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Deep Black

Part 2 of ST's Exclusive Report on America's Military Space Programs

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Satellite Times

Cover Story

Shedding Light on Deep Black

By Philip Chien, ST Staff

Badly kept secrets, secret shuttle missions, Project White Cloud, Stars Wars, and much more are discussed in this second of a three part series on America's secret military space program. Author Chien uncovers the secrets starting on page 10.

Cover Photo: *An artist's rendition of a Defense Satellite Program (DSP) early warning satellite in geostationary orbit monitoring one-third of the earth for a missile attack on the United States. (U.S. Air Force photo)*

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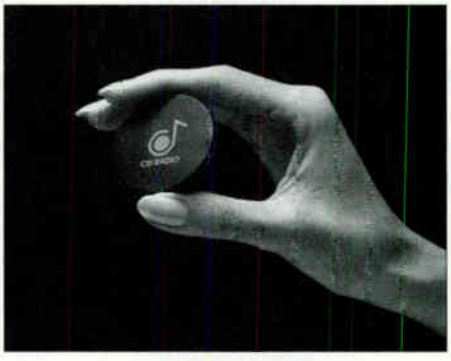
July/August 1997

In the Driver's Seat with Satellite Radio

By Kirk A. Kleinschmidt, NT0Z

With FCC licenses in hand, two companies are racing to deliver nationwide, CD-quality music programming to your car radio via satellite. In 1999, cruising the boulevard to the pleasant blare of your favorite tunes will be an out-of-this-world experience. Story on page 17.



From Shortwave to Satellites and on to Cyberspace

By George Wood, ST Staff

Shortwave ain't what it used to be. More and more domestic shortwave stations have turned into "international broadcasters," lured by the seductive sirens of satellites. Often the change has been met with recriminations by shortwave radio listeners, protesting the end of their close relationship with the stations. *ST*'s own George Wood has endured the attacks on two accounts. We asked George to comment on the traumatic experience in the story on page 22.

DEPARTMENTS

As two NASA spacecraft speed toward a rendezvous with Mars this month and in September, astronomers using the Hubble Space Telescope are providing updated planetary weather reports to help plan the missions. If you think the weather on Earth is unpredictable, try living on Mars. See the latest pictures on page 86.

ST

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DOWNLINK

By Larry Van Horn
Managing Editor
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NPR Update

The following is an update to the article written in the January/February 1997 issue of *Satellite Times,* titled *This is NPR From Space* by Brad Alan Finlan.

"National Public Radio (NPR) claims it will not block the sale of the ABR-700 receivers needed to pick up NPR's satellite feeds to the public. However, NPR will not sell directly to the public. ComStream, the manufacturer of the unit will not deal directly with the public, either. They will deal with a retailer who sells to the public provided that the retailer is willing to invest some $50,000.00 in a maintenance program for the unit when it is out of warranty (NPR repairs its own units).

"Even assuming one could convince a dealer to stock the unit, the cost would probably be in the $3,000.00 range for the receiver alone. As the receiver's input is 70 MHz, an external blockdown converter would be required as well as a phase-locked-loop (PLL) LNB. Since very low noise specifications are required for the downconverter, the price to purchase one is a stiff $1,800.00. A PLL LNB adds another $400.00 to the overall pricetag.

"In addition, due to interference from adjacent satellites, NPR recommends a dish size of at least 12 feet. With these obstacles in place, I would not expect anyone to go through the trouble, and NPR probably doesn't either, to receive their digital broadcasts.

"Even if you are willing to go through the expense and hassles, there is one additional hurdle, NPR has to authorize your receiver, and they are on record as saying they are not going to do that.

"I mentioned in my article that NPR subleases unused SCPC space to commercials networks. Their current charge for a 256 kbit/sec stereo C-band channel is $2,370.00 per month. This is a very good deal as far as competitive pricing goes. In fact, it is too good a deal according to NSM Satellite Services. NSM is a midwest firm which is in the business of leasing SCPC space. They allege that NPR is dumping satellite space on the market below wholesale prices. Since NPR has no overhead in its transponder costs (your tax dollars paid for this), they can set prices for the industry anywhere they want. In a total contradiction, NPR sells the same space to its affiliates for $11,000.00 per month. I would ask the NPR affiliates who is taking care of whom here.

"On a more positive note (*you mean there is one, Brad-editor*), Comstream has announced that it will be marketing a new digital receiver sometime later this year. The ABR-2000 will have the same feature as the current model, plus front controls (the existing model must be operated by a computer terminal), at half the cost, $1,000.00.

"Many networks use the ABR-200 currently to distribute their programming. Both the ABR-200 and the ABR-2000 have L-band inputs and require the use of a PLL LNB due to stability requirements. Some NPR affiliates still use the ABR-200 for distributing their signals to remote FM transmitter locations. The system contains no security feature other than the requirement that a few parameters be set at the receiver to match the uplink. "Thus in the near future it will be possible to build a receiving system, including an ABR-2000, PLL LNB, and dish for about $1,700.00 (ComStream and its distributors will sell the unit directly to the public). Hope of getting NPR back on satellite and in the clear is on the horizon."

—Brad-Alan Finlan, San Marcos, California

Legislative Update

Sen. John McCain

Our elected officials in Washington have struck again. Senator John McCain of Arizona has introduced Senate bill S-705, *The Digital Television Conversion Act.* S-705 forces television broadcasters to change from analog to digital on a schedule determined by Congress. This bill is being introduced, even though the Federal Communications Commission has not finished the rule making process.

In his press release, McCain says he introduced the bill to guarantee that the transition to digital (DTV) takes place as quickly as conditions will reasonably allow. All of this is done in the interest of the American taxpayer, right?

The fine print is frightening, however. Your free TV is now going to cost you bigtime to "improve technology." You will have to purchase $2,000 TV receivers, new VCRs, etc., in order to view the new DTV. They say market forces will drive the price down, but this has not happened in Japan after ten years of high definition television sales. If you can't get the price down in Japan, how does Senator McCain think that it will come down here in the U.S?

Oh, and one other thing! Nowhere in either the S-705 or the FCC rulings on DTV has anyone mentioned how the more than 6,000,000 satellite dish owners are going to be converted over to digital TV! When will analog NTSC no longer be used on satellite delivered broadcast, and what rules will be used to convert these broadcasters to the new standard? I guess satellite viewers don't count until it is time to pay our satellite programming bills.

Chairman Reed Hundt of the Federal Communications Commission wrote recently on broadcast television, "..it is our only free, universally available communications medium."

Hey, Mr. Hundt: I have a bill for $50.00 in my hand from Primetime 24 for my satellite delivered network (ABC, NBC, CBS, FOX, and PBS) programming for the next year. Would you like to pay for my "free network programming?"

More next issue ... ST

SATELLITE MONITOR

By Wayne Mishler, KG5BI

Pathfinder to reach Mars on Independence Day

By the time you read this, *Mars Pathfinder* will probably be transmitting information from the surface of the red planet to anxious scientists on Earth.

The spacecraft, with its payload of science instruments and surface rover, is expected to land in a region of Mars about the size of southern California on America's Independence Day, July 4, 1997.

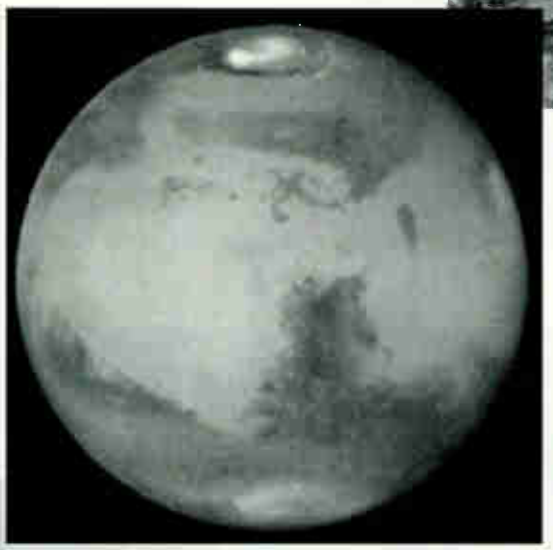
At this writing the spacecraft is about midway in its journey, traveling at about 50,000 miles per hour, or about 22 kilometers per second.

The Mars Pathfinder Mission is the second launch in NASA's Discovery Program. Its primary goal is to demonstrate technologies for use in future Mars missions. It is to deliver scientific instruments to the planet's surface to investigate the martian atmosphere and planetary surface including the composition of rocks and soil. The surface rover will deploy instruments and conduct experiments as it moves about on the surface.

Scientists chose the landing site based on safety, sufficient sunlight, acceptable slopes, surface roughness, and visibility. Another factor was the probability of finding important science data. The chosen site is located near the mouth of a catastrophic flood channel and is called a "grab bag" site for its potential samples, including the ancient crust of the planet.

The landing process will actually begin several days before the scheduled July 4 touchdown. Controllers on Earth will send commands to the spacecraft to tell it precisely when and how to begin the series of steps for landing safely on the site. Actual touchdown is scheduled for about 3 a.m. local time on Mars, which will be about 10 a.m. on the U.S. Pacific coast.

Beginning about 3 hours before landing, and continuing until about 3 hours after landing, the spacecraft will be controlled by autonomous on-board software.



Top: the Mars Pathfinder landing site, Ares Vallis, is in he Chryse Planitia region in the northern hemisphere of Mars.

Middle: recent photos by the Hubble Space Telescope are providing new insights to Martian weather (see pp. 86-87)

Left: The small rover which will be deployed by the Mars Pathfinder.

On approach, *Pathfinder* will vent fluid which kept the lander and rover cool during the seven-month cruise.

The cruise stage will be jettisoned about 30 minutes prior to landing.

As the spacecraft enters the outer fringes of the atmosphere, about 80 miles (125 kilometers) above the surface, its spin will be stabilized at two revolutions per minute.

A Viking-derived aeroshell heat shield will protect the lander from intense heat of entry. At the peak of heating the shield will more than 100 megawatts.

The spacecraft will plow into the main atmosphere and slow to about 900 miles per hour precisely at a 14.8-degree angle. This is important. A shallower entry angle would result in the vehicle skipping off the atmosphere, and a steeper entry would not provide enough time to do all of the entry, descent and landing tasks.

The deceleration of about 20-Gs will be detected by on-board sensors and will

set in motion a sequence of preprogrammed events that are completed in quick succession.

A parachute is deployed, slowing the spacecraft to about 150 miles per hour. The heat shield is blasted away from the lander, which separates and "rappels" down a metal tape. The slow descent down the tape puts the lander in position at the end of a tether. A radar altimeter is then activated and will detect the surface 32 seconds prior to landing. The altimeter will help time the actual events of landing, including the firing of solid rocket motors which will stop the lander about 40 feet above the surface. The tether will be cut, allowing the lander, encased in airbags, to drop safely to the surface.

If the lander falls on its side, it will be righted by opening a side petal with a motor drive. Once upright, all petals will be opened.

During the landing process, the lander's X-band radio transmitter will be turned off for the first time since being launched on December 4, 1996. This saves battery power and will allow the transmitter to cool after being warmed during entry. It also allows time for the Earth to rise well above the local horizon and be in a better position for communications with the lander's low-gain antenna later in the morning.

Japan lays groundwork for lunar exploration

Twenty-five years after America's Apollo Project, scientists are anxiously looking forward to returning to the moon in Japan's SELENE Project soon after the turn of the century.

The National Space Development Agency of Japan (NASDA) is moving forward with SELENE, an acronym for Selenological and Engineering Explorer, and is planning to launch its first lunar probe around 2003.

The purpose of the mission is to challenge the mysteries of the origin and formation of the Moon, which remains a potential source of space resources, and to build a basis for lunar exploitation, says NASDA.

Scientists consider the SELENE mission to be important for the international community as a whole. It is a joint project between NASDA and the Institute of Space and Astronautical Science (ISAS).

In the SELENE Project, Japan plans to develop technology for soft landing on the Moon, which is vital to gathering data for researching future use of the lunar environment.

SELENE is an explorer vessel consisting of a lunar orbit satellite, a Moon-landing experiment vehicle, and a relay satellite.

After launch, the orbit satellite will be injected into an elliptical orbit around the Moon, and will slowly settle into a circular orbit about 160 miles (100 kilometers) over the lunar surface. After circular orbit is attained, the experiment vehicle will separate from the orbit satellite and descend to the surface from where it will transmit research data. The relay satellite will go into elliptical orbit with apogee of 7,000 miles lunar altitude, and will relay data between Earth and the orbit satellite.

The orbit satellite is expected to operate for one year to map the entire lunar surface.

Scientists are still considering the science instrument payload which will analyze the composition of elements and minerals of lunar materials. They plan to include a topographic camera, altimeter, and radar sounder to investigate surface and subsurface features. They are also interested in measuring the Moon's gravity including the gravitational field on the backside. A plasma imager will probably be included to measure the environmental conditions of the magnetosphere between the Moon and Earth.

New Los Alamos observatory will study flashes in the night

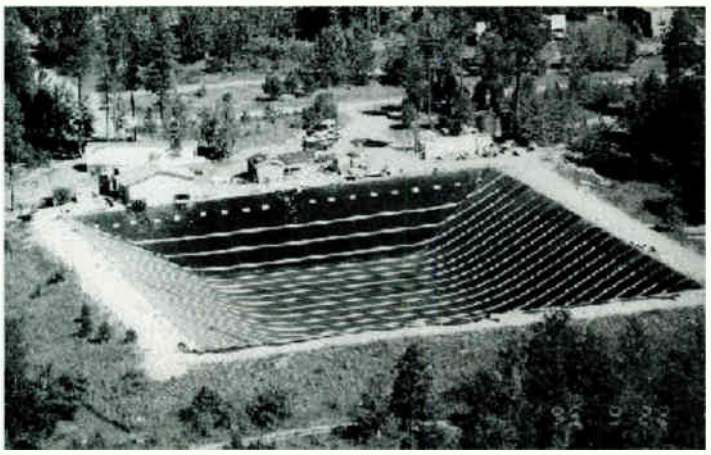
A new observatory 35 miles west of Los Alamos in northern New Mexico will study objects that brighten in the night sky and then quickly fade away, including supernovae, flare stars, and brief but high-energy flashes from space called gamma-ray bursts.

The Los Alamos National Laboratory Fenton Hill Observatory, with an elevation of 8,500 feet above sea level, may also help catalog near-earth objects, including potential Earth-crossing comets and asteroids.

"Fenton Hill will contribute in a big way to our knowledge of all manner of astrophysical transients," says Los Alamos astronomer Galen Gisler. "We'll have a rapid response to alerts from other instruments, varied depth of field, and the ability to cover a large part of the sky."

Fenton Hill will be equipped with telescopes especially suited for optical observations with short time scales, from fractions of a second to hours. This will allow broad searches of the sky and a chance to catch transient optical events before they vanish.

One such event occurs when a star at the end of its life explodes as a supernova, producing in seconds as much energy as our Sun will release in its lifetime.



The new observatory will also look for flare stars, similar to Sun flares. Other stars, some the same size of our Sun, brighten in varying degrees of magnitude when they flare. A systematic study of flare stars may help researchers predict activity on the Sun.

Something in space—scientists are not sure what—can suddenly emit thousands of times more gamma ray-energy than any other source in the sky, and then vanish in seconds. In 1973, the Vela satellites, built by Los Alamos to monitor atmospheric nuclear tests, recorded brief bursts of gamma-rays of cosmic origin coming from random directions in the sky. Scientists theorize on the origin of the bursts, but the question remains unanswered.

To find the answer, astronomers need to record the bursts in the visible light spectrum. This would enable them to compare the recordings to familiar objects such as stars, galaxies, and nebulae. In the frequency range of visible light, astronomers have established ways for determining distances and relationships. But to date only one optical counterpart of a gamma-ray burst has been detected.

"We want to solve the mystery of gamma-ray bursts," says Gisler. "No one else is set up to respond within seconds to catch optical signals from points in the sky where gamma-ray bursts have been observed."

The Fenton Hill facility will also help scientists detect and map the orbits of asteroids and comets, including those that could collide with Earth.

The key to Fenton Hill's mission is its computer power which can hold and analyze an enormous volume of data. "Los Alamos has the storage capacity to manage huge data streams," says Gisler. "And we have the computing ability and expertise to find the rare signals we are looking for in large volumes of data."

The first optical telescope at Fenton Hill will be REACT, an acronym for Research and Education Automatically Controlled Telescope. This will be an automatic and robotic telescope enabling astronomers and students to search the sky from computer terminals. REACT will have a narrow, half-degree field of view with high resolution. In its "event alert" mode, REACT will automatically swing around to take a series of one-minute exposures to catch any optical signals coinciding with gamma-ray transients seen by other instruments.

"We intend for the Fenton Hill observatory to benefit the local community too," Gisler says. "We will involve students from local high schools and colleges to operate the telescopes and analyze the data."

The next instrument to be installed will be ROTSE I, the Robotic Optical Transient Search Experiment, a four-barreled system with 200mm wide-field lenses on electronic cameras. It will have an intermediate, 15-degree field of view. ROTSE will use telemetry data from NASA Compton Gamma-Ray Observatory to direct its cameras toward burst events as they occur. Response time can be as short as ten seconds.

ROTSE will spend most of its time watching for comets. If one happens to pass in front of a star, ROTSE will record the tenth of a second dip in light intensity from that star. This data may help detect and track the comets long before they can be seen optically.

A proposal has been made to fund another device called ATOMIC, the Astrophysical Transient Observatory Multiple-Imaging Cameras. This will be an array of cameras mounted on a dome-shaped table. This low-resolution instrument will have a 120-degree field of view that will cover most of the overhead sky.

The new telescopes will stand beside an unusual observatory already in place at Fenton Hill, called Milagro. Using more than 700 sensitive light detectors submerged in a five million gallon artificial pond, plus another 200 detectors arrayed around the pond, Milagro will record signals from high-energy cosmic emissions, including gamma ray bursts. Milagro will stare continuously at the sky from horizon to horizon, day and night, acting like a camera whose shutter is always open. And when Milagro alerts ROTSE, it will be watching the same region of the sky, increasing the odds of capturing transient flashes.

Milagro was to produce its first data this spring. The $2.5 million system is to go into full operation by 1998, funded by the National Science Foundation, and the U. S. Department of Energy.

Reports of SETI League's death greatly exaggerated

The Search of Extra-Terrestrial Intelligence (SETI), which disappeared after the U. S. Government withdrew funding for the project several years ago, is alive and well as a non-profit corporation.

It is now known as the SETI League, Inc., directed by engineering professor and radio astronomer H. Paul Shuch.

SETI scientists seek to determine through microwave measurements whether mankind is alone in the universe. Since Congress terminated NASA's SETI funding in 1993, the SETI League and other scientific groups have been trying to privatize the research.

"Our young organization now boasts roughly 500 members in 26 countries and enjoys strong support in Europe," says Shuch.

If you'd like to find out more about the group, visit their web site at **http://www.setileague.org**. To join, send e-mail to **join@setileague.org**, or call the membership hotline 800-TAU-SETI.

Life on Mir goes on, despite TV news

No doubt you've heard TV news complaining about the U.S. spending tax dollars on the aging and reportedly dangerous Russian Space Station *Mir*. Is it really as bad as the media says? Astronauts returning from *Mir* say no, even though conditions aboard *Mir* were deteriorating before the U.S. stepped in with neighborly help.

Astronauts now say *Mir* is doing well, thank you, as attested by the following status report from Energia.

Crew health: All three crew members recently passed a rigorous physical exam by Russian flight surgeons who cleared commander Vasily Tsibliyev and astronaut Jerry Linenger for a space walk on April 29.

Climate in *Mir*: The oxygen, carbon monoxide, temperature and humidity levels have returned to normal.

Cooling systems: Small leaks remain in the cooling system and core module, but are scheduled for repair. Hydraulic thermal control systems are working well.

Oxygen generation systems: Repaired and working normally. One unit was malfunctioning unit was to be replaced by a new unit delivered by shuttle *Atlantis*.

Other oxygen reserves: There is a total reserve of 223 man-days aboard.

Carbon dioxide absorption systems: Operating normally. A back-up system is to be delivered by space shuttle. There is an 18-day reserve supply of CO_2 on board.

Overall: The situation aboard *Mir* has been improving with U.S. help.

Energia is Russia's oldest space organization. It operates *Mir* and maintains other support facilities for the Russian Space Agency. The company is also the prime contractor for the Russian segment of the International Space Station, headed by NASA.

And finally . . .

Mothers often send postage stamps to sons or daughters who don't write. Mine always sent the sheriff with a message to call home collect. So I probably identify more than most with astronaut Jerry Linenger who got an unexpected call while on a four-month mission aboard space station *Mir*.

Astronuat Jerry Lenenger works out on a bicycle ergometer.

"Hi, Jerry," the caller said. Linenger had no trouble recognizing the voice. It was his Mom, Frances, according to the Associated Press.

There was plenty of news to share with her: the fire that almost forced evacuation of *Mir* in February, the view of Hale-Bopp comet zipping past the space station, the experiments to help scientists build better spacecraft in the future, the medical tests of how his immune system is holding up in space.

"I'll be at your landing," she said.

"All right, Mom."

He's lucky. Mine would send the sheriff.

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Sources: Associated Press, Energia Ltd, Los Alamos National Laboratory, NASA, NASDA, SETI League Inc.

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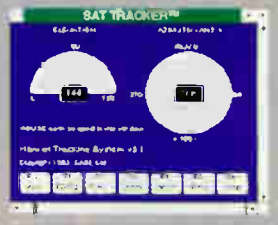
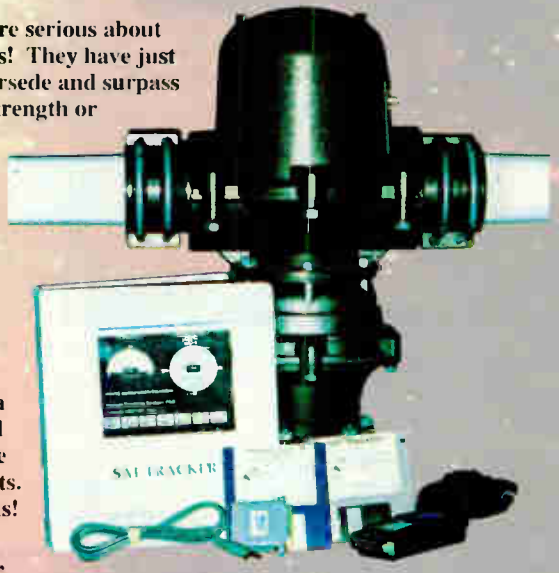


The SAT TRACKER© is a combination of hardware and software which allows you to accurately track all types of satellites or celestial objects from Horizon to Horizon. The system will even assist in accurately tracking rapidly moving low orbit satellites such as the military "LEO" Satellites or Amateur radios' "MICROSAT" Satellites. The SAT TRACKER© can be used in multitude of applications, besides satellite tracking, which require real time computer control of antenna systems.

EMOTO - EV800X & EV800DX

Good News for all you amateur satellite, moonbounce and microwave dish operators. You're serious about your modes of communications and Emoto is serious about meeting your AZ-EL rotator needs! They have just released the long awaited EV800DX and EV800X AZ-ELs. The beefed-up units actually supersede and surpass Emoto's already legendary EV700D5X. The new "EMOTATORS" simply have no equal for strength or accuracy! Emoto's secret is its new unified, single body construction elevation section head along with a newly developed running mechanism. The EV800DX should hold almost anything still! The EV800DX version offers a high-tech digital controller with unmatched, almost zero backlash, +/-1° accuracy for both elevation and horizontal rotation, which is very important for the precise aiming of your dishes and satellite arrays! Remote terminals on the rear panel of both the EV800DX and EV800X are included as standard. These allow for automatic computer control using your compatible computer and commercial or user-written software. By the way, as an added convenience, after rotator and array installation, all calibration adjustments may be done in the shack, at the control box. No need to go outside, climb the tower and tweak the dish or antennas in to exact position. If needed, the EV800DX may be separated into its two component parts. For example, the elevation head at the top of a mast and the horizontal section from within the tower, if you should feel this application would be helpful in your installation. Of course, all units include, as standard, the extras you've come to expect from Emoto: complete mounting hardware, all connectors and weather proofing boots. When you erect a large AZ-EL antenna system, the very last thing you need is rotator problems! With Emoto, the bottom line is rugged, long term reliability, user-friendly operation and cost effectiveness. With the new EV800DX AZ-EL and EV800X elevation rotators here at long last, we can tell you they were certainly worth the wait! Check with your favorite dealer today or call us for the authorized dealer nearest you!



Skywave Propagation Prediction Software for Windows 3.1/Windows 95 is Available

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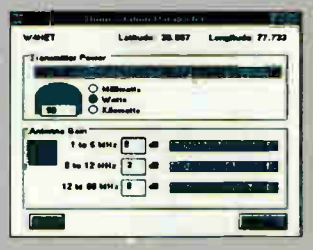

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Part 2, by Philip Chien, Earth News

In part one of this feature on U.S. military satellites (*Satellite Times* May/June 1997, page 10) we looked at the USA numbering system, and the first six types of satellites to use the numbering scheme—GPS navigation satellites, Keyhole photographic reconnaissance satellites, Hitchhiker satellites, and the SDS high altitude comsats. Part two of Deep Black will explore satellites used for missile early warning, ocean surveillance, Satellite Defense Initiative (or Star Wars), electronic intelligence and much more!

A Badly Kept Secret

USA 7 was a Defense Support Program (DSP) missile warning satellite (*Satellite Times* September/October 1995, page 84). The DSPs are the least secret of the secret satellites. Their existence was kept fairly quiet, but knowledge of their role was well established in the aerospace and military industries.

Early Midas missile warning satellites were in fairly low orbits. They used infrared sensors to detect adversarial missiles, tests of new designs and upgrades and operational tests used for training purposes. The problem with these low earth orbit sensors is their pass times are fairly predictable, and any adversary can easily calculate when to schedule missile tests or even an attack while your sensors are on the opposite side of the planet. The DSP satellites, on the other hand, are stationed at geosynchronous altitude, with enough satellites to continuously monitor the entire world.

One reason the DSP concept works is that everybody's aware of their existence. If potential adversaries realize that they're being monitored, they're less likely to take potentially bellicose actions. During the long Iran-Iraq war short-range SCUD missiles were easily detected by DSP satellites and a vast database of how the missiles acted was collected. That information was used in the 1991 Gulf War to warn military and civilians in allied countries about potential SCUD attacks.

USA 7 and USA 28 were the last of the DSP 2 series, launched on Titan 34D vehicles. USA 39 (DSP 14) marked the first, third generation DSP and the first use of the Titan IV launch vehicle. USA 65 and USA 107 were also third generation DSPs launched on Titan IVs. USA 75 was a unique case—the launch of a DSP by the space shuttle. By this point the Department of Defense had decided not to use the shuttle anymore, especially for heavily classified satellites. DSP was innocuous

enough to partially declassify, especially after its performance during the Gulf War. So from the time DSP 16 arrived at the launch pad until its upper stage burn, it was declassified. The STS-44 shuttle crew nicknamed the satellite "Liberty."

USA 130, the most recent launch of a DSP satellite, marked the first launch of the Titan IVB launch vehicle. Whether a DSP is launched by a Titan 34D, IV, IVB, or by the shuttle, it uses an Inertial Upper Stage (IUS) to go from low earth orbit to geosynchronous altitude. It's interesting to note that the current generation DSP satellites were designed to fit within the Titan IVA's capabilities and only 70 percent of the launch vehicle's performance is used whenever a DSP flies on a Titan IVB.

Currently NASA and the Air Force are discussing the potential to fly some future DSPs on the space shuttle. In theory the system saves money—the incremental cost of adding an additional shuttle flight is less than the cost of a Titan IV launch vehicle. However the concept of risking a $2 billion space shuttle and the lives of the astronauts to save a relatively small amount of money to launch a satellite which is as easily launched on an expendable vehicle is questionable. In addition, those shuttle flights could be used for missions which require the shuttle's unique capabilities for scientific, commercial, and military applications—if enough funding could be found for their experiments.

As reported in *Satellite Times* the four operational DSP satellite locations are:

94 84A	DSP 17	103.5W
91 80B	DSP 16	70.736 W
90 95A	DSP 15	37.442 E
89 46A	DSP 14	145.06 E

Deepest Black Elint

USA 8 is one of the darkest of the dark black payloads—a radio reconnaissance satellite (ELINT-Electronics Intelligence). The ultimate goal of a military radio designer is a system which is incredibly directional and can only be heard by the intended party, without any sidelobes or stray signals which can be detected by adversaries. In practice, it's not practical to isolate your signals perfectly.

For line-of-sight VHF, UHF, and microwave frequencies the best place to put a monitoring post to eavesdrop on your adversary's communications is on as high a mountain as possible. Low earth orbit gives you a fairly strong signal, but outages occur where you don't have satellites in the proper positions. So the U.S. has had geosynchronous radio monitoring satellites in orbit since 1973. The early Rhyolite series was severely compromised when classified details were sold to the Soviet Union. That incident formed the concept behind the fictional novel and movie *The Falcon and the Snowman*. Geosynchronus radio monitoring satellites require extremely large antennas to isolate individual radio signals.

USA 8 was code named Magnum as the first of the Aquacade series. The giant satellite required the space shuttle's capabilities, with an Inertial Upper Stage (IUS). A seal failed on the IUS second stage on the first shuttle-IUS flight, STS-6, which carried the unclassified TDRS-A satellite. So, future shuttle IUS flights were temporarily placed on hold. By this point the first classified space shuttle crew had been assigned—commander T.K. Mattingly, pilot Loren Shriver, and mission specialists Jim Buchli and Ellison Onizuka. The decision was made to keep the crew and payload together. The mission had been planned as STS-10 with a launch in January 1984, but was delayed a year; it eventually flew as 51-C in January 1985. The first manned spaceflight engineer, Gary Payton, was a late addition to the crew.

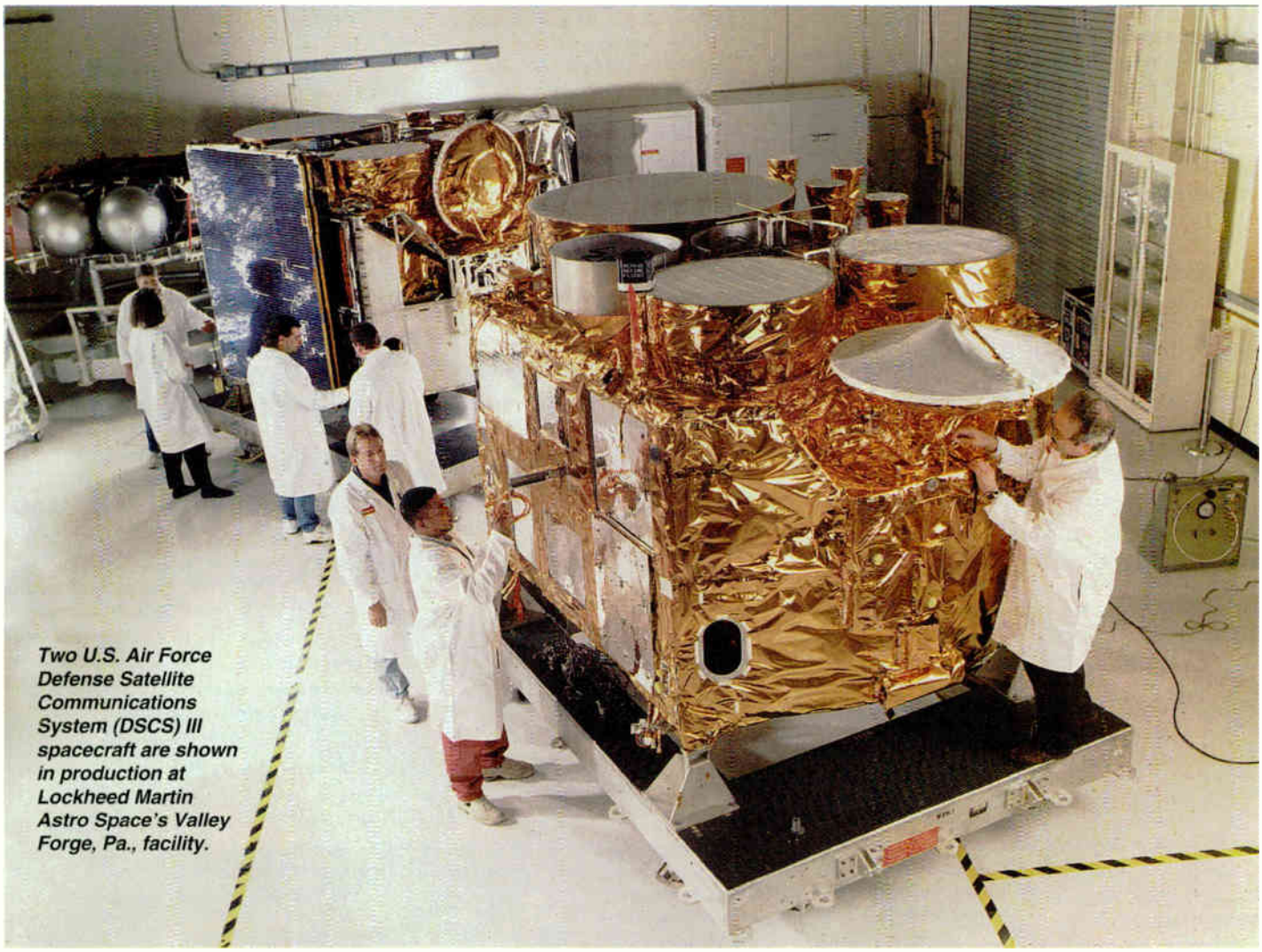
As the first classified shuttle mission there was a lot of controversy about how the mission would be run. The Air Force wanted to close off the Kennedy Space Center to any non-essential personnel for the launch, but NASA balked at that much interference with the normal day-to-day operations.

Eventually it was agreed that an unclassified four hour launch period would be released, concealing the actual launch window. The actual launch time would only be revealed 9 minutes before launch. Once the shuttle reached orbit there would be no statements on the flight's progress until 24 hours before landing, when normal communications would be permitted and the landing time would be announced.

The Air Force did attempt to muzzle the press ahead of time. Many of the details about the payload and the shuttle mission's objectives had already been released in unclassified forms, or leaked.

Shown below, a Taurus launch of an undisclosed payload.

Opening page: A Defense Satellite Communcations System (DSCS) III satellite is shown in geosynchronous orbit in this Lockheed Martin Astro Space artist's rendition.



Two U.S. Air Force Defense Satellite Communications System (DSCS) III spacecraft are shown in production at Lockheed Martin Astro Space's Valley Forge, Pa., facility.

The next day the *Washington Post* published a front-page story outlining the Magnum payload and its purpose.

The secrecy did result in some rather amusing news stories though. CBS reported that a large structure was erected to block the view of the shuttle. Why that reporter thought that the military would want to go to that much expense is questionable, but what's more amusing is that the structure he was referring to was the shuttle's fixed service structure, which had been there since the start of the shuttle program!

Since it was acknowledged that the payload would be the first flight of an IUS after its failure on the STS-6 mission, the Air Force did agree to release a statement on the success or failure of the IUS. So the only official indication of the mission's purpose was a one-line release stating that the Inertial Upper Stage met all of its objectives!

USA 48, named Mentor, was a similar Aquacade satellite launched on the STS-33 mission in November 1989. USA 31 and USA 37 were earlier ELINT satellites of the Vortex series launched on Titan 34D launch vehicles. USA 110 and USA 118 are much larger satellites in the Advanced Orion series, launched on Titan IV-Centaurs. The Titan IV-Centaur has a quoted capacity of 10,000 lbs (454,000 kg) to geostationary orbit—much higher capacity than any previous launch vehicle.

Most of the black satellites in geosynchronous orbits are electronics intelligence platforms. As with the DSP satellites, the principle is to have a group of satellites constantly monitoring adversaries without any gaps. In 1995 the U.S. surprised the 1995 World Radio Conference by announcing the existence of twelve geosynchronous slots where there were satellites operating in the Ka-band, with 17.8-21.2 GHz downlink and 30 GHz uplink. These notifications were made to preempt the use of those frequencies by Teledesic and other manufacturers of satellite constellations.

The geosynchronous locations indicated are:

US CSID-A1	000 E
US CSID-A2	044 E
US CSID-A3	075 E
US CSID-A4	082 E
US CSID-A5	092 E
US CSID-A6	110 E
US CSID-E1	010 E
US CSID-E2	013 E
US CSID-E3	024 W
US CSID-E4	030 W
US CSID-W1	141 W
US CSID-W2	144 W

(Continued on Page 14)

It's likely that some of these locations are not actually in use, both to disguise the locations of the actual operational satellites, and to reserve additional slots for future satellites.

The Second Classified Shuttle Launch

USA 11 and 12 were launched together on STS 51-J, the second classified shuttle flight. It was fairly well known in the aerospace industry that this flight carried a pair of DSCS-III (Defense Support Communications Satellites).

The Titan 34D could carry a pair of one DSCS-III and one DSCS-II satellite, but only the shuttle or Titan IV had the launch capabilities to carry a pair of DSCS-III satellites. Many years later the unclassified DSCS history indicates that a pair of DSCS-IIIs were launched in the fall of 1985: the only possible launch vehicle was the 51-J shuttle mission. Unfortunately, with the secrecy rules in effect the astronauts still can't discuss this mission with their own families!

USA 43 and 44 marked the last flight of a Titan 34D, carrying a DSCS III and the final DSCS II. After the *Challenger* accident the decision was made to use expendable launch vehicles for most military missions. It was theoretically possible to launch the DSCS IIIs in pairs on Titan IV-IUS launch vehicles, but more cost effective to launch them individually on Atlas II launch vehicles. USA 78, USA 82, USA 93, USA 97, and USA 113 have been unclassified DSCS III launches on Atlases.

Skeet in Space

USA 13 and 14 were a unique pair of satellites, the AFITV (Air Force Instrumented Test Vehicle), launched on a NASA Scout rocket from Wallops. These were target satellites for anti-satellite (ASAT) weapons.

The U.S. developed a missile which could be launched from a modified F-15 fighter plane. The missile would accelerate to orbital altitudes where it would be a road hazard to an orbiting enemy-owned satellite. The missile wouldn't need to carry an explosive since it would be standing still and the enemy satellite would run into it at orbital velocity. Due to a Congressional ban on anti-satellite tests, the AFITV satellites were never used operationally.

The only test of the U.S. missile-based ASAT system used an existing military satellite in orbit, Solwind (1979 17A). While Solwind was not instrumented as an anti-satellite test target the sudden cutoff of its telemetry and subsequent radar tracking of the debris indicated that the ASAT had successfully hit its target. Or, more accurately, Solwind had run in to the ASAT and shattered in to 163 pieces.

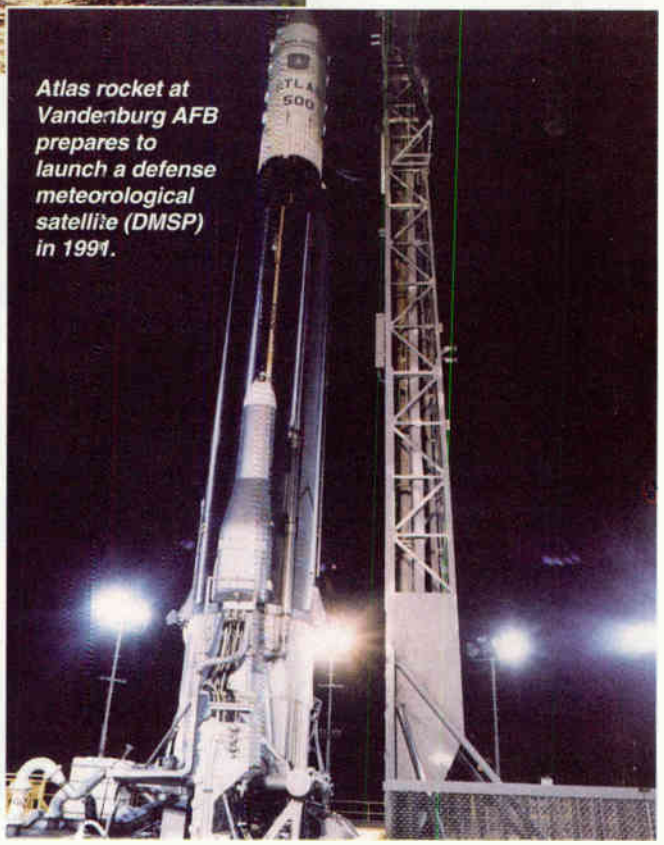
It's interesting to note that even though the launch took place 12 years ago, NASA's Wallops Flight Facility refuses to release photos of the launch because it carried a Strategic Defense Initatives (SDI) payload—even though those photos are unclassified!

The only test of the U.S. missile-based ASAT system used an existing military satellite in orbit, *Solrad*. While Solrad was not instrumented as an anti-satellite test target, the sudden cutoff of its telemetry and subsequent radar tracking of the debris indicated that the ASAT had successfully hit its target. Or, more accurately, Solrad had run into the ASAT and was shattered to pieces.

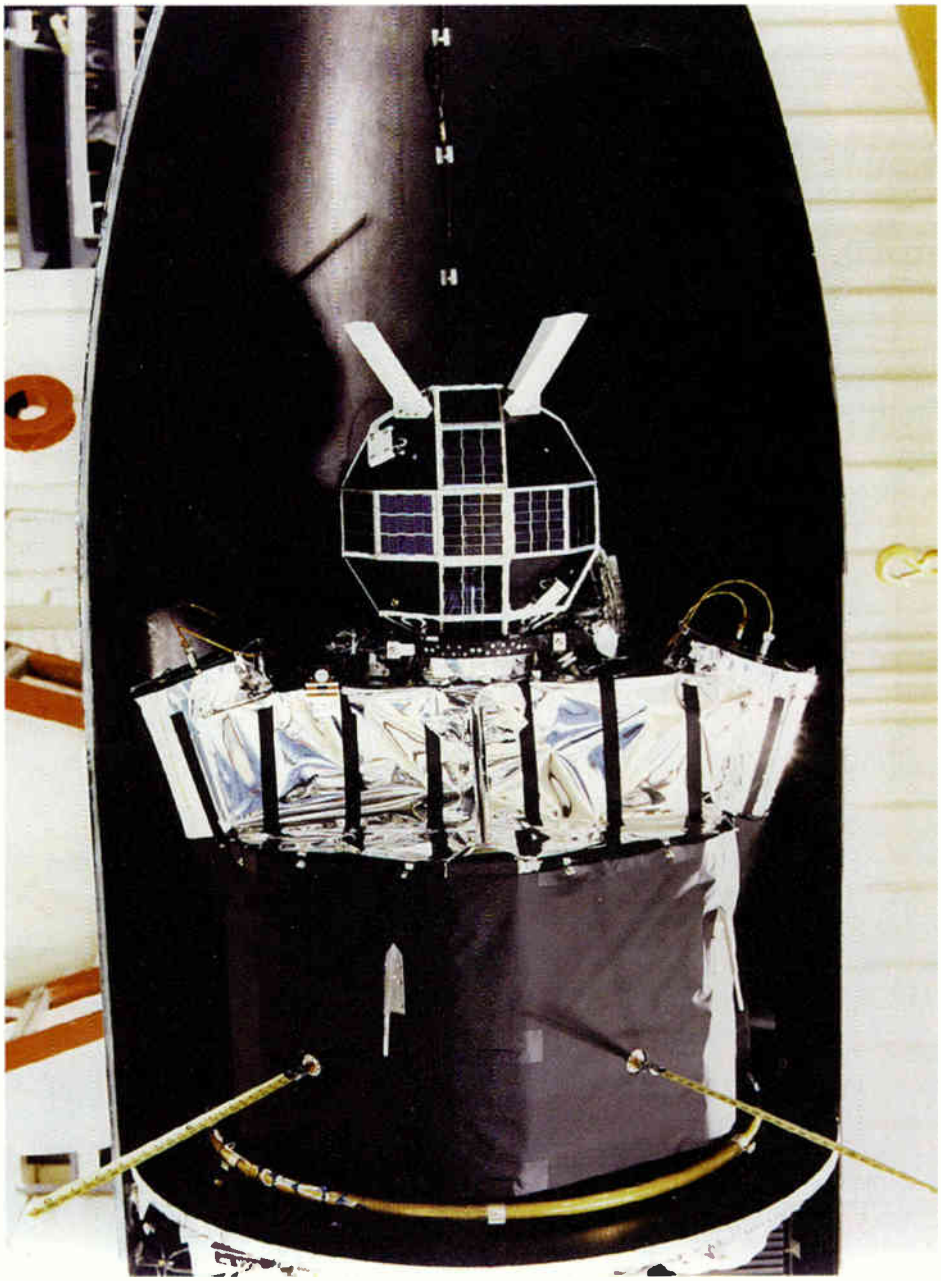
The first dedicated Department of Defense mission of the Space Shuttle Discovery was in early 1985.

White Cloud

USA 15, 16, 17, and 18 were the NOSS (Navy Ocean Satellite Surveillance) 7 series,



Atlas rocket at Vandenburg AFB prepares to launch a defense meteorological satellite (DMSP) in 1991.



GLOMR satellite is the sphere shaped-satellite in the nose cone of a Pegasus rocket.

also known as White Cloud. One of the easiest clues to identifying classified satellites is to look for the number of USA designations. If there are at least three, it's likely to be a White Cloud series.

For many years NOSS were launched in absolute secrecy. From 1976 to 1987 eight sets of three satellites deployed from single-stage Atlas launch vehicles. The three-satellite constellation permits the satellites to receive simultaneous signals from naval vessels. A pair of satellites, receiving signals at very slightly different times, permits a doppler shift to be calculated to determine a ship's distance from the satellite. A third satellite adds an additional intersecting line, accurately locating the target.

Visually, the satellites look like three star-like objects flying in formation. Contrary to some rumors the satellites are not interconnected with long tethers. However, the satellites do rapidly increase in visibility on many occasions, and may use some form of solar sail to remain in formation.

The existence of the White Cloud series was accidentally revealed when stamped commemorative envelopes suddenly appeared for sale in a NASA gift shop! The NOSS 8 series was assigned USA 22-25.

Star Wars Defense Program

USA 19 (DM43), and USA 30 (Thrusted Vector) were launched on the Delta launch vehicle. A Delta was also procured for USA 36—Delta Star. All three missions were partially classified research flights for the Strategic Defense Initiatives Organization (SDIO).

USA 51 and 52 were a pair of research satellites for the SDIO: LACE, and RME. Low Atmospheric Composition Explorer was a research satellite which could monitor rocket exhausts from space. Remote Mirror Experiment added the capability to reflect laser signals off a satellite in orbit.

Other Military Space Programs

USA 20 and USA 46 were Navy Fltsatcom communications satellites launched on NASA-owned Atlas-Centaur launch vehicles.

USA 26, 29, 73, 106, and 109 were DMSP—Defense Meteorological Satellite Platforms. DMSP are low altitude weather satellites, launched on Atlas ICBMs converted in to launch vehicles. After all of the remaining Atlases were used, retired Titan II ICBMs were converted into launch vehicles; USA 131 was the first DMSP launched on a Titan II. NOAA maintains a DMSP home page at **http://www.ngdc.noaa.gov/dmsp/dmsp.html**.

USA 32, 45, and 81 were launched on converted Titan IIs. They're all very similar in appearance and orbital characteristics and clearly part of the same satellites series. Occasionally the name "Navigation Technology Satellite" has been used, but this has not been verified.

Spaceborne Radar

USA 34 was the first Lacrosse satellite. It was launched on the STS-27 shuttle mission in December 1988. The shuttle flew into a 57.1 degree inclination orbit, the maximum normal safe inclination

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from the Kennedy Space Center. The Lacrosse satellite is the military's freeflying radar satellite. Rumors claim it has 45.7 meter (150 foot) wide solar arrays to power its 10,000 watt radar, and the equivalent computing power of a supercomputer.

The shuttle's robot arm was used to place Lacrosse in orbit, and there were stories circulating that two astronauts were ready to make an unscheduled spacewalk, if necessary to help deploy the solar arrays or antenna, or if necessary cut off the appendages if the satellite didn't check out properly so it could be returned to Earth.

In 1988 the only launch vehicle capable of carrying Lacrosse was the shuttle, launching out of Florida. However, a higher inclination orbit is preferable, which requires a launch out of Vandenberg Air Force Base in California. Not surprisingly the first Titan IV from Vandenberg carried the second Lacrosse (USA 69). Its inclination is in a 68 degree orbit, enough to view the highest latitude locations in the Soviet Union. It's possible that Lacrosse 2's orbit is a compromise to adjust the original plan to the lower inclination 57 degree orbit forced onto Lacrosse 1 by its satellite launch.

Amateur satellite observers have not seen Lacrosse 1 in the last couple of months, so it's likely that it's been purposely deorbited after reaching the end of its useful lifetime, or moved to a different orbit. The Lacrosse satellites use NASA's Tracking Data and Relay Satellite System (TDRSS) to relay their data, necessitating classified facilities at the TDRSS ground terminals.

Public Knowledge Classified

USA 41 is the best example of trying to lock the barn door after the horses have already escaped. In October 1985 a soccer-ball shaped satellite, GLOMR (Global Low Orbit Message Relay Satellite), was ejected from a getaway special canister during the STS 61-A shuttle mission. GLOMR was 406 mm. (16 in.) in diameter with a deployed mass of 68 kg. (150 lbs.). The communications payload consisted of four antennas, a transmitter/receiver, and a telemetry/tracking and command system. The surface was covered with 12 solar cells. It was built by DSI, a highly respected manufacturer of small military satellites. None of this information was classified in any way and many technical papers were presented on GLOMR's objectives.

A General Dynamics Atlas rocket lisfts off from Cape Canaveral, sending the last in a series of FLTSATCOM spacecraft into orbit for the U.S. Navy.

DARPA, STP (Space Test Program), and the US Navy used GLOMR for readout and command oceanographic sensors and to locate ground user equipment. Due to the shuttle's relatively low altitude, GLOMR was only expected to remain in space for about a year, but during that period it far exceeded its original expectations and proved to be a useful tool. So the military decided to classify the program! It's important to note that as an unclassified research satellite the original GLOMR did not receive a USA designation.

In 1989 a satellite of almost identical size was launched from *Columbia*'s cargo bay aboard the STS-28 classified shuttle mission. It's quite clear that if it wasn't GLOMR's twin brother, the differences must have been very small. The partially classified STS-39 shuttle flight in May 1991 carried another GAS-launched GLOMR, USA 70, under the generic code name MPEC—Multipurpose Experiment Canister. By coincidence, the STS-39 astronaut responsible for its deployment, Guy Bluford, was the same astronaut who deployed the original GLOMR from the shuttle in 1985! NASA did not downlink any video or release any photos of the satellite ejection from the STS-39 mission. However, video footage is available from the 61-A mission.

It's important to note that USA 41 and USA 70 were fairly small satellites deployed by the space shuttle at a fairly low altitude. At that altitude a spacecraft has an orbital lifetime of about a year. And the shuttle safety rules prohibit hazardous propellants in getaway special canisters. So there is absolutely no doubt that neither satellite remains in orbit. However, USSPACECOM satellite situation reports imply that the classified GLOMRs are still in orbit.

A third GLOMR was launched on the maiden flight of the Pegasus air-launched launch vehicle. NASA and the Air Force didn't want to risk an expensive satellite on the maiden flight of an unproven launch vehicle and decided to use the launch for some relatively inexpensive payloads instead. Pegsat used chemical release canisters which were left over when the CRRES satellite was converted from a shuttle payload to an expendable launch vehicle. The GLOMR was attached to the top of the Pegsat. It's interesting to note that even though the satellite is classified—photos were released! The NASA press release just makes a casual mention of a "launch of a Navy small experimental communications satellite," but the satellite is displayed prominently on the mission's patch! Unlike the shuttle-launched GLOMRs, the Pegasus-launched satellite was in a much higher orbit, which results in a longer lifetime.

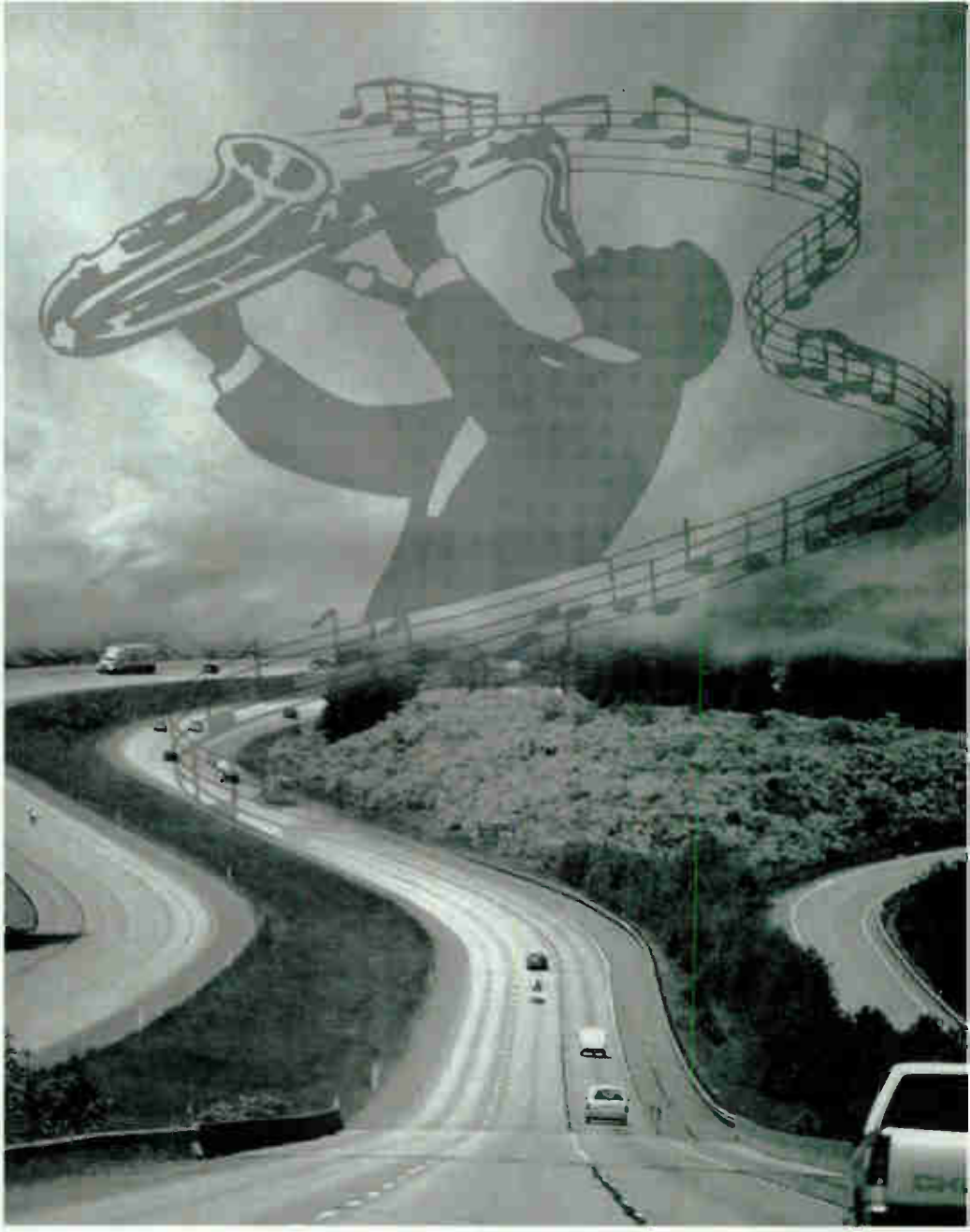
In the next issue of *Satellite Times*, we will present the conclusion to our three part series on Deep Black—the U.S. military space program. ST

With FCC licenses in hand, two companies are racing to deliver nationwide, CD-quality music programming to your car radio via satellite. In 1999, cruising the boulevard to the pleasant blare of your favorite tunes will be an out-of-this-world experience.

In the Driver's Seat with Satellite Radio

By Kirk A. Kleinschmidt, NT0Z

kirk@cloudnet.com



From the first vibrator-powered tube radios of the 1930s, to today's microprocessor-controlled miniature marvels, car audio has remained fundamentally unchanged. We've come a long way since those early, temperamental vacuum-tube jobs, but—CD players, cassette tapes, and thumping subwoofers aside—radio is still radio.

Drivers still ease the frustration of traffic jams by tuning to their favorite local stations—AM and FM. Whether beautiful music, top 40, album rock, country western, all sports, all talk or all shock, drivers choose whatever's on the local media menu.

More than 10,000 local stations across the country offer programming to listeners in a free market system of supply and demand, supported by advertisers paying to reach numerous listening audiences.

A number of national networks furnish a measure of programming consistency from coast to coast, but the stations themselves provide only local or regional coverage. Thanks to recent action by the FCC, however, this venerable era in broadcasting history will soon come to an end. Before the end of this century, "pay for play" satellite radio will compete with local radio stations for mobile listeners.

Wooed by high-fidelity, commercial-free specialty programming—with consistent nationwide coverage—the drivers of America's 200 million cars and trucks will enjoy unprecedented listening opportunities.

DARS, the digital audio radio service, the FCC's official name for "high-fidelity

The benefits of digital satellite radio include CD-quality stereo sound and radios that can display titles and artists alphanumerically. (photo courtesy of CD Radio)

satellite radio," has endured more than seven years of development, politics and financial maneuvering. In two short years it will be as real as cable TV—and perhaps as influential.

The Road to DARS

On April 2, 1997, the FCC gave the final go-ahead to two competing companies to begin the process of taking DARS from a technically feasible proposition to an "in your dashboard" reality.

Over the past few years, as many as four companies sought to obtain one of the two DARS licenses to be awarded by the Commission. In the end—and after a harrowing 26-round, two-day spectrum auction in Washington, DC—CD Radio Inc. and American Mobile Radio Corporation walked away as the winners.

CD Radio, based in Washington, DC (but moving to New York City), bid $83.3 million for the first license. AMRC, of Reston, Virginia, a subsidiary of wireless giant American Mobile Satellite Corporation, paid $89.9 million to capture the second and final license. Two other contenders, Digital Satellite Broadcasting Corporation and Primosphere Limited Partnership, did not make the final cut.

The same technological advances in microelectronics and digital transmission systems that made "mini dish" satellite TV systems possible have been available for DARS for several years. Implementation of satellite radio, however, has been slowed mostly by politics and industry lobbying.

The National Association of Broadcasters argued that satellite-delivered pay radio would siphon ad dollars from conventional local stations. Although space-based digital radio was inevitable, the NAB and other agents managed to delay introduction of the service until the turn of the century, when terrestrial digital radio begins its march to eventually replace traditional analog AM and FM broadcasts.

"Pay radio and local broadcast radio are totally compatible," says CD Radio founder and CEO David Margolese, one of the earliest DARS proponents. "What we're about to experience is very similar to the early days of cable TV. But today, the pervasiveness of cable systems is taken for granted, and local TV stations are still flourishing. In broadcasting, technology offers better performance and more variety, but there will always be a need for locally produced programming."

AMRC President Lon Levin agrees. "Just because you watch movies on pay TV doesn't mean that you abandon local stations for news, information, local on-air personalities and your favorite sitcoms. It will be the same with satellite radio. The two will coexist peacefully."

System Overview

Each DARS provider will use a pair of high-power geosynchronous satellites to deliver programming to the continental US, and each has a 12.5 MHz slice of the 25 MHz DARS frequency allocation at 2.320–2.345 GHz.

Earth-based receivers (mobile and fixed) will be compact (the mobile antenna is the size of a silver dollar) and interoperable. That is, DARS decoders, whether stand-alone or built into your car radio or home stereo, must be able to receive programming from both providers.

Expect digital electronics and powerful software to make that happen, as CD

WHAT'S ON THE RADIO?

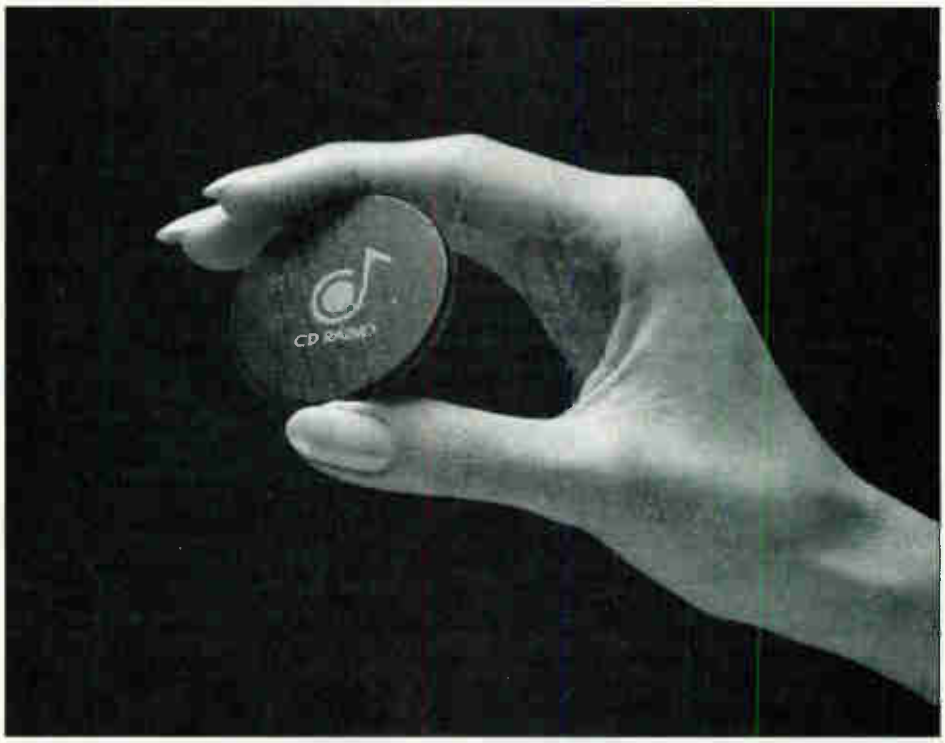
Initial music programming from CD Radio's Satellite Broadcast Center (these 30 CD-quality music channels will be in stereo; an additional 20 channels of talk, sports and news will be broadcast at reduced fidelity. Although the lineup of non-music providers hasn't been finalized, look for potentially interesting offerings such as the BBC or other powerhouse international broadcasters).

Channel	Programming	Channel	Programming
1	Symphonic	16	Latin Rhythms
2	Chamber Music	17	Reggae
3	Opera	18	Hip-Hop and Rap
4	Today' Country	19	Dance
5	Traditional Country	20	Urban Contemporary
6	Contemporary Jazz	21	Soft Rock
7	Classic Jazz	22	Singers and Songs
8	Blues	23	Beautiful Music
9	Big Band	24	Album Rock
10	Top of the Charts	25	Alternative Rock
11	Classic Rock	26	New Age
12	'50s Oldies	27	Broadway's Best
13	'60s Oldies	28	Gospel
14	Folk Rock	29	Children's Entertainment
15	Latin Ballads	30	World Beat

Radio's system uses spread-spectrum CDMA modulation, while AMRC will likely transmit fewer channels via more conventional TDMA methods. Receivers "listen" to both satellites simultaneously (like hand-held GPS receivers), but seamlessly switch between individual satellites to lock in the best signal.

Programming subscription fees will range from $5 to $10 per month, and will tend to decrease as the number of users increases. Initially, DARS decoders (standalone and built in) will increase the cost of car audio by about $150. To get things off the ground, both companies need to raise about $500 million each to pay for satellite construction, launch fees and uplink/programming centers. Each company is well on its way financially.

Domestically, previous users of spectrum at 2.3 GHz, mostly aeronautical telemetry licensees, have been accommodated elsewhere. With Canada and Mexico, which may experience interference problems with telemetry systems located near U.S. borders, DARS providers must take reasonable steps to minimize or eliminate problems that may arise.



If you're wondering how you'll fit a satellite dish on your car, worry no longer. CD Radio's diminutive "patch" antenna simply sticks to your car's rear windshield. High-power satellites do all the work. (photo courtesy of CD Radio)

DARS Technology

While there are potentially significant differences between the two DARS providers when it comes to program offerings, CD Radio and AMRC will use similar systems in the hardware department (perhaps to help ensure interoperability).

Satellite Systems

Loral's FS-1300 satellite chassis will serve as the space platform for CD Radio's system. There are 24 FS-1300s in production (with 61 on order), making the three-axis stabilized Loral system mature and popular.

With a healthy 2-kW transmitter output power and high-gain antennas, CD Radio's satellites put out nearly a megawatt of effective radiated power, more than enough to overcome the considerable satellite-to-earth path loss and blanket the lower 48 states with a signal that can be received with the company's miniature mobile antennas.

Loral will build two orbiting DARS birds for CD Radio and a third ground-based spare. Launch dates are set for August and November of 1999, and if all goes well, the FS-1300s will end up in orbital slots at 80° W and 110° W.

According to AMRC's FCC application, its satellite system is tentatively based on the Hughes HS-702 chassis, a three-axis stabilized bird that will cover the lower 48 (and Alaska and Hawaii) with an impressive megawatt-plus effective radiated power. With orbital slots of 85° W and 115° W, the two Hughes sats are scheduled to launch in late 1999 and early 2000.

Hughes is a major AMRC/AMSC partner, as is WorldSpace, a Washington, DC-based technology company that is leading the push for worldwide satellite-based international broadcasting—a potential evolutionary step for today's shortwave broadcasters.

Digital Compression

To pack so much programming into a relatively small 12.5 MHz bandwidth, both DARS providers use advanced digital transmission (and encryption) techniques to compress and protect their signals.

CD Radio uses AT&T/Lucent's PAC system, short for perceptual audio coding system, which has also been chosen by USA Digital for future earth-based digital radio systems. PAC takes the normal 1.44 Mbit/s CD-quality digital audio data stream and compresses it to a manageable 128 kbit/s (a 12:1 ratio).

AMRC's compression scheme is based

SELECTED DARS HARDWARE AND PERFORMANCE SPECIFICATIONS

Specification	CD Radio	AMRC
Satellite Chassis	Loral FS-1300	Hughes HS-702 (tentative)
Type	3-axis stabilized	3-axis stabilized
Power Output	60 dBW EIRP	62 dBW EIRP
Mission Life	15 years	15 years
Orbital Position	80° and 110° W	85° and 110° W
Modulation Method	Synchronous CDMA	TDMA
Digital Compression	AT&T/Lucent PAC	MPEG Audio Layer 3
Uplink Freqs	7.025 – 7.075 GHz	7.025 – 7.075 GHz
Downlink Freqs	2320 – 2332.5 MHz	2332.5 - 2345 MHz

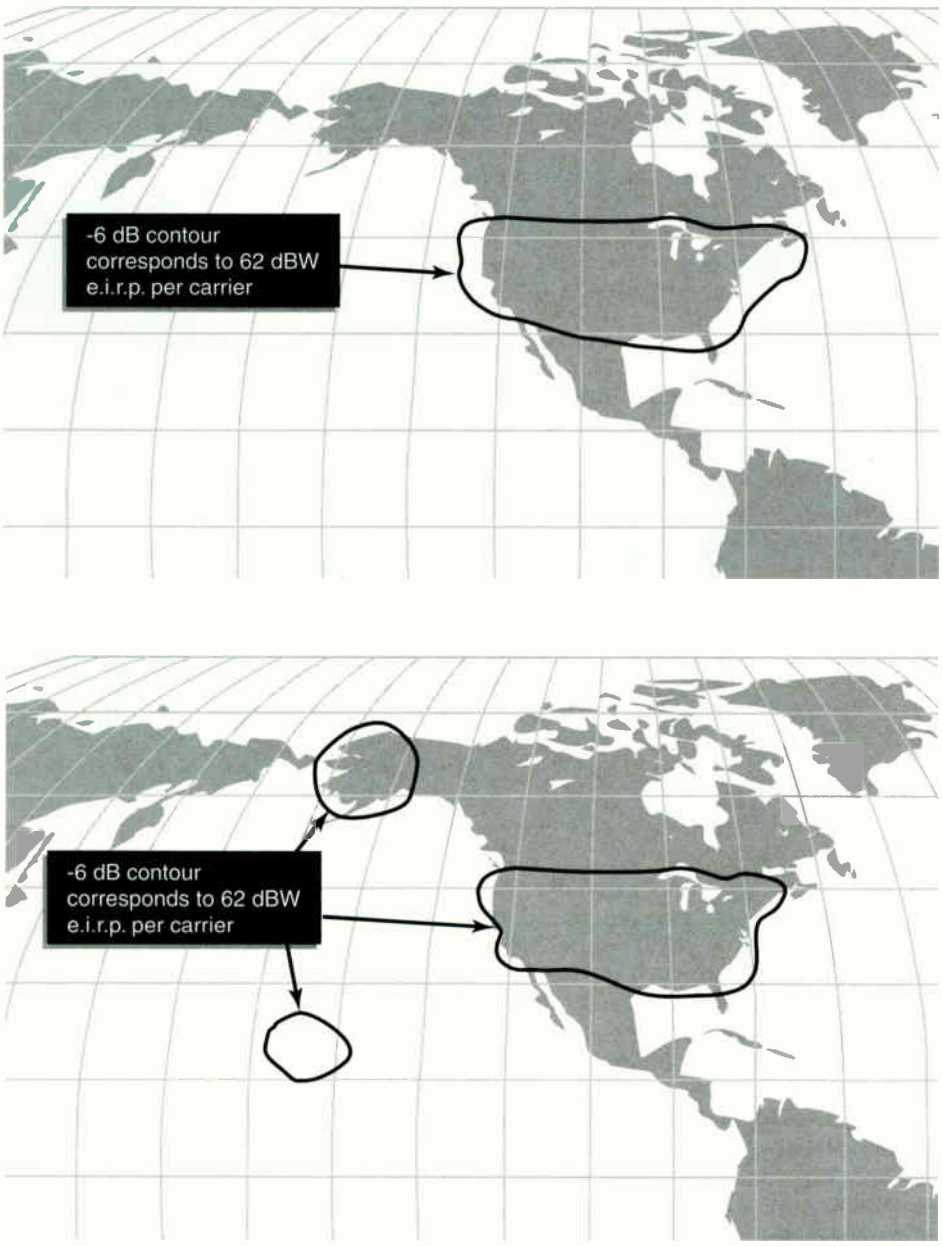


FIGURE 3—*Signal footprints for AMRC DARS satellites at 85° W (top) and 115° W. (figures are from AMRC's FCC application)*

on a dynamically allocated MPEG Audio Layer 3 system that compresses source audio from 12:1 (128 kbit/s for CD-quality sound) to 48:1 (16 kbit/s for "better than shortwave" quality sound). Using its multichannel TDMA modulation system, AMRC's control center can dynamically allocate channel resources and compression ratios to accommodate various program sources and quality levels.

Receivers/Car Audio

The satellite technology used by DARS is notable—but the receiver and decoder systems that will end up in your car will impress even the most jaded techno-junkies.

Both providers will offer add-ons that let drivers receive DARS programming through their existing car stereos, and both will work with manufacturers to provide built-in OEM AM/FM/cassette/DARS receivers. By the time DARS is operational you'll be able to purchase receivers and adapters at local retailers.

Providers will feature decoders that have unique digital IDs, much like today's satellite TV and pay-per-view systems. The really fun stuff, however, involves the hardware and techniques used to provide users with easy, affordable access to the new satellite service.

CD Radio co-founder and technology guru Rob Briskman developed (and is patenting) many of the system's most elegant components, including the silver-dollar-size antenna that sticks on your car's rear window.

The small, thin, planar array, sometimes called a "patch antenna," contains a lot of high-tech goodies, including the receiving antenna itself, a solar battery charger, a battery, a 2.3 GHz-to-900 MHz "block downconverter," a 1-microwatt 900-MHz transmitter and a 900-MHz loop antenna (located on the underside of the disc).

To eliminate the need for running signal and power leads to the mini antenna, the solar-charged system receives the digital data stream from the satellites, converts it (without demodulating the signals) to a frequency in the 900-MHz ISM band and retransmits the data to the receiver/decoder.

If your car has an in-dash DARS-compatible receiver, its built-in 900-MHz data module receives the flea-power signal from the patch antenna/converter, translates the digital music back to analog audio and passes it to your stereo's audio amplifiers. You hear only the CD-quality audio. There are no wires to run here, there, or anywhere.

Thanks to an unusual, elegant engineering solution, users without OEM DARS-compatible radios aren't left out in the cold. If you have a cassette player in your car radio, you're only seconds away from satellite radio.

Briskman's cassette adapter provides the magic link. Hiding inside a conventional-looking cassette housing is a 900-MHz receiver/decoder, a battery, a power generator and a high-fidelity "tape-head magnetic transmitter."

When it's time to listen to DARS, simply insert the CD Radio "cassette," push a channel-select button or two and away you go. The adapter receives and decodes the 900-MHz data stream from the patch antenna's low-power translator and passes it to the magnetic transducer that's now adjacent to your tape deck's own magnetic heads.

Your car radio thinks it's playing a tape and you hear high-fidelity DARS audio through your speakers. My favorite part of this amazing system is the micro-

size electric generator (and battery charger) *inside the cassette adapter* that's powered by the tape deck's capstain drive (the rubber drive wheel that normally moves the tape past the magnetic heads)!

The internal battery is really only needed to provide "instant on" capability when the unit is first inserted, eliminating the 1-second delay before the internal generator gets up to speed. Again—no wires required!

Although it may never be manufactured because in-dash CD players are widely being replaced by in-trunk, multi-CD changers, Briskman developed a similar adapter for CD players that translates the 900-MHz signals from the patch antenna to a flashing (modulated) light beam that is compatible with the CD player's own laser decoder!

Margolese says CD Radio's complete system (cassette adapter, patch antenna and all batteries, manuals, program guides, etc) will retail for about $150. Simply take your kit home, stick the antenna on the rear window of your car, plug the cassette adapter into your tape deck, and dial CD Radio's convenient 800 telephone number (from your satellite cell phone, perhaps?).

You can set up your account over the phone, and when you provide your unit's digital ID number to the customer service rep, your satellite radio system will "authorize," and in a matter of minutes you'll be up and running.

Decisions haven't been finalized, but Briskman says the technology may be licensed to other manufacturers.

Programming

Although program providers and channel lineups haven't yet been determined, AMRC's DARS system appears to be flexible enough to accommodate many program providers using multiple uplink methods. This should allow AMRC to pick and choose among existing program providers if the company decides not to produce its own content.

CD Radio, on the other hand, will definitely provide its own programming. The company is building a large uplink center in New York City—a large music programming operation under one roof.

"Think of it as 50 radio stations in one facility," says Margolese, who is quick to point out that CD Radio "is a media company that happens to use satellite technology to deliver its content. We're not a primarily satellite company."

See, *What's on the Radio*, for more information.

Marketing

Margolese and Levin are both confident that the market for DARS will be large enough to allow both companies to prosper. According to a May 19, 1997, article in the *Washington Post*, satellite industry analysts are optimistic about the future of DARS and its financial viability.

One analyst estimates that CD Radio alone should have 7.5 million subscribers generating more than $600 million in annual revenue by 2003. The convenience and relatively low cost to obtain DARS access is of particular benefit—especially to the owners of the 15 million new cars purchased in the US each year—and to the 5 million drivers who buy new car audio components each year.

There are potential problems, however. Satellite and launch failures have produced setbacks for several recent ventures. And if the two DARS providers end up subsidizing hardware (radio/adapter) manufacturers, as do "mini-dish" satellite TV providers, cash flow might be tight, especially at the outset.

Digital Radio's Future

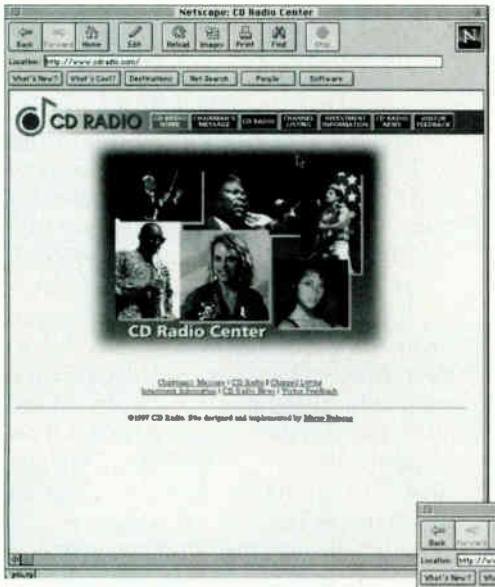
There's no doubt that digital radio is here to stay, terrestrially and from space. The benefits in signal quality, programming variety, spectrum utilization and reduced circuit complexity (eventually) are too compelling to ignore.

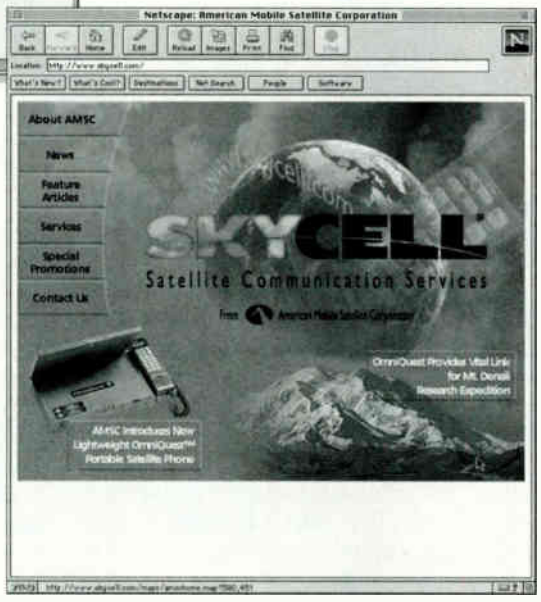
In these early years, CD Radio and American Mobile Radio Corporation will compete *and* cooperate in making DARS a household name and household technology. While they work out the details, we drivers will reap the amazing benefits of satellite radio.

As always, it's out with the old, in with the new. If they only had a Stevie Ray Vaughan "Texas Blues" channel....

About the Author

As a freelance writer/photographer who specializes in technology and business topics, Kirk Kleinschmidt has written several features for Satellite Times, *the first of which appeared in ST's premier issue. Formerly an editor for* QST *(call sign NT0Z), Kirk now works from his home office in Minnesota's Lake Country.* ST





DARS RESOURCES ON THE INTERNET

Because the details of DARS and its implementation change almost daily, there aren't many information sources that are readily available. At press time, CD Radio's corporate home page at http://www.cdradio.com is a good place to start. There is also material available at the FCC homepage, http://www.fcc.gov/, and http://www.skycell.com/, the homepage of AMRC's parent company.

From Shortwave to Satellites

and on to

CYBERSPACE

Although the BBC is deeply interested in alternative methods of delivery, it remains committed to shortwave broadcasting. Shown is the BBC's Asia relay station in Thailand.

By George Wood

Satellites have completely changed international broadcasting. That much is uncontroversial. Whether the change has been for the better depends on who you are. I have a feeling lot of shortwave listeners and hardcore DXers are not terribly pleased about how satellites have changed their hobby over the past ten years or so. Certainly when "Sweden Calling DXers" turned into "MediaScan" and shifted its focus from shortwave to satellites, there were a lot of letters denouncing the change.

But for a broadcaster, satellites are wonderful.

For years we've struggled with sunspots and the ionosphere, shifting frequencies to follow the illusive whims of propagation or to avoid accidental or intentional interference. Now, not only can our programs appear on listeners' receivers in perfect FM quality, but thanks to satellites, they are also reaching far more listeners directly or via rebroadcasts from local radio stations and cable systems.

We can also turn off some of those huge 500 kilowatt shortwave transmitters that have been consuming massive amounts of electricity, and rely instead on much lower-powered uplinks and solar-powered space downlinks.

For the sake of the planet's resources, satellites are wonderful.

With so many shortwave broadcasters moving to satellites, the over- crowded shortwave spectrum is opening up, making it possible to hear the more exotic stations that used to be under the interference before. After all, most DXers don't seem to care much about listening to "easy" European broadcasters, they hunt for the rare signals from little transmitters in the tropics.

However, even the "easy" stations have a few programs of interest. One of the first applications of satellites to international broadcasting was to provide direct links to relay stations. That meant that Radio Netherlands could broadcast live from its studios in Hilversum, rather than send tapes for rebroadcast three weeks later. *DX Jukebox* became *Media Network*, with up-to-the-minute news about unusual new stations or shifting propagation. Similar programs like Glenn Hauser's *World of Radio* or the VOA's *Communications World* suddenly became accessible in Europe and other locations where shortwave reception had been difficult. There's also a whole new hobby hunting satellite DX and on-the-spot news feeds.

For DXers, satellites are wonderful.

The End of the Cold War & the Beginning of the Satellite Era

Aside from feeds to relay stations by major broadcasters like the BBC World Service, VOA, Deutsche Welle, and Radio Netherlands, the real impact of satellites on international broadcasting came in Europe at about the same time the Cold War was ending, in the early 90's. With the launch first of satellites from Eutelsat, followed by the first Astra satellites, several radio signals could ride along on each TV transponder. Suddenly there was a relatively inexpensive way to reach all of Europe with an FM quality signal. For European shortwave broadcasters this seemed too good to be true.

In a way it was. It turned out that there were a number of problems. For one thing, the audience was different. Shortwave listeners are a hobbyist community, and shortwave programming was designed for them, cozy, not terribly slick, and put together with potential poor conditions, interference, and fading in mind. Satellite listeners were perceived, in contrast, to be "normal" people, not hobbyists. Radio Sweden's management decided that the satellite program format had to sound more like domestic radio, and suddenly we were ordered to produce extra satellite shows in a new format, with the same staff resources, or less.

Less...that was the other repercussion of the end of the Cold War. Military budgets were slashed, but it also turned out that shortwave radio was considered by some politicians to be an obsolete remnant of the struggle between East and West, whose purpose had gone the way of the Berlin Wall. Across Europe and North America, funds for international broadcasting were cut back. Since satellite transponder rental was cheaper than the electricity burned up by half a megawatt shortwave transmitters, one way a station could reduce costs was to switch to satellite delivery.

Radio Finland is a good example of a small station that's gotten heavily involved in satellites, yet still relies on shortwave. But Managing Director Juhanii Niinistoe

says he's not about to give up shortwave completely:

"The two forms of delivery complement each other. Satellite reception is for fixed location listening only, while shortwave offers mobility. The individual tourist will carry a portable SW for immediate news service, but may also enjoy hi-fi radio in his or her hotel, delivered by satellite."

At Radio Sweden separate programming for the satellite audience didn't work out. Partly it was a matter of resources, as you just couldn't do twice as much radio with fewer people. But it also turned out that the satellite audience was not as "normal" as management first thought. A particular part of the general population bought satellite dishes, and then most of them just watched TV. The few who did explore the opportunities on radio turned out to be another kind of hobbyist, not that much different from the SWLs (shortwave listener) and DXers (a person who listens for distant shortwave stations) on shortwave.

The satellite turned out to be just another type of transmitter.

Thoughts turned from using satellites directly to reach listeners, to using them instead to feed local stations for rebroadcasting. For years shortwave stations have had Transcription Services, sending recorded programs on tape to stations around the world. (Back when I worked in college radio at UC Santa Barbara, we loved this stuff, since once we'd played the programs, we could erase the reels and avoid having to buy new tape.)

Satellites could deliver programs in real time to stations providing up-to- the-minute news, rather than "timeless" features. At many international broadcasters, the overall programming format began to gradually change, away from the cozy shortwave community of the past towards something a little more modern and fast-paced; something that fitted in on local stations, yet hopefully still worked on shortwave.

Initially there was a bonanza for some of the larger stations. As Eastern European countries regained their freedom, the airwaves opened up and people hungered for uncensored news and entertainment from abroad. In the early days it was easy for stations like the Voice of America, Radio Free Europe, or the BBC—which had been regarded as friends during the decades of repression—to acquire local transmitters in the former Warsaw Pact countries. Satellites made relays from home countries possible. But this brief era had to end.

As the new democracies rediscovered and rebuilt their journalistic traditions, there was more interest in their own stations, and less in listening to outsiders, no matter how important those voices had been during the years of darkness. The disappearance earlier this year of VOA Europe, which had mixed American rock with news and features from Washington, marked the end of that era.

North America was hard to get into as well. There was the NPR satellite system, of course. If you could get your signal across the Atlantic (which was still expensive in the days before ISDN), you could pay NPR to put your programs on the satellite. But there was no guarantee at all that the local affiliates, faced with 16 channels of audio from NPR, American Public Radio (now PRI), and numerous independent producers, would run the material from abroad. A number of stations bought time anyway. Others booked ordinary audio channels on regular TV transponders and hoped some of the 1 or 2 million TVRO fans would listen in.

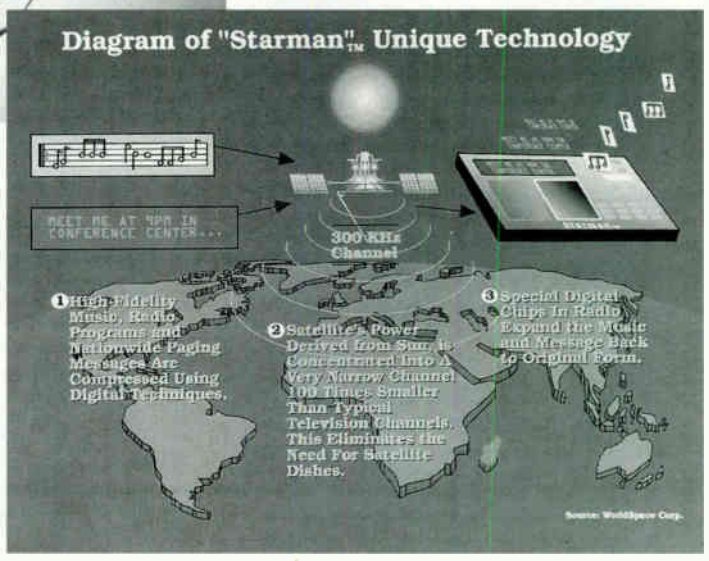
Then there was cable. Cable systems were already well established in North America, and were opening up across Europe, in connection with the satellite explosion that brought in so many new TV stations from around the world. Most cable networks carry radio, although that side of the operation is not always well-developed in Europe.

The problem was that only the major broadcasters like the BBC, Radio France, and Deutsche Welle could afford 24 hour services in a single language. Smaller stations leased a single sound channel to carry their entire output in a variety of languages. But no cable system was likely to relay a channel that switched every half hour from English to French to German to Russian, etc. A cable network in Britain would want a 24 hour channel in English, just as the Paris cable system would only be interested in relaying a 24 channel in French.

Even direct satellite listeners may object to the multi-lingual approach. Radio Finland's Juhani Niinistoe comments: "I have a letter on my desk from a Finnish professor demanding an explanation for why we air French on our Eutelsat channel...I will try to explain it to him."

Swiss Radio International took the ambitious route. It was easy to set up 24 hour satellite channels in the country's national languages, German, French, and Italian. But SRI expanded its English programming as well into a 24 hour operation.

Most smaller stations couldn't afford that kind of expansion. The solution, best expressed by Uwe Schoop, then head of the Swedish service at Deutschlandfunk, who called it "time-sharing," was for stations to get together to put all their programs in a single language on one satellite sound channel. The idea was obvious; the only problem was doing it, considering



The new "Starman" technology utilizes compressed digital signals and a special digital radio to expand the music and message back to its original form.

the nature of European public broadcasting. Large media bureaucracies just couldn't work together that way. The "Gang of Four" of Radio Netherlands, Radio Sweden, Radio Canada International, and Swiss Radio International discussed the idea, but couldn't agree on its implementation. The European Broadcasting Union belatedly set up a special forum for international broadcasters, which also talked about the concept, but couldn't make anything happen either.

Who would run the system? Who would decide who got to broadcast in prime time? How would be costs be divided up? Who would pay for lines to the uplink site? There were lots of questions, and no experience in actually working together on that level.

WRN Runs With the Ball

In the end, three defectors from the BBC made it happen. Karl Miosga, Jeff Cohen, and Tim Ashburner kept their day jobs while they talked to stations about their World Radio Network. They got UPI to provide temporary facilities by doing some work for them, and talked British Sky Broadcasting into providing a free sound channel as a test. For a week stations from all over Europe, and as far away as Israel and India, shared a common satellite channel. The signals poured into a tiny room at UPI's headquarters in London's Docklands by satellite link, expensive broadcast circuits, ISDN, and even off shortwave.

It looked like chaos with cables running everywhere into equipment just patched together for the week, but it worked. Some weeks later, supported by a contract from National Public Radio to bring its programs to Europe, WRN Network One went on the air on Astra, relaying some 20 international broadcasters. Separate deals to relay Vatican Radio and Radio Canada International/CBC to Europe followed. Then WRN turned towards North America, and began relaying its European broadcasters on the WTBS transponder on Galaxy 5. That was followed by a second channel, WRN 2, which turned things inside out by carrying programs in various stations' native languages for their nationals in North America.

C-SPAN has relayed international broadcasters on its Secondary Audio Programs for several year: one channel for the BBC World Service, another for a variety of stations, most of which have been available in North America via some satellite relay. Recently, several hours a day of that service has relied on WRN 1.

One of WRN's biggest successes was talking Canada's CBC, beset by budget cutbacks, into taking the WRN 1 service to provide all-night programming on one of its national AM networks. Suddenly international broadcasters really were being heard by "normal" people, that is, normal insomniacs and normal night shift workers. (This has had interesting repercussions. One way Radio Sweden has dealt with budget cutbacks has been to regularly recycle various interviews and reports. That's worked on shortwave, where few people seem to listen to every broadcast. But numerous complaints about the repeats have come in from the Canadian night owls.)

More recently, WRN has expanded to Africa and Asia. The African service is on Intelsat 707, and is then relayed on the Multichoice DBS package on PAS-4. A deal similar to that with CBC Overnight has been worked out, and WRN 1 programs are carried in the middle of night across South Africa on a national network called SAfm.

The Asian service is part of a package of European radio broadcasters on Asiasat-2. Both the African and Asian relays differ from those to Europe and North America in that they are digital. That means right now the average home listener can't tune in. Instead they are intended for local and cable rebroadcasts.

I've devoted a lot of space to the World Radio Network story, because WRN is probably the most important tool for smaller international broadcasters to reach listeners on satellite. There's simply nothing better right now. The larger broadcasters, of course, have their own 24 hour channels. NPR was so pleased with its response in Europe that it leased its own channel, America One, together with PRI. However, both continue to provide programming on WRN as well.

The New Generation Broadcasters

The international radio broadcasters currently on satellite have all started with shortwave. But the coming digital age in broadcasting will see new stations that have never used any other medium. Europe is just introducing Digital Audio Broadcasting. The first regular transmissions began in September 1995 in Britain and Sweden. Canada, Denmark, Norway, Finland, Germany, France, and Belgium have all followed suit, and DAB is also testing or planned in the rest of Western Europe, India, Australia, and Russia.

European services are not expected to take off until the first consumer receivers arrive on the market this fall. Ultimately, DAB receivers will pick up transmissions from both terrestrial and satellite transmitters. In preparation for this, the BBC World Service, Deutsche Welle, Radio Netherlands, and Radio France International have, together with a number of smaller stations, organized EuroDAB. Right now the co-operation involves a number of weekly programs called Radio E carried on satellite and shortwave by the stations involved. The intention is to provide WRN-type services in English, German, and French that would run on DAB channels in each of the participating countries, as well as via satellite.

This goal seems rather remote, as DAB spectrum will be limited until the FM band is phased out after the turn of the century: most countries will be filling their current DAB allocations with their own stations and are unlikely to make room for Radio E. While DAB transmissions are possible from Astra and Eutelsat, a proper service that could seamlessly fit in with terrestrial DAB and portable receivers will have to wait for low-orbit digital satellites.

Following the time-honored "Not Invented Here" philiosophy the National Association of Broadcasters has rejected DAB in the U.S. in favor of an alternative system combining FM and digital signals. Meanwhile, the FCC has granted licenses to Satellite CD Radio and American Mobile Radio Corp for digital satellite radio services to the US. This DARS (Digital Audio Radio Service) will use spectrum above 2310 MHz for broadcasts from low orbit satellites. So Europe and America will be fighting out the NTSC/PAL wars once again, over digital radio, with receivers of limited geographic functionality.

One new digital international radio project is definitely moving forward. WorldSpace was founded by Noah Samara in 1990, and has its headquarters in Washington, DC. The plan is to launch three geostationary satellites which will provide programming specifically to Third World countries: AfriStar to Africa and the Middle East, AsiaStar to Asia, and AmeriStar to Latin America and the Caribbean. Each will provide 100 digital audio channels to the entire coveragearea.

The first satellite to be launched will be AfriStar in June 1998 on Ariane. It will be followed at six month intervals by AsiaStar and AmeriStar. All three are being made by Alacatel Espace of France. Broadcasters who have signed up so far include some familiar names to the shortwave and tropical band DX community, such as the Voice of America, Radio Netherlands, Colombia's Radio Cadena Nacional, the Ghana Broadcasting Corporation, and Kenya Radio and TV, along with Korea's New World Sky Media, and Nigeria's Ray Power 100 FM.

The plan depends on the development of affordable receivers. By using economies of scale, the goal is produce new satellite receivers costing between $20 and $30. These would be truly portable, with antennas the size of credit cards.

WorldSpace and similar projects may be a threat to traditional tropical band DXing. Some of those exotic stations may disappear from the shortwave bands if local listeners can tune into one hundred stations on cheap portable receivers. On the other hand, some of the exotic stations may become accessible for listeners over an entire continent, or even a hemisphere. (Some interesting DX prospects here?)

From Satellites to Cyberspace

The digital age could open up the planet for thousands more radio stations over the Internet. When Radio Sweden (and *Sweden Calling DXers*) changed focus from shortwave to satellites, *SCDX* founder Arne Skoog was very skeptical. Arne was sure satellites would never replace shortwave, and pointed to the cost and size of receiving equipment, and the lack of portability as the main reason.

I always thought Arne was forgetting the history he had been a part of. In Britain the simplest Astra dishes and receiver packages sell for under £100 (around $150 dollars). That's cheaper than almost any decent shortwave receiver. Even in Scandinavia, where a satellite package may cost 5000 kronor (around $800), that's still less than a quality professional DX machine.

Satellite receivers admittedly aren't very portable. But until very recently shortwave receivers weren't portable either; they were boxes at least as large as a modern satellite receiver, and just as firmly connected to antennas as the connection to the satellite dish. But this is about to change. The upcoming generations of DAB and WorldSpace receivers will be just as portable as any current pocket Sony shortwave model.

But then there's the Internet. Soundfiles have been available over the World Wide Web since its inception, but the drawback was the long time required to access the file-perhaps ten minutes of download for every minute of audio. That changed in April 1994, when Seattle's Progressive Networks introduced RealAudio, which allows an audio file to be played while it downloads, more or less instantly. Since then RealAudio has progressed to versions 2.0 and 3.0, and the Real (Video) player and competing systems like Streamworks have appeared, providing both audio-on-demand and live broadcasts. Right now there are hundreds of radio stations around the world you can listen to on the Internet, including many international broadcasters and the entire World Radio Network output.

For a small station like Radio Sweden this is wonderful. Swedes and interested non-Swedes anywhere in the world can access programs whenever they want, from wherever they are. The quality initially sounded worse than AM radio, and RealAudio 3.0 doesn't always live up to its claim of sounding like FM. But what does that matter to an international broadcaster? It's still better than shortwave, and high-speed permanent Internet access and a RealAudio server cost a lot less than a 500 kilowatt transmitter.

Juhani Niinistoe of Radio Finland says the Internet has some definate advantages over satellite distribution: "In parts of Africa the Internet is very popular due to the large size of the dish required for our Intelsat relay there, and due to the short length of our shortwave transmissions."

Oddly, while Arne Skoog is critical of satellite radio, he approves of radio on the Internet. This may have something to do with his granddaughter in Australia being able to listen to Swedish Radio on her desktop computer. But that's as good as reason as any.

So far, though, the portability is missing. I wrote an article about Internet Radio for the 1995 *World Radio TV Handbook* in which I fantasized cutting off the modem connection to the computer and somehow transmitting all the Internet bandwidth into the air. It was a vision that betrayed a less than perfect understanding of the way the Internet works.

Where an analog cable TV network has to provide bandwidth for all of its TV and radio channels, an interactive digital network essentially only has to provide one signal at any given moment. You can have access to thousands of radio stations out there on the Net, but generally you only ask for one at a time, and then receive just one at a time over your existing bandwidth.

Right now you can take a laptop computer and access the Internet over a digital GSM telephone in most of Europe, as well as parts of Africa, the Middle East, and Asia. So you can tune into a RealAudio radio station. The only problem is that, currently, GSM works at 9600 bps and RealAudio really requires 28.8 kbps or better, and the signal tends to break up a lot at slower speeds. GSM calls are also very expensive, so mobile listening to radio on the Internet can be pretty costly.

GSM manufacturers are working to improve the speed for digital access, and perhaps the cost of the calls will come down, but there are other solutions as well. In some American cities there is wireless Internet service from Richochet and other companies, at speeds and costs about the same as ordinary Internet Service Providers. With such a connection you can listen to Web radio on a laptop anywhere in the coverage area. (Finally a use for Newtons and other PDAs?)

Better still, after the turn of the century the planned Internet access from low orbit satellite networks like Iridium and Teledesic will make Internet Radio as portable as modern FM. This is where things can get a bit mixed up, as DAB, terrestrial or satellite, also carries images and text information using the standard HTML code used on the World Wide Web.

Is listening to a Teledesic relay of a RealAudio streaming audio program or accessing a DAB-station's Web page via Iridium *satellite radio* or *cyberspace radio*? Or will there be a difference?

Hopefully even in that networked future there will still be a few tropical radio stations for the DXers to chase. But (assuming the politicians and bureaucrats can work out the royalties for global netcasts) the rest of us will be able to listen to virtually any radio station in the world, from anywhere in the world. ST

By Lawrence Harris
lawrenceh@ndirect.co.uk

Depends on Your Viewpoint ...

An invitation to write a column for the prestigious *Satellite Times* was as pleasurable as it was unanticipated.

Back in the 1980s I was invited to write a column on weather satellites for the UK periodical *Short Wave Magazine*, having been a regular contributor to that column for a long time. Its author Pat Gowen (perhaps better known as G3IOR) wanted a change.

Writing for *Short Wave* resulted in a large postbag often including mail from other countries, not least America. Correspondence for this column can be either e-mailed or 'snail' mailed; either way it is very welcome. One obvious difference between the two columns is the readership language! Phrases often used across the pond (in Britain) have no meaning in America, so I shall have to watch my 'Ps and Qs'!

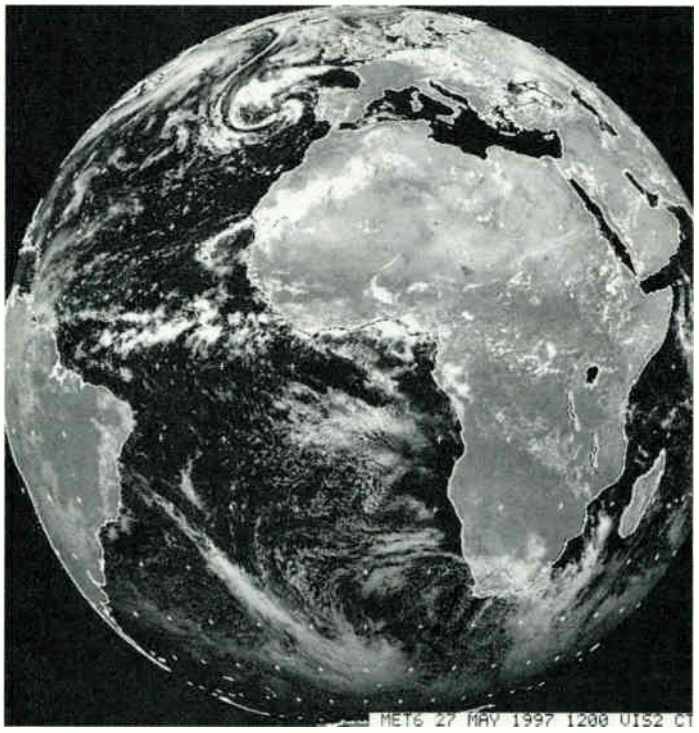


FIGURE 1: ***METEOSAT-6 whole-disc, (CTOT) visible-light image taken on May 27, 1997 at 1200 UTC.***

I want to start by explaining a little about where I live. Plymouth (UK) is a city in the county of Devon on the south-west peninsula and has a mixture of tourist spots and minor industrial works. Within Plymouth, the Barbican area is very much geared to the tourist scene. Virtually every day from late spring onwards sees Americans visiting the departure point where the Pilgrim Fathers set off on their pioneering voyage across the Atlantic ocean. There are some 40 towns world-wide bearing the name Plymouth.

Because of its coastal position Plymouth is very prone to the vagaries of the Atlantic weather so this is a never ending source of conversation to Plymothians, and a natural field of interest for me—but for a slightly different reason, as you will see.

Let us start with the big scene: the view of this side of the hemisphere as seen by METEOSAT-6.

As seasoned weather satellite monitors know, METEOSAT-6 is one of several geostationary weather satellites, providing European users with images 24 hours per day. Those with GOES equipment, and living on the northeast coast of America, might be able to 'hear' the WEFAX tones from METEOSAT-6—just above the eastern horizon. In the same way, because Plymouth (UK) is just inside its footprint, I can receive telemetry from GOES-8, just a few degrees above my western horizon. GOES-8 broadcasts a superb range of otherwise unobtainable images.

Figure 1 is one of only two such images transmitted in WEFAX format each day. Other whole-disc scans are available, but only in primary data format (PDUS). (I have a PDUS system requiring some construction work to fix the large dish on to its new mount, but time has not been available.)

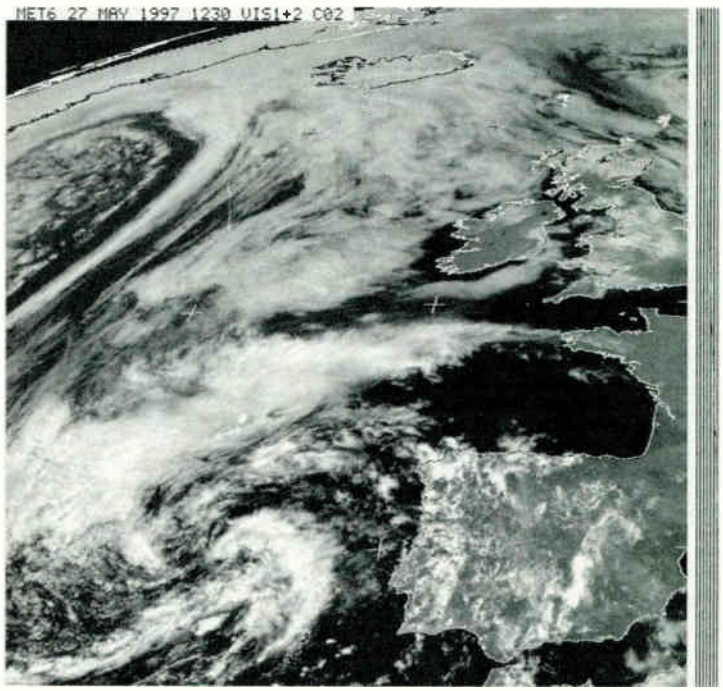


FIG URE 2: ***METEOSAT C02 visible-light image of Britain on May 27, 1997.***

Readers on the western side of the big pond may be unaware that METEOSAT primary data is almost entirely encrypted, forcing all users to purchase an expensive decryption unit costing 700 ECUs (equivalent to approximately US$800). In addition, an interface is required to fit the unit to the system, making it a very expensive deal.

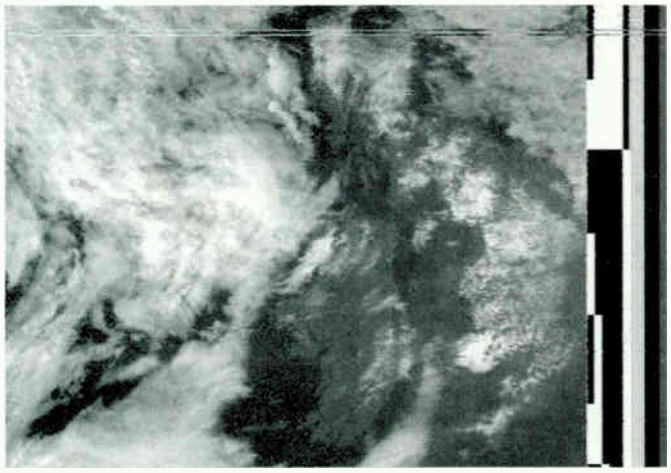


FIGURE 3: *Meteor 3-5 image of Britain on May 27.*

Readers on the western side of the big pond may be unaware that METEOSAT primary data is almost entirely encrypted, forcing all users to purchase an expensive decryption unit costing 700 ECUs (equivalent to approximately US$800). In addition, an interface is required to fit the unit to the system, making it a very expensive deal. For this reason I plan to get my own PDUS system operational just for 'foreign' images—GOES, GOMS and GMS!

Serious monitoring of the British weather is done using the C02 format—a visible-light format transmitted every 30 minutes (see figure 2).

METEOSAT-6 is stationed over longitude zero (the prime meridian). The C02 format shows the western half of the original image scan, and format C03 shows the eastern half. This image shows a high pressure area over Britain, providing good opportunities for astronomy.

(Yes, that is my other hobby. I have an American-made telescope and use it whenever time and weather are favorable!) The image shows clear skies above Plymouth and Dartmoor to the north of the city—where astronomers sometimes take their telescopes. I invariably remain at home and do astronomy from my backyard.

You can now see why weather satellite monitoring is of real interest to me. I am a registered user of the automatic telescope facility (ATF) at America's Iowa University. I send regular e-mail observation schedules to their observatory; these are usually completed and the resulting images held on a university server until my weekend collection. During the last year I have made about 50 observations including galaxies, comets, and star fields. I monitor Iowa weather by pointing my yagi at GOES-8 (remember, it is barely three degrees elevation from Plymouth, in the UK, between a house and a bush!).

My final picture of Plymouth is a METEOR 3-5 image also from May 27 (see figure 3). The image has been contrast expanded to improve clarity.

The British view of the Americas is as seen from METEOSAT-6 in figure 4. This is one of several retransmitted image formats the operators collect from GOES-8. Infra-red images from GOES-8 are transmitted from METEOSAT-6 every three hours.

New Weather Satellite Software

During recent weeks there have been releases of three weather satellite software programs. The one making all the news in Internet weather satellite discussion groups is Christian H. Bock's freeware program *WXSAT*, which uses a soundcard to do the work of digitizing an automatic picture

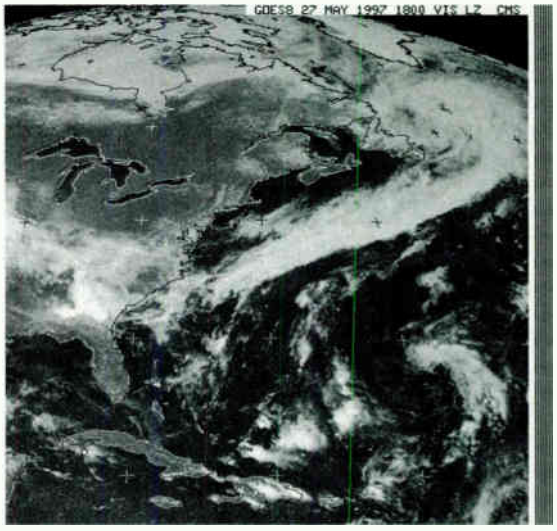


FIGURE 4: *GOES-8 (LZ visible-light format) May 27 1800 UTC.*

During recent weeks there have been releases of three weather satellite software programs. The one making all the news in Internet weather satellite discussion groups is Christian H. Bock's freeware program WXSAT, which uses a soundcard to do the work of digitizing an automatic picture transmission (APT)/WEFAX signal.

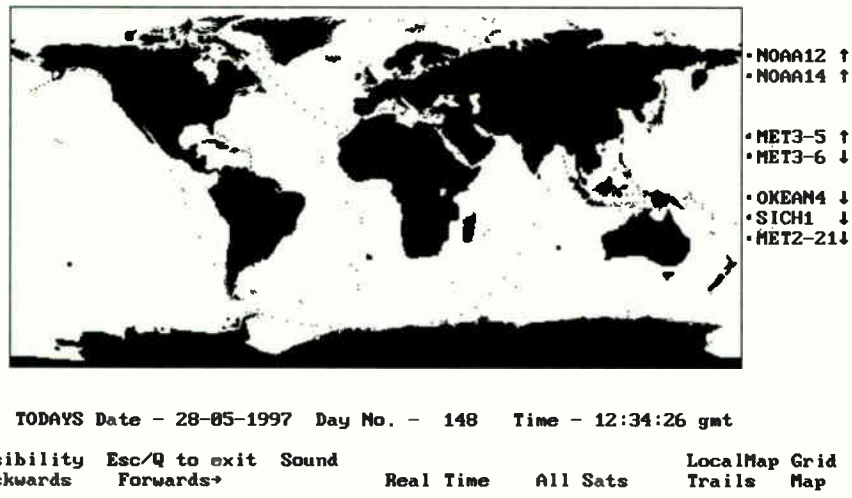


FIGURE 5: ***WST screen shot.***

transmission (APT)/WEFAX signal. This can save the expense of purchasing a commercial package. After some soundcard software problems were fixed, I set up the program to decode pictures from the polar orbiters—and they were excellent. The program deserves its own review. It can be obtained from several sources on the Internet.

Satellite Tracking Software

Several readers asked for details of software that will run on a very basic PC; there are still large numbers of these around! Gordon Train responded to my request for information by sending me his program *WST* (weather satellite tracker). Its contents occupy barely 300 kb of zipped program files and it installs itself. Figure 5 is a reversed color, screen shot of the main tracking screen. Apart from indicating satellite positions, the program has several facilities such as schedule printing and an audible warning of satellites rising above your local horizon. It is good on any PC machine.

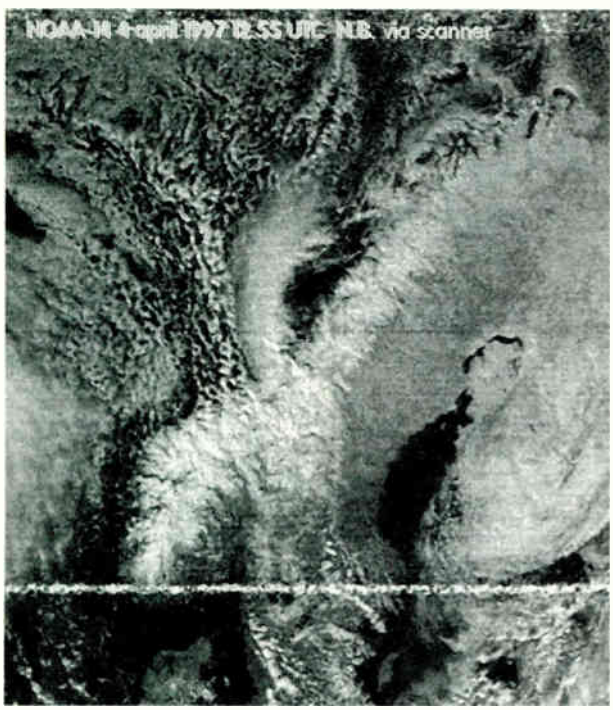


FIGURE 6: ***NOAA-14 visible-light image from Ap van Weeren of Holland***

PROsat for Windows

The final newcomer to the software scene is Timestep's new PROsat for Windows. Timestep is represented in America by Spectrum International. I am preparing a full review of this new package, having just received the latest upgrade version from their software writer Peter Arnold. The system includes an interface card, software and dongle. The program is hardware compatible with the earlier DOS version which, until recently (when I started testing other weather satellite products), has been in continuous use as my main weather satellite decoding system.

The new Windows version uses true multi-tasking, and during its early tests has proved very user friendly. I like to leave programs running while I do other computing operations—such as writing reviews!

The suite includes reception of all polar orbiter weather satellites, including the oceanographic SICH-1 and OKEAN 1-7 satellites (which transmit infrequently, and mostly over Europe). Animation of images from GOES and METEOSAT is simple and the software includes color as an option. The tracking program Track II is an updated Windows version which (sadly!) requires a dongle to be attached to the printer port. I look forward to doing a full feature on the program.

Letters from Distant Lands

I have received letters and e-mails from people all over the world who take an interest in weather satellite reception. Amateurs and retired professionals set up receiving stations at home, sometimes using state-of-the-art equipment, sometimes using older hardware. An e-mailed image of a NOAA-14 pass on April 4, 1997, came from former radio officer and vessel traffic controller Ap van Weeren, a reader in Holland.

He uses an unmodified VHF/UHF scanner, the Uniden/Bearcat 175XL, fed by an old VHF antenna (tuned to 144-162 MHz), originally from a fishing boat. Ap usually has his scanner in the living room to listen for the coast guard and port control. His computer is a 486DX4 100 MHz with 8 Mb RAM and now running *WXSAT*—the program previously mentioned.

Figure 6 clearly shows the large ice sheet covering the northern end of the Gulf of Bothnia. This area quickly freezes over in winter, then melts by late spring. I do not have archived images to see what happens to the Great Lakes during winter!

Internet Sites of Weather Satellite Interest

The Internet has a large number of sites—both official and unofficial—containing information about weather satellites.

Reader Ap van Weeren of Holland uses an unmodified VHF/UHF scanner, the Uniden/Bearcat 175XL, fed by an old VHF antenna (tuned to 144-162 MHz), originally from a fishing boat.

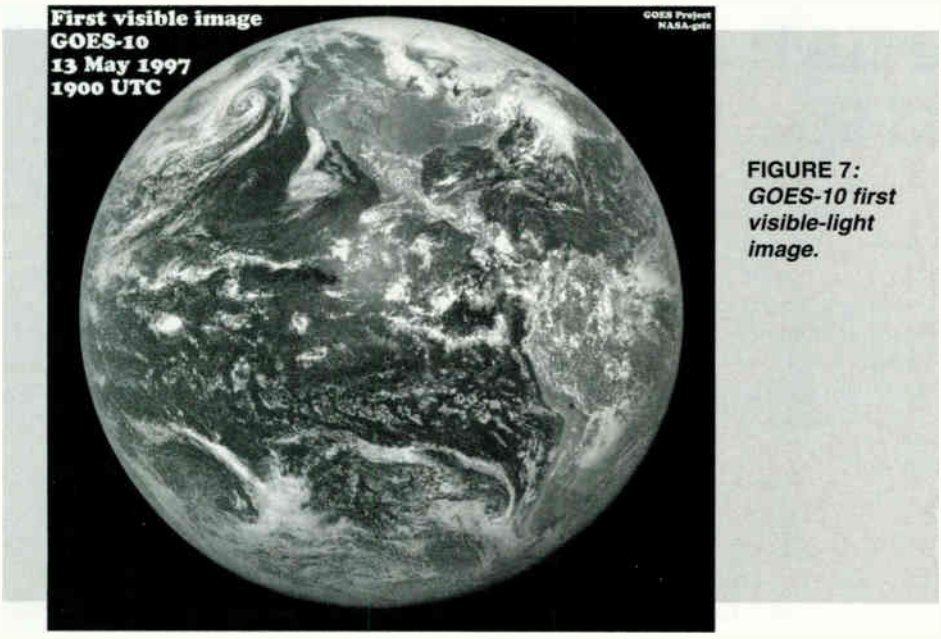


FIGURE 7: *GOES-10 first visible-light image.*

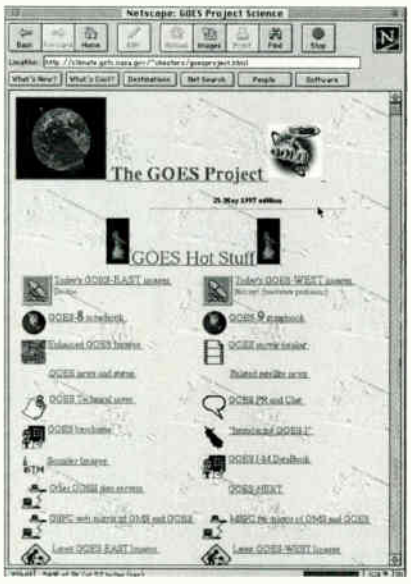
When I set up my own home page I decided not to compete, but to merely provide a summary of the current weather satellite status and some relevant links. Visitors to my site at: **http://www.ndirect.co.uk/~lawrenceh/** will not find collections of images, just a few selected links and locally-related space information.

One site well worth visiting is that of Dennis Chesters at: **http://climate.gsfc.nasa.gov/~chesters/goesproject.html** (see screen capture below).

He maintains an updated site carrying the latest information about GOES weather satellites and was the first site that I found showing the first-light images from GOES-10. This image is published courtesy of NASA at Goddard Space-Flight Center.

The site: **ftp://rsd.gsfc.nasa.gov/pub/Weather** has just been announced as an official GSFC primary distribution site for GMS-5, GOES-8, and GOES-9 images.

Finally, correspondence in any form is welcomed, but please do not e-mail large images! First let me know what you want to send. UK telephone rates are high! Suggestions and comments for this column are welcome—tell me what you would like to see. ST



ACTIVE WEATHER SATELLITE FREQUENCIES (AND MORE)

NOAA-14 transmits APT on 137.62 MHz and beacon data on 137.77 MHz.
NOAA-12 transmits APT on 137.50 MHz and beacon data on 136.77 MHz.
METEOR3-5 (sometimes 2-21) transmits APT on 137.85 MHz when in sunlight.
OKEAN-4 and SICH-1 use 137.40 MHz (rare transmissions-not continuous)
GOES-8 and GOES-9 use 1691 MHz for WEFAX
METEOSAT-5 (where receivable!) uses 1691 and 1694.5 MHz for WEFAX
Mir voice downlinks are on 145.80 and 143.625 MHz.

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

Update on PANSAT: Amateur Radio's First Spread Spectrum Satellite

Amateur radio's first spread spectrum digital communications satellite could be launched before the end of this year. PANSAT, the Petite amateur Navy Satellite, is currently undergoing construction by the Space Systems Academic Group at the Naval Postgraduate School in Monterey, California. It is currently targeted for launch into a low-earth orbit from the US Space Shuttle on mission STS-86. Its orbital lifetime is expected to be approximately two years.

PANSAT's objectives are to enhance the education of military officers at the Naval Postgraduate School through the development and operation of a spread spectrum, digital communications satellite. PANSAT will also be used to demonstrate the capability of a low-cost, packetized, spread spectrum system to enhance military communications using a small satellite platform, as well as provide store-and-forward communications using direct-sequence, spread spectrum modulation for the amateur radio community.

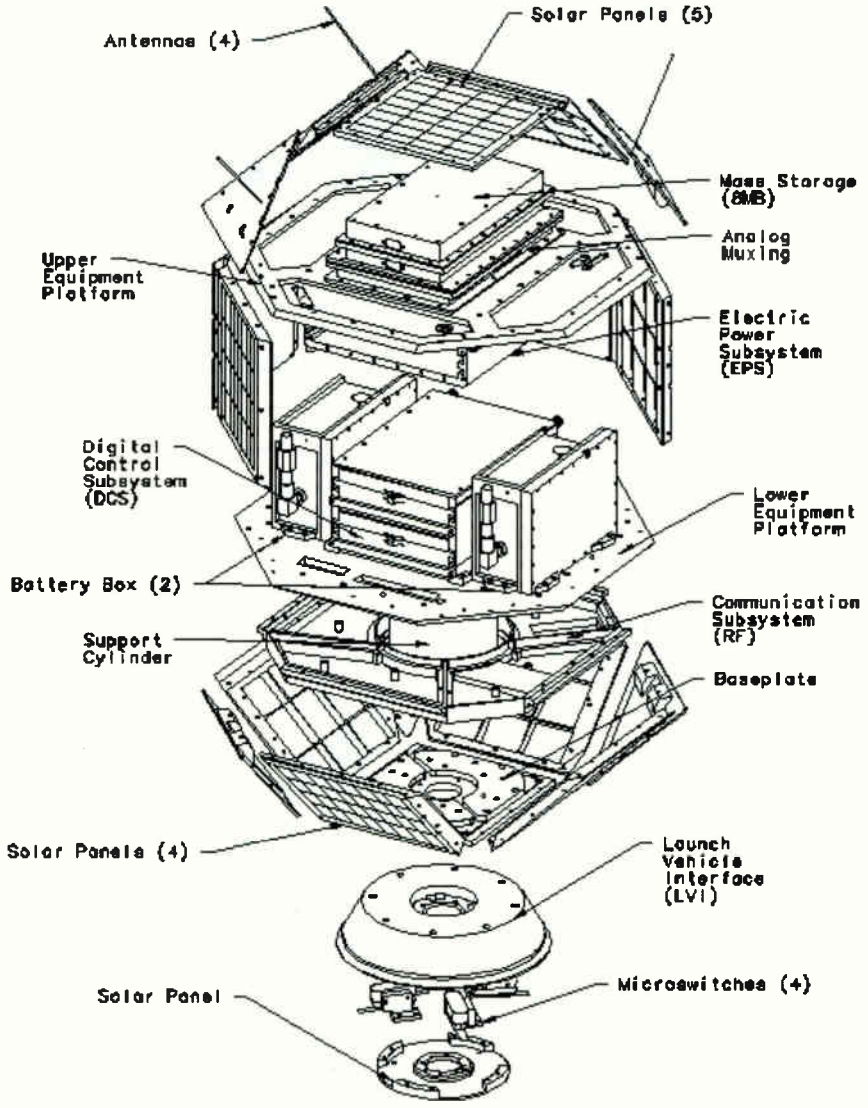
Physical Design

PANSAT's physical structure approximates that of an aluminum sphere with a diameter of about 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. PANSAT's physical structure provides sufficient flexibility to allow transport into space via a variety of different launch vehicles. Prior to launch, PANSAT will be mounted within a canister to a small spring loaded ejection mechnanism that will jettison the spacecraft away from the launch vehicle at a rate of about 3.5 feet per second.

The spacecraft interior structure is composed of two equipment plates along with a cylindrical support. A lack of attitude control or propulsion mechanisms within the spacecraft will cause PANSAT to tumble continuosly in space. The use of omni-directional antennas and the spherical structure of the satellite will help minimize the effect the lack of attitude control will have on the mission.

Spread Spectrum Communications

PANSAT is unique in its use of Spread Spectrum communications. Spread Spectrum uses techniques that dilute a normally narrow-band RF signal across a wide band-

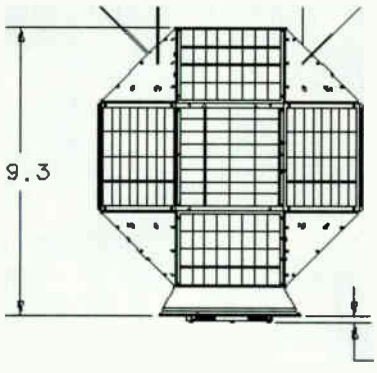


Exploded view of PANSAT (Photo from the Naval Postgraduate School Space Systems Academic Group, SSAG, web page)

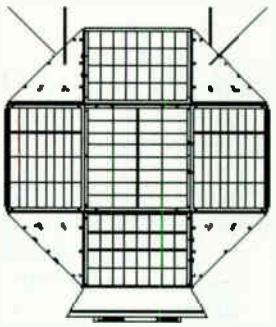
Direct-sequence spread spectrum modulation is a technique that spreads a conventional narrowband signal over a wide range of frequencies by mixing it with a high-speed pseudorandom-noise (PN) bit stream. The result is a dilution of the signal energy with respect to bandwidth.

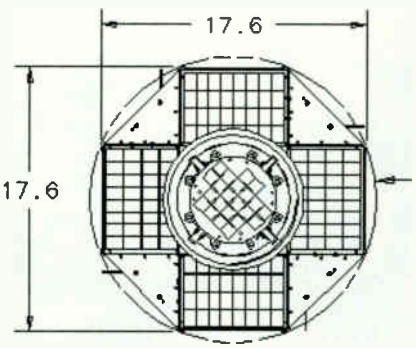
width in an effort to reduce interference between stations operating in the same frequency range and insure communications privacy between those sharing the same frequency spectrum. Spectrum spreading on amateur frequencies is usually carried out by such techniques as frequency hopping, direct PN sequences, or a combination of both.

It may come as a surprise that the original patent for spread spectrum communications actually belongs to actress Hedy Lamarr. Ms. Lamarr's patent was issued on August 11, 1942, and it has only been recently that communications hardware has evolved to the point of making spread spectrum a practical and inexpensive mode of communications. PANSAT represents the first attempt to incorporate spread spectrum communications techniques into an amateur radio communications satellite.

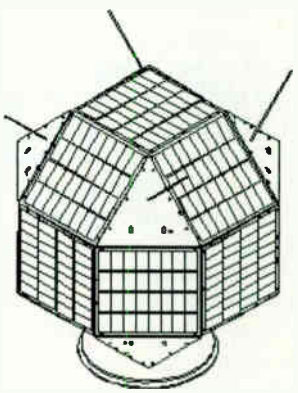


Drawings showing various views of the PANSAT spacecraft structure.





Notice the liberal use of solar arrays on virtually every facet of the spacecraft. (Photo via the SSAG web page)



PANSAT will carry a digital store-and-forward communications transponder and 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, and 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 pseudorandom-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 reduced. Using spread spectrum techniques, a narrow-band signal can be spread to the 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 PN code, therefore, serves as the "key" to demodulating the desired signal on a band of frequencies that may be shared with other users. The process of despreading a spread spectrum signal suppresses conventional narrow-band signals that may be present within the bandwidth of a spread sprectrum 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 will essentially perform the operations of a "flying electronic mailbox," and provide services similar to the FUJI and Pacsat style of digital communication satellites. After launch and testing, PANSAT's receiver will listen for request-to-connect commands from groundstations. After receiving such a request and acknowledging the user, PANSAT will begin an information relay phase of the virtual data connection at which time the user will be able to access a bulletin board software running on the satellite. The bulletin board will provide services that will allow users to send and receive mail messages stored on board PANSAT, upload and download small binary files, and read spacecraft telemetry. The use of sophisticated protocols will allow users to interleave their activities with those of PANSAT, thereby enabling multiple users to communicate simultaneously with the satellite. When the information relay is complete, the user will log out and send a request-to-disconnect command to the satellite to end the PANSAT session.

PANSAT will also incorporate a "broadcast protocol" similar to what is currently used with the Pacsat satellites to enable multiple groundstations within PANSAT's

The Digital Control Subsystem [on the PANSAT spacecraft] will 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 data.

footprint to capture data from the satellite without having to establish a point-to-point AX.25 virtual connection with PANSAT.

PANSAT Hardware

A Digital Control Subsystem (DCS) on the PANSAT spacecraft will be responsible for supporting an operating environment for the satellite software as well as provide control of the communications and electrical subsystems. The Digital Control Subsystem 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 data. The DCS will be implemented with redundant control boards designed to 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 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.

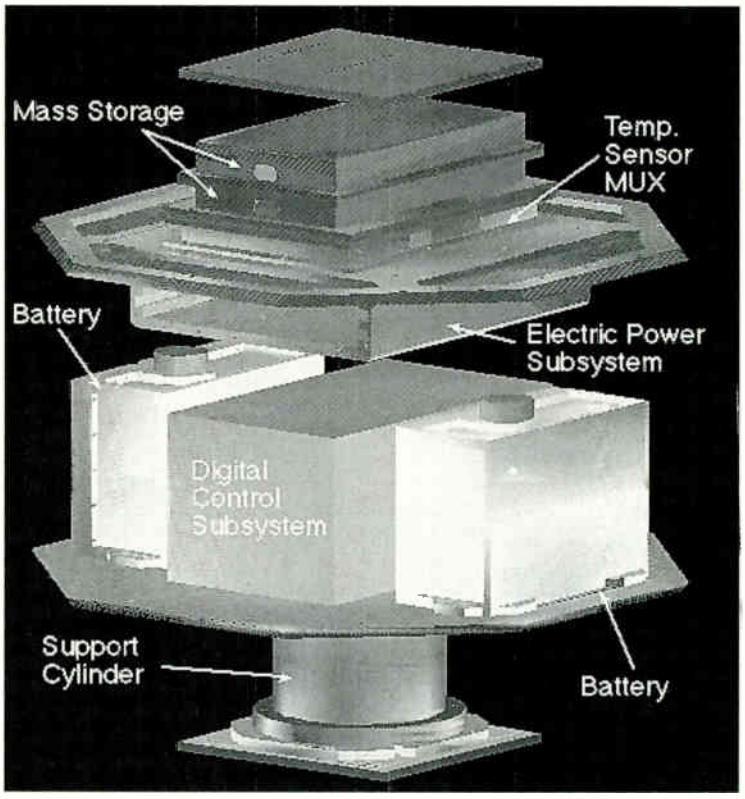
The PANSAT mass storage unit is contained within the DCS and will serve as a permanent storage device for user mail, files, telemetry, and storage for updates to the system software. Mass storage will be designed around either an array of static RAM chips with battery back-up, or by flash memories that require no power when idle. The only concern is whether the flash memories under consideration will be reliable in the high radiation environment of 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 (PCs) such as those currently used for PANSAT software development. Most 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 to several existing OSCAR satellites carrying digital store-and-forward communication transponders. These satellites include AMSAT-OSCAR-16, DOVE-OSCAR-17, WEBERSAT-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.



Exploded view of PANSAT showing the placement of various spacecraft subsystems.

OSCAR groundstations will be able to access PANSAT by using a personal computer, a packet radio terminal node controller (TNC), groundstation radio equipment, special spread spectrum hardware, and PANSAT-specific user interface software to match PANSAT's spread spectrum and BBS capabilities.

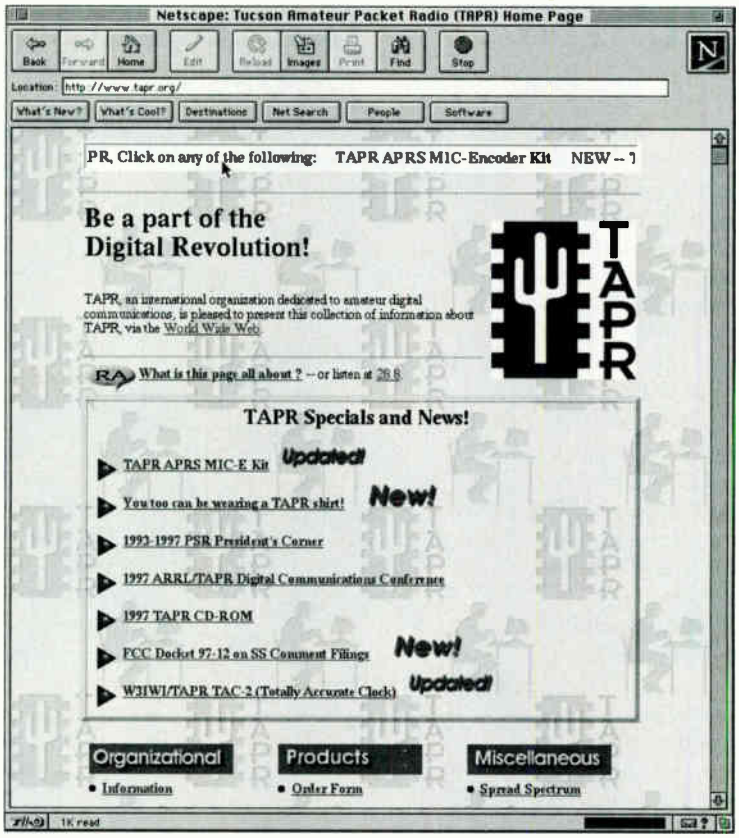
Groundstation Requirements

OSCAR groundstations will be able to access PANSAT by using a personal computer, a packet radio terminal node controller (TNC), groundstation radio equipment, special spread spectrum hardware, and PANSAT-specific user interface software to match PANSAT's spread spectrum and BBS capabilities. A generic and inexpensive groundstation package is expected to become available through the Space Systems Academic Group that will provide amateur radio operators with all the necessary hardware and software needed to access PANSAT satellite's bulletin board, and capture and decode spacecraft telemetry.

Spread Spectrum's Future

Spread spectrum communications is currently a topic of much debate and serious discussion in the amateur radio service. Technology has advanced to the point of making spread spectrum communications inexpensive, as evidenced by its use in a growing number of consumer devices (900 MHz digital cordless telephones, cellular telephones, wireless modems, GPS receivers, etc.). FCC Part 97 rules, however, severely limit the extent to which spread spectrum communications may be used within the amateur radio service. Such limitations do not exist for low-power FCC Part 15 comsumer electronics products. Furthermore, weak signal enthusiasts active on the UHF and microwave amateur bands are fearful that spread spectrum communications could raise noise floor levels to the point of making weak signal communications impossible. Advocates of spread spectrum communications point out that the processing gain possible with spread spectrum communications may make weak signal work (such as moonbounce communications) much more feasible using spread spectrum than what can be currently achieved using continuous wave telegraphy (CW) and analog single sideband (SSB) voice communications.

Further information on the status of spread spectrum communications in the amateur radio service may be found on the Tucson Area Packet Radio (TAPR) Home Page at: **http://www.tapr.org.** ST



Tucson Area Packet Radio (TAPR) Home Page at: http://www.tapr.org.

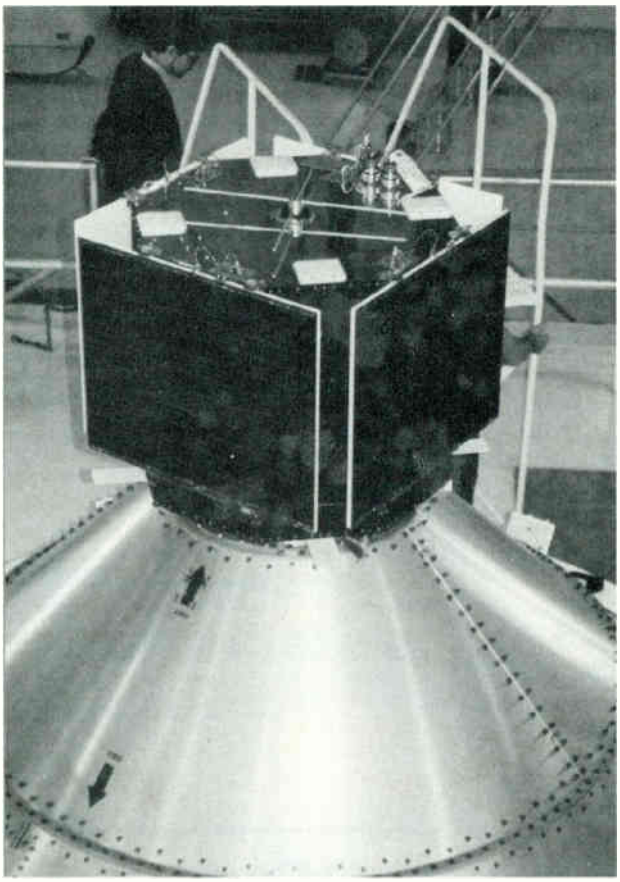
By Donald E. Dickerson, N9CUE

GEMNET — (Little LEOs, Round 2)

The FCC may soon announce its second round draft choice in the non-voice non-geostationary (NVNG) space race. In 1992 when the World Administrative Radio Conference (WARC) allocated frequency spectrum for the proposed little LEO mobile satellite service (MSS), three companies filed for a license; Orbcomm, Starsys, and VITA.

To date, Orbcomm is the only company to receive a license to construct and launch satellites. This gives them an obvious lead in the race to NVNG service. This, however, is not the end of the story, as the FCC has decided to entertain submissions for a second round filing from five additional companies who just happen to want to build LEO satellites.

CTA Commercial Systems, Inc., of Rockville, Maryland, is just such a company. They want to build their own worldwide LEO network of digital data messaging spacecraft—and with good reason. CTA has been in the satellite building business since the early 80's when it built the GLOMR spacecraft for the Defense Advanced Research Programs Agency (DARPA). Launched from the shuttle, GLOMR was a store-forward data relay satellite.



GEMstar-1™ satellite ready for launch aboard the launch vehicle LMLV-1. Photo courtesy of CTA.

Since then, CTA has built three spacecraft for the Navy, twelve for the Air Force, four commercial satellites, two for NASA, one for the Strategic Defense Initiative (SDI), and two additional spacecraft for DARPA.

CTA has used launch vehicles as small as the Scout, as unique as the Pegasus, as reliable as the Delta, as foreign as the Ariane, and as quaint as the Conestoga to boost their many and varied spacecraft.

In addition to their experience with the space segment of satellite communications, CTA has designed and built twelve ground stations for command and control of LEO satellites. They also maintain their own command and control station located in Mclean, Virginia. The company's satellite programs include two military satellites for the Navy called MACSATs. These two spacecraft were used during the Gulf War/Desert Storm. CTA was also responsible for the military Microsat program and was a pioneer in the creation of the store-forward communications satellite.

Many Facets to this Gem

GEMnet (global electronic message network), CTA's global two-way data communications system, has filed for a round two license to begin service...well, soon, since the race is officially on. And they feel they can be more an competitive in the race to get there first.

The GEMnet constellation will consist of 38 LEO spacecraft and two spares. The satellites will be placed in four planes of eight satellites each and one plane of six satellites in an inclined circular orbit of 50 degrees. The satellites will maintain an altitude of 1000 km. Each weighs 100 lbs, has a operational life of five to seven years. The spacecraft has a power budget of 100 watts.

The GEMnet ground segment will consist of gateway stations, three are planned for the U.S., and a Network Operations Center (NOC). The NOC will perform control and management functions for the entire system including tracking, telemetry, and control (TT&C) functions via the gateway stations.

Personal e-mail service will be available as customers will communicate directly with the satellite which will, in turn, interconnect with local and global gateway stations for message routing through the appropriate public switched telephone network (PSTN).

In addition to the e-mail service, GEMnet will also be able to provide customers with the usual type of monitoring and communications services we have talked about before when discussing the NVNG LEO systems. These include monitoring and tracking, utility meter reading, global paging, buoy, and environmental sensing, and even direct-to-home communications services.

Planning for Heavy Traffic

Two different classes of data formats will be implemented for the services: standard e-mail data messages and short data packet messages, which are similar to high level data link control (HDLC). Each GEMnet

Subscriber units transmit data to the spacecraft either by requesting an uplink data channel via the user uplink signaling channel or by being commanded via one of the signaling downlink channels. If the field units are requesting service or the messages is short, the unit can send the message on the random access signaling channel.

satellite uplink will consist of one signaling channel and a supporting set of data channels using frequency division multiplexing (FDM). The uplinks in the 148 MHz band of the existing commercial spectrum will consist of eleven uplink data channels operating at 2.4 or 4.8 kbps, with one of those channels reserved as the signaling channel.

Access to the GEMnet satellites on the uplink signaling channel may be obtained using modified reservation ALOHA protocol or a polling protocol. The ALOHA protocol uses the order channel to accept user requests for time slots in the subsequent frame time. This method is primarily used to support e-mail service and paging applications that have essentially burst access characteristics and larger message sizes. Those applications that allow predetermined scheduling will be serviced by the polling protocol that will permit larger numbers of subscriber field units with small data messages to access the satellite. Polling access will be employed for applications like utility monitoring and transportation asset tracking.

The GEMnet system will provide both access methods over intervals of typically five to ten seconds in order to service both random and polled applications within the same footprint.

Using dynamic channel assignment on the uplink band, each satellite will continually scan the uplink frequencies to determine the available channels and broadcast the frequency assignment to the subscriber field units. The subscriber field unit will track the appropriate subscriber-satellite downlink carrier to compensate for Doppler shift.

Subscriber units transmit data to the spacecraft either by requesting an uplink data channel via the user uplink signaling channel or by being commanded via one of the signaling downlink channels. If the field units are requesting service or the messages is short (less than 32 bytes), the unit can send the message on the random access signaling channel. If the message is larger, the unit will end a reservation request to the satellite. Then the satellite will examine the activity on the uplink bands and select an available clear channel, and a channel alignment to the subscriber field unit on the downlink channel.

When the field unit is being polled to initiate a transmission, the satellite will transmit an assignment message for the unit via the appropriate subscriber downlink channel. The message will specify the uplink data channel and the time offset from the signaling channel synchronization signal for transmission. The satellite may also issue group commands requesting a group of subscriber field units to respond. However, in this case the field units must respond on the signaling channel, either sending the response message or requesting a data channel.

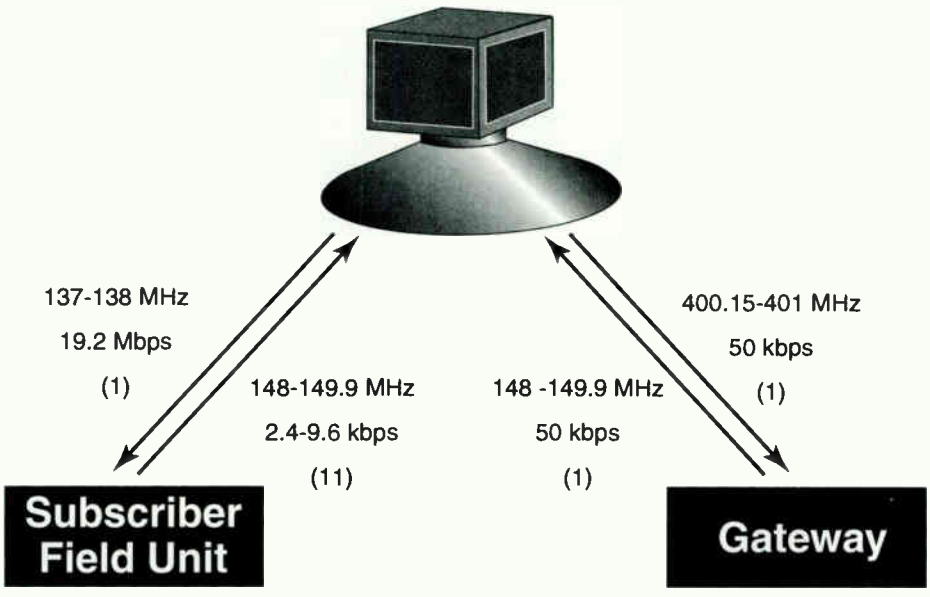
During data transmissions, the packetized data will use an HDLC format. Packet lengths can vary from 12 to 512 bytes excluding overhead to accommodate different applications. Furthermore, each subscriber unit is identified with a unique address which supports the required group schemes that allow the polled access approach to be effective.

According to FCC regulations, there are tight time restrictions on the transmission of data on this shared frequency plan. Each subscriber field unit can use a single frequency to access the satellite for a total of 9 seconds over any given 15 minute period. The maximum burst transmission length is 450 ms. In this protocol any message involved in a collision will contend for room in the next time frame.

The GEMnet system will use frequency bands that have been allocated to the NVNG MSS. These are 148-150.5 MHz for the subscriber/satellite uplink and gateway satellite station uplink (feeder Link), 137-138 MHz for the satellite/subscriber downlink, and 400.15-401 MHz for the gateway station feeder link. The prime consideration in selecting these frequencies was the low cost of subscriber units. Low-cost, compact, handheld or truck mounted terminals will be rugged, low-power, easy to interface, and have omnidirectional antenna gain patterns.

GEMnet will employ four types of simplex communications links, which will be used for subscriber-satellite and gateway satellite communications. The links are: user to satellite uplink, user to satellite downlink, Gateway to satellite uplink, and Gateway to satellite downlink. GEMnet will use differentially encoded offset-QPSK (OQPSK).

CTA's wealth of experience in the building and launching of spacecraft may give them a competitive advantage over some of the other second round applicants in the little LEO space race. For now, however, until the FCC makes its announcement, the only game in town is the waiting game. Till next time around. ST



Numbers in ( ) = Numbers of Channels per Satellite

ST SATELLITE LISTENING POST

By Keith Stein
kstein@erols.com

The L-band Spectrum

Navigation and imagery is the name of game in the L-band (500-2000 MHz) satellite spectrum. Some communication and telemetry downlinks will also be found in this portion of the spectrum. To monitor the L-band, you might think about putting up a satellite dish and some more advanced receivers than your average scanner and discone. There is so much activity in this band we'll only touch briefly on each service.

NAVSTAR Global Positioning System (GPS)

The NAVSTAR GPS system is a U.S. Air Force multisatellite constellation consisting of 24 satellites in earth orbit being used worldwide to provide latitude, longitude, and altitude data. The frequency 1227.6 MHz is designated for use by the military with 1575.42 MHz being used by civilians.

GPS also operates on 1381.05 MHz to relay data on nuclear burst detection around the globe.

Several commercial companies have GPS receivers on the market. You can get more information by obtaining the current copy of the Grove Buyers guide at 800-438-8155 or outside the U.S. at 704-837-9200. You can also check with some of our Satellite Times advertisers.

Orbital Sciences in L-band

The 1435-1530 MHz range could provide some interesting signal monitoring. This band is heavily used for aeronautical telemetry and telecommand. This is crucial to NASA and DOD research in the development and testing of aircraft and missile systems. This band is congested in many areas and new systems are being moved to 2360-2390 MHz.

Orbital Sciences Corp uses 1480.5 MHz to downlink telemetry from their L-1011 aircraft. The Pegasus air-launched booster is launched from this L-1011 to place small spacecraft into orbit.

A chase plane, usually a NASA F-18 or T-38, flying alongside the L-1011 downlinks video of the launch on 1727.5 MHz.

INMARSAT

The INMARSAT constellation of geostationary satellites can be found between 1530-1544 MHz providing distress, safety, and general communications. This system is currently being used by 17,000 ships throughout the world, including extensive operations within inland waterways for ship-to-shore communications. The number of users is expected to reach 40,000 within the next 10 years.

Swagur Enterprises answered a call by the monitoring community for INMARSAT monitoring equipment when they came out with their Apartment Dwellers' Special. This system is great for reception of GOES weather satellites and INMARSAT. Simply place the dish in a south facing window or patio and aim it at the satellite you want to hear. System configurations range from $775 to $1350 for the serious monitor.

Swagur Enterprises
P.O. Box 620035
Middleton, WI 53562-0035
(608) 592-7409

Sea-viewing Wide-Field-of-View Sensor (SeaWiFS/ SeaStar)

An Orbital Sciences Corporation SeaStar spacecraft will carry NASA's SeaWiFS instrument into orbit in July 1997. The system will estimate ocean color, and derive from these measurements, various biological indicators and other useful scientific products. The measurements are important to understand the role of the oceans in the global carbon cycle and its impacts on global climate.

SeaWiFS/SeaStar will transmit data on 1702.5 MHz with a real-time data rate of 665 kbps.

Systeme Probatoire D'Observation de la Terre-4 (SPOT-4)

SPOT-4 is an earth observation satellite for France. The system can take high-resolution 10-meter images and medium-resolution 20-meter images. Data obtained from the SPOT-1, 2, and 3 missions have been used for military planning, mapping and geologic studies. Currently the spacecraft is scheduled for launch in March 1998. Imagery is downlinked on 1704.0 MHz along with an X-band downlink.

Fill-in's

Here are some other L-band downlink allocations that have been covered in recent issues of Satellite Times:

922.750 MHz	Soyuz TM
926.000 MHz	Soyuz TM
1544.500 MHz	NOAA Polar Orbiting Satellites
1698.000 MHz	NOAA Polar Orbiting Satellites
1702.500 MHz	NOAA Polar Orbiting Satellites
1707.000 MHz	NOAA Polar Orbiting Satellites

TRW Ground Station Fights RFI

Engineers were puzzled when a hefty signal jammed the S-band downlink (2275.300 MHz) at a new control center built by TRW in Chantilly, Virginia, for NASA's Lewis satellite. The signal appeared to be coming from a neighboring building. An investigation traced the problem ... to a faulty car alarm system.

FLTSATCOM Supporting MIA Search

By Dudley Emer (N7MNA) of Las Vegas, NV

I have been following the missing-in-action (MIA) traffic over the U.S. Navy fleet satellite communication (FLTSATCOM) system for about three years now. So far they have been in Vietnam, Laos, and Cambodia. Most recently it sounds like they are in Laos and Vietnam. For the last two years,

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

the "boys" (as we call them), have been sending situation reports (sitreps) via modem rather than dictating the situation reports like they use to. The old sitreps were quite detailed and gave locations, serial numbers and remains descriptions. The length of time from the remains' discovery until we'd read it in the papers was about four months or so.

When they switched to computer transmitted sitreps they had quite a bit of trouble getting the field satcoms to get the traffic to Eagle (Hawaii)—or anywhere else, for that matter. During this transition they discussed the problems and setup. They were using straight ASCII at 2400 baud out of a DOS type computer running with what appeared to be Procomm type software, judging by the function buttons they were told to set up with.

The satcom signal sounds like 2400 baud and I assume they are using a satcom that runs 1200/2400 baud BPSK. In the early days, they would use a call button (produced a whooping alarm) until Eagle told them to not use that function. I would therefore assume that they probably use a PSC-3 or similar satcom. I have not as yet tried to decode the signal, as it is fairly weak into Las Vegas.

The satellite is located at 177 degrees West and is about 12 degrees off the horizon at this location. I use either a R-7000, Pro 2006, or an HST-4A SATCOM with a 20-dB gain GaAsFET preamp connected to either a DMC-152 or DMC 120 SATCOM antenna. Due to zoning restrictions the antennas are indoors which doesn't help. There are numerous signal fades and I suspect that the decoding will present a problem even though each message is usually sent twice.

The voice traffic goes on from 0200 to about 1200 UTC with prime time occurring at around 1100 UTC (I have a speaker in the bedroom and the wife is as addicted to listening to this traffic as I am). There have been some memorable exchanges over the years—a 20 second warble alarm (IR launch detect) in the cockpit of a C-130 on approach to a field in Cambodia, camp security issues (stolen passports, equipment, local bad guys, etc.), embassy VIP visits, negotiations with the locals for access, etc.

Our favorite person was a young new field personnel with the call sign Snapper. He and his indiginous security team were inserted on a ridge using a Stabo rig by a Russian helo. He stated he'd have a helipad cut in the sasa (bamboo) in about four hours. Having been in Vietnam in '67-68 I chuckled and told the wife "noway." Sure enough, seven hours later with the helo coming in he's nowhere near finished and has to run back up to ridge to get the Stabo gear because that's how they would have to be extracted. He asks Barracuda to tell the indigs on the security team not to touch the satcom antenna while he's gone. Barracuda instantly comes back speaking fluent Lao!

These guys are impressive. The talk of team houses and detachments (DETs) and the ability to speak in the local languages suggests this is a combination of Air Force and Army special forces.

Last year they still had over 1100 sites to examine. It's a shame there isn't more in-the-clear traffic of this nature.

NASA Terminates COBE Mission Support

On May 1, 1997, NASA's Goddard Space Flight Center in Greenbelt, Maryland, announced that all support toward the Cosmic Background Explorer (COBE) mission has been terminated.

After a very successful mission, the spacecraft was designated a test satellite, with the Wallops Flight Facility as the spacecraft support administrator.

COBE was launched from the Western Space and Missile Center (WSMC) aboard a McDonnell Douglas Delta launch vehicle into a circular parking orbit of about 900 km, with an inclination of 99 degrees.

COBE FREQUENCY ASSIGNMENTS

Downlink (MHz)	Polarization
2287.5	LCP
Telemetry	
Data Streams:	2 (Biphase-L)
Format:	PCX/PSK/PM
Subcarrier Frequency:	1.024 MHz
Bit Rates:	1.024 kb/s, 4.096 kb/s, 655.36 kb/s

NASA TV: Surprise, Surprise

On May 7, 1997, NASA TV performed their usual validation test period for the upcoming STS-84 space shuttle mission. During this period you get to watch some very interesting color bars and test patterns. It's so interesting that it made me sit down and start writing this part of the column.

But seriously (no, I don't get thrills out of watching TV test patterns), this particular day I just left the set on and went on doing something else, not paying attention.

Well, surprise, surprise, "Voice Control, GOES POCC." What is that? I thought. Looking at the set again, "Go ahead POCC." Some interesting audio was now going out over the channel. After listening for a while I nailed it down to being live audio from the GOES (weather satellite) payload operations control center, coordinating tracking operations with stations in Santiago, Chile, and Wallops Island, Virginia. Some rare stuff heard from inside the control rooms managed by NASA's Goddard Space Flight Center at Greenbelt, Maryland.

The audio continued for about an hour and then disappeared. It was some interesting stuff: You never know what you'll catch on the NASA channel. NASA TV is transmitted on GE-2, transponder 9C at 85 degrees West longitude, vertical polarization, with a center transponder frequency of 3880 MHz and an audio subcarrier of 6.8 MHz.

First Space Launch from Delaware

The Delaware Aerospace Education Foundation (DASEF), in conjunction with the Florida Spaceport Authority, conducted the first space launch from the state of Delaware in May.

This historic launch of a Super Loki sounding rocket was performed from Cape Henlopen State Park in Lewes, Delaware, on Sunday, May 11, 1997.

The 11-foot tall, solid propellant rocket carried an amateur TV (ATV) and global positioning system (GPS) experiment.

The first attempt to launch the rocket was made on Saturday, May 10, but failed when the booster did not ignite at T-0 (lift-

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off). As the vehicle remained on the launch pad, its onboard computer continued to run the launch program. About 120 seconds after the firing failed, the payload was jettisoned into the sky landing in the trees surrounding the launch pad. After scrubbing the launch on Saturday, a spare Super Loki was put in place and the payload was restowed for another try on Sunday.

Sunday's launch looked perfect, with ignition and payload deployment on-time, but amateur engineers were unable to retrieve any data from the experiment. "With the failed launch on Saturday, and the short battery life of the payload, I feel we just didn't have enough juice or endurance to survive a second launch on Sunday," said Dr. Sam Guccione from the Delaware Technical and Community College (DTCC).

The following frequencies were logged active during the event;

146.535 MHz	Payload Support Personnel (K3BY)
149.5375 MHz	Civil Air Patrol, Air Operations
157.175 MHz	Coast Guard Range Communications
439.275 MHz	Amateur TV Experiment (Saturday's failure in the trees)
463.350 MHz	Florida Space Authority, launch commentary

New Russian NAVSAT in Orbit

A new Russian NAVSAT Cosmos 2341 (24772) has now been activated. It is transmitting on 149.91 MHz replacing Cosmos 2310 in plane 2.

On a similar note, Cosmos 2142, which had been silent, was reactivated again. It is transmitting on 150.03 MHz in plane 5.

The Russian military "Musson" navigation satellites are spread over six orbital planes spaced 30 degrees apart. There is a civilian constellation that consists of four satellites orbiting in planes spaced 45 degrees apart.

Thanks to John Corby of Canada and the Hearsat-L newsgroup for this information. And now for your intercepts during the last two months.

Listening Post Intercepts (all times in UTC)

M91.7 WSHS local high school radio station providing play-by-play coverage of Super Loki launches from Sheboygan, WI (Gary Hahn-Milwaukee, WI)

M119.100 NASA 1 (Gulfstream 1 aircraft, tail# N1NA) cleared to land at Washington National Airport, 1119, AM mode (Keith Stein-Washington DC)

M123.100 Civil Air Patrol secondary air operations frequency during launch of Super Loki's from Sheboygan, WI, AM mode (Gary Hahn-Milwaukee, WI)

M124.800 NASA 903 and flight (Tail# N903NA) leaving Kennedy Space Center for Vandenberg, up with Orlando approach for about 1 min. and then switched to JAX center on 134.0, then to 133.32 advised JAX center he was VHF today (George Bortle, FL-KD4CBV)

M126.650 Weather aircraft heard during launch of Delta/Thor mission from Cape Canaveral Air Station, AM mode (George Bortle-FL, KD4CBV)

M148.125 Civil Air Patrol (CAP) ground operations during launch of Super Lokis from Sheboygan, WI. CAP ground units: Bluemound 700 (apparently in charge), 321, 432, 58 (Gary Hahn-Milwaukee, WI)

M149.5375 CAP air operations during launch of two Super Loki rockets from Sheboygan, WI. CAP flights 4832, 4820, 4825 patrol aircraft (Gary Hahn-Milwaukee, WI)

M156.800 Marine ch 16. USCG used for closing the harbor and warding off nearby vessels during Super Loki launches from Sheboygan, WI (Gary Hahn-Milwaukee, WI)

M157.100 Marine ch 22. USCG Notice To Mariners (NTMs) regarding launch danger area during Super Loki launches from Sheboygan, WI (Gary Hahn-Milwaukee, WI)

M157.175 Marine ch 83. USCG operations with Helo 541 and vessels 324, B7, B12, and B2 during launch of Super Lokis from Sheboygan, WI (Gary Hahn-Milwaukee, WI)

M255.400 NASA 902 (T-38 aircraft, tail# N902NA) heard around 1540 calling Ft. Worth Radio first, AM mode, then contacting San Angelo Radio. He advised he was enroute to TIK (Tinker AFB) (Brian Scott-Denton, TX)

M259.700 Picked up voice from space shuttle (mission STS-84) at 0829 - 0831, AM mode, heard Pilot-Eileen Collins (Sven Grahn-Sollentuna, Sweden)

M261.850 At 0340-0415 EAGLE-3 heard calling TIGER and finally called WOLF who responded immediately. EAGLE-3 then sent "TTY" traffic. Then arranged to run HF checks at 11:00 hours. TIGER had Vietnamese accent. Said that TTY was world news including article about Mike Tyson. Also heard EAGLE-1 and WOLF arranging meet on HF of 5670 kHz. Reported weak but readable. Then agreed to try 7770 kHz next. EAGLE-4 just called EAGLE-1. Next EAGLE-3 reported TIGER loud and clear on HF (Jim-near Pasadena, CA)

M268.450 2030-2035, Spanish language telephone conversation. Second time hearing phone traffic here; no conversation in English yet (Philip Collier-Schenectady, NY-KG2DH)

M269.750 King 4 heard over UHF Follow-On satellite supporting launch of space shuttle (mission STS-84) (Magnus Hammarstedt-Ostersund, Sweden)

G11.554 Naseem fight on Eutelsat 16E, H (Unknown)

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

INTRODUCTION

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

How to Use the Satellite Service Guide

The various sections of the SSG include:

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

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

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

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

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

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

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

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

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

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

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

AUDIO SUBCARRIERS

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

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

Classical Music

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

Satellite Computer Services

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

Contemporary Music

Radio Romance (from Philippines)	G4, 24 (Ku-band)	6.20
SuperAudio—*Light and Lively Rock*	G5, 21	5.96, 6.12 (DS)
Unidentified station —Upbeat music	C4,5	5.58
WYEZ-FM 96.9 South Bend, IN	G4, 15	6.48, 7.30 (DS)

Country Music

SuperAudio—*American Country Favorites*	G5, 21	5.04/7.74 (DS)
Transtar III radio network	S3, 9	5.76/5.94 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, TN., ID-*The Hit Kicker*	G6, 7	6.20
WSM-AM (650) Nashville, TN	C4, 24	7.38, 7.58

Easy Listening Music

IAM Radio-easy listening music	G4, 6	7.69
SuperAudio—*Soft Sounds*	G5, 21	5.58/5.76 (DS)
FCC Mandated safe-harbor program audio-easy listening music	E2, 5	6.20, 6.80 (DS)
FCC Mandated safe-harbor program audio-easy listening music	G3R, 10	6.80
United Video—easy listening music	C4, 8	5.895 (N)

Foreign Language Programming

Anteena Radio (Greek)	S4,14	7.80
Apna Sangeet Radio India	E2,22	6.80
Arab Network of America radio network	GE-2, 22	5.80
CBC Radio-East (French)	E2, 1	5.38/5.58 (DS)
	E2, 1	7.36
DZMM-Radyo Patrol (from Philippines)	G4, 24 (Ku-band)	6.80
French language audio service	E2, 11	6.12
Greek-language radio	GE-1,16	7.38
Indian Sangeet Sager	E2, 16 (Ku-band)	6.12
La Cadena CNN Radio Noticias (CNN Radio News in Spanish)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA—Asian Radio	GE-1, 22 (Ku-band)	6.20
Northern Native Radio (Ethnic)	E2, 26 (Ku-band)	6.43/6.53 (DS)
RAI Satelradio (Italian)	G7, 14	7.38
Radio Canada (French)	E2, 11	5.40/5.58 (DS), 5.76
Radio Dubai (Arabic)	G7, 10	7.48
Radio Maria (Italian-Religious programming)	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Sedeye Iran (Farsi)	S3, 15	6.20 (N)
Radio Tropical	GE-1,4	7.60
Unidentified station-foreign language	GE-1,22 (Ku)	5.80
WCRP-FM (88.1) Guyama, Puerto Rico-Spanish language religious	G4, 6	6.53
WLIR-AM (1300) Spring Valley, NY (Ethnic)	GE-1,18 (C-band)	7.60
XEW-AM (900) Mexico City, Mexico (Spanish), ID-*LV de la America Latina*	M2, 14	7.38
XEW-FM (96.9) Mexico City, Mexico (Spanish), ID-*W-FM 96.9*	SD1, 7	7.38
XEWA-AM (540) Monterrey, Mexico (Spanish), ID-*Super Estelar*—contemporary music	M2, 8	7.38

Jazz Music

Jazz Worldbeat Radio (2300-0500 UTC)	T402R, 6	6.20
KLON-FM (88.1) Long Beach, CA., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio—*New Age of Jazz*	G5, 21	7.38/7.56 (DS)

News and Information Programming

Business Radio Network	C4, 10	8.06 (N)
Cable Radio Network	C3, 23	7.24 (N)
CNN Headline News	G5, 22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
Standard News	S3, 17	5.20
USA Radio Network-news, talk and information	S3,13	5.01 (ch 1), 5.20 (ch 2)
Virginia News Service	G5,11	5.94
WCBS-AM (880) New York, NY—news	G7, 19	7.38
WCCO-AM (830) Minneapolis, MN	G6, 15	6.20

Religious Programming

Ambassasor Inspirational Radio	S3, 15	5.96, 6.48
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5, 11	6.12
Christian Music Network Lakeland, FL	GE-1, 14	6.20, 7.60
KHCB-FM (105.7) Houston, TX	C1, 10	7.28
Salem Radio Network	S3,17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WHME-FM (103.1) South Bend, IN, ID-*Harvest FM*	G4, 15	5.58/5.78
WROL-AM (950) Boston, MA (occasional Spanish)	S3, 3	6.20
Z-musis—Christian rock	G1, 6	7.38/7.56

Rock Music

SuperAudio—*Classic Hits*-oldies	G5, 21	8.10/8.30 (DS)
SuperAudio—*Prime Demo*-mellow rock	G5, 21	5.22/5.40 (DS)
WCNJ-FM (89.3) Hazlet, NJ/Skylark Radio network—Oldies	GE-1, 6	5.80

Sports

Prime Sports Radio—sports talk and information	S3, 24	5.80

Speciality Formats

Aries In Touch Reading Service	C4,10	7.87
California State Legislature audio	S4, 24	6.80
Colorado Talking Book Network	C1,3	5.60
In-Store Networks	S3, 24	5.04, 5.21, 5.40
Ozarkana Satellite Radio network	G4, 6	7.96
SuperAudio—Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
The Weather Channel-USA—part-time program audio	C3, 13	6.80
Voice Print Reading Service	E2, 6	7.44 (N)
Yesterday USA—nostalgia radio	G5, 7	6.80
	G1R, 24	7.38

Talk Programming

American Freedom Radio network	GE-1, 7	5.80
Amerinet Broadcasting	G1R, 17	8.10
Talk America Radio Network #1—talk programs	S3, 9	6.80
Talk America Radio Network #2—talk programs	S3, 9	5.41
Talk Radio Network—talk programs	C1, 5	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network (tech talk) network on when Megabingo is present)	SBS6, 13B (Ku)	6.20 (occasional
World Web News Network	G7, 14	7.70
Worldwide Freedom Radio network	GE-1, 7	7.56
WWTN-FM (99.7) Manchester, TN—news and talk	G5, 18	7.38, 7.56

Variety Programming

CBC Radio (English)	E2, 6	5.40/7.58, 5.58
CBC Radio (occasional audio)	E2, 1	5.78
CBC-FM Atlantic (English)	E2, 6	6.12/6.30 (DS)
CBC-FM Eastern (English)	E2, 6	5.76/5.94 (DS)
CBM-AM (940) Montreal, PQ Canada—variety/fine arts	E2, 1	6.12
CJRT-FM (91.1) Toronto, ON Canada—fine arts/jazz-nights	E2, 26 (Ku-band)	5.76/5.94 (DS)
KBVA-FM (106.5) Bella Vista, AR., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSL-AM (1160) Salt Lake City, UT—news/talk/country-overnight	C1, 6	5.58
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

Satellite Radio Guide/SCPC Services Guide

FM SQUARED (FM²) AUDIO SERVICES

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

Spacenet 3 Transponder 13 (C-band)

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

Spacenet 3 Transponder 17 (C-band)

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

Spacenet 3 Transponder 18 (C-band)

Data Transmissions: 4.800 MHz

Galaxy 4 Transponder 3 (Ku-band)

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

Galaxy 4 Transponder 4 (Ku-band)

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

Anik E1 Transponder 7 (Ku-band)

Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

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

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

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

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

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

Spacenet 3 Transponder-Horizontal 13 (C-band)

1207.90 (52.1) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.20 (52.8) Good News Radio Network—christian radio
1207.00 (53.0) Good News Radio Network—christian radio
1206.70 (53.3) Data Transmission
1204.45 (55.55) KJAV-FM (104.9) Alamo, Tex—spanish language religious *Nuevo Radio Christiana Network*
1204.25 (55.75) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1201.50 (58.5) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1201.30 (58.7) Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious

Galaxy 4 Transponder 1-Horizontal (C-band)

1443.80 (56.2) Voice of Free China (ISWBC) Taipei, Taiwan
1443.60 (56.4) KBLA-AM (1580) Santa Monica, CA—*Radio Korea*
1443.40 (56.6) Voice of Free China (ISWBC) Taipei, Taiwan
1438.30 (61.7) WWRV-AM (1330) New York, NY—Spanish religious programming and music, ID - *Radio Vision Christiana de Internacional*
1436.50 (63.5) West Virginia Metro News
1436.30 (63.7) KGIL-AM (1260) Beverly Hills, CA—All-Beatles Radio

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0) Illinois News Network
1404.80 (55.2) KOA-AM (850)/KTLK-AM (760) Denver, Colo—news and talk/Colorado Rockies MLB radio network
1404.60 (55.4) WGN-AM (720) Chicago, IL—news/talk/Chicago Cubs MLB radio network
1404.40 (55.6) Illinois News Network
1404.20 (55.8) Tribune Radio Networks
1404.00 (56.0) KFRC-AM (610) San Francisco, CA—oldies/Oakland Athletics MLB radio network
1403.00 (57.0) KSJN-FM (99.5) Minneapolis/St. Paul, MN—Minnesota Public Radio classical music service
1402.70 (57.3) WLAC-AM (1510) Nashville, TN—news/talk
1402.10 (57.9) KNOW-FM (95.3) St. Paul, MN—fine arts, Minnesota Public Radio
1401.80 (58.2) Michigan News Network
1401.50 (58.5) Occasional Audio/Agrinet/USA Radio Network
1399.60 (60.4) Talk America Radio Network 1
1399.20 (60.8) Talk America Radio Network 2
1399.00 (61.0) Sports Byline USA/Sports Byline Weekend/*On Computers* radio show
1398.80 (61.2) United Broadcasting radio network—talk

(Continued on Page 42)

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

(Continued from Page 41)

1398.50 (61.5) Occasional audio
1398.30 (61.7) WSB-AM (750) Atlanta, GA—news/talk/Atlanta Braves MLB radio network
1398.00 (62.0) Occasional audio
1397.80 (62.2) Occasional audio
1397.50 (62.5) Minnesota Talking Book network
1397.30 (62.7) Occasional audio
1397.10 (62.9) WTMJ-AM (620) Milwaukee, WI - talk/Milwaukee Brewers MLB radio network/Wisconsin Radio Network
1396.90 (63.1) Chicago White Sox MLB radio network
1396.40 (63.4) Georgia Network News (GNN)
1396.20 (63.8) WCNN-AM (680) Atlanta, GA—all sports talk radio
1396.00 (64.0) WHO-AM (1040) Des Moines, IA—talk/Iowa News Network
1395.80 (64.2) WTMJ-AM (620) Milwaukee, WI - talk/Milwaukee Brewers MLB radio network/Wisconsin Radio Network
1395.60 (64.4) WGST-AM/FM (640/105.7) Atlanta, GA—news/talk
1395.40 (64.6) Michigan News Network
1395.00 (65.0) Occasional audio
1394.70 (65.3) WJR-AM (760) Detroit, MI—news/talk/Detroit Tigers MLB radio network
1394.50 (65.5) XEPRS-AM (1090) Tijuana, Mexico—Spanish language
1394.00 (66.0) KSJN-FM (99.5) Minneapolis/St. Paul, MN—Minnesota Public Radio classical music service
1391.00 (69.0) Occasional audio
1388.90 (71.1) Data transmissions (burst)
1387.80 (72.2) Data transmissions (constant)
1384.40 (75.6) KOA-AM (850)/KTLK-AM (760) Denver, CO—news/talk/Colorado Rockies MLB radio network
1384.20 (75.8) WSB-AM (750) Atlanta, GA—news and talk/Atlanta Braves MLB radio network
1383.70 (76.3) Motor Racing Network (occasional audio)
1383.40 (76.6) United Broadcasting Network—talk
1383.90 (76.9) KIRO-AM (710) Seattle, WA—news/talk/Seattle Mariners MLB radio network
1382.90 (77.1) Michigan News Network
1382.60 (77.4) Soldiers Radio Satellite (SRS) network—U.S. Army information and entertainment
1382.00 (78.0) Tennessee Radio Network
1381.80 (78.2) WHO-AM (1040) Des Moines, IA - news/talk/Iowa News Network
1381.60 (78.4) KEX-AM (1190) Portland, OR—news/talk
1381.40 (78.6) Occasional audio
1381.20 (78.8) KJR-AM (950) Seattle, WA - sports talk
1377.40 (82.6) Data transmission (packet burst/tones)
1377.10 (82.9) In-Touch—reading service for blind
1376.90 (83.1) Data Transmissions
1376.00 (84.0) Kansas Audio Reader Network
1375.40 (84.6) USA Radio Network/Agrinet Ag service

Anik E2 Transponder 1-Horizontal (C-band)

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

Anik E2 Transponder 13-Horizontal (C-band)

1206.00 (54.0) Canadian Broadcasting Corporation (CBC) Radio—southwestern Northwest Territories service
1205.50 (54.5) Canadian Broadcasting Corporation (CBC) Radio—Yukon service

Anik E1 Transponder 17-Horizontal (C-band)

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

Anik E2 Transponder 23-Horizontal (C-band)

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

Anik E1 Transponder 21-Horizontal (C-band)

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

SBS5 Transponder 2-Horizontal (Ku-band)

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

SBS5 Transponder 12-Vertical (Ku-band)

1095.00 (91.0) Russian-American Radio Network

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2) RFD Radio Service
1404.60 (55.4) KGHL-AM (790) Billings, MT—country music
1400.60 (59.4) Learfield Communications
1400.40 (59.6) Learfield Communications/Missouri Net
1400.20 (59.8) Occasional audio/Data transmissions
1400.00 (60.0) Learfield Communications
1396.60 (63.4) Kansas Information Network/Kansas Agnet
1396.40 (63.6) Nebraska Agriculture Network/University of Nebraska sports
1396.20 (63.8) Missouri Network/St. Louis Cardinals
1396.00 (64.0) MLB radio network
1396.00 (64.0) Occasional audio
1395.90 (64.1) KGHL-AM (790) Billings, MT—country music
1395.70 (64.3) Missouri Net/WIBW-AM (580) Topeka, KS—news and talk/Kansas City Royals MLB radio network
1386.40 (73.6) Learfield Communications
1386.20 (73.8) Radio Iowa
1386.00 (74.0) United broadcasting Network—talk
1384.60 (75.4) Capitol Radio Network
1384.00 (76.0) Occasional audio/ABC Direction Network
1383.80 (76.2) Occasional audio
1383.40 (76.6) Capitol Radio Network
1382.90 (77.1) Missourinet
1382.30 (77.7) Virginia News Network
1382.10 (77.9) Learfield Communications/Missourinet
1378.10 (81.9) Occasional audio

RCA C5 Transponder 21-Vertical (C-band)

1045.00 (55.0) Occasional audio
1043.60 (56.4) Unistar Music Radio—*Today's Hits, Yesterday's Favorites*
1043.40 (56.6) CNN Radio Network
1043.20 (56.8) Unistar Music Radio—*Today's Hits, Yesterday's Favorites*
1042.80 (57.2) Unistar Music Radio—*Greatest Music of All Time*
1042.60 (57.4) Unistar Music Radio—*Greatest Music of All Time*
1042.40 (57.6) Unistar Music Radio—*Good Times and Great Oldies*
1042.20 (57.8) Data transmissions
1042.00 (58.0) Unistar Music Radio—*Good Times and Great Oldies*
1041.80 (58.2) CNN Radio Network
1034.40 (65.6) Unistar Music Radio—*Hits from 60s, 70s, 80s, and Today*
1034.20 (65.8) Data transmissions
1034.00 (66.0) Unistar Music Radio—*Hits from 60s, 70s, 80s, and Today*
1033.20 (66.8) Unistar Music Radio—*Country and Western*
1032.80 (67.2) Data transmissions
1032.40 (67.6) Unistar Music Radio—*Country and Western*

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

Alphastar (United States/Canada)

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

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

Alpha Star U.S. Programming: A&E Network, ABC (WJLA Washington DC), Alpha Preview Channel, Asian Television Network, C-Span 1 (US House), C-Span 2 (US Senate), Cartoon Network, CBS (WRAL Raleigh, NC), Cinemax, Cinemax 2, Cinemax West, Classic Sports Network, CNBC, CNN, CNN International/CNN fn, Comedy Central, Country Music Television, Court TV, Discovery Channel, Disney Channel (E), Disney Channel (W), E! Entertainment Television, Egyptian Satellite Channel, Encore, Encore Plus, ESPN, ESPN2, Family Channel, FOX Network (Foxnet), Fox Sports Southwest, Fox Sports Northwest, Fox Sports Rocky Mountain, Fox Sports Midwest, Fox Sports West, Fox Sports Pittsburgh, Fox Sports Americas, Galavision, GEMS TV, Golf Channel, HBO, HBO 2, HBO 2 West, HBO 3, HBO West, Headline News, History Channel, International Channel, Learning Channel, Lifetime, Madison Square Garden, MSNBC, MTV, Nashville Network, NBC (WNBC New York), Nickelodeon / Nick at Nite, Nike Drama, Nile TV, PBS Network (National), Playboy TV, 10 PPV Channels, RE/MAX Satellite network-private business channel, Sci-Fi Channel, Showtime, Showtime 2, Showtime West, Starz!, Sundance Film Channel, Sunshine Network, TBS Atlanta, The Movie Channel, The Movie Channel West, Turner Classic Movies, Turner Network Television (TNT), TV Land, USA Network, Venus (adult), VH-1, Weather Channel, WGN-Chicago, 30 DMX Audio Channels

AlphaStar Canada Programming: A&E, ABC network affiliate, CBC, CBC Newsworld, CBS network affiliate, CNBC, CNN, CNN Headline News, CPAC, CTV, Canal D, Canal Famille, Digital Music Services, Discovery Channel, FOX network affiliate, Family Channel, MuchMusic Canada, MusiquePlus, NBC network affiliate, PBS network affiliate, Pay-Per-View, RDI, RDS, SRC, Showcase, South Asian Television Network, Super Ecran, Superstation TBS, TNN, TSN, TV5, TVA, The Learning Channel, The Movie Network, WGN, YTV

DirecTV and USSB (United States)

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

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

100	Direct Ticket Previews
101-199	Direct Ticket Pay Per View
120/121	Letterbox
140-142	Unknown service (LC)
200	Direct Ticket Previews
201	DirecTV Information Updates
202	Cable Network News
203	Court TV
204	CNN Headline News
205	DirecTV Special Events Calendar
206	ESPN 1
207	ESPN Alternate
208	ESPN 2
209	ESPN 2 Alternate
210	DirecTV Sports Schedule
212	Turner Network Television
213	Home Shopping Network
214	Home and Garden TV
215	TV Food Network
216	MuchMusic
217	E! Entertainment TV
218	DirecTV Access Card Information
220	American Movie Classics
221	Turner Classic Movies
222	Romance Classics
224	Direct Ticket Previews
225	STARZ! (East)
226	STARZ! (West)
227	STARZ! 2 (East)
229	STARZ! 2 (West)
230	Encore (East)
231	Encore (West)
232	Encore 2—Love Stories
233	Encore 3—Westerns
234	Encore 4—Mysteries
235	Encore 5—Action
236	Encore 6—True Stories!
237	Encore 7—WAM!
238	Bravo
239	Independent Film Channel
240	Arts and Entertainment
241	The History Channel
242	Disney Channel (East)
243	Disney Channel (West)
245	Discovery Channel
246	The Learning Channel
247	Cartoon Channel
248	Animal Planet
253	USA Network
254	The Sci-Fi Channel
256	WGN Chicago
258	The Family Channel
259	WTBS Atlanta, GA
260	Trio
261	QVC
262	The Nashville Network
263	Country Music TV
265	Access Television
267	Platinum Presents Channel
268	Black Entertainment TV
271	C-SPAN 1
272	C-SPAN 2
274	Bloomberg Information Television
275	CNBC
276	MSNBC
277	The Weather Channel
278	FOX News Channel
279	CBC Newsworld International
281	CNN International/CNN fN
283	Channel Earth
286	Trinity Broadcasting
289	America's Health Network
290	WRAL-CBS Raleigh, NC
291	KPIX-CBS San Francisco, CA
292	WNBC-NBC New York, NY
293	KNBC-NBC Los Angeles, CA
294	PBS National Feed
295	WJLA-ABC Washington, DC
296	KOMO-ABC Seattle, WA
297	FOXNet
299	Guthy-Renker TV
300	DirecTV Sports Offers
301	Sports Special Events Calendar
302	Special Events Calendar
303	Newsport
304	The Golf Channel
305	Classic Sports Network
306	Speedvision
307	Outdoor Life Channel
308	Platinum Presents Channel
309	SportsChannel New England
310	Madison Square Garden
311	New England Sports Network
312	SportsChannel New York
313	Empire Network
314	SportsChannel Philadelphia
315	Fox Sports Pittsburgh
316	Home Team Sports
317	Fox Sports South
318	Sunshine
319	SportsChannel Florida Sports
320	Pro AM Sports
321	SportsChannel Ohio
322	SportsChannel Cincinnati
323	SportsChannel Chicago
324	Midwest SportsChannel
325	Fox Sports Southwest
326	Fox Sports Rocky Mountain
327	Fox Sports Midwest
329	Fox Sports Arizona
330	Fox Sports Northwest
331	Fox Sports West
332	Fox Sports West 2
333	SportsChannel Pacific
334-399	Direct Ticket PPV
400	Adult Television
401	Spice
402	Playboy
501	Music Choice—Hit List
502	Music Choice—Dance
503	Music Choice—Rap
504	Music Choice—R&B Hits
505	Music Choice—Reggae
506	Music Choice—Blues
507	Music Choice—Jazz
508	Music Choice—Lite Jazz
509	Music Choice—New Age
510	Music Choice—Eclectic Mix
511	Music Choice—Alternative Rock
512	Music Choice—Metal
513	Music Choice—Classic Rock

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

514 Music Choice—The 80s
515 Music Choice—The 70s Super Hits
516 Music Choice—Solid Gold Oldies
517 Music Choice—Soft Rock
518 Music Choice—Today's Country
519 Music Choice—Country Horizons
520 Music Choice—Classic Country
521 Music Choice—Easy Listening
522 Music Choice—Big Bands
523 Music Choice—Singers and Standards
524 Music Choice—Show Tunes
525 Music Choice—Classics Favorites
526 Music Choice—Classical Masterpieces
527 Music Choice—Contemporary Christian
528 Music Choice—For Kids Only
529 Music Choice—Sounds of the Seasons
530 Music Choice—Spectrum I
531 Music Choice—Spectrum II
550 Music Choice—Lite Classical
551 Music Choice—EE-Vocals
552 Music Choice—Soft Album Mix
553 Music Choice—The Trend
554 Music Choice—Tropical
555 Music Choice—Mexicana
599 NRTC Radio Service
757 Microsoft TV
790 RealNet — Real Estate Channel

USSB (United States)

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

899 USSB Programming Higlights
900 Special Event programming
910 Special Event Programming
960 TVLand
963 All New Channel
965 Video Hits One
967 Lifetime
968 Nickelodeon
970 Flix
973 Cinemax East
974 Cinemax 2
975 Cinemax West
977 The Movie Channel East
978 The Movie Channel Wes
980 HBO East
981 HBO 2 East
982 HBO 3
983 HBO West
984 HBO 2 West
985 Showtime East
986 Showtime 2
987 Showtime West
989 MusicTV
990 Comedy Central
995 Sundance Channel
999 USSB Programming Highlights
TBA M2: Music Television
TBA HBO Family
TBA Showtime 3

EchoStar (United States)

The new Echostar 1/2 high power DBS (Ku-band 12.2-12.7 GHz) satellites are now operational at 119° West. Echostar's service is called "TheDISH (Digital Satellite Network) Television Network.

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

100 DISH on Demand Previews
102 USA Network
104 Comedy Central
106 TVLand
108 Lifetime
110 TV Food Network
112 Home and Garden Network
114 E! Entertainment TV
116 Game Show Network
118 Arts and Entertainment
120 History Channel
122 Sci-Fi Channel
124 Black Entertainment TV
132 Turner Classic Movies
138 Turner Network Television
140 ESPN
141 ESPN Alternate
142 ESPN2
143 ESPN2 Alternate
144 ESPNews
160 MTV
161 M2: Music Television
162 VH-1
166 Country Music Television
168 The Nashville Network
170 Nickelodeon (East)
171 Nickelodeon (West)
172 The Disney Channel (East)
173 The Disney Channel (West)
176 The Cartoon Network
178 The Learning Channel
180 The Family Channel
182 The Discovery Channel
184 Animal Planet
200 Cable News Network
202 CNN Headline News
204 Court TV
206 CNN International/CNN fN
208 CNBC
210 C-SPAN
212 C-SPAN 2
214 The Weather Channel
216 National Empowerment TV
220 The Travel Channel
222 Home Shopping Network
230 WTBS Atlanta, GA
232 KTLA Los Angeles, CA
234 WPIX New York, NY
236 WSBK Boston, MA
240 WGN Chicago, IL.
241 WNBC-NBC New York, NY
242 KNBC-NBC Los Angeles, CA
243 WRAL-CBS Raleigh, NC
244 KPIX-CBS San Francisco, CA
245 WJAL-ABC Washington, DC
246 KOMO-ABC Seattle, WA
247 FOXNet
249 PBS
260 Trinity Broadcasting Network
261 Eternal Word TV Network
267 American Family Radio
268 Calvary Chapel Radio
269 Bob Jones University Radio
270 The Worship Channel
271 Praise TV
272 FamilyNet
273 Cornerstone TV
274 100 Plus Ministries
275 Dominion Variety and International Home School Channel
300 HBO East
301 HBO2 East
302 HBO3 East
303 HBO West
304 HBO2 West
310 Showtime East
311 Showtime West
312 Showtime East 2
318 Sundance
319 FLIX
320 Cinemax East
321 Cinemax East 2
322 Cinemax West
330 The Movie Channel East
331 The Movie Channel West
401 The Golf Channel
412 Madison Square Garden
414 Fox Sports Rocky Mountain
416 Fox Sports Southwest
417 Fox Sports West
418 Fox Sports Midwest
420 Fox Sports South
422 Sunshine Network
424 Home Team Sports
426 Fox Sports Northwest
428 Fox Sports Pittsburgh
430 Pro-Am Sports
432 Empire Sports Network
434 New England Sports Network
436 Midwest Sports Channel
500 PPV 1 DISH-on-Demand (events)
501 PPV 2 DISH-on-Demand
502 PPV 3 DISH-on-Demand
503 PPV 4 DISH-on-Demand
504 PPV 5 DISH-on-Demand
505 PPV 6 DISH-on-Demand
506 PPV 7 DISH-on-Demand
507 PPV 8 DISH-on-Demand
508 PPV 9 DISH-on-Demand
509 PPV 10 DISH-on-Demand
600 RAI (Italy)
602 ART (Arab Radio and Television)
604 Antenna TV Greece
620 MTV Latino
626 Fox Sports Americas
628 Telemundo
700 DISH 2 (Showroom Promo)
900 Business TV 1
901 Business TV 2
TBA Lawyers Communications Network

Direct Broadcast Satellite (DBS) Systems

DISH CD ‡

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

ExpressVu (Canada)

Canadian digital medium power direct-to-home satellite TV service. The service will provide Canadian, American, and international video and audio programs. The service will be offered using Canada's Anik E2 (Ku-band 11-.7-12.2 GHz) satellite at 107.3° West. Channel assignments were not available at presstime.

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

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

Allego audio channels: Just For Kidz, Divertimento, Nos Souvenirs en Musique, Blues Deluxe, Country Coast-to-Coast, Jazz-Plus, Love Songs, The Beat, Classic Rock, Hot Hits, The Edge, 70s-90s Superstars, 50s-60s Soundtrack From Your Life, Today's Country, 30s-50s Silver Memories, Rock Leger

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

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

Galaxy Latin America (Mexico, Central and South America)

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

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

Primestar (United States)

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

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

1-22	**News and Info Channels**
1	PrimeView One (Information/Preview Channel)
2	Prevue Guide
3	CNN Headline News
4	CNN
5	CNNSI
6	CNBC
7	CNNfn/CNNI
8	MSNBC
9	MSNBC Weather by Intellicast: Northeast
10	MSNBC Weather by Intellicast: Mid Atlantic
11	MSNBC Weather by Intellicast: Southeast
12	MSNBC Weather by Intellicast: Midwest
13	MSNBC Weather by Intellicast: South Central
14	MSNBC Weather by Intellicast: Central Plains
15	MSNBC Weather by Intellicast: Northern Plains
16	MSNBC Weather by Intellicast: Four Corners
17	MSNBC Weather by Intellicast: Southwest (Pacific)
18	MSNBC Weather by Intellicast: Northwest
19	C-SPAN
20	C-SPAN2
21	The Weather Channel
22	CourtTV
33-43	**Broadcast Channels**
33	WSB-ABC Atlanta, GA
34	KABC-ABC Los Angeles, CA
35	WUSA-CBS Washington, DC
36	KOIN-CBS Portland, OR
37	WHDH-NBC Boston, MA
38	KCRA-NBC Sacramento, CA
39	WTXF-FOX Philadelphia, PA
40	KTVU-FOX San Francisco, CA
41	PBS National Service
42	WGN Chicago, IL
43	WTBS Atlanta, GA
44-53	**Variety Channels**
44	A&E
45	USA Network
46	Turner Network Television (TNT)
47	Nick at Nite's TV Land

Direct Broadcast Satellite (DBS) Systems

By Larry Van Horn

48	Comedy Central
49	The Nashville Network (TNN)
50	BET
51	QVC
52	E! Entertainment TV
53	Game Show Network
66-69	**Music Channels**
66	VH1
67	MTV
68	Country Music TV
69	MuchMusic (U.S.)
77-85	**Family Channels**
77	Nickelodeon/Nick At Nite
78	Cartoon Network
79	Disney Channel (East)
80	Disney Channel (West)
81	Lifetime
82	Family Channel
83	Sci-Fi Channel
84	Odyssey
85	Trinity Broadcasting Network
88-93	**Living and Learning Channels**
88	Discovery Channel
89	The Learning Channel
91	History Channel
92	TV Food Network
93	Home and Garden TV Net
99-115	**Movie Channels**
100	HBO
101	HBO2
102	HBO3
103	Showtime (East)
104	Showtime 2 (West)
105	STARZ!
106	Encore
107	Westerns
108	Mystery
109	Cinemax
110	Cinemax 2
111	Sundance Channel
112	Independent Film Channel
113	Turner Classic Movies
114	American Movie Classics
115	Romance Classics
122-143	**PrimeCinema Channels**
123	PrimeCinema Today (Promo for PPV)
124	PrimeCinema 1
125	PrimeCinema 2
126	PrimeCinema 3
127	PrimeCinema 4
128	PrimeCinema 5
129	PrimeCinema 6
130	PrimeCinema 7
131	PrimeCinema 8
132	PrimeCinema 9
133	PrimeCinema 10
143	Playboy TV
166-215	**Sports Channels**
166	Prevue Guide
167	ESPN
168	ESPN2
170	ESPN Alternate
171	ESPN2 Alternate
172	CNNSI
173	Classic Sports Network
174	Outdoor Life Network
175	Speedvision
176	The Golf Channel
177	NESN
178	SportsChannel New England
179	MSG
180	SportsChannel New York
181	Empire Sports Network
182	SportsChannel Philadelphia
183	HTS
184	Fox Sports South
185	Sunshine Network
186	SportsChannel Florida
187	Fox Sports Pittsburgh
188	PASS
189	Fox Sports Midwest
190	SportsChannel Ohio
191	SportsChannel Cincinnati
192	SportsChannel Chicago
193	MSC
194	Fox Sports Rocky Mountain
195	Fox Sports Southwest
196	Fox Sports Arizona
197	Fox Sports Northwest
198	Fox Sports West
199	SportsChannel Pacific
211	Sports Plus 1
212	Sports Plus 2
213	Sports Plus 3
214	Sports Plus 4
215	Sports Plus 5
288-299	**Spanish Channels**
288	Prevue Guide
289	Univision
290	Cartoon Network (Spanish)
291	Family Channel (Spanish)
292	HBO en Espanol
293	HBO2 en Espanol
294	HBO3 en Espanol
295	Showtime En Espanol
298	Cinemax Selecciones
299	Cimemax 2 Selecciones
299	STARZ! (Spanish)
311-340	**PrimeAudio by DMX**
311	Symphonic
312	Bluegrass
313	Children's
314	Christian Inspirational
315	Gospel
316	Contemporary Christian
317	Hottest Hits
318	Alternative Rock
319	80's Music
320	Album Rock
321	Adult Contemporary
322	Contemporary Instrumentals
323	Soft Hits
324	Traditional Blues
325	Traditional Country
326	Classic Jazz
327	Modern Country
328	Lite Classical
329	Lite Jazz
330	Folk Music
331	70's Oldies
332	Classic Rock
333	60's Oldies
334	Big Band/Swing
335	50's Oldies
336	Motor City Sound
337	Urban Adult Contemporary
338	R&B/Rap Hits
339	Latin Contemporary
340	Salsa
401-402	**Other Channels**
401	TV Japan (English)
402	TV Japan (Spanish)
500-699	**Sports Channels**
501-554	NBA League Pass Package
556-599	NHL Center Ice package
656-699	MLB Extra Innings package
TBA	The People's Network Private Television Network

StarChoice (Canada)

STARCHOICE MARKETING INC.

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

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

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

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

Ku-band Satellite Transponder Services Guide

By Robert Smathers

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

Spacenet 2 (S2) 69° West

21	11900-H	Occ video
22	11980-H	Occ video
23	12060-H	Occ video
24	12140-H	Occ video

SBS 6 (SBS6) 74° West

1	11717-H	Data transmissions/FamilyNet [digicipher]
2	11749.5-V	FOX SNG feeds
3	11774-H	MSNBC feeds
4	11798.5-V	Occ video
5	11823-H	Occ video
6	11847.5-V	Occ video
7	11872-H	Occ video
8	11896.5-V	Occ video/digital video (occ)
9	11921-H	Occ video
10	11945.5-V	Occ video/CONUS Communications (occ)/ CONUS digital video (upper half)
11	11963-H	CONUS Communications (half transponders)
12	11994.5-V	CONUS Communications (half-transponders)
13	12019-H	CONUS Communications (half transponders)
14	12043.5-V	Occ video
15	12075-H	Occ video
16	12092.5-V	Occ video
17	12110-H	Digital video (user unknown)
18	12141.5-V	Occ video
19	12174-H	CNN Newsbeam (occ)

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

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

GE-2 (GE2) 85° West

7	11840-V	TV Asahi feeds [LEITCH]

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

Spacenet 3R (S3) 87° West

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

Telstar 402R (T402) 89°West

Alphastar DBS uses T402 Ku-band transponders 6, 9-14, and 16

1	11730-V	AT&T Tridom [digital]
2	11743-H	AT&T Tridom [digital]
3	11790-V	AT&T Tridom [digital]
4	11803-H	AT&T Tridom [digital]
5	11850-V	Data transmissions
7	11910-V	PBS Adult Learning Service (analog lower half)
7	11910-V	PBS Schedules 5A0, 5A5, 5B5, 5B6, X (digicipher upper half)
8	11923-H	Data transmissions
15	12157-V	DMX for Business [digital data]

Galaxy 7 (K7) 91° West

TCI Headend in the Sky [digicipher] uses transponders 1, 4, 6-7, 9-10, 12-13, 15, 19, and 21-22

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

Galaxy 3R (G3R) 95° West

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

Telstar 5 (T5) 97° West

Satellite in testing, loading to be announced

Galaxy 4 (K4) 99° West

1	11720-H	FM² services/Data transmissions
2	11750-V	Data transmissions
3	11750-H	FM² services/Muzak/Data transmissions
4	11780-H	FM² services/Planet Connect computer service (19.2 kbps)/ Other data transmissions
5	11810-V	Data transmissions
6	11810-H	Video Plus Contract Channel (occ video)
7	11840-H	Chinese Television Network *Chung Ten* - Chinese/Taiwan all-news service
8	11870-V	Data transmissions
9	11870-H	Data transmissions
10	11900-H	CNN Airport Network [Powervu]/Data transmissions
11	11930-V	Dcc video (half-transponders common)/The Asian Network (TAN)
12	11930-H	Occ video
13	11960-H	Digital video (user unknown)
14	11990-V	Data transmissions
15	11990-H	Digital video (user unknown)
16	12020-H	FM² services/Data transmissions
17	12050-V	CBS Newsnet and affiliate feeds (half-transponders)
18	12050-H	Honk Kong TVB Jade Channel (Chinese) [videocrypt]
19	12080-H	Data transmissions
20	12110-V	Data transmissions
21	12110-H	Asian-American TV Network (occ)/Occ video
22	12140-H	Data transmissions
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders-lower half usually in CBS Newsnet digital video transmissions)
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

19	11740-H	Failed transponder
20	11820-H	Data transmissions
21	11900-H	Failed transponder
22	11980-H	Data transmissions
24	12140-H	Georgia Public TV [digicipher] (lower half)
24	12140-H	E.M.G. courses [digicipher] (upper half)

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

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

GE-1 (GE1) 103° West

1	11720-H	Qualcomm data [digital]
2	11740-V	Data transmissions
3	11760-H	NBC Eastern Time Zone programming
4	11780-V	Data transmissions
5	11800-H	Qualcomm data [digital]
6	11820-V	Empire Sports [Wegener digital]/Kentucky Educational TV (KET) [digicipher]
7	11840-H	NBC Pacific Time Zone programming
8	11860-V	Qualcomm data [digital]
9	11880-H	NBC Mountain Time Zone programming
10	11900-V	Qualcomm data [digital]
11	11920-H	NBC feeds [digital]/Data transmissions
12	11940-V	Microspace Velocity [digital]
13	11960-H	NSN data transmissions [digital]
14	11980-V	Qualcomm data [digital]
15	12000-H	NBC Contract Channel
16	12020-V	Spectravision? [Spectrumsaver]
17	12040-H	NBC Contract Channel
18	12060-V	Starnet [digital video]
19	12080-H	NBC News Channel
20	12100-V	Cyclesat [analog/digital]/Occ video
21	12120-H	NBC/MSNBC/CNBC/NBC NewsChannel SNG feeds [Wegner digital]
22	12140-V	Chinese Communications Channel (CCC) [Oak]
23	12160-H	NBC Newschannel SNG/NBC Contract Channel
24	12180-H	Fed Ex TV [BMAC]/Occ video

GSTAR-4 (GST4) 105° West

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

Anik E2 (A1) 107.3° West

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

1	11717-V	Telesat Canada DVC: MovieMax!, Family Channel E&W, SuperChannel [digital video compression]
3	11778-V	CanCom [digital video compression]
4	11804-V	Shaw [digital video compression]
5	11839-V	Canadian Parliamentary Access Channel, Youth TV E&W, Vision TV, CHSC Shopping [digital video compression]
6	11865-V	Moviepix!; The Movie Network [digital video compression]
7	11900-V	Rogers Network [digital video compression]
8	11926-V	Rogers Network [digital video compression]
12	12048-V	Saskarchewan CommunicaNetwork [digital]
15	12144-V	Telesat Canada stationkeeping (GLACS)
16	12170-V	Knowledge Network
17	11730-H	Bravo Canada, MuchMusic [digital video compression]
18	11756-H	Showcase E&W/Discovery Channel Canada/Life Network/ The Sports Network [digital]
19	11791-H	Telesat [digital video compression]
20	11817-H	CBC feeds
24	11939-H	Ontario Legislature
25	11974-H	La Chaine (TV Ontario's French lanaguage service)
26	12000-H	TV Dntario (English)
29	12096-H	Atlantic Satellite Network (ASN)
30	12122-H	Telesat Canada stationkeeping (GLACS)
31	12157-H	CBC feeds

Solidaridad 1 SD1 109.2° West

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

Anik E1 (A2) 111° West

Note: Due to loss of power from the satellite south solar panel on March 26, 1996, Anik E1 Ku-band transponders 7-8, 11-16, 21-28, and 31-32 are off indefinitely according to Telesat officials.

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Data transmissions
5	11839-V	DirectPC [digital]
6	11865-V	NovaNet FM² Services
9	11961-V	Occ video
10	11987-V	Occ video
17	11730-H	Woman's Television Network E&W [digital video compression]
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	SCPC/Data transmissions/ Shaw:New Country Network, Access Network of Alberta [digital video compression]
29	12096-H	Expressvu DBS (summer 1997)
30	12122-H	RDI feeds

Solidaridad 2 (SD2) 112.9° West

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

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

(This satellite rarely has video transmissions)

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

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

Anik C1 (C1) 118.6° West

32	12183-H	Occ video

EchoStar 1/2 & Tempo 1 119°West

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

SBS 5 (SBS5) 123° West

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

GSTAR-2 (GST2) 125° West

6	12035-H	Occ video
9	11744-V	Data transmissions
11	11866-V	GSTAR-2 ID slate
13	11988-V	Occ video
14	12049-V	Dcc video
15	12110-V	Occ video
16	12171-V	Occ video

Satellite Transponder Guide

By Robert Smathers

	Galaxy 6 (G6) 74°	GE-2 (GE2) 85°	Spacenet 3 (S3) 87°	Telstar 402R (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	GE-1 (GE1) 103°	Anik E2 (A1) 107.3°	Solidaridad 1 (SO1) 109.2°
1	Tokyo BS New York feeds	La Cadena de Milagro	Data Transmissions	FDX feeds	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	SCPC services	Data Transmissions	MLB International/o/v	CBC-H English Eastern	Data Transmissions
2	o/v	ABC feeds (o/v)	American Independent Network (AIN) [Spectrumsaver]	Data Transmissions	CBS West [occ VC1]	TVN Theatre 2 [V2+]	Buena Vista TV distribution	STARZ! 2 [V2+]	Data Transmissions	o/v	Data Transmission
3	o/v	o/v	WSBK-UPN Boston [V2+]	XXXplore TV (adult) [V2+]	Action PPV [V2+]	TVN Theatre 3 [V2+]	SCPC services	Data Transmissions	(none)	CBC [digital]	SCPC services
4	o/v	o/v	Nebraska Educational TV (NETV) [Digicipher]	Shop at Home	fX East [V2+]	TVN Theatre 4 [V2+]	Data Transmissions	Encore-Westerns [V2+]	SC Ohio/Cincinnati [V2+]	Cancom [PowerVu]	Data Transmissions
5	CNN feeds/o/v	NASA Contract Channel	Univision [V2+]	FDX feeds	fX West [V2+]	TVN Theatre 5 [V2+]	4 Media Company feeds	Data Transmissions	Hero Teleport [digital]	True Blue (adult) [V2+]	[redacted]
6	NHK (TV Japan) feeds	o/v	(none)	The X! Channel (adult) [V2+]	Game Show Network [V2+]	TVN Theatre 6 [V2+]	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	WNBC-NBC New York (PT24E) [V2+]	CBC Newsworld	Data Transmissions
7	Video Catalog Channel (VCC)	o/v	Data Transmissions	Adam and Eve/Spice (adult)/Williams Infomerical [Digicipher]	The Golf Channel [V2+]	Guthy-Renker TV (infomercials)	Warner Brothers Dom TV/WB Network	Basil Bassett Bingo (3BTV)	Cornerstone TV (Rel)	CBC-M English	XEO-TV canal 9
8	[redacted]	Data Transmissions	Data Transmissions	ABC feeds East [LEITCH]	o/v	Pandamerica Home Shopping	[redacted]	KOMO-ABC Seattle (PT24W) [V2+]	SC Chicago [V2+]	Global TV [Leitch]/Global feeds	Data Transmissions
9	MuchMusic U.S. [V2+]	NASA TV	WPIX-Ind New York [V2+]	Horse Racing [digital]/Fashion Network TV/o/v	Eye on People/WI Sports Networks [PowerVu]	TVN Theatre 9 [V2+]	o/v	Data Transmissions	Fox Sports South [V2+]	CBC-B English Atlantic	o/v
10	o/v	Data Transmissions	Data Transmissions	FDX News Edge	United Arab Emirates TV Dubai	TVN Theatre 10 - adultTVision (adult) [V2+]	Paramount TV Distribution/UPN network feeds	FOXNet (PT24E/W) [V2+]	WJLA-ABC Washington (PT24E) [V2+]	[redacted]	Mexican Government Channel
11	o/v	(none)	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	Gem Shopping Network/o/v	o/v	STARZ! East [V2+]	Univision [digital]	CBC-A French	Multivision DBS [Digicipher]
12	[redacted]	Data Transmissions	Data Transmissions	Horse Racing [digital]/AIN (occ)	Romance Classics [V2+]	MCI Andover o/v/RAI TV	o/v	o/v	TurnerVision Promo Channel (occ)/o/v	Cancom [PowerVu]	(none)
13	RTPi	Data Transmissions	SCPC/FM2 services	FDX feeds West	Ovation/CSN/Kaleidoscope/Bloomberg/-Box [Digicipher]	Horse Racing [digital]/o/v	B Movie Channel/o/v	Data Transmissions	Fox Sports/SC Alternate (occ)/o/v	CBC-C English Pacific	[redacted]
14	Gospel Music TV	USIA Worldnet TV/VOA radio [PowerVu]	(none)	ABC NewsOne Channel	Independent Film Channel [V2+]	o/v	o/v	WWOR-UPN New York [V2+]	SC New England [V2+]	Cancom [PowerVu]	Data Transmissions
15	Midwest Sports Channel [V2+]	Data Transmissions	KTLA-Ind Los Angeles [V2+]	o/v [digital]/o/v	Your Choice TV [Digicipher]	o/v	World Harvest TV (Rel)	Data Transmissions	ABC East hot backup [LEITCH]	o/v	[redacted]
16	Horse Racing [digital]	Data Transmissions	CNN International/CNN fN [V2+]	Eurotica (adult) [V2+]	Access Television [Digicipher]	HBO 2 East [V2+]	CBS West [occ VC1]	NPS Promo Channel	SC Pacific [V2+]	Cancom [PowerVu]	Data Transmission
17	o/v	Data Transmissions	FM2 services	FDX feeds	ESPN Intl Pacific Rim [B-MAC]	Cinemax 2 East [V2+]	CBS East [occ VC1]	(none)	SC Philly/NY Plus/Alternates (occ)/o/v	CBC-D feeds	o/v
18	Caribbean Video Network	o/v	(none)	PBS Schedule X	Teleport Minnesota/CBS Backhaul feeds/o/v	Inforamerica TV (Informercials)	CBS Backhaul feeds/Eyemark Syndicated feeds	STARZ! West [V2+]	SC New York [V2+]	Telesat [digital]	o/v
19	University Network-Dr. Gene Scott (Rel)	Data Transmissions	SSN Extra [V2+]	Venus (adult) [V2+]	CBS East [occ VC1]	HBO 3 [V2+]	CBS East [occ VC1]	Data Transmissions	National Empowerment TV (Net)	Telesat [digital]	Data Transmissions
20	CNN Feeds (o/v)	Digital Video (user unknown)	La Cadena de Milagro	FDX feeds	FOX News Channel	HBO 2 West [V2+]	CBS East [occ VC1]	(none)	[redacted]	o/v	(none)
21	o/v	o/v	SSN Pro Am Sports (Pass) [V2+]	ABC feeds West [LEITCH]	BET on Jazz	Infoamerica TV/o/v	CBS feeds/o/v	Data Transmissions	Univision feeds (occ)	Telesat [digital]	(none)
22	Horse Racing [digital]	Arab Network of America (ANA)	American Collectibles Network (ACN)	ABC feeds East [LEITCH]	o/v	Horse Racing [digital]	Paramount feeds/o/v	(none)	o/v	Exxxtasy (adult) [V2+]	(none)
23	Worship TV/Praise TV (Rel) [Nokia]	NHK Secondary Feeds	SSN Home Teams Sports (HTS) [V2+]	FDX feeds East	fX Movies [V2+]	3 Angels Broadcasting	SCOLA [Wegener]/LDS TV (occ)	Data Transmissions	ABC West hot backup [LEITCH]	CBC-E English	Data Transmissions
24	Horse Racing [digital]/o/v	o/v	America One	ABC feeds	Intl Channel/Encore Themed Channels [Digicipher]	Horse Racing [o/v digital]/ACN o/v	CBS Newspath	KPIX-CBS San Francisco (PT24W) [V2+]	WRAL-CBS Raleigh (PT24E) [V2+]	(Inactive)	(none)

Satellite Transponder Guide

By Robert Smathers

Telesat E1 (A2) 111°	Solidaridad 2 (SD2) 112.9°	Morelos 2 (M2) 116.8°	Galaxy 9 (G9) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133°	Satcom C4 (F4) 135°	Satcom C1 (F1) 137°	
Data Transmissions	Data Transmissions	Data Transmissions	BBC Breakfast News/Reuters Newsfeeds/o/v	Disney East [V2+]	Family Channel West [PowerVu]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Prime Network [V2+]	1
(Inactive)	Data Transmissions	(none)	Reuters Newsfeeds/o/v	Playboy (adult) [V2+]	The Learning Channel [V2+]	Univision/Galavision [PowerVu]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
Data Transmissions	Data Transmissions	Data Transmissions	NHK TV	Trinity Broadcasting (Rel)	Viewer's Choice PPV [digital]	Encore Themed Services [Digicipher]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
Data Transmissions	Data Transmissions	Data Transmissions	General Communication [digital]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food/Outdoor Life Networks [Digicipher]	Lifetime East [V2+]	o/v	4
Data Transmissions	o/v	Data Transmissions	Showtime/MTV (West) [Digicipher]	CNN [V2+]	Odyssey (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	5
(Inactive)	Data Transmissions	Data Transmissions	o/v	WTBS-Ind Atlanta [V2+]	Court TV/NW Cable News [Digicipher]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
Data Transmissions	o/v	Data Transmissions	TVN Video [digital]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	FOX Sports West [V2+]	7
(Inactive)	Data Transmissions	XHGC canal 5	General Communication [digital]	HBO West [V2+]	Q2 QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
(Inactive)	(none)	Data Transmissions	TVN Video [digital]	ESPN [V2+]	Music Choice [digital]	ESPN2 Blackout [V2+]	QVC Network	FOX Sports Net Base	9
(Inactive)	(none)	XEIPN canal 11	TVN Video [digital]	MDR Music	Home Shopping Club Spree	MSNBC [V2+]	Home Shopping Network (HSN)	FOX Sports SW [V2+]	10
(Inactive)	Data Transmissions	Data Transmissions	TVN Video [digital]	Family Channel East [V2+]	American Sports Classics [V2+]	Eternal Word TV Network (Rel)	SpeedVision	Network One N1	11
o/v	(none)	Data Transmissions	General Communication [digital]	Discovery West [V2+]	History Channel [V2+]	Valuevision	Global Shopping Network	Data Transmissions	12
(Inactive)	(none)	Data Transmissions	TVN Video [digital]	CNBC [V2+]	The Weather Channel [V2+]	Encore Themed Service [Digicipher]	Travel Channel [V2+]	Fox Sports Midwest [V2+]	13
o/v	(none)	XEW canal 2	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Alternate [V2+]	Fit TV	KUSA-NBC Denver [V2+]	14
(Inactive)	(none)	Digital Video	Showtime West [V2+]	HBO East [V2+]	Showtime East [V2+]	CNNSI/CNN fn/CNN Intl [digital]	Animal Planet [V2+]	SC Florida [V2+]	15
CTV Network [PowerVu]	(none)	XEIMT Canal 22	General Communication [digital]	Cinemax West [V2+]	M2 Music Television	Turner Classic Movies [V2+]	Request TV 1 [V2+]	FOX Sports Arizona/Americas [Digicipher]	16
(Inactive)	(none)	Digital Video	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	FOX Sports (alternates) [V2+]	17
(Inactive)	(none)	Clara Vision (Rel)	The Movie Channel West [V2+]	TNN [V2+]	TVLand	HBO Multiplex [Digicipher]	Viewer's Choice [Digicipher]	FOX Sports Rocky Mountain [V2+]	18
TV Northern Canada [digital]	Data Transmissions	Digital Video	MTV West [V2+]	USA East [V2+]	Showtime/MTV (East) [Digicipher]	Cinemax East [V2+]	C-SPAN 2	FOXNet [V2+]	19
o/v	(none)	Data Transmissions	General Communication [digital]	BET [V2+]	Jones Services [Digicipher]	Home and Garden Network [V2+]	Showtime 2 [V2+]	Las Vegas TV Network	20
SCPC services/ Data Transmissions	(none)	Mexican Cable [Digicipher]	ESPNews [V2+]	Knowledge TV	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	FOX Sports West 2 [V2+]	21
(Inactive)	(none)	XHIMT canal 7	o/v	CNN/HN [V2+]	Discovery Channel Services [Digicipher]	Nostalgia Channel	FLIX [V2+]	FOX Sports NW [V2+] (occ)	22
(Inactive)	Data Transmissions	Mexican Cable [Digicipher]	Computer Network TV	A&E [V2+]	E! Entertainment TV [V2+]	HBO Services [digital]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
(Inactive)	(none)	XHDF canal 13	General Communication [digital]	Showtime/Movie Channel [PowerVu]	Digital Music Express Radio (DMX) [digital]	Outdoor Channel	CMT [V2+]	Sunshine Network [V2+]	24

Other Satellites:

Brasilsat A1 (BA1) 79°
Occasional video: 3 and 4

Telstar 302 (T2) 97°
Occasional video: all transponders

Telstar 303 (T3) 120°
Occasional video: 4 and 16
ABC feeds: 19

Satcom C5 (C5) 139°
SCPC services:
3, 4, 10, 14, 16, 21
DART services: 15
SEDAT services: 19, 21
Occasional video: 18
Alaskan TV Services:
24 [PowerVu]

LEGEND:

Unscrambled/non-video

Subscription

Not available in U.S.

o/v = occasional video

International Shortwave Broadcasters via Satellite

By Larry Van Horn and Robert Smathers

AFRICA NO. 1

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

ARAB REPUBLIC OF EGYPT RADIO

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

BRITISH BROADCASTING CORPORATION (BBC)

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

C-SPAN AUDIO SERVICES

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

C-SPAN Audio 1

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

C-SPAN Audio 2

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

CHINA RADIO INTERNATIONAL

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

DEUTSCHE WELLE (DW)

P.O.Box 100 444, 50968 Cologne, Germany. Telephone: +49 221 389 4563 (voice), +49 221 389 3000 (fax)
Deutsche Welle services are available on the following satellites: Satcom C4/F4 (135 west) Tr 5 (3800 MHz V) 7.02, 7.22, 7.38/7.56, 7.74 MHz audio, Astra 1A (19.2 east) on Tr 2 (11229 MHz V) 7.38/7.56 MHz audio, Eutelsat (13.0 east) Tr 27 (11163 MHz V) 7.02/7.20 MHz. audio, Intelsat K (21.5 west) Tr H7 (11605 MHz H), 7.38/7.56 MHz audio, and Intelsat 707 (1.0 west) Tr 23B (3.911 MHz RHCP) digital MPEG-2 subcarrier.

ISLAMIC REPUBLIC OF IRAN BROADCASTING (IRIB)

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

ISRAEL RADIO

P.O. Box 1082, Jerusalem 91010, Israel. Intelsat 707 (1.0 west) Tr 73 (11178 MHz V) 7.20 MHz audio.

LA VOIX DU ZAIRE

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

RADIO ALGIERS INTERNATIONAL

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

RADIO AUSTRALIA

GPO Box 428G, Melbourne, Vic. 3001, Australia. Telephone: +613 9626 1800 (voice), +613 9626 1899 (fax)
Palapa C1 (113.0 east) Tr 9 (3880 MHz H) 7.20 MHz audio

RADIO BELGRADE

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

RADIO BUDAPEST

Body Sandor u. 5-7, 1800 Budapest, Hungary. Telephone: +36 1 138 7224 (voice), +36 1 138 8517 (fax) E-mail: *h9563mes@ella.hu.* Eutelsat II F3 (16.0 east) Tr 33 (11596 MHz H) 7.02 MHz audio from 2300-0500 UTC

RADIO CANADA INTERNATIONAL

P.O. Box 6000, Montreal, Canada H3C 3A8. Telephone: (514) 597-7555 (voice), (514) 284-0891 (fax). Eutelsat II F6 (Hot Bird 1 at 13 east) 11265 MHz H 7.20 MHz audio for Canadian troops in Bosnia.

RADIO EXTERIOR DE ESPANA (REE)

Apartado 156202, Madrid 28080, Spain. Telephone +34 13461083/1080/1079/1121 (voice); 34 13461097 (fax).
Eutelsat II F6 (Hot Bird 1 at 13.0 east) (11220 MHz H) 7.92 MHz audio, Hispasat 1A/B (31.0 west) Tr 6 (12149 MHz RHCP) 7.92 MHz audio, and Asiasat-2 (100.5 east) 4000 MHz H. MPEG-2.

RADIO FRANCE INTERNATIONAL (RFI)

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

RADIO MEDITERRANEE INTERNATIONALE

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

RADIO NETHERLANDS

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

RADIOSTANTSIYA MAYAK

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

RADIO SWEDEN

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

RADIOTELEVISIONE ITALIANA (RAI)

Viale Mazzini 14, 00195 Roma, Italy. Telephone: +39 6 5919076. Selected programs of RAI's external service are carried on Eutelsat II F6 (Hot Bird 1 @ 13.0 east) (11446 MHz V) 7.56 MHz audio. This is a feed to the BBC Atlantic relay station on Ascension Island. Galaxy 7 (91.0 west) Tr 14 (3980 MHz V) 7.38 MHz audio.

RADIO VLAANDEREN INTERNATIONAL

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

RDP INTERNATIONAL

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

International Shortwave Broadcasters via Satellite

SWISS RADIO INTERNATIONAL

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

TRANS WORLD RADIO (TWR)

Astra 1A (19.2 east) Tr 16 (11436 MHz V) 7.38/7.56 MHz audio with German language programming from Evangeliums Rundfunk and TWR-UK. Astra 1C (19.2 east) Tr 38 (11038 MHz V) 7.38 MHz audio Multilingual from TWR-Europe.

TUNIS INTERNATIONAL RADIO

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

VATICAN RADIO

I-00120, Vatican City State, Italy. Telephone: +396 6988 3551 (voice), +396 6988 3237 (fax)
Eutelsat Hotbird (13 east) 10987 MHz V; Intelsat 603 (34.5 west) 4097.75 MHz LHCP; and Intelsat 704 (66 east) 4152.45 MHz RHCP.

VOICE OF THE ARABS

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

VOICE OF SAHEL

Niger Radio and Television Service. Transmissions of the domestic radio shortwave service have been reported on Intelsat 707 at 1.0 west. No other details are available at this time.

VOICE OF THE IRAQI PEOPLE (CLANDESTINE)

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

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

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

WORLD RADIO NETWORK

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

WRN 1 North American English Program Schedule

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

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

WRN 2 North American Multilingual Program Schedule

Galaxy 5 (125.0 west) Tr 6 (3820 MHz V) 6.20 MHz audio. New 24 hour multi-lingual channel for North America designed for the re-broadcasting of programs in a variety of languages for domestic FM/AM relays and cable distribution.

WRN European Service

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

WRN Asia-Pacific Service

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

WRN Middle East and Africa Service

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

WORLDWIDE CATHOLIC RADIO - WEWN

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

YLE RADIO FINLAND

Box 10, SF-00241 Helsinki, Finland. Telephone: +358 9 1480 4320 (voice), +358 9 1481 1169 (fax). Toll free in the US 800-221-YLEX (9539). WWW URL: www.yle.fi/fbc/radiofin.html. E-mail: *rfinland@yle.fi* Most of YLE's broadcasts to Europe are available on Eutelsat II F1 (13.0 east) Tr 27 (11163 MHz V) 8.10 MHz. audio, and Asiasat 2 (100.5 east) Tr 10B (4000 MHz H) early this year.

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 249 active geostationary/synchronous satellites at publication deadline. Synchronous satellite location information is supplied to *Satellite Times* by NASA's Goddard Space Flight Center-Orbital Information Group (Mr. Adam Johnson). We are particularly grateful to the following individuals for providing payload information and analysis: Earth News: Philip Chien; Molniya Space Consultancy/Janes *Spaceflight Directory* Editor: Mr. Phillip Clark; Baylin Publications: Dr. Frank Baylin; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; Havard-Smithsonian Center for Astrophysics: Jonathan McDowell; U.S. Space Command/ Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

d indicates that satellite is drifting (moving into a new orbital slot or at end of life). *i* indicates an orbital inclination greater than 2 degrees. # indicates that the satellite has started into an inclined orbit.

Radio Frequency Band Key

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

Satellite Service Key

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

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
22912	1993-073B Meteosat 6 (MOP 3) (ESA)	0.2E#	Met (L)
23426	1994-082A Luch 1 (Russia)	0.3E#/d	Tracking & Relay CSDRN (Ku)
23730	1995-067A Telecom 2C (France)	2.9E	Dom FSS/Gov-Mil (X/C/Ku)
23712	1995-060A USA 115 (Milstar-2) (US)	4.0E/i	Mil-Comm (P/S/K)
19919	1989-027A Tele X (Sweden)	4.9E	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-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	7.0E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg FSS (Ku)
22269	1992-088A Cosmos 2224 (Russia)	11.8E#	Mil-Earl Warning (X)
22557	1993-013A Raduga 29 (Russia)	11.8E#	Dom FSS/Gov-Mil (X/C)
19596	1988-095A Raduga 22 (Russia)	12.7E/i	Dom FSS/Gov-Mil (X/C)
24208	1996-044A Italsat 2 (Italy)	13.1E	Dom-Telephone/Mob (L/S/ K/Ka)
23537	1995-016B Eutelsat II F6 (Hot Bird 1)	13.1E	Reg BSS (Ku)
21055	1991-003A Italsat 1 (Italy)	13.1E	Dom-Telephone (S/K/Ka)
24665	1996-067A Eutelsat II F7 (Hot Bird 2)	13.1E	Reg BSS (Ku)
20777	1990-079B Eutelsat II F1	13.8E	Reg FSS (Ku)
21803	1991-083A Eutelsat II F3	16.0E	Reg FSS (Ku)
22653	1993-031A Astra 1C	19.1E	Reg BSS (Ku)
23842	1996-021A Astra 1F	19.1E	Reg BSS (Ku)
23331	1994-070A Astra 1D	19.1E	Reg BSS (Ku)
23686	1995-055A Astra 1E	19.2E	Reg BSS (Ku)
19688	1988-109B Astra 1A	19.2E	Reg BSS (Ku)
21139	1991-015A Astra 1B	19.3E	Reg BSS (Ku)
19331	1988-063B Eutelsat 1 F5 (ECS 5)	21.6E#	Reg FSS (VHF/Ku)
22175	1992-066A DFS 3 (Germany)	23.5E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.5E/i	Reg FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (Russia)	25.6E/i	Dom/Gov FSS (C/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	25.9E	Reg FSS/BSS (C/Ku)
20706	1990-063B DFS 2/Kopernikus (Germany)	28.5E	Dom BSS (S/Ku/K)
24652	1996-062A Arabsat 2B (Arabsat)	30.8E	Reg FSS/BSS (C/Ku)
21894	1992-010B Arabsat 1C (Arabsat)	31.0E#	Reg FSS/BSS (S/C)
23200	1994-049B Turksat 1B (Turkey)	31.2E	Reg FSS (Ku)
15629	1985-025A Intelsat 510	32.9E/i	Int FSS (C/Ku)
20263	1989-081A Gorizont 19 (Russia)	33.6E/i	Dom/Gov FSS (C/Ku)
21821	1991-087A Raduga 28 (Russia)	34.4E/i	Dom FSS/Gov-Mil (X/C)
23717	1995-063A Gals 2 (Russia)	35.9E	Dom BSS (Ku)
22963	1993-002A Gals 1 (Russia)	36.0E	Dom BSS (Ku)
20929	1990-095A USA 65 (DSP F15) (US)	37.4E#	Mil-Early Warning (S/X)
23775	1996-005A Gorizont 31 (Russia)	39.9E#	Dom/Gov FSS (C/Ku)
23949	1996-040B Turksat 1C (Turkey)	43.2E	Reg FSS (Ku)
22981	1994-008A Raduga 1-3 (Russia)	49.2E#	Dom FSS/Gov-Mil (X/C)
19687	1988-109A Skynet 4B (UK)	52.9E/i	Mil-Comm (P/S/X/Ka)
23880	1996-034A Gorizont 32 (Russia)	53.0E#	Dom/Gov FSS (C/Ku)
23305	1994-064A Intelsat 703	56.9E	Int FSS (C/Ku)
13040	1982-006A DSCS II E15 (US)	57.0E/i	Mil-IOR reserve operational (S/X)
20203	1989-069B USA 44 (DSCS III A2) (US)	57.0E/i	Mil-IOR primary operational (P/S/X)
24742	1997-009A Intelsat 801	58.0E/d	Int FSS (C/Ku)
20667	1990-056A Intelsat 604	59.9E	Int FSS (C/Ku)
22913	1993-074A USA 97 (DSCS III B10) (US)	60.0E/i	Mil-IOR primary operational (P/S/X)
20315	1989-087A Intelsat 602	62.8E	Int FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	62.7E#	Int Mar-POR (L/C)
23839	1996-020A Inmarsat 3 F1	64.0E#	Int Mar (L/C)
23461	1995-001A Intelsat 704	65.9E	Int FSS (C/Ku)
23636	1995-040A PanAmSat 4 (PAS 4)	68.4E	Int FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	69.8E#	Dom FSS/Gov-Mil (X/C)
22787	1993-056A USA 95 (UFO-2) (US)	71.5E/i	Mil-IOR primary (P/S)
10669	1978-016A Ops 6391 (FltSatCom 1) (US)	71.6E/i	Mil-IOR Reserve (P-Alpha/S/ X)
13595	1982-097A Intelsat 505	71.7E/i	Int FSS/Mar (L/C/Ku)
23589	1995-027A USA 111 (UFO-5) (US)	72.4E/i	Mil-IOR reserve (P/S/K)
08882	1976-053A Marisat 2 (US)	72.6E/i	Int Mar-IOR (P/L/C)
22027	1992-041A Insat 2A (India)	74.1E	Dom FSS/BSS/Met (S/C)
23327	1994-069A Elektro 1 (Russia)	76.0E#	Met (L)
23680	1995-054A Luch 1-1 (Russia)	77.5E#	Tracking & Relay SDRN-2 (Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.4E	Reg FSS (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.5E	Reg FSS (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	79.9/i	Dom/Gov FSS (C/Ku)
23653	1995-045A Cosmos 2319 (Russia)	80.0E#	Data Relay (C)
24435	1996-058A Express 2 (Russia)	80.3E	Int FSS (C/Ku)
20643	1990-051A Insat 1D (India)	83.3E	Dom FSS/BSS/Met (S/C)
19548	1988-091B TDRS F3 (US)	85.1E/i	Gov-Tracking & Relay (C/S/ Ku)
22836	1993-062A Raduga 30 (Russia)	85.5E#	Dom FSS/Gov-Mil (X/C)
18922	1988-014A PRC 22 DFH2-1(China)	87.7E/i	Dom FSS (C)
22880	1993-069A Gorizont 28 (Russia)	89.6E#	Dom/Gov FSS (C/Ku)
23765	1995-003A Measat 1 (Malaysia)	91.4E	Dom FSS/BSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.0E	Dom FSS/BSS/Met (S/C)
23731	1995-067B Insat 2C (India)	93.4E#	Dom FSS/BSS/Met (S/C/Ku)
22245	1992-082A Gorizont 27 (Russia)	96.8E#	Dom/Gov FSS (C/Ku)
20473	1990-011A PRC 26 DFH2A-1 (China)	98.3E#	Dom FSS (C)
22210	1992-074A Ekran 20 (Russia)	99.1E#	Dom BSS (P)
23723	1995-064A AsiaSat 2	100.5E	Reg FSS (C/Ku)
21922	1992-017A Gorizont 25 (Russia)	102.6E/i	Dom/Gov FSS (C/Ku)
20558	1990-030A Asiasat 1	105.5E	Reg FSS (C/Ku)
20570	1990-034A Palapa B2R (Indonesia)	108.0E	Reg FSS (C)
23176	1994-040B BS-3N (Japan)	109.9E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.9E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.9E	Dom BSS (Ku)
19710	1988-111A PRC 25 DFH2-2 (China)	110.7E#	Dom FSS (C)
23864	1996-030A Palapa C2 (Indonesia)	113.0E	Reg FSS (C/Ku)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.6E#	Dom FSS (C/Ku)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	115.9E	Dom FSS/BSS (Ku)
23768	1996-003A Koreasat 2 (Mugunghwa 2)	116.0E	Dom FSS/BSS (Ku)
21964	1992-027A Palapa B4 (Indonesia)	117.9E	Reg FSS (C)
20217	1989-070A GMS-4 (Himawari 4) (Japan)	120.2E/i	Met (P/L)
24769	1997-016B BSAT-1A (Japan)	121.9E	Dom BSS ((Ku)
21132	1991-014A Raduga 27 (Russia)	126.0E/i	Dom FSS/Gov-Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.9E	Dom FSS (Ku)
23651	1995-044A N-Star 1 (Japan)	132.0E	Dom/Mob FSS (S/C/Ku/Ka)
23943	1996-039A Apstar 1A (China)	133.9E	Reg FSS (C)
23781	1996-007A N-Star 2 (Japan)	135.7E	Dom/Mob FSS (S/C/Ku/Ka)
23185	1994-043A Apstar I (China)	138.0E	Dom BSS (C)
24732	1997-007A JCSAT 4 (Japan)	139.2E	Dom FSS (Ku)
23522	1995-011B GMS-5 (Himawari 5) (Japan)	139.8E#	Met (P/L)
20953	1990-102A Gorizont 22 (Russia)	139.9E/i	Dom/Gov FSS (C/Ku)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.6E#	Reg FSS (C/Ku)
17706	1987-029A Palapa B2P (Indonesia)	143.9E#	Reg FSS (C)
20923	1990-094A Gorizont 21 (Russia)	145.0E/i	Dom/Gov FSS (C/Ku)
20066	1989-046A USA 39 (DSP F14) (US)	145.4E/i	Mil-Early Warning (S/X)
24653	1996-063B Measat-2 (Malaysia)	147.9E	Dom FSS/BSS (C/Ku)

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19874	1989-020A JCSAT 1 (Japan)	149.9E	Dom FSS (Ku)
23779	1996-006A Palapa C1 (Indonesia)	150.4E	Reg FSS (C/Ku)
18316	1987-070A ETS V/Kiku 5 (Japan)	150.3E/i	Experimental (L/C)
18350	1987-078A Optus A3 (Aussat K3)	151.8E#	Dom FSS/BSS (Ku)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	154.0E	Dom FSS (C/K)
20402	1990-001B JCSAT 2 (Japan)	154.0E	Dom FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	Dom BSS/Mob (L/Ku)
12994	1981-119A Intelsat 503	157.1E/i	Int FSS (C/Ku)
22253	1992-084A Superbird A1 (Japan)	157.9E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	160.0E	Dom BSS/Mob (L/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	160.7E#	Reg FSS (C/Ku)
21893	1992-010A Superbird B1 (Japan)	161.9E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	164.0E/i	Dom BSS (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	168.9E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(US)	172.7E/i	Mil-POR reserve (P-Bravo/ S/X)
22871	1993-066A Intelsat 701	174.1E	Int FSS (C/Ku)
22719	1993-046A USA 93 (DSCS III B9) (US)	175.0E/i	Mil-WPAC primary operational (P/S/X)
23124	1994-034A Intelsat 702	177.0E	Int FSS (C/Ku)
24674	1996-070A Inmarsat 3 F3	178.1E/i	Int Mar (L/C)
20918	1990-093A Inmarsat 2 F1	178.9E#	Int Mar-IOR (L/C)
16117	1985-092C USA 12 (DSCS III B5) (US)	180.0E/i	Mil-WPAC reserve operational (P/S/X)
15873	1985-055A Intelsat 511	180.0E/i	Int FSS (C/Ku)
23467	1995-003A USA 108 (UFO-4) (US)	177.8W/i	Mil-POR (P/S/K)
19121	1988-040A Intelsat 513	176.8W#	Int FSS (C/Ku)
21639	1991-054B TDRS F5 (US)	174.4W	Int FSS/Gov-Tracking & Relay (C/S/Ku)
23613	1995-035B TDRS F7 (US)	171.4W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
18631	1987-100A Raduga 21 (Russia)	170.2W/i	Dom FSS/Gov-Mil (X/C)
20499	1990-016A Raduga 25 (Russia)	169.4W/i	Dom FSS/Gov-Mil (X/C)
21392	1991-037A Satcom C5 (Aurora II)(US)	139.1W	Dom FSS (C)
20945	1990-100A Satcom C1 (US)	137.1W	Dom FSS (C)
23581	1995-025A GOES 9 (US)	135.3W	Met (P/L/S)
22096	1992-057A Satcom C4 (US)	135.1W	Dom FSS (C)
21873	1992-006A USA 78 (DSCS III B14) (US)	135.0W/i	Mil-EPAC primary operational (P/S/X)
23016	1994-013A Galaxy 1R (US)	133.2W	Dom FSS (C)
22117	1992-060B Satcom C3 (US)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (US)	130.1W/i	Mil-EPAC reserve operational (P/S/X)
21906	1992-013A Galaxy 5 (US)	125.1W	Dom FSS (C)
16649	1986-026A Gstar 2 (US)	125.0W#	Dom FSS (Ku)
23877	1996-033A Galaxy 9 (US)	123.1W	Dom FSS (C)
19484	1988-081B SBS 5 (US)	123.0W	Dom FSS (Ku)
22988	1994-009A USA 99 (Milstar 1) (US)	120.0W	Mil-Comm (P/S/K)
15826	1985-048D Telestar 3D (303) (US)	119.9W#	Dom FSS (C)
24313	1996-055A Echostar 2 (US)	119.1W	Dom BSS (Ku)
23754	1995-073A EchoStar 1 (US)	119.0W	Dom BSS (Ku)
24748	1997-011A Tempo 2 (US)	118.8W#	Dom BSS (Ku)
16274	1985-109B Morelos 2 (Mexico)	116.9W	Dom FSS (C/Ku)
13652	1982-110C Anik C3 (Canada)	115.0W/i	Dom FSS (Ku)
23313	1994-065A Solidardad 2 (Mexico)	113.0W	Dom FSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.2W	Dom FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.2W	Dom FSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom FSS (C/Ku)
23846	1996-022A MSAT M1 (Canada)	106.5W	Dom Mobile (L/X)
08747	1976-023B LES 9 (US)	105.8W/i	Mil-Experimental (P/Ka)
19483	1988-081A Gstar 3 (US)	105.4W/i	Dom FSS/Mob (L/Ku)
15677	1985-035A Gstar 1 (US)	105.3W#	Dom FSS (Ku)
20946	1990-100B Gstar 4 (US)	105.1W	Dom FSS (Ku)
23696	1995-057A USA 114 (UFO-6) (US)	104.8W/i	Mil-CONUS (P/S/K)
03029	1967-111A ATS 3 (US)	104.5W/i	Experimental (VHF/C)
24315	1996-054A GE-1 (US)	103.1W	DOM FSS (C/Ku)
23435	1994-084A USA 107 (DSP F17) (US)	103.0W#	Mil-Early Warning (S/X)
22930	1993-078A DBS 1 (US)	101.2W	Dom BSS (Ku)
21227	1991-028A Spacenet 4 (US)	101.1W	Dom FSS (C/Ku)
23553	1995-019A AMSC 1 (US)	101.0W	Dom Mobile (L/X)
23598	1995-029A DBS 3 (US)	100.9W	Dom BSS (Ku)
23192	1994-047A DBS 2 (US)	100.8W	Dom BSS (Ku)
22796	1993-058B ACTS (US)	100.0W	Experimental (C/K/Ka)
17181	1986-096A USA 20 (FltSatCom F7)(US)	99.4W/i	Mil-CONUS (P/S/X/K)
22694	1993-039A Galaxy 4 (US)	99.0W	Dom FSS (C/Ku)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
08746	1976-023A LES 8 (US)	97.2W/i	Mil-Experimental (P/Ka)
15237	1984-093D Telestar 3C (302) (US)	97.0W#	Dom FSS (C)
23741	1995-069A Galaxy 3R (US)	95.0W	Dom/BSS (C/Ku)
16650	1986-026B SBTS 2 (Brazil)	92.0W	Dom FSS (C)
22205	1992-072A Galaxy 7 (US)	91.0W	Dom FSS (C/Ku)
23670	1995-049A Telstar 402R (US)	89.1W	Dom FSS (C/Ku)
18951	1988-018A Spacenet 3R (US)	87.1W	Dom FSS (L/C/Ku)
16482	1986-003B Satcom K1 (US)	87.0W#	Dom FSS (Ku)
16276	1985-109D Satcom K2 (US)	85.4W	Dom FSS (Ku)
24713	1997-002A GE-2 (US)	85.1W	Dom FSS (C/Ku)
15561	1985-015B SBTS 1 (Brazil)	79.0W/i	Dom FSS (C)
15235	1984-093B SBS 4 (US)	77.2W/i	Dom FSS (Ku)
23051	1994-022A GOES 8 (US)	76.0W	Met (P/L/S)
14133	1983-059B Anik C2 (Argentina)	75.9W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (US)	75.8W/i	Dom FSS (C)
20872	1990-091A SBS 6 (US)	74.1W	Dom FSS (Ku)
20873	1990-091B Galaxy 6 (US)	74.0W	Dom FSS (C)
24714	1997-002B Nahuel 1A (Argentina)	71.8W	Dom FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom FSS (C)
21805	1991-080B USA 75 (DSP F16) (US)	70.0W#	Mil-Early Warning (S/X)
15385	1984-114A Spacenet 2 (US)	69.0W	Dom FSS (C/Ku)
23536	1995-016A Brasilsat B2 (Brazil)	65.1W	Dom FSS (C/X)
16101	1985-087A Intelsat 512	55.5W/i	Int FSS (C/Ku)
21149	1991-018A Inmarsat 2 F2	55.3W/i	Int Mar-AOR-W (L/C)
21940	1992-021B Inmarsat 2 F4	54.0W/i	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	53.0W	Int FSS (C/Ku)
24786	1997-019A GOES 10 (USA)	52.8W#/d	Met (P/L/S)
23628	1995-038A USA 113 (DSCS III B4) (US)	52.5W/i	Mil-WLANT primary operational (P/S/X)
22314	1993-003B TDRS F6 (US)	47.0W	Int FSS/Gov-Tracking & Relay (C/S/Ku)
23915	1996-035A Intelsat 709	45.3W	Intl FSS (C/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Int FSS (C/Ku)
23764	1996-002A PanAmSat 3R (PAS 3R)	43.1W	Int FSS (C/Ku)
16116	1985-092B USA 11 (DSCS III B7) (US)	42.5W/i	Mil-ATL reserve operational (P/S/X)
19883	1989-021B TDRS F4 (US)	41.2W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
12089	1980-098A Intelsat 502	40.3W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (US)	37.6W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.6W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A (UK)	34.1W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.43/i	Int FSS/Mar (L/C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	Dom BSS/FSS (Ku)
22723	1993-048A Hispasat 1B (Spain)	30.0W	Dom BSS/FSS (Ku)
21765	1991-075A Intelsat 601	27.6W	Int FSS (C/Ku)
15386	1984-114B Marecs B2	25.8W/i	Int Mar-AOR (L)
21653	1991-055A Intelsat 605	24.5W	Int FSS (C/Ku)
23967	1996-042A USA 127 (UFO-7) (US)	23.7W/i	Mil-AOR (P/S/K)
20253	1989-077A USA 46 (FltSatCom 8) (US)	23.3W/i	Mil-AOR (P-Charlie/S/X/K)
21989	1992-032A Intelsat K	21.5W	Int FSS (Ku)
19772	1989-006A Intelsat 515	21.3W	Int FSS (C/Ku)
20705	1990-063A TDF 2 (France)	18.8W	Dom BSS (Ku)
15391	1984-115A NATO III D	18.6W/i	Mil-Comm (P/S/X)
23528	1995-013A Intelsat 705	18.0W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W/i	Mil-Comm (P/S/X)
20391	1989-101A Cosmos 2054 (Russia)	16.3W/i	Tracking & Relay WSDRN (Ku)
24307	1996-053A Inmarsat 3 F2	15.6W/i	Int Mar (L/C)
23132	1994-035A USA-104 (UFO-3)(US)	15.4W/i	Mil-AOR primary (P/S)
23319	1994-067A Express 1 (Russia)	14.0W	Int FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	13.4W#	Dom Data Relay (C)
22009	1992-037A USA 82 (DSCS III B12) (US)	12.0W	Mil-ELANT primary operational (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	10.8W/i	Dom/Gov FSS (C/Ku)
21813	1991-084A Telecom 2A (France)	8.1W	Dom FSS/Gov-Mil (X/C/Ku)
21140	1991-015B Meteosat 5 (MOP 2) (ESA)	7.6E#/d	Met (L)
21939	1992-021A Telecom 2B (France)	5.1W	Dom FSS/Gov-Mil (X/C/Ku)
24209	1996-044B Telecom 2D (France)	5.0W	Dom-FSS/Gov-Mil (C/X/Ku)
23865	1996-030B Amos 1 (Israel)	4.1W	Dom FSS (C)
23816	1996-015A Intelsat 707	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.1W#	Mil-comm (P/S/X/Ka)
20762	1990-074A Thor 1/Marcopolo 2 (BSB R-2)	0.8W	Reg BSS (Ku)
20168	1989-062A TV Sat 2 (Germany)	0.6W	Dom BSS (Ku)

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode	Frequencies
OSCAR 10 (AO-10) (Notes 1 & 12)	B (u/V)	Dn 145.825 835 845 855 865 875 885 895 905 915 925 935 945 955 965 145.975 Up 435.179 169 159 149 139 129 119 109 099 089 079 069 059 049 039 435.029
	Bcn	145.810 (Steady unmodulated carrier)
RS 10/11 (Notes 2, 3, 4 and 12)		Dn 29.360 370 380 390 29.400 29.403 Up 145.860 870 880 890 145.900 (CW) 145.820
	Bcn	29.357 (CW)
RS-12/13 (Notes 2, 5 & 6)		Dn 29.410 420 430 440 29.450 29.454 Up 21.210 220 230 240 21.250 (CW) 21.129
	Bcn	29.408
RS-15 (Note 12)	A (v/a)	Dn 29.354 29.364 29.374 28.384 29.394 Up 145.858 145.868 145.878 145.888 145.898
UoSat 11 (UO-II) (Note 13)	Bcns	Dn 145.826 435.025 2401.500 Up None
PACSAT (AO-16) (Notes 7, 8 & 10)	[a]	Dn 437.025 (Sec)437.050 Up 145.900 145.920 145.940 145.960
DOVE (DO-17) (Notes 9 & 10)	[b,c]	Dn 145.825 2401.220 Up None
WEBERSAT (WO-18) (Note 10)	[a]	Dn 437.075 437.100 (Sec) Up None
LUSAT (LO-19) (Notes 7 & 10)	[a]	Dn 437.125 437.150 (Sec) Up 145.840 145.860 145.880 145.900

NOTES

1. The AO-10 beacon is an unmodulated carrier. This satellite has suffered computer damage making it impossible to orient the satellite for optimum service or solar illumination. In order to preserve it as long an possible, do not transmit to it when you hear the beacon FMing.
2. RS-10/11 and RS-12/13 are each mounted on common spaceframes, along with comunication and navagation packages.
3. 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.
4. 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.
5. 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.
6. 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.
7. Transmitters on both AO-16 & LU-19 are currently using Raised Cosine Mode.
8. 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.
9. 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.
10. 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)
11. PO-28 is available to amateurs on an intermittent, unscheduled basis.
12. Modes of operation used include: CW,/USB/FAX/Packet/RTTY
13. Modes of operation used include: FM (AFSK) & PSK Data.
14. Modes of operation used include: Packet & FM Voice.

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

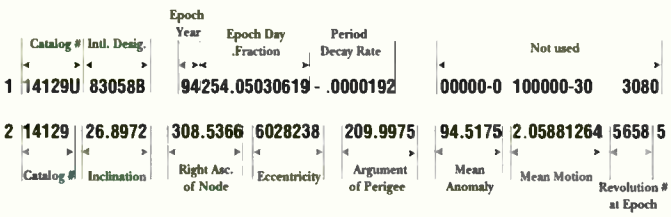
Satellite	Mode	Frequencies
JAS-1b (FO-20) (Notes 10 & 12)	JA Linear	Dn 435.800 810 820 830 840 850 860 870 880 890 435.900 Up 146.000 990 980 970 960 950 940 930 920 910 900
	Bcn	435.795 (CW)
	JD [a] Dgtl	Dn 435.910 Up 145.850 145.890 145.910
OSCAR 22 (UO-22) (Note 10)	[c]	Dn 435.120 Up 145.900 145.975
KITSAT A (KO-23) (Note 10)	[c]	Dn 435.173 Up 145.850 145.900
KITSAT B (KO-25) (Note 10)	[c]	Dn 435.175 436.500 Up 145.870 145.980
IT-AMSAT (IO-26) (Note 10)	[a,c]	Dn 435.820 (Sec.) 435.867 Up 145.875 145.900 145.925 145.950
EYESAT /AMRAD (AO-27) (Note 10)	[b,a]	Dn 436.800 Up 145.850
POSAT (PO-28) (Notes 10 & 12)	[c]	Dn 435.250 435.280 Up 145.925 145.975
FUJI/ OSCAR 29 (FO-29) (Notes10 &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
	JD Digtl (b,c)	Dn 453.910 Up 145.850 145.870 145.890 145.910
MEXICO/ OSCAR 30 (MO-30) (Note 10)	(b)	Dn 437.138 (sec) 437.206 (pμ) BCN: Up 145.815 145.835 145.855 145.875 40.997 MHz
MIR (Note 14)	[b] FM Voice	Dn 145.800 Up 145.200
SHUTTLE (SAREX) (Note 14)	[b]	Dn 145.840 Up 144.450 144.470

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

Amateur and Weather Satellite Two-Line Orbital Element Sets

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

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



Notice that there is no decimal point printed for eccentricity. The decimal point goes in front of the number. For example, the number shown above for eccentricity would be entered into your computer tracking program as .6028238.

AMATEUR RADIO SATELLITES
OSCAR 10 (AMSAT OSCAR 10, AO-10)
1 14129U 83058B 97148.24139209 .00000193 00000-0 10000-3 0 4846
2 14129 25.9153 145.4198 6068989 120.9634 312.2846 2.05878785 76972
OSCAR 11 (UoSAT 2, UoSAT 11, UOSAT OSCAR-11, UO-11)
1 14781U 84021B 97153.93909479 .00000143 00000-0 31988-4 0 9767
2 14781 97.8339 135.7426 0013147 49.1649 311.0699 14.69556149709161
Russian Mir Space Station
1 16609U 86017A 97154.20632962 .00002051 00000-0 31775-4 0 3438
2 16609 51.6516 156.1011 0005641 109.0678 251.0971 15.59464749644845
RS-10/11 (Radio Sputnik 10/11, Cosmos 1861)
1 18129U 87054A 97152.56917812 .00000015 00000-0 38702-6 0 3589
2 18129 82.9278 250.2730 0010344 267.1879 92.8088 13.72378490498099
OSCAR 16 (PACSAT, AMSAT OSCAR-16, AO-16)
1 20439U 90005D 97150.20097439 .00000070 00000-0 43979-4 0 688
2 20439 98.5360 235.1480 0010547 264.7517 95.2459 14.30009267383665
OSCAR 17 (DOVE, DOVE OSCAR-17, DO-17)
1 20440U 90005E 97152.28757576 .00000038 00000-0 31351-4 0 714
2 20440 98.5400 238.0423 0010604 256.3105 103.6895 14.30152148383996
OSCAR 18 (WEBERSAT, WEBERSAT OSCAR-18, WO-18)
1 20441U 90005F 97150.25612687 .00000022 00000-0 25174-4 0 734
2 20441 98.5384 235.9489 0011132 262.5721 97.4195 14.30119190383708
OSCAR 19 (LUSAT, LUSAT OSCAR-19, LO-19)
1 20442U 90005G 97152.25366156 .00000009 00000-0 20158-4 0 714
2 20442 98.5430 238.5709 0011394 255.2657 104.7263 14.30233828384010
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 97150.88082449 -.00000005 00000-0 55844-4 0 9695
2 20480 99.0439 115.7248 0541376 56.5633 308.6024 12.83238609342488
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 97153.87373501 .00000087 00000-0 76926-4 0 9827
2 21089 82.9195 289.2534 0029436 340.4327 19.5702 13.74082335317197
OSCAR 22 (UoSAT-F, UoSAT-5, UOSAT OSCAR 22, UO-22)
1 21575U 91050B 97152.23176869 .00000028 00000-0 23655-4 0 7758
2 21575 98.3014 213.3371 0007106 306.6553 53.3979 14.37071762308194
OSCAR 23 (KITSAT-A, KITSAT-1, KITSAT OSCAR-23, KO-23)
1 22077U 92052B 97150.56182584 -.00000037 00000-0 10000-3 0 6652
2 22077 66.0775 182.1351 0010210 215.7957 144.2376 12.86302900225481
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR-27, AO-27
1 22825U 93061C 97152.22546341 .00000022 00000-0 26365-4 0 5614
2 22825 98.5464 226.8031 0008335 295.0973 64.9339 14.27727463191797
OSCAR 26 (ITAMSAT, ITAMSAT OSCAR-26, IO-26)
1 22826U 93061D 97151.70460362 .00000006 00000-0 19769-4 0 5583
2 22826 98.5451 226.5303 0008601 295.0997 64.9292 14.27836696191736
OSCAR 25 (KITSAT-B, KITSAT-2, KITSAT OSCAR-25, KO-25)
1 22828U 93061F 97151.25243772 .00000039 00000-0 33048-4 0 5378
2 22828 98.5416 226.1714 0009452 279.7007 80.3106 14.28179877159795
OSCAR 28 (POSAT, POSAT OSCAR-28, PO-28)
1 22829U 93061G 97152.25423835 .00000071 00000-0 46022-4 0 5530
2 22829 98.5429 227.2415 0009520 277.4932 82.5166 14.28164450191852
RS-15 (Radio Sputnik 15)
1 23439U 94085A 97151.57631463 -.00000039 00000-0 10000-3 0 2221
2 23439 64.8143 179.6979 0149629 135.7195 225.5813 11.27527428100061
OSCAR 29 (FUJI 3, FUJI OSCAR-29, FO-29)
1 24278U 96046B 97152.53268485 -.00000044 00000-0 -73151-5 0 828
2 24278 98.5397 195.8960 0350546 226.7632 130.3747 13.52630420 39008
OSCAR 30 (MEXICO OSCAR-30, MO-30)
1 24305U 96052B 97153.06411467 .00000203 00000-0 20364-3 0 1085
2 24305 82.9373 5.7687 0028722 248.4088 111.3992 13.73092788 36986
RS-16 (Radio Sputnik 16)
1 24744U 97010A 97154.24559831 .00002945 00000-0 99608-4 0 459
2 24744 97.2768 59.5689 0008252 127.4234 232.7748 15.31374568 13958

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 7 (Standby Geostationary Spacecraft-USA)
1 17561U 87022A 97151.46035116 -.00000151 00000-0 10000-3 0 3589
2 17561 3.7382 67.1077 0002038 84.5816 165.4163 1.00256949 20798
GOES 8 (Operational East-USA)
1 23051U 94022A 97149.38475164 -.00000264 00000-0 00000+0 0 7143
2 23051 0.0264 266.6518 0000465 316.6661 87.3833 1.00279288 18832
GOES 9 (Operational West-USA)
1 23581U 95025A 97150.35699572 .00000073 00000-0 10000-3 0 4302
2 23581 0.3114 90.8561 0001836 337.7889 172.7129 1.00279313 7408
GOES 10 (Standby Geostationary Spacecraft-USA)
1 24786U 97019A 97149.60799850 -.00000100 00000-0 00000+0 0 607
2 24786 0.4149 277.5032 0002746 61.8306 21.3761 1.00267425 373
ELEKTRO (Operational-Russia)
1 23327U 94069A 97152.73334182 -.00000108 00000-0 00000+0 0 3038
2 23327 0.7473 93.1162 0004362 24.0723 112.7189 1.00269570 9508
Meteosat 5 (Operational ESA, aka MOP-2)
1 21140U 91015B 97154.12466331 -.00000095 00000-0 00000+0 0 3501
2 21140 1.2591 78.8378 0000774 336.1266 231.8225 1.00273203 25125
Meteosat 6 (Operational-ESA)
1 22912U 93073B 97148.19388310 -.00000018 00000-0 00000+0 0 6806
2 22912 0.1654 8.7631 0001974 34.0359 272.5194 1.00269903 11310
GMS 4 (Standby-Japan, aka Himawari 4)
1 20217U 89070A 97152.66583912 -.00000379 00000-0 10000-3 0 5811
2 20217 2.4983 73.4677 0001119 232.1130 304.3556 1.00278986 28926
GMS 5 Operational-Japan, aka Himawari 5)
1 23522U 95011B 97151.61384942 -.00000298 00000-0 00000+0 0 2981
2 23522 0.4453 347.4240 0002399 213.1458 49.5700 1.00266413 7941

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning spacecraft-USA 137.500 MHz)
1 21263U 91032A 97154.01548184 .00000128 00000-0 76268-4 0 4030
2 21263 98.5380 168.7136 0012951 340.9659 19.1043 14.22717226314342
NOAA 14 (Operational afternoon spacecraft-USA 137.620 MHz)
1 23455U 94089A 97153.00322158 .00000026 00000-0 39221-4 0 636
2 23455 98.9905 104.2549 0009780 341.9464 18.1354 14.11670307124808
Meteor 2-21(Off at last report)
1 22782U 93055A 97150.23625579 .00000056 00000-0 37193-4 0 5673
2 22782 82.5496 72.1042 0023796 83.6523 276.7345 13.83074572189100
Meteor 3-5 (Operational-Russia 137.850 MHz)
1 21655U 91056A 97153.85008724 .00000051 00000-0 10000-3 0 9810
2 21655 82.5528 72.8058 0014569 18.2941 341.8698 13.16853276278829
Meteor 3-6 (Off at last report)
1 22969U 94003A 97153.66475478 .00000051 00000-0 10000-3 0 3484
2 22969 82.5588 13.2196 0016613 80.5532 279.7463 13.16745075161171
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 97154.00824441 .00000059 00000-0 55108-4 0 2470
2 23233 98.7780 212.7581 0011560 266.4790 93.5061 14.12806922142362
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 97154.00823310 .00000003 00000-0 25517-4 0 10
2 23533 98.8474 158.0947 0007596 132.5798 227.6018 14.12791314113165
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 97154.01475078 .00000082 00000-0 67885-4 0 559
2 24753 98.9358 198.3356 0010053 86.7076 273.5247 14.12980537 8382

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Okean 4-Russia 137.400 MHz)
1 23317U 94066A 97153.91383101 .00000173 00000-0 22691-4 0 2462
2 23317 82.5417 96.3630 0027256 23.0538 337.1888 14.74103349142208
SICH-1 (Oceanographic satellite-Russia 137.400 MHz)
1 23657U 95046A 97154.20791810 .00000253 00000-0 35247-4 0 1729
2 23657 82.5340 237.4403 0028215 353.2801 6.8023 14.73558299 94522
IRS-1C (Remote Sensing-India)
1 23751U 95072A 97152.49457288 -.00000044 00000-0 00000+0 0 2106
2 23751 98.7060 227.8255 0001359 68.4103 291.7221 14.21632703 74061
IRS-P3 (Remote Sensing-India)
1 23827U 96017A 97154.22895595 -.00000044 00000-0 00000+0 0 1659
2 23827 98.7135 233.1614 0001665 48.3086 311.8231 14.21620928 62365
TOMS-EP (Total Ozone Mapping Spectrometer-USA)
1 23940U 96037A 97153.92068511 .00002455 00000-0 10872-3 0 1203
2 23940 97.4239 61.0678 0011770 190.4501 169.6505 15.22532079 50977
ADEOS (Advanced Earth Observation Satellite-Japan 467.7, 2200, 8150, 8250, and 8350 MHz)
1 24277U 96046A 97154.23588698 -.00000044 00000-0 00000+0 0 1824
2 24277 98.5975 231.9713 0001118 105.8029 254.3277 14.27646138 41376

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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-94	July 1997 Columbia*	28.5/160	16 days	MSL-1 (Reflight)
STS-85	August 1997 Discovery**	57.0/160	11+1 days	CRISTA-SPAS-02
STS-86	Sept 1997 Endeavour***	51.6/213	9+1 days	S/MM-07

*Crew Assignment: CDR: Jim Halsell, PLT: Susan Still, MS: (PLC): Janice Voss, MS: Mike Gernhardt, MS: Donald A Thomas, PS: Roger K Crouch, PS: Gregory T Linteris.

**Crew Assignment: CDR: Curtis L Brown, PLT: Kent V Rominger, MS: N Jan Davis, MS: Robert L Curbeam, MS: Stephen K Robinson, PS: Bjarni Tryggvason (CSA).

***Crew Assignment: CDR: James D Wetherbee, PLT: Michael J Bloomfield, MS: Vladimar G Titov (RSA), MS: Scott E Parazynski, MS: Jean-Loup J. M. Chretien (CNES), MS: Wendy B Lawrence (U).

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

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

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1997	Pegasus XL	VAFB	FORTE
July 1997	Atlas IIA	CCAS	Superbird-C
July 1997	Pegasus XL	VAFB	SeaWIFS/SeaStar
July 1997	Titan IV	VAFB	DoD
July 1997	Delta II	CCAS	GPS IIR-2
August 1997	Delta II	CCAS	GlobalStar-1
August 1997	MSLS	VAFB	JAWSat-1
August 1997	Titan IV/Cent	CCAS	DoD
August 1997	Pegasus XL	WFF	STEP-4
August 1997	Delta II	VAFB	Iridium #3
August 1997	Atlas IIAS	CCAS	EchoStar-III
August 1997	Delta II	CCAS	ACE
August 1997	???????	CCAS	GE-3
September 1997	Atlas	CCAS	Echostar
September 1997	Atlas IIAS	CCAS	Galaxy-VIIIi
September 1997	Pegasus XL	WFF	ORBCOMM-1
September 1997	Pegasus XL	VAFB	WIRE
September 1997	LMLV 2	CCAS	Lunar Prospector
September 1997	Delta II	VAFB	Iridium #4
September 1997	Taurus	VAFB	GFO

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

L-1011 A/C	**Downlink Frequency Assignments**
L-band	1480.5 and 1727.5 MHz
S-band	2250.5 MHz
C-band	4583.5 and 5765.0 MHz

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

Superbird-C	**Downlink Frequency Assignments**
Ku-band	11.70-12.70 GHz
Ku-band	12.25-12.75 GHz

SeaWIFS	**Downlink Frequency Assignments**
L-band	1702.5 MHz
S-band	2272.5 MHz

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

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

GPS IIR-2	**Downlink Frequency Assignments**
L-band	1227.6, 1381.05, and 1575.42 MHz
S-band	2227.5 MHz

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

ACE	**Downlink Frequency Assignments**
S-band	2278.35 MHz

WIRE	**Downlink Frequency Assignments**
S-band	2215.0 MHz

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

GlobalStar	**Downlink Frequency Assignment**
S-band	2.4835-2.5000 GHz

Lunar Prospector	**Downlink Frequency Assignment**
S-band	2273.0 MHz

Satellite Launch Schedules

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
July 1997	Ariane 4	Kourou	Sirius-2A

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

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

Japanese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
August 1997	H-II	Tangashima	COMETS

COMETS — **Downlink Frequency Assignment**
S-band: 2269.68 MHz

List of Abbreviations and Acronyms

ACE	Advanced Composition Explorer, a charged particle detector for study of isotopic and elemental composition of energetic particles in interplanetary science.
C-band	3700 to 6500 MHz.
CCAS	Cape Canaveral Air Station, FL
CDR	Commander
CNES	Centre National d'Etudes Spatiales (National Center for Space Studies, France).
COMETS	Japanese Communications & Broadcast Engineering Test Satellite designed to demonstrate new high quality mobile, inter-satellite & broadcasting.
CRISTA	Cryogenic Infrared Spectrometer Telescope for Atmosphere, a U.S./German joint aeronomy payload to explore the variability of the atmosphere and to provide measurements that will complement those provided by Upper Atmosphere Research Satellite (UARS).
CSA	Canadian Space Agency
(D)	Crew member coming down from Russian Space Station MIR.
DoD	Department of Defense.
ECHOSTAR	A direct-to-home TV system working through 45 cm dishes.
FORTE	Fast On-orbit Recording of Transient Events will test the detection of nuclear detonations by RF pulses.
Galaxy	Hughes telecommunications satellite with principal applications including network TV, radio, VSAT, business video and data services.
GE-3	General Electric telecommunications satellite that will cover the continental United States including Alaska and Hawaii.
GFO	The GEOSAT Follow-On program is the Navy's initiative to develop an operational series of radar altimeter satellites to maintain continuous ocean observation from the GEOSAT Exact Repeat Orbit.
GHz	GigaHertz
GlobalStar	This system will offer mobile voice, data, and position determination using CDMA L-band up and S-band down for users.
GPS	U.S. Air Force global positioning satellite for military and civilian navigation services.
Iridium	The Iridium system is a planned commercial communications network comprised of 66 low earth orbiting satellites. The system will use L-band to provide global communications services through portable handsets.
JAWSat	An educational project with the major goal of developing a 3-axis control system. It will also demonstrate a Pulsed Plasma Thruster for stationkeeping by using ionised Teflon.
LMLV	Lockheed Martin Launch Vehicle.
Lunar Prospector	The goal is to map the Moon's global chemical composition, magnetic field and gravity field.
MHz	Megahertz
MS	Mission Specialist, a member of Shuttle flight crew primarily responsible for Orbiter subsystem and payload activities.
MSL-1	Microgravity Science Laboratory-1 is a payload which remains attached to the Shuttle to perform materials processing experiments in low-g.
ORBCOMM	Orbcomm will provide low-cost alpha numeric data communications and position determination for emergency assistance, data acquisition and messaging services using pocket portable and mobile subscriber terminals.
PLC	Payload Commander, a member of the Shuttle crew having overall crew responsibility for planning, integration, and on-orbit coordination of payload mission activities.
PLT	Pilot, a member of the Shuttle crew whose primary responsibility is to pilot the Orbiter.
PS	Payload Specialist, a member of the Shuttle crew, who is not a NASA astronaut, but whose presence is required to perform specialized functions with respect to one or more payloads or other mission unique activities.
RSA	Russian Space Agency.
S-band	2000 to 2300 MHz
SeaWIFS	To estimate ocean color, and derive from these measurements, various biological indicators and other useful scientific products.
Sirius-2	A telecommunications satellite for Nordiska Satellitaktiebolaget (NSAB) to be placed at 5 degrees East longitude.
S/MM-07	Shuttle mission to the Russian Space Station MIR to support design and assembly of the International Space Station.
STEP-4	The fifth U.S. Air Force Space Test Experiment Platform.
SUPERBIRD	The Superbird-C Ku-band communications payload supports 24 simultaneously active channels with flexible switching capability between antenna coverage areas.
TLM	Telemetry
TRK	Tracking
(U)	Crew member going up to Russian Space Station MIR.
UHF	Ultra High Frequency (390 to 499 MHz)
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
WBFM	Wideband FM
WIRE	Wide-Field Infrared Explorer, the 5th small explorer mission; which make wide field infrared studies of galaxies.
XL	Extra Large

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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 1997. The format of the listing is as follows:

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

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

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

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

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1997 Mar 1/0107	1997-009A	INTELSAT 801		3,420 kg
1997 Feb 28.85	7.01 deg	630.36 min	215 km	35,735 km
1997 Mar 12.97	0.06 deg	1,435.98 min	35,765 km	35,803 km

First launch of new-generation communications satellite for INTELSAT:manufactured by Lockheed Martin. Mass quoted is at launch: on station at the beginning of operations the mass is 2,044 kg and the dry mass is 1,601 kg. Operational lifetime is planned to be 15 years. Initially located over 46-47 deg East and was manoeuvred off-station approximately April 21 and relocated over 62 deg East (the planned operational location) approximately May 6, 1997. Launched from Kourou using an Ariane-44P.

1997 Mar 4/0200	1997-010A	Zeya		87 kg
1997 Mar 5.12	97.28 deg	94.06 min	467 km	480 km

Zeya is a small satellite which might be based on the Strela-1M military field communications satellites launched in octuplets during the 1970s and 1980s: this indicates that it is a spheroid, with a diameter of 0.6 meters. It carries 20 laser reflectors for geodesy and GLONASS and GPS navigation receivers for orbital determination to support its geodesy mission. It also carries the RS-16 amateur radio payload. Satellite was manufactured by NPO Prikladnoi Mekhaniki jointly with the Mozhaisky military space engineering academy. Maiden flight from the Svobodny launch site which is located at approximately 51.2 deg North, 128 deg East: launch vehicle was Start-1.

1997 Mar 8/0601	1997-011A	Tempo 2		3,561 kg
1997 Mar 8.14	25.84 deg	368.76 min	161 km	21,152 km
1997 Mar 21.24	0.60 deg	1,435.98 min	35,751 km	35,817 km

First flight of a new-generation of high power direct broadcast satellites to be operated by Tele-Communications Inc and built by Loral Space and Communications Ltd. Mass quoted is at launch: dry mass is 1,341 kg. Planned operating lifetime is 12 years. Initially located over 250 deg East, but to be operated over 241.2 deg East. Launched from Cape Canaveral using an Atlas-2A.

1997 Apr 4/1647	1997-012A	DMSP-2 9 (USA 131)		823 kg
1997 Apr 4.88	98.94 deg	101.91 min	844 km	855 km

Block 5D-2 military meteorological satellite (serial number S-14): manufactured by Lockheed Martin Astro Space (prime contractor). Design lifetime is four years. Launched from Vandenberg AFB using a Titan-23G: the launch vehicle stages are sub-orbital, with a STAR-37S motor—integral to the satellite's structure—performing the actual orbital injection.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1997 Apr 4/1921	1997-013A	Columbia (STS-83)		96,643 kg
1997 Apr 6.60	28.47 deg	90.54 min	299 km	304 km

Seven astronauts flying the Microgravity Science Laboratory (MSL-1) mission: J D Halsell (commander), S L Still (pilot), J S Voss (mission specialist, MS-1 and payload commander), M L Gernhardt (MS-2 and EVA crewman if required, EV1), D A Thomas (MS-3, EV2), R K Crouch (payload specialist, PS-1) and G T Linteris (PS-2). Planned 16-day mission curtailed due a faulty fuel cell and is scheduled to be reflown as STS-94 in July 1997. Returned to Kennedy Space Center on April 8, 1997, landing at 1833 UTC.

1997 Apr 6/1604	1997-014A	Progress-M 34		7,156 kg
1997 Apr 6.72	51.64 deg	88.63 min	187 km	227 km
1997 Apr 8.90	51.65 deg	92.25 min	378 km	392 km
1997 Apr 15.75	51.66 deg	92.36 min	384 km	397 km

Unmanned cargo freighter carrying supplies to the crew on board the Mir Complex. Docked at the rear port of the complex (-X) April 8, 1997 at 1730 UTC). Launched from Baikonur using a Soyuz-U vehicle.

1997 Apr 9/0859	1997-015A	Cosmos 2340		1,250 kg?
1997 Apr 9.42	62.92 deg	708.52 min	527 km	39,370 km
1997 Apr 18.34	62.94 deg	717.82 min	541 km	39,815 km

Oko early warning satellite manufactured by NPO Lavotchkin. Launched from Plesetsk using a Molniya-M vehicle.

1997 Apr 16/2309	1997-016A	THAICOM 3		2,650 kg
1997 Apr 17.20	7.02 deg	630.80 min	220 km	35,752 km
1997 May 4.64	0.09 deg	1,436.31 min	35,726 km	35,855 km
1997 Apr 16/2309	1997-016B	B-SAT 1A		1,236 kg
1997 Apr 17.64	7.01 deg	630.11 min	212 km	35,725 km
1997 Apr 28.26	0.17 deg	1,436.03 min	35,745 km	35,826 km

THAICOM 3 is a telecommunications and direct broadcasting satellite, to be operated by Shinawatra Satellite in Thailand and manufactured by Aerospatiale Espace et Defense. Mass quoted is at launch:in geosynchronous orbit at the beginning of operations it was 1,570 kg and the dry mass is 1,179 kg. Satellite to be located over 78.5 deg East. Planned operational lifetime is 15 years. B-SAT 1A is a direct broadcast satellite launched for B-SAT in Japan and manufactured by Hughes Space and Communications. Mass quoted is at launch: at the beginning of operations the mass was 724 kg and the dry mass is 490 kg. Satellite initially located over 121 deg East, but to be operated over 110 deg East Planned operational lifetime is about 12 years. Launched from Kourou using an Ariane-44LP.

1997 Apr 17/1303	1997-017A	Cosmos 2341		795 kg?
1997 Apr 18.18	82.92 deg	105.03 min	978 km	1,014 km

Military navigation satellite in the Parus system, co-planar with Cosmos 2310. Satellite manufactured by NPO Prikladnoi Mekhaniki. Satellite should be operational for about five years. Launched from Plesetsk using a Cosmos-3M. It had been planned to launch the United States FaiSat 2 with this satellite, but because the necessary documentation had not been ready in time for the launch this satellite was not carried: it is expected that FaiSat 2 will be launched in the second half of 1997.

1997 Apr 21/1159	1997-018A	MINISAT 01		209 kg
1997 Apr 21.54	150.96 deg	96.11 min	563 km	582 km
1997 Apr 21/1159	1997-018B	Third stage/Celestis 1		200 kg?
1997 Apr 21.61	150.97 deg	96.03 min	554 km	582 km

MINISAT 01 is the first Spanish-built satellite to be launched and it is manufactured by Construcciones Aeronauticas SA. Planned lifetime is 1-2 years. Pegasus-XL third stage had the Celestis 1 payload attached, carrying the cremated ashes of 24 people. L-1011

aircraft took off from Gando Air Force Base at 1100 UTC and the Pegasus was dropped at 1159 UTC to begin the ascent to orbit. First orbital launch from Gando, which is located at approximately 27.5 deg North, 344.8 deg East. This mission accomplished the greatest orbital inclination yet reached and also is the first launch (depending upon definitions) from Western Europe.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1997 Apr 25/0549	1997-019A	GOES 10		2,105 kg
1997 Apr 25.00	27.04 deg	758.27 min	144 km	42,190 km
1997 May 9.32	0.46 deg	1,437.69 min	35,617 km	36,019 km

GOES 10 (GOES-K before launch, Geostationary Operational Environmental Satellite) is part of the U.S. National Oceanic and Atmospheric Administration's (NOAA) program to provide synoptic visible and infra-red imaging and an infra-red/thermal sounding for atmosphere temperature profiles. Prime spacecraft contractor is Space Systems/Loral. Expected operational lifetime is about five years. Launched from Cape Canaveral using the final Atlas-1 rocket.

Updates for Previous Launches

International Designation	Comment
1964-006B	Elektron 2 decayed from orbit 1997 Apr 22.
1972-027A	Intercosmos 6 has been identified as undertaking a mission designated Energiya.
1976-017A	MARISAT 1 was manoeuvred off-station over 253 deg East approximately 1997 Apr 2 into what appears to be a retirement orbit. Add the following orbital data: 1997 Apr 14.91 12.79 deg 1,451.51 minutes 36,057 km 36,119 km
1978-069A	Cosmos 1026 has been identified as being photoreconnaissance satellite variant undertaking a mission designated Energiya, carrying a scientific payload.
1978-121A	Cosmos 1066 has been identified as being a scientific satellite, Astrofizika.
1981-050A	It has been confirmed that INTELSAT 501 has been retired.
1982-097A	INTELSAT 505 was relocated over 71 deg E approximately 1997 Mar 20.
1982-106A	In early April 1997 DSCS-2 15 was manoeuvred off-station over 65-66 deg E into what appears to be a retirement orbit. Add the following orbital data: 1997 Apr 19.12 8.73 deg 1,451.48 minutes 36,083 km 36,091 km
1983-058A	EUTELSAT-1 1 has been drifting since 1996 December 11 and has been confirmed as having been retired. Add the following orbital data: 1997 Apr 4.50 6.16 deg 1,456.42 minutes 36,150 km 36,217 km
1983-077A	ARABSAT 1D-R (the former TELSTAR 301) has been drifting since 1996 September 30 and is thought to have been retired, although confirmation of this has not been received. Add the following orbital data:- 1997 Apr 4.31 2.70 deg 1,446.93 minutes 35,897 km 36,100 km
1983-105A	It has been confirmed that INTELSAT 507 has been retired.
1984-026A	Cosmos 1543 has been identified as being photoreconnaissance satellite variant undertaking a mission designated Efir, carrying a scientific payload called Sokol.
1984-093C	It has been confirmed that LEASAT 2 has been retired.
1985-028B	Anik-C 1 was manoeuvred off-station over 288 deg E approximately 1997 April 11.
1985-028C	It has been confirmed that LEASAT 3 has been retired.
1985-120A	Cosmos 1713 has been identified as being photoreconnaissance satellite variant undertaking a mission designated Efir, carrying a scientific payload called Sokol-2.
1988-012A	Sakura 3A has been drifting since 1996 September 28 and is thought to have been retired, although confirmation of this has not been received. Add the following orbital data: 1997 Apr 2.78 0.70 deg 1,467.36 minutes 36,359 km 36,434 km
1988-098A	TDF 1 has been drifting since 1996 October 4 and is thought to have been retired, although confirmation of this has not been received. Add the following orbital data: 1997 Apr 6.51 0.69 deg 1,451.65 minutes 36,078 km 36,103 km
1988-108A	Ekran-M 4 has been drifting since October 1996 and it believed to have been retired.
1989-030A	Raduga 23 has been drifting since July 1996 and is believed to be no longer operational.
1989-048A	The last set of orbital data for Raduga-1 1 for 1996 was issued for epoch Dec 20.71 and this showed the satellite located over 69-70 deg E. No further orbital data were issued until 1997 April 3, showing the satellite drifting in a retirement orbit. The satellite was possibly boosted off-station in late-1996 and "lost" by USSPACECOM. Add the following orbital data: 1997 Apr 3.43 4.90 deg 1,458.83 minutes 36,165 km 36,296 km
1989-052A	The recent orbital history of Gorizont 18 is somewhat contradictory. The last sets of orbital data issued in 1996 were for October 15 showing the satellite over 137-138 deg, slightly off-station. No further data were issued by USSPACECOM until 1997 March 15 showing the satellite's longitude stabilised over 150 deg E. The last set of data to show this location was issued for 1997 March 31, but for the next date the satellite was shown drifting over 105 deg E with a drift rate which is incompatible with the longitude change and time change.
1989-084B	The Galileo Jupiter Orbiter performed a fly-by of the Jovian satellite Europa on 1997 Feb 20, the minimum distance being 587 km.
1990-116A	Raduga-1 2 has been drifting since the middle of 1996 and is believed to be no longer operational.
1991-015B	METEOSAT 5 was manoeuvred off-station over 0-1 deg E approximately 1997 Mar 15.
1991-084B	INMARSAT-2 F-3 has been relocated from 180 deg E to 64-65 deg E: details of the relocation based upon the two-line orbital elements are not too clear, but the satellite was last shown over 180 deg E 1997 Feb 14 and first shown over 65 deg E 1997 Mar 19.
1992-059A	Cosmos 2209 has been drifting since October 1996 and is believed to be no longer operational.
1993-072A	Gorizont 29 had its orbital longitude stabilised over 160-161 deg E 1997 Mar 8.
1994-082A	Luch 1 was manoeuvred off-station over 95 deg E 1997 Mar 28.
1995-008A	Add the following orbital data for Cosmos 2306: 1997 Apr 22.14 65.85 deg 94.34 minutes 458 km 515 km
1995-008G	Add Cosmos 2306 sub-satellite 5, a sphere. Orbit: 1997 Apr 22.02 65.86 deg 94.46 minutes 469 km 515 km
1995-008H	Add Cosmos 2306 sub-satellite 6, a sphere. Orbit: 1997 Apr 22.02 65.84 deg 94.40 minutes 464 km 515 km
1995-008J	Add Cosmos 2306 sub-satellite 7, a sphere. Orbit: 1997 Apr 22.02 65.86 deg 94.29 minutes 453 km 515 km
1995-008K	Add Cosmos 2306 sub-satellite 8, a sphere. Orbit: 1997 Apr 22.02 65.83 deg 94.24 minutes 448 km 515 km
1995-008L	Add Cosmos 2306 sub-satellite 9, a sphere. Orbit: 1997 Apr 22.27 65.87 deg 94.34 minutes 458 km 515 km
1995-008M	Add Cosmos 2306 sub-satellite 10, a sphere. Orbit- 1997 Apr 26.01 65.83 deg 94.34 minutes 459 km 515 km
1995-016B	Hot Bird 1 appears to have been relocated from 18 deg E to 12-13 deg E during the first half of April 1997, but the available orbital data do not allow the dates of the relocation to be pinpointed.
1995-028A	Cosmos 2313 performed an end-of-life manoeuvre to lower perigee on 1997 Apr 22-23. This leaves two EORSATs operating: Cosmos 2326 (1995-071A) and Cosmos 2335 (1996-069A). Add new orbital data (pre-manoeuvre): 1997 Apr 22.75 65.03 deg 92.78 minutes 403 km 419 km (post-manoeuvre) 1997 Apr 23.54 65.04 deg 90.96 minutes 227 km 416 km
1997-002A	GE 2 apparently had its orbital longitude restabilised over 275 deg East during the first week of March 1997.

Marisat 2 and Marisat 3: Mystery Solved

It was previously noted that there was confusion over the orbital data when Marisat 3 was retired, since the orbital data indicated that it was Marisat 2 which was retired. There were two reasons for the confusion which solve the "mystery."

First 1976-053A (8882) is Marisat 3 and 1976-101A (9478) is Marisat 2.

Secondly USSPACECOM occasionally interchanged the orbital data for the two satellites. When Marisat 3 was retired USSPACECOM switched the orbits with the international designators to correct their cataloguing error, and also having the Marisat numbers interchanged caused the confusion.

Interchanging the satellite names compared with the international designators (and catalogue numbers) now correctly shows Marisat 3 as being retired in a drift orbit and Marisat 2 located over 72 deg East.

ST

Explore the World of Satellite Audio with Universal's SC-50

By Ken Reitz, KS4ZR

Just when you thought there wasn't anything new in the world of C-band satellite, here comes Universal Electronics with a totally new approach to enjoying the more than 100 audio services being delivered via satellite every day. Audio subcarriers are frequencies on satellite transponders which are below the video transmission and are used to transmit, among other things, the audio portion of the program you see on your television.

In the early days of the satellite TV hobby, broadcasters used one of two standard audio subcarriers to transmit program audio. The other channel was most often unused or, at best, merely duplicating the other. Indeed, many old satellite receivers tuned only the two common subcarrier frequencies usually with an on/off switch on the front panel. Later model satellite receivers tuned through a set of frequencies from 5 to 9 MHz. By the early 1980's audio program services were transmitted to cable systems around the country which featured commercial-free, formatted programming. One such service was called *Studio Line*, with several separate channels offering a wide variety of audio programming. Today's Super Audio service is similar.

By the 1990's, satellite receiver manufacturers were taking advantage of the great quantity of auxiliary programming and had made improvements on the audio portion of their receivers. Among the improvements were two separate audio channels which could be tuned independently to receive stereo; most featured digital read-out tuning for accuracy. Today's receivers do the tuning electronically via the remote control and display the audio frequencies on the television screen.

But, there are some drawbacks to the way things are done today. First, as mentioned, the tuning is done on the TV screen; you have to have the TV on in order to tune the audio. Secondly, if you're tuning a VCII encrypted channel you have to step through a number of hoops to access the subcarrier tuning. Even when you do, if you switch channels the receiver defaults to the VCII setting and you have to re-tune the audio. Thirdly, the receivers don't tune the full audio spectrum from 0.01 to 9.00 MHz. Dozens of audio subcarriers are lost. And, finally, there's very limited ability for storing popular channels in receiver memory without having to re-tune.

SC-50 to the Rescue

Many of you will recognize Universal Electronics as the maker of the SCPC-200, the full featured Single Channel Per Carrier (SCPC) receiver. And if you look closely at their SC-50 you'll notice the family resemblance. Using the same case and front panel controls, the SC-50 appears identical.

A look at the back panel shows some changes. Since the SC-50 uses the baseband signal from your satellite receiver, there's no need to connect to the LNB directly. Instead, a simple patch cord with RCA connectors goes from the baseband output on your receiver to the input of the SC-50. There are two outputs on the back which allow the tuned signal to be heard either through an external 8 ohm speaker or line output to your stereo. There's also an on/off toggle switch which mutes the audio while tuning to avoid the hiss of the spaces between carriers.

The main feature of the SC-50 is the LCD display screen. Unlike the SCPC-200, the SC-50 is back-lit to make reading the screen easier. It's a snap to see the status of the subcarrier currently tuned: an "N" or "W," indicating narrow or wide bandwidth tuning, is seen at the extreme left of the screen. Next the frequency is displayed followed by a five character "service identifier." And, finally, the memory location is indicated.

Using the SC-50

Installation of the SC-50 couldn't be easier. Inserting the included power jack; plug in the patch cord from your satellite receiver's baseband output; and plug in a speaker or hook it up to your stereo system. The SC-50 is ready to go in minutes. If you set your satellite receiver to go to Spacenet 3 channel 24 and tune the SC-50 to subcarrier 5.80 MHz, you'll hear Prime Sports Radio, a 24 hour/day sports talk network.

How do you know if it's properly tuned in? Aside from the digital readout there are three LED indicators aligned vertically with a green LED between two red LEDs. When the green LED is lit, you've tuned the center of the signal. It's that simple! Now tune to channel 9, 6.80 MHz and you'll hear Talk America. So far, it's just like any other satellite audio receiver. But, tune to channel 17, .33 MHz. and you'll hear the UPI Radio Network. Keep tuning and you'll hear more music and information. This is where the SC-50 leaves the others behind.

If you have a Ku-band LNB you'll hear dozens more signals just by going to Galaxy 4 and tuning channels 3, 4, and 16. For a complete look at all the audio services you could be listening to, check out the *Satellite Services Guide* in this magazine on pages 40 and 41. The SC-50 comes with a very well presented *Installation and Operation Manual* and the latest copy of the *Satellite Radio Guide for the Universal SC-50.* The 12 page *Guide* lists all the FM and FM Squared frequencies in detail.

One big advantage of the SC-50 is the 50 channels of memory you can use for quick

access to your favorite channels. Using the left and right Next keys on the front panel, a cursor highlights the various characters on the LCD screen. When you're ready to store a favorite channel just move the curser and press the Up/Down buttons to spell the name on the service identifier segment of the LCD screen and store the whole screen in memory. When you return to that satellite and channel later, you'll simply scroll through the memory to tune the channel. If you're using a speaker attached to the SC-50, the volume control knob on the right will adjust the volume. If you're using the line-out on the back, your stereo amp will adjust the volume.

SC-50 Performance

I tested the unit alongside my satellite receiver using an A/B switch to flip back and forth between the two to try to detect any differences. The SC-50 delivered audio every bit the equal of my receiver and considerably better than the outboard stereo processor I had been using for additional subcarrier listening.

The SC-50 delivered crisp, clean audio. The tuned signals had greater dynamic response with a fuller-bodied audio than my satellite receiver. When the audio was in-between songs, the subcarriers were even quieter with the SC-50. The tuning is precise and drift-free. It's also much faster than tuning with a remote control, thereby making it easier to switch services on the same channel even if they're not in the memory bank.

This makes it a breeze to spot all the channels for new audio services. I ran across several of which I had been unaware when I first fired up the SC-50. The SC-50 tuning speed really takes the work out of tuning the hundreds of satellite channels for undiscovered audio services.

The Up Shot

The SC-50 has only one drawback: it's not stereo. The way subcarriers work is that information on the left and right channels of a stereo program are transmitted on separate frequencies. Satellite receivers equipped with two separate audio subcarrier tuners can tune in both frequencies for stereo. This is not as big a problem as one might first think. First, many satellite receivers don't tune stereo anyway; second, many subcarriers are only transmitted in monaural; and third, audiophiles can buy two SC-50s, if they really have to, and tune them separately.

The SC-50 provides the first opportunity the satellite hobbyist has had to be able to tune the entire transponder for subcarrier signals, and, combined with the SCPC-200, becomes a compact and versatile listening post for the entire satellite audio spectrum. The SC-50 can also be used as a stand-alone unit dedicated to audio services-only by using the baseband output of any satellite receiver hooked up to a fixed dish to tune the desired signals. This means that you can have a stand-alone radio dedicated to one particular service, like the BBC or KLON.

The SC-50 is thoughtfully designed, very easy to use, extremely well built and delivers superb audio. What more could anyone want? It's a terrific addition to every satellite enthusiast's listening post.

You can order a Universal SC-50 receiver through Grove Enterprises by calling 800-438-8155 or outside the U.S. at 704-837-9200. ST

ST THE BEGINNER'S COLUMN

By Ken Reitz, KS4ZR
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Increasing Your Satellite Times IQ

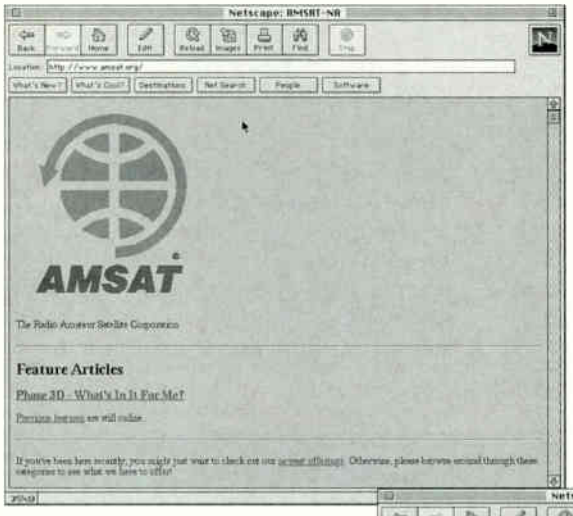
I hope you saw the report on the news (and, this is a true story) about the group of amateur rocket scientists from North Carolina who successfully launched their own suborbital payload. According to the news report, they built their rocket, made entirely from off-the-shelf parts, and carried it aloft to about 50,000 feet in a helium balloon where the rocket was ignited and soared to an altitude of 38 miles. While this news may be unsettling to those of us who might use commercial aircraft or who happen to live down-range from similar groups, it's a fascinating look at what hobbyists with a passion, and a couple thousand spare bucks, can do.

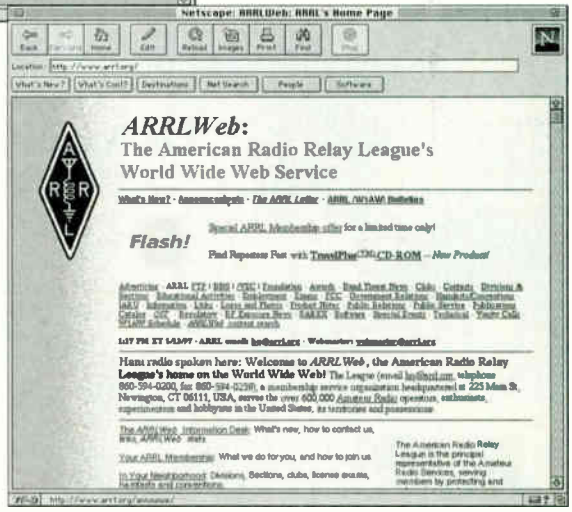
Amateur radio operators have been doing similar things since 1937 when Grote Reber built a 31 foot radio telescope in his backyard to map the sky and, in so doing, invented radio astronomy. Since then, hams have been busy bouncing radio signals off the moon and building their own sophisticated satellites. There seems to be no limit to what an individual or group of individuals will try to do to satisfy that quirky part of the human brain which itches with curiosity.

That's what this magazine is all about: scratching the itch of hobbyists who have a passionate curiosity about space, satellites, electronics, and everything in between.

Born Ignorant

I hope you don't think that everyone else was born knowing about Keplerian element sets, uplinks, and apogee. Even at this stage in the development of space technology this is pretty arcane stuff. It's a bit like being a sorcerer's apprentice; not everyone has enough curiosity to put in the time it takes to gain the knowledge. But, the more you learn, the more interesting it becomes and the more you can do. Anything this complicated will take a long time to really master. But, luckily, there are plenty of interesting things to do while you cultivate this knowledge.





The best part is that you need not wait long for this quest for knowledge to bear fruit. You can apply the simplest things you've learned and explore the more complex aspects as your life permits. Let's face it, most of us are not endowed with unlimited funds or time to pursue our satellite hobby. Since you're reading the *Beginner's Column*, I'm going to assume that not only do you not know a downlink from a sausage link, but that you have an interest in learning the difference. So, let's get started. If you bought this magazine off the newsstand, the first thing I'm going to recommend is that you waste no time starting your subscription. That's because, as you get more into this hobby, you'll realize that you'll never find this much useful, timely, and detailed information on the satellite hobby, this cheaply, anywhere. You won't want to miss an issue.

Amateur Radio Satellites

With the pending launch of the next generation of amateur satellites, this segment of the hobby will become the hot place to be. If you're not a licensed ham you might be surprised to learn that it's never been easier to get your ticket. But, even if you don't have your license, there will be plenty of action to monitor with your scanner or shortwave radio.

How do you get started? Simple, go to the source: AMSAT, the Radio Amateur Satellite Corp. Contact AMSAT at 850 Sligo avenue, Suite 600, Silver Spring MD 20910-4703 or call 301-589-6062. Website: **http://www.amsat.org**.

The Amateur Radio Relay League (ARRL) has all the information you need on earning your license and they can direct you to amateur radio clubs in your area which host license testing sessions and hold club meetings where you can meet the similarly afflicted. Contact ARRL at 225 Main St., Newington, CT 06111-1494 or call 860-594-0200 FAX 860-594-0259 Website: **http://www.arrl.org**.

Weather Satellites

Unlike amateur radio, there's no single organization for weather satellite enthusiasts. There is, however, one very informative book which serves as an excellent introduction to the hobby: *The Weather Satellite Handbook* (reviewed in this column *ST* Jan/Feb 1997). There are cheap and easy ways

to get started in viewing weather satellite imagery without a big investment in fancy equipment. Using your computer, a short-wave radio, a simple modem, and a shareware program, you can begin receiving weather satellite imagery in no time. Order the book from the Grove Buyer's Guide. Contact: Grove Enterprises P.O. Box 98, Brasstown, NC, 28902-0098 or call 800-438-8155, Fax 704-837-2216. Website: **http://www.grove.net.** For information on the modem and shareware get a copy of *HF FAX On A Shoestring* (*Monitoring Times*, August, 1996 pp. 13-15.) at $3 plus an SASE from Grove Enterprises.

Satellite Television

Information on satellite television tends to be expensive. Typically, industry trade books and journals run in the $40 to $100 category. But, there is one book which is cheap enough and yet informative enough for beginners: WRTH's *Satellite Broadcasting Guide.* This annual publication has 350 pages of enough information to keep you occupied for many long nights. It features footprint maps of all the world's satellites, an extensive glossary, and a useful introduction to physics and mechanics of broadcast satellite technology. Since this information changes so quickly, make sure you get the latest issue available. The book sells for around $20 and is also available from the Grove Buyers Guide.

This Is Not A Test

So, there you have it, fellow beginners: An easy introduction to three of the most popular facets of the satellite monitoring hobby. Start your learning quest today and the next time you hear about amateur rocket scientists and their amazing accomplishments you'll know just how they got there. Heck, you just might be with them!

Mailbag

This time we have two interesting questions from *ST* readers and they're both related to the question of signal strength and antenna gain. Erik Forrest of Athens, Ohio, bought his C-band satellite TV system primarily to receive classical music on the various audio subcarriers. He's using a six foot dish, a 26 degree LNB, and a Drake ESR 1424 receiver. He says, "...I get good television reception on most channels on a number of satellites but I am having some problems with sound quality on the audio stations...There is a lack of lower and middle-lower frequency output. [Reception]...is quite good on E2 (Canadian stations), less good on G5 (WFMT) and is least good on F4 (WQXR)...Can you tell me if this is due to some deficiency in the receiving equipment or is it inherent in the quality of the audio broadcasts themselves?"

Erik, the first thing I did was tune in the audio services in question on my receiver and all three came in quite nicely, though, I have to say there was a dramatic improvement when comparing the audio from my receiver (a Uniden President 500XL) and the new Universal SC-50 stand-alone subcarrier receiver (see review in this issue of *ST*). Next, make sure you have configured your receiver properly. It needs to be in narrowband audio and tuned for best signal, not necessarily the frequency listed in any of the guides. This is because each receiver and LNB combination is slightly different and may result in slight frequency read-out discrepancies.

Your location puts you in a good position as far as the signal level within the footprint of the satellite goes. There is a possibility that a six foot dish is not up to the task, but I've installed a six footer further south than your location and got nice audio on the subcarriers. Assuming an efficiency of 70 percent (typical for prime-focus C-band mesh dishes), a 10 foot dish has a gain of about 40.6 dB, whereas a six foot dish, at the same efficiency, is said to have a gain of just under 36.2 dB. That's a lot of signal to give up which can't be regained through lower temperature LNBs or any other tricks. There's also a chance that there might be some leafy obstructions from nearby trees which will cause a loss of signal.

But, since the signals degrade as you go west in the Clarke Belt, my suggestion is that your system could do with a little peaking. Since the audio is a narrow bandwith transmission, it requires a much more accurate installation. Many dealers, when doing installations, peak the system so that the video is sparkle free. But, with a little extra work, reception on almost any installation can be improved. Ask your dealer to peak the system for noise-free audio. A good dealer will rise to the occasion. You might consider trying the SC-50.

David Neal of Erie, Pennsylvania, wants to know if it's "...possible to receive the exact same satellite programming in the Hawaiian Islands that is available on the mainland U.S. I also understand that you can get the Playboy Channel in Iran. I don't understand how this is possible."

It is possible to get the same programming in the Hawaiian Islands as on the mainland providing that the satellites in question have spot beams for the islands. Even so, there will be a dramatic drop in signal due to the curvature of the Earth. As an example, footprint charts indicate that Galaxy 5 provides a signal of 39.5 Effective Isotropic Radiated Power (EIRP) for the center of the footprint and 32.5 EIRP for the Islands. That's a whopping 7 dB loss! The only way to make up for such a loss is by using a large dish. By installing a 23-foot dish in the Hawaiian Islands you could, theoretically, add enough gain (7 dB), to make up for the difference. Of course, it would cost several thousand dollars more than a traditional 10-foot dish.

The situation regarding the Playboy Channel in Iran is a little different. First, private satellite dishes in Iran are illegal. Secondly, the Playboy Channel would be considered offensive material to Muslims. According to the WRTH *Satellite Broadcasting Guide*, the Playboy Channel is only found in Europe on transponder 47 in the PAL format using VideoCrypt encryption on Astra 1C at 19.2 degrees East.

Frequencies on the Ku-band are subject to the same laws of physics as C-band. It would require a *very* large dish and a subscribed VideoCrypt-authorized receiver to do the job. ST

By Steve Dye, *gpsyes@aol.com*

Product Review: Delorme Tripmate GPS Receiver

This edition's column is a little different in format from the usual. As promised in the last edition, it features a review of the Delorme Tripmate—a newcomer to the PNS (Personal Navigation System) market.

Product Description

The Tripmate is a small, 12 channel GPS receiver that connects to a laptop computer's serial port and works in unison with the CD-ROM-based software, Street Atlas 4 also by Delorme. The GPS receiver provides a serial stream of data pertaining to the latitude, longitude, elevation, and speed of the vehicle it's situated in. The software largely consists of a database of streets, towns, cities, and zip codes. Street Atlas 4 reads in the GPS serial data, and plots the receiver's position on the map. No matter where you are in the USA, your position, direction of travel, and path traveled is shown on the screen.

The general principal behind this product is to assist people, be they general business or pleasure travelers, to quickly locate their position in unknown territory and find the way to their destination with ease. GPS is particularly suited to this type of application by its ability to pinpoint a position with workable accuracy and to determine the direction and speed of travel.

Using the Tripmate

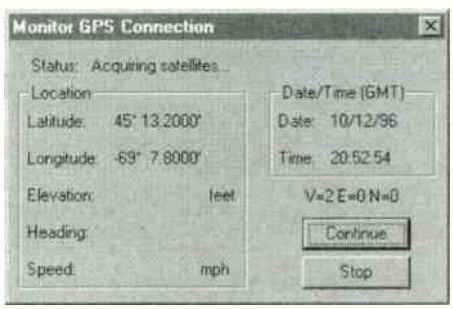
Setting up the Tripmate could not have been an easier task. Four AA batteries are inserted into the device, and the serial data plug is connected to the laptop's serial port. Ideally, a laptop with a built-in CD ROM drive should be used with the Tripmate so that program and data files can be directly loaded and accessed from the CD. If the user's laptop has no CD ROM drive, a desktop multimedia PC will be required to down load the pertinent files to the laptop. 25 MB of drive space will be required, in addition to the space needed for the map of the area you wish to navigate.

Once the software has been loaded, the GPS initialization procedure is carried out by following on-screen commands. Figure 1 shows a screen shot of the "Initialize GPS" dialog box that appears. Selecting the state, time, and date, helps the Tripmate work out its location and the position of the satellites it needs.

FIGURE 1. ***Screen shop of the "Initialize GPS" dialog box.***

Figure 2 shows the next window that appears, providing more GPS information such as latitude, longitude, heading, elevation, and speed. There also three other items of interest featured in this dialog box: namely V, E, and O. The V parameter indicates the number of satellites visible to the Tripmate: E refers to the number of satellites Ephermeris data is being received from; N indicates the number of satellites providing navigation data to the Tripmate.

FIGURE 2. ***Screen shot of the "Monitor GPS Connection" dialog box.***



Once the initialization process is complete and visibility to satellites is achieved, a green dot should appear in the screen's center indicating the user's location. If the user starts to drive, the green dot turns into an arrow pointing in the direction of travel. The green arrow will *always* point in the direction of travel, a useful feature to many of us!

Should the number of satellites fall below four, the arrow turns to yellow. In the event no navigational data is received, due to satellite visibility, the arrow turns red. This useful function enables the user to reposition the Tripmate for better satellite visibility if possible.

On the Road

In practice, the Tripmate performs very well. The 12 channel receiver with its built-in antenna allows visibility to several satellites, invariably 6 or more on a light urban road. Good access to the constellation is really only possible when the unit is positioned on the dashboard, since the windshield provides most visibility to the sky.

In a series of drives around my neighborhood, the accuracy of the Tripmate in conjunction with the software was impressive. The vehicle's position was accurately indicated on every journey. Similarly, the vehicle's position at cross streets was also precisely positioned. The accuracy of civilian GPS, as regular readers will know, is to within 100 meters. In general, you can expect better than 30 meters most days, but the Tripmate seemed to perform so well that accuracy was not an issue at all.

Figure 3 shows a photograph of the Tripmate. The antenna is encased in the circular end of the housing and the cable appearing out of the opposite end connects to the computer's serial port.

The Tripmate is powered by four AA batteries and will provide continuous operation for at least 15 hours. The power supply on the Tripmate is an unfortunate issue: There is no power switch on the unit! Powering down involves opening the receiver's case and removing the batteries. This is hardly a convenient feature for an item designed to be, consumer-friendly. The battery life of 15 hours is a result of the fact that the manufacturer purposely omit-

FIGURE 3. ***Delmore Tripmate Hyperformance GPS Navigation***

ted the clock and the memory that retains the satellite's ephemeral data.

All other GPS receivers feature an onboard memory module of some form that retains the receiver's last position, keeps the current time, and information pertaining to the last satellites' position and orbital errors etc. Without this information, a GPS receiver must perform a sky search to download all this data from the visible satellites every time the unit is powered up. In omitting the memory module, the GPS receiver will certainly save on battery power, but at great inconvenience to the user.

The Tripmate has a temperature operating range of between -10 and 60 Celsius. It would be extremely prudent, therefore, to take your Tripmate out of the car if you live in a state where these temperatures would be easily reached on the dashboard. Another small, but annoying, feature of the Tripmate is that in order to receive a reliable navigation signal, the Tripmate must be positioned on the dashboard, in front of the windshield. This can be of great inconvenience, particularly when making a sharp turn or breaking sharply.

The Street Atlas software is very limited in functionality. GPS provides so much more information than just latitude and longitude, that I am surprised the software did not exploit this to the fullest. The GPS monitoring dialog box displays elevation, bearing, and speed, but only when the user intervenes and calls for it from the menu bar. However, navigation using the map is not possible when this dialog appears and no other simultaneous function can be used. There would have been no harm in displaying these items adjacent to the latitude and longitude on the status bar, and it is a shame these have been missed out.

If the program featured the ability to enter destination information, suitable software could be included to show your relative distance and bearing to the destination as well as the ETA in real time. This demonstrates how limited the software is in not fully utilizing the interaction of GPS information and with GIS (Graphical Information Systems).

Summary

Delorme has to be congratulated on what appears to be the first, off-the-shelf PNS device for everyday use. The Tripmate is a useful little device and serves its function well. Providing all you want to do is track a route, see where you are, where you're going, and in what direction, then the Tripmate is perfect for the job, and affordable, too. The Tripmate, I am sure, will serve as a paradigm for more devices that will surely follow its entry into the market. The software and receiver are very easily set up, and no real problems should be experienced in using the system.

The Tripmate has no external power switch and requires that you open the case to remove the short-lived batteries every time you have finished using it. An optional power adapter kit for $39 pushes the price above what may have been affordable, making the economics of the device questionable. The software, though functional, could offer more considering the wealth of information GPS provides, and the storage space available on a CD ROM. The Tripmate does have a tendency to come unstuck from the dashboard during routine driving maneuvers but is only reliable when placed in that position.

Navigating using the Tripmate is really a task that requires two people: one to drive and one to operate the computer. It is both dangerous and difficult to read your position on the screen as you try to drive as well. A navigator would certainly alleviate this problem, but I'd hate to be that person if the passenger air bag went off with a notebook on my lap.....

On a one- (worse) to four- (best) star scale:

Usability	★★	
Functionality	★★	
Affordability	★★★	
Overall figure of merit	★★1/2	ST

Steve Dye's book GPS Principles and Applications is available from Grove Enterprises.

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

Software Review: *Micro Orbiter 3.0*

One of the most common questions I get when talking to satellite tracking enthusiasts—both amateur and professional—is "what's the best satellite tracking software currently available?" Of course, there is no "best" package, because the features that make a particular software package great for one person won't satisfy another. That being said, some packages are better suited for certain tasks, but without a review of the contenders, it's hard to know which ones those are.

With that in mind, I'd like to start off with a review of *Micro Orbiter 3.0*. Of all the packages I've had a chance to look at, it is one of the few that will still run on a PC under *MS-DOS* and provide stunning graphics while doing so. It will also run in full-screen mode under newer operating systems such as *Windows 95*, but running in a standalone window requires some extensive configuration (instructions for which are not included in the documentation). Let's take a closer look at how *Micro Orbiter 3.0* stacks up.

Installation and Documentation

Micro Orbiter 3.0 Release 4.2, written by Peter D. Armstrong of Precision Software Solutions, comes on three 3.5-inch diskettes together with an 82-page users guide, a command summary/quick start and reference summary card, and a postage-paid registration card—it even comes with a pen to use for filling out the registration card!

Precision Software Solutions has made every effort to make installation a snap. The installation instructions are very simple and the process itself is very straightforward. Overall, it took me less than five minutes to install the software and get the program up and running. And, the entire installation (including the optional US-only airport data) takes up just over 4 megabytes of disk space. The documentation is thorough, well organized, and easy to read.

Features

If you are serious about your satellite tracking, your first concern when evaluating a satellite tracking package is to determine what kind of orbital model is used. Since most of us rely on the NORAD two-line element sets as our data source, it is important that a satellite tracking program include the SGP4 and SDP4 orbital models. *Micro Orbiter 3.0* incorporates not only SGP4 and SDP4 but also includes the older SGP and the newer (but never implemented) SGP8 and SDP8.

Micro Orbiter 3.0 will allow for tracking of up to 20 satellites from a database of 65,535 satellites—more than enough, since NORAD itself only tracks about 7,500 today. Options for how to display these satellites abound, with no less than ten different projection modes:

- Mercator (see figure 1)
- Orthographic (see figure 2)
- Armadillo
- Alber's Equal-Area
- Littrow
- Gnomonic
- Aitoff
- Lagrange
- Oblique Aspect
- Star Chart (see figure 3)

If anything, the wealth of projections is almost overwhelming. It quickly becomes apparent that projections were added to the program incrementally, since the hot-key combinations, mapping features, and modes of operation vary among the many projections. But even here, *Micro Orbiter 3.0* provides a solution by providing a pull-down menu which provides a much cleaner presentation of the options available—I only wish it had mouse support to make this type of access easier.

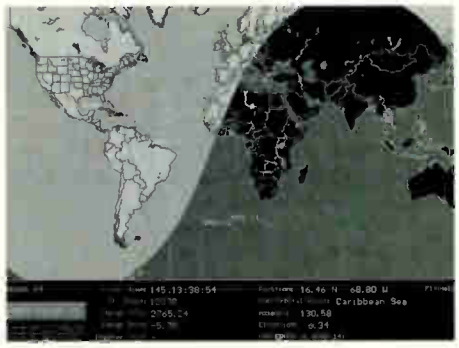


FIGURE 1. *Mercator projection of NOAA weather satellites.*

FIGURE 2. *Orthographic projection of NOAA weather satellites.*

The program has a clean, professional-looking interface and the graphics are both fast and superb, especially for *MS-DOS*. Most displays include: time (elapsed or local), range, range rate, doppler, latitude and longitude, and azimuth and elevation. These data can also be output to a text file for more precise analysis. And, context-sensitive help is available throughout the program—that is, when you hit F1, you get help tailored to the part of the program you are currently working with.

The only problem I had with the interface was using the hot key combinations. Not all of the hot key sequences make sense (most likely the result of features being added over time) and the command summary card has the hot keys listed in alphabetical order rather than functionally grouped. The context-sensitive help is a great aid here and the pull-down menus do group things functionally.

Almost everything in *Micro Orbiter 3.0* is configurable to accommodate varied user tastes. Don't like the map colors? Change them. Want to show constellation names on your star chart? Go right ahead. The

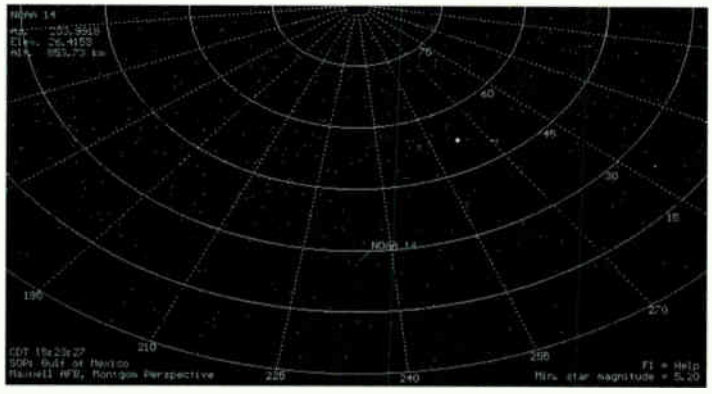


FIGURE 3. ***Sky projection of NOAA 14 satellite.***

options for displays are well thought out, right down to allowing night-vision colors for the star chart (see figure 3).

Micro Orbiter 3.0 is best suited to real-time tracking. While it does have features to do some rudimentary time control, such as advancing manually or automatically (in most modes) or jumping to a particular time, this control lacks flexibility. For example, there is no way to look at a satellite's position prior to the epoch of the element set being used—the program assumes such a projection would be invalid and provides no option to override it. These limitations can make analysis difficult.

In real-time tracking mode, however, *Micro Orbiter 3.0* excels. There are features to calculate upcoming passes—visible or otherwise—and event timers which count down to inform you of when an upcoming event (rise, set, peak elevation) will occur. In fact, the user can set *hundreds* of event timers. The user can even generate pass schedules for large numbers of satellites at once, although this output goes to a text file. Displays show the position of the sun and moon, and will indicate when a satellite is illuminated and visible above the observer's horizon. For star backgrounds, *Micro Orbiter 3.0* uses the *Yale Bright Star Catalog* of over 9,000 stars (down to magnitude 8.2).

Last, but not least, is the ability to input orbital data. The layout here is not as clear as other parts of the program, but the context-sensitive help will guide you through. It is quite easy to update, append, merge, or replace elements in the master database using text files containing NORAD two-line element sets found on the Celestial WWW site and many other sources. The only apparent limitations are in the delete function which will only work with a single satellite at a time—making it difficult to clear out the file and start over, and the search function—which requires a case-sensitive exact match.

Selecting 20 satellites out of 65,535 to begin tracking might seem like a daunting task, but *Micro Orbiter 3.0* does provide a mechanism to track groups of satellites with a little pre-configuration. By defining a list of satellites in a text file and then creating an *MS-DOS* batch file to make this file the default tracking file, it is easy to start up by tracking your favorite weather, amateur radio, or visible satellites.

Benchmarking

The bread and butter of any satellite tracking program lies in the accuracy of its predictions. All the fancy graphics in the world won't amount to much if the results can't be relied upon. In an earlier column on benchmarking ("Real-World Benchmarking," *Satellite Times*, Volume 3, Number 2), we demonstrated that the basic routines used in my *TrakStar* program were able to predict satellite positions within about one-tenth of a degree—*TrakStar* has also been validated against test cases for SGP4 and SDP4 provided by US Space Command.

As such, we can use the output from *TrakStar* and compare it to that of *Micro Orbiter 3.0* to give us an idea of how well the latter performs. I used NORAD Element Set 201 for *Mir* and generated ephemerides (tables of predictions) of ECI position and velocity, and latitude, longitude, and altitude for the period 1200-1230 UTC on 1997 April 17; and azimuth, elevation, and range for the period 0157-0207 UTC on 1997 April 18 for a limited test case. The results are shown in table 1.

There was no difference at all in the SGP4 position and velocity predicted by *Micro Orbiter 3.0*, indicating a good implementation of the NORAD model. There was some small difference in the latitude and altitude (but not the longitude) of *Mir*, most likely due to a difference in the model of the earth's shape used by the two programs—*TrakStar* uses WGS 72; *Micro Orbiter 3.0* uses WGS 84. Finally, there was no difference in azimuth or range between the two programs, but there was a difference in elevation, which was inversely proportional to the elevation. This result is probably due to the fact that *TrakStar* models atmospheric refraction at standard temperature and pressure, and *Micro Orbiter 3.0* does not. Overall, a very good performance by *Micro Orbiter 3.0*.

It should be noted that by "differences," I do not mean to imply that *Micro Orbiter 3.0* is in error—only that it uses different modeling assumptions than *TrakStar*. These differences are well within the error tolerance of the SGP4 orbital model (5 kilometers with 90 percent confidence) and should not be treated as significant.

Summary

Micro Orbiter 3.0 is a superb choice for real-time satellite tracking—especially if you are still using *MS-DOS*. Installation is a snap, taking less than five minutes to get it up and running. Orbital predictions are quick and accurate, based upon the NORAD orbital models, and an easy mechanism for importing two-line element sets is provided. The interface is professional and graphics are excellent, rivaling even some Windows-based packages. It features a wealth of map projections and options for configuring them which, although cumbersome to access via hot keys, are easy to access via pull-down menus. And, at a price of $49.95 (plus $4 shipping and handling), it is a hard deal to beat.

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

ST

TABLE 1. MAXIMUM DIFFERENCES BETWEEN *TRAKSTAR* AND *MICRO ORBITER 3.0*.

X position	Y position	Z position	X velocity m/s	Y velocitym/s	Z velocitym/s
0.000	0.000	0.000	0.000	0.000	0.000
Latitude deg		**Longitude deg**		**Altitude km**	
0.1810		0.0001		3.299	
Azimuth deg		**Elevation deg**		**Range km**	
0		0.3481 (at ~1.5° elevation)		0.000	

By Steven J. Handler
ontheair@grove.net

The FBI Goes The Distance

When you hear the FBI's name the first thing you think of is special agents chasing down bank robbers and other criminals. Most people are unaware that one of the Federal Bureau of Investigation's many important roles is that of teacher. Each year the FBI helps train thousands of city, county, and state police officers.

The FBI Academy occupies a large parcel of land on the U.S. Marine Corps base in Quantico, Virginia. Not only do all FBI agents come here for training, but it is also the site for a new technological thrust for training local police officers throughout the country.

The Academy, like every teaching institution, has a limited number of training slots. However, through the interactive use of satellites, the FBI has achieved the ability to train almost an unlimited number of officers.

History

In 1986, the FBI began using satellites to assist in the training of law enforcement personnel. Called the Law Enforcement Training Network (LETN), it consisted of satellite teleconferences jointly produced by the FBI and the Kansas City Police Department. Every other month they produced a live teleconference dealing with law enforcement topics, which they broadcast by satellite.

Production of the LETN programs alternated between Kansas City and the FBI Academy. Since both partners lacked adequate television studios, they used studios located at public access television stations to produce the program. Les Davis, FBI Supervisory Special Agent, who was both the host and producer of LETN, retired in 1994. His last program aired that spring, with LETN going on hiatus.

In September 1994, the FBI's Law Enforcement Communications Unit, located at the Academy, assumed active responsibility for the program. Thomas Christenberry, Supervisory Special Agent, became the Program Manager and the program was renamed the FBI Training Network/Distance Learning Initiative (FBI/TN).

One of Christenberry's first goals was to produce the programs at the FBI Academy. The FBI's Instructional Technology Services Unit (ITSU), located at the Academy, already had a television studio and handled the technical support for TV productions. To accommodate production of the FBI/TN programs, their studio, equipment, and facilities were upgraded.

In April 1995, the FBI's Training Network went back on the air, live from the Academy via satellite. Their first program discussed the topic of how police departments should deal with the media in crisis situations. This program was followed by three additional programs in 1995. Another four programs followed in 1996. Then, in 1997, production expanded to six per year with a program airing every other month.

Tom Christenberry, Executive producer and Host of FBITN, on the Satcast set.

FBI/TN programs are not dull monotonous lectures by a professor. Rather, the programs can accommodate up to four guests and the moderator, who all participate in discussing the training topic. In addition, the programs are interactive, allowing police officers viewing the program to call in with questions and participate in live discussions with the guests. Questions are also accepted by fax during the program.

According to Christenberry, the program's executive producer and moderator, the program's interactivity enhances its teaching value. He said that phone calls received from police officers are taken anytime throughout the program. "At the first available moment I will take the question and throw it to a guest," said Christenberry.

Their most recent program aired May 14th. *Power of Prevention with Community Policing* was an example of their success in using the interactive character of the program. During the program they accommodated five live phone calls as well as a half dozen faxed questions.

FBI Academy, Quantico, VA

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- American Express
- Diners

Date ..... Signature.....

The FBI Training Network is not considered a replacement for "in person" law enforcement training. Said Christenberry, "We look at it as the ability to enhance and augment the current training we can do. It gives us the ability to reach more people involved in law enforcement." Rather than limiting a presentation to a small classroom of officers, distance learning can reach numerous sites around the country, each of which can accommodate any number of officers or students. It provides training to those who might not otherwise have an opportunity to receive that education. According to Christenberry, it "is the next best thing to having a live person in front of you."

The Biograph Theater of Hogans' Alley Complex (houses FBI Training Network offices and TV Studio)

The FBI/TN's programs are not encrypted and are broadcast simultaneously on both C- and Ku-band satellites. They are targeted to law enforcement officers, police agencies, and anyone involved in criminal justice. However, since the programs are not encrypted, anyone thumbing through the satellite arc can also find and view them. As a result, topics cover general law enforcement and do not include highly sensitive law enforcement information.

Viewers are required to provide their own satellite dishes and receivers. FBI/TN estimates there are currently 1500 law enforcement related downlink sites around North America viewing their programming. Those viewers include police academies, universities, and community colleges who use the programming as part of the educational program for their criminal justice students.

How Do They Do It

Since the FBI does not own their own satellite transponders, they contract with Vyvx, Inc,. of Tulsa, Oklahoma, to provide the needed C- and Ku-band transponder time. Generally, they have been on the

Buildings of Hogans' Alley Complex (pseudo town created for training purposes which also houses offices, shops and the TV Studio)

same satellites, although the transponder may vary. FBI/TN is alerted one to two months ahead of time and provides this information to those on its mailing list. Even though they are classified as an occasional broadcaster, they have seldom been bumped.

According to FBI/TN estimates, it costs approximately $20,000 to produce and distribute each of their two hour programs. Two satellites are used to distribute their programming, allowing reception both on Ku and C-band. The production cost is a bargain for the taxpayers, considering the million dollar sums it costs to produce a half hour prime time television program.

The FBI Academy does not have its own satellite uplink facility. For each program they rent a satellite uplink truck on the day of the broadcast. It costs about $2500 for the rental of the truck and the technical engineer that operates the truck's Ku band uplink.

FBI/TN is staffed by Christenberry as well as an FBI training technician. In addition, there are two full time contract employees who are both television producers. Because they broadcast only six times a year, the FBI/TN finds it more cost effective and efficient to hire a freelance crew of about 14 people to produce each program. The crew includes directors, sound technicians, make-up artists, and the rest of the required production crew. With each production requiring three days, the cost for the hired crew runs $12,000 to $13,000 per program.

Rental of the Ku and C-band satellite transponders costs the FBI a total of $4000 for each two hour program. Because the satellite truck uplinks on Ku, a ground station teleport is used to turn the signal around and get it onto a C-band satellite. FBI/TN uses a teleport located in Atlanta that receives the program via the Ku satellite transponder and simultaneously uplinks it to the C-band satellite, where it is instantly beamed to the C-band viewers.

Another expense associated with the production is the cost of guests. Typically, only one of the four guests for a show is an FBI employee. FBI/TN pays for the transportation and lodging of the other guests, as well as paying them a fee for their appearance.

Future

Currently, the FBI Training Network is looking into the feasibility of doubling their programming, airing a program every month.

In addition, they are now considering international training. Since the fall of communism in Eastern Europe, their police agencies have been in need of Western style law enforcement training. The FBI, as well as other federal law enforcement agencies and the State Department, provides teachers and support for the International Law Enforcement Academy (ILEA) located in Budapest, Hungary. ILEA uses law enforcement instructors from the United States, Canada, England and other Western nations to train the eastern European police officers.

Christenberry anticipates that in the near future, rather than exporting a person to Budapest, the FBI/TN will be able to provide training via satellite to ILEA and cut down on FBI agents' travel and the time away from their assignments.

He also hopes that the FBI will acquire a dedicated satellite transponder and downlinks for all of its field offices. Since the government is in an era of dwindling resources, noted Christenberry, "If I am an instructor teaching 30 students that's all I can do. But if I add ten other sites by distance learning I can teach 300 and that makes it [the training] more cost effective when you consider all the personnel you can train."

He also sees distance learning expanding the FBI's ability to fulfill its mission of assisting in the training of state and local law enforcement officers. Christenberry hopes that as technology matures, police departments will be able to afford satellite dishes and video conferencing equipment.

Christenberry also has taken note of the predictions of experts in the field of law enforcement training and communications. The real wave of the future may be to provide law enforcement training over the internet. Internet and intranet applications may be able to provide a less expensive and more widely available medium for law enforcement training. Although security and privacy will be issues, he believes they are surmountable problems. Until then, the FBI will continue to provide law enforcement training, *On The Air.*

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

ST

PROGRAM AND TRANSPONDER DETAILS

Next FBI Training Program, Law Enforcement and the Internet Tentative Schedule July 9, 1997. 11:30 a.m. EDT test, Noon - 2 p.m. EDT program.

Law enforcement officers and criminal justice students can call (800) 862-7577 for additional recorded program information, transponder details, and other information. Or send a fax request for information to (703) 640-1673.

Past Birds Used For FBI TN Programs: Galaxy 6 (C-band), SBS 6 (Ku-band)

PCM-CIA cards, the kind used in laptop computers. One manufacturer, Galaxis, offers a model with two slots, which means users can easily subscribe to services from two distributors.

A number of manufacturers also unveiled receivers with no decoder slots at all, for reception limited to clear MPEG-2 channels. While there are a number of such channels on the air now during the infancy of digital broadcasting, these receivers may soon become very expensive paperweights.

Both Astra and Eutelsat also showed off their new satellite-based Internet access services at the Cable and Satellite Show. Eutelsat's DirecPC (which certainly sounds like it has something to do with Hughes) offers download access via three different satellites at speeds up to 3 Mbps. Users would transmit back over ordinary telephone lines at the more conventional rates of 28.8 or 56 kbps (and several new digital receivers include modems). Eutelsat says it may try to get around this problem by offering a subscription service where users specify certain Web sites, from which they would receive regular updates via satellite.

Astra's rival Astra Net service won't be launched until this fall, in co-operation with Intel. It will offer speeds up to 38 Mbps for businesses (who ironically, already can afford fast Internet access), and 6 Mbps for home users. Like DirecPC, the return path would be via telephone modems, but in order to speed up the return bottleneck, Astra Net says that there are plans to offer a two-way service on a satellite scheduled for launch in 1998.

Telenor plans to offer similar services to Scandinavia from Thor 2A, at speeds up to 2 Mbps, with the users' regular Internet provider as the return path. This is supposed to be available in September. Internet access is also part of Rupert Murdoch's plans for Britain. (On the other hand, based on the way Murdoch ran Delphi into the ground, messed up his Internet venture with MCI, and the less than state-of-the-art performance of the oh-so-slooowwww British Sky Broadcasting Web site, perhaps British Web surfers shouldn't hold their breath waiting for satellite access.)

Around the World with Rupert Murdoch

We've already covered British Sky Broadcasting's move into Scandinavia. Other parts of this magazine are probably taking up Murdoch's American Sky Broadcasting and its attempts to merge with Echostar and its flirt with Primestar. Here's news from some other parts of Rupert Murdoch's global empire:

While British Sky Broadcasting has been refusing to offer subscriptions outside Britain and Ireland, British Armed Forces personnel have won a battle to watch BSkyB channels while posted overseas. After years of campaigning by forces staff, Sky has given them some 630 decoder cards, for viewing by army units in Germany, Italy and Cyrpus, and on Royal Navy ships.

Sky will be launching National Geographic television in August, initially for six hours a day, probably on Astra transponder 24 or 11. The channel will go to 12 hours service in Sky's coming digital package.

Murdoch also seems to have convinced one of his biggest British rivals "if you can't beat them, join them." The chairman of Cable and Wireless Communications had said the company's 200 channel digital TV service would be available this fall, possibly beating out the launch of BSkyB's rival service. CWC was formed by the merger of Mercury Communications (Britain's second largest telephone company) with the British cable operations of Nynex, Bell Cablemedia, and Videotron.

But Sky has reportedly been holding talks with CWC about co-ordinating their pay-per-view operations. According to the *Sunday Telegraph*, if the talks are successful, this could mean that CWC would use BSkyB to run its PPV operations.

Murdoch has also lined up more partners for his British digital package. On May 7 BSkyB announced with British Telecom, Matsushita, and the Midland Bank the launch of British Interactive Broadcasting Ltd. The set-top decoder boxes, which will come from Matsushita's Panasonic, will be subsidized for 200 (around $340) each. BT (Britain's major telephone operator, now merging with MCI) will be responsible for the telephone links, while BSkyB will provide the satellite transponders. Among the interactive services planned are home shopping, banking, travel, and community and educational progrmaming. Subscribers will be also be able to access e-mail via their TVs. (No web-surfing?)

Dozens of American channels are reported to be lining up to be included in the package. These include E! Entertainment, MGM Gold, a channel from Turner Broadcasting, National Geographic TV, The Home and Garden Channel, the USA Network, Comedy Central, Knowledge TV, The Sundance Movie Channel, Classic Sports, and The Golf Channel. Flextech and the BBC have also confirmed that they will give Sky the first option of transmitting their planned eight digital channels. Sky also plans to offer up to 100 pay-per-view channels of sports, concerts, and theatrical events.

While BSkyB now seems fully committed to launching its digital package this fall, *What Satellite TV* reports there's going to be an unexpected satellite shuffle to make this possible. Problems with the Xenon Ion Propulsion System on Astra 2A, which is supposed to carry the BSkyB package at 28 degrees East, have forced Astra's owner SES to shift the launch to a Proton rocket in October, so the satellite will be ready to go into service in December, later than the promised start for Murdoch's digital service. To bridge the gap, Astra 1G, launching on a Proton in August, is likely to be used both to satisfy its intended customers on 12.50-12.75 GHz as well as double for Astra 1F on 12.10-12.50 GHz. Astra 1F could then be moved to 28 degrees East to relay Sky's 14 and Flextech's six digital transponders. This would ensure that British satellite digital TV has a start in the fall as scheduled, albeit with slightly reduced power.

Murdoch's late-comer Japan Sky Broadcasting has grabbed an advantage over its rivals. Fuji Television Network, a major Japanese TV network, is joining the venture, bringing with it a large library of Japanese programming. JSkyB also includes electronics giant and Hollywood studio owner Sony Corp. The beefed up programming libraries will be necessary to take on the competition. When JSkyB starts its 100 channel service next spring, Japanese viewers will then have access to 360 digital satellite channels from the three competing operators.

PerfecTV, owned by a consortium of Japanese trading companies, began service last year and plans to boost its number of channels to 110 this spring. Hughes Communications' DirecTV will start its 100-channel service this fall.

In other parts of Asia, Murdoch's Star-TV is taking on entertainment channel NBC Asia, changing the name of its Star Plus International channel to Star World. Star is expected to revamp the channel's programming over the next few months. The former Star Plus is known for carrying television relics such as *Lost in Space* and *Charlie's Angels* (this parallels the programming on Murdoch's original Sky Channel in then-TV-starved Europe), in addition to more up-to-date programs such as *The X-Files* (which is produced by Murdoch's Fox

Television).

A Star TV spokesman says one reason for the name change is to reduce viewer confusion between Star Plus International, which is transmitted on Asiasat-1's northern beam, and Star Plus, which is on the southern beam. The southern Star Plus has changed drastically in the past year with the addition of Hindi-language programming, and may change its name to Star Plus India.

On April 29 the Indian cabinet approved a proposal for a bill that would end the state monopoly in broadcasting. It would allow satellite and cable stations into Indian homes only if they had licenses to uplink from India, in partnership with Indian firms. This opens the door for Murdoch's India Sky Broadcasting, which has already taken out full-page ads in Indian newspapers. Until the new legislation is approved, satellite broadcasters like Star-TV will continue to broadcast to India from Hong Kong and other Asian centers.

I wrote last time that India Sky Broadcasting would broadcast on seven transponders from PAS-4 at 68.5 degrees East. In mid-May Mark Long reported to Satco DX that seven MPEG-2 transponders on that satellite had lit up with ISkyB promos on: 12.266, 12.326, 12.356, 12.386, 12.416, 12.451, and 12.481 GHz.

Europe

After many delays, Britain's new terrestrial Channel 5 is now broadcasting on Astra transponder 63, which had been used by Filmnet to relay its Central European service. It is soft- scrambled in Videocrypt, which means anyone in the Astra footprint with a Videocrypt decoder can watch. Response to the new channel has been disapppointing. According to media research specialist CIA MediaLab, more than one third of 15-24 year olds say Channel 5 is not as good as expected and is worse than rival channels. This is bad news, as Channel 5 has aimed particularly at the under-35 audience. One redeeming feature is that Channel 5 is carrying middle-of-the-night live Major League Baseball a couple of nights a week. In one early case Channel 5 carried exactly the same game that was being broadcast at the same time on NBC Europe, but hopefully the two channels will sort things out before the baseball season is over.

Germany's public TV networks ARD and ZDF launched the Phoenix information channel on April 5. Phoenix mixes coverage of breaking news with live broadcasts from parliamentary debates in Germany and other European capitals, modeled on C-SPAN. In contrast with the fast-paced delivery of CNN or its German counterpart N-TV, Phoenix aims to let viewers form their own opinions. The new channel broadcasts for 16 hours a day, and can be seen on Astra transponder 61 (10.891 GHz) in clear PAL and on Kopernikus 3 on 12.743 GHz in clear MPEG-2. It is being carried on cable in a few cities, but has not gained access to the national cable network, because of a shortage of capacity.

On May 14 Eutelsat took advantage of the Cannes Film Festival to launch a French-language channel devoted to fashion and haute couture, called Fashion TV, via Hot Bird 1 (it had been testing since May 1) 11.308 GHz in clear MPEG-2. For the first two days of regular operation the channel was also available in clear PAL, on Hot Bird 2 on 11.765 GHz.

Discovery's Animal Planet channel launches July 1 from Hot Bird in MPEG-2. Reception is intended initially for British and Scandinavian cable distribution, but the channel will later become part of the Sky digital package.

A new station called Babylon Blue has started on Israel's Amos 1 satellite, on 11.344 GHz in clear PAL. While initial reports said the channel was Hungarian, Attila Kardos reports that Babylon Blue is aimed instead at the Romanian cable market and is uplinked from the Czech Republic.

The Swedish business newspaper *Dagens Industri* claims "Sweden is a hotbed of television decoder bootleggers." According to an informed source at a TV industry exposition in Cannes this spring, there are an estimated 200,000 pirate circuit boards for satellite dishes in the Nordic region, 150,000 of them in Sweden alone. The European cable TV industry, including broadcasters, consumer electronics organizations, and distributors, has formed an anti-piracy lobby organization called Aeopoc, to be headquartered in Brussels.

This allegation seems a bit hard to believe. Pirate decoders and subscription cards are illegal in Sweden. With the exception of cards for viewing British Sky Broadcasting, pirate cards and decoders are not against the law in Britain, and British magazines are filled with advertising for cards to watch Scandinavian D2-MAC channels like Filmnet and TV1000 (which are popular in prudish Britain because they carry late-night hard core pornography). On the other hand, the center for pirating BSkyB cards seems to be Germany (and the Internet).

Denmark's new TV Danmark has changed transponders on Intelsat 707 to 11.107 GHz, in MPEG-2. This channel is owned by the Scandinavian Broadcasting System, which operates similar channels in Sweden and Norway, and which in turn is largely owned by ABC/Disney.

The Norwegian Christian radio station Kristen Riksradion is broadcasting mornings and afternoons on Intelsat 707, 11.016 GHz (TV Norge) sound channel 7.56 MHz. A new Norwegian all-music station called P5 is on in stereo on the D2-MAC transponder 11.001 GHz (Cartoon Network/TNT).

The Rest of the World

Libya's Jamahirya Satellite Channel has started broadcasting to Europe on Eutelsat II-F3 on 11.617 GHz in clear PAL, as well as to the Middle East on Arabsat 2B on 4.167 GHz in PAL. Iran's Baztab has been reported on Arabsat 2B on both 4.126 and 4.085 GHz. Baztab has also started relays on the trans-Atlantic Orion 1 satellite (37.5 degrees West) on 12.685 GHz (European beam).

There are some additions to the Orbit Network to the Middle East from Intelsat 703: Viva Cinema and (Rupert Murdoch's) Sky News have started on 11.075 GHz, the Disney Channel has started on 11.600 GHz. Disney was in the clear (MPEG-2) for the entire month of April.

On May 14 China successfully launched the Dongfanghong ("The East is Red") -3 communications satellite from its Xichang Satellite Launch Center in Sichuan Province. Considering China's poor track record in launching foreign satellites recently, this is good news for the cut-rate launch provider.

DFH 3 carries 24 C-band transponders. Its life span in geostationary orbit is about eight years—almost half that of modern satellites. This is probably (at least partly) owing to the reduced station-keeping capabilities of indiginous Chinese satellites which, as a consequence, consume more fuel because their position has to be corrected more frequently.

Xinhua reports that the satellite will be positioned at 125 degrees East.

Thanks for contributions from the usual suspects: Curt Swinehart, James Robinson, the SATCO DX Chart (www.satcodx.com), *Tele-satellit News*, and Richard Karlsson, along with Kent Andersson of the Swedish magazine *Elektronikvaerlden*, and *What Satellite TV* magazine in Britain.

ST

By Doug Jessop

Rupert Watch

Television broadcasters are objecting to Rupert Murdoch's proposed national satellite-TV service, Sky. In a government filing, 650 affiliate stations of the three biggest networks claimed that Sky should be subject to the same rules as cable operators, including being required to carry the on-air signals of all local stations. In written testimony filed with the U.S. Copyright Office, the broadcasters said "no rational distinction can be fashioned for exempting satellite carriers from a must-carry requirement." In addition, they argued, satellite services like Sky should be subject to the federal law barring ownership of cable and television stations in the same market.

News Corp. Ltd. announced that it will delay a $1 billion investment in a venture with EchoStar Communications Corp. to enter into the competitive direct-TV satellite business. News Corp. said it wouldn't invest until new conditions for the agreement were met. Industry analysts report that several issues had hurt the investment, announced in February.

One of the main issues, they speculated, were the strong personalities of News Corp. Chairman Rupert Murdoch and EchoStar Chairman Charles Ergen (surprise, surprise, surprise!), each of whom is accustomed to being in charge. Analysts also suggested that Murdoch may be having second thoughts about investing in a venture that faces regulatory hurdles.

News Corp.'s merger partner EchoStar Communications Corp., is now suing the media titan in federal court. News Corp., the Australia-based company owned by

Rupert Murdoch, said it would "vigorously contest" EchoStar's attempt to obtain a court order compelling News Corp. to lend EchoStar $200 million. EchoStar, an Englewood, CO-based direct broadcast satellite company, charged that News Corp. reneged on terms of the $1 billion buyout agreement the two announced in February and says the merger contract includes a condition that News Corp. lend EchoStar $200 million should it need the money prior to federal approval of the acquisition. EchoStar, which makes dishes to receive signals from orbiting satellites, and News Corp. announced in February that they were combining to form a direct-TV satellite network (ASkyB) that would offer up to 500 channels of digital television, Internet services, and local-broadcast TV signals to markets nationwide.

Rupert didn't waste any time after the EchoStar fiasco. His News Corp. has set its sights on joining PrimeStar partners, a satellite-dish television service owned by the nation's largest cable operators; this despite objections by Time Warner Inc. Murdoch's latest move means he may be able to salvage his satellite venture and gain a broader programming distribution. The tentative pact calls for Murdoch to contribute transmission sites, government licenses, and the satellites that he and MCI control in exchange for a minority, nonvoting stake in PrimeStar Partners. Terms of the deal have not been nailed out (financing etc.) and, sources said, there is a chance it won't go through.

The price for International Family Entertainment Inc., for which Rupert Murdoch's News Corp. and Disney will bid this week, has risen to $1.8 billion, according to a report in the *Los Angeles Times*. Although News Corp. is thought to have an edge in the bidding, people close to the talks say that Disney has remained a strong contender. Sources added that Viacom Inc., which was reported to have taken an interest in IFE, has withdrawn from the competition.

And of course "Rupert Watch" would be incomplete without at least a mention of the reports that broadcasting's famous Aussie is looking at buying the Los Angeles Dodgers. In what seems like a case of keeping up with the Turners (Ted and Jane own the Atlanta Braves) it's actually a pretty good fit with the Fox Sports position that has gained/bought a lot of respect with big name deals, for example the NHL and Super Bowl. Be watching for more baseball to be heading to a Fox feed near you...

New Channels

Ziff-Davis, the publishing giant, announced recently that it will invest more than $100 million to launch a new cable network and accompanying Web site dedicated to computers and the Internet. ZDTV: Your Computer Channel will launch in the first quarter of 1998. The Web site will begin in the last quarter of this year.

The Discovery Channel (Satcom C4 tr 21/Galaxy 5 tr 16), which began in 1985 within about 156,000 cable subscribers, reports that it now has the third-largest cable distribution in the United States, behind TBS and CNN. Discover, with a cable and

satellite universe of 71,166,000 homes, edged past ESPN in May. The channel reaches 73.4 percent of all U.S. television homes.

General Electric Co.'s NBC unit has announced an agreement with the direct-to-home (DTH) television system Sky Mexico to carry the network's two cable networks, MSNBC and CNBC. Transmission of both networks to Mexico began on June 1. Sky Mexico is a part of the global DTH venture launched this year by Grupo Televisa SA, Mexico's biggest media conglomerate. The venture is a partnership between Televisa, Rupert Murdoch's News Corp., Tele-Communications Inc. and the U.S. and Brazil's Organizacoes Globo SA. The move is expected by industry insiders to be the first step in expanding NBC's cable programming throughout Latin America and Spain, where Televisa's Sky system will begin operation in the next 18 months.

Net and News

WKYT-TV began broadcasting its 6 p.m. newscast audio and video on the Internet each evening. The broadcasts are a partnership with the *Lexington Herald-Leader* to jointly provide content and promote each other's web offerings. Station officials commented, "One of the important uses of the broadcast is to give people planning to move to Kentucky a headstart at looking at what is news in our area. We hope that once they watch on the Internet, they'll become viewers when they arrive here."

Those wanting to view the newscast need to get a plug-in at **http://www.Kentuckyconnect.com**. The Web address for the newscast is **http://www.wkyt.com**.

AccuWeather Inc. said it has created the Internet's first meteorology chat forum. By logging on the site Web site (**http://www.chat.accuweather.com:4080**) directly or through links provide on the AccuWeather home page, users can have live discussions with AccuWeather experts as well as broadcast personalities and other guests.

Visitors to the site are invited to submit questions or subjects they'd like to have addressed, and they'll find listings of upcoming forums so that users can prepare questions or a list of subject ideas. All dialogue will be archived. Another service from the State College, PA-based company, Your Personal AccuWeather, is being tested and is slated for launch on June 30. AccuWeather provides data to a number of broadcast and online outlets, including the Associated Press, CNN Interactive, PointCast, Microsoft Sidewalk, Web TV, CompuServe and Netscape In-Box.

If you ever wondered what is behind the thought process for the folks that put all those news feeds on your friendly neighborhood satellite, there is a new Web site aimed at news gatherers—assignment editors, reporters, field producers, managing editors, and anyone else who tracks down the news stuff that goes on the tube at **http://www.crunch.com**. It has tips, statistics, ideas, essays, etc.

CNN Interactive and Oracle Corp. unveiled a new website at the Comdex/Spring trade convention in Atlanta in a joint keynote presentation by Ted Turner, vice chairman of CNN Interactive parent Time Warner, and Oracle chairman Larry Ellison. CNN would join the Microsoft-NBC venture MSNBC and Disney's ABCNews.com as the big-name television players delivering news online, with CBS News expected to announce its Internet plans shortly.

According to a recent Roper poll, commissioned by the three major networks, Americans would rather stay home and watch TV than go on a family outing. Additionally, those polled said that they trust TV news more than any other news and that they even enjoy commercials. In the door-to-door survey of about 2,000 Americans over the age of 18, 69 percent said that they get most of their news from TV, compared to 37 percent newspapers, 14 percent radio, 5 percent magazines and 7 percent "other people."

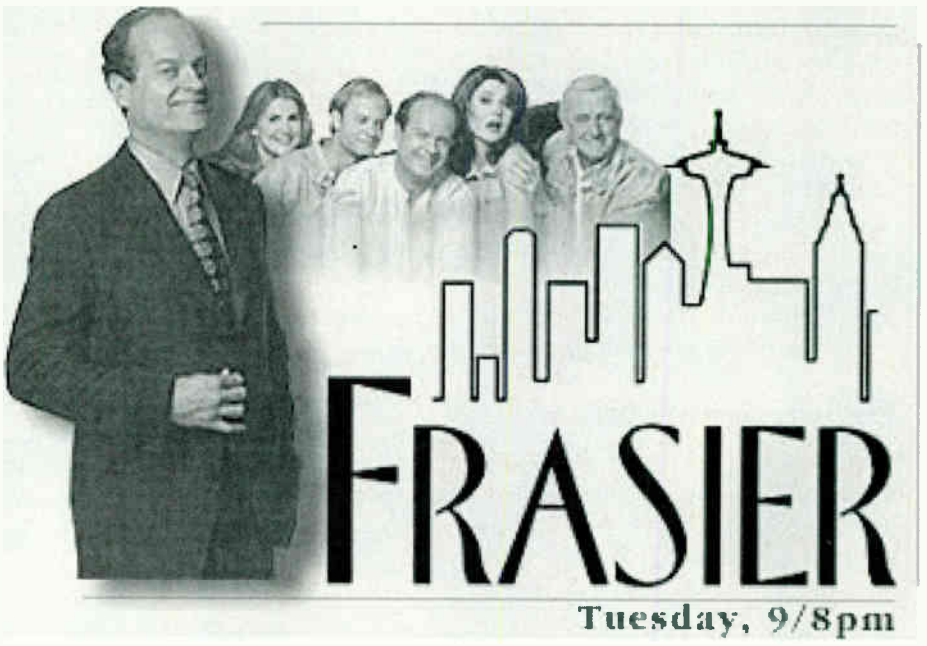
The margin is the second-largest ever for TV news in the forty-year history of the poll. When asked which news is the most credible, 52 percent said TV news, compared with 23 percent who answered newspapers. Seventy-four percent they don't mind TV commercials and 63 percent said they even enjoyed them.

Entertainment Page

I've had a chance to see some of the new fall lineups for the various networks and candidly you won't be seeing anything earth shatteringly new. The biggest syndication wildfeeds on the birds to be watching for will be *Frasier* and *Grace Under Fire.*

On the network side, be warming up your dish for a lot of network hopping as shows like *The Naked Truth* stay on the air, but move across the street.

The WB network unveiled its new fall



lineup, with executives stressing family as a means of increasing ratings. WB chief Jamie Kellner, singling out the more established networks as those which pursue viewers between the ages of 18 and 49, announced that WB will continue to present family-friendly sitcoms and dramas from 8-9 p.m.

"The goal is to be alternative to the Big Four networks for disenfranchised family viewers," said Kellner. In addition to the fall schedule, WB executives said Johnny Carson sidekick Ed McMahon would be returned to TV as part of the cast of *The Tom Show*, Tom Arnold's new WB sitcom. McMahon will play Tom's boss at a small-town TV station.

Maury Povich is taking his issues-oriented talk show to Universal Television in the fall of 1998. Povich, who has hosted his show for Paramount Domestic Television since 1991, will host a new one-hour show for Universal. Povich had been negotiating with Paramount to extend his contract, which expires in the fall, beyond 1998 when Universal reportedly offered him $10 million a year. According to sources, Paramount was offering him $6 million. "Maury and Paramount have enjoyed a successful relationship over the past six years, but now we are looking forward to continual growth of our current talk shows, as well as to the future of new projects," said a Paramount spokeswoman.

THE MAURY POVICH SHOW

Court TV (Satcom C3 tr 6) announced that *Legal Cafe*, a daily, two-hour, live coffee-klatsch for legal questions and concerns, will debut June 14. Producer Emily Benton said that the show is unique because, "you're not going to learn how to make a crumb cake, but you might learn how to fire that contractor."

COURT TV

The program will be hosted by Court TV anchor June Grasso, who will be joined by different experts, depending on the day's theme- Mondays will be devoted to family law, Tuesdays to health, Wednesdays to the home, Thursdays to the work place and Fridays to lifestyle. Viewers will be able to call-in, e-mail, fax and appear from remote locations with their questions.

Sources for this issue include a variety of friends and neighbors in the broadcasting and satellite industry as well as *Cowles/Simba Media Daily*, *LA Times*, *NY Daily News*, *NY Post*, *Washington Post*, and the *Wall Street Journal*. As always, I welcome your comments at: **http://www.searcher.com/STcomments.html**

ST

Names of Russian and Kazakh Launch Sites

by Phillip Clark

For 1997 launches, *ST*'s *Satellite Launch Report* will be changing the way that FSU launch sites are identified to be more in line with the Russian designators. The official designation of the Plesetsk launch site is 1-y GIK (Gosudarstvennyy Ispytatelnyy Kosmodrom - First State Test Spaceport) and *Satellite Launch Report* will continue with the name Plesetsk. The name of the Tyuratam launch site is now officially Baikonur and its designator is 5-y GIK (Gosudarstvennyy Ispytatelnyy Komplex - Fifth State Test complex): in future launches from this site will be shown as Baikonur.

Previous Bion Missions

The Russian biological satellite launched December 24, 1996 was identified as Bion 11. The previous Bion missions were flown within the "Cosmos" program, as follows:

1970 Oct 8	1970-080A	Cosmos 368 (un-numbered test flight)	Bion
1973 Oct 31	1973-083A	Cosmos 605	Bion 1
1974 Oct 22	1974-080A	Cosmos 690	Bion 2
1975 Nov 25	1975-110A	Cosmos 782	Bion 3
1977 Aug 3	1977-074A	Cosmos 936	Bion 4
1979 Sep 26	1979-083A	Cosmos 1129	Bion 5
1983 Dec 14	1983-121A	Cosmos 1514*	Bion 6
1985 Jul 10	1985-059A	Cosmos 1667*	Bion 7
1987 Sep 29	1987-083A	Cosmos 1887*	Bion 8
1989 Sep 15	1989-075A	Cosmos 2044*	Bion 9
1992 Dec 29	1992-095A	Cosmos 2229*	Bion 10

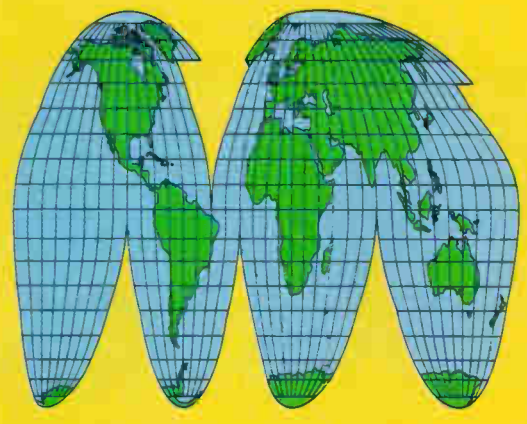
The flights marked with an asterisk carried a pair of Rhesus monkeys.

Rumored Russian Launch Failure

There have been stories circulating on the Internet suggesting that the Russians had a launch failure on January 17, the same day that the United States Delta-2 exploded with Navstar 28 on board (see above).

What is certain is that the planned launch of a Cosmos satellite from Plesetsk aboard a Molniya-M vehicle during the evening (Moscow Time) had been postponed "for technical reasons" and no new launch date was set (ITAR-TASS News Agency, 1542 UTC, January 10, 1997). Although not stated by the Russian announcement, the payload would have been an Oko-class early warning satellite, the only type of Cosmos payload to still use the Molniya-M.

The Russians have not announced any launch failures for January 1997 and bearing in mind the speed with which failures have been announced in recent years it does not seem likely that a failure in-flight did take place. The Internet rumours can probably be explained by confusion of the Delta-2 failure with the Molniya-M postponement the week before.



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By Philip Chien

Microgravity in Space

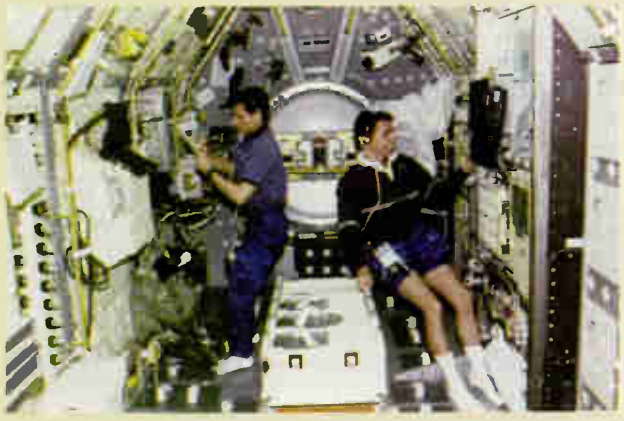
One of NASA's least glamorous activities is microgravity experiments aboard the shuttle: One of NASA's most important activities is microgravity experiments aboard the shuttle. A contradiction? Not really. Microgravity scientists acknowledge that they aren't the most exciting things to watch. But science isn't measured by glamor or what's exciting, it's measured by what's learned, and how that knowledge can be used. Spacelab missions have been considered the least interesting shuttle missions—but for the scientists they're a cornucopia of knowledge.

Spacelab science complements experiments aboard *Mir*. Spacelab has the advantages of a large amount of power, sophisticated laboratory instruments, several crewmembers, frequent flights, real-time communications, and the ability to bring back large quantities of results. *Mir* missions have the advantage of much longer stays in space.

Tainting the Science

In an effort to explain and justify the microgravity experiments to the American public, NASA's public affairs offices talk about spinoffs. They cite statistics showing the potential for billions of dollars in savings if combustion efficiency can be improved by just one percent, or the savings if gasoline refining efficiency is improved. What they don't say is those impressive statistics have no direct connection with any of the science experiments being performed on the shuttle.

Coca-Cola has flown on three shuttle flights, and in each case it was a highly publicized "experiment." Some supporters claim that the taste tests were justifiable because changes to the astronauts' taste buds in space are similar to how human tastes change as a person ages. Unfortunately while they are two similar phenomena, there has not been a single piece of scientific research which shows that changes to taste perception in microgravity has any connection to taste perception in the elderly. It's the equivalent of theorizing parrots are related to plants because parrots are the only green colored animals!



Coca-Cola spent $750,000 developing their space "Coke machine"—less than the cost of a 30 second commercial for a major television event.

With all of the hype it's hard to understand the leading edge science which is being performed on the shuttle and the key scientific justification for the multi-billion dollar International Space Station.

When NASA decides to fly a Spacelab flight, a research announcement asks for proposals from research organizations including commercial companies, universities, and NASA field centers.

The proposals are examined by many levels of peer reviews. The review panels look at the viability of the experiment, whether or not it really requires the shuttle's capabilities, the chances for success, and how well the proposing team has performed in the past. Based on their recommendations NASA decides which experiments will fly on a particular flight. It's an exacting process to ensure that the experiments are world class science.

Self-proclaimed space program experts with fancy titles have claimed that the microgravity flights are just make-work flights, to fill the shuttle's manifest until the space station's assembly begins. NASA thinks the science is more valuable—valuable enough to set a new record for reflying a mission to accomplish its science.

STS-83 was planned as the 16 day Microgravity Space Laboratory (MSL) mission. Spacelab was filled with combustion science, materials processing, protein crystal growth, and plant experiments. During the countdown a voltage glitch was noticed in fuel cell three. Similar glitches had been noticed on previous missions but they disappeared after the shuttle reached orbit. This time the voltage differential continued. With 20/20 hindsight it would have made sense to have stopped the countdown and replaced the fuel cell. With limited information about the fuel cell's condition, NASA managers chose to shorten the mission.

The decision was a preemptive safety measure—just in case another component failed. The shuttle's design philosophy is fail-safe. If a critical system fails in orbit there is no immediate safety concern. If a second unit fails then the shuttle can still return safely, although with less margins. So most critical systems are flown as three independent components.

Only two previous missions have been

cut short—the STS-2 test flight due to a flooded fuel cell, and STS-44 due to the failure of an inertial measurement unit. Each mission was able to complete its primary objectives, and still had full redundancy.

Even as NASA made the decision to cut the mission short, preliminary plans were made for a rapid turnaround. It would permit the science team to remain together, minimizing the costs for the reflight.

STS-83 accomplished about one sixth of its planned science. But raw numbers don't tell the entire story—some of the experiments made new discoveries. The scientists have the enviable position of the best possible simulation ever—three days of actual science followed by three months of analysis and replanning how to do things better on the reflight.

When managers were notified of the decision to perform the rapid turnaround, now named STS-94, many decisions had to be made. It takes time to remove Spacelab from the shuttle, take it to another building for processing and testing, and return it to the shuttle. Each time electrical connectors are reconnected, tests have to be performed. Mechanical tests, safety and quality control checks are needed, etc. So the key decision was to keep Spacelab in *Columbia* through the processing flow.

For safety reasons a limited number of people are permitted inside the shuttle. If there's an emergency it's critical to get everybody out as quickly as possible. So technicians removed the tunnel which connects the Spacelab module to the shuttle's crew cabin and installed scaffolding for direct access to the Spacelab module. With this separate path the payload people could process Spacelab while the shuttle people worked on the shuttle.

Two key waivers were necessary for the rapid turnaround. The insulation on the extended duration orbiter pallet (the tanks of oxygen and hydrogen which supply power on long flights), is supposed to be inspected every five or six flights and was scheduled for inspection. Since the pallet is made from the same materials as other orbiter structures, engineers decided that it was safe to defer the inspection for another flight. Another inspection involved the bolts which connect the shuttle's wings to its body. With Spacelab installed, access to the bodyside would be extremely difficult. Technicians inspected the bolts from the wing side where they could be accessed, and, since they showed no signs of turning or other indications that anything was wrong, it was considered acceptable.

Since the experiment racks could not be removed from Spacelab, servicing was limited—some processed samples are making a second trip into space because it isn't worth the time to remove them! Technicians replenished the samples and other materials for each of the experiments as required.

In addition to the normal turnaround activities, technicians removed the faulty fuel cell and shipped it back to its manufacturer for analysis.

Columbia was rolled over to the vehicle assembly building on June 4, just 54 days after the STS-83 mission landed. It broke the previous post-*Challenger* record of 61 days which was set during the STS-37 to STS-43 turnaround. STS-94's launch is currently scheduled for July 1, 1997.

Mir update

Final Frontier (May/June *Satellite Times*) described the situation aboard *Mir* and the planned repairs. Our deadline is one month before the magazine hits the newsstand, and it's often difficult to predict the future. It turns out that the Russian contractor Nee Chim Mach (Chemical Equipment Manufacturing) was able to deliver an Elektron unit far earlier than planned. It arrived in the U.S. on April 15, in time for a conventional horizontal installation in the Spacehab module.

STS-84 was launched on May 15. The first piece of cargo transferred to *Mir* was astronaut Mike Foale, taking the place of returning astronaut Jerry Linenger. Elektron was transferred to *Mir* and placed in storage for use whenever the unit already on *Mir* fails.

As we go to press the crew members are repairing the final coolant leak in Kvant 1. *Atlantis* brought up a last second patch kit to seal off the leak once it's isolated. Among the items *Atlantis* returned to Earth are samples of *Mir*'s condensed water to determine if it was contaminated with the ethylene glycol coolant, or if the filters worked properly and the reclaimed water is good enough to use aboard *Mir*.

The next shuttle-*Mir* flight is STS-86, scheduled for September. On that flight astronaut Wendy Lawrence will replace Foale. Several of the crewmembers have experience aboard *Mir*, most notably Vladimir Titov. During his year-long stay he became the first Soviet ham cosmonaut—U1MIR. He recently earned the U.S. ham license KD5AOS. ST

ST WHAT'S NEW

by Wayne Mishler, KG5BI

Even "ET" Can Phone Home With New Satellite Com Tools

Several new satellite products carried by Grove Radio and Electronics Products Sales enable you to phone or send e-mail to anyone from anywhere. For more information on any of the following three satellite products, contact Casey Davis at Grove Enterprises, 704-837-9200, e-mail: **casey@grove.net**.

A pocket-size e-mail and navigation machine

One of the most amazing of the new products is The Magellan GSC 100 handheld global satellite communicator with integrated GPS. It operates from internal rechargeable batteries or from an external power source of 10 to 35 volts DC. The unit measures 8 by 3.5 by 1.75 inches and weighs 37 ounces. But don't let its small size fool you.

The GSC 100 gives you the power to receive and send e-mail via the Internet from anywhere in the world via satellite. Simply extend the telescoping antenna, turn on the unit, and download your e-mail, or enter your own e-mail message (up to 2,000 bytes) and transmit. Its wireless.

The Magellan GSC 100 uses standard e-mail protocols, enabling you to send and receive e-mail via the Internet or another GSC 100 unit. And you can add the capability of sending messages via fax or voice.

Plus the unit gives you full Global Positioning System capability. It enables you to find your way and transmit your location from anywhere in the world, even from places where there are no telephone lines, no cellular phone towers, no couriers, no mailboxes. Pinpoint your position. Plot and track your course. Store way-points. And communicate this information to anyone anywhere.

The GSC 100 sends and receives data via the ORBCOMM satellite network, a wireless two-way personal communications system with global coverage.

ORBCOMM is a joint venture of Orbital Sciences Corporation and Teleglobe Inc. Their system employs a growing network of low-Earth orbit (LEO) satellites which is expected to be 36 strong by early next year.

In announcing the launch of its first satellites in 1995, ORBCOMM promised that its service would be offered worldwide, and they have delivered.

"ORBCOMM is creating not simply a new service, but a new industry that will affect the world as profoundly as the personal computer," said company president Alan Parker. "ORBCOMM will offer low-cost, portable, personal two-way communication that can operate everywhere on the planet."

The Magellan GSC 100 communicates with ORBCOMM satellites on a standard narrow-band VHF frequency. E-mail goes up to a satellite and then down to a gateway station, and then is routed to its destination via traditional methods. To receive e-mail you simply turn on the GSC 100 and it downloads your e-mail automatically.

Portable satellite phone goes anywhere; Inmarsat takes voice, fax and data worldwide

Grove now offers a self-contained satellite telephone system that fits in your briefcase and gives you the power of worldwide voice, fax, and data communications via Inmarsat.

The unit is ideal for international business travelers, multinational corporations, broadcasters, journalists, emergency relief providers, and others who must stay in touch while traveling or in remote areas.

Produced by O'Gara Satellite Networks, The Compact-M weighs 5 pounds and is available with fax, data, and secure phone capabilities. It comes ready to use with a worldwide number.

The Compact-M works with the Inmarsat-3 satellite. The basic unit is priced at $4,995, and usage is billed at $4.25 per minute. It employs new smartcard technology. That is, the unit works in conjunction with a pre-paid card that resembles a credit card.

To use the system, you unfold the antenna and connect it to 12 volts DC. Aim the antenna at the nearest Inmarsat satellite, insert the access card, and the Compact-M comes alive, ready to make or receive calls. Fax, data, and secure phone options can be set up in seconds.

The access card is pre-programmed with the number of minutes you have purchased. It automatically selects your LES number and keeps track of on-air usage. You can replenish time on the card by contacting the provider and purchasing additional minutes on the spot.

Your Compact-M's serial number is programmed into your card, inhibiting unauthorized usage. Multiple cards can purchased for additional authorized users.

O'Gara Mobilfone overcomes cellular restrictions

Still another satellite phone product available from Grove is the O'Gara Mobilfone which is as easy to use as a cellular phone but without the usual cellular restrictions.

This unit is similar to the Compact-M; however, the Mobilfone is smaller, lighter, and slightly less expensive to buy and use. It weighs just 4.85 pounds including handset, battery pack, and antenna. The basic unit sells for $4,495 and usage is billed at $3.50 per minute. A variable rate is available ranging from $2.95 to $3.95 per minute, depending on where you are calling from.

The Mobilfone is about the size of a desk phone and just as easy to use. And of course it is wireless. It gives you voice, fax, data, or e-mail from anywhere in the world.

Like the Compact-M, the Mobilfone employs pre-paid smartcard access.

Satellites offer anti-theft security

At least two companies are now offering car security services via satellite which operate similar to home security systems and render old-fashioned alarms obsolete.

OnGuard from Texas-based ATX Technologies, 800-466-4827, **http://www.track.com**, is primarily a tracking service which you activate by telephoning the provider in time of need. CarCop, offered by ADT Security Systems based in Georgia, 888-353-9900, **http://www.carcop.com**, operates like a home security system by transmitting a code to the provider via your cell phone.

When activated, OnGuard determines your vehicle's location, speed, and direction. It alerts and guides police to your vehicle. And it stops your engine if you authorize police to do so.

You telephone the OnGuard Response Center to report a theft. The Center activates a tracking device hidden inside your vehicle. The tracker interprets signals using GPS and transmits this data to the center using cellular technology. Computers at the center track and display your vehicle's location under the eye of emergency communication specialists who alert police and guide them to your vehicle.

If you lock your keys in your vehicle, OnGuard can unlock electric doors remotely for you—with your authorization, of course. You can use OnGuard to summon help in case of a breakdown. You can even use the service to get directions if you become lost.

CarCop is designed to automatically know when your vehicle is in trouble, such as a theft, carjacking, or medical emergency. Like OnGuard, CarCop uses the U. S. Government's $12 billion GPS network to track your vehicle's precise location. Then, using your vehicle's cellular phone combined with sophisticated safeguards, CarCop provides a live link to a central monitoring center.

CarCop works much like a home security system. When you get in your car, you enter your authorization code via your cell phone. If the proper code is not entered, CarCop activates an alarm and the monitoring center receives the signal in seconds. The location and status of your car appears on a digital street map in real time on a computer screen in the center. A professional relays this information to police and stays on the line with you until the situation is resolved.

With CarCop, the professional in the center can also provide vital information about you in a medical emergency.

It can also call road service, remotely unlock your vehicle's automatic doors, and even warn you if your battery is low.

Omniquest satellite telephone system debuts

American Mobile Satellite Corporation in May sent its new Omniquest satellite phone into action for the first time in a rigorous mountain climbing telemedicine expedition in Alaska to prove its usefulness in a real-life situation.

Telemedicine is the practice of medicine via conventional and fibre-optic phone lines, satellite, microwave, and the Internet.

The 1997 Denali Telemedicine Expedition, which kicked off May 21 in the former Mount McKinley National Park 240 miles north of Anchorage, provided a rugged test for Omniquest which weighs about 5 pounds and offers digital voice and data transmission through Skycell Satellite Communications Services.

Located 120 miles south of Fairbanks, Mount Denali is the highest point in North America, rising 20,320 feet from glaciers in the Alaska range. More than half the mountain is blanketed by a permanent layer of snow. The weather changes suddenly and drastically. Springtime temperatures fall to 31 degrees Fahrenheit below zero and winds gust to more than 100 miles per hour. Some say the notorious Himalayan mountains are tropical by comparison.

The purpose of the expedition was to carry out scientific and medical research. The low oxygen content of the thin polar atmosphere allows doctors to gather data on physical changes in strenuous high-altitude activity. Climbers collected data using a heart monitor and transmitted that data to the University of Ottawa Heart Institute, using Omniquest and SKYCELL.

They also used Omniquest to send voice messages, e-mail, and update images on the expedition web site. The web address is **http://www.denali97.carleton.ca.**

"The research we're doing will advance telemedicine," says Dr. Christian Otto, expedition team leader. "The portability of the Omniquest satellite telephone system means we can communicate results in real time from even the most extreme environment."

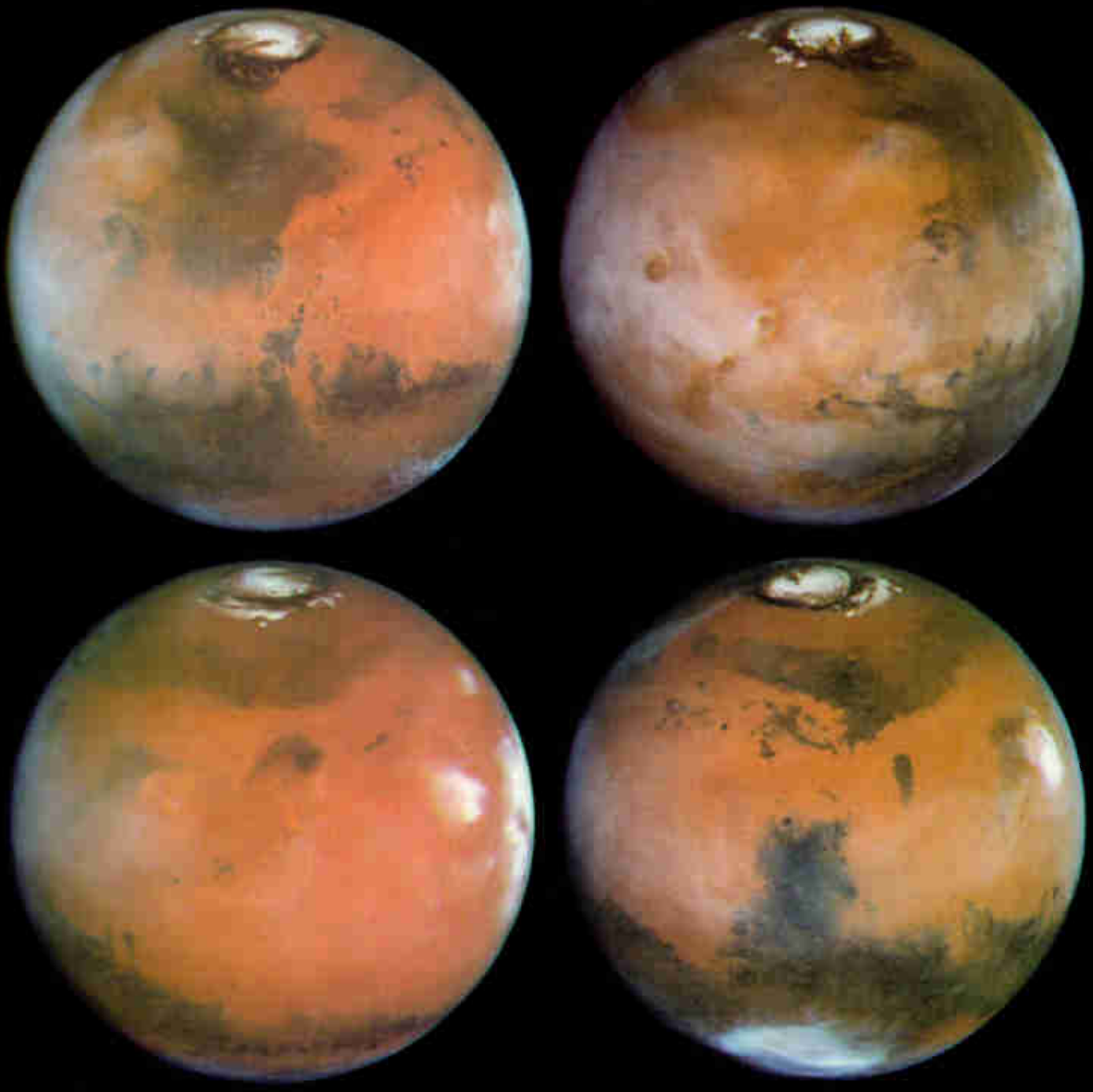
This of course is crucial in life-saving expeditions and other emergency situations requiring immediate medical diagnosis in extreme and remote conditions.

The Omniquest Satellite Telephone offers reliable communications where no communications infrastructure exists. Like other satellite phone units, it is a useful tool for industry and public service in remote areas. ST

ST SPACE WATCH

By Larry Van Horn

Extended Forecast for Mars: *Chaos*



Preceding page: Four faces of Mars as seen on March 30, 1997 are presented in this montage of NASA Hubble Space Telescope images. See descriptions below, right. (Pictures courtesy of Steve Lee, University of Colorado; Todd Clancy, Space Science Institute, Boulder, Colorado; Phil James, University of Toledo; and NASA.)

Upper left: This view is centered on Ares Valles, where Pathfinder will land on July 4, 1997; the Valles Marineris canyon system stretches to the west across the lower left portion of the planet, while the bright, orangish desert of Arabia Planitia is to the east. The bright polar water-ice cap, surrounded by a dark ring of sand dunes, is obvious in the north; since it is northern summer and the pole is tilted toward us, the residual north polar cap is seen in its entirety in all four images. Acidalia Planitia, the prominent dark area fanning southward from the polar region, is thought to have a surface covered with dark sand. Numerous "dark wind streaks" are visible to the south of Acidalia, resulting from wind-blown sand streaming out of the interiors of craters.

Upper right: The Tharsis volcanos and associated clouds are prominent in the western half of this view. Olympus Mons, spanning 340 miles (550 km) across its base and reaching an elevation of 16 miles (25 km), extends through the cloud deck near the western limb, while (from the south) Arsia Mons, Pavonis Mons, and Ascraeus Mons are to the west of center. Valles Marineris stretches to the east, and the Pathfinder landing site is shrouded in clouds near the afternoon limb.

Lower left: This relatively featureless sector of Mars stretches from the Elysium volcanic region in the west to the Tharsis volcanoes (shrouded by the bright clouds near the afternoon limb) in the east. The group of three dark specks just left of center are all that remain of Cerberus, a very prominent dark region during the Viking and Mariner 9 missions. This is an example of the remarkable large scale changes which can occur on Mars due to windblown dust: the former dark area has now been covered by a layer of bright dust, masking the underlying material.

Lower right: The dark Syrtis Major region dominates this image. Syrtis Major is one of the most prominent dark features on Mars, and has been visible since ground-based observers first peered at Mars through telescopes. The bright cloud at 3 o'clock is associated with Elysium Mons. The bright bluish-white feature near the southern limb of the planet is Hellas, a 1,200 mile (2,000 km)diameter impact basin formed by the collision of a large body with Mars long ago. Hellas is covered with dry ice frost and clouds during this season (winter in the south).

Seasonal changes in the north polar icecap of Mars are shown in this Hubble montage.

If you think the weather on Earth is unpredictable, try living on Mars. One week, the sky is pink and cloudless, filled with windblown dust raised from the rusty Martian surface. By Martian standards, it's warm, about minus 40 degrees Fahrenheit. Then, in a matter of days, the dust is swept from the atmosphere, temperatures plummet 40 degrees, and brilliant water ice clouds appear against a dark blue sky.

Dramatic weather changes like these may not seem very different from a batch of severe thunderstorms passing through your home town, but for Mars these changes can sweep over the entire planet every week. It appears that Mars' roller coaster-like weather is more chaotic and unpredictable than scientists first thought.

As two NASA spacecraft speed toward a rendezvous with Mars this month and in September, astronomers using the Hubble Space Telescope are providing updated planetary weather reports to help plan the missions.

Martian atmospheric conditions will affect the operation of both the Mars Pathfinder landing on July 4, and the September 11 arrival of the Mars Global Surveyor which will map the planet from orbit. Hubble images taken barely three weeks apart, on March 10 and March 30, reveal dramatic changes in some local conditions, and show overall cloudier and colder conditions than Viking encountered two decades ago.

Four Views of Mars in Northern Summer

Four faces of Mars as seen on March 30, 1997 are presented in this montage of NASA Hubble Space Telescope images. Proceeding in the order upper-left, upper-right, lower-left, lower-right, Mars has rotated about ninety degrees between each successive time step. For example the Tharsis volcanoes, which are seen (between 7:30 and 9 o'clock positions) in mid-morning in the UPPER-RIGHT view, are seen near the late afternoon edge of the planet (about 3 o'clock position) in the lower-left image. All of these color images are composed of individual red (673 nanometers), green (502 nm), and blue (410 nm) planetary camera exposures.

Zowie, It's Maui!

By Larry Van Horn

This spaceborne radar image shows the "Valley Island" of Maui, Hawaii. The cloud-penetrating capabilities of radar provide a rare view of many parts of the island, since the higher elevations are frequently shrouded in clouds.

The light blue and yellow areas in the lowlands near the center are sugar cane fields. The three major population centers, Lahaina on the left at the western tip of island, Wailuku left of center, and Kihei in the lower center appear as small yellow, white or purple mottled areas. West Maui volcano, in the lower left, is 1800 meters high (5900 feet) and is considered extinct.

The entire eastern half of the island consists of East Maui volcano, which rises to an elevation of 3200 meters (10,500 feet) and features a spectacular crater called Haleakala at its summit. Haleakala Crater was produced by erosion during previous ice ages rather than by volcanic activity, although relatively recent small eruptions have produced the numerous volcanic cones and lava flows that can be seen on the floor of the crater. The most recent eruption took place near the coast at the southwestern end of East Maui volcano in the late 1700s. Such a time frame indicates that East Maui should be considered a dormant, rather than an extinct volcano. A new eruption is therefore possible in the next few hundred years.

The multi-wavelength capability of the SIR-C radar also permits differences in the vegetation cover on the middle flanks of East Maui to be identified. Rain forests appear in yellow, while grassland is shown in dark green, pink and blue.

Radar images such as this one are being used by scientists to understand volcanic processes and to assess potential threats that future activity may pose to local populations.

This image was acquired by spaceborne imaging radar-C/X-band synthetic aperture radar (SIR-C/X-SAR) onboard the space shuttle *Endeavour* on April 16, 1994. The image is 73.7 kilometers by 48.7 kilometers (45.7 miles by 30.2 miles) and is centered at 20.8 degrees North latitude, 156.4 degrees West longitude. North is toward the upper left. The colors are assigned to different radar frequencies and polarizations of the radar as follows: red is L-band (24 cm), horizontally transmitted and received; green is C-band (6 cm), horizontally transmitted and received; and blue is the difference of the C-band and L-band channels. SIR-C/X-SAR, a joint mission of the German, Italian, and United States space agencies, is part of NASA's Mission to Planet Earth. ST

Galileo Finds Wet and Dry Spots on Jupiter

Jupiter has both wet and dry regions, just as Earth has tropics and deserts, according to new images and data from the Galileo spacecraft. The data may explain why Galileo's atmospheric probe found much less water than scientists had anticipated when it dropped into the Jovian atmosphere in December 1995.

"We had suspected that the probe landed in the *Sahara Desert of Jupiter*," said Dr. Andrew Ingersoll, a professor at the California Institute of Technology, Pasadena, CA, and member of the Galileo science team. "But the new data show there is moisture in the surrounding areas. Jupiter is not as dry overall as we thought."

The area where the probe entered was a clearing in the clouds—a dry spot through which deeper, warmer layers can be seen. By studying various areas, including those resembling the probe entry site, the Galileo orbiter has helped scientists understand the probe results. In fact, the air around a dry spot has 100 times more water than the dry spot itself, according to Dr. Robert Carlson of NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA, principal investigator for the imaging spectrometer instrument onboard Galileo.

Such dry spots cover less than one percent of the Jovian atmosphere, and they appear to be regions where the winds converge and create a giant downdraft, according to Cal Tech graduate student Ashwin Vasavada. In fact, the water content of the giant, gaseous planet varies at least as much as the moisture varies from place to place on Earth.

This photographic mosaic of images from NASA's Galileo spacecraft covers an area of 34,000 kilometers by 22,000 kilometers (about 21,100 by 13,600 miles) in Jupiter's equatorial region. The dark region near the center of the mosaic is an equatorial hotspot similar to the site where the Galileo Probe parachuted into Jupiter's atmosphere in December 1995. These features are holes in the bright, reflective, equatorial cloud layer where heat from Jupiter's deep atmosphere can pass through. The circulation patterns observed here along with the composition measurements from the Galileo Probe suggest that dry air may be converging and sinking over these regions, maintaining their cloud-free appearance. The bright oval in the upper right of the mosaic as well as the other smaller bright features are examples of upwelling of moist air and condensation. These images were taken on December 17, 1996, at a range of 1.5 million kilometers (about 930,000 miles) by the Solid State Imaging camera system aboard Galileo. North is at the top. The mosaic covers latitudes 1 to 19 degrees and is centered at longitude 336 degrees west. The smallest resolved features are tens of kilometers in size.

"Winds rise from the deep atmosphere and lose water and ammonia," explained Dr. Glenn Orton, a Galileo interdisciplinary scientist at JPL and Photopolarimeter-Radiometer co-investigator. "At the top, when they converge and drop back down, nothing is left to condense back into clouds, and a dry clearing is created. These dry spots may grow and diminish, but they recur in the same places, possibly because of the circulation patterns on Jupiter."

Ingersoll said the dry spots are found in a northern hemisphere band at five to seven degrees latitude. When the Galileo probe was released near the tops of the clouds, it found dry air underneath. But at other locations, the weather might be rather Earth-like.

In the months since the probe's descent, Galileo mission scientists have debated whether the dry conditions it encountered were due to the downdraft concept, or whether Jupiter's water had somehow been concentrated deep in the gas planet's interior as it formed and evolved four billion years ago. "There was a cosmochemical explanation and a meteorological explanation, and our latest analysis clearly favors the idea that the dry spots are a consequence of weather-related activity," Ingersoll said.

"Fifty miles below the cloud tops, we could expect thunderstorms, lightning and rain," Ingersoll added. "But in contrast to Earth, individual Jovian storms and weather systems sometimes last for months, years or even centuries. The Great Red Spot, for example, has existed for at least the 300 years that we've been aware of it."

Despite the relatively warm temperatures and the presence of water on Jupiter, Ingersoll said it is "highly unlikely" that the planet could sustain life in its thick, gaseous environment without any solid surface. He expressed the opinion that any Jovian life forms would have to hover, and "while we might imagine an advanced life form that could adapt, pre-biotic compounds would not survive in that environment and, therefore, evolution could not take place there."

Galileo was launched in 1989 and entered orbit around Jupiter on Dec. 7, 1995. The Galileo mission is managed by JPL for NASA's Office of Space Science, Washington, DC.

ST

Jeff Lichtman

OSCAR, A Beginner Radio Astronomy Project

OSCAR translates to: O*uter Space Collector of Astronomical Radiation.* It is the name of Bill Walkers radio telescope (Society of Amateur Radio Astronomers member, Bill Walker, of West Virginia). This article below describes, in Mr. Walkers own words, its construction and observations.

This entire project was built at a cost of less than $500, due to the many friends who donated equipment and parts, and to the many visits I made to ham radio flea markets, (hamfests) and garage sales.

The eleven-foot parabolic dish was purchased for only $33. A meridian transit mount was constructed from pipe and treated wood posts (see Figure 1B).

To set the scope to the desired declination, I used a ratchet wrench to loosen the four muffler clamps which were held tight with 3/8-x 9-inch lag screws, in the top of the treated posts. Once the antenna is loosened, I can move it with one finger, due to the careful balancing mechanism, that utilizes barbell weights (bought at a garage sale). The weights are off center because I could not find a pipe cross fitting (at the junkyard) and had to make one from two "T's." The declination is read on a protractor cut from aluminum and painted with the proper scale (straight up is 38 degrees, my latitude.) The pointer in the end cap of the declination support pipe is a six-inch machine screw with the head filed to a point and painted black. The clamps are then tightened down to hold the antenna at the desired setting.

To support the dish on the three-inch declination axis, I used an existing one-inch hole in the center of the dish's central plates. I simply sandwiched the plates with pipe pieces (see Figure1B) and then welded everything tight.

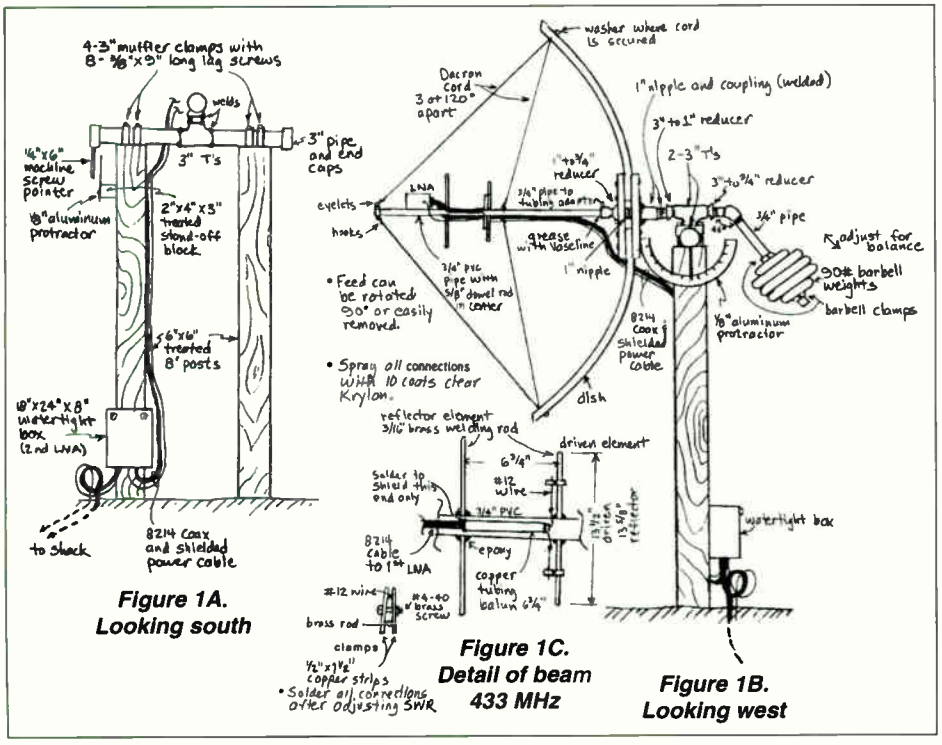
The feed is fabricated of 3/4 inch PVC pipe, with a wood dowel rod in its center for added strength. The two element beam was made from 3/16" brass welding rods, slipped into holes drilled in the PVC and dowel rod, then epoxied in place. A T match and copper tubing balun were used to match and balance the driven element to low-loss coax (obtained from my local cable company). The copper tubing balun is described in the *Radio Amateur's Handbook* by Sickels (available from Radio Astronomy Supplies).

The first LNA (low noise amplifier) is held in place behind the reflector element with nylon tie wraps. It is also connected to low-loss coax, which runs with a shielded power cable, to a watertight box, mounted on one of the wood support posts (see Figure 1B). A second LNA is housed in the box, and from there, more coax and shielded power cable go underground to my "shack" (ham radio station), 130 feet away. The LNAs are essentially identical: GasFet, 0.5 dB noise figure, and 20dB gain (made by Carl Lyster). N-type connectors are used in all field connections. The watertight box was acquired from a local contractor. The scraps of copper tubing, brass welding rods, and PVC tubing were given to me by our local hardware store. The only things purchased in the entire feed assembly were the dowel rod, eyelets for the support cords, and the end cap for the PVC pipe.

The T match was made with strips of scrap copper, held by a single brass screw, so that the tuning could be adjusted (see Figure 1C). Using a ham radio walkie-talkie connected to an SWR meter, I adjusted the connections for lowest standing wave, about 1:1 to 1, and then soldered them firmly into place. All connections were then sprayed with ten coats of Krylon to protect them from the weather.

To keep the feed from flexing, fishing line cords were connected to the PVC support and attached at the edge of the dish. It is important to note that the coupling which holds the PVC tubing to the center of the dish, is NOT cemented. in fact, it is greased with Vaseline to allow easy turning. This allows the whole assembly to rotate 90 degrees for changes in feed polarity.

The air-conditioned shack, which



Bill Walker's "shack." The DX-1000 receiver is just under the desk lamp.

houses the receiver backend electronics, are located, over my garage.

The feed is tuned to 433 MHz. This frequency was chosen simply because the 433 to 29 MHz downconverter was donated by a ham. Unfortunately, it turned out to be unstable, so Carl Lyster built a new one for me. If I had it to do all over again, I probably would have chosen 611 MHz or even 1420 MHz, the hydrogen line.

My receiver is a Uniden DX-1000 communications receiver. It has three bandwidth selections, the widest of which is 12 KHz. The AGC has a variable setting. In fast mode, there is practically no AGC action at all. I have obtained good results using a detector in the audio output as described by Jeff Lichtman's article in a 1990 SARA journal. I have modified it by adding a switch to select various capacitors for changing the integration time constant.

Better results can be had by tapping into the radio's IF output (but it is not absolutely necessary to do that). The method used in all of the attached graphs was audio detection. When using audio detection, set the tone control to maximum treble, leave the RF gain at maximum, and adjust gain using the AF level control.

My first chart recorder was an old Westronix unit bought at a hamfest; it had no DC amps or bias control. I built the latter using a 50k pot and a 12 volt battery. The DC amplifier was a simple 741 op amp. I now have a newer Esterline-Angus recorder (donated by a ham friend) that has built-in DC amps and bias controls. I do not have an A/D card yet, but occasionally I have borrowed a data logger from the company I work for, to capture the data in digital form.

Calibration turns out to be easy at 433 MHz because the ground, at about 300K, is close to the temperature of the galactic center at about 190K.

An integration time of only one second was used to try to catch any solar activity. There were a lot of spikes that day, as the strip chart shows, but I don't know whether they were local interference or whether they were truly the solar events.

I have a tape recorder hooked up to the audio output—by playing back the audio, I can sometimes tell if the interference is local or not. Lawn tractors, weed eaters, and automobiles are a constant problem and make a very distinctive popping noise.

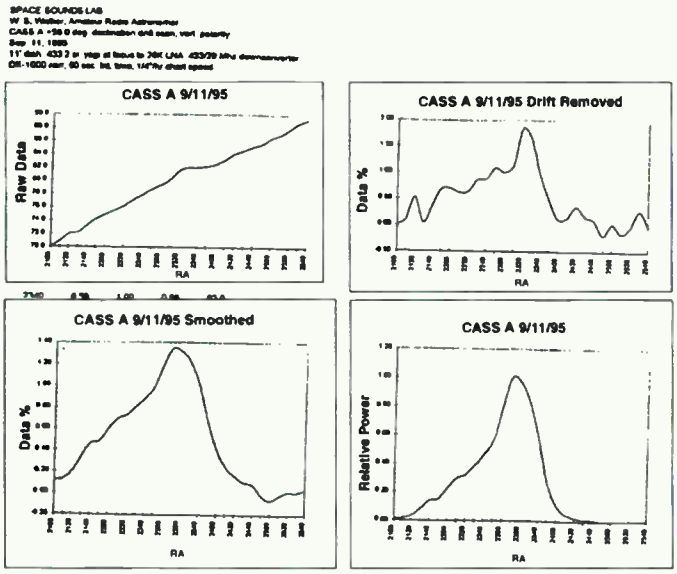


Figure 2. Cass A drift scan. A high gain setting exaggerates temperature drift.

I have found that using detection in the audio output, as was done in this scan, produces output proportional to voltage and not total power. To get a relative power reading, I normalize the voltage with a simple linear transformation to a range of zero for the minimum reading and 1.0 for the maximum. Squaring this produces a graph of relative power that is a perfect Gaussian shape.

Plans are to do several of these scans, and to build a contour map of the galaxy at 433 MHz.). As shown in the calculations in figure 10, it is quite easy to determine beamwidth from such a graph.

At high gain settings, temperature drift is a problem. The graph of Cass A (Figure 2) shows the steep climb caused by changing temperatures in the LNAs. This can be flattened out using data processing, so long as the time is kept short, so not to cause the recorder or data logger to "peg out." Of course, this is a poor substitute for cooling the field electronics, which I plan to do in the future. Other projects on the drawing board are to add a calibrator of some sort and to build a wideband 29-MHz amplifier and square-law detector.

Here are a few of the difficulties in building OSCAR:

- The dish did not have any of its feed hardware, so I did not know the focal length. I had to apply the standard f/d formula.
- I had no idea where to put the two-element beam in relation to this calculated focus. After discussion with ham friends that have worked "moonbounce" at this frequency, I decided to put the focus at the exact center of the beam, that is, in between the two elements. I plan to run some tests to determine if this is really the optimal feed point.
- The original downconverter was very unstable. This problem was solved by buying a downconverter of much better quality.
- Oscillation caused by high gain in the front end eluded me for weeks. It was solved by stagger tuning the two LNAs slightly, and by using separate power supplies for the two LNAs and the rest of the electronics.
- Finally, the greatest challenge of all is justifying to my family the long hours spent in my shack, often into the wee hours of the morning, watching the little chart pen move up and down.

Mr Walker may be reached via the Internet; his address is **DxFlatline@aol.com.** ST

World Radio Network Schedules

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

0030	WRN Announcements, until....
0200	YLE Radio Finland (Mon-Sat)
0255	YLE, Church Service (Sunday only)
0400	WRN Announcements, until....
0600	YLE Radio Finland, News in Finnish
0625	YLE, News in Swedish
0630	YLE, News in English
0700	WRN Announcements, until....
0800	RTE News in Irish
0900	Radio Prague in Czech
0927	WRN Announcements, until....
1000	YLE, Radio Finland, News in Finnish
1005	YLE, Regional News
1030	YLE, News in Finnish
1100	YLE, News in Swedish
1130	YLE, Easy Listening Music and Chat in Finnish
1200	Radio Netherlands in Dutch
1400	WRN Announcements, until....
1500	Radio Vlaanderen International in Dutch
1530	WRN Announcements, until....
1630	ORF Radio Austria International in German
1700	Radio Budapest in Hungarian
1800	Polish Radio Warsaw in Polish
1830	YLE Radio Finland, Devotional Music
1855	YLE, News in Swedish
1900	YLE, News in Finnish
1930	YLE, Easy Listening Music and Chat in Finnish
2010	YLE, Current Affairs in Finnish
2030	YLE, Documentaries in Finnish
2030	YLE, New Classical releases in Finnish (Sunday)
2130	YLE, Easy Listening Music in Finnish
2230	YLE, News in Finnish
2300	WRN Announcements, until....
2330	ORF Radio Austria International in German

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

BST/CET

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

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

BST

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

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

UTC/AET

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

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

UTC/CAT
Next five hours can be heard in South Africa on SAfm 104-107

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

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ST SPACE GLOSSARY

The following are some terms used in the satellite business and are described in layman's terms.

ALTITUDE (ALT): The distance between a satellite and the point on the earth directly below it, same as height.

AQUISITION OF SIGNAL (AoS): The time at which a particular ground station begins to receive radio signals from a satellite.

APOGEE: The point in a satellite's orbit farthest from the Earth's center.

ARGUMENT OF PERIGEE: This value is the number of degrees from the ascending node the perigee point occurs. The perigee point is the point where the satellite is the closest to the earth (assuming an orbit which is elliptical to some degree). This number may be entered as a real value between 0.0 and 360.0.

ASCENDING NODE: Point at which the satellite crosses the equatorial plane from the southern hemisphere to the northern hemisphere. (See RIGHT ASCENSION OF THE ASCENDING NODE.)

AZIMUTH (AZ): The angle measured in the plane of the horizon from true North clockwise to the vertical plane through the satellite.

CATALOG NUMBER: A 5-digit number assigned to a cataloged orbiting object. This number may be found in the NASA Satellite Situation Report and on the NASA Two Line Element (TLE) sets.

COORDINATED UNIVERSAL TIME (UTC): Also known as Greenwich Mean Time (GMT). Local time at zero degrees longitude at the Greenwich Observatory, England. Uses 24 hour clock, ie. 3:00 pm is 1500 hrs.

CULMINATION: The point at which a satellite reaches its highest position or elevation in the sky relative to an observer. (Known as the Closest Point of Approach)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups polling resources for space exploration and development.

FOOTPRINT: A set of signal-level contours, drawn on a map or globe, showing the performance of a high-gain satellite antenna. Usually applied to geostationary satellites.

GROUND STATION: A radio station, on or near the surface of the earth, designed to receive signals from, or transmit signals to, a spacecraft.

INCLINATION (INC): The angle between the orbit plane and the Earth's equatorial plane, measured counter-clockwise. 0 (zero) degrees inclination would describe a satellite orbiting in the same direction as the Earth's rotation directly above the equator (orbit plane = equatorial plane). 90 degrees inclination would have the satellite orbiting directly over both poles of the earth (orbit plane displaced 90 degrees from the equatorial plane). An inclination of 180 degrees would have the satellite orbiting again directly over the equator, but in the opposite direction of the Earth's rotation. Inclination is given as a real number of degrees between 0.0 and 180.0 degrees.

INTERNATIONAL DESIGNATOR: An internationally agreed upon naming convention for satellites. Contains the last two digits of the launch year, the launch number of the year and the piece of the launch, ie A-indicates payload, B-the rocket booster, or second payload, etc.

LATITUDE (LAT): Also called the geocetic latitude. the angle between the perpendicular to the Earth's surface (plane of the horizon) at a location and the equatorial plane of the earth.

LONGITUDE (LONG): The angular distance from the Greenwich (zero degree) meridian, along the equator. This can is measured either east or west to the 180th meridian (180 degrees) or 0 to 360 degrees west. For example, Ohio includes 85 degrees west longitude, while India includes 85 degrees east longitude. But 85 degrees east longitude could also be measured as 275 degrees west longitude.

LOSS OF SIGNAL (LoS): The time at which a particular ground station loses radio signals from a satellite.

MEAN ANOMALY (MA): This number represents the angular distance from the perigee point (closest point) to the satellite's mean position. This is measured in degrees along the orbital plane in the direction of motion. This number is entered like the argument of perigee, as a value between 0.0 and 360.0.

MEAN MOTION (MM): This is the number of complete revolutions the satellite makes in one day. This number may be entered as a value greater than 0.0 and less than 20.0. (See DECAY)

NASA: U.S. National Aeronautics and Space Administration.

ORBITAL ELEMENTS: Also called Classical Elements, Satellite Elements, Element Set, etc. Includes the catalog Number; epoch year, day, and fraction of day; period decay rate; argument of perigee, inclination, eccentricity; right ascension of ascending node; mean anomaly; mean motion; revolution number at epoch; and element set number. This data is contained in the TWO LINE ORBITAL ELEMENTS provided by NASA.

OSCAR: Orbiting Satellite Carrying Amateur Radio.

PERIOD DECAY RATE: Also known as Decay. This is the tendency of a satellite to lose orbital velocity due to the influence of atmospheric drag and gravitational forces. A decaying object eventually impacts with the surface of the Earth or burns up in the atmosphere. This parameter directly affects the satellite's MEAN MOTION. This is measured in various ways. The NASA Two Line Orbital Elements use revolutions per day.

PERIGEE: The point in the satellite's orbit where it is closest to the surface of the earth.

POSIGRADE ORBIT: Satellite motion which is in the same direction as the rotation of the Earth.

RETROGRADE ORBIT: Satellite motion which is opposite in direction to the rotation of the Earth.

REVOLUTION NUMBER: This represents the number of revolutions the satellite has completed at the epoch time and date. This number is entered as an integer value between 1 and 99999.

REVOLUTION NUMBER AT EPOCH: The number of revolutions or ascending node passages that a satellite has completed at the time (epoch) of the element set since it was launched. The orbit number from launch to the first ascending node is designated zero, thereafter the number increases by one at each ascending node.

RIGHT ASCENSION OF THE ASCENDING NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period, inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

UPLINK

By Bob Grove, Publisher
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America in Space: Domination by Default?

Time flies. In just four decades we have witnessed a steady, sometimes frenetic, progression in global space programs, from Sputnik and Vanguard to Mercury and Gemini, from Luna and Lunik through Mariner and Pioneer, from Soyuz and *Mir* through Apollo and the Space Shuttle. These and other project names are now immortalized in the history books. Most of our memories are glorious, although we have shed tears as well when we witnessed tragedy unfold among our heroes.

The American program was delayed at the onset, ostensibly because the administration wanted a civilian, not a currently-ready military platform to carry us into orbit. The delay cost us dearly, with the Russians capturing the coveted "First in Space" award. China, Japan, Israel, the U.K., France, Canada, Indonesia, and other nations got into the race as well. It seems to many observers that we have been playing an extravagant game of "catch-up" ever since.

The real race has always been between Russia and the U.S.; it was a question of both national pride and military superiority during the Cold War, even during the thaw. But the gap may be finally closing.

The dissolution of the Russian Republics has had disastrous consequences on the Russian economy, with far more pressing problems now imposed upon the Russian government than their standing in the space program. Even Russia's commitment to supply a $139 million service module for the International Space Station may be in jeopardy as Russian contractors report non-payment by their government. NASA announced a protracted delay in launching the next phase of the space station to accommodate Russia's participation—at a U.S. cost of $100 million.

Japan, too, has been feeling the competitive brunt of the world's economy. An enormous budget deficit has forced that powerful island country to reassess their priorities, substantially reducing support of their National Space Development Agency (NASDA), and even threatening NASDA's parent organization, the Science and Technology Agency, with dissolution.

Even the European Space Agency (ESA) is feeling turmoil amidst the aftershock of the June 1996, Ariane 5 failure. Considerable reorganization among prime contractors seems likely, with extensive retrenching expected.

So where does this leave the U.S.? Apparently in the lead by default. But we can't stand in the center of the court holding the ball forever; eventually other players will rebound, attempting to grasp both global attention and economic control by exercising their leadership in a revitalized race for space.

Will we remain in the race? Only by holding steadfast to clearly defined goals, and investing logically and vigorously in the future of the American space program. It appears that we are off to a good start. NASA Administrator Dan Goldin seems to have a harmonious relationship with the White House, capturing a pledge for no further budget cuts for his administration.

Forecasters see U.S. companies playing the role of prime contractor for 75% of the world's information satellites over the next decade. It looks good; *let's hold onto that regained lead and make it count.*

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