person does it poorly, he is quoted by a second source and soon people all over are saying the wrong thing. It's easy to start and hard to set right.

Actually when you are translating from one language and alphabet to another there is no absolute correct. There is only bad, good and better.

Bad is simply when you can't pronounce it correctly by using the rules of American English. So when you see someone using a less than pronounceable translation, take a minute and let them know that there is a better way. After all, if we don't say what we mean, how can we mean what we say?

Mailbag

John Musgrave of Campbell River, British Columbia Canada, writes that he enjoys reading *Satellite Times* and gets a lot out of it. He also offers a couple of comments.

His first comment is that "all readers of *Satellite Times* should have computers and phone service". While I heartily agree, I also know that we haven't been able to figure a way to include a Pentium computer insert within the pages of this magazine. Perhaps in 10 years such a thing will be common place. But his point is well taken and whenever I talk about doing something with 'your computer prediction program' I have tried to show that you can also do it with a pen and paper.

Unfortunately, this incredible onrush of computer technology has resulted in an amazing increase in computing power, but the price has remained from the very early days at about $2,500 for a usable system. That's what I paid for my first Apple II+ many years ago and that's what I paid for my Pentium a few months ago. I don't have a solution for how to get a computer to someone that can't afford that, unless maybe some of you readers out there have some old Apples, 80386's or 80486's that you use for holding the door open now and would like to pass them along to someone to get some use out of it. What say you out there? Got an extra computer or two? Need a computer? Let me know and I will see if we can put you people together.

I might add here that I have talked to a lot of people out there who really live in the boondocks and to whom commercial power is not a reality. Some have managed to pick up a portable and arrange to charge the battery with solar cells. Any old portables or laptops out there that someone could run some text programs on? Maybe even EGA or VGA graphics in B&W? They don't take much power and someone could sure make use of such a thing. Don't toss it or even let it gather dust (you know you can't sell those things for anything anymore) pass it along to someone that can use it. (Let's face it, shipping charges may be the deciding factor in these matters.) Write me and tell me what you have or what you need. I'll put a likely pair of you together and you two can conduct the transaction. That way you can know where it went and how it's being used. Come on, do it now! (But PLEASE only working units.)

As to the matter of all *ST* readers having phone service, I can attest to the fact that its not always possible, even in the U.S.

John's other comment was "What *Satellite Times* needs is a satellite-frequency- signals list". Right John we do, but... (you knew there was going to be a but there didn't you?) the facts of the situation are that I have about 2,800 listings and there must be at least 2,800 other people out there with their own lists. Who knows what's on their lists? Indeed. I can't print my list here every other month as the nice managing editor says I can have only these few pages. However, he does say that I can print frequencies and signals heard from the readers out there up to a page every issue. So let's go folks! Send in your frequencies heard and what you heard and we'll include what we get in every issue from now on. The other guys writing columns in *Monitoring Times* get to do it with their low band reports (Yes sir, Theo is up to two pages every month in the Ute World column-Editor), so we're going to do it here too! Get those cards and letters coming people and be sure you write or print your name and address clearly so I can read it. Send them to me at P. O. Box 1592, Owosso, MI 48867-6592. Thanks John for your letters.

Well it's summer again and as you might remember that back in the Nov/Dec 1994 issue I mentioned that "TIROS 10 (International Designator 1965-051A, Catalog number 1430) was heard at times of peak sunlight actually transmitting APT-like signals. Absolutely amazing for this ancient weather satellite launched more than 30 years ago, deactivated over 28 years ago and long forgotten by it's creators. Those of you in the southern hemisphere should listen up on 136.235 MHz and you too may hear it during your summer solar season. Those of you north of the equator, mark it on your calendar for next summer." Well, it's next summer!

Listen up and if you have APT imaging capability, have it ready and see what you can catch when (not if) it starts transmitting with the longer sunlight periods and higher bus voltages. If you get anything send me the file and we'll try to get it in the next issue. TIROS 10 is not the only thing up there that gets more sunlight in the Northern Hemisphere summer. You can hear some fascinating things.

Speaking of hearing some fascinating things. If you heard some strange signals on or about 137.41 Mhz back around April 3, 1995 and thereafter, you were lucky. If you think you heard something, you may well have. Actually if you only heard something you really missed the show. You really needed a spectrum analyzer to fully appreciate what was up there. I can recommend the Avcom SDM-42A. It's not a full spectrum analyzer because it uses the high IF from my Icom R-7000 (or the 10.7 Mhz or whatever IF from your receiver) and displays up to 10 Mhz of what it receives. Frankly I couldn't afford the $18,000 to $45,000 for the beauties in the catalogs the big boys use, but for something in the $1,000 range, it shows me what I want to know about unknown signals.

If you caught some of these interesting transmissions, I'd like to know what you think about them and the future they portend. There is much to be gained by looking at signals on a visual instrument like the Spectrum Display Monitor and if you have a top notch tunable monitor and are looking for the next place to put some money to get more signal information, a spectrum analyzer will give you a perspective you simply cannot imagine by just listening to the signal. As soon as I can figure out how to get the display imaged some way and make a hard copy, I'll include some examples here.

It's been a great first year for me (has a year of *ST* gone by already?) and I hope you have been here from the very beginning. If so, it's time to renew. The coming year can only be better than this year has been. Thanks for all your comments and suggestions.

That's it until next time when Thomas Mishler from Lapeer, Michigan lets us in on the secrets of DDPN. ST

DOMESTIC TVRO

By Dr. Frank Baylin & John McCormac

Thoughts on Encryption Systems and Hackers

Before HBO encrypted its signal in late 1985 hackers had it easy. The scrambling systems were simple analog ones that used easy methods including video inversion, sync suppression, sync replacement and interfering sine waves. Most systems were generally some combination of these methods. But the system that HBO had chosen was different. In the midst of all this, HBO made one fatal mistake—they loudly proclaimed that they had a totally secure system that would beat any and all hackers.

The cat and mouse game that has been continually played out between broadcasters and hackers has always fascinated me. With the launch of DSS the game has entered a new phase. This time the stakes are higher and so are the penalties for losing. It is easy to stand on the sideline and appreciate the bravado and the fumbles. But at the end of the day, I believe that programmers should be paid for their efforts. Whether that results in high quality entertainment and education or junk television is another story.

In the early 1980s, the skies were clear. It was truly interesting time for TVRO pioneers surfing between backhauls and movies. The comments and gestures on some of those backhauls would have been embarassing if the programmers and technicians had been aware of their audience. Then the "problem" created by TVRO pioneers began to mushroom as the new industry rapidly grew. The free use of these programs and feeds in commercial establishments and very small-scale cable TV systems forced the programmers to react. They threatened to cut the "pirates" off by scrambling their signals.

This was a terrifying prospect to people who had gone out and spent thousands of dollars on equipment. Some of the magazines carried cartoons about $5,000 bird baths (satellite TVRO dishes—*Editor*). The prospect of scrambling made some people quite angry. They had believed the "open skies" call. In retrospect the belief that "if my dish can pick it up then I should be able to watch it" seems strange.

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The system that HBO had used was VideoCipher II. It digitized the audio, encrypted it with the DES algorithm and inserted it in the vertical blanking interval. It also replaced the snyc pulses in the video with the encrypted digital audio data and other access control data. Hacking the video was a trivial exercise. The audio, however, was a whole new ball game.

As with any game, there are mistakes. While no side has a monopoly, it seemed that HBO had just made a big one. A flaw in the design of the VideoCipher II decoder meant that it was possible to rewrite the EPROM to give access to all channels for the price of one. The hacking became progressively worse from that point on. As a result, the the legal framework was changed to make signal piracy a clearly defined crime.

The turmoil that ensued caused some jobs to be lost, a few careers to end, a few fines to be levied and exiled one well-know person. The final result of all this was that a new and improved system, VideoCipher II+, was created.

Three fundamental mistakes were made with VideoCipher II. The first was that a not-so-subtle challenge was issued to the home satellite industry. The second was that the legal framework was not defined as clearly as it is today. The third was that the architecture of the scrambling system was set in stone a "frozen architecture."

The underlying element in all of this was the hacker. As differentiated from pirates who are in it solely for the potentially vast financial rewards to be made, the true hacker is simply responding to a technical challenge.

VideoCipher II+ has not been hacked, or at least pirates have not marketed a hack. On the other side of the fence, General Instruments has improved their corporate security system and makes fewer inflammatory marketing pronouncements.

The VideoCipher II+ is again about to be upgraded with the addition of the DigiCipher II module. Subscribers wishing to receive MPEP 2 digitally compressed broadcasts will be able to do so by replacing their VCII+ module with this new backwards compatible module.

Have DIRECTV and USSB fared as well? Have they made a fatal mistake in the selection of their access control system? Rumor has

Perhaps it is time to adopt a totally "fluid architecture" in which the decoder can itself be reconfigured electronically. Such a decoder would theoretically be able to morph from being a DSS to a DigiCipher decoder just by the insertion of a super smart card or by some over-the-air configuration. This, of course, goes against conventional sales "wisdom" and business practice.

it that their smart card has already been hacked and that the basic tier pirate card will sell for about $150. Four tiers of pirate cards are planned. The second, third and fourth tiers will include subscription movie channels, then sports and finally everything including pay-per-view channels with a credit of $500 per pirate card. This is, at this time, all rumor. I have not personally seen one.

I do not condone piracy and believe that it will harm us all—except for the few pirates who become rich in the process. It is a serious business with serious consequences for both the pirates and the broadcaster. Nobody believes for a moment that GM Hughes Electronics, a very powerful and financially capable corporation, will sit by idly and take this lying down. But what mistakes, if any, have been made and what remedies are there to these errors?

John McCormac's book is now in its fourth edition.

Putting a patent number on a smart card is not clever. It has given both hackers and pirates a starting point, namely Europe. The patent number refers to the Fiat Shamir Zero Knowledge Test, an algorithm used in the decoder so that it can authenticate the card in the slot as being a genuine one. This algorithm is also used in the analog VideoCrypt system in Europe. The designers of the VideoCrypt access control system is News Datacom Ltd. This system has become as leaky as the proverbial screen door.

When DSS was being prepared for launch in the United States in early 1994, the 07 card issue of VideoCrypt in Europe had been hacked. The full source code of the hack had been distributed freely on the Internet and via BBSes. The common element between the two systems was News Datacom. Would what had happened in Europe happen in the U.S.? That was the million dollar question.

At this point the trade magazine barrage began. One particular article claimed that VideoCrypt had been unhacked in Europe since its introduction in 1989. A well-known hacker, John McCormac, stated that "the person who wrote the article was either being paid to give out disinformation or was just clueless because VideoCrypt had been hacked on a continual basis since its introduction." At the same time that article appeared the new 09 card was being issued because the 07 card had been so devastatingly broken.

Since this time the 09 card issue has been hacked in Europe. That card contained some rather sophisticated technologies such as the ability to accept over-the-air modifications to the program in the card. The entire contents have been dumped out electonically using the "Vampire Hack." Where does this leave DSS? Why did DIRECTV and USSB choose the News Datacom technology that was such a hot target in Europe?

The technology probably appeared cheap and the anti-piracy law in the United States are stringent. When enforced, these laws are quite tough. News Datacom also have a performance contract so that if the system is hacked they simply do not get paid until it is secure again. It was perhaps the best and most cost effective deal on offer to DIRECTV and USSB at the time.

The smart card approach is, I believe, a step both in the right and the wrong direction. The semi-fluid architecture does allow for a complete upgrade via card replacement, but it also offers the pirates an easily packaged and distributed device. Such a card fits in an envelope and would be difficult to spot in the mail or, at least, would not be as obvious as a pirated VideoCipher module.

Perhaps it is time to adopt a totally "fluid architecture" in which the decoder can itself be reconfigured electronically. Such a decoder would theoretically be able to morph from being a DSS to a DigiCipher decoder just by the insertion of a super smart card or by some over-the-air configuration. This, of course, goes against conventional sales "wisdom" and business practice.

DSS may have actually encouraged piracy by choosing a smart card as the key element in their system. Pirates may have a more difficult time marketing hacked DigiCipher modules, if indeed it is hacked, since it would require a box rather than an small envelope. The hope is that most consumers will honor the need to pay programmers, especially in an environment where anti-piracy law enforcement might be quite strict. ST

Dr. Frank Baylin, president of Baylin Publications, has served the industry as author and consultant since the early 1980s. He has authored and co-authored more than ten books as well as software and a video. He has recently published two new books "Miniature Satellite Dishes The Digital Television Revolution" available for $20 plus $4 s/h and the "1995/96 World Satellite Yearly" available for $90 plus $4 s/h. Interested readers can also obtain a free catalog from his company by writing Baylin Publications at 1905 Mariposa, Boulder, CO 80302 or by calling 800-483-2423.

John McCormac (e-mail: jmcc@wizardr.ie) is considered to be the leading European authority on pay television piracy. He is also the editor of "Hack Watch News" and the author of "European Scrambling Systems," now in its 4th edition. This detailed tome is the definitive work on pay-television piracy and hacking. It covers all aspects of hacking from from the mentality of hackers to the fine details of numerous hacks, including the source code of the VideoCrypt hack.

By George Wood
(SMOIIN/KA6BIN)

Satellite News on the Web

Swedish Radio's World Wide Web pages on the Internet didn't go online as scheduled (at http://www.sr.se). However, in the meantime, I've managed to set up a MediaScan page via Sweden's ABC Computer Club (see at right). If you have access to the Web, set your browser to:

http://www.abc.se/~m8914/media.html

There you'll find links to the MediaScan text and sound archives, as well as links to other WWW pages about satellite broadcasting, shortwave, and amateur radio. I'm also planning to make available other material, such as these *Satellite Times* International TVRO columns.

There are a number of European satellite broadcasters available over the WWW as well. Here are a few:

BBC http://www.bbcnc.org.uk
Sky Radio http://euronet.nl/users/skyradio
Deutsche Welle http://www-dw.gmd.de
World Radio Network http://town.hall.org/radio/wrn.html

One of the best sources of satellite news on the Internet is on the Usenet newsgroups. There are a number devoted to radio and TV topics, but for European satellite news, my favorite Cyberstop is:

alt.satellite.tv.europe

Most of the conversations there seem to circle around the latest pirate decoder programs to watch British Sky Broadcasting's Multichannels package, pirated smartcards to watch the Scandinavian film channels TV1000 and FilmNet, or the appearance and disappearance of soft and hardcore porno channels. Actually, the latter two subjects overlap, since the only reason most people who can't legally get cards to watch TV1000 and FilmNet want them to watch late night pornography. But in between the pirates, the erotics, and the erotic pirates, there is usually some ordinary, and interesting, satellite news on this Internet newsgroup.

Recently a British company named Wildfire announced a new package to make Usenet newsgroups available to European TVRO monitors. The idea is to use a transponder on one of the Astra satellites to downlink the most recent 24 hours of newsgroup postings every day in the middle of the night. Subscribers would have decoders attached to their home computers, where the Usenet postings would be stored on their hard disks. Naturally the system would work only one way, and anyone wishing to send their own postings to newsgroups would have to subscribe as well to an ordinary telephone-based Internet provider.

Wildfire says its initial decoder will be an 8 bit PC card for IBM PC compatibles. They want to sell them for around 100 dollars a month, and subscriptions would be around 15 dollars a month. However, since making this amazing announcement in January, Wildfire doesn't seem to have gotten anywhere. If you have access to the WWW, you can see far they've gotten by checking out:

http://www.tecc.co.uk/wildfire/index.html

European News

Leaving Cyberspace for Outer Space, there's been relatively little happening on the European satellite scene since Eutelsat's Hot Bird-1 went into operation in late April. Despite claims by Eutelsat and Astra's owner SES that all the transponders on their newest satellites were booked long before launch, both Hot Bird and Astra 1D have been slow in filling up. A number of transponders on each have remained unoccupied weeks after the satellites went into operation.

One the most interesting European developments recently was on the terrestrial scene rather than in the Clarke Belt. The British government took bids for a new fifth national network, in addition to the current two BBC networks, the ITV network, and Channel Four. Rupert Murdoch was reported to be extremely interested in gaining the franchise for his British Sky Broadcasting, and before the bidding opened, fears were expressed about the extraordinary power Murdoch would have should he win the license.

Europeans still remember Silvio Berlusconi's grab for power, when he used the propaganda base he held as owner of Italy's three

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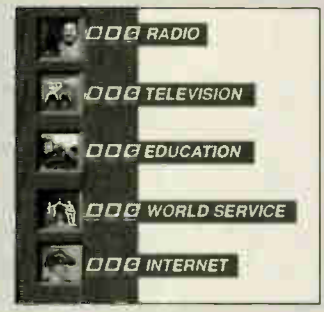
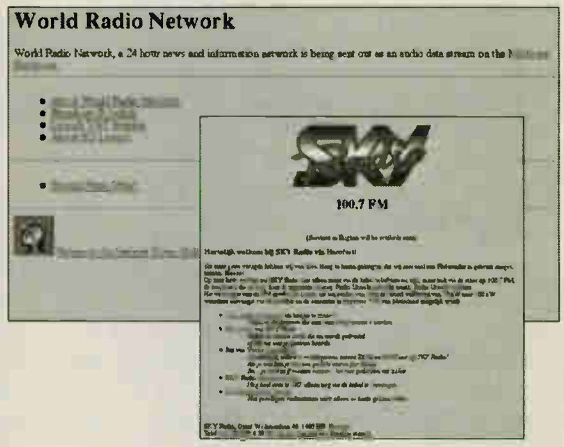
Satellite broadcasters on the World Wide Web

See previous page for details





commercial TV networks to organize a political party overnight and capture control of the government, only to then attempt to impose his control over the country's three public broadcasting networks as well. Besides British Sky Broadcasting, Murdoch controls the Fox Network in the US and Star-TV in Asia, making him a significant factor globally.

Be that as it may, there was a gasp of disbelief when the Channel 5 bids were announced. The highest bid, a whooping 36.26 million British pounds (59 million U.S. dollars) came from UK TV, made up of CanWest Global Communications in Canada, Network Ten Australia, Scandinavian Broadcasting Systems (largely owned by ABC), and SelecTV. That dwarfed the next highest bids, both for 22 million pounds (36 million U.S. dollars), from Virgin Television (made up of the Virgin Group, Philips Electronics, HTV, Paramount Pictures, and Associated Newspapers) and Channel 5 Broadcasting (MAI, Pearson, and Luxembourg's CLT).

The bid from New Century Television, the consortium organized by British Sky Broadcasting, Granada Television, and Sweden's Kinnevik, was for a paltry 2 million pounds (3.24 million U.S. dollars). British media observers were astonished at Murdoch's low bid, given his obvious interest in gaining the franchise. Channel 5 will use European UHF channels 36 and 37, which are currently used by VCRs, satellite receivers, and video games. The holder of the winning bid will be obliged to visit every household in the Britain to help retune equipment, which will be a considerable expense.

It's not certain that UK TV's huge bid will be accepted, since the British licensing authority the ITC has the right to reject any bid considered to be economically unviable.

Meanwhile, British Sky Broadcasting, which has been remarkably slow in using any transponders on Astra 1D, does seem to be intent on capturing the coming digital TV frontier. Astra 1D carries four extra transponders that are being used for digital tests, but Astra 1E, scheduled to be launched this Fall, and next year's 1F will carry a full complement of digital transponders. The first MPEG digital receivers, from Pace, were demonstrated at the recent Cable and Satellite Show in London. The plethory of digital, pay-per-view, and video-nearly-on-demand channels that should emerge on the new satellites should mark a quantum change in European broadcasting.

Sky obviously intends to be there, and to use the technology to the max. "Electronics Times" recently wrote: "BSkyB, the satellite broadcaster, is in negotiations with British Telecom to link its digital set-top boxes to the public telephone network. The plan, confirmed by industry sources, will enable BSkyB to access a viewer's digital decoder from a central server, via an integrated modem."

According to a posting on alt.satellite.tv.europe from Derek Boyd, the article goes on to say that this will be done in the early hours of the morning, and will enable BSkyB to monitor viewing habits, and in theory to stop pirate viewing.

Digital radio is set to begin on Astra. According to another posting on alt.satellite.tv.europe, by Heike Claudia Zimmerer, here is a provisional list of Astra Digital Radio:

Transponder 39, 11.053 GHz H (WDR - Germany)
6.12 1 Live (WDR)
6.30 WDR 2
6.48 WDR 3
6.66 WDR 4
6.84 WDR 5

Transponder 41, 11.112 GHz H (Discovery/TLC)
7.56, 7.74, 7.92, 8.10, 8.28, 8.46 DMX Test

Transponder 42, 11.097 GHz V (Bravo/Adult)
7.74, 7.92, 8.10, 8.28, 8.46 DMX Test

Transponder 43, 11.112 GHz H (MDR - Germany)
6.30 MDR Live
6.48 MDR Info
6.66 MDR Kultur
6.84 MDR Sputnik

Transponder 45, 11.141 GHz H (Bayern 3 - Germany)
6.12 Bayern 1
6.30 Bayern 2
6.48 Bayern 3
6.66 B 5 aktuell
6.84 B 4 Klassik

The most interesting new channel viewable in Europe is Med-TV on Eutelsat II-F2 on 11.575 GHz. Uplinked from London, this is a Kurdish channel, supporting more autonomy for the Kurdish population of Turkey. Among its first broadcasts was the opening of the Kurdish parliament in exile in the Hague in the Netherlands. The station takes its name from the ancient name of the Kurdish people, "Medes".

Transponder 48, 11.186 GHz V (Suedwest 3 - Germany)

6.12 SDR 3	6.84 hr 2 (planned)
6.30 SDR 1 (planned)	7.74 hr 1
6.48 S2 Kultur (planned)	7.92 Deutschlandradio Berlin

Transponder 19, 11.494 GHz H (ARD - German)

6.30 DLF Koeln (planned)	6.66 SWF 1 (planned)
6.48 hr 3 (planned)	6.84 SWF 3
6.66 hr 4 (planned)	

So far there are no consumer receivers available for any of this, but hopefully within a few months Europeans will also be able to tune into DMX. According to reports, special ADR receivers will cost around $500.00 when they appear.

Pornography in the Skies

As I mentioned, one of the major topics on alt.satellite.tv.europe is about access to hard and softcore pornography. German channels seem to dominate Astra. Unfortunately the Germans dub rather than subtitle, and watching "Deep Space Nine" or "Murder She Wrote" in German is not everyone's idea of fun, although one day I did see "Hogan's Heroes" on a German channel, and that at least made some sort of weird sense. But the German channels do attract many British viewers late weekend evenings, when they often show softcore pornography, that is to say, a lot of bare female bodies, but not much else. Tame as the programming is, such material is strictly verboten in Britain. Britain's only porno channel, the Adult Channel, which is coded and expensive, offers nothing more revealing than the free German channels. British viewers are forbidden to watch anything naughtier.

There's a flourishing business in Britain in pirate decoder cards for Sweden's TV1000 and FilmNet, which include some late night hardcore among their offerings. Recently Bertil Sundberg, satellite columnist in the Swedish TV magazine "Paa TV", denounced the British regulatory agency the ITC for permitting the sale of pirate cards for TV1000 and FilmNet, while loudly protesting a new hardcore channel being uplinked from Sweden.

The new channel is the American-owned TV Eurotica, which broadcasts on Eutelsat II-F3 (16° East) on 10.987 GHz in coded D2-MAC for four hours after midnight every night. Currently its only competition is Eurotica, owned by SPICE, but with interests from the Adult Channel and Danish Satellite TV, who uplink it from Denmark. While the channel is supposed to complement the Adult Channel, and uses the same Videocrypt system, UK viewers are not allowed to subscribe, although the same pirate software that unlocks the Sky Multichannels package apparently also works on Eurotica. It broadcasts from Eutelsat II-F1 (13° East) on 11.181 GHz.

Meanwhile, there's a report the Playboy Channel may be expanding to Europe, using the Astra transponder of the Discovery Channel after midnight.

Scandinavia

In Scandinavian satellite news, Kinnevik, owner of the TV3 channels in Swedish, Danish, and Norwegian, as well as TV1000, may be preparing some kind of move against pirate cards. Recently TV3 Norway disappeared for pirate card owners. That very specific electronic countermeasure may be a sign of things to come.

There's a report Kinnevik will soon change its encoding system for all three TV3 outlets, as well as the two TV1000 channels and the oldies movie channel FilmMax, from the current Eurocrypt M to a new system called Eurocrypt S2. The CTV card, used for subscribers to the Thor satellite (CNN, Eurosport, MTV, Discovery, and Children's Channel) is reported to be on the way out. Norway's Telenor, which has supplied the CTV card, is part of Nordic Satellite Distribution, along with Kinnevik. According to the report, the CTV card is to be replaced with an enhanced card from Kinnevik's distributor Viasat.

Meanwhile, Europe does have its first regular MPEG-2 channels: Z-TV (Kinnevik's MTV clone) on Tele-X (5° East) on 12.600 GHz and its soap opera channel TV6 on Intelsat 702 (1 degree West) on 11.597 GHz.

The former German TV-Sat 2 is now broadcasting Nordic programming from 1 degree West (alongside Intelsat 702 and Thor). Current programming is TV6 Denmark on 11.747 GHz, Z-TV Denmark on 11.977 GHz, and the new Norwegian station TV Plus on 11.823 GHz, all in clear D2-MAC.

Kurdish TV

The most interesting new channel viewable in Europe is Med-TV on Eutelsat II-F2 on 11.575 GHz. Uplinked from London, this is a Kurdish channel, supporting more autonomy for the Kurdish population of Turkey. Among its first broadcasts was the opening of the Kurdish parliament in exile in the Hague in the Netherlands. The station takes its name from the ancient name of the Kurdish people, "Medes".

Since any kind of ethnic separatism violates the Turkish constitution (it has been forbidden to even speak the Kurdish language in Turkey and several Kurdish members of the Turkish parliament have recently been sent to jail for advocating some autonomy for their region), the Turkish authorities have protested vociferously to the British government for permitting the uplink.

In other news, Greece's ET 1 has left Eutelsat II-F4 (7 degrees East) for Eutelsat II-F2 (10 degrees East), on 11.596 GHz. Replacing it on II-F4 11.178 GHz is Serbia's RTS Beograd, which transmits a picture of the war in nearby Bosnia unlike any you'll ever see on CNN.

The most unusual report comes from Bertil Sundberg in "Paa TV" who says that the Indian channel Apna, which has been transmitting in the C-band on the new Russian Ekspress II satellite (14 degrees West) suddenly appeared on Ku-band 11.525 GHz on the neighboring Russian Statsionar at 11 degrees East.

NBC's relay from the US to NBC Super Channel (on Astra and Eutelsat II-F1) has transferred to a new satellite, Intelsat 603 (34.5

Japan opened its skies to foreign satellite broadcasters on April 19, by allowing two Hong Kong-based companies to beam their programs to Japanese subscribers. Rupert Murdoch's Star-TV is to launch four channels to Japan, while Turner Entertainment is planning a Japanese version of its Cartoon Network/TNT movie channel.

degrees West) on 11.638 GHz. There are reports NBC may change its programming so that the two satellite transponders will no longer simulcast. A disappointment for me has been that this year NBC Super Channel has dropped "Baseball This Week", which was the only program for Europeans covering baseball. I'm still waiting for Turner Broadcasting to wake up and relay Braves games on TNT (even the middle of the night is better than nothing).

The new Orion-1 Atlantic relay satellite at 37.5 degrees West has come alive. VH-1 is using 11.472 GHz to reach Europe, while there are so far unidentified carriers on 11.003, 11.472, and 11.532 GHz.

The Ariane launch program, after finally getting Hot Bird into orbit, months late, suffered a new set-back in early May when two technicians at the Kourou, French Guiana, launch station died after inhaling inert gas during a test of the new Ariane 5 engine. The Ariane 5 rocket is scheduled to be used first in November.

It appears that the cutbacks in the Corporation for Public Broadcasting budget by the new Republican Congress in Washington has had an effect on European satellite radio. NPR now says that its previously announced plan to launch a 24 hour NPR/PRI only channel via the World Radio Network on Astra is now only a future hope. NPR/PRI programming continues to share the existing WRN channel on Astra with 20 international broadcasters, including Radio Sweden.

Also on Astra, Japan's new NHK International has appeared on the JSTV transponder number 24 (11.568 GHz). This means more programming in the clear in what was an expensive coded subscription channel for Japanese in Europe. JSTV admirably did drop its coding for several in the aftermath of the Kobe earthquake.

Asian News

In the other direction, Japan opened its skies to foreign satellite broadcasters on April 19, by allowing two Hong Kong-based companies to beam their programs to Japanese subscribers. Rupert Murdoch's Star-TV is to launch four channels to Japan, while Turner Entertainment is planning a Japanese version of its Cartoon Network/TNT movie channel. Reports say Turner hopes to conclude contracts with 10 to 15 Japanese cable operators by the end of the year, obtaining 30,000 to 50,000 subscribers in Japan.

The problem is the cable systems. Currently only one million Japanese homes are wired for cable TV. Turner will use the Apstar 1 satellite, and Star will use its current home on Asiasat-1.

Meanwhile, Murdoch is having trouble in India. The country's biggest owner of Hindi film rights says he will sue one of Murdoch's TV affiliates over cable distribution rights. Dhirubhai Shah and the satellite network Asian Television Network say they intend to bring the action against Zee Cinema in India and Hong Kong on the grounds of violation of copyright of more than 1000 Hindi movies. Zee Cinema is a Hindi pay movie channel launched April 9, a joint channel between Murdoch's Star-TV and Zee Television, in which Murdoch's News Corp has a 49 percent stake.

According to Shah and ATN, Zee Cinema will be encroaching on their cable TV rights of more than 1000 popular films.

Almost exactly one year after being dumped by Rupert Murdoch from his Star-TV package on Asiasat-1, MTV has returned to Asian skies. MTV Mandarin started on Indonesia's Palapa B2P satellite (113 degrees East) on April 21, followed on May 5 by the return of the English language MTV Asia. The new channel, operated in co-operation with Polygram in the Netherlands, is scrambled, and reaches viewers in Indonesia, Thailand, the Philippines, Singapore, and Hong Kong. MTV Mandarian is primarily aimed at Taiwan.

India's staid public broadcaster Doordarshan, shaken by the sudden appearance of satellite-borne competitors over the past few years, has now struck back with a plan to take its own programming to the rest of the world. Doordarshan International began broadcasts on March 14th. Now the channel has signed an agreement with PanAmSat for three transponders on the upcoming PAS-4 satellite. This is to be placed at 72 degrees East, which in theory should give Doordarshan coverage from Western Europe to Eastern Australia. Unfortunately footprint maps are one thing, actual-on-the-ground reception is something else. Even as far east as Stockholm, 72 degrees East is out of reach for ordinary TVRO monitors.

The Doordarshan signal is supposed to be downlinked in Paris for a relay via PAS-1 (45 degrees West) over the Atlantic to North America.

Iranian Ban

Iran's ban on satellite dishes went into effect in late April. The police immediately seized 500 satellite TV dishes. An Interior Ministry official was quoted as saying that about 26,000 of the 27,800 dish antennas in Tehran had been removed by their owners before the deadline. Unofficial estimates put the number of antennas at more than 200,000.

On the other hand, Pakistan has risked the wrath of Moslem clerics by cutting customs duties and withdrawing sales tax on satellite receivers and VCRs. Prime Minister Benazir Bhutto's government reduced duties on 33 items and exempted them from sales tax on May 8, in an effort to stop smuggling.

Mailbag

Jeames Weiler in Fort Wayne, Indiana has sent more clippings on the latest in the Rimsat saga. This satellite operator, who's birds are above the Pacific in Tonga's positions, has been facing bankruptcy for months. According to the Fort Wayne "Journal Gazette", Rimsat has a new trustee, pending acceptance by a US Bankruptcy Court judge. The lawyer representing the company's Malausian directors. who filed a motion asking for the trustee election, has expressed optimism that Rimsat can "come out of this". Another lawyer, representing Rimsat's creditors was also positive: "Hopefully it will mean stability."

Chuck Felts in Los Angeles has sent a fax wondering who makes receivers for the Japanese BS3 A/B Yuri (Lily) satellites. He's looking for units covering between 11.714 and 12.009 GHz, with DQPSK audio modulation. I have no idea, but anyone who knows can write care of *Satellite Times*, P.O. Box 98, Brasstown, NC 28902 or send e-mail to wood@stab.sr.se, and we'll pass the message along. And by all means write or e-mail with any comments /contributions to the column. ST

ON THE AIR

By Steve Handler

So, You Like to Play Games . . .

Do you like TV Game Shows? Do you play along with the TV game show contestants? Well, you will really like what a new satellite delivered network has done—interactive game show play for the home viewer is here!

As a satellite dish TVRO viewer of the new Game Show Network (GSN), you can now dial a 800 number and win your share of $151,000! This is according to Russell Myerson, Vice President-Operations of the Game Show Network in an exclusive *Satellite Times OTA* interview. In fact, in the first 100 plus days they were on the air, they gave away over $151,000.00 in prizes, to viewers who played *Decades*, their first interactive game show.

Decades airs six times each weekday during "Prime Games" which is on from 7-11 pm EDT and is hosted by Peter Tomarken. Each episode lasts about six minutes. Two viewers are selected by computer and play by telephone. They are asked to select the correct decade in which an historical event took place. It accommodates two players. Thirteen times each day their 800 number is given out on the air, and for a short period of time viewers can call to register to be a contestant. Six times each weekday evening, registered viewers can dial another 800 number to play. Viewers dial the special number and punch in their personal identification number (PIN). The computer then selects two players. "Not bad for a free phone call" said Myerson. You can win prizes which have averaged between $500 and $750 in value.

The new service was launched December 1, 1994 and is owned by Sony Pictures Entertainment. It can be found on Galaxy 7, C-band transponder 6. The Game Show Network is headquartered adjacent to the old Metro Goldwyn Mayer (MGM) movie studio lot in Culver City, CA which is now part of Sony Pictures Entertainment. The goals of the network include providing the best of the past, present and future game shows.

When they first went on the air, they broadcast their programming in the clear, (unscrambled) for a two month period, to more than 2 million legally authorized C-band dish owners. This gave dish owners a chance to watch the network for free and become interested in their programming. In February 1995 they started to scramble their broadcast and require subscriptions to view their programming. C-band TVRO viewers can subscribe through most satellite program service carriers to receive their programs. GSN is included in many of the "packages" sold by programmers. For those whose programmer is not currently including it in the package you subscribe to, the ala carte price varies. One programmer recently advertised an add-on fee of $5 per year or $1.50 a month to add the network for those subscribers whose package does not already include the Game Show Network.

A mix of game show programs from the 50's, 60's, 70's, 80's and 90's can be viewed on the channel. These game show programs provide a history of the fashion, manners and conduct of America. It is a window to the past. The classic game shows of the 1950's typically were broadcast from New York studios and consisted of panelists that were made up of the New York intelligentsia establishment. Such programs as *To Tell the Truth*, *I've Got a Secret* and *What's My Line* are as interesting and entertaining 40 years after their original airing as some of the current game shows on the air.

If you want a lesson in how fashions change, compare the tuxedos that the classic game show panelists of the 50's wore to the attire worn by panelists and contestants during the late 1960's and early 1970's.

Who are typical viewers of GSN? Myerson indicated that their audience at the end of the first quarter of 1995 was between 1.5 and 2.0 million subscribers, one third of which were C-band dish owners. Myerson also provided some interesting demographics obtained by reviewing information supplied by roughly 20,000 viewers from all 50 states who registered to play *Decades* in the first days the network was on the air. He indicated that about half were men and half were women, aged 25 to 39. He noted that prior to the Game Show Network the typical game show viewers were women over 45 and men over 50, with more women than men as viewers. Myerson reports that 78% of US households watch at least one game show once a month.

In an interview with Dick Block, Vice President-Advertising Sales for the network, a brief history of the network unfolded. Developed by Block on behalf of United Video Satellite Group, from the time the original concept was

Host Peter Tomarken on the set of Decades, the Game Show Networks first live interactive game show. (Photo courtesy of Game Show Network)

A mix of game show programs from the 50's, 60's, 70's, 80's and 90's can be viewed on the channel. These game show programs provide a history of the fashion, manners and conduct of America. It is a window to the past. The classic game shows of the 1950's typically were broadcast from New York studios and consisted of panelists that were made up of the New York intelligentsia establishment.

Steve Day and Laura Chambers, hosts of Club A.M., Game Show Network's Morning Show. (Photo courtesy of Game Show Network)

first conceived until the time it aired its first program, five years had elapsed. The network was brought to the attention of Sony Pictures Entertainment in February 1992. By then GSN had acquired a library of over 43,000 game show episodes to air. Included in the network's library are episodes of such game shows as:

Beat The Clock, Card Sharks, Child's Play, Family Feud, I've Got A Secret, Jeopardy!, Joker's Wild, Match Game, Newlywed Game, Password, Super Password, Tattletales, Tic Tac Dough, To Tell The Truth and *What's My Line?.*

Wheel of Fortune and *Jeopardy!* were shows produced by Merv Griffin Productions, which is owned by Sony Pictures Entertainment.

To the delight of classic game show viewers, from time to time GSN presents theme programming. In April, famous baseball players Stan Musial, Roy Campanella, Ted Williams, and Joe DiMaggio appeared on four episodes of *What's My Line?* as part of the weekly two hour special *Wild World of Games.* In March, five episodes of *To Tell The Truth* were aired which included famous Attorney F. Lee Bailey (one of the O.J. Simpson's defense attorneys) as a panelist.

Personally, I enjoy watching TV as a form of passive entertainment. My personal favorite shows for viewing are the classic game shows such as *I've Got A Secret, What's My Line?* and *To Tell the Truth.* I find that these game shows have stood the test of time. Many of the classic programs are over 40 years old, yet I find them more entertaining than many of the current game shows. Perhaps the passive viewer is becoming a technological dinosaur? Is interactivity "in" and passive viewing now "out"? I am not sure. Only the test of time will provide that answers. However, judging from the number of viewers that have registered to play the network's *Decades,* many viewers are interested in interactive game shows. Using the network as a spring board for interactivity, Sony has found a market programming niche and it appears they are meeting the needs of a previously unserved or underserved audience. A second interactive game show, *Numbers Please,* was added to the GSN lineup in June, 1995. Similar to *Decades,* contestant viewers play by using their telephone to select the correct number to the corresponding question.

Where is the Game Show Network headed? What can the viewers expect to see in the future? Myerson outlined some of their future plans. As of April, they were negotiating with DirectTV and Hubbard for a DBS channel slot. They are also negotiating with major cable networks for placement on cable systems and actively marketing to C-band viewers. In the next five years they plan to introduce more original interactive programming that will be produced and aired by the network. A longer format for the programs, (1/2 hour or more) will be used. Myerson noted that he believes that there are not many game shows currently being broadcasts that appeal to the younger viewer. GSN intends to create and air programs that will appeal to younger audiences. Myerson also envisions the Game Show Network as a two way interactive network. He stated that they believe that it is important to stay in touch with their viewers and learn what they like and dislike. In addition to a page on the World Wide Web [Internet WWW address is: htpp://www.sony.com] they can be reached by E-Mail at the following Internet address: winnie@-gameshownet.com.

Allen Ludden, host of Password (Photo courtesy of Game Show Network)

So, the next time you are watching the Game Show Network, remember, if you don't register you can't win your share of the prizes that they are giving out. And if you are a dinosaur like me, wanting passive enjoyment, forget the registration, sit back and enjoy the programming of the Game Show Network, *On The Air.*

Updates

For those who would like to contact old time radio show broadcaster Bill Bragg at Yesterday USA (the subject of the May/June 1995 *On The Air* column), he can be reached by mail or telephone as follows: Bill Bragg, Yesterday USA, 2001 Plymouth Rock, Richardson, Texas 75081, Telephone (214) 690-3636.

If you like NASA Select speak now or risk loosing it. NASA Select broadcasts live audio and video of all space shuttle missions using GE Ameicom's Satellite S-2, transponder 5 (channel 9). The live shuttle broadcasts on NASA select are one very tangible way that taxpayers can see their taxes being spent for a worthwhile endeavor.

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Some news accounts indicate that the Congress is considering major budget cuts at NASA. If you enjoy the availability of live shuttle mission broadcasts on NASA Select and wish them to continue, express your opinion right now and write your congress person or senator. You can also write the NASA Select directly and request that live shuttle broadcasts not be discontinued or cut. NASA Selects address is: Director, NASA Television, NASA Headquarters, Code P, 300 E Street SW, Washington, DC 20546. ST

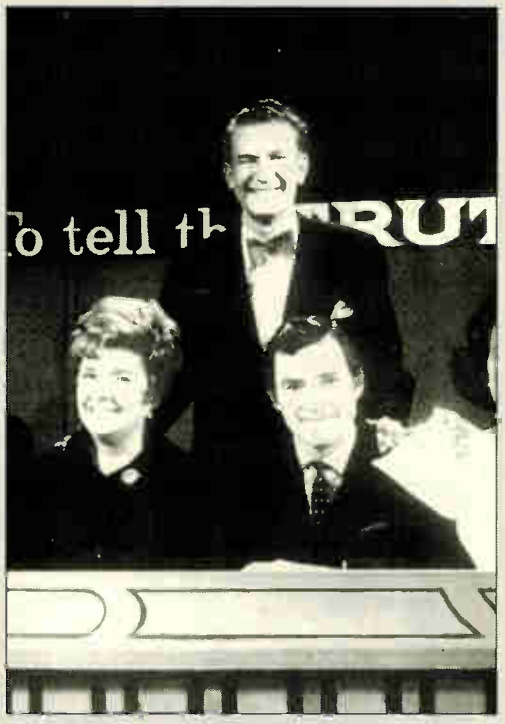
Name That Game Show

1. He hosted *The Price Is Right.* He is:
A. Dick Clark
B. Bob Barker
C. Jim Baker

2. Clayton "Bud" Collyer was one of the Hosts of *Beat The Clock.* He also was one of the hosts of a famous 1950's game show. Name that show.
A. *To Tell The Truth*
B. *I've Got A Secret*
C. *What's My Line*

3. Two of the three hosted *Hollywood Squares.* Who did not?
A. Peter Marshall
B. John Davidson
C. Art Fleming

4. She is as well known as Pat Sajak for her roll on *Wheel of Fortune.*
A. Joan Rivers
B. Minnie Pearl
C. Vanna White



Bud Collyer, host of To Tell The Truth. (Photo courtesy of Game Show Network)

5. Peter Tomarken now hosts *Decades,* an Interactive Game show currently on the Game Show Network. What other game show didn't he host?
A. *Bargain Hunters*
B. *You Don't Say*
C. *Press Your Luck*

6. Popular game show host "Wink" Martindale's correct surname is?
A. William
B. Wilton
C. Winston

7. Monty Hall regularly gave players a chance to choose prizes hidden behind a door. Among how many doors didcontestants usually have a choice?
A. Two
B. Three
C. Four

8. In an early television game show, this man crowned the *Queen For A Day*
A. Jack Bailey
B. Jack Berry
C. Jack Kelly

9. In what month and year did the Game Show Network go on the air?
A. February 1968
B. July 1992
C. December 1994

10. Ed McMahon was one of the hosts of this game show?
A. *Concentration*
B. *Can You Top This*
C. *College Bowl*

Answers: 1(B); 2(A); 3(C); 4(C); 5(B); 6(C); 7(B); 8(A);9(C); 10(A)

Scoring:
10 Correct: You spend too much time watching television.
7 - 9 Correct: You're a game show expert.
4 - 6 Correct: Not bad.
1 - 3 Correct: Spend more time watching the Game Show Network and you'll do better next time.
0 Correct: Oh well, maybe you'll like my next column better.

INTRODUCTION

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

How to Use the Satellite Service Guide

The various sections of the SSG include:

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

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

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

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

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

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

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

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

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

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

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

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

CLASSICAL

Classical music	E1, 9	6.32 (N)
Classical music	E2, 22	6.30
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 service	G4, 6 (Ku-band)	7.40
Planet Connect, Planet Systems, Inc 100 kbps service	G1, 9	7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
	G1,14	7.265

CONTEMPORARY

Adult contemporary, unidenified station	E1, 9	7.58
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
	E1,14	6.80
WVTY-FM (96.1) Pittsburgh, Pa. — adult contemporary	C1,18	7.28

COUNTRY

CISN-FM (103.9) Edmonton, Alberta Canada, ID-"Country 104"	E1,18	7.53/7.62 (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"	E2,18	6.20
WSM-AM (650) Nashville, Tenn.	G5,18	7.38, 7.56
WSM-FM (95.5) Nashville, Tenn.	C4,24	7.38, 7.56

EASY LISTENING

Easy listening music, unidentified station	G4,6	7.69
Horizon — Background music	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	C4, 8	5.895 (N)

FOREIGN LANGUAGE

Antenna FM (Greek)	G3, 9	5.88
CBC Radio-East (French)	E1,20	5.38/5.58 (DS)
	E1,20	7.36
CHIN-AM/FM (1540/100.7) Toronto, Ontario Canada — multilingual	E1, 2	7.89
CITE-FM (107.3) Montreal, Quebec Canada (French) — soft adult contemporary	E1,21(Ku)	6.12, 6.20
CKAC-AM (730) Montreal, Quebec Canada (French) — adult contemporary	E1,21(Ku)	6.43
Cosmos FM, Hellenic Public Radio, New York, N.Y. (Greek)	S2,11	8.20
DZMM-Radyo Patrol (from Philippines)	G4,24 (Ku)	6.80
French language audio service	E1,15	6.12
French language audio service	E2,21	6.46 (N)
French language audio service	E1,24(Ku)	6.55
India ethnic radio (Hindu)	E1,22	7.70
Indian Sangeet Sager (Hindu)	E1,15(Ku)	6.12
Irish music (Sat 1430-0000 UTC)	S3, 3	6.20
Northern Native Radio (Ethnic)	E1,26 (Ku)	6.43/6.53 (DS)
RAI Satelradio (Italian)	C1,15	7.38
Radio Canada (French)	E1,15	5.40/5.58 (DS), 5.76
Radio Dubai (Arabic)	G7,10	7.48
Radio Energie	E1,24(Ku)	6.12/6.30 (DS)
Radio Maria (Unid language-Religious programming)	G7,10	8.03
Radio Maria? (Italian-Religious programming)	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
The Clanny Channel (Spanish) — Anti-Castro Cuban clandestine programming -occasional audio (See Satellite Monitor Jul/Aug 95)	S2,4	5.80
The Weather Network-Canada (French)	E1,9	5.94
Trinity Broadcasting radio service (Spanish) SAP — religious	G5, 3	5.96
WCMQ-FM (92.3) Hialeah, Fla. (Spanish) — contemporary hit radio	S2, 4	7.74, 7.92
WCRP-FM 88.1, Guyama, P.R. (Spanish) — religious	G4, 6	6.53
WLIR-AM (1300) Spring Valley, N.Y. (Ethnic)	S2, 1	7.60
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 (Spanish), ID-"Radio ACIR"	M2,22	7.38
XEW-FM (96.9) Mexico City, Mexico (Spanish), ID-"W-FM 96.9"	SD1,7	7.38
XEW-AM (900) Mexico City, Mexico (Spanish), ID-"La Voz de la America Latina	M2, 8	6.80
XEWA-AM (540) Monterrey, Mexico (Spanish), ID-"Super Estelar" — contemporary music	M2, 8	7.38
XEVZ-AM (1490) Acayucan, Mexico (Spanish), ID-"Radio Sensacion" — rock music	M2,22	6.80
XEX-FM (101.7) Mexico City, Mexico (Spanish), ID-"La Super"	M2,14	7.38
XEX-AM (730) Mexico City, Mexico (Spanish), ID-"Frecuencia Libre"	M2,14	6.80

JAZZ

KJAZ-FM (92.7) Alameda, Calif, ID-"K-Jazz"	C1, 4	7.78/7.92 (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

Satellite Radio Guide

NEWS, TALK AND INFORMATION

AEN Michael Reagan (0100-0700 UTC)	C3, 1	6.20
American Spirit Network-Houston, Tex. — Religious/variety (weekends)	S3,24	7.42
American Urban Radio — news/features/sports	S3, 9	6.30/6.48 (DS)
Arkansas State radio network	G4, 6	6.20
Business Radio Network	C4,10	8.06 (N)
Cable Radio Network	C3,23	7.24 (N)
CNN Headline News	G5,22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
For the People radio network — talk and information	C1, 2	7.50
Independent Broadcasting Network — talk	C1,20	7.38
Mutual Broadcasting Network — talk show feeds	E1, 2	7.54
O.J. Radio Network (trial hours only)	G5,5	6.30
One on One Sports radio network — sports talk	E1, 2	7.45
Prime Sports Radio — sports talk and info	C1,10	7.20
Standard News	G5,11	5.96
Sun Radio Network feeds — talk programs	C1,15	7.58
Talk America — talk programs	S3, 9	6.80
Talk Radio Network — talk programs	C1,5	5.80
Tech Talk Radio Network	T2,21	5.80
(Note: TTR Network will follow Skyvision Channel video uplink to G7 or other occasional video spots in the arc that Skyvision will use in the future)		
USA Patriot Radio Network	G6,14	5.80
USA Radio Network — news, talk and info	S3,13	5.01 (Ch 1), 5.20 (Ch 2)
Various talk radio programs	G6,14	7.58
WCBS-AM (880) New York, N.Y. — news	G7,19	7.38
WCCO-AM (830) Minneapolis, Minn.	G6,15	6.20
WGN-AM (720) Chicago, Ill./Interstate Radio Network (overnight) — talk	E1,2	5.22
XETRA-AM (690) Tijuana, Sonora Mexico, ID-"Newsradio 690"	C1, 7	7.38

RELIGIOUS

Ambassasor Inspirational Radio	S3,15	5.96, 6.48 (DS)
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5,11	6.30/6.48 (DS), 6.12
	C3, 1	6.20
Christian music service	S2,23	6.20, 7.60
Heaven Radio Network	G1,17	7.92
International Broadcasters Network	E1, 2	7.64
KILA-FM (90.5) Las Vegas, Nev.—SOS r. net.	C4, 8	7.38/7.56 (DS)
Religious programming	E1,11 (Ku)	6.52
Salem Radio Network	S3,17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WHME-FM (103.1) South Bend, Ind, ID-"Harvest FM"	G4,15	5.58/5.78
WROL-AM (950) Boston, Mass. (occasional Spanish)	S3, 3	6.20
Z-music — Christian rock	G1,6	7.38/7.56

ROCK

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	7.80 (N)
Rockline — classic rock	E1,11 (Ku)	6.12,6.30
Safeway In-Store — oldies	S3,18	5.20, 5.40, 7.58
Seltech Radio Syndicated service — classic rock	E1, 2	5.40/5.58 (DS)
SuperAudio — Classic Hits (oldies)	G5,21	8.10/8.30 (DS)
SuperAudio — Prime Demo (mellow rock)	G5,21	5.22/5.40 (DS)

SPECIALITY FORMATS

Aries In Touch Reading Service	C5,24	6.48
	C4,10	7.87
Colorado Talking Book Network	C1, 2	5.58
C-SPAN I ASAP (program schedule)	C3, 7	5.58
C-SPAN II ASAP (program schedule)	C4,19	5.58
Georgia Radio Reading Service	T401,14 (Ku)	5.76
Nebraska Talking Book Network	S3, 2	6.48
Starsound Gold Radio Network	S3,24	5.80
SuperAudio — Big Bands (Sun 0200-0600 UTC)	G5,21	5.58/5.76 (DS)
The Weather Channel-USA — occasional audio	C3,13	6.80
The Weather Channel-USA — classical music	C3,13	7.78
The Weather Network-Canada (English)	E1,9	5.41, 5.58, 5.76, 6.8, 7.78
Voice Print Reading Service	E1,16	7.44 (N)
Yesterday USA — nostalgia radio	G5, 7	6.80

VARIETY

CBC Radio (English)	E1,16	5.40/7.58, 5.58
CBC Radio (occasional audio)	E1,20	5.78
CBC-FM Atlantic (English)	E1,16	6.12/6.30 (DS)
CBC-FM Eastern (English)	E1,16	5.76/5.94 (DS)
CBM-AM (940) Montreal, Quebec Canada — variety/fine arts	E1,20	6.12
CBU-AM (690) Vancouver, B.C. Can.	E1,22	7.42
CBU-FM (105.7) Vancouver, B.C. Canada	E1,22	5.76/5.94 (DS)
CFR-FM	E2,19 (Ku)	6.12/6.30
CFWE-FM (89.9) Lac Le Biche, Alberta Canada, ID-"Aborigine Country"—cntrry. music/eth.	E1,2	6.40
	E1,12	5.40
	E1,18	6.435 (N)
	E1,18	7.875 (N)
	E2,19	6.80
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-day, ethnic-night	E1,18	7.42 (N)
CKLB-FM (101.9) Yellowknife, NWT Canada — country/ethnic	E1,14	5.41
CKUA-AM/FM (580/94.9) Edmonton, Alberta Can.	E1, 9 (Ku)	5.76/5.94 (DS)
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-overnight	C1, 6	5.58
MBC Radio (Saskatchewan Canada), ID-"Aborigine Radio"	E1,18	7.71
Peach State Public Radio (Georgia PBS)	T401,14 (Ku)	5.40/5.58 (DS)
Startalk Radio Network — talk/nostalgia music	G3,11	7.58
	G6,14	7.58

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	KQED-FM (88.5) San Francisco, Calif — NPR affiliate (occasional audio)/Some sports talk shows overnight (occasional audio)
1404.600	Talk America radio network
1403.800	Occasional audio
1403.200	Motor Racing Network (occasional audio)
1400.800	WBAL-AM (1090) Baltimore, Md — Baltimore Orioles MLB radio network
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
1394.700	Sun Radio Network
1394.500	Various talk shows (No network ID)
1393.600	Florida's Radio Network
1393.400	WGN-AM (720) Chicago, Ill — talk radio/ Chicago Cubs MLB radio network/Interstate Radio Network/Other occasional 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/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	Occasional audio/data transmissions (burst)
1389.500	Data transmissions (burst)
1388.900	Florida's Radio Network
1388.200	Chicago White Sox MLB 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 Tigers MLB radio network
1386.300	Illinois News Network
1385.800	WMAQ-AM (670) Chicago, Ill — news
1385.100	For the People radio network
1384.200	KMPC-AM (710) Los Angeles, Calif — talk radio/California Angels MLB radio network
1383.800	KJR-AM (950) Seattle, Wash — sports talk
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
1375.400	USA Radio Network
1374.100	Northwest Direct — news and talk

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
1207.200	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
1202.250	ABC Satellite Music Network — golden oldies format "Pure Gold"
1202.100	ABC Satellite Music Network — golden oldies format "Pure Gold"
1201.900	Occasional audio
1201.700	ABC Satellite Music Network — modern rock "The Heat"
1201.500	Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious
1201.300	Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious

Spacenet 3 transponder 17 (C-band)

1123.500	Salem Radio Network — religious
1123.300	Salem Radio Network — religious
1123.100	Salem Radio Network — religious

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
1435.200	National Public Radio (NPR) feeds
1429.000	Occasional audio

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
1398.800	Progressive Farmers Network
1398.200	Occasional audio
1398.000	Oklahoma News Network
1397.200	Oklahoma News 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/Colorado Rockies MLB radio network
1404.600	Occasional 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 Eastern Time)
1403.000	Minnesota Public Radio Network
1402.400	KNOW-FM (95.3) St. Paul, Minn — fine arts, Minnesota Public Radio (occasional 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
1398.000	Tennessee Radio Network
1397.800	KRLD-AM (1080) Dallas, Tx. — news and talk/ 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	Occasional audio
1396.400	Georgia Network News/Univ of Georgia sports radio network
1396.200	WCNN-AM (680) Atlanta, GA — all sports talk radio
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 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 (NPR) 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 — news and talk/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 flagship station
1383.100	Mutual Broadcasting System/VSA Radio Network — Ag news
1382.900	Minnesota Radio Network
1382.600	Soldiers Radio Satellite (SRS) network — U.S. Army information and entertainment/Army sports radio network
1382.300	Motor Racing Network (occasional audio)
1382.000	WFAE-FM (90.7) Charlotte, N.C. — NPR affiliate

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1381.800	WHO-AM (1040) Des Moines, Iowa — talk radio/Iowa News Network
1381.600	Alabama Radio Network
1381.400	Various talk shows (No network ID)
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
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

Galaxy 4 transponder 6 (C-band)

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

Galaxy 4 transponder 1 (Ku-band)

959.200	ABC Satellite Music Network — country and western "Real Country"
959.000	ABC Satellite Music Network — country and western "Real Country"
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

Anik E1 transponder 12 (C-band)

1226.000	CKRW-FM (90.5) Whitehorse, Yukon Territory, Canada — adult contemporary music
1225.500	CHON-FM (90.5) Whitehorse, Yukon Territory, Canada — variety

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 — occasional carrier

Anik E1 transponder 14 (C-band)

1185.500	CKLB-FM (101.9) Yellowknife, NWT Canada — country music

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

Anik E1 transponder 21 (C-band)

1024.300	Canadian weather conditions and warnings Note:This transponder also has 62 other carriers consisting of data transmissions 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	Occasional audio (Missouri Net?)
1400.200	Occasional 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	Occasional 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	Capitol Sports Network
1384.200	Capitol Sports Network
1384.000	Occasional audio/ABC Direction Network
1383.800	Occasional audio
1383.600	WPTR-AM (1540) Albany, N.Y. — talk radio
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
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 21 (C-band)

1045.000	KABC-AM (790) Los Angeles, Calif. — news and talk/Los Angeles Dodgers MLB radio network (English)
1044.000	Occasional 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	Occasional 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

AFRICA NO. 1

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

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)

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

BRITISH BROADCASTING CORPORATION (BBC)

Bush House, London, WC2. Telephone: +44 171 240 3456 (voice), +44 171 240 8760 (fax)
English BBC World Service transmissions can be found on the following satellites:
Astra 1B (19.2 east) transponder 23 (11552 MHz H) audio subcarrier 7.38 MHz
Eutelsat II F1 (13.0 east) transponder 25 (10987 MHz V) audio subcarrier 7.38 MHz
Intelsat 601 (27.5 west) transponder 73 (11155 MHz V east spot) audio subcarrier 7.56 MHz
Asiasat 1 (105.0 east) transponder 5 (3900 MHz V south beam) audio subcarrier 7.20 MHz
Satcom C3/F3 (131.0 west) transponder 7 (3840 MHz V) audio subcarrier 5.41 MHz

C-SPAN AUDIO SERVICES

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

C-SPAN Audio 1

Satcom C3/F3 (131.0 west) transponder 7 (3840 MHz.V) audio subcarrier 5.20 MHz. All broadcasts are daily and in English. These broadcast are live feeds unless otherwise indicated.

UTC/EDT/PDT	SERVICE/PROGRAM
0000/2000/1700	Radio Havana Cuba - Havana
0100/2100/1800	YLE Radio Finland - Helsinki
0130/2130/1830	Classical Music (taped)
0200/2200/1900	Radio Prague - Prague
0230/2230/1930	Radio Austria - Vienna
0300/2300/2000	Deutsche Welle - Cologne
0400/0000/2100	China Radio International - Beijing
0500/0100/2200	Classical Music (taped)
0530/0130/2230	Radio Austria - Vienna
0600/0200/2300	Swiss Radio International - Berne
0700/0300/0000	ABC Radio Australia - Melbourne
0800/0400/0100	KBS Radio Korea International - Seoul
0900/0500/0200	Voice of Russia -Moscow (Mon-Fri)
0930/0530/0230	Radio Netherlands - Hilversum
1030/0630/0330	KBS Radio Korea International - Seoul
1100/0700/0400	Radio Japan - Tokyo
1200/0800/0500	Radio Canada International - Montreal (Mon-Fri)
	Radio Telefis Eireann (RTE) - Dublin (Sat/Sun)
1300/0900/0600	KBS Radio Korea International - Seoul (Mon-Fri)
	Radio France International - Paris (Sat)/Rendezvous (taped)
	Canadian Broadcasting Company (Sun until 1600)/Sunday Morning
1330/0930/0630	Radio Sweden - Stockholm (Sat)/Sweden Today (taped)
1400/1000/0700	YLE Radio Finland - Helsinki (Mon-Fri)
	Classical Music (Sat until 1600) (taped)
1430/1030/0730	Radio Vlaanderen International - Brussels Calling (Mon-Fri)
1500/1100/0800	Radio France International - Paris (Mon-Fri)
1600/1200/0900	Voice of Russia - Moscow (Mon-Fri)
	C-SPAN Weekly Radio Journal (Sat until 1700) (taped)
	Classical Music (Sun until 1800) (taped)
1630/1230/0930	Radio Netherlands - Hilversum (Mon-Fri)
1700/1300/1000	Classical Music (Sat until 1800) (taped)
1730/1330/1030	Radio Telefis Eireann (RTE) - Dublin, Ireland (Mon-Fri)
1800/1400/1100	Voice of America (VOA) - Washington, D.C. (Broadcast last 6 hours until 0000 UTC)

C-SPAN Audio 2

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

DEUTSCHE WELLE (DW)

Radio & TV Intl, D-50588 Cologne, Germany. Telephone: +49 221 389 4563 (voice), +49 221 389 3000 (fax)
Certain Deutsche Welle services are available on the following satellites:
Satcom C4/F4 (135 west) transponder 5 (3800 MHz V) audio subcarriers 7.38/7.56 MHz
Astra 1A (19.2 east) on transponder 2 (11229 MHz V) audio subcarriers 7.38/7.56 MHz
Eutelsat (13.0 east) transponder 27 (11163 MHz V) audio subcarriers 7.02/7.20 MHz.
Intelsat K (21.5 west) transponder H7 (11605 MHz H), audio subcarriers 7.38/7.56 MHz

ISLAMIC REPUBLIC OF IRAN BROADCASTING (IRIB)

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

ISRAEL RADIO

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

LA VOIX DU ZAIRE

Station Nationale, B.P. 3164, Kinshasa-Gombe, Zaire. Telephone +243 12 23171-5
Broadcasts service in French is on Intelsat 510 (66.0 east) transponder 12 (3790 MHz RHCP) audio subcarriers 7.38/7.56 MHz.

RADIO ALGIERS INTERNATIONAL

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

RADIO AUSTRALIA

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

RADIO BELGRADE

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

RADIO BUDAPEST

Body Sandor u. 5-7, 1800 Budapest, Hungary. Telephone: +36 1 138 7224 (voice), +36 1 138 8517 (fax)
Eutelsat II F3 (16.0 east) transponder 33 (11596 MHz H) audio subcarrier 7.02 MHz (2300-0330 UTC)

RADIO EXTERIOR DE ESPANA (REE)

Apartado 156202, Madrid 28080, Spain. Telephone +34 13461083/1080/1079/1121 (voice); 34 13461097 (fax).
Eutelsat II F2 (10.0 east) transponder 22 (11149 MHz H) audio subcarrier 7.56 MHz
Hispasat 1A/B (31.0 west) transponder 6 (12149 MHz RHCP) audio subcarrier 7.92 MHz

RADIO FRANCE INTERNATIONAL (RFI)

B.P. 9516, F-75016, Paris, France. Telephone: +33 1 42 30 30 62 (voice), +33 1 42 30 40 37 (fax)
RFI broadcast can be heard in French, 24-hours a day.on the following satellites:
Intelsat 601 (27.5 west) transponder 23B (3915 MHz RHCP) audio subcarrier 6.40 MHz (to Africa/Middle east)
Palapa B2P (113 east) transponer 8 (3860 MHz V) audio subcarrier 6.15 MHz (to Asia)
Anik E2 (107.3 west) transponder 21 (4120 Mhz H) audio subcarriers 5.41/6.12 MHz. (to the Americas)
Spacenet 2 (69.0 west) transponder 4 (3780 MHz V) audio subcarrier 7.38 MHz. (to the Americas)

RADIO MEDITERRANEE INTERNATIONALE

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

RADIOSTANTSIYA MAYAK

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

RADIO SWEDEN

S-105 10 Stockholm, Sweden.. Telephone: +46 8 6676283 (voice), +46 8 6676283 (fax).
Tele-X (5.0 east) transponder 40 (12475 MHz) audio subcarrier at 7.38 MHz.
Astra 1B (19.2 east) transponder 26 (11597 MHz V) audio subcarrier 7.74 MHz.

RADIOTELEVISIONE ITALIANA (RAI)

Viale Mazzini 14, 00195 Roma, Italy. Telephone: +39 6 5919076
Selected programs of RAI's external service are carried on Eutelsat II F2 (10.0 east) transponder 26B (11095 MHz V) audio subcarrier 7.56 MHz. This is a feed to the BBC Atlantic relay station on Ascension Island.
Satcom C1 (137.0 west) transponder 15 (4000 MHz V) audio subcarrier 7.38 MHz

RADIO VLAANDEREN INTERNATIONAL

P.O. Box 26, B-1000, Brussels, Belgium. Telephone: +32 2 741 3802 (voice), +32 2 732 6295 (fax)
Astra 1C (19.2 east) transponder 63 (10921 MHz H) audio subcarrier 7.38 MHz.

International Shortwave Broadcasters via Satellite

RDP INTERNATIONAL

Av. 5 de Outubro 197, 1000 Lisbon, Portugal. Telephone: +351 1 535151 (voice), +351 1 793 1809 (fax).
RDP International uses the following satellites for various broadcast to the indicate coverage areas:
Eutelsat II F2 (10.0 east) transponder 39 (11658 MHz V) audio subcarrier 7.02/7.20 MHz to cover Europe.
Express 2 - Russian Statsionar 4 (14.0 west) on 4025 MHz (RHCP) audio subcarrier 7.0 MHz to cover South America, Africa, the US east coast and southern Europe.
Gorizont 22 - Russian Statsionar 12 (40 east) transponder 11 (3925 MHz RHCP) audio subcarrier 7.02 MHz to cover Africa, southern Europe, and the Indian Ocean region.
Telstar 302 (85 west) transponder 5 (3880 MHz V) audio subcarrier 8.00 MHz to cover North America.

SWISS RADIO INTERNATIONAL

Casa Postale, CH-3000 Bern 15, Switzerland. Telephone: +41 31 439222 (voice), +41 31 439544 (fax).
Astra 1A (19.2 east) transponder 9 (11332 MHz H) audio subcarrier 7.38 MHz (Multilingual)/ 7.56 MHz (24-hour English)
Eutelsat II F1 (13.0 east) transponder 26 (11080 MHz V) audio subcarrier 7.74 MHz.
Intelsat K (21.5 west) transponder 7 (11605 MHz H) audio subcarrier 8.10 MHz.
Satcom C4/F4 (135.0 west) transponder 5 (3800 MHz V) audio subcarrier 8.10 MHz

TRANS WORLD RADIO (TWR)

Astra 1A (19.2 east) transponder 16 (11436 MHz V) audio subcarriers 7.38/7.56 MHz. Broadcasts consists of German language programming from Evangeliums Rundfunk and TWR-UK.
Astra 1C (19.2 east) transponder 38 (11038 MHz V) audio subcarrier 7.38 MHz. TWR-Europe (Multilingual)

TUNIS INTERNATIONAL RADIO

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

VATICAN RADIO

I-00120, Vatican City State, Italy. Telephone: +396 6988 3551 (voice), +396 6988 3237 (fax)
Eutelsat II F1 (13.0 east) transponder 32 (11554 MHz H) audio subcarrier 7.74 MHz.

VOICE OF AMERICA (United States Information Agency)

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

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

NTSC system baseband subcarrier frequencies

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

PAL system baseband subcarrier frequencies

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

VOICE OF SAHEL

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

VOICE OF THE ARABS

P.O. Box 566, Cairo 11511, Egypt
Eutelsat II F3 (16.0 east) transponder 27 (11178 Mhz V) audio subcarrier 7.20 MHz.

VOICE OF THE IRAQI PEOPLE (CLANDESTINE)

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

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

P.O. Box 12, South Bend, IN 46624.
Galaxy 4 (99.0 west) transponder 15 (4000 MHz.H)
Religious broadcaster WHRI/KHWR uses audio subcarriers to feed their three shortwave broadcast transmitters as follows:

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

WORLD RADIO NETWORK

BCM, London, WC1N 3XX, England, Telephone: +44 171 896 9000 (voice), +44 171 896 9007 (fax). E-mail via Internet: wrn@cityscape.co.uk or Compuserve 100041,3344. WRN can also be heard live on the World Wide Web to users with high speed connections at: http//town.hall.org/radio/wrn.html. WRN schedules are subject to change.

North American Service Schedule

Galaxy 5 (125.0 west) transponder 6 (3820 MHz V) audio subcarrier 6.80 MHz. All broadcasts are daily unless otherwise indicated. WRN program information can be heard daily on North American service at 1025 and 1725 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. LATE BREAKING NEWS: Watch for a new multilingual service to start in July on audio subcarrier 6.20 MHz.

UTC/EDT/PDT	SERVICE/PROGRAM
0025/2025/1725	YLE Radio Finland - Helsinki (News in Finnish)
0030/2030/1730	Radio Sweden - Stockholm
0100/2100/1800	YLE Radio Finland - Helsinki*+
0130/2130/1830	Israel Radio - Jerusalem
0200/2200/1900	Radio Prague (Slovakia)
0230/2230/1930	Radio Austria International - Vienna
0300/2300/2000	Radio Budapest (Hungary)
0330/2330/2030	Radio Netherlands - Hilversum
0430/0030/2130	BBC Europe Today (Mon-Sat) BBC International Call (Sun)
0500/0100/2200	Deutsche Welle - Cologne (Germany)
0600/0200/2300	Swiss Radio International - Berne
0630/0230/2330	Radio Canada International - Montreal
0700/0300/0000	ABC Radio Australia - Melbourne*+
0800/0400/0100	KBS Radio Korea International - Seoul*+
0900/0500/0200	Voice of Russia - Moscow*
0930/0530/0230	Radio Netherlands - Hilversum
1030/0630/0330	WRN Program Information/TBA (Mon-Fri) BBC International Call (Sat) BBC Intl Money Prog & Health Watch (Sun)
1100/0700/0400	Radio Australia - Melbourne*+
1200/0800/0500	Radio Telefis Eireann (RTE) - Dublin, Ireland+
1300/0900/0600	KBS Radio Korea International - Seoul*
1400/1000/0700	YLE Radio Finland - Helsinki*
1430/1030/0730	Radio Vlaanderen International - Brussels Calling*
1500/1100/0800	Radio France International - Paris*
1600/1200/0900	Voice of Russia - Moscow*
1630/1230/0930	Radio Netherlands - Hilversum*
1730/1330/1030	Radio Telefis Eireann (RTE) - Dublin, Ireland*
1800/1400/1100	ABC Radio Australia - Melbourne*
1900/1500/1200	Blue Danube Radio - Vienna (Mon-Fri) UN Radio and BBC Europe Now (Sat) Glen Hauser's World of Radio (Sun)
1930/1530/1230	Radio Vlaanderen International - Brussels Calling
2000/1600/1300	BBC Europe Today (Sun-Fri) BBC International (Sat)
2030/1630/1330	Radio Sweden - Stockholm
2100/1700/1400	Radio Telefis Eireann (RTE) - Dublin, Ireland/News and Both Sides Now
2300/1900/1600	Polish Radio - Warsaw
2330/1930/1630	Radio Netherlands - Hilversum

European Service Schedule

Astra 1B (19.2 east) transponder 22 (11538 MHz V) audio subcarrier 7.38 MHz. All broadcasts are in English and daily unless otherwise indicated. Program information is available on Astra 1B VH-1 text page 222/MTV text 535. WRN network information can be heard on the European service daily at 0525, 1225 and 1925 CET.

YLE RADIO FINLAND

Box 78, 00024 Yleisradio, Finland. Telephone: +358 0 14801 (voice), +358 0 1481169 (fax)
Most of YLE's broadcasts to Europe are available on Eutelsat II F1 (13.0 east) transponder 27 (11163 MHz V) audio subcarrier 8.10 MHz.

DBS/Primestar Channel Guide

By Robert Smathers

DIRECTV™

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	Previews	Previews
201	Special Events Calendar	Promo
202	CNN	News
203	Court TV	Speciality
204	CNN Headline News	News
206	ESPN 1	Sports
207	ESPN Alternate	Sports
208	ESPN 2	Sports
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 documentary	Science/TV
226	The Learning Channel (TLC) documentary	Science/TV
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	Previews	Previews
270	STARZ!	Movies
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	Special Events Calendar	Promo
302	Sunday Ticket 95 Promo/World League of American Football	Sports
304	The Golf Channel	Sports
305	Prime Sports	Sports
306	Prime Sports	Sports
307	New England Sports Network	Sports
308	Prime Sports	Sports
309	Prime Sports	Sports
310	Prime Sports KBL	Sports
311	Home Team Sports (HTS)	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
350	NFL Sunday Ticket/NBA League Pass	Sports
356	NFL Sunday Ticket/NBA League Pass	Sports
401	Spice	Adult
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

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DBS/Primestar Channel Guide

USSB

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®

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) documentary	Science/TV
66	The Learning Channel (TLC) documentary	Science/TV
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-PBS, Philadelphia, Penn.	Network TV
131	ESPN	Sports
132	Future service	
138	Mega+1	Sports
141	New England Sports Network (NESN)	Sports
142	Madison Square Garden Network (MSG)	Sports
143	Empire Sports Network	Sports
144	Prime Sports KBL	Sports
145	Home Team Sports (HTS)	Sports
146	SportSouth	Sports
147	Sunshine	Sports
148	Pro American Sports (PASS)	Sports
149	Future service	
151	Prime Sports Upper Midwest	Sports
152	Prime Sports Midwest	Sports
153	Prime Sports Rocky Mountain	Sports
154	Prime Sports Southwest	Sports
155	Prime Sports Inter-Mountain West	Sports
156	Prime Sports Northwest	Sports
157	Future service	
158	Prime Sports West	Sports
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 — occ service	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

Ku-band Satellite Transponder Services Guide

By Robert Smathers

Spacenet 2 (S2) 69º West

20	11820	Occ video
21	11900	TV ASAHI [Leitch]
23	12060	Kentucky Educational Television (half-transponders)
24	12140	Occ video

SBS 2 (SBS2) 71º West (Inclined Orbit)

2	11780	NBC feeds (occ video)
3	11823	NBC feeds (occ video)
5	11921	NBC feeds (occ video)
6	11970	NBC feeds (occ video)
7	12109	NBC feeds (occ video)
9	12117	NBC feeds (occ video)

SBS 3 (SBS3) 74º West (Inclined Orbit)

(No video has been seen on SBS3since NBC moved their feeds to SBS2)

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

1	11725	Data transmissions
10	12166	Data transmissions

Satcom K2 (K2) 81º West

1	11729	NBC-East
2	11758.5	Data transmissions/Pagesat computer service
3	11788	NBC-Pacific (West spot beam)
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
10	11994.5	Data transmissions
11	12024	NBC contract channel (network feeds)
12	12053.5	FM² services
13	12083	NBC NewsChannel
14	12112.5	Occ video
15	12142	Data transmissions
16	12171.5	Data transmissions

Satcom K1 (K1) 85º West

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 Primestar channel guide is in the DBS section of the *ST* SSG.

Spacenet 3R (S3) 87º West

23	12060	Oregon Educational Network (West spot beam)
24	12140	NYNET (SUNY) Ed Net/NY Lottery feeds (East spot beam)

Galaxy 7 (K7) 91º West

1	11720	Occ video/G.O.P. TV (occasional)
3	11750	Compressed Video (Indiana Higher Education)
4	11780	Occ video
6	11810	Classic Sports Network
7	11840	Occ video
10	11900	The People's Network (TPN)/ Hospitality TV [B-MAC]/Occ video
12	11930	Asian American TV Network
13	11960	Occ video
14	11990	Occ video/Muslim TV
15	11990	The Asian Network (TAN)/Your Choice TV/Occ video
16	12020	Occ video/Microsoft TV (occasional)
17	12050	Westcott Communications ASTN [B-MAC]/ANTN
18	12050	Occ video
19	12080	The People's Network/Occ video
21	12110	TCI Promo Channel [B-MAC]
22	12140	BBC 9 p.m. News (PAL)/Real Estate TV Network/Occ video
24	12170	Occ video

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

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

SBS 6 (SBS6) 95º West

1	11717	Occ video
2	11749.5	SCPC transmissions
3	11774	Occ video/Northfield horse racing
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/ Catholic Telecommunications Network (half-transponders)
14	12043.5	CONUS Communications (half-transponders)
15	12075	Occ video
16	12092.5	Massachusetts Educational Network/Occ video
17	12110	Occ video
18	12141.5	Occ video
19	12174	Occ video

Telstar 401 (T401) 97º West

1	11730	SCPC transmissions
2	11743	AT&T Skynet [digital]
3	11790	South Carolina Educational TV
4	11798	National Tech University [Digital video]
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]/ VSAT traffic
10	11980.75	Louisiana Public TV feeds [Digicipher]
11	12040	Occ video/DMX music (half of transponder)
12	12046	CLI Spectrumsaver compression
13	12095	CLI Spectrumsaver compression
14	12108	Georgia Public TV (upper half transponder)/Peachstar Educational Network (lower half transponder)
15	12147	ABC network and affiliate feeds (half-transponders)
16	12167	ABC network and affiliate feeds (half-transponders)

Galaxy 4 (K4) 99º West

1	11720	SCPC services
2	11750	Data transmissions
3	11750	FM² services/MUZAK
4	11780	FM² services/Planet Connect computer service (19.2 kbps)
6	11810	Occ video/A.A.T. Chinese programming
7	11840	National Weather Networks/Occ video
8	11870	Occ video
10	11900	Occ video
11	11930	Occ video (half-transponders common)
12	11930	Channel One/WMNB (Russian)/ Occ video
14	11990	Occ video (half-transponders common)
16	12020	FM² 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
22	12140	Possible video compression channel
23	12170	CBS Newsnet and affiliate feeds (half-transponders)
24	12170	The Filipino Channel [TRW scrambling system]

Spacenet 4 (S4) 101º West

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

GSTAR-1 (GST1) 103º West

1	11730	Data transmissions
3	11852	Occ video
5	11974	O.J. TV (CourtTV)/CourtTV feeds
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 University EdNet
16	12171	Data transmissions

GSTAR-4 (GST4) 105º West

1	11730	Data transmissions
2	11791	Data transmissions
3	11852	CNN Newsource (Primary) [Leitch]/some feeds in clear
4	11913	Occ video
5	11974	O.J. TV (CNN/ABC/others)/Occ video
6	12035	Occ video
7	12096	CNN feeds/Occ video
8	12157	Occ video
9	11744	Data transmissions
11	11866	Occ video
12	11927	Occ video
13	11988	CNN feeds/occ video
15	12110	CNN Newsource (secondary)

Anik E2 (A1) 107.3º West

1	11717	Data transmissions
2	11743	Data transmissions
3	11778	Future home of Expressvu
4	11804	Future home of Expressvu/occ video
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	Meteo Media
23	11913	Showcase TV (East)
24	11939	Woman's Television Network (WTN) (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 109.2º West

(No video has been seen on any Ku transponder)

Anik E1 (A2) 111º West

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 FM² 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/Occ video
14	12109	RDI feeds/Occ video
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) 114.9º West (Inclined Orbit)

(This satellite rarely has video transmissions)

Morelos 2 (M2) 116.8º West

(No video has been seen on any Ku transponder)

SBS 5 (SBS5) 123º West

1	11725	Comsat Video in-room programming [B-MAC] (half transponders) — Satellite Cinema 1/3
2	11780	SCPC services
4	11872	Comsat Video in-room programming [B-MAC] (half transponders) — Satellite Cinema 4/2
6	11970	Data transmissions
8	12068	Comsat Video in-room programming [B-MAC] (half transponders) — ESPN/ Showtime
9	12117	Comsat Video in-room programming [B-MAC] (half transponders) — CNN Headline News/WTBS
10	12166	ID Channel/Occ video
11	11748	Data transmissions
12	11898	Occ video
13	11994	Occ video
14	12141	Occ video

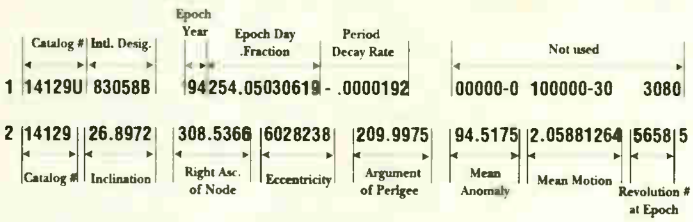
GSTAR-2 (GST2) 125º West

3	11852	Airport Network/CNN International [SA MPEG]
4	11913	Occ video
5	11974	Occ video
6	12035	Occ video
7	12096	Occ video
8	12157	Occ video
9	11744	Data transmissions
10	11805	Bluffs Run Greyhound racing/ Occ video
11	11866	Occ video/Spacenet GSTAR-2 ID slate
12	11927	Occ video
13	11988	Occ video
14	12049	Occ video
15	12110	Occ video
16	12171	Occ video

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 95150.26886339 -.00000278 00000-0 10000-3 0 3554
2 14129 26.4691 265.6627 6003533 280.9615 20.7451 2.05880627 61961
OSCAR 11 (UoSAT 2, UO-11 OR UoSAT 11)
1 14781U 84021B 95152.99974445 .00000136 00000-0 30758-4 0 8029
2 14781 97.7825 156.2498 0010769 226.9664 133.0644 14.69347953601676
COSMOS 1861 (Carries RS-10/11 or Radio Sputnik 10/11)
1 18129U 87054A 95150.18927751 .00000030 00000-0 15968-4 0 723
2 18129 82.9250 72.3731 0012420 134.6803 225.5369 13.72352740397506
OSCAR 13 (AO-13)
1 19216U 8851B 95145.13020627 -.00000189 00000 0 99999-5 41
2 19216 57.5449 185.6151 7292698 9.6968 359.1460 2.09726975 2168
OSCAR 14 (UoSAT 3, UO-14, or UoSAT 14)
1 20437U 90005B 95153.24774186 .00000042 00000-0 33382-4 0 1016
2 20437 98.5622 237.8524 0010063 241.8075 118.2097 14.29888432279610
OSCAR 16 (AO-16 or PACSAT)
1 20439U 90005D 95150.21125994 .00000000 00000-0 17071-4 0 8994
2 20439 98.5790 236.5152 0010547 253.1157 106.8872 14.29941477279191
OSCAR 17 (DO-17 or DOVE)
1 20440U 90005E 95146.21346116 .00000028 00000-0 27608-4 0 8988
2 20440 98.5800 233.0279 0010711 264.8923 95.1031 14.30082493278642
OSCAR 18 (WO-18 or WEBERSAT)
1 20441U 90005F 95150.18343342 -.00000006 00000-0 14755-4 0 9031
2 20441 98.5800 236.9155 0011209 253.7421 106.2525 14.30054036279219
OSCAR 19 (LU-19 or LUSAT)
1 20442U 90005G 95145.17024548 0.00000063 00000 0 32056-4 912
2 20442 98.5813 232.3277 0011604 268.4376 91.5476 14.3015585327851
JAS 1B (FUJI 2, FO-20 or Fuji Oscar 20)
1 20480U 90013C 95149.30656423 -.00000015 00000-0 48796-4 0 7953
2 20480 99.0720 241.4179 0540035 276.0693 77.9149 12.83229848248526
COSMOS 2123 (Carries RS-12/13 or Radio Sputnik 12/13)
1 21089U 91007A 95152.91217497 .00000025 00000-0 10398-4 0 8035
2 21089 82.9203 112.1057 0028083 212.8534 147.0880 13.74057773216673
OSCAR 22 (UoSAT-F, UoSAT 5, UO-22 or UoSAT 22)
1 21575U 91050B 95149.69520405 .00000012 00000-0 18655-4 0 6050
2 21575 98.3965 221.4709 0007915 342.8826 17.2078 14.36976844202845
OSCAR 23 (KITSAT 1, KITSAT A or KO-23)
1 22077U 92052B 95150.39729976 -.00000037 00000-0 10000-3 0 4965
2 22077 66.0832 273.0133 0008273 202.3475 157.7175 12.86291458131449
KITSAT B (KITSAT 2 or KO-25)
1 22825U 93061C 95145.74322518 .00000022 00000-0 26882-4 0 3936
2 22825 98.6185 222.4697 0008130 292.8797 67.1520 14.27662988 86565
POSAT 1 (PO-28)
1 22826U 93061D 95146.75002639 .00000025 00000-0 27924-4 0 3928
2 22826 98.6195 223.5560 0008438 289.9666 70.0599 14.27770666 86710
EYESAT A (AO-27)
1 22829U 93061G 95146.48254561 .00000025 00000-0 27813-4 0 3842
2 22829 98.6153 223.3572 0009408 275.8881 84.1224 14.28079379 86691
RADIO ROSTO (RS-15 or Radio Sputnik 15)
1 23439U 94085A 95145.44183405 -.00000039 00000-0 10000-3 0 527
2 23439 64.8176 291.7733 0167727 266.2927 91.8801 11.27523581 16954

WEATHER SATELLITES

NOAA-14
1 23455U 94089A 95138.75510809 -.00000020 00000-0 13303-4 0 1809
2 23455 98.8996 81.5029 0008745 282.9835 77.0329 14.11510039 19661
ELEKTRO
1 23327U 94069A 95129.79349846 -.00000101 00000-0 10000-3 0 696
2 23327 0.8226 265.3442 0005264 151.0836 172.5717 1.00270283 1941
DMSP B5D2-7
1 23233U 94057A 95138.64797283 .00000103 00000-0 79644-4 0 3420
2 23233 98.8828 197.0048 0011397 219.8029 140.2299 14.12604863 36987
GOES-8
1 23051U 94022A 95137.17964735 -.00000265 00000-0 10000-3 0 3133
2 23051 0.0463 264.1106 0002716 210.4465 110.0559 1.00265599 11385
METEOSAT 6
1 22912U 93073B 95135.95603337 -.00000091 00000-0 00000+0 0 3081
2 22912 0.1714 269.2670 0001156 213.5319 84.6674 1.00272713 3865
Meteor 2-21
1 22782U 93055A 95137.96889374 .00000052 00000-0 34265-4 0 4022
2 22782 82.5449 301.1350 0023521 11.0834 349.0836 13.83032130 86368
DMSP B5D2-6
1 21798U 91082A 95138.74445803 .00000106 00000-0 79820-4 0 8411
2 21798 98.9622 150.4275 0011986 271.8492 88.1308 14.13886380179048
Meteor 3-5
1 21655U 91056A 95136.76006051 .00000051 00000-0 10000-3 0 8022
2 21655 82.5498 241.1348 0014569 82.0255 278.2498 13.16838742180368
NOAA 12
1 21263U 91032A 95138.64594343 .00000156 00000-0 88964-4 0 4887
2 21263 98.5867 163.4674 0013060 348.9692 11.1196 14.22519227208229
DMSP 2-5
1 20978U 90105A 95138.57757940 .00000143 00000-0 66965-4 0 1997
2 20978 98.6420 206.9103 0077970 257.0519 102.1948 14.32544985233072
GMS 4
1 20217U 89070A 95135.18902199 -.00000293 00000-0 10000-3 0 1887
2 20217 0.9727 76.2938 0003663 44.9924 318.8621 1.00260562 21424
GOES 7
1 17561U 87022A 95135.93320383 .00000076 00000-0 10000-3 0 3860
2 17561 2.2557 72.9343 0003977 347.0249 13.8204 1.00289650 13313
NOAA 9
1 15427U 84123A 95138.58569980 .00000039 00000-0 44664-4 0 2558
2 15427 99.0017 197.1310 0015348 356.0053 4.0994 14.13705899537730
Nimbus 7
1 11080U 78098A 95136.65102951 -.00000088 00000-0 -41412-4 0 5018
2 11080 99.0046 11.9994 0008884 322.4269 37.6261 13.83710808836190

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69°	Galaxy 6 (G6) 74°	Telstar 302 (T2) 85°	Spacenet 3 (S3) 87°	Galaxy 7 (G7) 91°	Galaxy 3 (G3) 93.5°	Telstar 401 (T1) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	Anik E2 (A1) 107.3°
1	SC New York [V2+]	o/v	o/v	SCPC/FM2 (AP) services	Sega Channel [interactive digital]	Hero Teleport contract channel	Exxxtasy (Adult) [V2+]/VTC	SCPC services	Data Transmissions	Spice (adult) [V2+]
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+]	Spice 2 (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 Video Store [V2+]
5	NASA Contract Channel [Leitch]	NHK New York feeds	o/v	Univision [V2+]	fX West	Fox News Feeds/o/v	4MC Syndicated feeds/NC Open Net/o/v	o/v	Data Transmissions	o/v
6	Data Transmissions	NHK TV Japan feeds	o/v	(none)	Game Show Network [V2+]	American Independent Network	Buena Vista TV feeds	Shepard's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	(none)
7	(none)	o/v	TurnerVision Infomercials/o/v	Data Transmissions	The Golf Channel [V2+]	RAI/o/v	Fox feeds	o/v	Data Transmissions	ABC East [Leitch]
8	Data Transmissions	o/v	Syndicated show feeds/o/v	Data Transmissions	HBO East 2 [V2+]	High Tech Channel/o/v	PBS X	Telemundo [GI Digicipher]	KOMO-ABC Seattle (PT24W) [V2+]	Global TV [Leitch] Global feeds
9	NASA TV	MuchMusic U.S. [V2+]	Radiotelevisao Portuguesa Internacional	WPIX-Ind New York [V2+]	MCI (Andover) contract channel/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	Unied Arab Emirates TV Dubai	o/v	Fox SNG feeds	WABC-ABC New York (PT24E) [V2+]	WFLD-Fox Chicago (PT24E) [V2+]	Channel America
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	o/v	Data Transmissions	CTV (Blue)/o/v
13	Data Transmissions	Independent Film Channel [V2+]	o/v	SCPC/FM2 services	[digital compression?]	o/v	Fox East	o/v	Data Transmissions	o/v
14	Data Transmissions	Cornerstone TV WPCB-TV (Rel)	NPS Promo Channel	CNN [Leitch]	HBO West 2 [V2+]	o/v	Fox 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	Exxxtasy 2 (adult) [V2+]	World Harvest TV (Rel)	Data Transmissions	Global feeds/Exxxtasy promos/o/v
16	Data Transmissions	o/v	Wv EdNet/o/v	CNN International [Leitch]	Access TV/o/v	ESPN International [B-MAC]	o/v	CBS West [VC1]	Data Transmissions	CTV (Green)
17	Data Transmissions	Tokyo BS New York feeds	o/v	FM2/SCPC services	Via TV - home shopping	Shop at Home (SAH)	o/v	CBS East [VC1]/o/v	Data Transmissions	Climaxxx (adult) [V2+]
18	(none)	Merchandise and Entertainment TV (MET)	o/v	Shop-at-Home/In-store radio audio	CBS feeds/o/v	Univision feeds/o/v	o/v	CBS feeds [VC1]/o/v	WPLG-ABC Miami (Atlantic 3) [V2+]	Video Catalog Channel
19	Data Transmissions	University Network/Dr. Gene Scott (Rel)	o/v	SSN Sportsouth [V2+]/ American Collectables Network	CBS East [VC1]	o/v	United Paramount Network/o/v	CBS East [VC1]/o/v	Data Transmissions	TV Northern Canada (TVNC)
20	Armed Forces Radio & Television Service [B-MAC]	CNN Headline News Clean Feed [V2+]	ABC East (contingency channel) [Leitch]	Shop-at-Home	National Empowerment TV (NET)	o/v	ABC East [Leitch]	CBS East [VC1]	Data Transmissions	Newfoundland TV (NTV)
21	SC New England [V2+]	o/v	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-Network /CBS feeds/o/v	Data Transmissions	TV 5 (French)
22	Newsport [V2+]	o/v	Syndicated show feeds/o/v	Data Transmissions	NewsTalk Television	LVTN/Around World After Dark (adult) [V2+]/o/v	ABC West [Leitch]	WXIA-NBC Atlanta (PT24E) [V2+]	Data Transmissions	3 Angels Broadcasting (Rel)
23	NHK TV Japan secondary feeds	Worship TV (Rel)	o/v	SSN Home Teams Sports (HTS) [V2+]	fX Movies	o/v	ABC East [Leitch]	(none)	Data Transmissions	Exxxtreme TV/The Cupid Network (adult) [V2+]
24	SC New York Plus-o/v [V2+]	o/v	TV Erotica [V2+]	America One	HBO East 3 [V2+]	o/v	Best of NASA TV/o/v	CBS Newspath feeds	KPIX-CBS San Francisco (PT24W) [V2+]	CTV (Red)

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

Satellite Transponder Guide

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Solidaridad 1 (SD1) 109.2°	Telesat E1 (A2) 111°	Morelos 2 (M2) 116.8°	Telstar 303 (T3) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133°	Satcom C4 (F4) 135°	Satcom C1 (F1) 137°	Satcom C5 (F5) 139° West	
(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+]	SC Hawaii/SC Chicago Plus/o/v	(none)	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+]	(none)	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+]	SCPC services	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+]	(none)	4
(none)	Data SCPC	Data Transmissions	TVN 5 PPV [V2+]	CNN [V2+]	Faith and Values Channel/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	Data Transmissions	5
Telemax	WDIV-NBC Detroit [Oak]	Data Transmissions	TVN 6 PPV [V2+]	WTBS-Ind Atlanta [V2+]	CourtTV	Z-Music	Madison Square Garden 1 [V2+]	KMGH-CBS Denver [V2+]	(none)	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+]	SSN Prime Sports West [V2+]	Data Transmissions	7
(none)	Cancom (CHCH City TV WUHF CFTM) [SA MPEG]	XHGC canal 5/Q-CVC	TVN 8 PPV [V2+]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	(none)	8
o/v	The Weather Network	(none)	TVN 9 PPV/CVS [V2+]	ESPN [V2+]	Music Choice [digital audio]	ESPN2 Blackout [V2+]/SAH	QVC Network	SC Alt/Kaleidoscope-DIs Net/o/v	Data Transmissions	9
Mexican Parliament	WXYZ-ABC Detroit [Oak]	SEP	Ostrich Emu TV/Superior Livestock Auction	MDR Music	Home Shopping Club 2	America's Talking [V2+]	Home Shopping Club 1	Prime Sports SW [V2+]	(none)	10
(none)	CBC-North Pacific feed	XEIPN canal 11	Data Transmissions	Family Channel East [V2+]	Prime Network [V2+]	Eternal Word TV Network (Rel)	The Box [Digicipher]	Network One 'N1'	Data Transmissions	11
Data Transmissions	WTOL-CBS Toledo [Oak]	Data Transmissions	Data Transmissions	Discovery West [V2+]	History Channel [V2+]	Valuevision	Nustar (Promo Channel)	Data Transmissions	(none)	12
(none)	CBC feeds/o/v	(none)	o/v	CNBC [V2+]	The Weather Channel [V2+]	Encore [GI Digicipher]	Travel Channel [V2+]	SC Chicago [V2+]	o/v	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+]	(none)	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/Ohio [V2+]	DART Services	15
Data Transmission	CBC Newsworld [Oak]	TV Unam	Flix [V2+]	Cinemax West [V2+]	MTV West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Newsport [V2+]	(none)	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	Data Transmissions	17
o/v	CITV-Ind Edmonton [Oak]	Clara Vision (rel)	Showtime 2 [V2+]	TNN [V2+]	Nickelodeon West [V2+]	HBO Multiplex [GI Digicipher]	Viewer's Choice [GI Digicipher]	Prime Sports Showcase	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	SEDAT Services	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+]	(none)	20
(none)	SCPC/Data Transmissions	(none)	(none)	MEU	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Prime Sports West [GI Digicipher]	SCPC services	21
Caliente Jai Alai/Caliente greyhound racing	BCTV-CTV Vancouver [Oak	XHIMT canal 7	(none)	CNN/HN [V2+]	(none)	Nostalgia Channel	Movie Channel-West [V2+]	SSN PSNW [V2+]/STEP/o/v	(none)	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+]	SEDAT Services	23
(none)	Superchannel [Oak]	XHOF canal 13	TVN Preview/TVN PPV o/v [V2+]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio [Digital Audio]	ESPN International [B-MAC]	CMT [V2+]	SSN Sunshine [V2+]	Alaska Rural TV Project	24

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

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 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, Mr. Keith E. Stein, Satellite Times Staff and Chief D.R. Hill-Florida.

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 (DEG)	TYPE SATELLITE
18952	1988-018B Telecom 1C (France)	3.0E	Dom/Gov/Mil (C/Ku)
19919	1989-027A Tele X (Sweden)	5.0E	Reg BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.1E	Reg BSS (Ku)
22921	1993-076A USA 98 (NATO 4B)	5.9E/i	Mil (C)
22028	1992-041B Eutelsat II F4	7.1E	Reg (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg (Ku)
22557	1993-013A Raduga 29 (Russia)	11.2E	Gov/Mil (C)
22269	1992-088A Cosmos 2224 (Russia)	11.7E	Mil-Early Warning
23537	1995-016B Hot Bird 1 (Eutelsat)	12.6E	DBS (Ku)
19596	1988-095A Raduga 22 (Russia)	12.7E/i	Gov/Mil (C)
20777	1990-079B Eutelsat II F1	13.1E	Reg (Ku)
21055	1991-003A Italsat 1 (Italy)	13.1E	Dom-Telephone (S/Ku/Ka)
21803	1991-083A Eutelsat II F3	16.0E	Reg (Ku)
23331	1994-070A Astra 1D	19.1E	Reg BSS (Ku)
22653	1993-031A Astra 1C	19.2E	Reg BSS (Ku)
19688	1988-109B Astra 1A	19.3E	Reg BSS (Ku)
21139	1991-015A Astra 1B	19.3E	Reg BSS (Ku)
14234	1983-077A Telstar 3A (301) (USA)	19.9E	Dom (C)
19331	1988-063B Eutelsat 1 F5	21.6E	Reg (Ku)
13010	1981-122A Marecs 1 (ESA)	22.3E/i	Intl Mar (L/C)
22175	1992-066A DFS 3 (Germany)	23.7E	Dom BSS (Ku/Ka)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.5E	Reg (Ku)
11622	1979-098B DSCS II E15 (USA)	27.9E/i/d	Mil-reserve (C)
20706	1990-063B DFS 2 (Germany)	29.1E	Dom BSS (Ku/Ka)
21894	1992-010B Arabsat 1C	30.9E	Reg FSS/BSS (S/C)
20041	1989-041B DFS 1 (Germany)	33.5E	Dom BSS (Ku/Ka)
21821	1991-087A Raduga 28 (Russia)	34.6E	Gov/Mil (C)
20953	1990-102A Gorizont 22 (Russia)	40.2E/i	Dom/Gov (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	42.6E	Reg FSS (Ku)
23010	1994-012A Raduga 31 (Russia)	45.0E	Gov/Mil (C)
14421	1983-105A Intelsat 507	46.0E/i/d	Int FSS/Mar (L/C/Ku)
22981	1994-008A Raduga 1-3 (Russia)	48.6E	Gov/Mil (C)
21038	1990-116A Raduga 1-2 (Russia)	49.4E/i	Gov/Mil (C)
19687	1988-109A Skynet 4B (UK)	53.3E/i	Mil (P/C/Millimeter)
22245	1992-082A Gorizont 27 (Russia)	54.4E	Dom/Gov (C/Ku)
15629	1985-025A Intelsat 510	57.0E/i/d	Int FSS (C/Ku)
14675	1984-009A DSCS III A2 (USA)	60.0E/i	Mil-IOR primary (P/C)
20667	1990-056A Intelsat 604	60.0E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	63.5E	Int FSS (C/Ku)
20918	1990-093A Inmarsat 2 F1	64.4E	Intl Mar (L/C)
13636	1982-106A DSCS II F16 (USA)	64.6E/i	Mil-IOR reserve (C)
13595	1982-097A Intelsat 505	65.0E/i	Int FSS/Mar (L/C/Ku)
23461	1995-001A Intelsat 704	66.1E	Intl FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	69.5E	Gov/Mil (C)
20083	1989-048A Raduga 1-1 (Russia)	70.0E/i	Gov/Mil (C)
22963	1993-002A Gals 1 (Russia)	71.0E	Dom BSS (Ku)
20410	1990-002B Leasat 5 (USA)	71.5E/i	Mil-IOR reserve (P)
22787	1993-056A USA 95 (UFO-2)	71.5E/i	Mil-IOR primary (P)
08882	1976-053A Marisat 2	72.1E/i	Intl Mar (P/L)
22027	1992-041A Insat 2A (India)	73.9E	Dom (S/C)
20693	1990-061A Cosmos 2085 (Russia)	75.3E/i	Data Relay (C)
23327	1994-069A Elektro 1 (Russia)	76.2E	Met (L)
23314	1994-065B Thaicom 2 (Thailand)	78.4E	Reg (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.4E	Reg (C/Ku)
21111	1991-010A Cosmos 2133 (Russia)	78.7E	Mil-Early Warning
23267	1994-060A Cosmos 2291 (Russia)	80.0E	Data Relay (C)
21759	1991-074A Gorizont 24 (Russia)	80.1E	Dom/Gov (C/Ku)
20643	1990-051A Insat 1D (India)	82.8E	Dom BSS/Met (S/C)
13969	1983-026B TDRS 1 (USA)	84.4E/i	Gov (C/Ku)
22836	1993-062A Raduga 30 (Russia)	85.3E	Gov/Mil (C)
18922	1988-014A PRC 22 (China)	87.1E	Dom (C)
22880	1993-069A Gorizont 28 (Russia)	90.0E	Dom/Gov (C/Ku)
12474	1981-050A Intelsat 501	91.2E/i	Int FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.4E	Dom BSS/Met (S/C)
21016	1990-112A Raduga 26 (Russia)	94.7E/i/d	Gov/Mil (C)
23426	1994-082A Luch 1 (Russia)	95.2E/i	Tracking/Relay CSDRN (Ku)
20263	1989-081A Gorizont 19 (Russia)	96.1E/i	Dom/Gov (C/Ku)
20473	1990-011A PRC 26 (China)	98.2E	Dom (C)
22210	1992-074A Ekran 20 (Russia)	98.4E	Dom BSS (P)
19683	1988-108A Ekran 19 (Russia)	98.9E/i	Dom BSS (P)
21922	1992-017A Gorizont 25 (Russia)	102.9E	Dom/Gov (C/Ku)
20558	1990-030A Asiasat 1	105.4E	Reg (C/Ku)
20570	1990-034A Palapa B2R	107.9E	Reg (C)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.0E	Dom BSS (Ku)
23176	1994-040B BS-3N (Japan)	109.5E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.9E	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.3E	Dom (C)
17706	1987-029A Palapa B-2P	112.6E	Reg (C)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.4E	Dom (C/Ku)
21964	1992-027A Palapa B4	117.8E	Reg (C)
15152	1984-080A GMS-3 (Himawari 3) (Japan)	121.1E/i	Met (P/L) Reserve spacecraft
21132	1991-014A Raduga 27 (Russia)	128.1E/i	Gov/Mil (C/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	129.9E	Dom/Gov (C/Ku)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.8E	Dom (C/Ka)
14134	1983-059C Palapa B1 (Indonesia)	134.0E/i	Regional (C)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	135.9E	Dom (C/Ka)
23185	1994-043A Apstar A1 (China)	137.9E	Reg FSS (C)
20217	1989-070A GMS 4 (Himawari 4)	140.1E	Met (P/L)
20107	1989-052A Gorizont 18 (Russia)	140.3E/i	Dom/Gov (C/Ku)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.8E	Reg (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	144.9E/i	Dom/Gov (C/Ku)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
19874	1989-020A JCSAT 1 (Japan)	150.0E	Dom (Ku)
18316	1987-070A ETS V (Japan)	150.3E/i	Reg (L/C)
23227	1994-055A Optus B3 (Australia)	151.2E	Dom/Mob (l/Ku)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom (Ku)
18350	1987-078A Optus A3 (Aussat K3)	155.9E	Dom (Ku)
22253	1992-084A Superbird A (Japan)	157.9E	Dom (Ku/Ka)
23522	1995-011B GMS-5 (Himawari 5)	159.7E	Met (P/L)
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)	164.0E	Dom (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	168.9E	Reg (C/Ku)
12046	1980-087A OPS 6394 (Fltsatcom F4)(USA)	172.5E/i	Mil-POR reserve (P-Bravo)
22871	1993-066A Intelsat 701	174.0E	Int FSS (C/Ku)
20202	1989-069A DSCS III B9 (USA)	175.0E/i	Mil-WPAC primary (P/C)
23305	1994-064A Intelsat 703	176.9E	Intl FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	178.1E	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)
23467	1995-003A USA 108 (UFO-4) (USA)	178.2W/i	Mil-POR (L/C/K)
09478	1976-101A Marisat 3	178.0W/i	Intl Mar-POR (P/L/C)
15236	1984-093C Leasat 2 (USA)	177.6W/i	Mil-POR primary (P)
12994	1981-119A Intelsat 503	176.9W/i	Int FSS (C/Ku)
10061	1977-048A GOES 2	174.6W/i	Met (L)
21639	1991-054B TDRS F5 (USA)	174.4W	Gov (C/Ku)
19548	1988-091B TDRS F3 (USA)	171.6W	Gov (C/Ku)
20499	1990-016A Raduga 25 (Russia)	169.5W/i/d	Gov/Mil (C)
18631	1987-100A Raduga 21 (Russia)	169.4W/i	Gov/Mil (C)
21392	1991-037A Satcom C5 (Aurora II)(USA)	139.0W	Dom (C)
20945	1990-100A Satcom C1 (USA)	137.2W	Dom (C)
17561	1987-022A GOES 7 (USA)	136.2W/i	Met (L)
22096	1992-057A Satcom C4 (USA)	135.0W	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)	131.1W	Dom (C)
13637	1982-106B DSCS III A1 (USA)	130.0W/i	Mil-EPAC reserve (P/C)
21906	1992-013A Galaxy 5 (USA)	125.1W	Dom (C)
16649	1986-026A Gstar 2 (USA)	125.0W	Dom (Ku)
15826	1985-048D Telestar 3D (USA)	123.1W	Dom (C)
19484	1988-081B SBS 5 (USA)	123.0W	Dom (Ku)
16274	1985-109B Morelos B (Mexico)	116.9W	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)	111.2W	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	106.4W/i	Intl Mar-AOR (P/L)
08747	1976-023B LES 9 (USA)	105.6W/i	Mil (P/C)
15643	1985-028C Leasat 3 (USA)	105.3W/i	Mil-CONUS reserve (P)
20946	1990-100B Gstar 4 (USA)	105.1W	Dom (Ku)
03029	1967-111A ATS 3 (USA)	104.8W/i	Exp
15677	1985-035A Gstar 1 (USA)	103.1W	Dom (Ku)
22930	1993-078A DBS 1 (USA)	101.3W	Dom BSS (Ku)
23553	1995-019A MSAT-2 (USA)	101.2W	Mob (L/X)
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)	99.1W	Mil-CONUS primary (P/C)
22694	1993-039A Galaxy 4 (USA)	99.1W	Dom (C/Ku)
22927	1993-077A Telstar 401 (USA)	97.0W	Dom (C/Ku)
08746	1976-023A LES 8 (USA)	95.9W/i	Mil (P/C)
20872	1990-091A SBS 6 (USA)	94.9W	Dom (Ku)
15308	1984-101A Galaxy 3 (USA)	93.5W	Dom (C)
19483	1988-081A Gstar 3 (USA)	93.1W/i	Dom (Ku)
22205	1992-072A Galaxy 7 (USA)	91.1W	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)	81.0W	Dom (Ku)
15235	1984-093B SBS 4 (USA)	76.9W	Dom (Ku)
12309	1981-018A Comstar D4 (USA)	76.0W/i	Dom (C)
14133	1983-059B Anik C2 (Argentina)	75.8W/i	Dom (Ku)
23051	1994-022A GOES 8 (USA)	74.3W	Met (L)
20873	1990-091B Galaxy 6 (USA)	74.2W	Dom (C)
13651	1982-110B SBS 3 (USA)	74.0W/i	Dom (Ku)
15642	1985-028B Anik C1 (Argentina)	71.9W	Dom (Ku)
12855	1981-096A SBS 2 (USA)	71.0W/i	Dom (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom (C)
15385	1984-114A Spacenet 2 (USA)	69.1W	Dom (C/Ku)
19215	1988-051A Meteosat P2 (ESA)	68.7W/i	Met (L)
16650	1986-026B SBTS 2 (Brazil)	65.0W	Dom (C)
15561	1985-015B SBTS 1 (Brazil)	63.1W	Dom (C)
23536	1995-016A Brasilsat B2 (Brazil)	60.9W	Dom (C/X)
21940	1992-021B Inmarsat 2 F4	54.1W/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)
23528	1995-013A Intelsat 705	51.9W	Intl FSS (C/Ku)
14077	1983-047A Intelsat 506	50.0W/i/d	Int FSS (C/Ku) Replace 504
22314	1993-003B TDRS F6 (USA)	46.3W	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	41.0W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (USA)	37.6W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.6W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.0W	Mil (P/C)
13083	1982-017A Intelsat 504	31.3W/i	Int FSS (C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.2W	Dom (Ku)
22723	1993-048A Hispasat 1B (Spain)	30.0W	Dom (Ku)
21765	1991-075A Intelsat 601	27.5W	Int FSS (C/Ku)
19928	1989-030A Raduga 23 (Russia)	24.6W/i	Gov/Mil (C)
21653	1991-055A Intelsat 605	24.6W	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)	22.4W/i	Mil-AOR primary (P-Charlie/K)
21989	1992-032A Intelsat K	21.6W	Int FSS (Ku)
16101	1985-087A Intelsat 512	21.3W	Int FSS (C/Ku)
15391	1984-115A NATO III D	21.0W/i	Mil (P/C)
20705	1990-063A TDF 2 (France)	19.0W	Dom BSS (Ku)
19621	1988-098A TDF 1 (France)	18.9W	Dom BSS (Ku)
19772	1989-006A Intelsat 515	18.1W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W/i	Mil (P/C)
18384	1987-084A Cosmos 1888 (Russia)	16.2W/i	Data Relay (C)
20391	1989-101A Cosmos 2054 (Russia)	16.1W/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	14.9W/i	Intl Mar (L)
10669	1978-016A Ops 6391 (FltSatCom 1) (USA)	14.8W/i	Mil-AOR reserve (P-Alpha)
23132	1994-035A USA-104 (UFO-3)(USA)	14.7W/i	Mil-AOR primary (P)
21789	1991-079A Cosmos 2172 (Russia)	13.9W	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)	10.0W	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom/Gov/Mil (C/Ku)
19876	1989-020B Meteosat 4 (MOP 1)(ESA)	8.0W	Met (L)
21939	1992-021A Telecom 2B (France)	5.1W	Dom/Gov/Mil (C/Ku)
23124	1994-034A Intelsat 702	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.0W	Mil (P/C)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.9W	Reg BSS (Ku)
20168	1989-062A TV Sat 2 (Germany)	0.6W/d	Dom BSS (Ku)
21140	1991-015B Meteosat 5 (MOP 2)	0.1W	Met (L)

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											
		Up	145.860	870	880	890	145.900											
	Robot	Dn	29.403															
		Up	145.820															
	Bcn		29.357															
RS-12/13 (Notes 3,) 6 & 7	K (h/A)	Dn	29.410	420	430	440	29.450											
		Up	21.210	220	230	240	21.250											
	Robot	Dn	29.454															
		Up	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 Ralsed 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.

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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-69	July 1995/ Endeavour*	28.4/200	11 days	SPTN 201-03
STS-73	Sept. 1995/ Columbia**	39.0/150	16 days	USML-02

*Crew Assignment: CDR-David M. Walker, PLT-Kenneth D. Cockrell, MS (PLC)-James S. Voss, MS-Michael L. Gernhardt, MS-James H. Newman.
**Crew Assignment: CDR-Kenneth D. Bowersox, PLT-Kent V. Rominger, MS (PLC)-Kathryn C. Thornton, MS-Catherine G. Coleman, MS-Michael E. Lopez-Alegria, PS-Fred W Leslie, PS-Albert Sacco, Jr.
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
July 1995	Soyuz	Baikonur	PROGRESS M-29
July 1995	Cyclone	Plesetsk	SICH-1 & FASAT-ALFA
August 1995	Soyuz	Baikonur	SOYUZ TM-22
August 1995	Molniya	Baikonur	IRS-1C
September 1995	Soyuz	Baikonur	Progress M-30
September 1995	Cosmos	Plesetsk	COSMOS FAISAT 2

PROGRESS Downlink Frequency Assignment: 165.000 MHz, 166.000 MHz, and 922.755 MHz.
FASAT-ALFA Downlink Frequency Assignment: 400-401 MHz.
SOYUZ TM-22 Downlink Frequency Assignment: 121.750 MHz
COSMOS Downlink Frequency Assignments: 149.910-150.030 MHz,
FAISAT 2 Downlink Frequency Assignments: 137-138 MHz, and 400-401 MHz.

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1995	Pegasus XL	VAFB	TOMS-1
July 1995	Conestoga	WFF	METEOR
July 1995	Atlas 2AS	CCAS	JCSAT 3
July 1995	Pegasus	VAFB	MSTI-3
August 1995	Delta II	CCAS	XTE
September 1995	Pegasus XL	WWF	SAC-B/HETE
September 1995	Delta II	VAFB	RADARSAT SURFSAT
September 1995	Titan 4	CCAS	MILSTAR 1-2
September 1995	Atlas 2-A	CCAS	GALAXY III-R

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
METEOR 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 Downli.. Frequency Assignments: S-band TLM 2244.5 MHz, 2241.5 MHz, 2252.5 MHz, C-band TRK 5765.0 MHz.
XTE Downlink Frequency Assignments: S-band TLM 2287.5 MHz.
SAC-B Downlink Frequency Assignments: 2255.5 MHz.
HETE Downlink Frequency Assignments: 137.96 MHz and 2272.0 MHz.
RADARSAT Downlink Frequency Assignments: 2230.0 MHz.

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1995	Ariane 4	Guiana	HELIOS-1
August 1995	Ariane 4	Guiana	TC2C
September 1995	Ariane 4	Guiana	ISO

Ariane 4 Downlink Frequnecy Assignments: S-band TLM 2203.0 MHz, 2206.0 MHz, and 2218.0 MHz.
HELIOS-1 Downlink Frequency Assignments: S-band TLM 2200-2220 MHz, 2206.53 MHz, TRK 2200.2220 MHz, and X-band TLM 8253.0 MHz.
TC2C Downlink Frequency Assignments: S-band TLM and TRK 2207.13 MHz.
ISO Downlink Frequnency Assignments: S-band TLM and TRK 2266.5 MHz.

List of Abbreviations and Acronyms

C-band	3700 to 6500 MHz
CCAS	Cape Canaveral Air Station.
CDR	Commander.
COSMOS	Russian navigation satellite.
FAISAT 2	The system will provide data acquisition services, remote monitoring, tracking, personal and business non-voice messaging, and emergency communications/distress calls.
FASAT	FASAT-ALFA will become the first Chilean satellite. The main mission objective is ozone layer monitoring, remote sensing, and data transfer.
GALAXY 3R	Principal applications include network TV, radio, VSAT, business video and data services.
GHz	Gigahertz.
HELIOS-1	The main objective of the HELIOS system is to provide the Italian, Spanish and the French defense systems with remote sensing data.
HETE	High Energy Transient Experiment, a spacecraft to study gamma ray burst sources and source locations, and x-ray burst sources and source locations.
IRS-1C	The Indian Remote Sensing satellite will provide improved image resolution, onboard recording, stereo viewing capability and more frequent revisits.
ISO	The Infrared Space Observatory will conduct imaging, photometric, spectroscopic and polarimetric observations of selected sources.
JCSAT	Japanese telecommunication satellite.
K-band	10.90 to 17.15 GHz.
METEOR	Multiple Experiment Transporter to Earth Orbit and Return, designed to provide experimenters access to a low earth orbit with several years of orbital lifetime.
MHz	Megahertz.
MILSTAR	A telephone switchboard in space to route all military message traffic and conversations around the world.
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.
PLC	Payload Commander.
PLT	Pilot.
Progress	Unmanned cargo flight to resupply manned space station.

Satellite Launch Schedules

PS	Payload Specialist.
RADARSAT	Radarsat is a remote sensing free flying satellite that will monitor land, sea and ice for five years over the poles (U.S./Canadian).
RNG	Ranging.
SAC-B/C	Satelite de Aplicaciones Cientificas-B/C, a Argentine spacecraft carrying hard x-ray spectrometer to investigate solar flares and cosmic transient x-ray emissions.
S-band	2000 to 2300 MHz
SICH-1	Designed to take ocean and atmospheric measurements for environmental monitoring.
SOYUZ TM	Manned spacecraft for flight in Earth orbit.
SPTN 201	Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN). X-ray astronomy, medium energy survey mission, using retrievable free flyer.
SURFSAT	Summer Undergraduate Research Fellowship Satellite is a secondary payload launched to simulate a deep space vehicle by radiating in S, X, Ku, and Ka Bands.
TC2C	European telecommunications satellite.
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.
USML-2	United States Microgravity Laboratory-2. A series of flights of a microgravity materials processing laboratory attached to the Shuttle.
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
WFF	Wallops Flight Facility.
XTE	X-ray Timing Explorer, a payload to be used in Earth orbit to investigate the physical nature of compactx-ray sources by studying fluctuations in x-ray brightness over time-scales ranging from microseconds to years.

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Weather Satellite Equipment/Software Vendors

The information in this list was compiled by *Satellite Times* magazine and the Dallas Remote Imaging Group. This list does not represent an endorsement, recommendation or guarantee for any person or product, nor does a listing here imply a connection with *Satellite Times* magazine or the Dallas Remote Imaging Group. If you manufacturer weather satellite equipment, software or publications and would like to be listed in future editions of this list, send your current catalog, information, or publication to: Weather Satellite Vendors List, Satellite Times magazine, P.O. Box 98, Brasstown, NC 29802.

A&A Engineering
2521 W. LaPalma #K
Anaheim, CA 92801
voice: (714) 952-2114
fax: (714) 952-3280
(Hardware/Software)

Advanced Electronics Applications (AEA)
P.O. Box C2160, 2006-196th St. SW
Lynnwood, WA 98036
voice: (800) 432-8873/ (206) 774-5554
(Hardware)

AMSAT
P.O. Box 27
Washington, D.C. 20044
voice: (301) 589-6062
fax: (301) 608-3410
(Satellite tracking software)

Clear Choice Education Products
216 Blackberry Lane
Cleveland, GA 30528
voice: (800) 533-5108
fax: (706) 865-7808
(Educational materials only)

Comar Electronics
Unit 3, Medina Court
Arctic Road, Cowes
Isle of Wight PO31 7XD UK
voice: 44 0983 200308
fax: 44 0983 280402
(Software)

Dallas Remote Imaging Group
P.O. Box 117088
Carrolton, TX 75011-7088
voice: (214) 394-7325
fax: (214) 492-7747
bbs: (214) 394-7438
(Weather satellite information/ Software/Information)

Down East Microwave
954 Rt 519
Frenchtown, NJ 08825
voice: (908) 996-3584
fax: (908) 996-3702
(Hardware)

EDCO Distributors Co.
325 Mill Street, N.E.
Vienna, VA 22180
voice: (703) 938-8105
fax: (703) 938-6911
(Satellite Tracking Hardware/ Software)

ERIM
Earth Observation Group
PO Box 134001
Ann Arbor, MI 48113
voice: (313) 994-1200 ext 3350
fax: (313) 668-8957

Fisher Scientific
4901 West LeMoyne Street
Chicago, IL 60651
voice: (800) 955-1177
fax: (312) 378-7174

GTI
1541 Fritz Valley Road
Lehighton, PA 18235
voice: (717) 386-4032
fax: (717) 386-5063

Hamtronics, Inc
65-B Moul Road
Hilton, NY 14468-9535
voice: (716) 392-9430
fax: (716) 392-9420
(Hardware)

Lone Eagle Systems, Inc
5968 Wenninghoff Road
Omaha, NE 68134
voice: (402) 571-0102
fax: (402) 572-0745
(Hardware/Software)

Marisys Inc
131 NW 43rd Street
Boca Raton, FL 33431
voice: (407) 361-0598
fax: (407) 361-0599

Martelec Communications Systems
The Acorns, Wyck Lane
East Worldham, Alton, Hants GU34 3AW UK
voice/fax: 44 0420 82752
(Hardware/Software)

MultiFAX
Rt 1, Box 27
Peachland, NC 28133
voice: (704) 272-9028
fax: (704) 272-9036
bbs: (716) 425-8759
(Hardware/Software)

Northern Video Graphics, Inc
511 11th Avenue South, Box 92
Minneapolis, MN 55415
voice: (612) 338-6589

OFS Weatherfax
6404 Lakerest Court
Raleigh, NC 27612
voice/fax: (919) 847-4545
(Hardware/Software)

Quorum Communications, Inc
8304 Esters Boulevard, Suite 850
Irving, TX 75063
voice: (800) 982-9614
voice: (214) 915-0256
fax: (214) 915-0270
BBS: (214) 915-0346
(Hardware/Software)

R. Myers Communications
P.O. Box 17108
Fountain Hills, AZ 85269-7108
voice: (602) 837-6492
fax: (602) 837-6872
(Software/Publication)

Satellite Data Systems, Inc
800 Broadway Street, P.O. Box 219
Cleveland, MN 56017
voice/fax: (507) 931-4849
(Hardware/Software)

Software Systems Consulting
615 S. El Camino Real
San Clemente, CA 92672
voice: (714) 498-5784
fax: (714) 498-0568
(Hardware/Software)

Spacetech
21 West Wools
Portland, Dorset DT5 2EA UK
voice: 44 0305 822753
fax: 44 0305 860483
(Software)

Spectrum International, Inc
P.O. Box 1084
Concord, MA 01742
voice: (508) 263-2145
fax: (508) 263-7008
(US distributor of Timestep products/Hardware)

Swagur Enterprises
Box 620035
Middleton, WI 53562-0035
voice/fax: (608) 592-7409
(Hardware/Software)

Systems & Software International
4639 Timber Ridge Drive
Dumfries, VA 22026
voice: (703) 680-3559
fax: (703) 878-1460
(Hardware/Software)

TH2 Imaging
34 Princes Gardens
Margate, Kent CT9 3AR UK
voice: 44 0843 223831
fax: 44 0843 596256
(Hardware/Software)

Timestep
P.O. Box 2001
Newmarket CB8 8XB England
voice: 01440 820040
fax: 01440 820281
(Hardware/Software/Products distributed in US by Spectrum International, Inc)

Tri-Space, Inc
P.O. Box 7166
McLean, VA 22106-7166
voice: (703) 442-0666
fax: (703) 442-9677

Vanguard Electronic Labs
Dept ST, 196-23 Jamaica Avenue
Hollis, NY 11423
voice: (718) 468-2720
(Hardware/Software)

WeatherSat Ink
4821 Jessie Drive
Apex, NC 27502 USA
(Weather Sat Publication)

Western Canada Aerospace
P.O. Box 1318
Stony Plain, AB Canada T0E 2G0
or in the United States
P.O. Box 7012
Great Falls, MT 59406-7012
voice/fax: (800) 563-8597 (orders)
voice/fax: (403) 967-4423
Ask for Rene A. Matthijssen, VE6WCA

Wilmanco
5350 Kazuko Court
Moorpark, CA 93021
voice: (805) 523-2390
fax: (805) 523-0065
(Hardware/Software)

SATELLITE LAUNCH REPORT

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

How to Use the Satellite Launch Report

The "Satellite Launch Report" is a complete list of satellite launches which took place during March and April 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 / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1995 Mar 2/0638		1995-007A	Endeavour (STS-67)	98,740 kg
1995 Mar 2.45	28.46 deg	91.59 min	347 km	358 km
1995 Mar 18.86	29.25 deg	88.44 min	348 km	357 km

Carried seven astronauts: Stephen S Oswald (commander), William G Gregory (pilot), John M Grunsfeld (mission specialist, MS-1), Wendy B Lawrence (flight engineer, MS-2), Tamara E Jernigan (payload commander, MS-3), Samuel T Durrance (payload specialist, PS-1) and Ronald Parise (PS-2). Primary payload for the mission was ASTRO 2, carrying three instruments attached to a Spacelab Instrument Pointing System: assembly with a mass of 7,885 kg remains fixed to the shuttle's payload bay. ASTRO 2 was dedicated to ultra-violet astronomy, using the Hopkins Ultraviolet Telescope, Ultraviolet Imaging Telescope and Wisconsin Ultraviolet Photo-Polarimeter Experiment. Shuttle orbiter has a body diameter of 5.5 metres, body length of 37.3 metres and a wingspan of 23.8 metres. Mass quoted above is that projected for landing: second orbit is that tracked during the return to Earth.

Launched from kennedy Space Center: landing at Edwards Air Force Base was at 2147 UTC, completing the longest shuttle flight to date: 16d 15h 8m. This mission duration briefly gave Lawrence and Jernigan the record for the longest flight to be completed by a woman, although this record was broken when Kondakova returned to Earth aboard Soyuz-TM 20 on March 22 (see updates which follow).

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1995 Mar 2/1300		1995-008A	Cosmos 2306	1,000 kg *
1995 Mar 2.85	65.85 deg	94.47 min	469 km	517 km

Main satellite launched for calibration of land-based radars. No details of appearance, etc., but possibly manufactured by NPO Yuzhnoye. Four sub-satellites were deployed to permit radar tracking of small objects in orbit. Intermediate Cosmos second stage is in an orbit similar to that of the satellite. Launched from Plesetsk.

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1995 Mar 7/0923		1995-009A	Cosmos 2307	1,300 kg *
1995 Mar 8.80	64.81 deg	676.10 min	19,131 km	19,147 km
1995 Mar 25.35	64.80 deg	675.77 min	19,113 km	19,149 km
1995 Mar 7/ 0923		1995-009B	Cosmos 2308	1,300 kg *
1995 Mar 9.75	64.80 deg	676.13 min	19,128 km	19,152 km
1995 Mar 21.90	64.79 deg	675.74 min	19,101 km	19,159 km
1995 Mar 7/ 0923		1995-009C	Cosmos 2309	1,300 kg *
1995 Mar 9.75	64.80 deg	676.08 min	19,129 km	19,149 km
1995 Mar 18.66	64.79 deg	675.73 min	19,117 km	19,142 km

Three "Uragan" navigation satellites in the GLONASS system, built by NPO Prikladnoi Mekhaniki: launched into plane 3 of the system. Satellites have cylindrical bodies with two vanes of solar cells deployed. Operational lifetime of each satellite is expected to be about five years.

Launched by four-stage Proton from Tyuratam: third stage was left in a 64.81 deg, 87.66 minutes, 142-176 km orbit from which it decayed March 11, fourth stage (Block DM-2) is in an orbit similar to the initial ones listed for the satellites.

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1995 Mar 14/0611		1995-010A	Soyuz-TM 21	7,150 kg *
1995 Mar 14.31	51.65 deg	88.61 min	191 km	221 km
1995 Mar 18.17	51.64 deg	92.43 min	391 km	396 km

Piloted spacecraft, carrying Vladimir N Dezhurov (commander), Gennady M Strekalov (flight engineer) and Norman E Thagard (first American to be launched using a Russian spacecraft). Docked with Mir Complex at the rear port on Kvant 1 March 16 0746 UTC. Astronauts are to remain in orbit until US shuttle Atlantis (STS-71 mission) docks with Mir Complex in mid-1995, which will make Thagard's flight the longest by an American: spacecraft will return to Earth approximately September 1995 carrying two cosmonauts to be launched aboard the shuttle. Launched from Tyuratam by Soyuz vehicle: third stage was in an orbit similar to the first one listed for the spacecraft, decayed from orbit March 16.

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1995 Mar 18/0801		1995-011A	Space Flyer Unit	4,000 kg *
1995 Mar 18.32	28.46 deg	91.07 min	313 km	341 km
1995 Mar 23.86	28.46 deg	94.24 min	467 km	496 km
1995 Mar 18/0801		1995-011B	Himawari 5	746 kg
1995 Mar 18.58	25.10 deg	647.17 min	346 km	36,466 km
1995 Apr 9.20	1.05 deg	1,436.14 min	35,787 km	35,788 km

First flight of Space Flyer Unit is a reuseable platform, planned for recovery aboard the United States STS-72 mission in late 1995. Satellite is an eight-sided stubby cylinder, 4.46 metres diameter and 2.8 metres high at launch and retrieval: when deployed in orbit the two vanes of solar panels span 24.4 metres. Mass quoted above is at launch: that projected for the time of shuttle retrieval is 3,200 kg. ISAS is in charge of the SFU project, in collaboration with NASDA and the Institute for Unmanned Space Experiment Free Flyer.

Himawari 5 (GMS 5, "Geostationary Meteorological Satellite" before launch) is a meteorological satellite, forming part of the Global Observing System for the World Weather Watch: built by Hughes Space and Communications Company and based upon its HS-378 satellite bus. Satellite is cylindrical, 2.15 metres diameter and 3.54 metre high (4.44 metres high with the apogee kick motor attached): mass quoted above is at launch, on station it is 345 kg. The satellite was initially located over 159-160 deg E but when operational it will be over 140 deg E. Expected operating lifetime is five years. Launched by third H-2 vehicle from Tanegashina. H-2 second stage remained in the following orbit: 25.53 deg, 583.10 min, 276-33,208 km.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1995 Mar 22/0409	1995-012A		Cosmos 2310	825 kg *
1995 Mar 22.38	82.94 deg	105.02 min	980 km	1,011 km

"Musson" navigation satellite in the military "Parus" system, coplanar with Cosmos 2184. Satellite is a cylinder, approximately 2 metres diameter and 2.1 metres long, plus a boom for gravity stabilisation: built by NPO Prikladnoi Mekhaniki. Operational lifetime is expected to be about four years. Launched from Plesetsk: second stage of Intermediate
Cosmos launch vehicle is in an orbit similar to that of the satellite.

1995 Mar 22/0618	1995-013A		INTELSAT 705	3,660 kg
1995 Mar 22.05	26.53 deg	718.54 min	175 km	40,217 km
1995 Apr 7.60	0.03 deg	1,436.02 min	35,618 km	35,952 km

Communications satellite, built by Space Systems/Loral for INTELSAT. Main body of the satellite is a box 2.45 x 2.20 x 4.20 metres high at launch: with the two vanes of solar panels deployed the span is approximately 21.8 metres. 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. Initially located over 303-304 deg E. On April 27 the satellite was manoeuvred off-station and started to drift to the east. To be operated over 310 deg E. Launched from Cape Canaveral by Atlas 2AS: second stage remained in a 26.56 deg, 711.67 min, 171-39,881 km orbit.

L1995 Mar 22/1645	1995-014A		Cosmos 2311	6,500 kg *
1995 Mar 22.88	67.19 deg	89.54 min	168 km	336 km
1995 Mar 30.19	67.17 deg	90.10 min	170 km	388 km

"Yantar" fourth generation close-look photoreconnaissance satellite, expected to remain in orbit for about two months. Data capsules are returned to Earth during the flight and it is believed that the main descent module is recovered at the end of the mission. No details of appearance, but possibly cylindrical with a maximum diameter of 2.5 metres and a length of about 7 metres. Launched from Plesetsk using a Soyuz vehicle: third stage was in an orbit similar to the first one listed for the satellite, decayed from orbit.

1995 Mar 24/1405	1995-015A		DMSP-2 8 (USA 109)	823 kg
1995 Mar 24.77	98.83 deg	101.93 min	847 km	854 km

Block 5D-2 "Defense Meteorological Satellite Program" payload. Satellite bus based upon Martin Marietta Astro Space's NOAA TIROS bus: 1.22 metres wide, 6.4 metres long with a single solar panel deployed. Orbital injection is performed using a STAR-37S motor which is built into the satellite. Expected operational lifetime is four years. Launched from Vandenberg AFB using an Atlas E.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1995 Mar 28/1000			Gurwin 1	55 kg
	Failed to reach orbit			
1995 Mar 28/1000			UNAMSAT 1	12 kg
	Failed to reach orbit			
1995 Mar 28/1000			EKA 2	200 kg
	Failed to reach orbit			

Maiden flight of Start launch vehicle. Gurwin 1 was an Israeli satellite, carrying amateur digital store and forward transponder, Elisra Earth observing CCD camera, ultra-violet spectroradiometer, millimetre-wave digital video experiment, GPS navigation receiver and X-ray detectors. Satellite was box-shaped, 0.46 metres high and 0.43 metres across. It was developed as the result of collaboration between the Faculty of Aerospace Engineering at Technion Institute in Haifa, Israeli Space Agency in Tel Aviv and Amsat-IL. UNAMSAT 1 was an amateur radio satellite, built by UNAM Autonomous University of Mexico using Amsat-NA's MICROSAT design. Carried amateur store-and-forward communications link and meteor detector. Russian EKA 2 was a dummy satellite.

Reports suggested that the fifth stage of the Start launch vehicle disintegrated with debris falling in the Sea of Okhotsk. Start is a five-stage launch vehicle, similar to the four-stage Start-1 (used for the 1993-14 launch). Launched from Plesetsk. ITAR-TASS stated that the intended orbit for the three satellites was inclination 78 deg, altitude 700 km (presumably a near-circular orbit was intended).

1995 Mar 28/2314	1995-016A		BRASILSAT B2	1,780 kg
1995 Mar 28.77	7.07 deg	637.64 min	287 km	36,037 km
1995 Apr 7.70	0.14 deg	1,435.90 min	35,762 km	5,803 km
1995 Mar 28/2314	1995-016B		Hot Bird 2	1,800 kg
1995 Mar 29.65	6.98 deg	631.51 min	235 km	35,774 km
1995 Apr 9.65	0.04 deg	1,436.18 min	35,779 km	35,797 km

Brasilsat B2 is a telecommunications satellite (data and television transmissions, telephone and telex links) launched for Embratel in Rio de Janeiro, Brazil and built by Hughes Space and Communications. Satellite is cylindrical, 3.6 metres diameter, 3.6 metres high at launch and 8.4 metres high deployed in orbit. The mass quoted above is that at launch: on station it is 1,052 kg and the dry mass is 856 kg. The satellite is to be operated over 295 deg E, but was initially located over 298-299 deg E.: its operational lifetime is expected to be twelve years.

Hot Bird 1 is a television and radio broadcasting satellite, operated by Eutelsat (Paris) and built by Aerospatiale. Body of satellite is a box, 2.8 x 2.2 x 2.5 metres: with the two vanes of solar panels deployed in orbit the span is 22.40 metres. Mass quoted above is at launch: on station it is 1,050 kg and dry 840 kg. Initially located over 11-12 deg E. To be operated over 13 deg E and expected to have an operational lifetime of 11 years.

Launched from Kourou using an Ariane 44LP: third stage remains in an orbit with parameters 6.74 deg, 653.58 min, 299-36,839 km.

1995 Apr 3/1328	1995-017A		ORBCOMM 1	40 kg
1995 Apr 3.89	69.99 deg	99.67 min	736 km	749 km
(In Orbit)	1995-017A/23545 L-1011/Pegasus			
1995 Apr 3/1328	1995-017B		ORBCOMM 2	40 kg
1995 Apr 4.24	69.99 deg	99.62 min	734 km	747 km
1995 Apr 3/1328	1995-017C		MICROLAB 1	68 kg
1995 Apr 4.17	69.98 deg	99.63 min	733 km	749 km

ORBCOMM satellites use Orbital Sciences Corporation MicroStar satellite platform. Each satellite has a body shaped like a thin drum with two circular panels of solar cells deployed, plus a gravity gradient boom carrying a UHF/VHF antenna. Stowed the satellites are individually 1.4 metres diameter x 0.165 metres deep: deployed in orbit the length is 4.32 metres and the width across the solar panels is 2.24 metres. Satellites launched for communications, but reportedly the satellites developed problems in orbit. Planned operating lifetime was 4-6 years.

MICROLAB 1 is again based upon the MicroStar satellite platform: carries Optical Transient Detector for the study of lightning and understanding of major atmospheric storm systems and a GPS meteorological experiment to study the occultation of GPS signals. Planned operating lifetime is 2 years.

Lockheed L-1011 "Stargazer" Tristar took off from Vandenberg Air Force Base at 1251 33 seconds UTC and Pegasus was deployed at 1348 29 seconds UTC. Pegasus third stage is in an orbit similar to those listed for the satellites.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1995 Apr 5/1116	1995-018A		Ofeq 3	225 kg
1995 Apr 5.79	143.38 deg	95.63 min	368 km	730 km

Third satellite launch from Israel. Ofeq 3 ("Horizon") is a three-axis stabilised platform, 1.2 metres diameter at the base, 0.7 metres diameter at the top and 2.3 metres high: has two deployed solar panels. Mass of satellite bus is 189 kg and the mass of the on-board experiments is 36 kg. Ofeq series is reportedly a test-bed for future reconnaissance systems, and Ofeq 3 is widely reported to have carried an imaging system. At the first pass through apogee an on-board propulsion system ignited to raise the perigee of the orbit - the first time that an Israeli satellite had manoeuvred in orbit. Planned final orbit is approximately 500 km circular, although no further manoeuvres had taken place through to the end of May 1995. Launched from Palmachim: Shavit ("Comet") third stage remained in an orbit with parameters 143.38 deg, 94.39 min, 246-732 km

1995 Apr 7/2347	1995-019A		AMSC 1	2,700 kg *
1995 Apr 8.27	26.43 deg	718.32 min	220 km	40,162 km
1995 Apr 19.62	0.09 deg	1,435.68 min	35,760 km	35,797 km

AMSC 1 is a communications satellite using Hughes HS-601 bus, operated by American Mobile Satellite Corporation (AMSC) for mobile telephone communications: also called MSAT 2. Satellite has a box-shaped body: at launch it is 3.63 metres across and 4.4 metres high. With its two solar panels deployed in orbit the span is 20.96 metres: across the two main antennae the span is 18.9 metres. Mass quoted above is at launch: on station it is initially approximately 1,650 kg, with a dry mass of approximately 1,270 kg. Satellite is to be operated over 259 deg E: planned operating lifetime is 12 years. Launched from Cape Canaveral using an Atlas 2A: second stage remained in and orbit with parameters 26.45 deg, 716.91 min, 208-40,104 km.

1995 Apr 9/1934	1995-020A		Progress-M 27	7,250 kg *
1995 Apr 9.86	51.66 deg	88.58 min	187 km	221 km
1995 Apr 12.05	51.65 deg	92.41 min	389 km	396 km

Unmanned cargo freighter, carrying supplies to the cosmonauts aboard the Mir Complex. Spacecraft docked with the front port of the Mir Complex April 11 at 2101 UTC. Spacecraft is a cylinder with two vanes of solar panels + beehive + spheroid, maximum diameter 2.72 metres, length 7.9 metres (including the docking probe). When Progress-M 27 is de-orbited at the end of its mission it is thought to be deploying the Raduga capsule launched in November 1994 aboard Progress-M 25. Launched from Tyuratam using a Soyuz vehicle: third stage was in an orbit similar to the first one listed for the satellite, decayed April 11.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1995 Apr 21/0144	1995-021A		ERS 2	2,516 kg
1995 Apr 21.14	98.55 deg	100.52 min	783 km	784 km

Second "European Remote Sensing" satellite to be launched. Prime contractor was DASA/Dornier GmbH in Germany. Body of satellite is box-shaped, 11.8 metres high at launch. Solar array is 2.4 x 11.7 metres span extended from one end of the spacecraft, with a synthetic apature radar antenna (1 x 10 metres) extended from the opposite end of the satellite. Primary mission comprises remote sensing of the Earth's oceans, atmosphere, ice and land in the microwave, infra-red and visible wavelengths. Planned operating lifetime is three years. Launched by an Ariane 40 from Kourou: Ariane third stage is in an orbit similar to the one listed for the satellite.

Updates from previous launches

1977-048A GEOS 2 restabilised its orbit over 185-186 deg E during 1995 Apr 12-21.

1979-098B DSCS-2 14 was boosted off-station over 85 deg E approximately 1995 Apr 12. It was still drifting at the end of the month.

1983-094A RCA Satcom 2R was manoeuvred off-station over 287-288 deg E approximately 1995 Mar 5-6.

1985-025A INTELSAT 510 was manoeuvred off-station over 65-66 deg E approximately 1995 Mar 17.

1985-087A The period during which INTELSAT 512 was relocated was 1994 Sep 18-29.

1986-017JE Add a German satellite ejected from the Mir Complex during 1995 Apr 19-20. GeoForschungsZentrum 1 (GFZ) is a laser-reflecting geodetic satellite, built by Kaiser-Threde in Germany. The satellite is a sphere with a diameter of 0.215 metres and a mass of 20 kg. It was launched aboard Progress-M 27 (1995-020A). Orbital data:
1995 Apr 20.06, 51.65 deg, 92.34 minutes, 384 km, 394 km

1989-062A TVSat 2 had its orbit restabilised over 359 deg E approximately 1995 Mar 11.

1991-021A Cosmos 2137 decayed from orbit 1995 Apr 3.

1993-029A Cosmos 2244 decayed from orbit 1995 Mar 18.

1993-044A Cosmos 2258 was manoeuvred off-station during 1995 Mar 1-2 and has been retired: orbital data (the first is the operational orbit):
1995 Mar 1.45, 65.03 deg, 92.78 minutes, 399 km, 422 km
1995 Mar 2.35, 65.03 deg, 90.99 minutes, 229 km, 418 km

1993-060A Cosmos 2264 was manoeuvred off-station 1995 Apr 4 and has been retired. Orbital data (the first is the operational orbit):
1995 Apr 4.28, 65.01 deg, 92.78 minutes, 401 km, 421 km
1995 Apr 5.04, 64.99 deg, 90.85 minutes, 240 km, 393 km
The satellite is now decaying from orbit. This leaves Cosmos 2293 (1994-072A) as the sole operating EORSAT following the retirement of Cosmos 2258 noted above.

1994-006F ODERACS E decayed from orbit 1995 Mar 3.

1994-025A Cosmos 2280 was de-orbited 1995 Mar 10. If the satellite was returned to Earth at the time of the nominal equator-crossing window for its orbital inclination then recovery would have been 1995 Mar 10.3. This implies a lifetime of 316.6 days which is short compared with other recent flights of this class of satellite.

1994-053A Cosmos 2290 continued to manoeuvre in orbit (pre-manoeuvre orbits noted by *):
1995 Mar 5.61, 64.80 deg, 90.31 minutes, 177 km, 402 km *
1995 Mar 5.79, 64.80 deg, 90.96 minutes, 184 km, 459 km
1995 Mar 16.20, 64.80 deg, 90.62 minutes, 183 km, 428 km

1995 Mar 16.57, 64.80 deg, 90.40 minutes, 179 km, 409 km
995 Mar 27.91, 64.80 deg, 90.00 minutes, 179 km, 370 km *
1995 Mar 28.23, 64.80 deg, 92.13 minutes, 182 km, 577 km
The satellite was de-orbited and decayed 1995 Apr 4. If it came down on a pass which would have allowed part of the craft to be recovered then the decay would have been Apr 4.7-Apr 4.8.

1994-063A Soyuz-TM 20 undocked from the Mir Complex 1995 Mar 20 and landed 55 km (some reports have said 36 km) north-east of Arkelyk Mar 22 at 0404 UTC with cosmonauts Viktorenko, Kondakova (both launched on Soyuz-TM 20) and Polyakov (launched on Soyuz-TM 18) on board. With this landing Polyakov has completed the longest space mission by a human being at 437d 17m 58m 16s and also holds the record for the total time in orbit: 678d 16h 33m.. Similarly, Kondakova completed the longest flight by a woman, her flight time (and also that of Viktorenko on this flight) being 169d 5h 21m 20s.

1994-075A Progress-M 25 undocked from the Mir Complex 1995 Feb 16 at 1305 UTC.

1995-003A UFO 4 was relocated from 189 deg E to 182-183 deg E during 1995 Mar 11-20.

1995-004F ODERACS 2D decayed from orbit 1995 Mar 2.

1995-005A Progress-M 26 undocked from the Mir Complex 1995 Mar 15 at 0227 UTC and was de-orbited later that day.

1995-006A Foton 7 (Flight 10) was recovered 1995 Mar 3.36 (0834 UTC), landing 135 km south-east of Orenburg. The descent module and the experiments were badly damaged (the ESA Biobox was wrecked and one of the experiments was lost) when the recovery helicopter was forced to drop the re-entry module due to the bad weather conditions at the landing site. The Soyuz launch vehicle's orbital stage had decayed from orbit on March 12.

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Preliminary Schedule (Abbreviated)

Friday, October 13, 1995

All Day	Tours—something for everyone!
10am-5pm	Exhibits and Listening Post
12-4 pm	Special interest groups
1-2 pm	Scanning Atlanta - Roger Cravens
2 - 4 pm	International Broadcaster's Forum
7-7-:30pm	Opening ceremony
7:30-8:30pm	MT Expert panel/ Rachel Baughn, host
8:45-9:45pm	ST Expert Panel / Larry Van Horn, host

Saturday, October 14, 1995

9-11:15am	Seminars
9am	Exhibits Open
11:15am-1pm	Lunch
3pm	Exhibits Close
1-4:15pm	Seminars
4:30pm	Bug Hunt (outdoors)
5:15pm	Prize drawing
7pm	Banquet, followed by Post-Banquet Bug Hunt

Sunday, October 15, 1995

9am-1:45 pm	Seminars

Pre-Registration Form

❒ Enclosed is my $55 registration fee
❒ Enclosed is my $23.95 Banquet fee

Name ______________________________
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City ____________________ State ______ Zip __________
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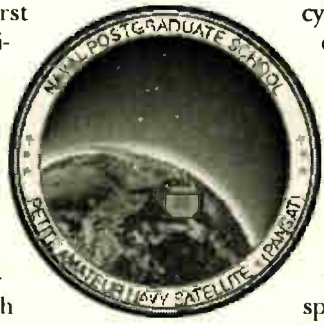
Card# ____________________ Exp. date __________

By John A. Magliacane, KD2BD

PANSAT: Amateur Radio's First Spread-Spectrum Satellite

Amateur Radio's first spread-spectrum digital communications satellite is currently under construction by the Space Systems Academic Group at the Naval Postgraduate School in Monterey, California. PANSAT (the Petite Amateur Navy Satellite) is expected to be ready for launch from the space shuttle perhaps as early as next year. PANSAT will offer the amateur radio community its first spread-spectrum, store-and-forward digital communications satellite, while offering students at the Naval Postgraduate School hands-on experience in system design, hardware and software development, system integration, testing, and operation studies.



PANSAT Description

PANSAT will be launched from a space shuttle Get Away Special (GAS) canister into a low-earth orbit with an altitude of 480 km (298 miles) and an inclination of 28.5°. The low altitude and inclination PANSAT's orbit will limit the access time to the satellite, particularly over extreme northern and southern latitudes. Atmospheric drag will limit the operational lifetime of the satellite to about two years.

PANSAT's physical structure approximates that of an aluminum sphere with a diameter of about 48.26 cm (19 inches). Eighteen square and eight triangular aluminum panels make up the outer surface of the satellite. Seventeen of the square panels are equipped with solar panels and four dipole antennas are attached in a tangential turnstile configuration to the triangular plates. The spacecraft interior structure is composed of two equipment plates and a cylindrical support. No attitude control or propulsion mechanisms will be employed by the spacecraft.

Spread Spectrum Communications

PANSAT will employ a half-duplex, direct-sequence, spread-spectrum modulation communications channel on a center operating frequency of 436.5 MHz. Baseband data will be sent at a rate of 9600 bits per second. Users will have access to four megabytes of random access memory (RAM) on the satellite for storage and transfer of messages and files.

Direct-sequence spread-spectrum modulation is a technique that spreads a conventional narrowband signal over a wide range of frequencies by mixing it with a high-speed pseudo-noise (PN) bit stream. The result is a dilution of the signal energy with respect to bandwidth. Spread-spectrum signals have the same energy per bit and the same communications effectiveness as narrowband signals, but their power density at any one frequency is significantly lower. Using spread-spectrum techniques, a narrow-band signal can be spread to a point where it is completely below the noise level of a conventional receiver, making it difficult to detect, intercept, or jam. The spreading effect also reduces interference with other signals on the band, and provides a sensible and practical approach to spectrum management in the Amateur Radio Service.

A spread-spectrum receiver signal uses the same PN code to despread the signal and retrieve intelligence from the spread-spectrum signal. The process of despreading a spread-spectrum signal suppresses conventional narrow-band signals that may be present within the bandwidth of a spread-spectrum signal, making the system robust and resistant to interference from other sources. Even signals much stronger than the desired spread-spectrum signal can be effectively rejected by a spread-spectrum receiver.

PANSAT Operations

PANSAT users will interact with the satellite in a manner similar those using the current constellation of OSCAR (Orbital Satellites Carrying Amateur Radio) satellites carrying digital store-and-forward communication transponders. Once connected to the satellite, a user may send and receive electronic mail messages that have been stored on-board PANSAT, upload and download files, and read spacecraft telemetry. Multiple users will have the ability of communicating with PANSAT simultaneously during the same window of time over just one discrete communications channel.

PANSAT groundstations will employ a packet radio Terminal Node Controller (TNC), a personal computer (PC), and a PANSAT spread-spectrum modem along with a UHF transceiver to establish communications with the PANSAT satellite. The Naval Postgraduate School will provide the groundstation software necessary for successful interaction with the satellite by amateur radio operators. The software promises to include a simple-to-use user interface, and support spacecraft telemetry decoding features so groundstations can keep tabs on the health of the satellite.

PANSAT's receiver will remain active at all times. Upon receiving a connect request from a user on Earth, PANSAT will grant a groundstation access to some of the services available on the satellite. Users will be required to send a disconnect packet to log off the satellite when their communications are completed.

PANSAT Features

As an orbiting mailbox, PANSAT will store electronic mail messages for any amateur radio user who desires delivery of a message via the satellite. A mail recipient must connect with PANSAT at a later point in time to request and retrieve the messages stored in PANSAT's electronic mailbox.

PANSAT's file transfer mechanism is not limited to text files or mail messages, but extends to binary (8-bit) files as well.

Binary files can consist of executable computer programs, graphic image files, or even sound files. Since storage space on the satellite will be somewhat limited, it will be necessary for users of the satellite to delete old messages from storage once they have been read and downloaded.

PANSAT Broadcast Protocol

PANSAT will also be able to "broadcast" files to multiple groundstations within the footprint of the satellite over its single spread-spectrum downlink channel. This will allow multiple groundstations who are receiving PANSAT's downlink to capture data from PANSAT, even though they are not connected to the satellite.

Spacecraft telemetry will be available to users who connect to the satellite, or who receive a telemetry broadcast made by the satellite during periods when the transponder is idle. PANSAT telemetry will be available in a "raw" and undecoded form so as to reduce the size of the telemetry files. The Naval Postgraduate School will provide telemetry decoding software for use with PANSAT. This will take the raw telemetry information issued by PANSAT, and display it in a format that is understandable by humans.

PANSAT Hardware

A Digital Control Subsystem (DCS) on the PANSAT spacecraft will be responsible for supporting an operating environment for the satellite software and provide control of the communications and electrical subsystems as well. It will also provide an interface with the experiment payload, provide access to sensors for telemetry gathering, and control a mass storage system that will organize user mail, files, and telemetry. The DCS will be implemented with redundant control boards that communicate via a shared status register. Should this register fail to update on a regular basis, the secondary DCS control board will assume control of spacecraft operations. DCS board selection will also be under the control of a ground command station.

Read Only Memory (ROM) and Random Access Memory (RAM) will be implemented in on each control board in an effort to provide another layer of redundancy. ROM and system RAM pairs will be made to switch under hardware control, allowing alternate pairs to operate. This redundancy can prevent a single ROM or RAM failure from permanently disabling the operation of the spacecraft. This is important since a single ROM or RAM failure can spell disaster for a satellite such as PANSAT that is under microprocessor control.

The PANSAT mass storage unit is contained within the DCS and will serve as a permanent storage device for user mail, files, telemetry, and storage for updates to the system software. Mass storage will be designed around either an array of static RAM chips with battery back-up, or by flash memories that require no power when idle. The only concern is whether the flash memories under consideration will be reliable in a high radiation environment such as space.

Microprocessor Control

PANSAT spacecraft designers have selected the M80C186XL microprocessor for control of PANSAT's subsystems. The M80C186XL offers low power consumption, high tolerance to radiation, and integrates many common digital peripherals that reduce the overall design complexity of the control system. In addition, the M80C186XL will provide a software environment that is object code compatible with personal computers such as those currently used for PANSAT software development. More importantly, the M80C186XL supports a special preemptive multi-tasking operating system called the Space Craft Operating System (SCOS), and a companion product called BekTek AX.25 (BAX), that implements the AX.25 Amateur Packet Radio (AMPR) communications protocol.

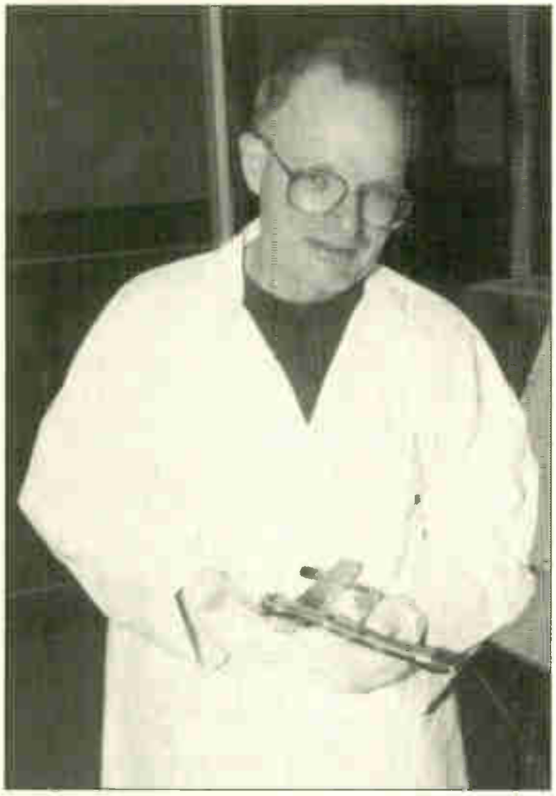
SCOS has had a successful history of providing multi-tasking capabilities in several existing OSCAR satellites carrying digital store-and-forward communication transponders. These satellites include AMSAT-OSCAR-16, DOVE-OSCAR-17, WEBER-SAT-OSCAR-18, LUSAT-OSCAR-19, UoSAT-3, UoSAT-5, and KITSAT. SCOS provides a standard application program interface designed to assist in the development of multi-tasking applications. These services include a real-time multi-tasking kernel, message passing facilities for inter-task communication, and Direct Memory Access (DMA) and Interrupt driven Input/Output (I/O) drivers.

BAX, a companion product of SCOS, has also enjoyed success by providing AX.25 protocol functions for many Amateur satellites carrying digital transponders (PACSATs) currently in operation. The use of both SCOS and BAX frees the PANSAT software developers from implementing operating system and AX.25 protocol driver applications by hand, thereby allowing attention and resources to be directed toward issues specific to the PANSAT satellite itself.

LOS

The Amateur Radio community has long been involved with packet radio communications and is responsible for standards in communication protocols, satellite development, control, and operations. PANSAT designers continue to work closely with the amateur radio community in order to profit from their existing design and operation standards, and to learn from past experiences. It is predicted that the PANSAT satellite will go far in exploring the virtues and benefits of spread-spectrum communications in the Amateur Radio Service, while it adds to microsatellite research and development, and provides additional educational opportunities in mission operations, astrodynamics, mechanical and electronic subsystem design, system integration, software development, and protoflight testing. ST

Phase 3D Construction Update

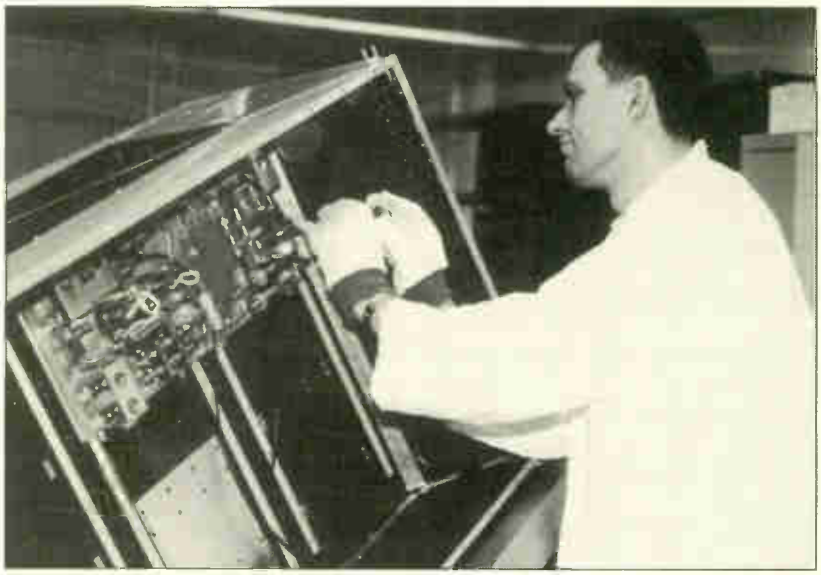


Above: Dick Jansson, WD4FAB, AMSAT-NA VP Engineering, holds the flight model arc jet motor prior to its integration into the AMSAT Phase 3-d spacecraft. The motor was built and donated to the project by students and staff at the University of Stuttgart, Germany, and will be used to make small corrections to Phase 3D's orbit over its anticipated 15 year lifetime. Using an ordinary automobile spark plug, the arc jet expands gaseous ammonia by heating it to a very high temperature. A small amount of thrust is then produced when the gas escapes from the motor's small nozzle.

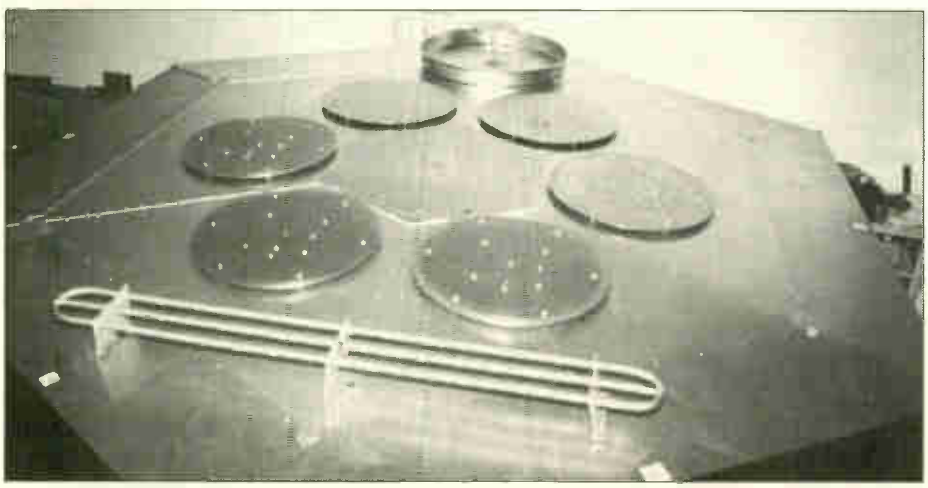
Work on amateur radio's newest satellite continues at the Phase 3D integration facility in Orlando, Fla. Phase 3D is currently scheduled to ride onboard the second Ariane 5 rocket test flight scheduled for launch in April, 1996. Phase 3D is truly international in scope. Not only is it being aimed at bringing satellite operation to within reach of virtually every licensed amateur in the world, but it is being designed and built by an international team comprising people from some dozen countries .

AMSAT still needs funds to help launch Phase 3D. If you are interested in the future of amateur radio in space, you might consider donating to the AMSAT-NA Phase 3D launch fund. If you haven't yet pledged, or made a contribution that can be arranged easily. Just drop a note to AMSAT, PO Box 27, Washington, D.C. 20044, or call 301-589-6062.

The pictures on these two pages show some of the work being done in Orlando by the assembly and integration team working on this ambitious project. Photos courtesy of AMSAT-NA by Keith Baker, KB1SF and Dick Daniels, W4PUJ.



Above: Dr. Dieter Zube installs a portion of Phase 3D's flight model Propellant Flow Assembly (PFA) into the spacecraft. The PFA will control both the flow of hypergolic propellants to the spacecraft's 400 Newton kick motor as well as the flow of ammonia to the satellite's arc jets positioning motor. The kick motor will be used to place Phase 3-D into its final orbit.



Left: A full scale mockup of Phase 3D's top panel has been constructed for testing antennas without disturbing ongoing spacecraft integration efforts. Here, one of three V-band dipoles, as well as the U-band patch array and L-band short backfire antennas are clearly visible in the mockup.

Above: The flight prototype U-band patch array undergoes testing on the Phase 3D integration facility antenna range. The array exhibits gain figures comparable to that of a commercial 40 element crossed yagi antenna. Actual on-the-air contacts, with surprisingly good results, have been made through the AMSAT Oscar 13 satellite using this array as an uplink antenna.

Above: The completed Phase 3D flight model L-band antenna undergoing gain and pattern testing at the integration facility's antenna test range. Preliminary gain measurements exceeded 15 dBic with a surprisingly clean pattern. The antenna is based on a short-backfire design and uses an all-aluminum wedding cake baking pan for a reflector!

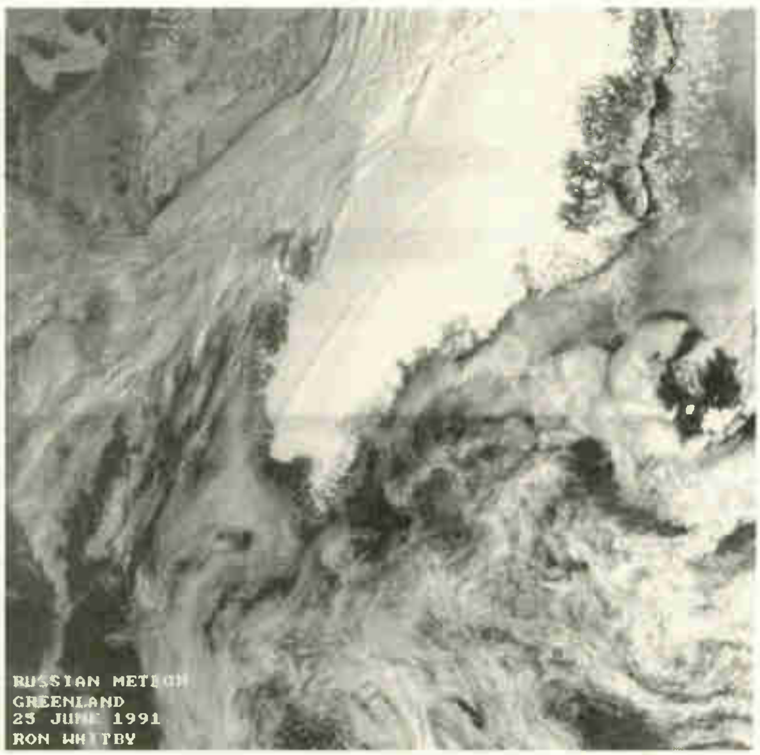
Above: Mike Garrity, N4OZC, displays a flight model prototype of Phase 3D's S-band antenna.

Right: Lou McFadin, W5DID, Phase 3D Integration Manager, holds one of the 12 torquing coils that he manufactured in his garage workshop for Phase 3D. The coils will be used to help position the satellite in space by working in concert with P3D's reaction wheels, and by interacting with the magnetic field of the Earth. A similar torquing coil system is currently in use onboard the Oscar 13 satellite.

The View from Above

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

Monitoring the Russian Weather Satellites



A typical visible APT image from Meteor 2-16 captured by Ron Whitby from the Remote Imaging Group in the United Kingdom.

Several weeks ago a *Satellite Times* subscriber called the Dallas Remote Imaging Group office to inquire about a strange signal monitored on 137.850 MHz. The signal, monitored at 1342 local time sounded almost like the NOAA weather satellite Automatic Picture Transmission (APT) mode, yet is was somewhat 'different'. Without the appropriate APT demodulator and display software, this satellite enthusiast had no way of capturing the signal. If she had, a beautiful weather satellite image of Cuba and the southern U.S. coast would have been displayed. The telemetry that she heard was an APT image from the Russian Meteor 3-5 weather satellite!

The CIS (former Soviet Union) has had, and continues to have a very active meteorological space program. In fact, weather satellites were the Russian's first civil applications satellite project (contrasted with the renowned military spy satellite and reconnaissance program).

The 'Meteor' program is a series of Russian polar-orbiting weather satellites, analogous to the U.S. NOAA Advanced TIROS platforms (NOAA 9,10,11,12,14). The Meteor satellites have both visible and infrared APT imagery, but no High Resolution Picture Transmission (HRPT has a 1 km or .62 mile resolution) data products like the NOAA series.

Meteor 1 was launched on March 27, 1969, and was the first satellite identified by the Russians as part of the 'Meteor' satellite series. Prior to Meteor, some precursor weather satellites under the Cosmos label had been launched as early as 1962. Cosmos 4, launched in April 1962, was a military observation satellite that also transmitted televised cloud coverage. Cosmos 122 launched in mid-1966 was the first Russian experimental weather satellite for civilian and military use. The early weather satellites were launched from the southern Russian cosmodrome at Baikonur into 65 degree inclined orbits, at about 640 km (397 miles) altitude. Cosmos 144 was the first weather precursor to be launched from the Russian's northern cosmodrome at Plesetsk into an 81 degree orbit. Plesetsk launches gave the Russians a higher launch latitude that made their polar orbiting spacecraft more efficient. The fifth Meteor 1 satellite was launched June 23, 1970, was the first to enter into a 900 km (558 miles) orbital slot which later became the standard for these first generation satellites.

Instrumentation on the first generation Meteors included television cameras and scanning radiometers. Meteor 10 (launched December 1971) was the first platform to carry the Automatic Picture Transmission (APT) data product and it was nearly compatible with the U.S. NOAA TIROS demodulation scheme.

Second generation Meteor satellite (Meteor 2-X) launches began in July 1979, and provided:

- Twice a day information on cloud, ice, snow in both visible and infrared.
- Twice a day global information on temperature fields and cloud data heights.
- Surface water temperature measurements.

The Meteor 2 spacecraft carry the following instrumentation:

- Scanning telephotometer for direct imaging in the 0.5-0.7 microns band with 2,100 km (1,302 miles) swath coverage at 2 km (1.24 mile) resolution.
- Scanning infrared (IR) radiometer in the 8-12 microns band with 2,600 km (1,612 miles) swath coverage at 8 km (4.96 miles) resolution.
- Scanning spectrometer with eight channels in the 11, 10-18 and 70 microns bands providing 1,000 km (620 miles) swath coverage at 30 km (18.6 miles) resolution.

APT downlinks from the Meteor 2 satellites are typically transmitted on 137.300, 137.400 and 137.850 MHz., depending on the satellite (most of the satellites can transmit on at least two of the three frequencies). The Meteor platforms generate a frequency modulated (FM) signal, with a 2,500 Hz modulated subcarrier which is different than the NOAA series spacecraft 2,400 Hz subcarriers.

An image from Meteor 3-4 that shows the telemetry bands, grayscale, and binary code described in the column. This image is by Charlie Davis of the Dallas Remote Imaging Group and shows Canada, Hudson Bay, the Manicugan Crater, and the Great Lakes.

Meteor 2 series spacecraft are typically launched into a 960 x 941 km (595 x 583 mile) near polar orbit, originally inclined at 81 degrees and was this was later changes to 82.5 degrees inclination. They were sent up as a 'constellation' of three satellites in orbital planes spaced 60 degrees apart that provided excellent global coverage.

Meteor 3 series spacecraft made their first appearance on October 24, 1985 with the launch of Meteor 3-1. These satellites are inserted into the same 82.5 degrees inclination orbit as the Meteor 2 series, but are placed at a greater altitude of 1,200 km (744 miles) to prevent coverage gaps in the equatorial regions. The standard payload for Meteor 3 series is also similar to that carried on Meteor 2 spacecraft.

- Scanning telephotometer for direct imaging in the 0.5-0.8 microns band with 2,600 km (1,612 miles) swath coverage at 0.7 x 1.4 km resolution.
- Scanning telephotometer for global coverage in the 10-12 microns band with 3,100 km (1,922 miles) swath coverage at 3x3 km resolution
- Scanning IR spectrometer with ten channels in the 9.65-18.7 microns band providing 1,000 km (620 miles) swath coverage at 42 km (26 miles) resolution.
- Multi-channel ultraviolet (UV) spectrometer in the 0.25-0.38 microns band with 200 km (124 miles) swath coverage at 3-5 km resolution in altitude
- Meteor 3-5 has a Total Ozone Mapper Spectrometer (TOMS - U.S. Instrument flying onboard Meteor) to measure atmospheric ozone depletion.

Most of the Meteor 3-X series satellites (Meteor 3-5 is currently the only spacecraft active in this series) transmit on 137.85 MHz.

One interesting observation concerning Meteor 2 on-orbit operations is that the spacecraft will be in the middle of an observable pass, transmitting beautiful imagery, then all of a sudden the transmitter is turned off! The spacecraft is still well above the horizon, and should still be transmitting....so then why does this happen?

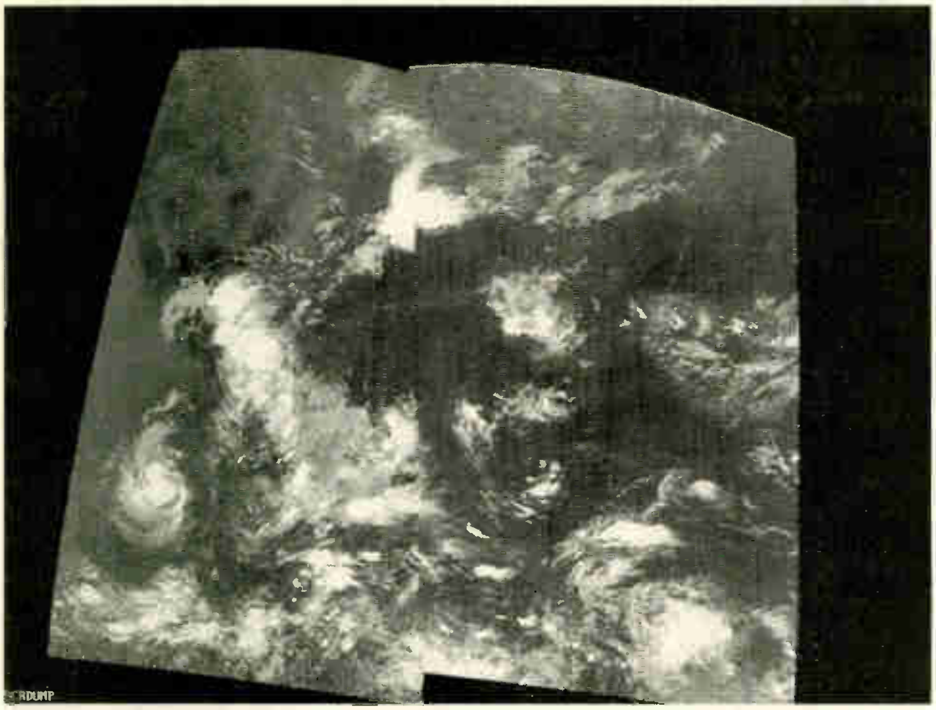
Careful analysis of the orbital track indicates that as the Meteor 2 satellite approaches the terminator (demarcation between daylight and darkness), the spacecraft switches off its APT transmissions when the satellite enters darkness. This is done by light sensors aboard the spacecraft. The reason for this is that the Meteor 2 satellites do not have a functional IR imaging system, and there was no reason to transmit visible imagery in areas of total darkness.

Early Meteor 3 satellites also lacked an IR system and consequently also shut off APT transmissions in darkness areas. Later spacecraft in the series (Meteor 3-4 to 3-6) have a good, functional 120 lines per minutes (LPM) IR imagery system and do not switch off APT imagery when the spacecraft crosses the terminator. It should be noted, however, that some of the Meteor 1 and 2 spacecraft did have a crude 20 LPM IR

Another visible image of the Great Lakes by Meteor 3-4 captured by Charlie Davis (another avid ST subscriber!).

capability, but it was typically turned off over the United States.

Another noticeable difference between Meteor and the U.S. NOAA satellites is the gray scale 'wedges' on the NOAA TIROS



Infrared map (mosaic) of the central U.S. imaged by Meteor 3-4 and captured by Mark Sims of DRIG. The longitude/latitude lines were created by one of Mark's utility programs.

birds vs. the six-bit analogue binary code next to the image of a Meteor satellite. The edge-code of Meteor 2 series correlates well with the solar illumination at the sub-satellite point on Earth and varies from 10, when the solar elevation is above 75 degrees to the maximum of 63, when the solar elevation is about 8 degrees. This binary code is most likely used for an automatic exposure mechanism for the proper exposure of imaged pictures. The Meteor 3 series satellites also contains a numerical edge-code which includes a clock. The top number in each one-minute frame advances by one in successive frames and is a count of the number of minutes after midnight, Moscow time.

Another Russian remote sensing satellite that can be monitored (usually on 137.400 MHz) and imagery captured by enthusiasts is the Okean series spacecraft. The Okean platform became operational in 1988 and is the first in a series of oceanographic remote sensing satellites. This satellite's payload includes:

- Synthetic aperture radar (SAR)
- Microwave radiometer/sounder
- Medium and high multispectral scanners
- Visible APT-like imagery (3 channels) with 200 meter (660 feet) resolution
- Infrared APT imagery (3 channels) with 600 meter (1,980 feet) resolution

A special system on the Okean platform called 'Condor' permits data collection by sea or ground-based instruments and transmissions are also relayed to ships at sea via the Ekran geostationary satellite system. The Okean satellites monitor:

- All-weather monitoring of sea-ice conditions
- All weather monitoring of seaway, storm, and cyclone regions
- Radar and optical monitoring of ocean surfaces

The Okean images are often accompanied by telemetry coding which is known as the 'piano-keys' by monitors because it resembled the black and white keyboard of that instrument. Images that are purely visible, or a mix of visible/IR, or very rarely visible/IR/SAR were accompanied by a number of sequence telemetry. These numbers have caused quite a bit of interest. Geoff Perry, Max White, and others in the European Kettering Space Group have successfully decoded this telemetry and it appears to be a relative of the clock information telemetry described above for the Meteor 3 series satellites.

As you can see, the Russians have a rather active polar orbiting weather satellite program. Keep your receivers tuned to 137.400 and 137.850 MHz and enjoy some interesting images!

If you would like to see a larger sample of Russian weather imagery, modem equipped hobbyists can access the Dallas Remote Imaging Group library of Russian satellite photos. Simply dial 214-492-7057 (28.8K) or telnet to 204.77.64.254 2008 (note TCP Port address of 2008) and login to the BBS. The ftp address is 204.77.64.2.

A View from Above Satellite Update

GOES-J (GOES 9) was successfully launched on May 23, 1995 at 0152 from Kennedy Space Center. It will be stationed at 90 degrees West longitude during the 3 month checkout period. For more information on this satellite and the rest of the GOES-Next program, see this issues cover feature on page 10.Till next issue, keep in touch and keep watching the View from Above. ST

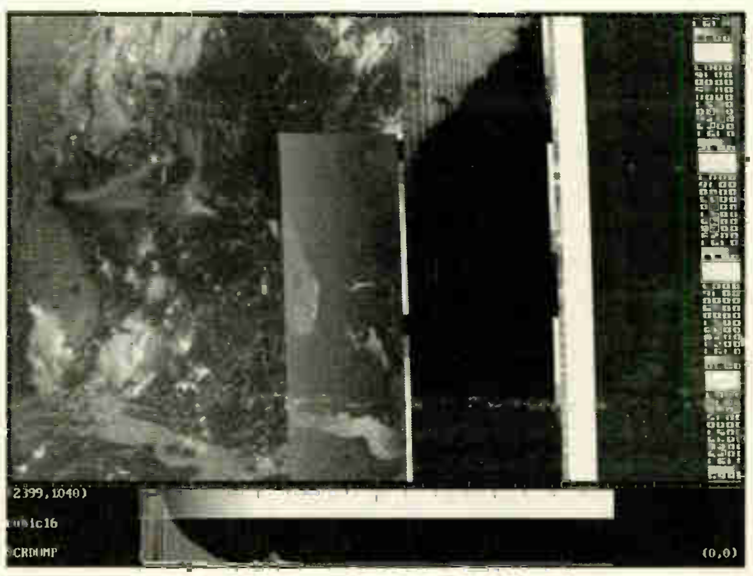
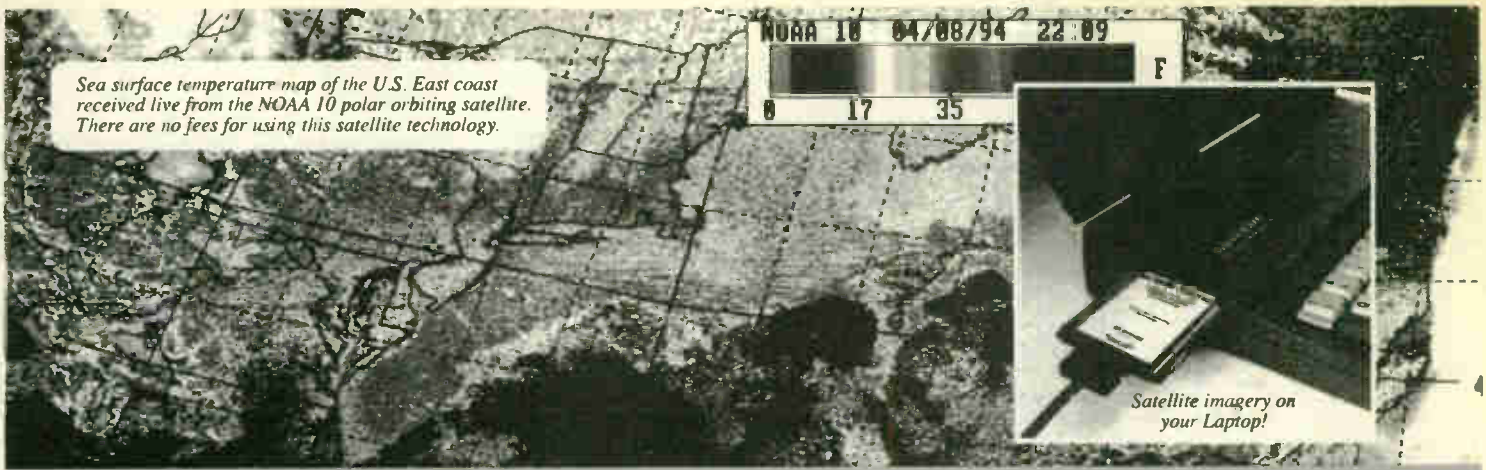


Image from Okean 1-7 and images Florida and Cuba in visible, IR, and radar bands.



Sea surface temperature map of the U.S. East coast received live from the NOAA 10 polar orbiting satellite. There are no fees for using this satellite technology.

Satellite imagery on your Laptop!

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OFS WeatherFAX PCMCIA Convertible is an easy-to-use card and software package for your desktop and laptop computer that acquires high quality satellite pictures directly from polar and geostationary orbiting weather satellites and HF Marine fax. Get real-time high resolution images of cloud cover and sea surface temperatures. Enhance your images using the extensive enhancement tools, print to a wide variety of printers, save using standard file formats and use with your other software programs. There are no fees for using this exciting satellite technology.

The compact PCMCIA "credit card" satellite demodulator is hot-plugable into IBM compatible Laptops and Desktops (using the ISA bus converter card) and attaches to the audio output of the portable satellite receiver. WeatherFAX is the only system to use military proven Carrier Peak Sampling (CPS) technology that provides noticeable clearer and sharper satellite images.

Plug into any unused slot in your desktop

Best NOAA/ Meteor APT! Unplug the PCMCIA card from your desktop and use on your laptop while traveling to always get the latest satellite information. Your laptop satellite system is completely portable for use on boats, airplanes or emergency vehicles. Just leave it unattended and all satellite passes are automatically captured, no satellite tracking is needed.

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<u>Captures All Satellites</u> - GOES/Meteosat/ GOESTAP WEFAX, NOAA/Meteor APT, NAFAX and wirephotos.

<u>Advanced Capture Board</u>

Low power PCMCIA type II card installs in desktops (ISA) and laptops (PCMCIA).
Carrier Peak Sampling (CPS) Technology provides a noticeably improved image.
Auto Start/Stop for all modes.
Crystal locked digital design eliminates all adjustments.
Digital automatic gain lock adjusts to all signal levels.
Captures full image at full resolution.
Self test modes verify operation.
FCC Part 15 Class B certified.

<u>Full Function Software:</u>

MS Windows compatible. Software runs under DOS or Windows.
Automatic operation, satellite tracking not required.
Temperature calibration & contour maps.
Coastlines, state outlines and latitude/longitude grid worldwide overlay.
Distance & Direction measurement tool.
Pixel Photometry using mouse cursor displays Lat/Lon & temperature.
Decodes Headers of Meteosat, WEFAX and GOESTAP for sorting animation loops. Scheduling not required.
Animate sequences of Vis, IR and WV.
3-D projection and filters that sharpen, smooth and remove noise.
Annotate image with labels/lines/points.
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Donald E. Dickerson, N9CUE

Orbcomm Launches First Two PCS Satellites

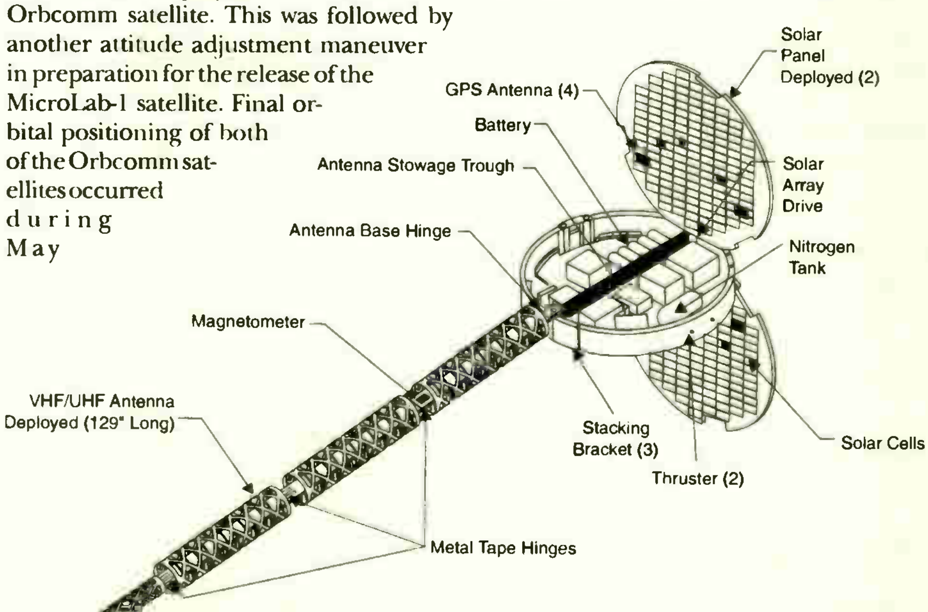
They are only 104 cm (41 inches) in diameter and 16.5 cm (6.5 inches) tall and weigh in at less than 40.5 kg (90 lbs). Two of them were placed into orbit on April 3, 1995 from Vandenberg Air Force Base in California and have reached their planned operating orbit of 728 km (455 miles). These two satellites have made history in several ways, not the least of which is the first two operational spacecraft in the personal communication satellite (PCS) service. They are intended to provide worldwide two-way data messaging, paging service.

These communications spacecraft are known as Orbcomm 1/2 and they are the property of Orbital Sciences Corporation (OSC). OSC has now fired the first shot in the PCS revolution. These two satellites are revolutionary in size and design and in their method of launch.

These satellites were launched by the Pegasus launch vehicle which was developed by Orbital Sciences and Hercules Aerospace Company with private capital. The innovative air-launch approach pioneered a full range of technological innovations in rocket design, manufacturing techniques and launch operations making Pegasus more reliable, flexible and affordable than other launch vehicle. A new, enhanced rocket the Pegasus XL is now available for more mission flexibility. The Pegasus system has excellent rapid response capability for the launch of new spacecraft or the replacement of failed satellites.

The Pegasus three stage launch vehicle is carried under the belly of a modified L-1011 aircraft. During the April launch, the two Orbcomm spacecraft (Flight Models 1 and 2) and a third satellite, the MicroLab-1, were carried to altitude of 40,000 feet by the company's L-1011 aircraft in the Pegasus rocket before being released for launch. Once released, the Pegasus rocket was allowed to free fall away from the aircraft in a horizontal position for 5 seconds before the first stage rocket motor ignited. The three stage launch vehicle followed a lift assisted trajectory with the use of a small wing. From this altitude the Pegasus vehicle and its three satellite payload reached orbit in approximately 12 minutes. The OSC L-1011 aircraft was 50 miles off the California coast during the launch.

Initial indications are that Orbital's patented Microstar satellite constellation deployment sequence worked as planned. For this mission, the first Orbcomm satellite was released from the rocket's third stage in a southerly direction minutes after orbit was achieved. Pegasus then carried out an attitude adjustment maneuver, re-aligning itself to face in a northerly direction for the deployment of the second Orbcomm satellite. This was followed by another attitude adjustment maneuver in preparation for the release of the MicroLab-1 satellite. Final orbital positioning of both of the Orbcomm satellites occurred during May and June and that maneuver placed these two satellites on opposite sides of the earth from each other.



The Orbcomm satellite based data and message communications system will have many commercial, personal and defense applications. Some of Orbcomm's commercial applications will include:

- The ability of the trucking industry to monitor and determine the location of cargo shipments
- Remote industrial and environmental monitoring
- Security alarm monitoring
- Animal tracking (for researchers)
- Satellite based alarm system for your car that can track it even if it is stolen.

Medical monitoring, emergency services, and search and rescue organizations will also be able to use the Orbcomm satellite system easily. To take this one step further, even the military can use many of these same applications and even some more specialized services. Ship, transport, aircraft and tanks can be monitored and located instantly. Special Forces as well as military search and rescue operations can take advantage of Orbcomm's data burst communication techniques that lower the risk of detection behind enemy lines.

"The launch of the first Orbcomm satellites," according to Orbital's President Mr. David Thompson, "culminates over four years of hard work and intense dedication from many people at Orbital. This successful launch brings Orbcomm's plans to the point of final implementation. At the same time, we are now ready to introduce a fundamental change in the way people all over the world live, work and play through our low-cost, satellite-based communications network that will work everywhere." Mr. Thompson further stated, "this successful launch marks the first time one company, in this case Orbital, has built all components of a satellite system, from the satellites to the launch vehicles to the ground control system. We are proud of these accomplishments and the team that has made them possible."

The successful launch and testing these two spacecraft will allow Orbcomm to begin deploying their proposed 26 satellite system over the next two years. Limited service to the United States using these first two satellites is expected to start this month.

The Microsat design of these spacecraft allows a single Pegasus XL launch vehicle to carry what Orbcomm calls an "Eight Pak" into orbit. It will require three Pegasus XL launches to get the rest of Orbcomm's 26 satellite constellation into orbit.

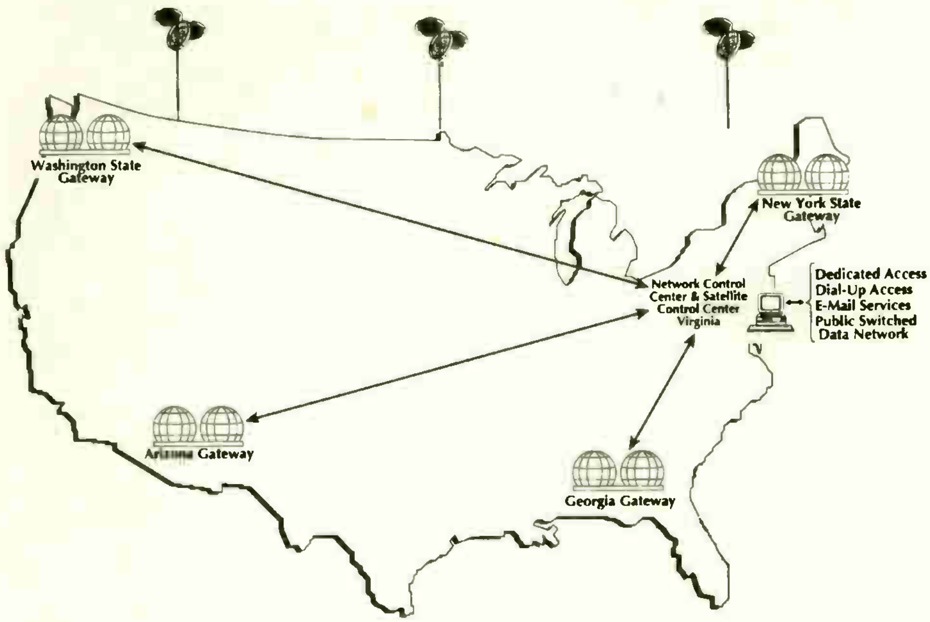
The satellites are considerable larger once deployed. The solar panels pop-out and span a total of 20.3 cm (88 inches) while a hinged VHF/UHF antenna extends out to 327.6 cm (129 inches). The spacecraft's power system will provide 14 volts and this is supplied by two solar arrays. The digital electronic bus will overate at a regulated 5 volts. Telemetry, Tracking and Command (TT&C) will be accomplished on a discrete VHF frequency at 57.6 Kbps. It will get further assistance from an onboard GPS navigation and timing system.

Telemetry from both satellites has been received at Orbcomm's gateway Earth stations (GES) and relayed to Orbcomm spacecraft control center (SCC) in Dulles, Va. Three GES's are operational in Georgia, Arizona and New York. A fourth is planned for Washington state. All three gateway stations have received satellite telemetry from the two orbiting satellites. Telemetry has indicated that both spacecraft successfully deployed their solar panels and antennas. Both spacecraft have sent to Earth telemetry indicating signal strength, temperatures, attitude control and power levels are all normal. Initial tests of Orbcomm communications system software indicates it is also operating as expected.

Above: Orbcomm hand-held personal communicator.

At left: One of four Orbcomm Gateway Earth Stations Is in the Arizona Desert.

Since the April launch, both satellites have suffered anomalies that have prevented them from communicating with ground stations. On April 15, SCC personal discovered a problem with the subscriber communications subsystem on the Orbcomm 1 satellite. On May 22, OSC announced that it had restored the ability to receive transmissions from the subscriber unit. The recovery of the subscriber communicator receiver function on Orbcomm 1 was accom-



plished by sending commands to the satellite that corrected an apparent software blockage. Additional efforts to restore the ability to transmit on Orbcomm 1 to subscriber units continues at presstime.

Shortly after launch, Orbcomm 2 developed a problem with its gateway communications subsystem, preventing the satellite from responding to transmission from ground stations. A software problem appeared to be the cause of this problem. The problem was resolved on May 13 when the satellite reset itself and normal communications was re-established.

According to Orbital spokeswoman Laura Ayres, "Just one component on each satellite was at issue, everything else has worked fine."

Orbcomm satellites will use uplink frequencies of 148.000 to 149.900 MHz for the hand held units used by the customers. The downlink to these handheld units will be from 137.000 to 138.000 MHz. The downlink frequencies to the gateway Earth stations will be between 400.050 and 400.150 MHz. These satellites will use either 2400 or 4800 bps data rates using the standard X.25 and X.400 (CCITT 1988) protocols.

For those of you who might be interested in the third spacecraft that was carried into orbit on this Pegasus launch, the MicroLab-1 was also built by Orbital Science Corporation and carried two scientific instruments. The first instrument is an Optical Transient Detector, developed by NASA's Marshall Space Flight Center and it is designed to study lightning patterns around the world. The second instrument is a Global Positioning System (GPS) meteorological experiment developed by the University Corporation for Atmospheric Research (UCAR) for the National Science Foundation and is intended to study the effects of the Earth's atmosphere on GPS signals.

With a little luck, the world's first affordable satellite based two-way data messaging system is just around the corner. There will probably be, what up to now has been unthought of applications, that will make the PCS space revolution even more exciting.

The SCC in Dulles, Va. enables engineers to monitor and control satellite operations.

AMSC 1 Testing Complete

American Mobile Satellite Corporation recently announced that in-orbit testing (IOT) has been successfully completed on its AMSC 1 (MSAT 2) satellite which was launched on April 7 from Cape Canaveral Air Force Station, Fla. The spacecraft met all testing performance expectations, allowing IOT to be completed ahead of schedule. AMSC 1 is positioned at its orbital slot of 101° West and the telemetry, tracking and control (TT&C) functions have been handed over to Hughes Communications Inc.

At presstime, AMSC was testing the ground segment located at the Reston, Va. facility and the mobile terminals in conjunction with operational testing on the satellite. In conjunction with this testing a transmission was sent to the satellite which caused certain components of the communications payload to overheat.

The overheating damaged one of eight output hybrid matrix ports that serve the spotbeams covering the Eastern and Central United States. The other seven hybrid ports are operating in accordance with specifications. The remaining four spotbeams, covering the Mountain and Western portions of the United States, Alaska, Hawaii and the Caribbean, were not affected.

Test to date have indicated that, notwithstanding the loss of this single hybrid port, the power output in the Eastern and Central spotbeams will not be significantly less than specifications. Furthermore, adjustments in the operation of the satellite can be made to compensate for the power loss. In addition, AMSC believes that the quality and the life of the satellite will not be affected.

"We are pleased with the exceptional performance of the satellite and the progression of the testing on the ground segment and mobile terminals. Everything looks great for the rollout of our services," said Brian Pemberton, President and Chief Executive Officer of AMSC. "We are excited about the level of enthusiasm and support our products have received in the marketplace."

Well that about does it for this issue's PCS column. Remember, if you have a question or comment, send them into our Brasstown address. Most of all stay tuned as the drama of this new PCS technology continues to unfold in the months to come...till next time around. ST

By Jeffery M. Lichtman

A Simple Solar Flare Detector

One of the simplest projects an amateur radio astronomer can construct is the VLF (Very Low Frequency) solar receiver. This receiver can be used to monitor Earth's nearest star—the Sun and its solar flares. The receiver itself, less the A/D (analog to digital) converter, can be constructed from a handful of audio frequency parts at minimal cost.

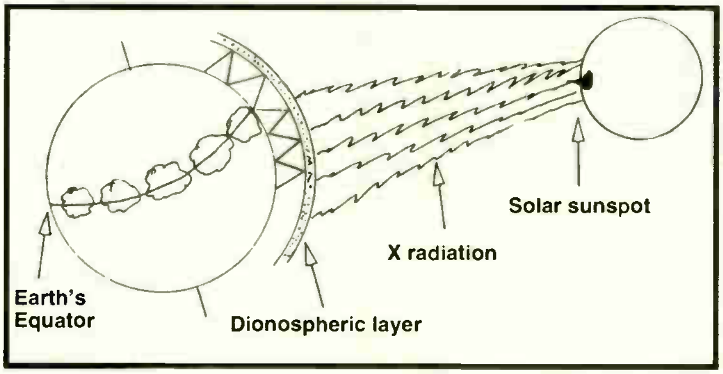


FIGURE 1: *Event Triggering (Courtesy of Radio Astronomy Handbook)*

Before we go any further, let's talk about the structure of the ionosphere and the effects of a solar flare. The lowest portion of the ionized ionosphere is the E layer. The approximate height of the region of maximum ionization is 70 miles. Air is fairly dense at this altitude thus making electrons active due to solar radiation. These particles do not move over great distances before recombining to form a neutral particle. The D layer remains fairly active during the daylight presence of solar radiation.

During times of violent sunspot activity, the solar eruptions generate visible and invisible radiation. Electromagnetic waves are emitted during flare activity at frequencies in the radio, microwave, infrared, visible, ultraviolet and x-rays. Within 8-9 minutes (time it takes the speed of light to travel the distance from the sun to earth), such an event will disrupt the D layer. X-ray flares from the sun will cause an increase number of free electrons making the layer a better conductor and a better waveguide. This has the effect of a sudden enhancement of atmospheric noise.

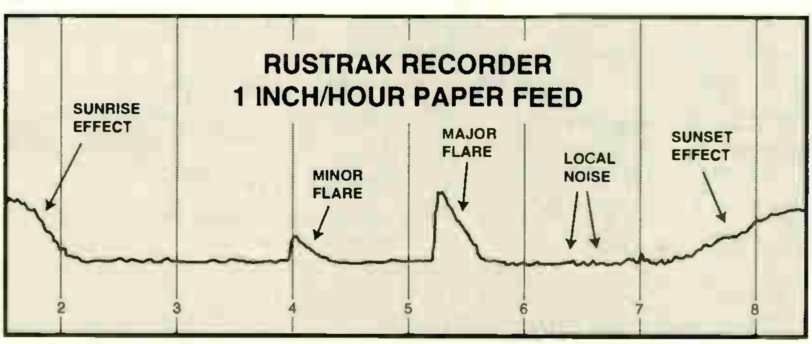


FIGURE 2: *Actual Solar Recording (Courtesy of Radio Astronomy Handbook)*

Referring to figure 1, equatorial lightning storms constantly rage about the earth's equator. The noise from these storms may be heard virtually all over this planet. The noise is conveyed around the earth's curvature with the planet's surface and the D layer of the ionosphere behaving like a waveguide. The lightning pulses can be easily detected many hundreds of miles away. The lightning pulses are propagated within the waveguide area between the earth and the D layer.

If one has a receiver monitoring the radio spectrum under 100 kHz and it is connected to a suitable recording device, these solar eruptions may be monitored. You can chart their amplitude and time characteristics.

Two methods of recording ionospheric disturbances commonly used are the Sudden Enhancement of Atmospherics (SEA), and Sudden Enhancement of Signal (SES).

When using the SEA method, a simple receiver tuned to 27 kHz will use the naturally occurring static caused by thunderstorms as the signal source. By recording the amplitude of these lightning pulse signals, disturbances due to solar flares will result in an increase in amplitude of the received signal, in most cases, rising rather suddenly and then decaying slowly as the ion clouds dissipate back to a normal state.

The SES method is quite similar to the SEA method except, that a known radio station is used as a signal source. By tuning to the particular frequency, (between 17 to 100 kHz) the observer may detect ionospheric disturbances. WWVB-Boulder, Colorado on 60 kHz is a common choice amongst hobbyists.

This method of solar storm monitoring is effective only during daytime hours. This is due to the D layer forming from the suns energy and then dispersing at night. Figure 2 is typical of a daytime WWVB strip chart during which several solar flare eruptions have occurred.

The effects of a major flare will produce a sudden rise in recorded energy with a decay period which typically lasts from 15 minutes to hours or until the D layer regains its balance.

Another popular activity in the VLF realm is monitoring, "whistlers". Whistlers are believed to be created by lightning storms and are propagated at long distances. They occur in the 1-10 kHz region. In the past, NASA (National Aeronautics and Space Administration) has encouraged amateurs to observe this phenomena. A good article on whistlers etc. was done by Michael Mideke for *Science Probe* magazine, July 1992, called "Listening to Nature's Radio." Another article on whistlers was written by *ST* editor Larry Van Horn in the December 1992 issue of *Monitoring Times* magazine called, "DX-ing the Planet Earth." That article is available for $2.00 and an SASE from Grove Enterprises at P.O. Box 98, Brasstown, NC 28902.

In addition, another area of interest is, Gamma Ray Bursts (GRB). In a joint meeting with the GRB investigators at NASA's Marshall Space

FIGURE 3: **VLF Receiver.**

Flight Center, Hunstville, Alabama (August 1993), and the Society of Amateur Radio Astronomers (SARA) it was discussed that there might be a radio component of these bursts. It was felt that some of High Energy Pulses (HEPS) recorded over the years, might be GRBs. For further information on GRBs, see *Air & Space* magazine, June/July 1993 "The Great Gamma Ray Mystery" and "Radio Dispersion As A Diagnostic of Gamma-Ray Burst Distances" by David Palmer, *Astrophysical Journal*, 417:L25 - L28, Nov 1, 1993. The equipment needed for GRB observations includes: a long wire antenna, a simple receiver and a recording device such as a chart recorder or A/D converter.

A simple 40 kHz receiver built by a SARA member, from a design by Robert M. Sickels is shown in figure 3. This receiver has been used for solar flares and Gamma Ray Bursts detection. Another simple SEA receiver used by amateurs is shown in figure 4. This receiver uses an RCA CA3035 and an SK3019. The receiver is fixed tuned for 40 kHz and is designed to operate on +12 VDC.

One of the problem areas the observer will have to guard against is, man made interference. A few types of interference are prevalent at these low frequencies. Power lines generate 60 Hz signals and harmonics, which are present everywhere due to alternating current (AC) power distribution. Any large carrier of power will cause problems for a sensitive receiver.

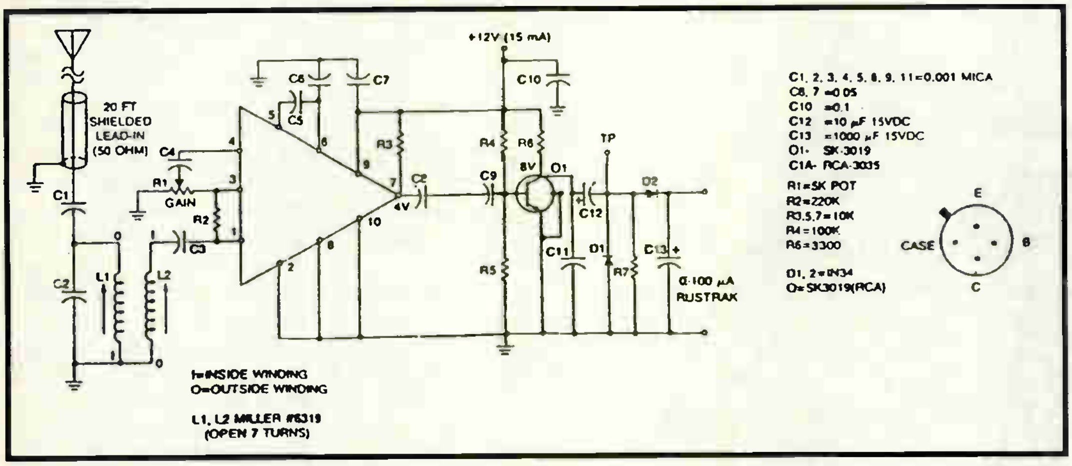


FIGURE 4: **VLF Circuit Schematic**

Another form of interference comes from television sets. The television sets horizontal oscillator operates at 15.734 kHz, and is of the pulse type. In addition, this oscillator produces sidebands. If any of us are married or have teenagers, the electric hair dryer can also causes havoc with sensitive receivers. So as you can see, it would be in the best interest of the observer to isolate the receiver as much as possible from interfering noise sources.

The antenna systems used for such a receiver are quite simple. Figure 5 illustrates a longwire antenna which is quite economical, if one has a suitable area for construction. The antenna should be placed on an east-west baseline. This orientation will allow the antenna to be broadside to the earth's equator from which the above described noise originates.

The antenna may be suspended from erected posts, house corners or from apartment windows to a local tree. The antenna wire and the down lead to the receiver are of the same material.

When you get started, you will want to correlate your data. Official data on solar flare activity can be obtainable from the Space Environment Services Center, 325 Broadway, R/E/SE2, Boulder, Colorado 80303. This bulletin lists times and intensities of a week's solar flares.

I would like to thank the following individuals for their help and information: Terry Littlefield, KA1STC of Communications Quarterly, Joseph Carr (Winter 1994 of Communications Quarterly), and Carl Chernan, WA3UER. Information was also used in the preparation of this column from the *Radio Astronomy Handbook* by Robert M. Sickels (Deceased) published in 1992. ST

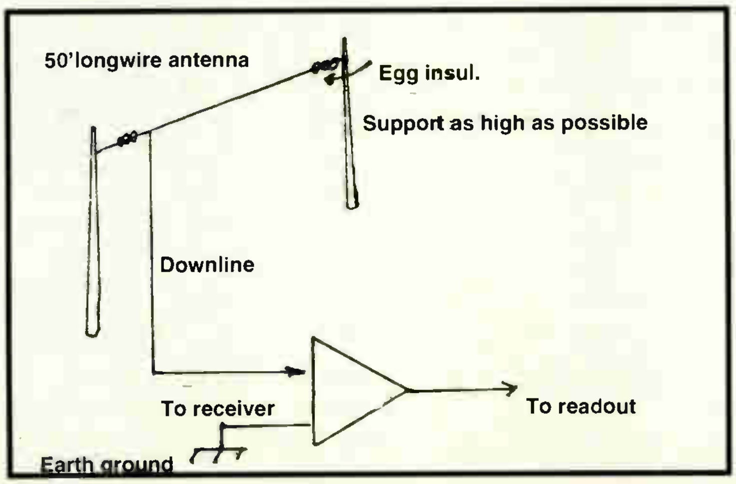


FIGURE 5: **Antenna Set-up**

NAVIGATION SATELLITES

By Todd D. Dokey

New GPS Product Guide Released

Are you looking for some GPS equipment, books or software. Then you need to get the new Navtech GPS Store catalog. I have just received a copy of their Spring 1995 catalog and it is chock full of interesting GPS products. I will cover some of the more interesting products in their new catalog in this edition of Navigation Satellites.

Cambridge Aero Instruments has produced the Secure GPS Data Recorder and Navigator. Originally designed for sport aviation to provide guidance and trip tracking, the system is now being used in marine applications and vehicle tracking systems.

This compact system has a 10 channel GPS receiver in a tamper proof box which produces a digitally fingerprinted record to encode each trip. The fingerprint assists in preventing forged records. The tracking data include latitude, longitude, time and speed overground.

This GPS tracking system can even sense when your vehicle has stopped moving and shut itself down. It can report overviews, detail views and scaled map overlay information which can be downloaded to a PC by a standard serial data cable and software (included). Data can be logged for 16 hours (at 4 second intervals and up to 32 seconds). There is also a real time tracking option when using optional transceivers.

If this is not enough for you, try using Multinav Vehicle Attitude Determination software. Multinav is a collection of programs in the C programming language that allows you to accurately reduce the data from a multi-antenna system to calculate roll, pitch and azimuth of the vehicle in motion. According to the literature, accuracies of a few arc minutes have been obtained in a marine environment. Not bad.

Do you have a 486DX 33 or faster computer? You can use it to experiment with GPS? The GPSBuilder 2 by GEC Plessey might be what you are looking for! The kit consists of a 12-channel GPS development kit that includes software and uses the new second generation GP2010 low power RF downconverter and includes filters and a GP2021 12-channel correlator running by PC control.

The main display screen shows channel status (continuously updating view of all the correlation channels) and the coordinates. Other information that can be displayed includes the satellite status, processing and task status, differential correction status, and the control of the data collection (all by function keys!)

Other development kits advertised in the catalog include the Oncore nade by Motorola and the 10-channel GPS "Black Box" by Magellan. The Oncore system includes an 8-channel GPS receiver, an active patch antenna with magnetic mount and feedline, power and data cables, PC controlling software (with manuals), a complete technical manual and more. This kits is the standard issue for the evaluation of Motorola Oncore OEM (original equipment manufacturer) boards and Motorola requires you purchase one of these kits prior to the purchase of a GPS receiver board (there are two parts to this kit -the test kit, and the receiver kit).

The 10-channel "Black Box" from Magellan is of interest because it dumps its data not only in NMEA standard, but also in ASCII and others by the RS-232 serial data standard. This "Black Box" is ready to take differential GPS code from a correction source at 4800 or 9600 baud. The fact that it is in a box makes it water resistant. The 10-channel kit includes an external active antenna with 30' of coax, power and data cables and mounting hardware.

There are also electronic compasses available which (in some cases) can be interfaced to that GPS handheld receiver you are building in your garage. Precision Navigation offers the Vector-2x compass module. The Vector-2x uses a 2-axis magnetometer (that apparently used to be proprietary for the U.S. military). It is a low power unit (5 volts at less than 10 mA) using a 10 Hz sampling rate when running in continuous mode. The system is easily added to existing projects and has a data clock that can run in either master or slave modes. The 2 degree accuracy with 1 degree of resolution is not bad at all for $46.95!

The higher resolution, higher accuracy (higher priced) TCM2 can also output compass information and has the added bonus of including pitch, roll, and temperature readings. It uses a proprietary triaxial magnetometer system and a biaxial electrolytic inclinometer, and has no moving parts! The TCM2 outputs data at about 16 times per second but uses less than 12 mA. It can be user configured and programmed, is tolerant of rugged environments and has built in distortion detection. All of these systems are in different price ranges, so I am sure there is one that will suit you!

Many of you have seen satellite tracking software I am sure. Much of this software is devoted to the amateur radio hobby and then there is the software devoted to the visual tracking of just about anything you can get the orbital elements for. Quick Plan by Trimble Navigation is designed to help you plan your GPS projects.

Quick Plan lets you calculate the visibility of the satellites and graphs the data so you know beforehand what to expect and when to expect it. This enables the GPS developer to quickly look up the availability of satellites and cutoff elevations, etc. Quick Plan runs on a PC or compatible 386 or higher system with coprocessor, VGA monitor and Windows 3.1.

If that software is not enough for you, the you ought to try the FieldPack Designer and FieldPack Mobile by All Points Software? How would you like to be able to design you own database system that non-computer people can operate and use in the field to collect data and digital images? The Designer lets you incorporate your own forms or databases and integrate them with text, data, GPS coordinates and even digital images! FieldPack Designer is icon-driven and requires no programming experience! Now you can set up electronic forms to suit your needs in the field.

FieldPack Mobile is the software used by the person in the field to collect the data and use your personalized forms and screens.

FieldPack Mobile can be loaded onto a laptop or pen based portable computer system with a GPS receiver and a digital camera! The data can be corrected to within 1 to 5 meters and software for use with differential systems is also available.

And now the real good news! GPS handheld receiver prices are falling! Magellan's Trailblazer leads the pack with a price tag of $299.00. This is closely followed by the Trailblazer XL and Meridian XL at $349.00 The new Magellan 10-channel sensor is nearby at $495.00! All prices are subject to change.

You can learn more about these and other GPS products you should contact the Navtech GPS Store (Navtech Book & Software Store), 2775 S. Quincy Street, Suite 610, Arlington, Virginia 22206. (703) 931-0500. If you are interested at all in GPS books, software, mapping, receivers, data, classes (the list goes on) contact them for a catalog or further information right away! Oh yea, be sure to tell them *Satellite Times* sent you.

And Now for the Weather...

The National Weather Service has for some time been working to bring its older weather radar system up to speed with newer technology. A new system has now been developed by Unisys Corporation and is called NEXRAD for Next Generation Weather Radars (the WSR-88D radar system). This innovative system provides a greater detail of data which permits users of the information to produce more accurate weather forecasts.

Unisys Corporation and Marta Systems came together in order to offer a more advanced weather information system utilizing advanced doppler weather radar systems. The system uses data from NEXRAD and couples it with a data imagery management system to provide economic advanced imagery to government, private, industry and emergency management end users. The NEXRAD radars are connected directly to the server system at Marta Systems by dedicated lines providing imagery in the shortest possible time.

Marta Systems has now developed a Windows based software package that incorporates many useful features such as image zooming, animation, and mapping. The mapping feature can incorporate weather data with radar ranging rings onto city, county, state, local or topical map information (such as water, airway, highway, administrative boundaries, railways, etc.) all of which can be user selected and overlaid at will. Windows compatible color printer support is also available with this system.

TABLE 1

NEXRAD Information

- National Mosaic, 4x4 km (based upon Composite Reflectant)
- Composite Reflectivity, 4x4 km, 16 data levels, 460 km range.
- Reflectivity (4 tilts) 1x1 km, 16 data levels, 230 km range.
- Layer Composite Reflectivity (3 layers)
- Echo tops
- Surface rainfall accumulation, 1 hour running total or 3 hour total once per hour.
- Storm total rainfall.
- Hourly digital rainfall array.
- Vertical integrated liquid (VIL).
- Radial velocity (4 tilts) 1x1 km, 16 data levels, 230 km range.
- Velocity azimuth display (VAD) Winds (time vs. height).

NEXRAD data is accessed by the user over a modem and the software automatically gives on screen updates of the weather imagery data overlaying it with a current map display. The advanced animation features permit the user to show the direction, the speed and intensity of the storm, and also provides the user with the ability to pause, speed up, or slow down the animation.

The software, called WinPUP also supports the animation of weather data while new data is being downloaded from the host computer and will automatically update the screen with the new imagery, while eliminating the oldest images. The system also supports animation of NEXRAD National Mosaic Reflectivity pictures which gives you a dynamic national outlook of radar imagery.

Some of the information and resolution data are listed in Table 1.

WinPUP can run completely unattended collecting new data, discarding old, and displaying current information on a map. The information also can include the latitude and longitude plus distance between user definable points of interest. Range rings, polar grid, calendar with Julian date and UTC/local time capabilities can also be selected. WinPUP can even save images in the transportable Windows BMP format.

If you are a U.S. Department of Commerce, Department of Defense, or Department of Transportation user, there is optional software that allows you a direct connection to the WSR-88D PUPs and RPGs. WinPUP will soon be available in a Windows/NT 32-bit version for high-performance applications.

Marta Systems does not charge connect or disconnect fees and does not charge extra for downloading at the highest standard data rate (they use 14.400 Kbps as their highest standard data rate at this time). The monthly fees are applied only in the month you access their system. The pictures can also be acquired on a per picture basis and there is a discount for Emergency Management users.

What does this have to do with GPS systems? I asked Marta Systems if there was any plans to incorporate real time GPS display of their data for vehicle and personnel tracking and was told that this was something they are working on. They also said that their map data could be saved and overlaid with other systems. My basic impression is, they are really working on it and will soon develop their system to allow GPS interface!

Marta Systems also supports weather satellite imagery, National Weather Service (NWS) Weather Wire alphanumeric products, lightning data and NWS DIFAX charts. If you are serious about having up-to-date and accurate weather information, contact Marta Systems at 15500 W. Telegraph Road, A5, Santa Paula, California, 93060. I would like to thank the Vice President of Marta Systems for providing information used in this column.

That's it for this month. If you have some GPS questions or topics you would like to see covered in this column, you can write us care of the Satellite Times address in Brasstown, NC. If you want a personal reply, be sure to include a self address, stamped envelope (SASE). ST *by Wayne Mishler, KG5BI*

Wagons Ho: Internet or Bust

There's a cloud of trail dust on the horizon, pilgrim. It's billowing up from the heels of the satellite industry. They're burning daylight and heading for the Internet. One pioneer, Keystone Communications, provider of telecommunications for more than 1,000 U. S. and international clients, and publisher of the North American and Asian-Pacific Satellite Guides, is already there. Keystone Satellite Publications Editor Doug Jessop, designer of the company's Internet presence, has carved out an electronic doorway called the Keystone Home Page, and the welcome mat is out for anyone with computer and modem. The URL (uniform resource locator) address for their home page is http://www.xmission.com/~keycom.

By venturing through that doorway, you enter a wonderland of hyberspace information, services and products of the space industry. There's a section for satellite terms. Another for current information on North American satellites. You can sample a page of the company's North American Satellite Guide, or you can buy the whole book on-line using a credit card. Of course you can access a directory of Keystone offices, and receive detailed information about the company's services including its uplinks, transatlantic service, transpacific service (Pacific Skylink), and business and television services as well.

Jessop says " Using the links is akin to reading a book, but instead of having to plow through the whole book to find the juicy parts, you can simply jump directly to the points that interest you."

Keystone also maintains a file transfer protocol through which you can download articles related to the satellite industry via ftp://ftp.xmission.com/pub/users/k/keycom.

Where in the World Are You?

In Frank Baum's literary classic, Wizard of Oz, the scarecrow got a diploma to prove his intelligence, the tin man got a ticker to tell him he was alive, and the lion got a medal to convince himself he was brave. Dorothy could have used the GEO location marker to tell her where in the world she was. It would've made a great conversation piece back home in Kansas with Aunty Em after the ruby slipper trick.

It's too late for Dorothy, but not for you. You can get your very own location marker, a yellow-brass medallion engraved with the longitude and latitude coordinates of your home, from Geographic Locations International, 1513 26th Ave. NE, Minneapolis, Minnesota, 55418.

The medallion is a beautifully finished lead-free brass alloy replica of the traditional geographic survey marker. It bears the inscription "Know where you are. Be where you're at." It's only available from GEO. And it makes a unique gift for surveyors, amateur radio operators, space buffs or anyone else interested in earth measurements.

That's not all. Betty Risser, GEO president, has some other great ideas. Her company offers the attractive marker mounted on executive desk sets, book ends, and in a sun dial, to name a few.

"It makes a bold and classy statement," she says. "It's a great conversation piece that connects with the history of surveying and marking geographic sites."

Not only does GEO guarantee satisfaction, they give a lifetime membership to their GEO-TO-GO club including a newsletter subscription to anyone who buys a location marker during its first year on the market. Don't wait too long to order yours. You can order or get more information by calling 800-GEO-SITU (800-436-7488).

New Mobile Satellite Antenna System Links RVers to DBS

There's a new DBS antenna system for recreational vehicles. It's called the Snowbird. It attaches to the roof of any RV, and it enables RVer's to receive programming from DBS satellites.

Travel-Sat, who specializes in satellite TV reception systems for the recreational vehicle market, introduced the system at a Family Motor Coach Association rally in Las Cruces, New Mexico, this Spring.

The Snowbird system features a 24-inch antenna dish that folds face down to a mere 9 1/2-inch travel profile. It is plated and powdercoat-finished for durability, and includes chrome interior hardware that enables users to aim the dish from inside their RVs.

Travel-Sat says their new product receives all currently available and future DBS satellite programs, and works well as an add-on for existing RCA DSS systems. Their sales department will be happy to give you more information. You can call them at (800) 270-1692 or (619) 568-0666.

Russian Space News Debuts in U.S.

An English language edition of a newsletter that covers the Russian space program is now available in the U. S.

Russian Space News is the progeny of a larger Moscow-based magazine of the same name (in Russian.) The U.S. version is sponsored by Tranquest Corporation with offices in Cleveland, Ohio. It specializes in space-related news from Russia and the ex-USSR.

"We receive inside facts on the Russian space program direct from the source," says Tranquest President Charles Radley.

The newsletter receives daily reports from the Mir space station filed by a correspondent at Mission Control in Kalingrad. Copies of the Russian edition are flown to Mir on a regular basis. The newsletter also covers manned and unmanned launches from Plesetsk, including crew and launch manifests. It publishes biographies of crew members, reports on Russian planetary probes, and covers news from the Cosmonaut training center.

"The Russian edition scooped the world with the first detailed description of the formerly top secret Russian first and second generation early warning satellites," says Radley.

The parent publication, entitled Novosti Kosmonautiki (Russian for Space News), grew from a six-page newsletter to a 50-page magazine. Radley has similar hopes for the U. S. version, which currently publishes 24 to 30 pages 26 times a year. A three-month subscription (six-issues) sells for $75. The price of an annual subscription is $175.

Radley invites inquiries. You can get more information about the newsletter and order a subscription by telephoning (800) 929-8953. Tranquest has three Internet e-mail addresses: cfr@tranquest.com, rsn@tranquest.com, and mail-server@tranquest.com. The newsletter's Internet FTP archive is located at ftp.wariat.org/pub/tranq.

Orbitron SX-6 antenna features durability, eye-appeal

Large satellite dish antennas and landscaping rarely compliment each other, but the Orbitron SX6 combines small size (69-inch diameter), attractive design, and solid engineering. It sits well on the lawn and provides reliable C and Ku band operations unavailable on fixed DBS systems. It features high-gain reception, compact sectional design, sturdy construction, quick assembly, and inexpensive shipping via UPS or container.

The sturdy construction of the SX6 reduces signal loss caused by wind vibration. The reflector bolts solidly to steel channel rib supports. The ribs are integral parts of the mount. The hub design, says Orbitron, is unique to the industry. The conventional polar mount has oilite bronze azimuth pivot bearings with a one-piece axle. All of this adds to strength and stability necessary for antenna alignment.

The SX6's feed system is supported by four legs attached to the dish frame. The

antenna has a latitude range of zero to 67 degrees, and a declination range of zero to eight degrees. The special "T" lock rib design supports the fine mesh reflector with uniform pressure, assuring a smooth, even surface and preventing panel blowout. All parts are black powder coated with a thermoset resin which Orbitron says resists corrosion in any environment.

If you are looking for an attractive, functional satellite antenna system, you would do well to check this one out. For more information, call Orbitron at (608) 588-2923.

For Hams in Space (and Elsewhere)

The 1995-96 Hamtronics catalog features 40 pages of kits and wired electronic equipment for amateur radio and industrial users. You can get one by calling the company at (716) 392-9430, or by writing to Hamtronics, Inc.; 65-G Moul Rd.; Hilton, New York; 14468-9535. Be sure to say you heard about the catalog from Satellite Times.

The new catalog features several new products. A new R100 series of professional VHF FM receivers was announced for the 50, 72, 144, 160 and 220 MHz bands. For 137 MHz weather satellite reception, a new R138 four-channel wide-band FM receiver is introduced (reviewed in ST Test this issue—*editor*), along with an AS-138 Scan Adapter to allow automatic tape recording of WeFax signals while away from your receiver.

Other new receivers include the RWWV receiver, which give you access to the 10 MHz WWV time and frequency standard broadcasts without investing in an expensive multi-band HF receiver. There is also a new R120 VHF aircraft receiver, and an R150 four-channel monitor receiver for VHF FM.

For repeater users, amateur radio and industrial, the catalog offers a new CWID-2 module that generates continuous wave (CW) Morse Code identification for radio repeaters, beacons and base stations. Their COR-6 repeater controller module gives voice station identification instead of CW.

There is also a new line of custom-designed RF-tight enclosures for transmitter and receiver modules. These are available in various kits, with connector holes pre-punched to accept components, provided with the kits.

These new products add to the previous line-up of electronic equipment by Hamtronics, which has been in the electronics manufacturing business for more than three decades.

Woodhouse Enters Antenna Market

Woodhouse communication of Plainwell, Michigan, debuted a new line of specialty VHF antennas at the Dayton Hamvention this year. They also offer an antenna for weather satellite reception.

The new company's series of amateur radio antennas for 144, 220 and 440 MHz offer exceptionally heavy construction. Booms are made of 1" OD, thick-wall tubing for extra strength. Elements are made of 3/8" solid metal rods that pass through the boom. All components are made of 6061-T6 aluminum, and are held together by stainless steel hardware. This is quality construction.

Of course a transmitting antenna only works if it takes power from the transmitter. Feedpoint impedance is crucial. Woodhouse antennas combine a unique matching transformer and conservative design to provide full band coverage with low standing wave ratio and good pattern response.

In the weather satellite reception department, Woodhouse offers the APT-4X4 designed to receive 137 MHz with circular polarization. This antenna also uses heavy construction techniques and durable materials. It zeroes-in on NOAA and MET APT imaging signals, and incorporates selectivity and gain for clean, noise-free images – even on satellite passes with nine-degree elevation over the horizon. Woodhouse assures us that this antenna provides a total East/West viewing range of up to 4,000 miles.

If you need a special antenna that Woodhouse does not stock, let them know. They just may be able to build one for your special need. The offer custom antennas.

You can get in touch with the company by writing Woodhouse Communication; P.O. Box 73; Plainwell, Michigan. Telephone them at (616) 226-8873. 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

Orbit Determination

Up to now in this column, we've talked about orbital models, sources of data, and some of the complexities involved with predicting the motion of artificial earth satellites. The goal here is to get a handle on the amount of error that can be expected in a particular calculation. After all, the art of celestial mechanics has been refined for centuries and, with the advent of computers, we'd like to think we can depend upon those calculations to be accurate. That way, when we're watching or listening for a satellite to pass overhead, we won't be wondering if we missed the pass because of a bad calculation.

Besides knowing what data to use with which models, the next most important part of the process is to understand is how orbital element sets are generated. An understanding of this process will help to answer two questions: How often are the orbital element sets updated and (most importantly) how often do I have to update my data? As with everything else in this field of study, answering these questions will require a bit of work.

To begin with, let's assume that we already have a basic orbit for our satellite of interest. After all, the overwhelming majority of satellites tracked every day have been on orbit for some time and we are really interested in how we update the orbital element sets for these objects. We will save a description of the process of how to determine an initial element set for a satellite orbit for a future column.

To update any existing orbital element set, observations must first be collected. NORAD, which has responsibility for tracking all man-made objects in earth orbit, uses the Space Surveillance Network (SSN) to collect these observations. This network is comprised of radar sensors for near-earth tracking (below approximately 6,000 kilometers altitude) and optical (actually, electro-optical) sensors for deep-space objects (above 6,000 kilometers altitude). These sensors are geographically distributed around the world to provide global coverage.

Typical observations from a radar site might include azimuth, elevation, range, and range rate while optical sensors provide angles only (azimuth and elevation or right ascension and declination). Each observation is time tagged as it is collected. If you are not familiar with some of these measurement types, don't be concerned – the specific measurement types won't be important to this development and we'll cover these terms in detail when we talk about coordinate systems in our next column.

Of course, since there are thousands of objects orbiting the earth, knowing which observations are associated with which object is no trivial task. NORAD must first process the observations to correlate them with the appropriate object or determine that the observations represent the track of a previously untracked (or lost) object. Once a set of observations has been associated with a particular satellite track, however, the mathematical process of updating the element set can begin. The process used is known as the method of differential corrections. Here's how it works.

As the differential corrections process begins, there are several things we know. The first is the initial two-line element set, the second is our time-tagged set of observations, and the third is the orbital model we want to use (SGP4, in this case). In order to determine whether our current two-line element set must be adjusted, we must be able to compare it directly to the set of observations we've collected.

While we don't know how to convert observations directly into an element set (after all, that's the goal of this process), we do know how to convert an element set into a set of predicted observations. To generate these predicted observations, we use the current two-line element set with the SGP4 orbital model to generate the satellite's expected position and velocity and then transform this information into expected observations for the particular viewing geometry of the sensor. Now, we can calculate the difference of the actual and expected observations. As might be expected, our goal is to minimize this difference (in reality, the sum of the squares of the differences).

So far, this process sounds simple enough. But how do we know which elements to change and by how much to make the overall difference smaller? Well, as it turns out, we can use some basic calculus to answer this question. Let's say we have one element, x (our independent variable), and one observation, y (our dependent variable). Also, let the transformation from element to observation be given by the transformation function

$$y = f(x).$$

Now, let the actual observation be y_a and the predicted observation be $y_p = f(x_p)$. From calculus, we know that we can approximate the derivative of our transformation at x_p as

$$\frac{x_a - x_p}{y_a - y_p} = \frac{x_a - x_p}{y_a - f(x_p)} = \frac{dx}{dy}$$

Solving for our "actual" value of the element yields

$$x_a = x_p + (y_a - f(x_p)) \cdot \frac{dx}{df(x)}\bigg|_{x = x_p}.$$

This is a basic Newton iteration for finding a root of a function. For it to work well, our initial value of the element must be "close" to the actual value. Each time we calculate a new actual value, we repeat the process by replacing our predicted value with the actual value until the difference in the predicted and actual elements between successive calculations is small.

We are still missing one part, however, in making this process work. The part we're missing is how to calculate the derivative of the observation with respect to the element (in other words, the rate of change in the observation with respect to a change in the element). If our transformation function $f(x)$ were simple enough, we could calculate this value analytically (well, at least some of us could). However, for our real problem, our transformation function takes the values from a two-line element set, runs them through the SGP4 orbital model, and then transforms them for the sensor viewing geometry and coordinate system. Calculating this derivative analytically would be extremely difficult, if not impossible. Instead, we will numerically estimate the derivative by using the same approximation as we did above. That is, we take our initial value of element and some small difference to produce this equation.

$$\frac{df(x)}{dx} = \frac{f(x+\Delta x)-f(x)}{(x+\Delta x)-x} = \frac{f(x+\Delta x)-f(x)}{\Delta x}$$

Once we have an estimate of the derivative at the point of interest, the process of updating the element is relatively easy. It is important to note here the dependence on the orbital model chosen in the transformation function. For the NORAD two-line orbital element sets, the orbital model is SGP4. Using another model would generate different elements because that model would produce a different "best track" through the observations. Therefore, to get the best fit for the NORAD two-line element sets, the SGP4 orbital model *must* be used.

In reality, the process of updating the NORAD two-line element set has many orbital elements and observations, so the full differential corrections process must use a multidimensional Newton search. But the basic approach is still the same. Once the process has converged, that is, the difference between the observed position and the calculated position is within some small tolerance, we have a new element set.

Does this mean that a new element set is issued by NORAD? The answer to this question is no. A new element set is issued only when the position predicted by the current element set differs from that predicted by the new element set by more than a certain amount. In the case of the NORAD two-line element sets, that amount is five kilometers (with a 90 percent confidence interval).

So how often are the element sets updated? Well, that depends upon the satellite and its orbit. For near-earth satellites, atmospheric drag can change an orbit in ways that aren't modeled in SGP4, requiring more frequent updates. Also, satellites which maneuver frequently, such as Mir or the US Space Shuttle, will also require more frequent updates since, again, SGP4 is unable to model these changes. You can get a rough idea of how often you need to update your element sets by looking at how long it takes NORAD to issue consecutive element sets for the objects you are interested in. If they issue one element set a week, that means that it takes roughly a week before the orbit has changed enough to require an update. Of course, if you don't need this level of accuracy for your application, then you won't need every update. Five kilometers is less than a second's error at orbital velocity.

Seperate Element Sets for Docked Spacecraft?

Now that we have seen how and when orbital element sets are updated, let's explore why NORAD issues separate element sets for objects which are docked together and why those element sets are not identical. A good example of this practice is with the Mir space station. The Mir complex is actually made up of many objects: the Mir core, Kristall, Kvant-1, Kvant-2, and an assortment of Soyuz and/or Progress modules. Each of these objects was launched individually and tracked by NORAD before docking with the space station. Some of these objects will subsequently undock. As such, NORAD maintains separate tracks of each object.

Of course, when these objects are physically locked together, the observations collected for one object could be used for updating the elements for all objects. But that's not necessarily how it works. Since NORAD has to track over 7,000 objects every day, the process is automated. Now, since all observations have error and each object started with its own independent element set, the element sets generated will remain in tolerance for differing periods of time. How long will depend on the site used to collect the observations, the viewing geometry, changes in atmospheric density or spacecraft attitude, maneuvers, and so on. As such, updates to separate components of a docked structure will be updated at different times.

Okay, so even if NORAD tracks each object separately and maintains separate element sets, why are the element sets different? To understand the answer to this question, you need only look to our last column. Remember, only ideal orbits describe true ellipses and have constant orbital elements. Real orbits experience both periodic and secular (trending) effects in their elements. Because of this, orbital element sets with different epochs will have different values (and different associated errors) for the remaining orbital elements.

Now, you might think that a single element set would result in no error. However, the error is still there – a single element set just seems more consistent. Actually, multiple element sets provide the advantage of redundancy – protecting you from the occasional bad element set.

Well, we covered a lot of territory in this column. If you feel a bit lost, don't feel bad. Remember, when we started, I promised to address issues for the novice to the professional. If you have questions, you are more than welcome to send them to me at **tkelso@afit.af.mil**. I'll do my best to help fill in any gaps.

For our next column, we'll finally start into the discussion of the various coordinate systems used in satellite tracking. Our goal will be to develop an understanding of the various terms used and the importance of each coordinate system. The end result will be to develop methods to transform orbital elements into things like look angles (azimuth and elevation or right ascension and declination) for visual observations and tracking or latitude, longitude, and altitude for plotting on a map or working with satellite imagery. Until then, keep looking up! ST

The Beginner's Column

By Ken Reitz, KC4GQA

Getting Started in TVRO Cheaply

By virtue of the fact that you're reading this magazine, you already have a keen interest in the satellite monitoring hobby. If you're like me, you're probably doing a little background reading before jumping in, wallet first into the vortex.

It won't take too many trips to the satellite showrooms before your initial enthusiasm is dampened by high sticker price anxiety. But before you give up on your dreams I may have some good news for you.

First, let's examine your requirements. If your interest in TVRO is primarily entertainment of the cable kind, let me steer you quickly to one of three small dish satellite broadcasters where you're just a toll free number away from HBO, CNN etc. If your interest in satellite technology goes a little deeper, then DSS isn't for you..

Getting the Full View

Who wants a portable AM/FM radio when, for a few dollars more, you can get AM/FM and several bands of international shortwave stations? Why settle for mundane cable fare with those dreary monthly bills when programming from around the world can be purchased for almost the same price? You will be amazed at how cheaply you can get into this hobby just by paying attention and nosing around.

You don't have to be a techno-geek to put together a satellite TV system. But, you will need some rudimentary knowledge of how things work. I'd like to think that you've been getting this magazine since the premier issue. If you have, you already have a good idea about how geostationary broadcasting satellites work and how their signals are received. If you haven't been with *ST* since the beginning don't worry, I'll quickly bring you up to speed in just a few short paragraphs.

The Basics

There are roughly 40 satellites transmitting in the C-band and/or Ku-band which are visible from most of North America. This gives us potentially 600 channels of programming, about half of which are unencrypted and in the clear. To view these channels you'll need two basic components—the dish assembly and a receiver. Either of these two components can be as sophisticated as you like, but as the system gets more complicated, the cost goes up. If you keep it simple, you'll keep it cheap.

As discussed in the previous two columns, the dish assembly (and by assembly I'm referring to the actual parabolic reflector, feedhorn support, mount, pole and actuator motor) is the key. You just can't find used dishes and piecing one together from junk is time consuming. Besides, the prices offered by most mail order companies for new dishes represents a good bargain. For example, Skyvision offers a Kaul-Tronics 6-foot C/Ku-band dish with a polar mount for roughly $250 delivered. A new actuator arm (the dish motor) will cost roughly $100 new.

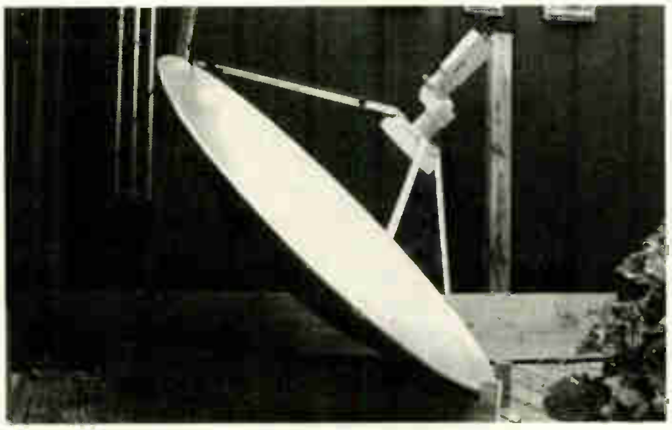
The next step is to put a feedhorn and LNB on the feed support. Now we can start looking for bargains. You should be able to find a nice used C-band feedhorn for about $25 and a fair (60 to 80 degree) LNB for about the same price. An all-in-one direct burial ribbon cable which carries the power to the actuator motor, the feedhorn servo motor and the LNB will cost you about 70 cents per foot.

Now all you need is a receiver. Good used receivers can be found from $25 to $150. The more expensive receivers will have more capabilities, such as built-in stereo processors and dish motor drives. Total cost of your satellite system is now a little over $500 or roughly $1,000 to $2,000 cheaper than the dealer's showroom price! For that price you've gotten a brand new dish, actuator and cable, a decent quality feedhorn, LNB, and receiver. Such a system should give you years of operating pleasure and open a whole new world of video and audio which will keep you occupied for a long time.

Where's That Scalpel?

Suppose you're a real bargain hunter? Can this price be improved on? You bet! It is possible to get a used dish with mount and feed support just for the asking. First, cruise your neighborhood for older looking dishes which are pointing into the ground, have no feed horn, or are obviously unused. The owners may have finally gotten cable out to their location and are no longer interested in satellite TV. Perhaps they just put in one of the newer small dish systems. Either way, they're in the market for someone to remove that old, ugly dish from the front yard. Make an offer, it never hurts to ask. You might even get paid for doing the removal!

Haunt your local satellite TV dealer. Dealers doing a lot of business and often take old equipment as a trade-in on an upgraded system. This old gear may be in perfect working order, but the customers may have wanted the latest integrated receiver descrambler (IRD) with all the latest bells and whistles. Reluctant to trash even old gear, dealers are often eager for offers, any offers! Don't be afraid to be ridicules. Offer $15 for a stripped down, low-end receiver and you



Not a thing of beauty, but it is a functional C-band antenna and it cost about $100. Hook this up to a $25 dollar satellite receiver, point it at Galaxy 5, and you have music from across America and around the world 24 hours a day! Oh, by the way, you can get video too! (photo by Ken Reitz)

might just walk away with it. Using the above techniques it's quite possible to have a complete satellite system up and running for under $100!

What To Avoid

First, avoid over priced dealers. Using the Yellow Pages for several cities in my area, I surveyed all the local dealers on their inventory of used equipment. It became quite apparent that some dealers were considerably out of touch with what the used gear was really worth.

Second, avoid flea markets or hamfests. Individuals selling at such markets have no reputation to protect and you're not likely to ever see them again. Unless they can demonstrate that the units are in working condition or the price is so cheap that you feel you won't mind throwing the money away, forget this venue. There are a lot of great bargains on the back room shelves of America's satellite TV dealers to hassle with flea markets and hamfests.

Third, there is a limit to how old equipment can be and still be useful. In the early days of the satellite TV industry the low noise amplifier (LNA) and the downconverter were two separate components. Today, they're in one unit known as a low noise block downconverter or LNB. The old downconverter changed the 4 GHz microwave signals to 70 MHz and the companion satellite receivers tuned to this 70 MHz frequency.

Modern TVRO receivers tune from 950-1450 MHz and the conversion down from microwave frequencies is done at the LNB which does the work of both the old LNA and downconverter. These relics of old were known as 70 MHz systems and are virtually useless today. The reason they are useless is that 70 MHz downconverters are very difficult to find and represent an outmoded standard. Besides, 950-1450 MHz LNBs are so cheap it's not worth trying to keep one of the older systems going. Also, the two systems are not interchangeable. Don't buy a 70 MHz receiver/LNA/downconverter system!

The Bottom Line

Use your imagination. How much would you pay for a radio which receives KLON-FM (jazz programming from Long Beach, Calif.), the CNN Radio Network, WFMT-FM (classical music from Chicago, Ill.), WSM-AM (country music from Nashville, Tenn.), seven channels of stereo music programming on Superaudio, or shortwave programming from the World Radio Network (see Satellite Services Guide in this issue)? I paid less than $150. Here's how.

First, I found a surplus aluminum dish for $50. Then I lashed a couple of scrap 2 x 6's together to hold the dish upright and at a right angle. I then fabricated a tripod feed support and mounted my $50 LNB/feedhorn on it. I then fed the output of the LNB via a RG/6 coax to my $25 satellite receiver. Voila! Later I added a surplus polar mount with hand crank for $50 and now my $200 system travels anywhere in the Clarke Belt and it even picks up video too! With the addition of a Radio Shack Portavision 40 radio I can receive single channel per carrier (SCPC) signals as well!

And now it time to hear about your stories. What kind of a cheap system have you put together? How low did you go to get a cure for this infectious hobby? Send your own tale of the bizarre to me care of this magazine and I'll let your fellow readers in on your secret. Meanwhile, let's find out what's on the minds of our readers and reach into the...

MAILBAG

David Uribe, of Brooklyn, NY would like information on building his own 15-25 foot dish. Well, David, I'm not sure why you need such a big dish, but I'll guess that it's because you would like to try receiving programming from Europe or South America. If that is the reason, you may not need a dish that big. Reports that I have received indicate that a top grade, 12-foot dish should do the trick. Orbitron makes a 12-foot model which sells for about $650, Paraclipse has one for about $950. Both manufacturers claim about the same antenna gain for both these models. My guess is that it would be impossible to build a dish that big with that much gain for that little amount of money. If you are wanting to watch some of the more exotic programming from overseas, you will also need a circularly polarized feedhorn.

It is also possible that you are interested in doing some Earth-Moon-Earth (EME) transmissions on the ham bands. If this is the case, a large parabolic antenna would be very helpful. Martin Davidoff, in his book *The Satellite Experimenter's Handbook* (BOK 85 from the Grove Enterprises catalog) has several pages devoted to the construction of a large dish, including formulae, diagrams and charts. Also the August, 1983 issue of *Mechanix Illustrated* has a very detailed article about constructing a parabolic dish antenna with parts you can get from a building supply house. Your local library might have this magazine in its archives.

Theodore Lawryk, of Yonkers, NY "...would like to install a small dish antenna and suitable equipment for reception of TV programs from Moscow, via Russian satellite 'Molniya'."

Theodore, there are a couple of potential problems we'll encounter here. First, the Molniya satellite is virtually out of service now. Second, a small dish antenna will not be possible from your location to receive Russian satellite TV direct. Not to despair though! There are some possible alternatives which may be of help to you. If you have a clear view to the East (like to the horizon!), and can put up a large enough dish (10 feet minimum), you should be able to receive the Russian Statsionar-4 (Express) satellite at 14º West. This bird carries Russian television programming. The second possibility is to use a Ku-band antenna (3-4 feet in diameter), LNB and receiver. Locate Galaxy 4 channel 13 and you'll will receive WMNB "Russian-American TV" which is an assortment of Russian heritage programs. Also on this channel, on an audio subcarrier, is the Russian-American Radio Network at .18 MHz and 1.35 MHz. The same radio programming can be heard on SCPC signal from the Galaxy 4 satellite. It's possible that the Ku-band system offered by R.C. Distributing Co. of South Bend, Ind. will do the job for you. They advertise here in the pages of *Satellite Times*.

Some sources for items mentioned in this column include:

Skyvision	(800) 334-6455
R.C. Distributing Co.	(219) 236-5776
Grove Enterprises	(800) 438-8155

Well that's it for this month. Do you have a question about satellites, equipment or whatever? Are you a beginner in this space stuff and need some help? Then you should contact the Beginners column via *ST*'s Brasstown address. We want to hear from you real soon. ST

SATELLITE TECHNICAL FORUM

Getting Weather Satellite Data - Cheaply

By Philip Chien, Earth News

A home weather satellite reception system is an excellent thing to own, but not practical for some hobbyists. The expense, deed restrictions for outdoor antennas, family desires, and other reasons may make owning a system impractical or impossible. So are you limited to seeing weather satellite images on the evening news?

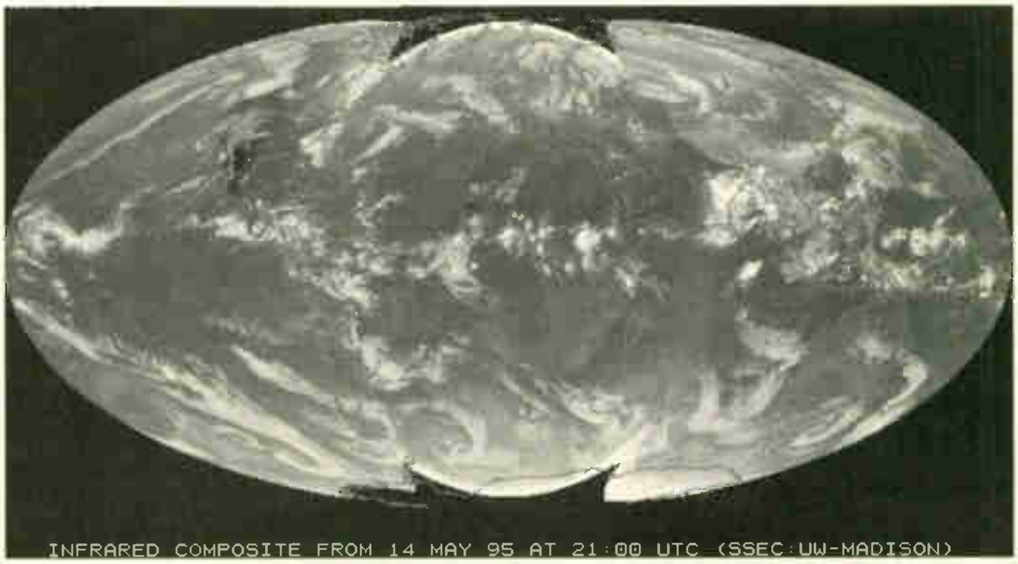
Most of the Eastern hemisphere, imaged by the Japanese GMS-4 spacecraft on March 31, 1995.

Heck no! Actually very few organizations are equipped receive the actual raw data from weather satellites. Raw weather satellite data is first received by NOAA's (National Oceanic and Atmospheric Administration) ground station in Wallops Island Va., and processed on specialized computer systems. That refined data is transmitted back up to the GOES satellite where it's available for reception by anybody with a 1691 MHz WEFAX receiver. But there are other ways to receive WEFAX transmissions.

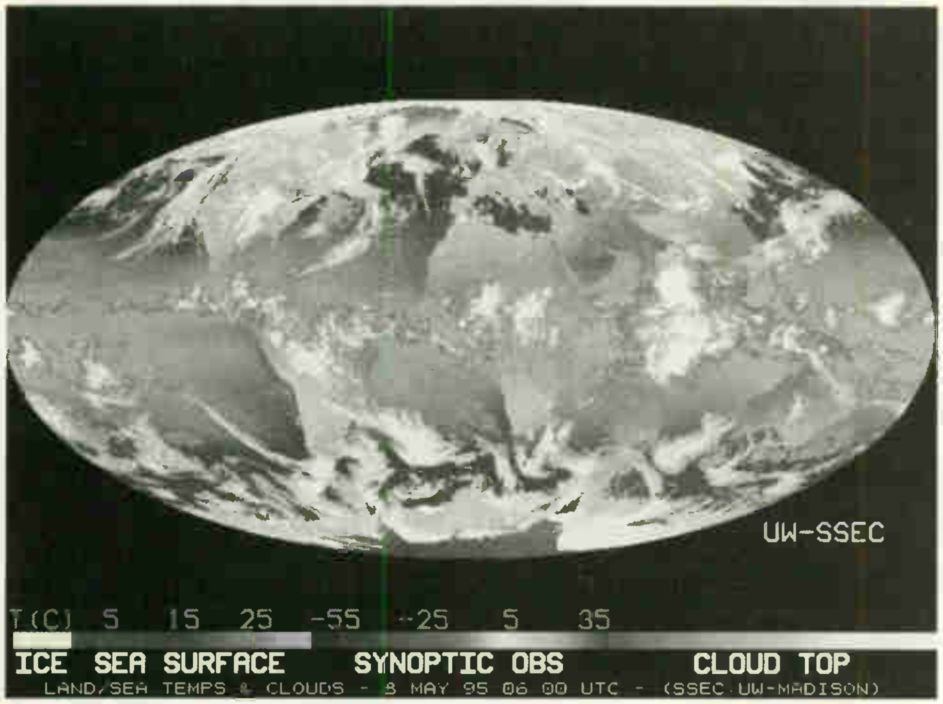
There are undeniable advantages to owning your own weather facsimile satellite receiving system, whether it's for the geosynchronous high altitude GOES satellites (typically a small dish pointed at a fixed location in the sky) or the low altitude polar orbiting NOAA satellite (typically a turnstile antenna). You aren't dependent on somebody else to retransmit the signal and can receive the latest data whenever you want it. On the other hand, even a professional television station or NOAA weather center with a full setup will not be able to receive data if the satellite isn't operational!

Weather facsimile data is also retransmitted via shortwave radio by a variety of stations around the world. Computer programs are available for several different types of micros which hook up the output from a shortwave receiver to your computer's audio input or serial port, and convert the audio tones into facsimile images. AEA's FAX III consists of a small demodulator which hooks up to a PC's serial port. It has a pass through connector to permit you to continue using your port for other serial devices. An audio cable connects to your shortwave receiver's earphone jack to the adapter. The accompanying software program through the provided serial adapter recognizes the high and low tones transmitted by the shortwave station. It converts these tones into bright and dark pixels on your computer's VGA monitor that form a received image. These images can also be saved as standard PCX, GIF, or TIF format files and edited with any program which manipulates graphical images.

One step even less expensive and complicated is RadFax for the Macintosh. You just put your Mac's microphone next to the shortwave receiver's speaker, and RadFax translates the incoming tones into images on the screen. RadFax is a shareware program written by Juri Munkki of Finland. All you



A composite infrared view of the world, created by combining weather satellite images from Japanese, U.S., and European weather satellites.



Temperature sensors on worldwide spacecraft produce data which is used to create false color images of ice and cloud tops. These images were taken on March 8, 1995.

have to do is set the reception speed and desired resolution and start receiving.

Ham Radio Offers Images

Ham radio is also an excellent way to receive weather information. Some amateur television transmitters are configured to permit hams to hook up the transmitter to local NOAA retransmissions. Weather satellite data is also often available via packet radio networks. Amateur radio operators receive the weather satellite images from any of a dozen different sources, save the image as a compressed JPEG format file, and put it on ham packet bulletin boards. The data is quickly disseminated to other packet boards where it's available to anybody who wants to receive it.

The Interent is the Best Place for Pics

If you have Internet access there are many different sources for weather satellite data. You can often obtain local weather forecasts and information via regional Internet providers, many World Wide Web sites include forecasts for their local areas, and there are several FTP (file transfer protocol) sites which store and archive weather satellite data and images. One of the best FTP weather satellite image sites is *explorer.arc.nasa.gov*. At this site you will find high resolution refined weather satellite images from the U.S. GOES and Japanese GMS satellites. The directory /pub/weather includes subdirectories for the GMS-4, GOES-7, and GOES-8 satellites.

Internet is also an excellent source for public domain and shareware programs which let you receive weather satellite data or manipulate the results. One of the best sites I've found image programs is the FTP site at *oak.oakland.edu*. Make sure you check both the /SimTel/ and /pub directories under ham radio and weather sub-directories for your particular computer type.

If you have a program like Mosaic or Netscape which accesses the WorldWideWeb one of the best locations to check out is *http://www.ssec.wisc.edu/data/* which has much of the latest weather satellite imagery available for display and download. Colorado State University's site *http://www.colostate.edu/Depts/CIRA/rammb/g8modpg1.html* includes demonstrations showing the improvements achieved with the new GOES-Next series of weather satellites. NOAA has its own web page, which includes information on all of the different NOAA activities and it is located at *http://www.noaa.gov/*.

While technically not data from weather satellites an excellent source for weather images from space is the Johnson Space Center's earth observation library. Digital versions are available of almost every photograph of the Earth taken on each space shuttle mission. Earth observation shots are typically taken with 70 mm. Hasselblad cameras using color or infrared film. The combination of the shuttle's relatively low orbit, the high resolution possible with film, and having an astronaut personally select interesting items to view results in incredibly high quality images. The Space Shuttle Earth Observation Project library can be accessed through several different methods from your home computer.

All earth-looking hand-held photography is examined by catalogers for the purpose of determining various facts about the pictures such as coordinates, country, prominent features, focal length of the camera lens, quality of exposure, percentage of cloud cover, tilt of the camera, whether photos are contiguous (stereo shots), and direction of the camera. This information is available via Internet at *sseop.jsc.nasa.gov* or 146.154.11.34. At the username prompt type *PHOTOS* and at the

The western hemisphere, as imaged on May 14, 1995 by the GOES-8 spacecraft.

Temperature sensors on worldwide spacecraft produce data which is used to create false color images of ice and cloud tops. These images were taken on March 14, 1995. Compare this image to Photo 4 to see how the Earth's weather has changed over six days.

password prompt type *PHOTOS.* You can also reach this site directly via modem over the phone lines at (713) 483-2500. If you're calling using a direct-dial phone line enter *SN_VAX* when you're asked for which computer you want to access. Once you log on to the Johnson Space Center computer a set of prompts ask you for what types of images you're interested in viewing.

In addition, the collected earth observation images from the first 50 shuttle missions (STS-1 through STS-44) have been put on a Laser video disk. Approximately 91,500 digital still photos are stored on the double-sided 12" disk. It's available for $55 directly from the Johnson Space Center. You can contact Ms. Bunny Dean mail code AP4, NASA Johnson Space Center, Houston, TX 77058-3696 or call (713) 483-8625 for more information on ordering the Earth Observation Images laser disk.

On the other hand, if weather on Earth is too mundane for you, how about weather on other planets? Planetary meteorology is a fascinating field for space scientists, and one of the key planetary tasks for the Hubble Space Telescope. While planetary probes like the Voyager spacecraft can give much higher resolution images, Hubble can produce images over a long period of time allowing scientists to keep track of how a planet's climate changes with the seasons. Mars and Venus are the favorite places for studying planetary meteorology, but some scientists are even examining the much further giant planets of Jupiter, Saturn, Uranus, and Neptune. On Internet, the anonymous FTP site *stsci.edu* will give you access to publicly released low resolution .GIF and .JPG format wide field/planetary camera images. ST

The Hamtronics R138 Weather Satellite Receiver

by Jeff Wallach, N5ITU, and Fred Piering

Hamtronics, of Hilton, New York, has been well known in the amateur radio community for well designed, easy to build radio receivers, of high quality and durability. One of their kits, the R137 weather satellite receiver, has been used by many amateur satellite sleuths interested in copying the imagery from the U.S. and Russians 137 MHz weather satellites in polar orbit. The Dallas Remote Imaging Group (DRIG) recently had the opportunity to evaluate one of their new, pre-assembled units, and we have provided our bench and on-the-air measurements of this new generation of weather satellite receiver for this edition of *ST Test*.

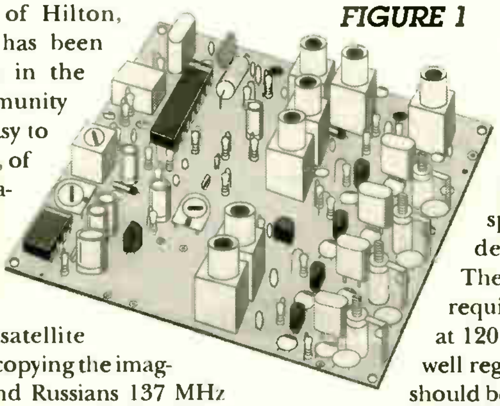


FIGURE 1

The Hamtronics R138 is a commercial grade, four channel, crystal-controlled VHF FM 137 MHz weather satellite receiver. It is engineered to be optimized for reception of the polar orbiting weather satellite imagery at 137.400 to 137.850 MHz. It features wide IF filters (34 kHz wide to accommodate the wide deviation used to transmit Automatic Picture Transmission imagery), low-noise dual-gate FET RF amplifier and mixer stages, and an integrated IF strip. The R138 has built-in multichannel capability, improved stability through the use of a double-side PC board, and appears to be easy to assemble (DRIG received a factory-assembled unit...prior experience with assembling the R137 model would tend to support this claim). Figure 1 shows a diagram of the R138 receiver in factory assembled form.

The pre-assembled unit comes as a PC board. The receiver must be installed in some type of chassis, adding control knobs for volume, squelch, frequency selection, and connections for power, speaker and WEFAX demodulator input. The power connections require +12 to +13.6 volts at 120 mA peak current. A well regulated power supply should be used to prevent distortion in the received signal. A loudspeaker with 8 ohms or higher impedance will be needed. The antenna connection is typically a short connection of RG174u to the PC board, and an SO-239 jack or BNC on the rear of the chassis. The channel selector switch will allow selection of one of the four frequencies (typically 137.400, 137.500, 137.620, or 137.850 MHz) depending on the satellite to be received. A squelch defeat switch and logic circuit to switch on a tape recorder round out the peripheral requirements.

The R138 receiver has several test points to allow for trouble-shooting and signal tracing. This is how we did our analysis of the receiver characteristics, and determination of the R138's suitability for weather satellite imagery.

The tests done by DRIG engineer Fred Piering shows the actual circuit board to be constructed of a high quality epoxy, double-sided board with plated through holes. The individual components used appeared to be a very high quality and state of the art semiconductors are used in the design. The receiver architecture is the prevalent RF amplifier and mixer (using dual gate FETs), bipolar crystal oscillator, followed by a complex integrated circuit that serves as a dual conversion mixer, IF amplifiers, limiters, demodulator, squelch and audio output stages. The receiver employs ceramic filtering at both the first IF stage of 10.7 Mhz and the second IF stage of 455 khz.

The crystal controlled local oscillator used in the R138 takes a somewhat unconventional approach. The typical VHF receiver used a third overtone crystal that is subsequently tripled in the following output stage. In the R138, the crystal is a 32 pF parallel resonant fundamental frequency crystal (~ 14 Mhz). This stage is followed by a tripler that employs a tripler input stage (42 Mhz) with the tripler collector circuit tuned at the desired frequency of 126.8 Mhz (actually providing a total multiplication factor of 9). Although not a conventional design, the local oscillator was exactly on frequency and the local oscillator level to the mixer input was very robust. The desired frequency for the supplied crystal was 126.800000 MHz and was measured to be 126.800055 MHz, or only 55 Hertz off frequency. This is very important since readily available IF filters for 455 kHz are marginally wide enough, and off frequency operation will degrade the overall image quality from the satellite. The second conversion crystal oscillator was measured to be 10.245220 MHz., or only 220 Hz off frequency. Both of these measurements reflect excellent characteristics.

During the evaluation of the R138 receiver, several important data points were observed. These data points relate to the characteristics of weather satellite radio transmissions. In receiving weather satellite images from the polar orbiting satellites, the frequency is in the 137 MHz band with an FM carrier that is amplitude modulated (AM) at 2400 Hz with the video information. Since the weather satellites are fairly low powered (~ 5 watts) and fairly wide FM modulation (~ 17 kHz on either side, plus doppler shift effect), there are several re-

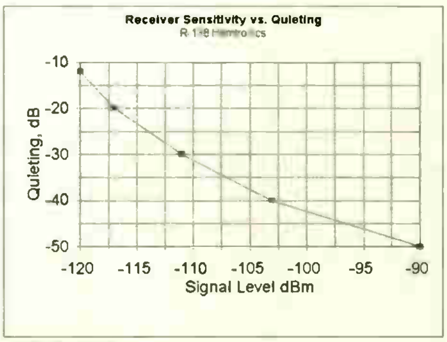


FIGURE 2

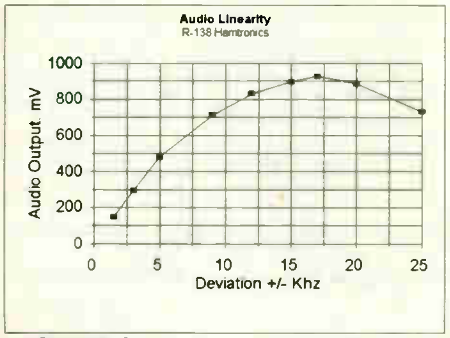


FIGURE 3

ceiver characteristics of interest. These characteristics include:

- Receiver Sensitivity
- IF bandwidth (relative to the required 40 kHz)
- Linearity of the signal
- During our tests, measurements were made on the factory supplied received, with no additional tuning or tweaking.

ST *Test Results*

The bench tests on the R138 receiver demonstrated the following:

- Receiver sensitivity measured at -120 dBm (0.224 uV) at +12 S+N/N (against published specifications of 0.15 - 0.20 uV)
- -20dB Quieting measured at -117 dBm (0.32uV) (against published specifications of 'about 0.25 uV)

Considering the minor variations in test equipment calibration and small errors in attenuators used, this data is in very good agreement with the published specifications from Hamtronics. This excellent level of sensitivity measured on the bench may actually allow the receiver to be used without a preamp at the antenna, provided the antenna has modest gain and low loss coax is used at the ground station. Figure 2 is a data point plot of R138 Receiver Sensitivity vs. dB Quieting as measured in the DRIG lab.

Overall modulation bandwidth was measured at +/- 17 kHz. This is actually barely adequate for the NOAA satellites (with Doppler shift the bandwidth needs to be at least +/- 23 kHz for acceptable dynamic contrast in the imagery). Measurements were made at both the -110 dBm and at -100 dBm levels. At the -100 dBm, the maximum modulation was measured at nearly +/- 19 kHz, providing sufficient bandwidth at this level, including doppler, to capture some acceptable imagery (this was most likely due to the skirt selectivity of the IF filter at 455 kHz). Figure 3 is a plot of the measured R138 Receiver Audio Linearity, demonstrating the plot of receiver deviation vs. audio output.

Analysis of the schematic diagrams and bench test reveal that the receiver does not use any audio filtering. The use of a bandpass or lowpass filter would provide better results on the bench tests.

On-the-air testing of the R138 receiver with NOAA APT transmissions provided some disappointing results (compared with the expectations from the bench testing) in the quality of the imagery. Note the excellent dynamic range of the contrast and detail in the image. Figure 4 shows the first image received on the R138 from NOAA 12. As may be seen, the image is very washed out (as far as contrast) and 'wavy'. Further analysis of the schematics revealed a big surprise! The audio network between the discriminator output and the input to the audio output stage appears to act like something like a 20 Hz low pass filter! This is resulting from the RC values used for this network (58K resister at R24 and 1 uF capacitor in series with 20K resistor to ground at the volume control). These values markedly distort the audio going to the APT demodulator, and hence the poor imagery observed.

Soldering a one pole R/C network from the discriminator pin to ground markedly improved the image as can be seen in Figure 5. The image is still not up to the quality of our lab receiver, but markedly improved. The problem with the 20 Hz. low pass filter would not have been discovered in normal bench testing, which begs the question as to whether or not Hamtronics actually did any imagery capture from NOAA satellites to test the R138 receiver. The good news is that the problem can be easily corrected by changing the 0.1Mfd capacitor to something on the order of 0.001 Mfd. in the audio network described.

FIGURE 4

FIGURE 5

In summary, the R138 receiver is a moderately priced unit the comes completely assembled and is easy to install in a case. With some very minor modifications by the manufacturer, this receiver can make an excellent entry into the fascinating world of weather satellite image reception. ST

The author would like to thank Mr. Fred Piering of the Dallas Remote Imaging Group for conducting the bench and on-the-air testing of the Hamtronics unit for ST Test.

Editors Note: Jeff Wallach and Jerry Vogt of Hamtronics discussed the findings of the R138 review noted above. Jerry was very interested in the results of the review, and is currently putting plans in effect to modify the low pass filter to improve the overall quality of the weather satellite imagery. That is what we call excellent customer service and customer focus. With the minor modifications noted in the review, our team from the DRIG staff is confident the R138 receiver will gain as much popularity as the forerunner, the well known and excellent R137 Hamtronics weather satellite rec5eiver kit.

You should also be aware that Hamtronics has another great product, the AS-138 scan adapter. The AS-138 will automatically scan for active weather satellites frequencies, and it includes a relay to switch on a tape-recorder so you can monitor passes while you are not in the shack.

I would like to thanks to Jerry Vogt and Hamtronics for providing us with some great products for the weather satellite community and the DRIG test team for their help in this review.

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UPLINK

By Bob Grove, *Publisher*

Listening in Isn't Quite the Same Anymore

It was a bittersweet message I received in which I learned that my long-time colleague, Tommy Kneitel, is relinquishing his position as editor of *Popular Communications* magazine. Tommy and I share a unique niche as communications journalists who have watched tube technology give way to solid state, and terrestrial links become satellite technology. We have been active, licensed amateurs for decades as Morse, AM, SSB and RTTY modes have obsolesced, supplanted by sophisticated digital techniques.

More relevant to *ST* readers, however, Tommy began co-writing *CB Horizons* magazine with TVRO legend Bob Cooper in 1961. This was just the beginning of his flirtation with magazine editing and book writing.

Tommy's writing style was often conflagrational, although he has mellowed in recent years. He loved to respond in print to letter writers in a manner that left them thinking, "what a smart ass," and the readership begging for more.

But as Bob Dylan lyricized decades ago, the times, they are a-changin'. No longer do we hear program feeds on shortwave, clear-text telegrams and newsfeeds in the HF spectrum, or even feast on boundless unscrambled video beaming down from the Clarke belt.

Digitization is the new technology, assuring message security and discouraging uninvited interception. But this added level of privacy brings with it an architecture that defies home experimentation, relegating technology to giant, funded laboratories, not the homebrew enthusiast.

Gone are the days when a young boy can dream of heating up a soldering iron and building a simple two-way radio from salvaged parts. The construction articles are gone, the technology is obsolete, the interest has fled, the art has evolved. The computer is on a chip and so is the radio. The parts houses have given way to condominiums; surplus components are often esoteric; RF and analog design are no longer in vogue.

While it is tempting to throw in the towel and submit to the end of an era, the fact is we are witnessing the birth of a new era of mass intercommunication. There is a bright light on the horizon. Personal communications and Internet are the next logical step. Tommy, pick up your PCS telephone and give me a call, and I'll be watching for you on video phone! ST

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