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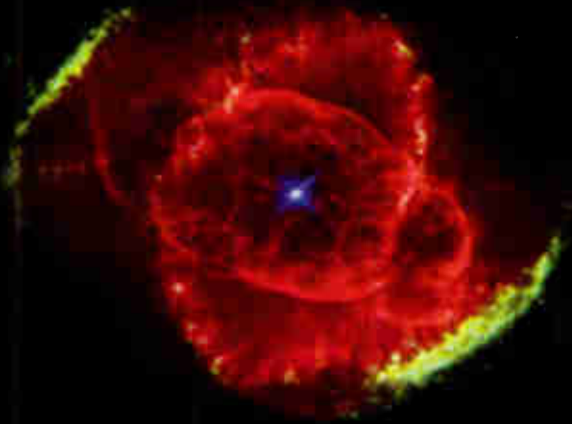
November/December 1995



Hubble's Greatest Hits

Satellite Times

Cover Story

Cover: An artist's rendering of the Hubble Space Telescope looking at NGC 6543, nicknamed the "Cat's Eye Nebula" (actual Hubble photo). It is one of the most complex planetary nebula ever seen. Hubble reveals surprisingly intricate structures including concentric gas shells, jets of high-speed gas and unusual shock-induced knots of gas.

Star Search

(NGC 6543 photo courtesy of J.P. Harrington and K.J. Borkowski-University of Maryland and NASA)

By Michael Mechanic

Are we alone? Are there other intelligent beings out there? Michael Mechanic takes a look at the history of SETI (Search for Extraterrestrial Intelligence) projects like Ozma and Phoenix. Story starts on page 10.

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November/December 1995

Search for Answers

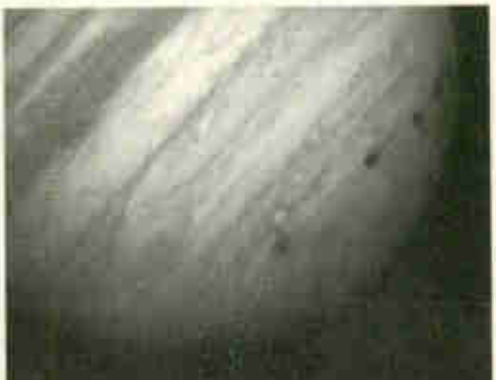
By Len Losik

NASA's astrophysics satellites have opened up a whole new Universe to scientists previously hidden by the atmosphere of the Earth. These great orbiting observatories have revealed that our Universe is incomparably richer in stars and matter than what had been imagined. Len Losik looks at five of these satellites and their scientific discoveries starting on page 16.

Hubble: Our Window on the Universe

By Keith Stein

The Hubble Space Telescope has ushered in a period of discovery more astounding and productive than any other space science mission to date. ST columnist Keith Stein takes an in-depth look at this massive orbiting observatory in the story starting on page 20.



The NRAO Facility

Since 1984, the Society of Amateur Radio Astronomers (SARA) have been holding their annual conference at the National Radio Astronomy Observatory in Green Bank, West Virginia. *ST* columnist Jeff Lichtman gives you a guided tour of this amazing facility in his Radio Astronomy column starting on page 72.

DEPARTMENTS

ST

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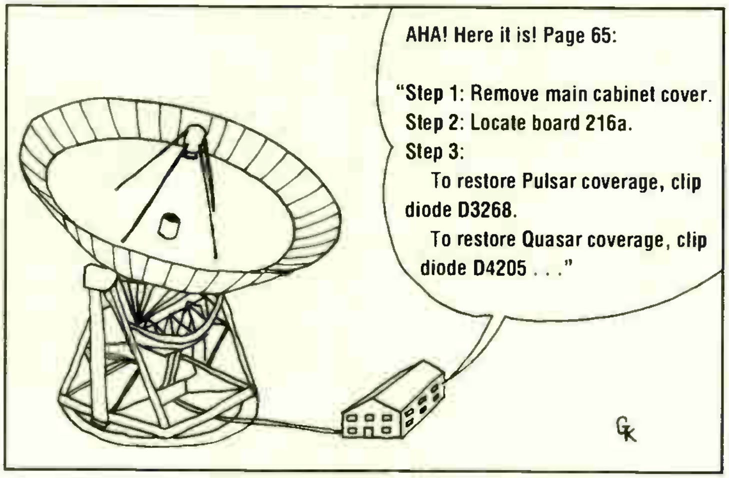
By Larry Van Horn
Managing Editor

Looking Toward the Stars

Launched on April 24, 1990, NASA's Hubble Space Telescope (HST) was designed to be the most powerful astronomical observatory ever built. And indeed, HST far surpasses the capabilities of ground-based optical telescopes for many types of research. The keys to Hubble's power are its operations in space, far above the interference of the Earth's atmosphere, and the unique instruments it carries as it orbits the planet.



While the launch on the space shuttle *Discovery* more than five years ago was flawless, Hubble was not. Two months after HST was deployed into orbit, Hubble produced a disquieting discovery. The curvature of its primary mirror was slightly — but significantly — incorrect. Near the edge, the mirror is too flat by an amount equal to 1/50th the width of a human hair.The result was a focusing defect or spherical aberration.

Just two short years ago, the space shuttle *Endeavour* came to Hubble's rescue. Tearing a page right out of a Buck Rogers script, the STS-61 astronauts repaired HST's blurry vision during one of the most dramatic shuttle missions to date. The results of that repair have been nothing short of fantastic. To honor the crew of STS-61, the NASA shuttle team, and the scientists at the Space Telescope Institute, *Satellite Times* presents in this issue *Hubble's Greatest Hits*. If you would like to see more HST photos and you have access to the World Wide Web, surf on over to my favorite site on the Internet at — http://www.stsci.edu and take a peek at these beautiful photographs in color.

Regular columnist Keith Stein looks past the pictures and gives *ST* readers a behind the scenes look at what makes Hubble tick in his feature story, *Hubble: Our Window on the Universe*.

HST isn't the only game in town when it comes to space-based observatories. As Len Losik points out in his feature, *Searching for Answers*, there are several astrophysical observatories in orbit imaging the Universe.

But, the age-old question still remains, "Are we alone?" Freelance journalist Michael Mechanic looks at a team of scientists who are attempting to answer that question by searching for extraterrestrial intelligence using radio communications in his article titled *Star Search*.

This issue of *Satellite Times* brings you even more. We have two new regular columnists joining the *ST* star-studded cast of regulars. Doug Jessop, editor of Keystone Communications *North American Satellite Guide*, takes over the reins of the *Domestic TVRO* column from Frank Baylin. Frank will still join us from time to time in the pages of *ST*'s *Satellite Technical Forum*.

Also commencing with this issue, I am sad to announce that Dr. Theo Pappan will no longer write his popular *Satellite Sleuth* column. Theo reports he is no longer able to continue his column because of worsening health conditions. Live long and prosper, my friend; and we hope to hear from you again.

Taking Theo's place, but with a new topic is Keith Stein, our *Launch Schedules* columnist. Keith is an aerospace freelance writer and will write a column in each issue called the *Satellite Listening Post*. Keith will cover frequencies, equipment, and more for those of you who want to get the most out of your satellite listening post. In addition, Keith will also run intercepts in each column from you — the readers — on what you have been hearing from the heavens.

After you have finished reading this issue of *ST*, why not grab the kids and the lawn chairs, go out into the backyard, and take a long relaxing look at the wide open skies of our Universe? Who knows; maybe you will see the Hubble one of these cold winter evenings as it orbits the Earth imaging the heavens. It is our sincere wish that all of you all have a safe and happy holiday season from the entire staff and management here at Grove Enterprises and *Satellite Times*. ST


SatellitePro

Satellite Monitor

By Wayne Mishler, KG5BI

Politicians Eye Possible Center for Unmanned Space Flight

Political eyes are turning ever so slowly to a little-known flight facility on the wave-battered Atlantic shore just south of the Maryland-Virginia border on Wallops Island. There is talk that the facility may someday become America's center of unmanned space flight.

The facility belongs to NASA. And like its big brother facility on the Florida coast, the Wallops Island Flight Facility has been launching space probes, but without much publicity and press coverage. Until now.

A writer for the Washington Times recently spoke of several visits to the facility by governor George Allen, and senators Paul Sarbanes and Barbara Mikulski. Following a vote by the House Appropriations Committee to curb funding for the Goddard Space Center, which oversees Wallops, there is growing hope that more of the nation's space program might be shifted to the Wallops facility.

"Cape Canaveral is the premier location of manned space flight. There's no reason why Wallops can't become the premier location of unmanned space flight. And there are lots of exciting things to do in space that are unmanned," says a vice president of one firm that launches commercial satellites from the island.

Wallops went into operation five years before Cape Canaveral's first launch in 1950. Initially the Wallops facility tested air-to-air missiles for use against Japanese kamikaze pilots, in 1945. Over the years, about 15,000 rockets have ascended from the facility. Some carried monkeys. Others tested the Mercury capsules that later put the first U. S. astronauts in orbit from Canaveral.

Today about 100 rockets are launched annually from Wallops. Some gather weather data, like the launch this summer of a Black Brandt IX into a thunderstorm to measure electrical conduction. Much of Wallops research is centered on the environment.

Wallops Flight Facility Museum Draws Thousands

Tens of thousands of people each year visit the museum at Wallops Flight Facility which chronicles the spaceport's historic role in flight and in America's exploration of the final frontier.

Admission is free. The museum is open from 10 a.m. to 4 p.m. daily from the 4th of July through Labor Day. After Labor Day through November, and from March through June, it is open Monday through Thursday. The phone number to call for information is (804) 824-1344.

The Teacher Resource Laboratory is open from 10 a.m. to 4 p.m. Friday and Saturday from June through November.

To reach the museum, take U.S. Route 50 east over the Chesapeake Bay Bridge to the Delmarva Peninsula. At Salisbury, turn south on U. S. 13, then left at T's Corner.

Van tours of the Island are available for groups. Requests must be made at least two weeks in advance.

"We are much smaller than the Smithsonian Air and Space Museum, but we try to tell the story of flight in our limited space. Of course we emphasize Wallops' involvement in space, scientific balloons, and aeronautics," says the museum's manager.

Visitor traffic is heaviest during Space Week which commemorates the Apollo moon voyage and the Viking 1 Mars landing.

Exhibits include a 3.75 billion-year-old rock from the Taurus-Litrow Valley of the moon.

Every month the museum hosts model-rocket launches. Occasionally astronauts make personal appearances and give talks at the museum.

"If you're in the area," says one recent visitor, "you definitely shouldn't miss it."

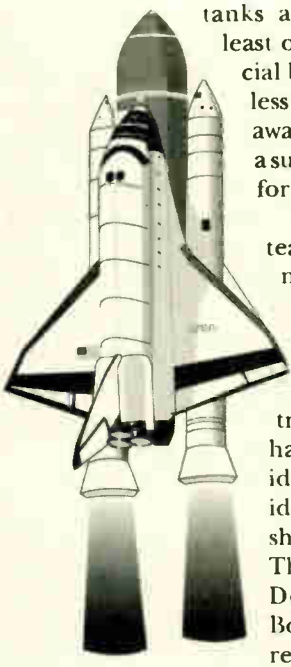
NASA Frowning on Shuttles

As the search for a practical spacecraft continues, the National Aeronautics and Space Administration concedes that their current fleet of shuttles is poorly suited for space operations.

Clearly the shuttle design has fallen short of expectations. There has been one tragedy and more close calls than anyone cares to count. Shuttle missions have been reduced to seven per year. This is partly because the cost of a shuttle flight has grown to $500 million instead of the budgeted $15 million.

Meanwhile, development of the experimental X-33 continues at a fevered pitch. NASA plans to choose the design of a $660 million demonstrator craft within a year. A test flight is planned by the end of the century. If tests succeed and Congress agrees, operational versions of the test craft could be ready to fly missions by the year 2005.

Single stage rockets are still a dream. No one has yet designed a craft big enough, light enough and strong enough to carry both a payload and the fuel required to reach orbit. But engineers are optimistic. Lightweight fiber materials like those used in the stealth aircraft, for example, might replace metal in rocket fuel



tanks and valves. At least one NASA official believes we are less than five years away from finding a suitable material for spacecraft.

Three design teams from the nation's largest aerospace corporations are bidding for the X-33 contract. Each team has a different idea of what the ideal spacecraft should look like. The McDonnell Douglas and Boeing team, as reported in *ST*, are proposing a cone-shaped, vertical take-off and landing rocket similar to McDonnell's Delta Clipper. Lockheed Martin envisions a wedge-shaped but wingless craft that could carry large payloads and glide to an earth landing. Rockwell International suggests a craft with wings that would take off vertically and glide to a landing on a conventional runway.

The craft proposed by all three teams share two things in common. They would be flying fuel tanks; 90 percent of their weight would be fuel. And they would require little maintenance and feature quick operational turnarounds.

Time and money are in short supply. "Our budget is shrinking, and if we are going to do things in space, we are going to have to figure out a way to (lower) the cost of getting there," says one NASA official. Which means the shuttle's days are numbered.

Clipper Continues to Enthrall Space Community

The McDonnell Douglas bullet-shaped Clipper is affectionately known at the White Sands Missile Range as the "little rocket that could." Time after time it has risen and descended to a gentle landing on the New Mexico desert, white-orange flames billowing from rocket nozzles in its base, desert sand swirling up in clouds, and exuberant engineers cheering its success.

MCDONNELL DOUGLAS CORPORATION

The Clipper has made eight such test flights with soft, powered, vertical landings, like science-fiction has shown it should be done, ready for another take-off.

"Buck Rogers would be proud," says an Air Force major who helped coordinate the flights. "When I came here two years ago, I thought this thing would never fly. Now I'm convinced it is the Kitty Hawk of modern rocketry."

The Clipper is an experimental craft. It's purpose is to test theories and systems that will lead America into an era of practical space ships and extra-terrestrial travel. It now costs $500 million for a shuttle flight. A grown-up version of the Clipper could make the same flight for $10 million.

But space experts emphasize that the Clipper itself could not stand the stresses of a flight into space orbit and back. Rather, it foreshadows a reusable spacecraft that could be practical for space travel. A full-scale version of the Clipper, if production were authorized by Congress, would be at least a decade in development and construction, and would carry a price tag of $10 billion.

McDonnell Douglas designed and

built the Clipper in two years for about $60 million. The cone-shaped craft is 42 feet tall and weighs 42,000 pounds at liftoff. It will fit on an average-sized flatbed truck, or inside the space shuttle's cargo bay. It is wingless, steered by directional rocket nozzles and movable flaps at its base. The hull is made of a lightweight fiber material about a quarter-inch thick. The engine, powered by liquid hydrogen and oxygen fuels, is a spare that NASA found stored in a warehouse.

The Clipper is be controlled in flight by one person with a mouse and a computer in a nearby house trailer. The landing pad is a concrete slab about the size of a basketball court. Fuel trucks sit parked near the slab.

Engine adjustments require only a single wrench and a 10-foot stepladder. "We buy a lot of (the parts) we need at a local hardware store," says a propulsion engineer. "You don't always have to do things the way a big bureaucracy does them."

But stand by. Bureaucratic eyebrows are raised. NASA has assumed a growing role in the Clipper project. They plan to spend $43 million to install new fuel tanks and other technological innovations that will increase the Clipper's speed and range. By government standards, that's cheap access to space.

Lockheed Investigates Launch Failure

Lockheed Martin Missiles & Space is trying to find out why its first launch vehicle, carrying a communications satellite, went out of control on its maiden flight about 3 minutes after launch, on August 15. Safety officials intentionally exploded the vehicle 290 nautical miles down range as it reached 484,000 feet. Debris fell harmlessly into the Pacific ocean. There are no plans to recover it.

CTA Inc. owned the doomed satellite and had planned to use it for monitoring pipeline activities and truck communications.


Lockheed's first launch vehicle

The solid-fueled rocket began zigzaging near the end of its first stage of flight, which it completed. But in the second stage, the oscillations worsened and the rocket began spiraling out of control, requiring destruction of the rocket and its payload.

Weather was ruled out as a cause, although fog had delayed the launch for several hours.

"We do not expect this to affect the schedule of future launches," says the firm's vice president of engineering. "We'll find the problem and fix it."

The Air Force has offered to support Lockheed in the investigation.

Satellite Dish: Mightier Than Sword?

Some say Saddam Hussein has met the mother of all thorns: truth beamed by satellite to Europe and the Middle East in the Kurdish language.

"What the Kurdish people need is (freedom of) information and entertainment," says the managing director of a new satellite television service for European ethnic minorities.

MED-TV began broadcasting this Spring to 30 million Kurds. The station's name was derived from the word "Medes," the ancient name of the Kurdish people.

The Kurd's homeland (eastern Turkey, Iran, Iraq, Syria and Armenia) was conquered by the Arabs in the seventh century. About 20 million Kurds live in those areas. Another eight million are in western Turkey, and two million in Europe.

Currently, Kurdish separatists are fighting for autonomy in southeastern Turkey and northern Iraq. Proponents of MED-TV say freedom of information will help them in their struggle.

The satellite revolution, says the secretary general of the Commonwealth Broadcasting Association, is revolutionizing freedom of information. Satellite television and radio passes over international boundaries uncensored. "You can't stop it."

The Iranian government banned satellite dishes earlier this year "to immunize the people against the cultural invasion of the West." Egypt banned the import of satellite decoders. But portable radios with internal satellite receivers continue the flow of information into forbidden areas.

Anyone with a transmitter site, space on a satellite transponder, and a few million dollars can set up and operate a satellite station.

MED-TV depends for funding on advertising from the Kurdish business community.

Satellite Dishes Bad for (Political?) Health

A French mayor has ordered the removal of satellite dishes from balconies and walls of homes because he says they may fall on someone in his multiethnic community. No one has reported any falling dishes.

The mayor denies having any ill feelings toward ethnic groups or the television programs they watch, but says "integration does not mean turning France into a Maghreb nation." Maghreb is the Arabic word for North Africa. He has banned the installation of any new satellite dishes and has decreed that existing dishes be removed.

His dubious order renewed emotional debate over integration of Muslim and other immigrants into French society.

"Officialdom breaks into a cold sweat at the very mention of satellite television," says an editorial in the French newspaper Le Monde. This may derive from fear among officials that international satellite television will influence France's 4 million Muslim residents against the government. Conflicts between Islam militants and Muslim governments in Europe are threatening to spill over into France. So is the civil war in Algeria.

There are about a million satellite dishes in use in France. About a fourth of them belong to families officially classed as "Arab households." France refuses to license broadcasters from the Middle East or North Africa.

From Russia With Love

Talk about turning your average every-day war machines into plow shares: Russia and the U.S. these days are actually sharing data collected by their mystic spy satellites for use in improving weather forecasts.

The two former cold war rivals these days are working together in projects that turn previously guarded secret information into scientific weather data, according to Undersecretary of Commerce James Baker, who heads the National Oceanic and Atmospheric Administration.

Spy satellites can collect more detailed information than civilian versions used by the National Weather Service, Baker explained.

VOA Reaches South Africa Via Satellite

Following the successful launch of the PanAmSat 4 Satellite, owners of home satellite dishes in South Africa for the first time can hear the Voice of America on their FM radios. The service stems from an agreement between the VOA and Africa's Multichoice Kaleidoscope satellite television service.

Downlink frequencies were not mentioned in an August 4 press release from VOA, but details of the service are available from their office of external affairs, at (202) 619-2538.

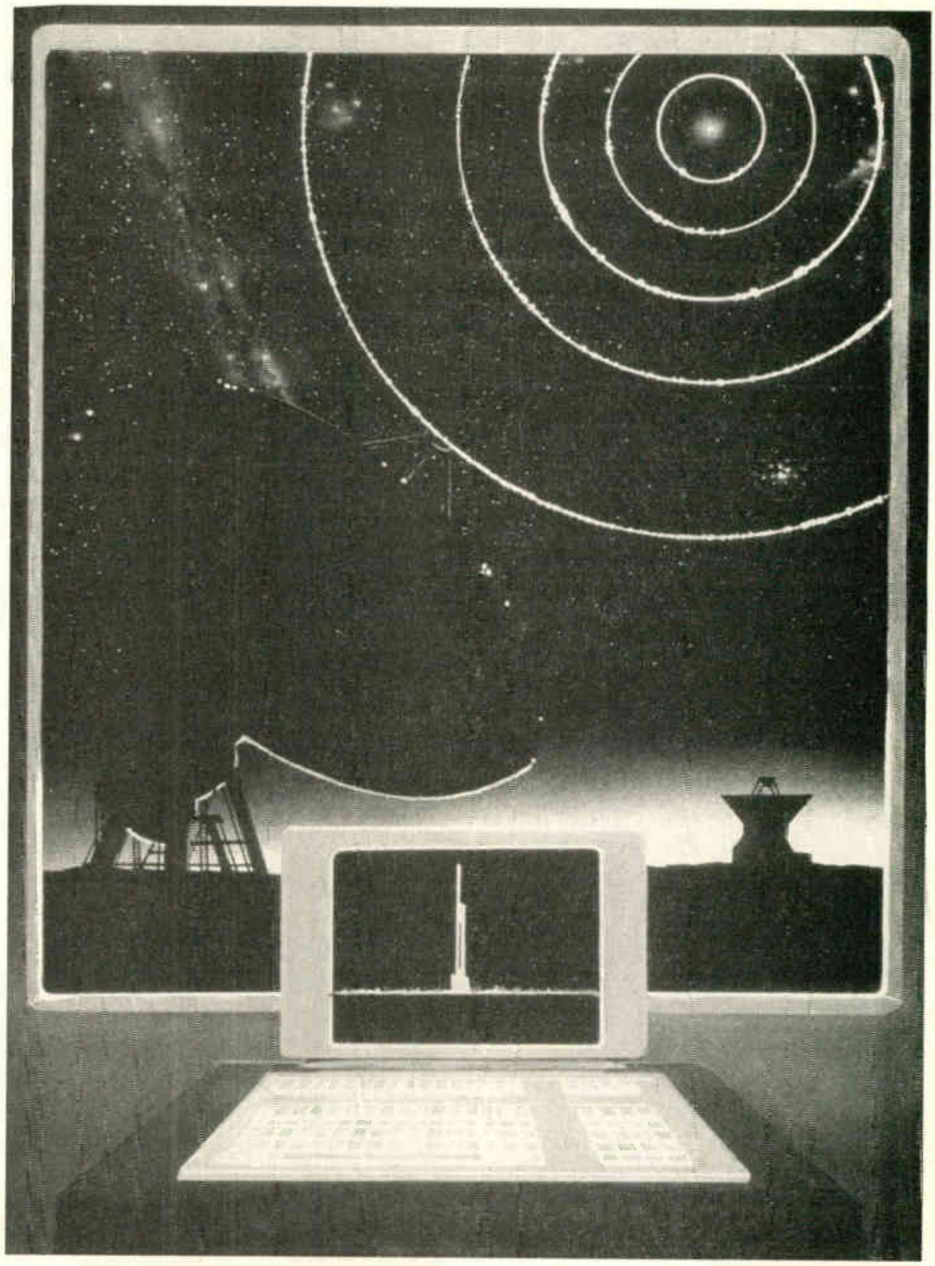
"We are looking forward to reaching our many listeners in South Africa via home satellite dishes no more than a meter wide," says VOA's director. "We'll be bringing VOA shows live to Africa's FM listeners."

Programming will focus on African audiences in round-the-clock broadcasts, and will include a variety of audio and television programming for subscribers.

Sources:
Art Audley, N3KUQ; Associated Press; Dave Alpert; Lockheed Martin Missiles & Space; Voice of America, U.S. Information Agency; Washington Times

STAR SEARCH

By Michael Mechanic
Photos courtesy of SETI Institute



It was cold, foggy and still dark at 3 a.m. in Green Bank, West Virginia, when Frank Drake's alarm clock sounded. Despite the early hour, the 29-year-old radio astronomer had no trouble dragging himself out of bed. Drake and two student assistants at the National Radio Astronomy Observatory — a facility then still under construction — were about to make history, and they knew it.

The date was April 8, 1960, and the team was going to take humankind's first-ever crack at interstellar communication. For the first time, human beings would turn an ear to the cosmos in an attempt to intercept radio signals transmitted from far-off planetary systems by intelligent, though probably quite non-human beings.

Drake had dubbed the project "Ozma," after a princess from L. Frank Baum's fictitious land of Oz, a faraway place inhabited by strange and exotic creatures. The experiment relied on the observatory's recently completed 85-foot-diameter radio telescope. The structure's receiving device is located within a cylinder at the reflector's focal point, more than five stories off the ground, and before proceeding with the observations on that cold morning, Drake had to spend nearly an hour inside this "glorified garbage can" tuning a special amplifier. By 5 a.m., however, he was back in the control room, ready to listen. It was a verifiable radio signal he sought — one that would stand out from the cosmic background noise in a distinctly artificial way.

It was a humble beginning for a search that would in time unite some of the world's greatest scientific minds, escort the emerging field of radio astronomy into prominence, engage NASA, Congress and roughly $75 million in private and federal funds, and, ultimately make a legitimate scientific pursuit of one of the oldest and most profound questions in human history: Are we alone in the universe?

Today, more than 34 years later — despite exponential leaps in technology and the completion of some 68 cosmic eavesdropping projects worldwide — the combined efforts still have covered only the tiniest fraction of our galaxy. "You can't even say we haven't scratched the surface, because it's too weak an analogy," says Dr. Jill Tarter, who has searched for alien signals with renowned UC Berkeley astronomer Stuart Bowyer and others, and is now the top project scientist at the SETI Institute (Search for Extraterrestrial Intelligence) in Mountain View. "If you want to enumerate it, which we used to do very assiduously, [we've covered] one part in 1012, one part in 1010 maybe."

Humble Beginnings

Drake, now 64, is a professor of astronomy at UC Santa Cruz and president of the SETI Institute, but in 1960 he was fresh from graduate school at Harvard University, where he was among the first few students to earn a doctorate in the nascent field of radio astronomy. Unlike conventional astronomy, where scientists look for visible phenomena, radio astronomers use special receiving devices to probe regions of the electromagnetic spectrum invisible to optical telescopes.

The field of radio astronomy was realized quite by accident in 1931, when New Jersey's Bell Telephone Laboratories dispatched a 25-year-old physicist named Karl Jansky to determine the source of interference on long-distance wires. Jansky built a crude receiving net and, after considerable observation, concluded the interference was coming from the center of the galaxy. Bell Labs soon dropped the project. With the notable exception of an uncredentialed radio operator named Grote Reber, who built the first true radio telescope in 1937, science was slow to pick up the ball. By 1960, radio astronomy was still very much the new kid on the block, and many astronomers publicly expressed doubts that it would last.

Drake worried about such things, but the new field gave him the wherewithal to pursue his favorite hypotheses. His first inklings that we might have company out there had been mere childhood musings, encouraged, perhaps, by forays through the Museum of Science and Industry in his hometown of Chicago. But these intellectual seeds were sown deeper during his undergraduate days in Cornell's physics department. During his junior year, a visiting lecturer — an acclaimed astronomer named Otto Struve — presented evidence for the existence of distant planets and suggested that their presence could mean the existence of life in the far reaches of our galaxy. It was, Drake recalls in his autobiography, an "electric" moment. Might some of these alien creatures be intelligent or even technologically capable?

Given the extraordinary number of stars like our sun thought to exist in the cosmos, SETI researchers are convinced that many planets capable of sustaining life also exist and some of these may have spawned creatures with the means and intelligence to develop technology. Drake and many others have bet their careers and a lot of private and federal dollars on this hunch — one that is still the subject of vigorous scientific debate.

While making radio observations of the Pleiades star cluster during his predoctoral years at Harvard, it occurred to Drake that radio telescopes might be used to search for advanced life in outer space. Soon after, he landed a job at Green Bank, where bigger and better antennae and telescopes were being built. There, the young man calculated that, with emerging technology, scientists could detect radio signals of the same intensity emitted by earth, but from 10 light years away — the distance to the nearest stars.

It was an exciting prospect, but Drake kept it quiet. Astronomers didn't talk about such things. Given the prevailing scientific climate, he feared the proposal would be seen by his peers as so outlandish that his career might be quashed before it had a chance to develop. But fortunately for Drake, his old inspiration Otto Struve took over as head of the Green Bank observatory and was receptive when Drake approached him with the idea.

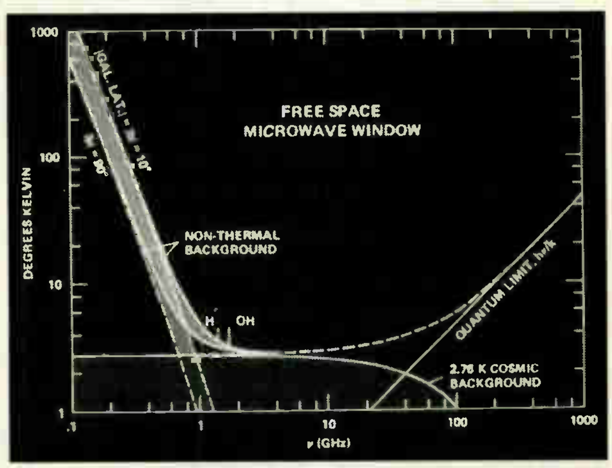
The young scientist still planned to keep the project a secret until complete. But, in Sept. 1959, a bold paper by Cornell physicists Giuseppe Cocconi and Philip Morrison appeared in Nature magazine. The pair presented calculations like the ones Drake had done, and they came to a similar conclusion, stimulating widespread press coverage. In response, Struve was quick to make public the planned Ozma experiment.

Project Ozma

On the fateful morning of April 8, 1960, Drake and his helpers had no idea of what they might find. In the Green Bank control room, the receiver had been rigged both to a speaker and a chart recorder — a device a bit like a seismograph that converts incoming signals into up-and-down scribbles of a pen on a moving sheet of paper. Drake had chosen to search at a radio frequency near 1420 MHz — the frequency of the Hydrogen atom.

Besides figuring out where to point their radio telescopes, researchers can only look — at any given time — at a tiny slice of the vast range of frequencies comprising the electromagnetic spectrum. It makes searching difficult. It's like moving to an unfamiliar rural Nevada town, setting the tuning knob on your radio while the gadget is turned off, and then turning it on in hopes of hitting on a station — but it's really much harder. Because Hydrogen is the most abundant element in the cosmos, Drake surmised that other intelligent civilizations might recognize that frequency as special. The frequency also falls into the cosmic "quiet zone," the portion of the electromagnetic spectrum relatively free of interference from natural celestial sources and artificial terrestrial ones. Set to receive at 1420, Drake pointed the telescope toward Tau Ceti, a nearby star in the constellation Cetus, the whale. The team waited in anticipation. And waited.

They waited uneventfully until noon, when their target plunged below the horizon. They then aimed the telescope at Epsilon Eridani — from the constellation Eridanus, the river — and resumed their wait. Minutes later, loud squawks burst forth from the speaker and the pen on the chart recorder flew crazily off scale with pulses that were coming in eight times a second. "We were running around trying to figure out what went wrong or what we should do next," Drake recalls. Barely able to contain his excitement, Drake did what he had been trained to do. He aimed the telescope away from the star, then moved it back to see if the signal returned. It didn't.



The free-space microwave window. Shows the section of the electromagnetic spectrum with the least "cosmic noise", including the area encompassed by Project Phoenix, a mere 1000 stars among a billion in the Milky Way galaxy alone.

Ten days later, the signal appeared again, long enough for the scientists to figure out its origin: Earth. Only much later did a military source confirm, as Drake had suspected, that the signal was an electronic countermeasure — a jamming device used by military aircraft.

Ozma had searched two stars for a total of two weeks at a single frequency. The materials to set it up had cost next to nothing, and the search had found nothing — except important life-long colleagues for Drake.

Order of the Dolphin

About a year later, Drake got a call from J. Peter Pearman, a member of the Space Science Board of the National Academy of Sciences. At Pearman's prompting, the two organized the first scientific conference on what came to be known as SETI. It was held at the Green Bank observatory in 1961. Among those in attendance were Otto Struve and Philip Morrison. Also present was Bernard Oliver, then Hewlett-Packard's vice-president of research and development, who now works with Drake at the SETI Institute. From Berkeley came Carl Sagan, the young hot-shot astronomer, and chemist Melvin Calvin — who would receive a 4 a.m. telephone call from Sweden during the conference, bringing with it news of a Nobel prize. When the nine attendees joined Drake in a Green Bank conference room, written on the blackboard was:

This equation, now printed in virtually every astronomy textbook, estimates the number N of civilizations in space that humans are capable of detecting. To get N, the "Drake" equation multiplies together the rate of star formation (R), times the fraction of stars with planets (fp), times the number of planets that could support life (nc), times the fraction of livable planets where life occurs (fl), times the fraction of life-bearing planets with intelligent life (fi), times the fraction of those planets with life capable of communicating with other star systems (fc), and finally, times the average longevity (L) of the advanced civilizations.

The attendees of the Green Bank meeting — who later dubbed themselves "Order of the Dolphin" — debated and assigned values for these numbers and concluded that N=L. That is, the number of detectable civilizations equals the number of years they last, on average. Drake puts that number at about 10,000. Other scientists have made calculations showing that the presence of a few very long-lived civilizations could boost that value into the ballpark of millions. Still others argue that N's value is closer to one: humans.

The Cyclops Report

An emeritus professor of evolutionary biology at Harvard University, Ernst Mayr questions the assumption that intelligence is a valuable evolutionary trait. Large brains require more energy, he argues, and the unusually long infancy of human babies — which may be necessary for the development of higher intelligence — could be a strike against us in evolution. Of the billion-plus species that have lived on Earth since its formation, Mayr points out, only humans have developed technological sophistication. "The development of high intelligence is not at all an inevitable consequence of life," he concludes in a recent article. "There are very many other mechanisms and devices than intelligence to cope with survival and successful reproduction, mechanisms that apparently can evolve far more easily than high intelligence."

140 foot Green Bank telescope. The home telescope for Project Phoenix, when the equipment is not deployed to one of the world's largest telescopes, such as Arecibo (Puerto Rico) or Nancay (France). Project Phoenix anticipates setting up shop at Green Bank in the spring of 1996.

Robert Sinsheimer, a professor emeritus of molecular biology and former chancellor at UC Santa Cruz, was the administrator who brought Drake to the campus in the early 1980s. By that time, some 42 separate searches had been conducted worldwide, three by Drake and his colleagues, and others by the likes of Bowyer at Berkeley and Paul Horowitz at Harvard — who in 1982 received a $100,000 gift from director Steven Spielberg to aid in his own searches.

NASA had entered the game, circa 1971, by hosting a summer-long brainstorming session of SETI experts that was dubbed "Cyclops." The resulting "Cyclops Report" had inspired many scientists, including Bowyer and Tarter. To speed development of new search technology, NASA also had spent $1.5 million to unite its Ames Research Center in Mountain View and Caltech's Jet Propulsion Laboratory in Pasadena.

But Sinsheimer says he recruited Drake for his administrative and academic prowess, but considers SETI a waste of money. He points out that most of the values scientists have plugged into the Drake Equation are pure speculation. "The calculations are pretty suspect," he says. "You can put in whatever numbers you want, but I could put it my own numbers that would make [the number of detectable civilizations] negligible. I'm not a person who feels it's an evil thing to do, but I wouldn't spend any money on it."

Fermi's Paradox

As a graduate student at Harvard University, UCLA Radio Astronomer Ben Zuckerman had an office down the hall from Carl Sagan, and couldn't help getting caught up in the SETI excitement. After receiving his doctorate, Zuckerman and Harvard colleague Patrick Palmer searched roughly 600 stars using Green Bank's new 300-foot-diameter radio telescope. Like its predecessor, "Ozma II" was unsuccessful, and Zuckerman eventually soured on SETI's chances for success. "I finally changed my mind after hearing some good arguments on the, 'They're not there' side," Zuckerman recalls. "I think Frank is hopelessly naive on this topic, not to say that most people don't agree with him."

The arguments that swayed Zuckerman

included what is known by some as "the Fermi Paradox," a simplistic argument raised by Nobel prize-winning physicist Enrico Fermi: If advanced civilizations are out there, we would have already seen them. This idea was later published and elaborated upon by Trinity College Physicist Michael Hart. Hart also constructed computer models of developing solar systems suggesting conditions were so harsh as to make the presence of life-sustaining planets like Earth a fluke. Jeff Marcy at UC Berkeley also has constructed computer models suggesting a scarcity of massive planets like Jupiter — planets some scientists believe divert objects that would otherwise have slammed into Earth, making the formation of life impossible. (In his autobiography, Is Anyone Out There?, Drake downplays the relevance of computer models and notes that Hart had failed to include the effects of clouds on his model climates). Zuckerman also cites the possible need for a life-supporting planet to have a moon, which may be needed for a stable climate. These arguments, Zuckerman says, point to a small value for N.

The fact is, nobody really knows much about what is or isn't out there. We can't predict climates that well, least of all on fictitious planets in theoretical computer models. For that matter, we've never actually seen any planet outside our solar system, although there is considerable evidence that they exist.

"People get stuck in a mode that life wouldn't come about any other way than how it happened with us, and frankly, I think that shows a lack of imagination," says Harvard researcher Paul Horowitz, who is building one of the world's most powerful receivers for his own search project. "Ernst Mayr may think we're the only intelligent life in the universe, but were talking 1022 stars. I find that theory completely preposterous.

"It could be the Ben Zuckerman's of the world are right," continues Horowitz, "but the world hasn't done much searching. If in 100 years we haven't found anything, then I'll be a hell of a lot more pessimistic."

Tarter won't suggest any value for N, except to say that it is greater than one. "Our chances of success are zero if we don't do it and greater than zero if we do, and that's a big distinction," she says. "I mean, you don't spend your life doing something you know can't work."

The Golden Fleece

Many in the scientific and political realms share Sinsheimer's feeling that SETI's unknown chances for success aren't worth its cost. In 1978, Senator William Proxmire awarded SETI one of his then infamous "Golden Fleece" awards, an honor he bestowed upon budget items he considered wasteful. The senator followed up on his award in 1981, convincing his colleagues to slash $2 million a year in SETI funding from NASA's proposed 1982 budget — a drop in the bucket for an entity that spends billions each year. Carl Sagan later convinced Proxmire of the program's merits and funding was restored the following year, but it was clear SETI could and would be targeted. In response to the funding crisis, Sagan shot a letter off to Science magazine signed by some 70 prominent scientists. The Sept. 1982 letter called for a "coordinated, worldwide, and systematic search for extraterrestrial intelligence." Among its signatories were Nobelists Sir Francis Crick, Linus Pauling, Edward Purcell, David Baltimore and Melvin Calvin, plus prominent names like Stephen Hawking, Stephen Jay Gould, Lewis Thomas and Edward O. Wilson. Also signing on were the members of Order of the Dolphin.

In 1988, Drake's beloved project struck gold with congressional approval of a 10-year, $100 million NASA program called SETI-MOP (Microwave Observing Project). At last, he and his colleagues could build the equipment necessary for a more thorough search. The actual observations began in 1992, and were to include a targeted search of more than 1000 sun-like star systems using equipment nearly 10 trillion times more powerful than Ozma, Drake says. Still, the targeted search would cover only about 1 percent of the sky. The remainder was to be covered by an all-sky survey, in which radio telescopes — like invisible spotlights — would slowly scan the sky, stopping for a close look only if a promising signal was received.

But the program was political cannon fodder almost from the start. From 1990 onward, members of Congress, including Senator Richard Bryan of Nevada, made unsuccessful attempts to kill SETI-MOP. One year, a congress member requested that SETI be dropped from the name, because of the E.T. "giggle factor." NASA obliged, changing the name of the search to NASA-HRMS (High Resolution Microwave Survey). The following year, however, Bryan assailed NASA over the name change, claiming it had done so to avoid budget cuts. The Senator finally convinced his colleagues to ax the program completely — after one year of observing.

Drake says the program made an easy target because it didn't fall directly into any senator's district. "It was not killed on the basis of any scientific criticism or discussion of any of the merits of the program," he says. "It was purely done to create an image that Congress was reducing the budget deficit."

Project Phoenix

The SETI Institute, established in 1984, is marching into the future without government funding, and has turned to other sources for help. The all-sky survey has been scrapped, but the institute's new project — dubbed "Phoenix" after the mythological bird that rose from the ashes — is pursuing the targeted search originally planned by NASA. Phoenix has received more than $7.3 million in private donations, enough to carry it into next year.

Between February and June, Project Phoenix researchers took up residence at the Parkes radio astronomy observatory in New South Wales, Australia. Using the facility's 64-meter radio telescope, they listened to about 200 Southern Hemisphere stars—some of the 1000 slated for attention — at frequencies from 1200-3000 MHz. The project's sophisticated new equipment is capable of scanning 28 million channels simultaneously at single-Hertz resolution, and, for the first time, the researchers had a follow-up scope, located 120 miles away, that allowed the scientists to immediately distinguish between terrestrial and potential extraterrestrial signals by the presence or absence of a Doppler shift.

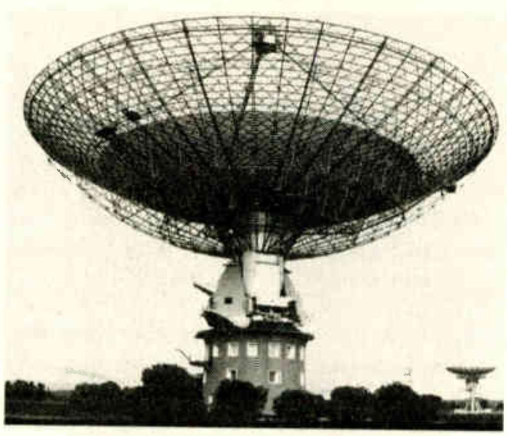
The fancy new setup found satellites, military radar and tv stations, but the extraterrestrials remained elusive. "It's disappointing but it doesn't discourage us. The equipment all worked pretty well and that was a technical triumph," says Seth Shostack, public programs scientist at the SETI Institute. "You never give up. If you look at 1000 stars and don't find anything, can you conclude we're alone? No you can't."

The elimination of the NASA-HRMS program left intact smaller-scale search projects at Berkeley, Harvard, and Ohio State, but last winter NASA informed these researchers that they, too, would no longer be considered for funding. Bowyer, Horowitz, and the Ohio State team each took a hit of roughly $100,000.

Bowyer's assistant Matt Lebofsky says the program, Serendip III — which joy-rides a special receiver on the world's largest radio telescope at Arecibo, Puerto Rico — has been subsisting on some left-over NASA funds and modest donations from the Planetary Society. "People have been taking salary cuts. We've been relying on volunteers. We're just cutting corners everywhere," he says.

Naturally, Frank Drake can cite many reasons why earthly societies should cough up money for SETI research. In all, NASA has spent between $60 million and $70 million on SETI since 1971. "That's less than the cost of one main battle tank or one fighter plane, but the potential payoff for Earth is much greater," says the astronomer. "It's a high-stakes gamble where the payoff is enormously large and, if you succeed, the benefit per dollar spent will be greater than for any project in history."

The long-term benefits Drake cites include knowledge of technology of other worlds, learning whether space colonization is practical and how it might be done, and whether nuclear fusion is feasible as a clean energy source. "We will learn just what the limits of growth and the quality of life are for other civilizations and this will give us great guidance in planning for our own world."



Parkes Observatory is located in New South Wales, Australia. The Project Phoenix team observed over 200 stars seen only in the southern hemisphere during the first five months of 1995 from this 210-foot diameter radio telescope. (Photo by ATNF.)

Would the source of such information be an intentional radio beacon? Even Drake considers that an unlikely scenario. We are more likely to pick up leakage radiation from everyday TV, radio, or military broadcasts. But intelligent alien civilizations might conceivably send out radio beacons into space for reasons of altruism or curiosity. Such beacons could be even galactic versions of Radio Free Europe or cosmic religious evangelists which, in Drake's opinion, would be a disappointment.

Primitive Earthlings

Whether or not the SETI researchers have a prayer of actually finding anything, debate continues about whether Drake's vision is realistic or, indeed, whether communicating with other worlds is even a good idea. Given that humans have just recently gained the technological capability to send out and possibly to receive interstellar beacons, it stands to reason and most astronomers would probably agree that any civilization we might encounter via radio would be far, far more advanced than ours. "The chances are they won't be hundreds of years ahead of us, they'll be billions of years ahead of us," says Shostak. "Compared with them, we might be like your average paramecium."

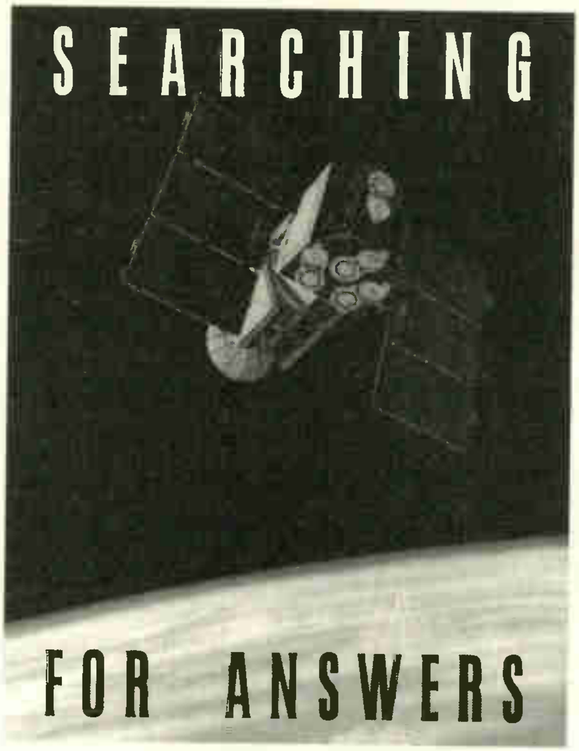
It's a scary thought, and such sentiment has created considerable concern. "In human history, encounters between primitive and advanced societies have always been disastrous to the primitives," says Sinsheimer, who thinks it could be dangerous to make our presence known to any intelligent beings that live within 10 to 20 light years from Earth. "The only positive I see is to satisfy our intellectual curiosity. But we need to learn things on our own. I'm very proud of what we've accomplished in science. It would be sad to depend on others for achievement."

Supporters point out that SETI projects don't talk to the stars, they simply listen. What's more, we are constantly leaking out artificial radiation from TV, radio, military radar and other sources. We have sent the Voyager and Pioneer probes out into deep space carrying plaques (which Drake helped design) with simple representations of our solar system and our position relative to known celestial markers.

Drake, Tarter, Horowitz and many other SETI researchers consider the chance of direct contact with an advanced civilization to be infinitesimally small. Their arguments are based on both physics and economics. "Our existing spacecraft, at the maximum speed they go, would take about 100,000 years to go to the nearest star, and this is not a feasible travel time for a colony or a mini-planet or anything else," Drake says. "You must go much faster and, when you do, the energy requirements become quite preposterous and you are exposed to very serious hazards ... At the speeds you must travel, a small pebble striking you releases as much energy as a hydrogen bomb, and that's going to be the end of your mission."

"Travel would be boring and expensive," says Horowitz. "Energetically, it's just a stupid thing to do."

But advanced civilizations may have their own means, motives and logic, and even strong SETI proponents like Shostak and Sagan are not ready to rule out the possibility of interstellar travel. We simply don't yet know enough about space, about extraterrestrials, if they exist, and about what is or isn't possible in the universe. All we can do is go about our small terrestrial lives, make our scientific discoveries in time, and, every so often, on quiet star-filled nights, turn our ears to the Milky Way galaxy and patiently listen. ST



SEARCHING FOR ANSWERS

NASA's Astrophysics Satellites

By Len Losik

How far does space extend? Does the universe end? What are the forces at work in the cosmos? What makes up matter? These are questions that mankind have been asking for centuries. NASA developed a whole series of astrophysics satellites to answer these questions. Satellites with acronyms like COBE, IUE, ROSAT and EUVE were developed to search for the origin, the evolution, and the fate of our universe.

By sending satellites beyond the protective but limiting screen of the atmosphere, it has been possible to enlarge the boundaries of the known Universe. These great astrophysics satellites have revealed that our Universe is incomparably richer in stars and matter than what had been imagined even up to a short time ago. The atmosphere prevented all but a restricted belt of electromagnetic waves to be picked up by ground based instruments. It was virtually only visible radiation that could tell us anything about the world beyond the air we actually breathe.

NASA turned to satellites after making many great discoveries from ground based telescopes, instrumented balloons, instrumented rockets and aircraft mounted telescopes. In the 1960's and 1970's, these Earth based observatories lead the way for discoveries that caught the public's attention: quasars; the big bang theory, black holes; cosmic radiation; pulsars; neutron stars; gravitational radiation; gamma rays; white dwarfs to name a few. Great observatories were proposed for space and meant to place mankind in a historical position to understand the Universe as never before.

The COBE, GRO, IUE (and Hubble) and Explorer satellite series complements airborne observatories, instruments carried on balloons, and instrumentation launched on sounding rockets in the study of astrophysics. NASA also places telescopes and astronomy instruments inside NASA's space shuttle cargo bay during Astro scientific missions.

In this article, we will profile five of NASA's orbiting astrophysics satellites and look at some of the science these observatories have done.

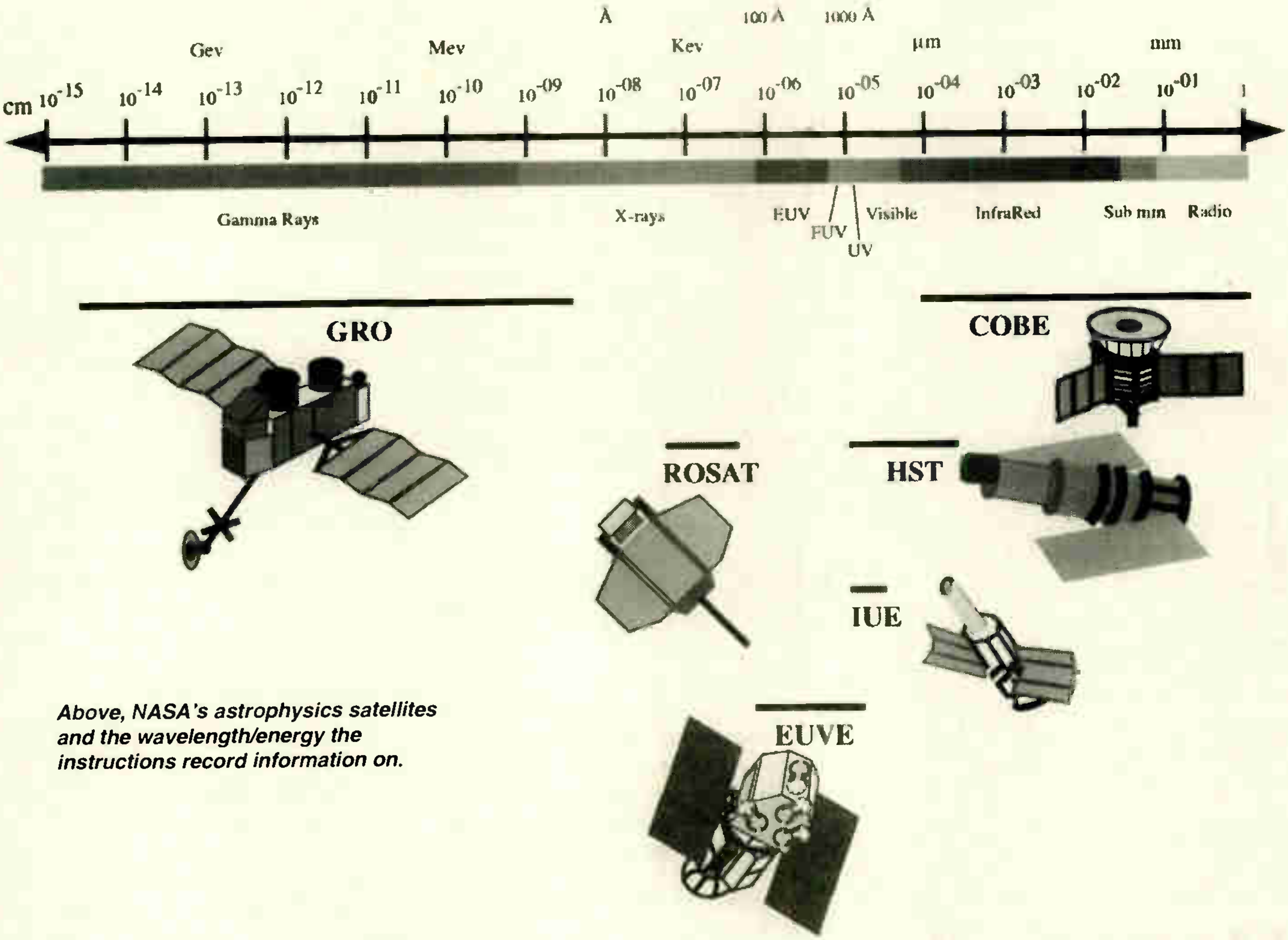
The COBE Satellite

The cryogenic operations background emissions (COBE) satellite was the first NASA Explorer satellite dedicated solely to a cosmological mission (e.g., the creation and evolution of the known universe). COBE was launched on November 18, 1989, from Lompoc, California, into a 99 degree inclined orbit at 558 mile's altitude. The orbit plane moves one degree a day just like the earth around the sun so that the COBE orbit plane and sun geometry remain fixed.

COBE has surveyed the sky looking at just the diffuse emissions from 1 micro-millimeter to 1 cm. Observations in this portion of the spectrum are designed to help understand the beginning of matter after the big bang, and answer the questions why the universe looks in disarray. Another portion of its mission was to collect light from the very first stars and galaxies. COBE is able to detect minute fluctuations in the microwave background.

COBE has 3 instruments — a far-infrared absolute spectrometer, a microwave radiometer, and a diffuse infrared spectrometer. A cryogenic (600 liters of liquid helium) was used for a year or two to improving the noise temperature on the infrared detectors. After the cryogenic were depleted, the detectors were operated warm until the COBE mission was ended. COBE spins at .8 rpm while it collects instrument information. The satellite is now used only for testing ground equipment and no science data is processed. NASA was responsible for building and integrating COBE.


The COBE Satellite



Above, NASA's astrophysics satellites and the wavelength/energy the instructions record information on.

The EUVE Satellite

The extreme ultraviolet Explorer (EUVE, shown at top of p. 16) is a member of NASA's Explorer satellite program and it culminated 25 years of effort to develop the field of extreme ultraviolet (EUV) astronomy. One of the earliest EUV experiments involved an instrument flown on the historical joint Apollo-Soyuz mission in 1975. The results from that experiment discovered four EUV sources above the diffuse EUV background. These observations opened the door to the previously unknown possibility of EUV astrophysics.

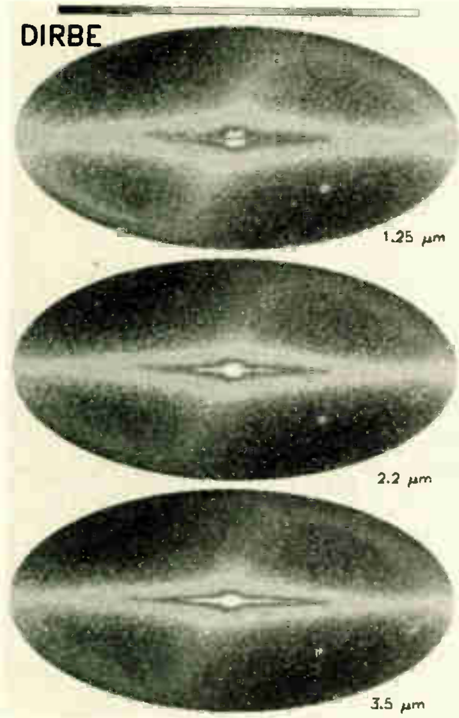
After some early successes, NASA chose to build and fly the EUVE satellite as their prime EUV astrophysics mission. The EUVE satellite looks at the very narrow band of the ultraviolet spectrum known as extreme ultraviolet. Like other forms of light such as infrared and x-rays, extreme ultraviolet light is blocked by Earth's atmosphere. For the first time, the EUVE satellite opened up this part of the spectrum to regular scrutiny and its observations were made available to scientists around the world.

The EUVE telescopes have mapped the sky for sources of energy with wavelengths between 10 and 1000 angstrom. From the information obtained from EUVE, we know that our own sun lies within an unusually low density region of space named the "local bubble." This space is so empty that there is only one atom in the space the size of a tea cup. The information from EUVE has produced a map of the sky with extreme EUV energy sources. A deeper survey of the sky along the ecliptic at much higher resolution has also been completed also looking for sources of energy in EUV.

Sky maps and deep survey maps are used by scientist from around the world to pick up sources of EUV and collect spectroscopic data from them. The targets are just point sources to an observer on earth. Scientists ask for lengths of observations on these point sources that are very faint using the EUVE satellite so that details on the spectra can be understood. An observation can be hours, days, weeks or even months long. Usually the fainter the point source, the longer the research scientist wants the satellite telescope to point at it.

Often, a light source will flare optically first. Usually there is a small delay before the UV energy flares. EUVE telescopes are oriented to catch the flares and record their energy in the EUV spectrum and then return to the original target. In this manner, a more complete survey of the electromagnetic spectrum is compiled.

There are stars that are used for calibrating the EUVE telescopes. Calibration sources or targets are used to track the performance of the detectors in the telescopes as they age and operate in space. The EUV photon detectors and the electronics are subject to a very harsh radiation environment. The EUV photon detectors are sensitive enough to register individual photons, one-at-a-time striking it. Background rates can be as low as one photon in 10 seconds. Target photon rates may be 10 to 100 photons a second and more. The calibration sources used to measure detector performances are known to have a predictable EUV output.



An all-sky map taken by COBE's DIRBE instrument at 2.2 mico-millimeters.

Calibration information is then used along with the data to define the make-up of the targets observed.

The EUVE satellite is about 4.5 meters wide and about 3 meters tall. This is almost as big as a 10-foot by 15-foot bedroom. Each of the satellite's four telescopes is about the size of a 30-gallon barrel. Three of the four telescopes are mounted together and one is mounted with the bore sight looking 90 degrees from the other three. Fairchild Space Systems built the satellite bus and the University of California at Berkeley designed and built the EUV telescopes.

The Explorer satellites are meant to be serviced by astronauts from either the space shuttle or the space station. All Explorer satellites — NASA's Solar Max satellite was one — were designed to be serviced in space. NASA is currently planning a space shuttle mission to the EUVE satellite in 1998 to retrieve, retrofit and launch it again with a new set of instruments. NASA will save the taxpayer many millions of dollars by doing this.

The GRO Satellite

The gamma ray observatory (GRO) satellite was launched to study black holes and nucleosynthesis (what happened to matter right after the Big Bang), by studying gamma-ray lines in our own and other galaxies. It was meant to understand if gamma ray bursts originate in neutron stars and identify the source of the excreting matter. GRO is one of four great observatories proposed by NASA. The other three are the Hubble Space Telescope (HST), the Advanced X-ray Astrophysics Facility (AXAF) and the Space Infrared Telescope Facility (SIRTF).

The GRO satellite mission is to study gamma-ray sources in our galaxy, neutron stars and their evolutionary cycle, and, search for black hole's tell-tail signs. The GRO satellite has a gamma-ray telescope, an imaging wide-field telescope, a scintillation spectrometer, and the burst and transient gamma-ray detector. The GRO satellite is incredibly heavy. It weighs over 3 and-a-half tons (almost 2 cars). The mass is needed to record enough gamma rays to make proper observations. The combination of all these instruments can measure gamma rays from 20 keV to more than 30 GeV.

The IUE Satellite

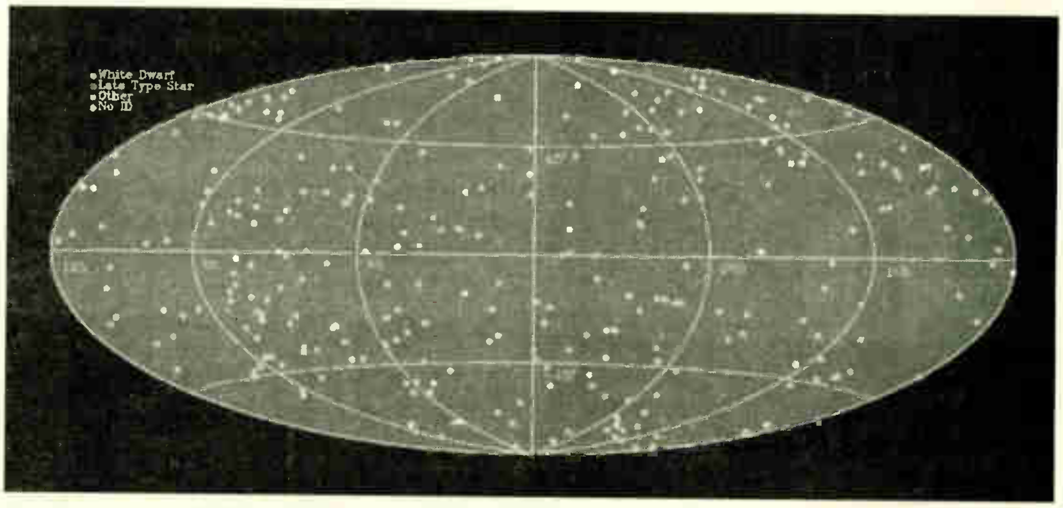
The international ultraviolet explorer (IUE), another Explorer satellite, was launch 17 years ago on January 26, 1978. IUE completed many observations that led to the discoveries of galactic halos, active galactic nuclei that are forming new galaxies, the stellar wind, a stellar mass loss, binary star evolution, the Io torus, and variable UV light sources. IUE satellite observations have discovered suspected massive black holes. Other observations have shown variations in mass flow in binary star systems and mass loss in stellar winds and flares. Early in its mission, IUE satellite generated nearly all the medium-resolution UV spectra observations in the world. By the end of 1989, over 1870 papers from IUE data had been published. Over 1700 astronomers from all over the world have used IUE satellite data for their research.

The IUE satellite was a collaborative project between NASA, Europe and Great Britain. IUE satellite has one telescope, two spectrographs and four electron television cameras. It can resolve sources in the following spectrum: 6-7 angstrom, 0.1-0.3 angstrom, and UV light between 1150 and 3350 angstrom. The IUE satellite was launched into an elliptical, geosynchronous orbit (24 hour orbital period around the Earths equator).

IUE satellite data was used with ROSAT satellite launched later to make an all-sky map of many astronomical sources. One special feature about IUE satellite was that scientists from all over the world were able to get their data from the telescope realtime. IUE and its instruments are still collecting useful information for scientists, 15 years after the planned end date of the mission.

The ROSAT Satellite

The Roentgen (a German scientist that discovered X-rays) satellite (ROSAT) was launched on June 1, 1990, to look at x-ray emissions from galaxies and provide the

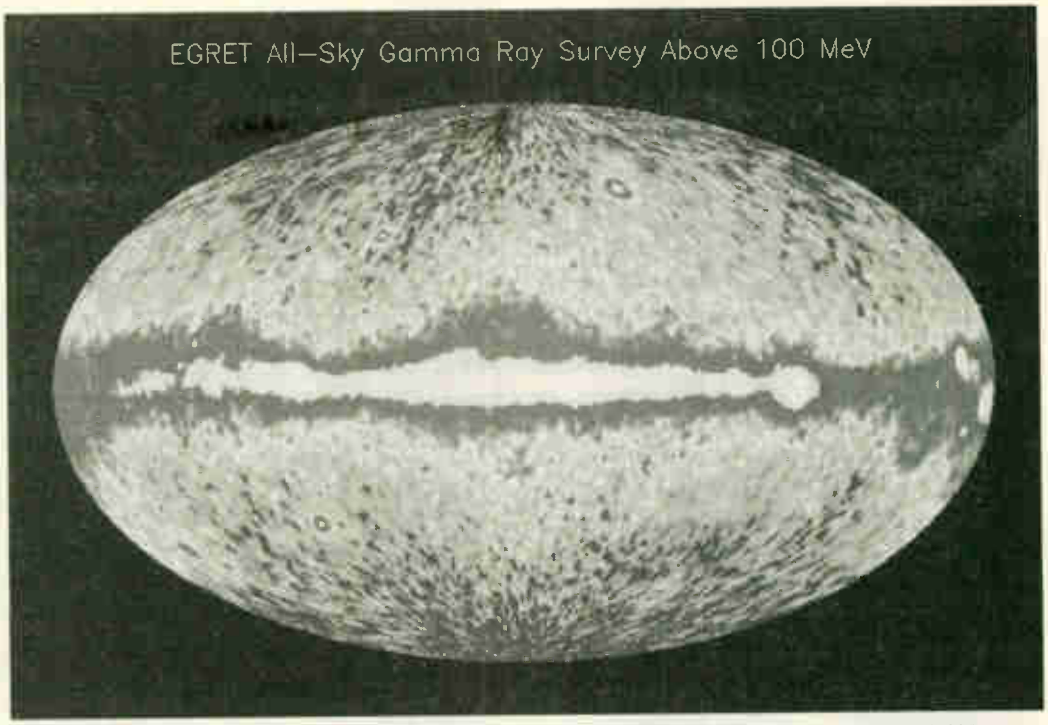


An all-sky map of EUV sources completed by EUVE in 1994.

first X-ray image of the moon. In its first 6 months ROSAT recorded over 60,000 new X-ray and extreme-ultraviolet sources as well as increasing the fidelity of other known sources.

X-ray satellites like ROSAT can trace gravitation fields and have moved to the forefront in the search for dark matter, a recent explanation to the missing mass needed to confirm the theoretical Big Bang. The ROSAT satellite is an international collaborative mission with Germany, United Kingdom and NASA. ROSAT is not part of the Explorer satellite series.

The ROSAT satellite instruments consists of a wide-field camera, a high resolution imager and a group of position-sensitive proportional counters. The ROSAT satellite's instruments observe wavelengths between 0.1 to 2.0 keV. The ROSAT satellite weighs about 1100 lbs (about 1/2 ton) and is about 15 ft tall and about 10 feet wide (about the size of a small bedroom). A German company, Dornier GmbH, built the satellite and the German Space Operations Center in Europe controls ROSAT in space.



The EGRET all-sky map shows an image of the sky at gamma-ray energies above 100 MeV in galactic coordinates.

Tomorrows Science Satellites

Building from the successes of recent years to reduce the complexity, size and cost of satellites, NASA is moving on to next level. NASA's vision for its satellites for the 21st century is bold and exciting.

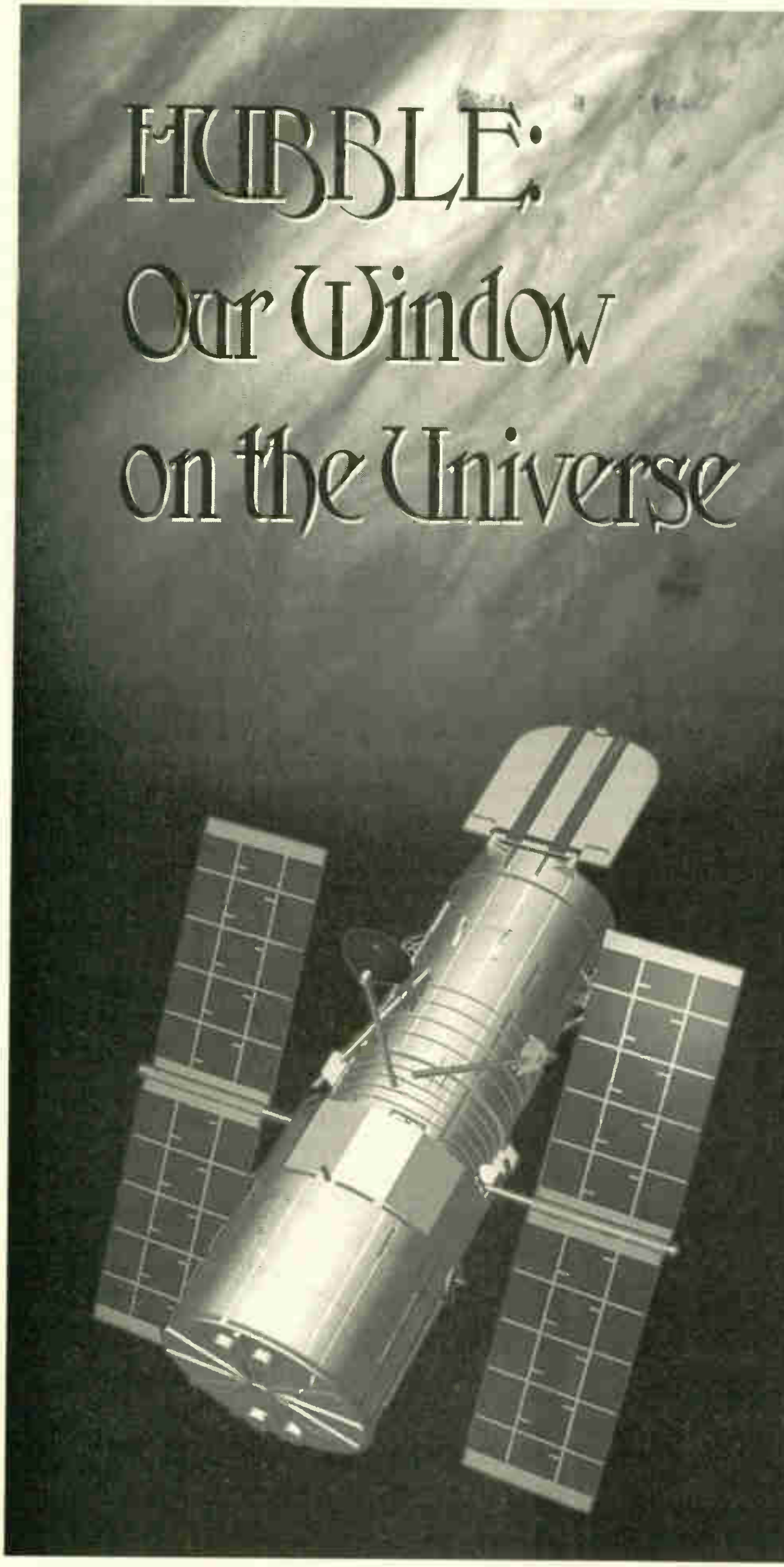
NASA is preparing the way for creating microsats with miniaturized instruments and equipment. On-board computers will operate them and miniature rockets will launch them. These new satellites from NASA will give the United States unprecedented access to space for the scientist, hobbyist, teachers and student alike. Advances in hardware reliability have allowed satellites that worked for two years just twenty years ago to have lifetimes over 20 years today. Fifty years of usable life is within achievable goals in the next century.

The age of the throw-away satellite has emerged today for business and institutions. Cheaper, smaller, longer lasting, automatic, durable, this is the legacy for NASA's science satellites in the next millennium.

NASA'S ASTROPHYSICS SATELLITES

Satellite Name	Energy Spectrum Interest	Inclination/ Altitude/ Period	Satellite Weight	Launch Year	Launcher	Downlink Frequencies
COBE	Diffuse emissions @ 1 micron to 1 cm	99 deg/ 558 miles/ 103 minutes	1,003 lbs	1989	Delta I	2287.5 MHz
EUVE	Extreme Ultraviolet	28 deg/ 328 miles/ 95 minutes	1,490 lbs	1992	Delta II	2287.5 MHz
GRO	Gamma Rays	28.5 deg/ 279 miles/ 90 minutes	7,106 lbs	1991	Space Shuttle	2287.5 MHz
IUE	Ultraviolet	34 deg/ 26140 miles/ 23 hr, 57 min	210 lbs	1978	Delta I	2249.8 MHz 136.86 MHz
ROSAT	X-rays	53 deg/ 360 miles/ 96 minutes	1,102 lbs	1990	Delta II	2276.5 MHz

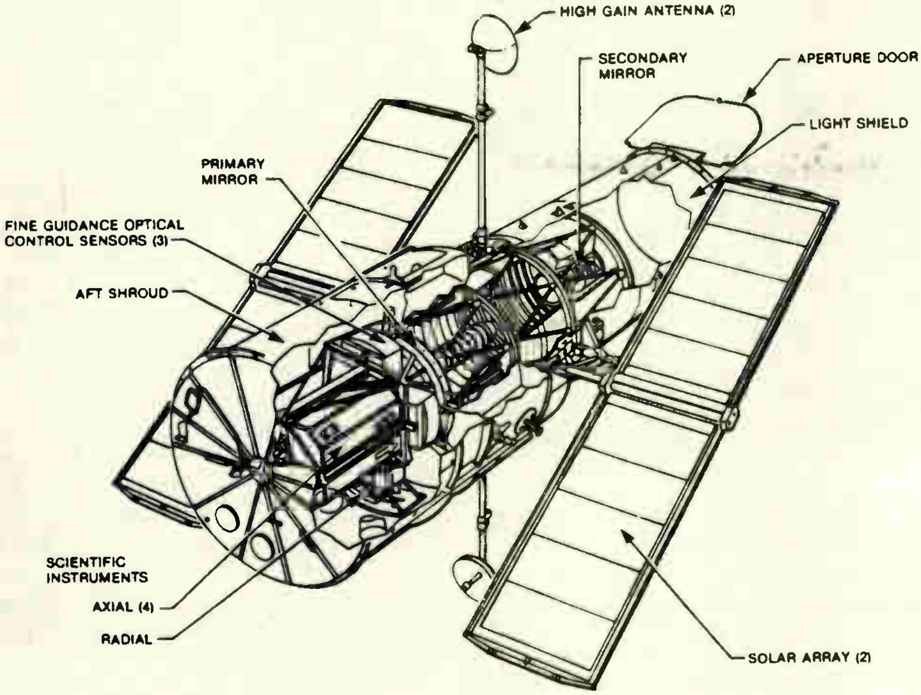
HUBBLE: Our Window on the Universe



by Keith Stein

Do you wear glasses? If you do then you might be familiar with the Pearl Vision Center's slogan "Glasses in an hour." But what if you're 600-kilometers above the earth, and your lenses are 2.4 meters (94.5-inch) in diameter? You're going to have a problem getting service.

Of course, we're not talking about human glasses, but something out of this world — the earth orbiting Hubble Space Telescope (HST). After receiving new optics in December 1993 courtesy of the STS-61 space shuttle mission, this massive orbiting astronomical observatory has ushered in a period of discovery more astounding and productive then any other space science mission to date.



With the capability of observing astronomy targets from earth orbit, the system is free from the turbulent, particle-filled atmosphere, which absorbs and distorts incoming starlight, severely limiting astronomical observations from the ground.

HST has successfully observed galaxies, stars, planets, comets, and quasars with 10 times the clarity of earth telescopes. The planet Saturn can be observed with the same resolution that past fly-by spacecraft have viewed it — only now with the Hubble observations can be made for longer periods of time.

Hubble is the product of a partnership between the United States National Aeronautics and Space Administration (NASA), and the European Space Agency (ESA). The telescope is named after Edwin P. Hubble, an American astronomer who discovered the expanding nature of the universe and was the first to realize the true nature of galaxies.

This telescope is like no other and is designed as the first repairable space observatory, detecting starlight that has traveled for billions of years. HST has seen and recorded events and phenomena that occurred close to the beginning of the universe following the Big Bang explosion.

Seven major packages make up this outstanding facility. They are the Optical Telescope Assembly (OTA), five Scientific Instruments (SIs), and a Support System Module (SSM) structure that houses electronics and mechanical support systems.

The spacecraft is 13 meters (42.5 ft) long and weighs 11,600 kg (25,500 lb). On the outside are four antennas for communications, two solar arrays panels that collect energy for the HST, and storage bays for electronic gear.

The SSM consists of the front-end light shield, with an aperture door that opens to admit light. The shield connects to the forward shell. The solar arrays and high gain antennas are mounted on the forward shell. The arrays, 40 feet long, provide electrical energy (from sunlight) to charge the spacecraft batteries which, in turn, power the HST. The antennas send and receive information.

Communicating With Hubble

Sending and receiving messages, commands, and data communications is conducted using a loop between HST and NASA's Tracking and Data Relay Satellite System (TDRSS).

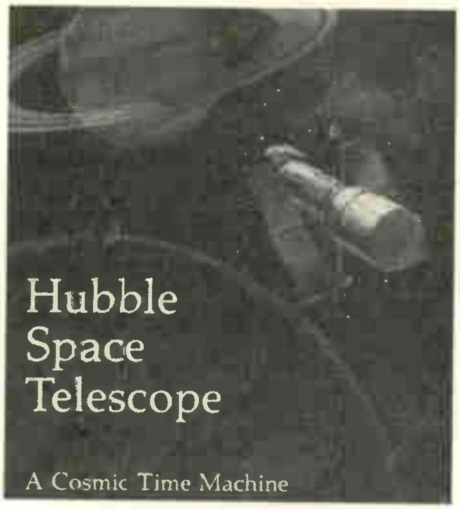
Two high gain antennas are the primary communications links to relay science data to the ground during operations. When HST is in sight of the TDRS constellation, the antennas can transmit a maximum of 90 minutes during each 96 minute orbit. The low-gain antennas are used when the high-gains are not extended.

Each high-gain antenna is a parabolic reflector (dish) antenna mounted on a mast, which gimbals in two-axis to 100 degrees in both directions. They are made of honeycomb aluminum and graphite-epoxy face sheets.

Each antenna can point to a fixed position to within one-degree of pointing error. The system transmits two downlink frequencies of 2255.5 MHz or 2287.5 MHz (plus or minus 10 MHz).

Low-gain antennas receive ground commands and transmit engineering data. Each one is a spiral cone, with a frequency range from 2100 to 2300 MHz. These antennas are used when HST is deployed, retrieved, or under an emergency situation.

NASA's Deep Space Network (DSN) is responsible for providing emergency support for the space telescope in the event a TDRS or spacecraft failure prevents communications. Stations in Goldstone, California (9-meter and 26-meter S-band antennas), Canberra, Australia (26-meter antenna), and Madrid, Spain (26-meter antenna) make up the DSN. HST down-



link data is transmitted in PCM (Biphase-L)/PM format to these stations.

Discovery After Discovery

Repaired by space shuttle astronauts during five dramatic spacewalks in December 1993, the space telescope has dominated NASA news for the last two years — rewriting astronomy textbooks with virtually every observation.

Compelling evidence of black holes, raw material for planet formation, confirmation of critical predictions of the Big Bang theory, and significant progress in determining the age and size of the universe are just a few of the recent headlines.

Hubble's first major discovery since its shuttle repair occurred in May 1994 when compelling evidence showed existence of a massive black hole in the center of the giant elliptical galaxy M87, located in the constellation Virgo.

After surveying 110 stars in June, Hubble found protoplanetary disks around 56 of the observed stars. This discovery seems to indicate that the process which may form planets is common in the Milky Way galaxy.

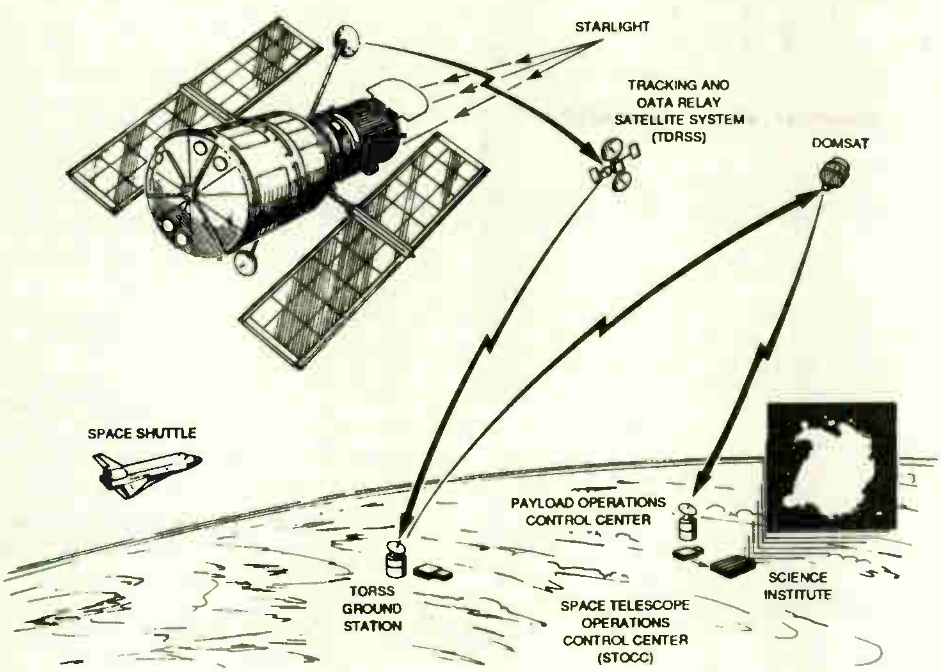
In July, Hubble investigated the most dynamic event ever discovered, the Big Bang. Using HST, researchers found the presence of helium in the early universe. This added to understanding of conditions that existed in intergalactic space when the universe was only a tenth of its present age.

Hubble's View of the Planets

In 1993 the Near Earth Object Program detected a "squashed comet" on a collision course with the planet Jupiter. Known as Comet Shoemaker-Levy, this event was the subject of worldwide interest. Altogether, at least 21 known fragments of the comet impacted Jupiter in July 1994, the largest being about two to three miles in diameter. During the first "Live" comet impact press conference held at NASA's Goddard Space Flight Center in Greenbelt, MD, scientist rushed into the room waving pictures of the first fragment impact. These pictures were compliments of the Hubble Space Telescope.

Several months later Hubble was used to investigate Jupiter's second moon Europa. These observations produced an outstanding find — oxygen in Europa's atmosphere. Amazed by Hubble's ability to detect such a small gas trace, scientist cautioned that the detection should not be misinterpreted as evidence of possible life on the Jupiter's moon. Europa is a small, frigid moon located 490 million miles from the Sun and is too cold to support life as we know it. The planets Mars and Venus are the only two planets

Edwin Hubble



beyond Earth known to have traces of oxygen, and only 3 out of 61 moons in our solar system have atmospheres. It took a total of six orbits of the Earth for the telescope to conduct these studies with Europa 425 million miles (684 million km) away.

In April 1995, Hubble was seeing spots before its eyes. Another problem with its mirror? Not at all. It was a new discovery. HST images show a new dark spot in the northern hemisphere of the distant planet Neptune, a near mirror-image of previous features first mapped by Voyager 2 in the southern hemisphere. Scientist reported the spot might be a hole in the planet's methane cloud tops thus giving us a peek into the lower levels of the planet's atmosphere.

In the future, cable TV's — *The Weather Channel* may be looking to hire some new weather forecasters. Don't be surprised if one day you tune in and hear "and that's what kind of weather we can expect for the next five days, now lets take a look at weather on Mars and Venus." This type of weather forecasting is now possible using Hubble. Scientists have already observed that Mars is cooler, clearer and drier than a couple decades ago. NASA hopes to send a manned mission to Mars someday and they might have to rely on earth-based weather forecast prior to setting down on the red planet.

Viewing HST in Dark Skies

Hubble is currently in a 599 km by 591 km orbit, inclined 28.5 degrees, with a period of 96.6 minutes. With this type of orbit, and the size of the telescope, you can observe HST in dark clear skies at times. It appears as a fast moving bright star. I have seen Hubble several times, and encourage you to go out some night and take a look.

You'll need some data before you start looking and with the help of a computer, satellite tracking software, and some current orbital elements, you'll be able to pinpoint the time and direction of where Hubble will appear in your night sky.

When you see this outstanding science instrument pass overhead, think of it as a child at age five, reaching out, touching, learning, and focusing on the past, present, and future of its surroundings. Its future will be its reward, improving its structure and pushing itself to the limits, look through it's window on the universe. ST

Keith Stein is a freelance aerospace writer based in Woodbridge, Va. You can contact him through his Internet World Wide Web home pageat: (http://www.newspace.com/publications/LaunchReport/LaunchReport.html).

DOMESTIC

TVRO

By Doug Jessop

Telstar 402R Launched

The satellite industry let out a collective sigh of relief after the long awaited successful launch of Telstar 402R. The satellite was the replacement for the failed Telstar 402 which as you remember did not answer communications commands about 4 hours after the launch.

The satellite insurance market really took a bath last year and the launch successes of 1995 are a welcome sight. To give you an idea of how costly flight insurance can be, five years ago (before the devastating 1994 launch year) flight insurance cost $1 million per minute from the time a satellite was launched until placed into geostationary transfer orbit.

After a one day delay, AT&T's Telstar 402R was launched from Kourou, French Guiana at 8:06 p.m. Eastern Daylight Time on Saturday September 23, 1995. The launch was aboard an Ariane 42L launch vehicle equipped with two liquid-propellant strap-on boosters.

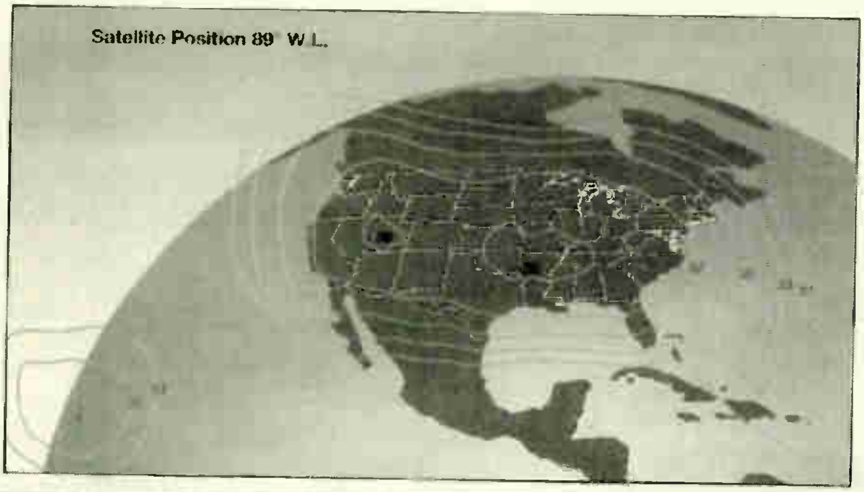
Provisional parameters at third stage injection into geostationary transfer orbit were:

Perigee:	249.1 km for a target of 250 km (+/- 3 km)
Apogee:	35,919 km for a target of 35,967 km (+/- 160 km)
Inclination:	7.03 degrees for a target of 7.0 degrees (+/- 0.06°)

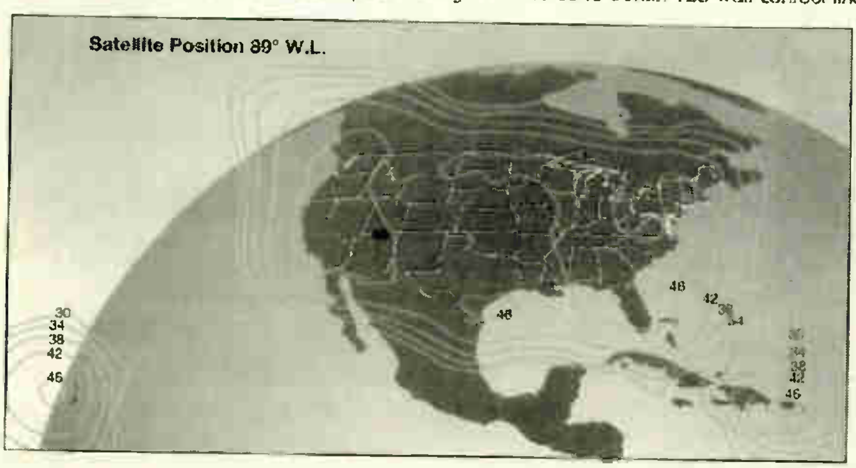
TELSTAR 402R

FIGURE 1: Telestar 402R footprints

Telstar 4 C-band EIRP (dBW).
Contours based on 12 watt power amplifier setting. Add 2.8 dB to obtain 23 watt contour lines.



Telstar 4 Ku-band EIRP (dBW).
Contours based on 60 watt power amplifier setting. Add 2.8 dB to obtain 120 watt contour lines.

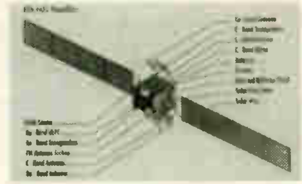


AT&T's Telstar 402R satellite was built by Lockheed Martin Astro Space and weighed in at 3,410 kg (7,502 lbs) at liftoff. The design life is 13 years. The satellite will be located over the Galapagos Islands at 89° West and is expected to be operational on December 1, 1995.

Each of the 24 C-band transponders (see figure 1 for C-band footprint) are already committed with major players including: ABC, Viacom, The SpaceConnection, Graff Pay-per-view, Channel America, Global Access, Autotote and Empire Sports. AT&T will reportedly keep two transponders in their occasional pool as a backup to contracted space in the event of a transponder failure. If you haven't read between the lines with who is going to be on the satellite, expect at least two and possibly as many as 4 new adult programming services to be on Telstar 402R. More about that later.

On the Ku-band side of the satellite, Canadian DBS operator Alphastar has signed on for 14 transponders. It should be noted that the satellite can operate at 60 or 120 watts and with the increasing use of digital compression the way that you can count the 24 Ku-band transponders could become rather creative (see table 1).

By the time you read this SBS 6 should be at its new home at 74° West to open up the 95° West slot for Galaxy 3R. The 21 degree relocation move was scheduled at presstime to begin on October 16, 1995 and will last approximately 2 weeks. Because SBS 6 is a Ku-band satellite and Galaxy 6 is C-band, the two satellites will be able to co-located without a problem.



Hughes' Galaxy 3R is scheduled to be launched by General Dynamics from Cape Canaveral around December 16, 1995. The C/Ku-band hybrid HS-601 satellite (at right) is already sold out. Eleven of the C-band transponders are already committed to TVN which will move from the inclined orbit Telstar 303.

TELSTAR 4

TABLE 1: Specifictions

EIRP (dBW)	C-band (12/23 watt)	Ku-band 54 MHz (60/120 watt)	Ku-Band 27 MHz (60/120 watt)
CONUS	35.2 2/38.0	44.3/47.1	44.1/46.9
Major Alaskan Cities	31.0/33.8	40.3/43.1	40.1/42.9
Hawaii	33.0/35.8	44.3/47.1	44.1/46.9
Puerto Rico/U.S. Virgin Islands	31.0/33.8	44.3/47.1	44.1/46.9

G/T (dB/K)	C-band	Ku-band
CONUS	-3.0	-1.0
Major Alaskan Cities	-6.0	-5.0
Hawaii	-3.0	-1.0
Puerto Rico/U.S. Virgin Islands	-4.0	-1.0

- Station-keeping ± 0.05 degrees in latitude and longitude
- 12 years of station-keeping fuel

Satellite	Orbital Location	Trandponders	Usable Bandwidth
Telstar 401	97 degrees W.L.	24 C-band and 16 Ku-band, or	36 MHz MHz
		24 C-band plus 8 Ku-band and 16 Ku-band	36 MHz 54 MHz 27 MHz
Telstar 402R	89 degrees W.L.	24C-band and 16 Ku-band, or	36 MHz 54 MHz
		24 C-band plus 8 Ku-band and 16 Ku-band	36 MHz 54 MHz 27 MHz

SFD (dBW/m^2)over CONUS

-74 to -92 at C-band
-78 to -96 at Ku-band
Ground controlled in 3 dB steps

Redundancy

C-band SSPAs 28:24 in 4 groups of 7:6
Ku-band TWTAs 36:24 in 2 groups of 18:12
Receivers 4:2 at C-band and 4:2 at Ku-band

AIDAL — Anti-Intrusion Defeater and Locator

This unique satellite design feature uses receive spot beams to minimize interfering uplinks. AT&T controls the uplinking coverage area to include one or more of four regional zones.

Cross-Strapping

Cross-strapping is designed between 16 Ku-band and 16 C-band transponders. With this feature, either a Ku-band or C-band uplink can be connected to C-band and Ku-band downlinks.

27 MHz Transponder Bandwidth Option

Eight Ku-band transponders may be individually reconfigured, under AT&T ground control, into two 27 MHz transponders. Each 27 MHz transponder has its own 60 watt TWTA. This offers the advantage of eliminating the intermodulation inherent in half-transponder transmissions and the requirement to back-off transmit power by 3 dB.

Variable Power Option

Within prime power constraints, the Telstar 4 design allows operation of all 24 C-band transponders from 12 to 23 watts nominal RF output and up to 12 Ku-band transponders at 120 watts nominal RF output power.

Driver-Limiter-Amplifiers

This capacity, provided for each Ku-band transponder, enables uplinks to maintain the proper saturation level for the TWTAs, over a 15 dB input level range to reduce the effects of rain fade.

AT&T

After playing a game of cat and mouse with satellite users, Hughes made the decision to move Galaxy 3 into a higher earth orbit and decommission the satellite on September 30, 1995. Industry watchers had expected the satellite to be kept in service until closer to the expected mid-December launch of Galaxy 3R. Apparently the earlier end-of-life date was at least partly a fuel based decision. Sources indicated that waiting much longer would mean the possibility of not being able to get the satellite into a safe orbit before shutting down the bird.

Hughes' Galaxy 3R is scheduled to be launched by General Dynamics from Cape Canaveral around December 16, 1995. The C/Ku-band hybrid HS-601 (figure 2) satellite is already sold out. Eleven of the C-band transponders are already committed to TVN which will move from the inclined orbit Telstar 303. Other players on the C-band side include HBO, Viacom, Global Access and Taurus Communications.

On the Ku-band side, Hughes is spreading their DBS empire to include Latin America. All of the transponders have been set aside for the new Galaxy Latin America (GLA), a subsidiary of Hughes Communications.

The first launch in quite a while for GE is scheduled to take place in the second quarter of 1996. GE-1 is slated for the 103° West slot with 24 C-band and 24 Ku-band transponders. Sources have indicated that a large number of the customers on the new GE satellite will be putting their hopes on MPEG-2 digital compression.

While GE officials are being rather tight lipped about who has committed to transponders, you can be sure that the satellite will be close to being sold out when it is launched. In the old days satellites were launched "on spec" taking a "build it and they will come" philosophy. With the current shortage of satellite capacity, and the phenomenally high costs of satellites, carriers are making sure that their bets are covered before they go hurling a multi-million dollar piece of hardware 22,300 miles into space.

New Entry to Launch into DBS Market

The United States DBS market should get more exciting in 1996 with the addition of EchoStar into the picture. At presstime, EchoStar 1 has a scheduled mid-November 1995 launch with China's Long March Company. You may remember that Long March has had some problems as of late getting satellites where they belong. After a heated debate over fault of the last failure being attributed to wind shear, Long March is back on course. However, before the Echostar 1 launch, Long March has a INTELSAT satellite launch. In the event of launch failure, EchoStar apparently has a alternate launch contract with Russia's Proton launch vehicle.

In related news, EchoStar has reportedly inked a deal with Philips Consumer Electronics Company to manufacture and market MPEG-2 receiving hardware.

Adult Programming

As I mentioned earlier, no matter what you think about the programming, sex sells. With the cost of satellite transponders being in the 6-figure range per month, you can bet that home satellite dish users keep ringing the cash register for adult programming. For those parents that want to know where to put the parental lockout refer to table 2.

In a surprising development, Solidaridad F1 (C-band), transponder 11N (channel 21) is now home to the only satellite delivered adult channel in Mexico, "Cine X Venus." While the channel is broadcasting using an undetermined digital system for

America's Health Network is scheduled to begin 16 hours of live programming in first quarter of 1996. The new network, which will originated from Universal Studios Florida, reportedly has programming and medical content support from Mayo Clinic.

TABLE 2: Adult Programming on North American Satellites

Location	Satellite	Transponder	Programming
125º W	Galaxy 5	2	Playboy TV
123º W	Telstar 303	10H	Adultvision
113º W	Solidaridad F2	8N	Cine X Venus promo
109.2º W	Solidaridad F1	11N	Cine X Venus
107.3º W	Anik E2	1A	Spice
107.3º W	Anik E2	1B	Adam & Eve
107.3º W	Anik E2	7B	Adultvision
107.3º W	Anik E2	9A	Climaxxx TV
107.3º W	Anik E2	12A	Exxxtreme TV/Cupid
100.8º W	DBS-1,2,3	401	Adam & Eve
100.8º W	DBS-1,2,3	402	Playboy TV
97º W	Telstar 401	1	Exxxtasy TV
97º W	Telstar 401	15	Exxxtasy 2
97º W	Telstar 401	17	TV Erotica
89º W	Telstar 402R	?	2-4 new adult channels
85º W	Telstar 302	1V	XXXplore TV
85º W	Telstar 302	6V	XXXpose TV
85º W	Telstar 302	8V	Exxxtreme TV promo
85º W	Telstar 302	9V	TV Erotica Primetime
85º W	Telstar 302	9H	TV Erotica PT promo
85º W	Telstar 302	10V	XXXpose TV promo
85º W	Primestar (K1)	211	Playboy TV

Source: Keystone Communications North American Satellite Guide©

their programming feeds, BUD users can check out the promo channel for Cine X Venus on Solidaridad F2 (C-band), transponder 8N (channel 15) . The promo channel is in the clear and uses 6.65 wide program audio. Please note that both Solidaridad F1 and F2 broadcast using regional spot beams that broadcast to Mexico and the southern part of the United States.

New Channels in 1996

Even with the current shortage of satellite transponder capacity there are still a number of new channels slated for 1996.

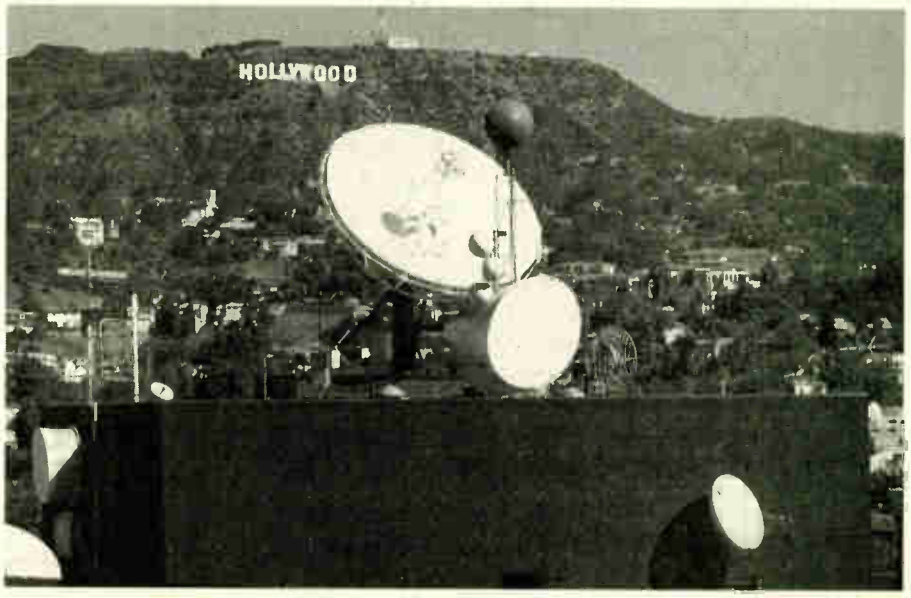
America's Health Network is scheduled to begin 16 hours of live programming in first quarter of 1996. The new network, which will originated from Universal Studios Florida, reportedly has programming and medical content support from Mayo Clinic. America's Health Network plans to broadcast on Galaxy 1R, transponder 4 using GI Digicipher. This transponder is currently home to Canal de Noticas and TV Food Network.

A new aerospace channel, Air & Space Network (ASN), is setting their sites on a launch sometime in the first half of 1996. The new channel is planned to begin on DBS and then move to C-band broadcasts with aviation news broadcasts and talk shows, aviation weather programs, etc.

In other news, the satellite industry was saddened with the September 20, 1995 death of Rene Anselmo at the age of 69. Mr. Anselmo created the U.S. market for Spanish language television, having served from 1963 to 1986 as the founding shareholder and president of the SIN Television Network, now called Univision. In 1984, Mr. Anselmo founded and personal financed PanAmSat, a startup venture that now is the world's only private global satellite services company. ST

Rene Anselmo

Doug Jessop, a 16 year veteran of the broadcasting industry, is the architect and editor of the Keystone Communciations North American Satellite Guide ©, the official professional satellite guide for such clients as NBC and PBS Master Control.



Keystone Communications is the largest provider of satellite transmission services in North America. Most of the United States syndication runs through Keystone's Southern California facilities.

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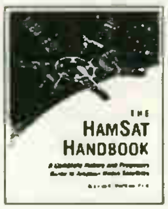

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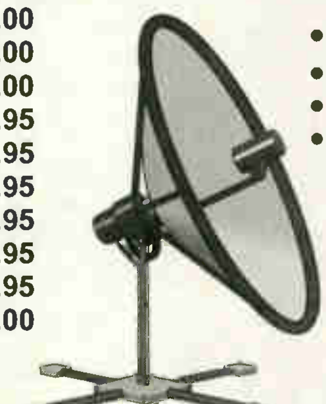

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INTERNATIONAL TVRO

By George Wood

Look—Up in the Sky . . .

I spent much of July and the first week of August at home in Northern California. There was certainly a lot going on in American media while I was there, with the Disney-ABC and Westinghouse-CBS mergers, the FCC allowing Rupert Murdoch to hold on to the Fox Network, and more. It was also a fairly quiet time in Europe. But since I've returned, the Fall TV season has seen many changes and new launches.

The best place to start is with Astra, and Rupert Murdoch's British Sky Broadcasting. In connection with an increase in its subscription fees in October, BSkyB has launched what it calls 7 new channels, to justify the fee hike. But BSkyB has a strange way of counting channels. With the new expansion, one single Astra transponder, number 47, now carries what BSkyB calls 6 channels!


George Wood

Most would probably call this diverse output one channel with widely varying programming. It breaks down like this:

Transponder 47 was already carrying Sky Soap weekday mornings and Sky Travel (which essentially exists to sell package tours from Murdoch's travel agency) afternoons and evenings, except Fridays and weekends, when Sky Sports 2 takes over. One addition is the uncoded Christian Channel for a couple of hours early every morning. The biggest surprise, however, is the Sci-Fi Channel, which had been expected to launch on rival Eutelsat's Hot Bird, as a coded channel for cable networks only. Instead, it joins the BSkyB basic tier package, and is being squeezed into transponder 47 on Mondays, Tuesdays, and Wednesdays between 7 PM and 10 PM British Time.

At that same time on Thursdays Sky is adding a classic sports channel, carrying great moments from sports history. Sky Travel's viewership figures have been low, hence its removal from prime time.

Over on transponder 42, which carries Bravo, featuring classic TV shows from the 60's and 70's, the Playboy Channel now follows after midnight British time. A softcore porno outlet called The Adult Channel had been in that spot, but it's now been moved over to Astra transponder 63, on the less watched 1D satellite, taking over from FilmNet Central Europe after midnight.

Another big change is on Astra transponder 26, which has been the home of Sky's third film channel, Sky Movies Gold. It's been offered free to subscribers to both of the other film channels, but ratings have been poor, and Sky has been changing the format around to add more classic TV programs. Now Sky Movies Gold is being moved to another Astra transponder, number 60. This transponder is on the new Astra 1D satellite, which operates on frequencies below those covered by most European satellite receivers. Those who want to watch the 1D channels have to buy either new receivers or converters, and apparently this hasn't happened to a very great extent, and viewership for the 1D channels remains much lower than for the channels on the 1A, 1B, and 1C satellites. So Sky is moving Gold to the slums of 1D and moving two new channels into the valuable real estate on transponder 26.

The first of these is European Broadcast News, operated by Dow Jones. This operates 24 hours a day on Hot Bird. But EBN is now also broadcasting on Astra transponder 26 mornings from 4:00 a.m. British Time until midday.

What takes over then is the new European Disney Channel. This, like Sky Movies Gold, is only being made available to subscribers to the two Sky film channels. For some reason, Disney is intentionally closing itself off from the entire European audience outside the British Isles (since Sky subscriptions are only sold to viewers in Britain and Ireland), and restricting access to only those British viewers willing to take the entire Sky package.

To make things even more complicated, Sky Movies Gold hasn't completely abandoned transponder 26. It still fills in for a few hours in the middle of the night after Disney signs off.

According to reports, Sky has leased Astra transponders 57 and 58, but despite squeezing in all those channels into transponders 26 and 47, Sky reportedly doesn't know what to do with 57 and 58, which are still empty.

Is Rupert Murdoch really a financial and media genius?

Murdoch certainly lost out on his attempt to take advantage of Italian media magnate Silvio Berlusconi's problems. The former Italian Prime Minister used the full power of his three TV networks to campaign against a referendum that would have forced him to sell most of his TV interests. After the media blitz succeeded, Berlusconi snubbed Murdoch, who wanted to buy control of the three networks, and instead reached agreement with a consortium of companies who will acquire a much smaller interest in Berlusconi's TV empire. By selling only 20 percent of the Mediaset company, Berlusconi retains control over his controversial networks.

More Astra News

There are broadcasts on Astra in other languages than English. Dutch viewers have two new channels, both on Astra 1D, which is slowly filling up, one year after launch. The Dutch domestic broadcaster Veronica (which started life as a offshore pirate radio station on a ship in the North Sea) began broadcasts on Astra transponder 51 on August 31. A month later, the Scandinavian Broadcasting System (owned by Capital Cities/ABC) followed up its VT-5 service to Flemish (Dutch) speak-

Murdoch certainly lost out on his attempt to take advantage of Italian media magnate Silvio Berlusconi's problems. The former Italian Prime Minister used the full power of his three TV networks to campaign against a referendum that would have forced him to sell most of his TV interests.

ing Belgium, with a service aimed to the Netherlands called SBS-6, on Astra transponder 53. There are new German channels on Astra 1D as well. The shopping channel Home Order TV is using transponder 61 and Cable Plus is using transponder 62.

Digital Radio

Besides the launch of the new BSkyB channels, the other major addition to Astra is the introduction of Astra Digital Radio. A number of analog audio subcarriers have been cleared off or reshuffled for the new project, which combines digital transmissions from a number of existing broadcasters, all German, with the new European DMX. The respected German talk and information channel RadioRopa is abandoning analog sound completely and switching to exclusive broadcasts using ADR. Other German broadcasters are following suit, the previous digital system used by German stations, Digital Satellite Radio, having been largely abandoned along with Germany's Kopernikus satellites, in favor of Astra.

The German stations are available for free to anyone with an ADR receiver. But the biggest draw is DMX, which officially launched its multi-channel subscription music service to European satellite dish owners at September's IFA show in Berlin. The new service offers subscribers up to 90 channels of digital, non-stop, commercial free music.

Besides the usual classical, rock, jazz and country channels, carried by DMX in North America, there are also many speciality and international channels such as Swiss Folk, Norwegian, Flemish and Hebrew music.

Initially, DMX is available only to listeners in Germany, Austria and Switzerland, who have the first retail access to the DMX direct-to-home receivers. Subscription drives are to follow in Britain, where British Sky Broadcasting will be selling DMX subscriptions, and then in Scandinavia and the Benelux, where Nethold's Multichoice will be the subscription distributor.

The question is if dish owners will buy the new ADR decoders, which at around $450 dollars, cost more than most satellite receivers. Since ADR is based on the MPEG-2 digital standard, which is also being used for the new generation of European digital television, many may choose to wait until MPEG-2 satellite receivers, which should include ADR access as well, enter the market in large numbers and lower prices. While there are some digital TV experiments on Astra 1D, Astra will truly enter the digital age with the 1E satellite, which was scheduled for launch in October. This is to be followed by Astra 1F in 1996, and Astra 1G in the second quarter of 1997. Astra's owner SES has announced some of the customers taking space on the coming digital satellites:

Satellite	Company	Transponders
Astra 1E	Kirch	3
	Canal Plus	3
	CLT	2
	Pro 7	1
Astra 1F	Kirch	3
	Canal Plus	4
	CLT	2
	Pro 7	1
Astra 1G	Kirch	2
	Canal Plus	2
	CLT	3
	Pro 7	1

A further 11 transponders on the 3 satellites are reported to have been signed by British Sky Broadcasting, and 8 by FilmNet's owner Nethold. SES is also going ahead with the 8th Astra satellite, Astra 1H, due to launch in the spring of 1998. It will have 28 active transponders.

Eutelsat

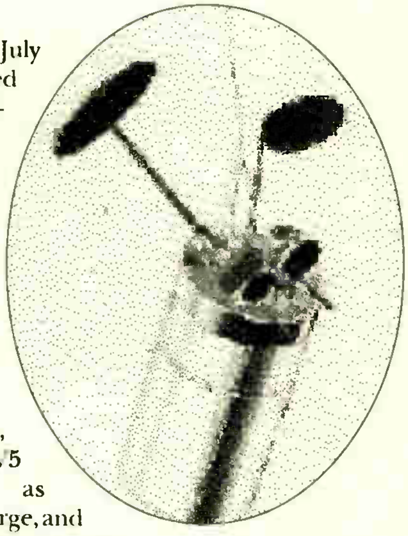
Meanwhile, rival Eutelsat is fighting back. The Eutelsat II-F1 and Hot Bird-1 satellites are both seeking to rival Astra from the 13 degrees East position. Hot Bird-2 and 3 are already ordered. Now Eutelsat's Board of Signatories has given the go-ahead for 5 new satellites. One will be Hot Bird 4, the 5th television satellite for direct-to-home transmissions from 13 degrees East. The 20 transponder satellite will be built by Matra Marconi Space, and will be launched in the third quarter of 1997.

Three new telecommunications satellites, marking the first Eutelsat III series satellites, will be built by a consortium headed by Aerospatiale, and will start to replace the Eutelsat II series at 7, 10, and 16 degrees East from 1998. Each of these satellites will provide 50 percent more capacity (24 transponders) than the current satellites, as well as increased power, broader coverage, and steerable beams.

A contract for the fourth telecommunications satellite will be finalized with NPO-PM of Russia, for launch in the beginning of 1998. Positioned at 48 degrees East, Eutelsat's most easterly orbital position, the satellite's 18 transponders will be used for communications in far eastern Europe and central Asia.

TV3 is part of the Kinnevik media empire, which has been talking with another arch-rival, Swedish Television, about creating a common sports channel. Like Rupert Murdoch's British Sky Broadcasting, TV3 has stolen some prime sports events from a slower moving public broadcaster, not used to the competition.

Nordic



I was in California on July 31, when Disney announced it had bought Capital Cities/ABC. The deal has major implications for Americans, of course, but as I watched the press conference with Disney's Michael Eisner on CNBC, I wondered what effect it would have on ABC's European operations, like the Scandinavian Broadcasting Systems, which owns Sweden's TV5 Nordic (also known as Femman), Norway's TV Norge, and a local TV station in Denmark, plus many radio interests. Fortunately, one of the assembled journalists actually asked that question, and Michael Eisner spoke very much in favor of Disney strengthening ABC's European operations.

When I got back to Sweden I interviewed the Managing Director of TV5, Lena Aahman, how the merger might be affecting their programs. At that point things were still unclear, although Eisner's remarks at the press conference were encouraging. She was also hoping the merger would mean access to Disney programming for TV5. Until now, Disney shows have only been available to Swedish viewers on the public broadcaster Swedish Television, and TV5's larger rival TV3.

But a week after our interview, Lena Aahman resigned from her job. According to reports, she quit because of a conflict with the new Nordic and Baltic division head for TV5's owner Scandinavian Broadcasting Systems, Jan Steinman, who's become Femman's acting Managing Director for the time being. Steinman was the first head of TV3, and he's expected to make the SBS channels more competitive against his former employer.

TV3 is part of the Kinnevik media empire, which has been talking with another arch-rival, Swedish Television, about creating a common sports channel. Like Rupert Murdoch's British Sky Broadcasting, TV3 has stolen some prime sports events from a slower moving public broadcaster, not used to the competition.

The new channel would be satellite-based, and would go on the air at the beginning of next year. Right now the lawyers and the Swedish Ministry of Culture are trying to work out how the channel could be financed without Swedish Television violating its licence, which is for non-commercial broadcasting, and its strict guidelines on sponsorship.

Kinnevik, is also causing waves over its announced decision to leave the Astra satellites in favor of Sirius at 5 degrees East, as well as the announcement that the currently uncoded PAL Sirius channels will be switching to coded D2-MAC. Something like one hundred thousand Swedish households bought cheap packages to watch Sirius, and now they'll have to buy decoders. Pelle Toernberg, the head of Kinnevik's media branch, MTG, has now promised the company will subsidize the decoders, reducing their price from about 540 dollars to around 200 dollars each. There are at least as many Nordic Astra viewers who now must decide whether they will move their dishes, add new multi-satellite LNB's, motorize their systems, or just stick with Astra anyway.

On the other hand, Astra's owner SES questions whether the Kinnevik channels will really be moving. They've got a 12 year contract, and have yet to contact SES about renegotiating. Of course Kinnevik could just sublet their very valuable Astra transponders.

Kinnevik's TV1000 pay movie channel has decided to discontinue its oldies film outlet FilmMax, and concentrate instead on TV1000 and its companion channel TV1000 Cinema. Like FilmNet, TV1000 offers its two channels for the price of one, although the main benefit seems to be time-shifted programming. TV1000 Cinema has replaced FilmMax on the Intelsat 601 satellite, and has also begun broadcasts at the Nordic 5 degrees West position on TV-Sat 2 on 11.900 GHz. (The other satellites at that position are Intelsat 702 and Norway's Thor.)

Kinnevik received a set-back earlier this year when the European Commission blocked Nordic Satellite Distribution, a joint venture of three of Scandinavia's largest telecommunications companies. Dominated by Kinnevik, NSD also included public telecommunications companies and cable operators in Norway and Denmark. The European Commission says the project is anti-competitive, the main problem being the fear that Kinnevik's domination might make it harder for rivals, like Nethold's FilmNet, to gain access to the satellites that would have been controlled by NSD.

Kinnevik had announced it was taking over the distribution of subscription cards on the Thor satellite, for the package that includes CNN, Nordic Eurosport, Discovery, Children's Channel, and MTV, along with arch-rival FilmNet. Now, apparently because of the European Commission ruling, that distribution has been taken over instead by FilmNet's owner MultiChoice.

While Kinnevik is moving its channels from Astra, SES says it has three new Swedish channels coming from Nethold. These will apparently be digital channels on the new Astra 1E satellite. Among the new stations that will begin in the new year are SuperSport, and a family-entertainment channel called Hallmark, a joint project with Hallmark Entertainment, which also hopes to launch channels to other parts of Europe.

Radio Sweden

Radio Sweden is now available on ZDF's transponder 33 on Astra, audio 7.38 MHz. There are at least three different stories as to why the station had to move from transponder 26. The official line from British Sky Broadcasting is that it has moved its downlink station, and the new downlink facility is outside the coverage area of the Tele-X satellite, which is used to relay the signals from Stockholm.

The Chinese authorities now admit that the explosion that destroyed the Apstar 2 satellite earlier this year was caused by windshear. Initially Chinese newspapers had blamed foreign sabotage for the failure, and when that explanation was ridiculed in the foreign media, the Chinese press switched to blaming instead the manufacturers of the satellite, Hughes.

But a report in the magazine "Paa TV" says that the real reason is because the audio channels on Astra transponder 26 are being used for Astra Digital Radio.

A third explanation from a very reliable source is that the switch is because Disney will be using the transponder and as a principle the American media giant won't allow subcarriers on its transponder to be used by other broadcasters.

(The reason Radio Sweden ended up on transponder 26 in the first place was because at the time Sky was using it for just a few hours every day for Sky Movies Gold's predecessor, the Comedy Channel. It was the only time Sky had a partial lease on a transponder — SES retained the rights to lease the other sound subcarriers. I remember calling a Sky executive some weeks later to ask a question, and mentioned we were satellite neighbors."What do you mean you're on our transponder," he screamed at me. "We haven't given you permission to use our transponder." Times change...it seems Disney may have the power Sky lacked.)

Africa

Nethold is based in South Africa, and its subsidiary Multichoice is launching the first digital multi-channel package to Africa. The 16 channel package is called Dstv, and will broadcast from PanAmSat's new PAS-4. It includes several Astra channels, mildly reworked for the African market, namely: TNT/Cartoon Network, Sky News, Sky Travel, VH-1, and Zee-TV. DMX says it will offer a 40 channel pay-audio service as well. The Sci-Fi Channel and BBC World are said to be considering joining Dstv, while Nethold's existing kids channel K-TV, the pay film channel M-Net, and the planned SuperSports channel have also signed up.

The PAS-4 Indian Ocean Relay satellite was successfully launched on August 3, and is positioned at 68.5 degrees East. Besides Africa, it reaches parts of Europe, the Middle East and South Asia. It carries 16 C-band and 24 Ku-band transponders, and broadcasters include China Central Television, Disney, ESPN, HBO, Liberty, the M-Net/MultiChoice package and South Africa's SABC/Sentech, Sony, Turner Broadcasting, and Viacom International.

The replacement for the crashed PAS-3 Atlantic Ocean Region satellite is scheduled for launch in December, 1995. PanAmSat's continued expansion plans include launches in 1996/1997 of the PAS-5 and PAS-6 satellites to serve the Americas.

Asia

August 29, just over three weeks after the launch of PAS-4, was a good day for Japanese satellite television, with the successful launch of two new satellites.

JCSAT 3 was launched on a Lockheed Martin Atlas 2AS from Cape Canaveral. It's the first Japanese digital TV broadcasting satellite, with 28 Ku band and 12 C band transponders. That same day Arianespace successfully placed into orbit Japan's N-STAR satellite. During its operational life of ten years, the spacecraft will provide Japan with telecommunications services in the C, Ku, S and Ka-bands.

The Chinese authorities now admit that the explosion that destroyed the Apstar 2 satellite earlier this year was caused by windshear. Initially Chinese newspapers had blamed foreign sabotage for the failure, and when that explanation was ridiculed in the foreign media, the Chinese press switched to blaming instead the manufacturers of the satellite, Hughes.

Meanwhile, the failure of a booster rocket to separate from the Delta rocket carrying Korea's first satellite into orbit could mean a reduced life. The satellite, called Mugunghwa, carries 12 TV transponders.

Binariang Sdn Bhd, operators of Malaysia's MEASAT-1 satellite, have announced the satellite will be launched in late December via an Ariane rocket. The satellite will begin broadcasting sometime next March, before which the Malaysian government is expected to rescind current laws banning satellite reception in the country.

MGM is to launch its first satellite channel, called MGM Gold, to Indonesia. It will be digitally encrypted, and part of the Indovision DTH package to broadcast from Palapa B2P early next year.

Latin America

Rupert Murdoch's media empire continues to expand. After Europe (British Sky Broadcasting), North America (Fox), Asia (Star-TV), and Africa (via Dstv) Murdoch's News Corporation is joining with Brazil's largest media conglomerate, Rede Globo, to launch a digital DBS package to South America next year. It's likely that either Intelsat or Panamsat will be used to deliver the primarily Portuguese-language programming.

This follows three other announced plans to begin satellite broadcasts to South America next year: DirecTV Latin America, Galavision, and the Peruvian based Amigo package.

Finally, if you want to send questions or contributions to this column, I've got a new e-mail address: **wood@rs.sr.se** ST

ON THE AIR

By Steve Handler

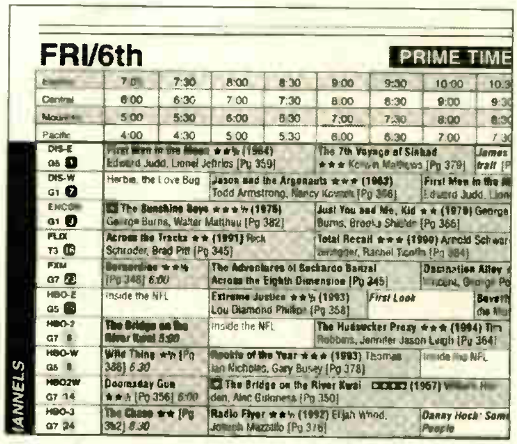
The Treasure of Satellite Mantra!

You sit down on your couch, lie back in your easy chair, gently rest your head on the pillows atop your bed and get ready to do some serious satellite tv watching. How do you know what's on the air?

Maps to the buried treasure of C-band satellite TV programing are at your disposal. In this issue of On-The-Air we will discuss several of the satellite programming guides available via subscription and on the newstands for the TVRO dishhead.

For those that like their treasure map to arrive weekly — *OnSat* — whose cover bills itself "America's Weekly Satellite Guide" is published by Triple D. Publishing, Inc. With their August 7th-13th issue gracing my mailbox, I had the pleasure of taking a peak. Measuring about 8 and 1/8 inches wide by 10 and 3/4 inches in length, it contained roughly 150 pages. Articles about satellite TV and television programming were included as part of the thirty full color pages in that issue.

The television programming information was listed in a 120 page section printed on newsprint. Programs were listed chronologically by date and time in a grid format and separate editions are published depending on the time zone in which you live.



FRI/6th — PRIME TIME

Eastern	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:3
Central	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:3
Mountain	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:3
Pacific	4:00	4:30	5:00	5:30	6:00	6:30	7:00	7:3

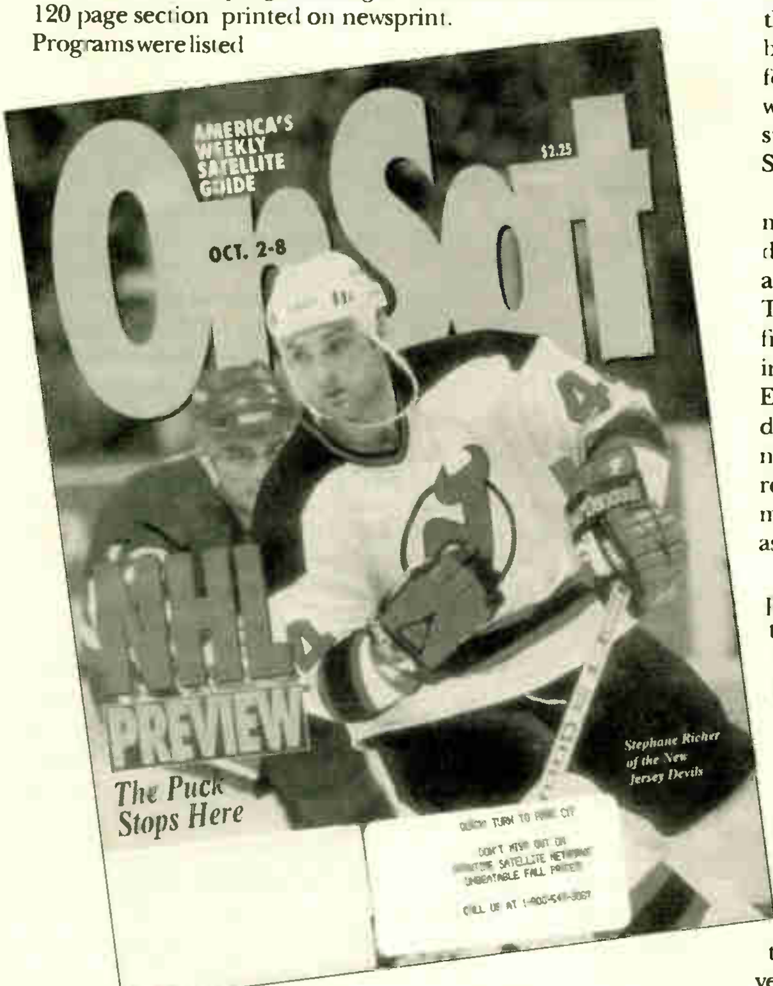
CHANNELS			
DIS-E G5 3	First Men in the Moon ★★½ (1964) Edward Judd, Lionel Jeffries [Pg 359]	The 7th Voyage of Sinbad ★★★ Kerwin Mathews [Pg 379]	James [illegible] trait [P
DIS-W G1 7	Herbie, the Love Bug	Jason and the Argonauts ★★★ (1963) Todd Armstrong, Nancy Kovack [Pg 366]	First Men in the M Edward Judd, Lion
ENCORE G1 J	The Sunshine Boys ★★★½ (1975) George Burns, Walter Matthau [Pg 382]	Just You and Me, Kid ★★ (1979) George Burns, Brooke Shields [Pg 366]	
FLIX T3 16	Across the Tracks ★★ (1991) Rick Schroder, Brad Pitt [Pg 345]	Total Recall ★★★ (1990) Arnold Schwarzenegger, Rachel Ticotin [Pg 384]	
FXM G7 23	Bernardine ★★½ [Pg 348] 6:00	The Adventures of Buckaroo Banzai Across the Eighth Dimension [Pg 345]	Damnation Alley [illegible] Vincent, George Pe
HBO-E G5 [illegible]	Inside the NFL	Extreme Justice ★★½ (1993) Lou Diamond Phillips [Pg 358]	First Look	Seventh [illegible]
HBO-2 G7 8	The Bridge on the River Kwai 5:00	Inside the NFL	The Hudsucker Proxy ★★★ (1994) Tim Robbins, Jennifer Jason Leigh [Pg 364]
HBO-W G5 8	Wild Thing ★½ [Pg 388] 6:30	Rookie of the Year ★★★ (1993) Thomas Ian Nicholas, Gary Busey [Pg 378]	Inside the NFL
HBO2W G7 14	Doomsday Gun ★★½ [Pg 356] 6:00	The Bridge on the River Kwai ★★★★★ (1957) William Holden, Alec Guinness [Pg 350]	
HBO-3 G7 24	The Chase ★★ [Pg 352] 6:30	Radio Flyer ★★½ (1992) Elijah Wood, Joseph Mazzello [Pg 376]	Danny Hoch: Some People

To find out what was airing at 7a.m. (CDT) on Thursday, August 10, 1995 for example, I turned to the page labeled Thursday morning, August 10 across the top of the page. I then located 7a.m. on the time bar. The time bar is divided into half hour slots which span the page. I then followed down that page and the next page as the grid showed what was available on the networks, Canada, superstations, the variety stations, music, religious, premium stations such as HBO and Showtime, pay- per-view stations and sports.

I found *OnSat* easy to use because the entire day's programming (all 24-hours) was listed in grid format. I could quickly look down the page to see what was on at a specific time and also see at a glance what programming had started slightly earlier or later. The movies were shaded in gray in the grid to make them easier to find. In addition, a movie guide entitled *Movies This Week* is included along with a separate guide for pay-per-view movies. Each movie was listed in alphabetical order with a very brief description about the movie and other information such as the movie rating. Zero to five stars were assigned by the magazine to represent their opinion of the quality of the movie. Additionally, most listings contained the name of the feature actors or actresses, as well as the length of the movie in minutes.

Also in *OnSat* was a two page *Special Feeds Update* section which provided a schedule of wild feeds listed chronologically by day of the week and time of the broadcast. For sports fans, the *Sports This Week* section provided a day by day, hour by hour listing of sports by category, such as baseball, billiards, cycling and other sports.

An eight page, multi-colored *OnSat Channel Guide* occupied the center section of the magazine. This guide listed the C-band satellites in a grid format (similiar to ST's center grid). It shows each satellite's transponders and TV program users for those transponders. Color coding is used within the grid to indicate whether the transponder user is pay-per-view, subscription, scrambled (decoder not available to TVRO viewers), or unscrambled/free. In addition, the grid also provided information about the satellite's transponder polarities (horizontal/vertical).



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OnRadio was also included as part of the center section of the magazine. It contained a concise list of radio stations available on C-band satellite transponders, listed by radio station format such as classical, country and jazz.

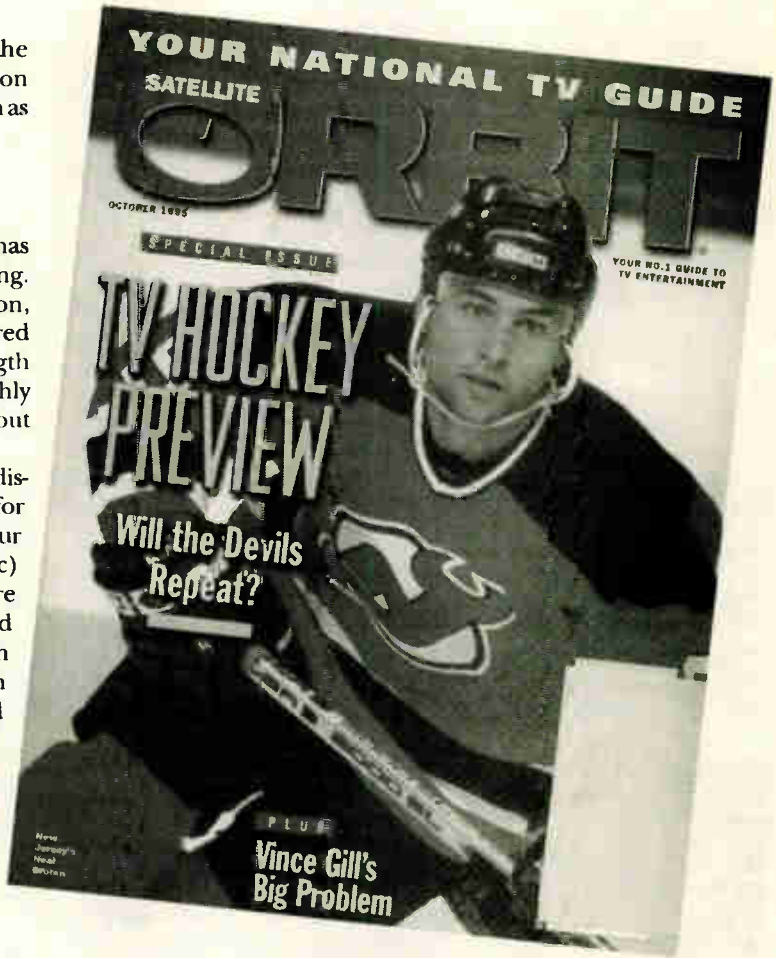
Satellite Orbit

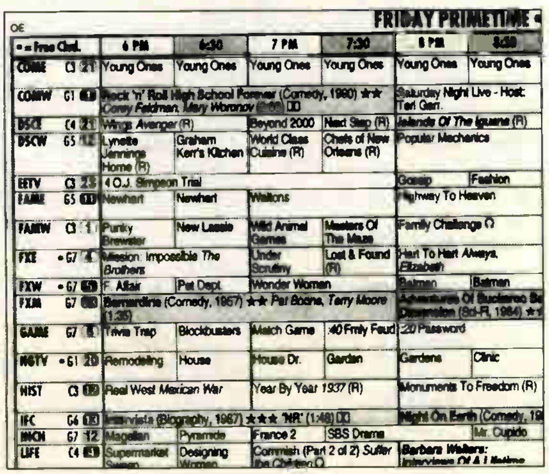
Satellite Orbit magazine, more commonly referred to as *Orbit*, has a long history in the field of satellite tv programming publishing. Published monthly by CommTek Communications Corporation, the September issue also made its way to my desk. It measured roughly 7 and 7/8 inches in width and 10 and 3/8 inches in length and weighed in with about 400 pages. Included in the roughly eighty full color pages were a number of interesting articles about programs on-the-air and satellite television.

Program listings for each day's prime time viewing were displayed in a grid format. Unlike *OnSat* which has a separate issue for each of the time zones, *Orbit* publishes one issue and uses four separate time bars (Eastern, Central, Mountain and Pacific) displayed at the top of each of the prime time page. Times are displayed in half hour blocks. Early in my use of *Orbit* I found myself confusing the time zones, which did not happen with *OnSat* because it had a separate edition for my time zone. I often have been accused of going through life in a confused state, and perhaps that contributed to my initial problems. However, once I got used to selecting my proper time zone, locating my favorite programs became easy.

To use the *Orbit* prime time grid, I followed down the page and found the programming listed by category. For example, the prime time grid listings for Monday — September 11, 1995 had the premium channels listed first, followed by superstations and then sports channels.

The opposite page continued the grid listings for basic and variety channels, followed by network listings for ABC, CBS, NBC, FOX and PBS. The type style used and size of the grids appear different than that of *OnSat* and I personally found *Orbit's* grids easier on my eyes than those in OnSat. Movies in the grid were shaded in gray making them easy to find with a quick glance. All





OE FRIDAY PRIMETIME

• = Free Chnl.	6 PM	6:30	7 PM	7:30	8 PM	8:30
COME C3 21	Young Ones	Young Ones	Young Ones	Young Ones	Young Ones	Young Ones
COMW G1 [illegible]	Rock 'n' Roll High School Forever (Comedy, 1990) ★★ Corey Feldman, Mary Woronov (2:00)				Saturday Night Live - Host: Teri Garr.	
DSCE C4 21	Wings Avenger (R)		Beyond 2000	Next Step (R)	Islands Of The Iguana (R)	
DSCW G5 [illegible]	Lynette Jennings Home (R)	Graham Kerr's Kitchen	World Class Cuisine (R)	Chefs of New Orleans (R)	Popular Mechanics	
EETV C3 23	4 O.J. Simpson Trial				Gossip	Fashion
FAME G5 11	Newhart	Newhart	Waltons		Highway To Heaven	
FAMW C3 1	Punky Brewster	New Lassie	Wild Animal Games	Masters Of The Maze	Family Challenge	
FXE • G7 [illegible]	Mission: Impossible The Brothers		Under Scrutiny	Lost & Found (R)	Hart To Hart Always, Elizabeth	
FXW • G7 [illegible]	F. Affair	Pet Dept.	Wonder Women		Batman	Batman
FXM G7 [illegible]	Bernardine (Comedy, 1957) ★★ Pat Boone, Terry Moore (1:35)				Adventures Of Buckaroo Banzai Across The 8th Dimension (Sci-Fi, 1984) ★★	
GAME G7 [illegible]	Trivia Trap	Blockbusters	Match Game	:40 Fmly Feud	:20 Password	
HGTV • G1 20	Remodeling	House	House Dr.	Garden	Gardens	Clinic
HIST C3 [illegible]	Real West Mexican War		Year By Year 1937 (R)		Monuments To Freedom (R)	
IFC G6 [illegible]	Intervista (Biography, 1987) ★★★ 'NR' (1:48)				Night On Earth (Comedy, 19	
INCN G7 12	Magellan	Pyramide	France 2	SBS Drama		Mr. Cupido
LIFE C4 [illegible]	Supermarket Sweep	Designing Women	Commish (Part 2 of 2) Suffer the Children		Barbara Walters: Interviews Of A Lifetime	

program listings were printed on newsprint.

Non prime time programming listings were displayed in chronological order sorted by half hour time blocks and satellite. For example, for Sunday — September 10th, 1995 the listing for 4:00 Eastern/3:00 Central/2:00 Mountain/1:00 Pacific has the times listed in bold with the satellites listed below in alphabetic order. Satellite F1, for example, had listings for transponders 3, 5, 6, 7, 10, 14 and 19. Included in the listings were the transponder number, the station (such as FOX or KRMA), and then a brief program description such as *Wall $treet Week*. I found *Orbit's* prime time grid system easier to use than its non prime time chronological listings. Others may prefer the chronological listings.

An extensive three page wild feeds section was also included in *Orbit* with wild feeds listed alphabetically by program name. Next to the name of the program I was interested in watching was the day or days of the week and the times (all in eastern) that the wild feeds aired along with the satellite name and transponder number.

Other handy features included a full page devoted to satellite radio, which listed radio stations available on various satellite transponder audio channels. Listed by type of station (such as classical, country, rock and the like), this listing was similar to the *OnRadio* section contained in *OnSat*.

To use the Orbit prime time grid, I followed down the page and found the programming listed by category. For example, the prime time grid listings for Monday — September 11, 1995 had the premium channels listed first, followed by superstations and then sports channels.

Orbit's movie guide was printed on a pinkish-red colored newsprint. The color change made it very easy to find in a hurry. It listed movies alphabetically with the movie stars' names, a brief description about the movie, the *Orbit* exclusive rating for the movie, length of the movie in minutes, the airtime and dates the movie airs, the satellite and transponder, and the movie's rating.

Satellite Entertainment Guide

Satellite Entertainment Guide is another monthly guide published by Vogel Satellite TV Publishing Inc of Alberta, Canada. The September issue was approximately 8 and 1/2 inches in width and 11 inches long and contained about 300 pages. With sixteen full color pages, which included articles about satellite television and programming, the balance of the issue was printed on newsprint. Program listings for prime time each day were displayed in a grid format and called *Prime Time Highlights*. Five (yes, part of Canada is in the Atlantic time zone) separate time bars (Atlantic, Eastern, Central, Mountain and Pacific) were displayed at the top of the page and were divided into half hour time blocks. To use the prime time highlights grid — I followed down the page where the programs were listed by category. Those categories included the networks, superstations and variety stations, the premium channels, sports, unscrambled free channels and adult viewing.

Non prime time programming was listed for each day in chronological order. A time bar listed the times for each zone, example 6:00A, 5:00E, 4:00C, 3:00M, and 2:00P in half hour groups followed by that half hour's programming information. Unlike *Orbit* whose non prime time listings have the satellites listed alphabetically for each half hour, *Satellite Entertainment Guide* chose to list the satellites in orbital position order that each satellite occupies in the sky.

Other sections of the magazine include the *Sports Events* and *Sports Hi-Lights*, which are of particular interest for the sports enthusiast. The *Sports Hi-Lights* listed viewing information for sports by category, including auto racing, major league baseball, and even events such as horse shows, rodeo and rugby. For each sport listed, a calendar by date and time was given listing the specific sporting events, and includes the satellite and transponder numbers.

The center pull out section contains a four page, multi-colored *Video Services* section which was similar to those contained in *OnSat* and *Orbit*. It listed the C-band satellites in a grid showing their transponders and the TV program providers broadcasting on each. Color coding within the grid is used to indicate whether the channel is an unscrambled free service or requires a videocipher II decoder, Oak Orion decoder (which is a scrambling system used in Canada), or scrambled (no decoder is available for the TVRO viewer). It also indicated whether the satellite uses normal or reverse polarity.

A movie guide was also included which listed movies alphabetically along with information such as the movie star's names, a brief description about the movie, a quality rating, the movie length in minutes and the day of the month and time, and satellite/transponder on which the movie will air. A similar section for Pay-Per View movies was also included.

In the limited space available for this column I haven't been able to list all of the features and types of information contained in each of these three fine magazines. (Also, *Satellite Entertainment Guide, OnSat* and *Satellite "Orbit* are not the only games in town.) Other programming guides are published both in print and yes, electronically. Space limitations precludes my reviewing all of these publications.

"Try before you buy" is my motto. Before you commit to a subscription you may wish to contact each of the programming guides that interest you and ask them to mail you a free sample copy (be sure to tell them *Satellite Times* sent you). If you are unable to snag a free copy you may consider purchasing a copy of each at your local newsstand or satellite TV dealer.

In your search for your personal map to the buried treasure of C-band satellite TV programing, my best advice is to test drive each of the programming guides. View first hand their publication and make your own decision as to which guide you like the best. Then sit back in your easy chair and enjoy what's On The Air". ST

Satellite Orbit
CommTek Communications Corporation
8330 Boone Blvd
Suite 600Vienna, VA 22182
Published Monthly
Subscription Information: 800 234-4220
Editorial Line 703 827-0511 x214
Recent advertised subscription price: US$57.00 a Year
Newsstand Price: US$5.95

OnSat
Triple D Publications, Inc.
1300 S. Dekalb Street
Shelby, NC 28152
Published Weekly
Subscription Orders: 800 234-0021
Customer Service: 704 482-8900
Recent Advertised Subscription Price: US$59.95 per year
Newsstand Price: US$2.25

Satellite Entertainment Guide
Vogel Satellite TV Publishing Inc.
1109 TD Tower NW
Edmonton, Alberta T5J 2Z1
Canada
Published Monthly
Subscription orders (US and Canada) 800 661-3203
Other Inquires (403) 424-6222
Recent Advertised Subscription Price: US$52.00 a year
Newsstand Price: US$4.95

LISTENING POST

By Keith Stein

Who's Left on HF?

Now that you have made it this far in the magazine, walk over and have a seat in front of your favorite communications receiver. Are you ready to plug in some satellite frequencies and see what you can hear? Are you ready to listen for the Russian cosmonauts aboard the Mir space station, or how about the U.S. astronauts aboard the space shuttle? Well, hold on a minute, you just can't jump right into things without a little information first.

What are you going to hear? Where should you start? What band should you be in? Does your receiver cover the satellite bands? You have to look at the full spectrum to understand where you are, and where you want to be.

One of the first questions the new satellite monitor must answer is, "What type of satellites can I listen to?" This depends on the frequency range and receiving equipment available to the individual. To give you a better understanding of what satellite frequencies are available, in this issue we'll start our tour by looking at the high frequency (HF) spectrum.

To monitor the HF band you'll need a shortwave (SW) receiver like a Sony ICF-2010, Sangean ATS-818CS, or even better. Next thing to consider would be an external antenna, this is always the better choice. Also, make sure your receiver has a Single sideband (SSB) mode, this is mandatory.

Well, now that you have your receiver specifications, and you just got back from the store after purchasing one, we can look at what space related activity occupies the HF bands.

Satellite activity in the HF spectrum is a lot different than in the early days of Sputnik, Mercury, and Gemini.. There use to be a lot of satellite signals in the shortwave spectrum, but as technology got better frequency usage changed. Most everyone has moved to higher ground, like VHF, UHF, L-band, all the way to SHF (the Super High Frequency band). Is anyone left? Sure there is, lets take a look.

GOES WEFAX Transmissions

As you scan the HF band (between 3-30 MHz) the whole world is literally at your finger tips. Communications from international broadcasting stations, Coast Guard rescue operations, military operations, ship-to-shore traffic, aeronautical communications and other government activity can be heard in the shortwave spectrum.

If you tune across the ship-to-shore band you hear frequencies which have what sounds like a dragging chain. You've might have just stumbled upon the retransmission of weather images from the GOES weather satellite system from one of the many coastal stations that broadcast facsimile weather charts and photos.

The GOES weather satellites are positioned over the earth's equator at a distance of 36,000 km (22,356 miles). The GOES system provides environmental information and imagery for weather forecasters around the world.

To decode these facsimile signals and display these weather images and charts, you'll need a demodulator interface, special computer software, and some extra cable hookups between your PC and shortwave receiver. Previous articles in *ST* have discussed the frame and image format of the GOES WEFAX imagery (see January/February 1995 article *View from Above*). There are plenty of books available that discuss how to receive HF facsimile broadcast. Here are a couple of the best HF frequencies to catch these fax re-transmissions: 3357 and 10865 kHz

Satellite Launch Support Operations

Not only will we cover satellite frequencies in this column, but I'd like to touch on some of the space center support communications like: aircraft radar surveillance, booster recovery ships, control center operations, and much much more. Just about any frequency relating to space, spacecraft or related operations is fair game here in the *Satellite Listening Post*. Here are some frequencies you might want to monitor that are active when spacecraft launch operations are conducted, mode is USB:

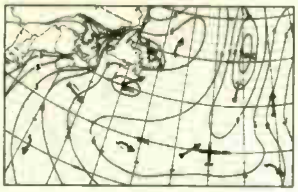
2764	Eastern Test Range Launch Support, Callsigns: DOD Radio, USS Boone, Bear Grass, King 1, King 2, King 3
3029	Western Test Range Launch Support, Callsigns: ARIA 1, ARIA 2, Abnormal 10
3187	Eastern Test Range Launch Support, Callsigns: Cape Radio
4520	Eastern Test Range Launch Support, Callsigns: Fisher, Trackstar, DOD Cape, SOC, USS Boone, King 1 and King 2
5011	Eastern Test Range Launch Support, Callsigns: Cape Radio, USS Boone
5180	Eastern Test Range Launch Support, Callsigns: DOD Cape, USS Boone, King 1 and King 2
5246	Eastern Test Range Launch Support, Callsigns: Fisher and Trackstar
5711	Eastern Test Range Launch Support, Callsigns: DOD Cape, King 1, USS Boone, Fisher, Trackstar, Barricks 21, C1A
6712	NASA SR-71 Blackbird Operations
6889	Western Test Range Launch Support, Callsigns: ARIA 1, ARIA 2, Abnormal 10
7765	Eastern Test Range Launch Support, Callsigns: Clearance 1, DOD Cape.
9023	NASA SR-71 Blackbird Operations
10780	Eastern Test Range Launch Support, Callsigns: King 64, Cape Radio, S4JG, Bear Grass, USS Boone, Antigua Radio, and ARIA 2
11217	NASA SR-71 Blackbird Operations, Callsigns: NASA 2 and NASA 832 (SR-71)

Space Shuttle Air-to-Ground Retransmissions

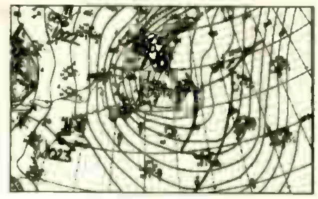
It's not difficult to listen in on the space shuttle air-to-ground communications, thanks to volunteer amateur radio operators around the world. With their dedicated support, we don't need to have large S-band and Ku-band dish antennas in our backyards. Crews aboard the space shuttle communicating with mission control are easily heard by tuning your shortwave receiver to the amateur radio retransmissions of shuttle audio.

Two-way signals between the shuttle and mission control are retransmitted on shortwave frequencies which are listed below. These live retransmissions can be heard over thousands of miles in the HF band. These broadcast originate from the amateur radio club station at the Goddard Space Flight Center, callsign WA3NAN. Here is their list of frequencies used during shuttle missions:

3860 (LSB)	7185 (LSB)	
14295 (USB)	21395 (USB)	28650 (USB)



Typical facsimile weather chart broadcast on shortwave by Canadian Forces station CFH-Halifax, NS. (Courtesy of Jacques d'Avignon)



COSMOS 1861

A group of Russian amateur radio engineers and the Russian government delighted the ham community June 23, 1987 with the launch of Radiosputnik-10 and Radiosputnik-11 (RS-10/11), a combination amateur radio/government navigation spacecraft. Designated Cosmos 1861, the satellite was placed into a 1,000 km (621 mile) high orbit with a period of 105 minutes.

The primary objective of the mission was to help Russian fishing fleets locate themselves in the world's oceans. We'll examine the navigation side of these systems a little closer in the next issue of *Satellite Times*. However, we'll detail the amateur radio side of the spacecraft in this column.

RS-10 downlinks 29.360-29.400 kHz, and 145.860-145.900 MHz.
RS-11 downlinks 29.410-29.450 kHz, and 145.910-145.950 MHz.

RS-11 is currently turned off. If you catch RS-11 activated, we are interested in hearing from you. Be sure to send us your intercepts for our satellite intercept section.

A robot system onboard the spacecraft sends morse code (CW) greetings, signal reports, and contact numbers on its telemetry beacon frequency which has a power output of 5 watts. Here are the best frequencies to catch RS-10 communications: 29357
29360 29370 29380 29390 29400 29403

COSMOS 2123

A second Russian amateur/government navigation satellite was placed in orbit February 5, 1991 designated Cosmos 2123. It carries the RS-12/13 amateur communications package. These spacecraft are open for use by amateurs around the world for two-way amateur communications. RS-12/13 also provides the amateur radio community with the capability to send slow-scan television (SSTV) between users, an option that is not available on its sister spacecraft RS-10/11.

RS-12 downlinks 29.410-29.450 kHz , and 145.910-145.950 MHz.
RS-13 downlinks 29.460-29.500 kHz , and 145.960-146.000 MHz.

RS-13 is currently turned off. Like RS 11 if you hear this package activated, we would love to see your intercept reports in our *Satellite Listening Post* intercept section.

Cosmos 2123 was placed in the same type of orbit as Cosmos 1861. Your best bet for hearing this satellite is on one of the following frequencies:
29408 29410 29420 29430 29440 29450 29454

Radio Rosto

Even a bigger delight for hams and shortwave listeners came at the end of 1994. Radio Rosto was launched by the Russians on a brand new launch vehicle called, Rokot. Launched December 26, 1994, this 155-lb. amateur radio satellite was assembled by the same team that had built and previously launched the RS spacecraft.

Currently in a 1,430-mi-high orbit, this new kid on the block (known as RS-15) can be found on the following frequencies:
29354 29364 29374 29384 29394

This is the first of a four-part series in the *Satellite Listening Post* on the various radio frequencies currently being used by satellites. In the next issue of *ST* (January/February 1996), we will take an in-depth look at satellite frequencies that can be monitored in the Very High Frequency (VHF) spectrum.

That's it for this issue and now it is time to see what you've been hearing at your satellite listening post.

Satellite Listening Post Intercepts

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

ATS	Applied Technology Satellite
CW	Morse Code
deg	degrees
FLTSATCOM	Fleet Satellite Communications
G	Gigahertz
K	Kilohertz
LASE	Lidar Atmospheric Sensing Experiment
M	Megahertz
NFM	Narrowband FM
RSO	Range Safety Officer
USB	Upper Side Band
W	West

K29408	Cosmos 2123 (Russian Amateur Satellite) heard sending CW at 2033, USB transmissions also noted. Transmissions also heard on 29410, and 29420. (Keith Stein-Woodbridge, VA)
M121.950	Navy radar surveillance aircraft heard at 2120 during sounding rocket test launch from Wallops Island, VA, in NFM. NASA 706 (U-2), NASA 427 (C-130), NASA 616 (Learjet) conducting joint water vapor measurement research with Lidar Atmospheric Sensing Experiment (LASE) at 0057 off Virginia eastern shore using NFM .(Stein-Wallops, VA).
M123.400	NASA432 (Fokker-27) radar surveillance aircraft heard at 2120 during Conestoga/Meteor launch countdown at NASA's Wallops Island, VA. Aircraft was providing heading & speed information on vessels in the surrounding waters. Launch was scrubbed one minute thiry-eight seconds before liftoff due to booster problem. Communications noted in NFM. (Stein-Wallops Island, VA).
M135.575	ATS-3 (105 deg W longitude) transmitting voice communications between South Pole and Florida, 0100-0300, NFM. Individuals were talking about a "sun rise party" at the pole. First time they have seen the sun since winter set in. (Matt Merrell-Hallstead, PA)
M156.600	NASA Control heard at 2120 coordinating Coast Guard auxiliary units during Conestoga/Meteor launch countdown in NFM. (Stein-Wallops Island, VA)
M164.700	Range Safety Officer net heard at 2120 during Conestoga/Meteor launch countdown in NFM. (Stein-Wallops Island, VA).
M170.350	NASA Wallops Island Security heard at 2120 during Conestoga/Meteor launch countdown in NFM. (Stein-Wallops Island, VA)
M170.400	NASA Wallops Island Paging System heard at 2120 during Conestoga/Meteor launch countdown in NFM. (Stein-Woodbridge, VA)
M171.000	Wallops Island Security Net (Wallops 9, and Wallops 33) heard at 2120 during Conestoga/Meteor launch countdown in NFM. (Stein-Wallops Island, VA)
M268.450	FLTSATCOM channel, Charlie bandplan. Heard a telephone conversation in what appeared to be Spanish at 0100 in NFM. (Merrell-PA)
M328.250	Downlink data noted here from a polar orbiter with a 90+ minute orbital period. The only bird that fits this frequency/orbital profile is the U.S. Navy TEX (Transceiver Experiment) satellite. Well worth watching this frequency for activity. (Larry Van Horn-Brasstown, NC)
M400.075	Unidentified satellite transmission at 2230 in NFM. (Stein-Woodbridge, VA)
G3.7375	TELECOM 2B (5 deg. W longitude) transmitting video of pre-launch countdown for Ariane/Telstar 402R launch at 2245. Launch was scrubbed due to third stage telemetry problem (Curt Swinehart-East Kingston, NH).

Keith Stein is a freelance writer based in Woodbridge, Va. You can contact him through his Internet World Wide Web home page (http://www.newspace.com/publications/LaunchReport/LaunchReport or at his e-mail address: us011192@pop3.interramp.com. 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 frequencies in MHz, All satellites/transponders are C-band unless otherwise indicated. DS=Discrete Stereo, N=Narrowband, W=Wideband

CLASSICAL

Classical music	E1, 9	6.32 (N)
Classical music	E2, 22	6.30
KUCV-FM (90.9) Lincoln, Neb. (Nebraska Pub. Radio)	S3, 2/4	5.76/5.94 (DS)
SuperAudio — Classical Collections	G5, 21	6.30/6.48 (DS)
WFMT-FM (98.7) Chicago, Ill.	G5, 7	6.30/6.48 (DS)
WQXR-FM (96.3) New York, N.Y., ID-*96.3 FM*	C4, 15	6.30/6.48 (DS)

SATELLITE COMPUTER SERVICES

Planet Connect, Planet Systems, Inc 19.2 kbps serv.	G4, 6	7.398
Planet Connect, Planet Systems, Inc 100 kbps serv.	G1, 9	7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
	G1, 14	7.265
	G4, 6	7.264
Storyvision	G5, 3	7.30
Superguide	G5, 7	5.48

CONTEMPORARY

Adult contemporary, unidenified station	E1, 9	7.58
Safeway In-Store Radio — contemporary	S3, 18	5.78, 5.96, **6.48**
SuperAudio — *Light and Lively Rock*	G5, 21	5.96, 6.12 **(DS)**
VOCM-AM (590) St. Johns, Newfoundland Canada — adult contemporary	E1, 12	6.20 (W)
	E1, 14	6.80

COUNTRY

CINC-FM (96.3) Thompson, Manitoba	E1, 2	6.40
CHON-FM (98.1) Whitehorse, Yukon	E1, 12	5.41
Safeway In-Store Radio — country	S3, 18	6.12
SuperAudio — *American Country Favorites*	G5, 21	5.04/7.74 (DS)
Transtar III radio network	S3, 9	5.76/5.94 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, Tenn., ID-*The Hit Kicker*	E2, 18	6.20
WSM-AM (650) Nashville, Tenn.	G5, 18	7.38, 7.56
WSM-FM (95.5) Nashville, Tenn.	C4, 24	7.38, 7.56

EASY LISTENING

Easy listening music, unidentified station	G4, 6	6,20,7.69
Horizon — background music	E1, 6	7.62 (N)
Safeway In-Store Radio — easy listening	S3, 18	6.32, 7.22, 7.40
SuperAudio — *Soft Sounds*	G5, 21	5.58/5.76 (DS)
United Video — easy listening	C4, 8	5.895 (N)

FOREIGN LANGUAGE

CBC Radio-East (French)	E1, 20	5.38/5.58 (DS)
	E1, 20	7.36
CHIN-AM/FM (1540/100.7) Toronto, Ontario Canada, D-*Chin* — multilingual	E1, 2	7.89
CITE-FM (107.3) Montreal, Quebec Canada (French) — soft adult contemporary	E1, 21(Ku-band)	6.12, 6.20
CKAC-AM (730) Montreal, Quebec Canada (French) — adult contemporary	E1, 21(Ku-band)	6.43, 6.55
Cosmos FM, Hellenic Public Radio, New York, N.Y. (Greek)	S2, 11	8.30
DZMM-Radyo Patrol (from Philippines)	G4, 24 (Ku-band)	6.80
French language audio service	E1, 15	6.12
French language audio service	E2, 21	6.46 (N)
India ethnic radio	E1, 2	7.61
Indian Sangeet Sager	E1, 15(Ku-band)	6.12
Irish music (Sat 1430-0000 UTC)	S3, 3	6.20
Northern Native Radio (Ethnic)	E1, 26 (Ku-bd.)	6.43/6.53 (DS)
RAI Satelradio (Italian)	C1, 15	7.38
Radio Canada (French)	E1, 15	5.40/5.58 (DS), 5.76
Radio Dubai (Arabic)	G7, 10	7.48
Radio Energie	E1, 24(Ku-bd.)	6.12/6.30 (DS)
Radio Maria (Italian-Religious programming)	G7, 10	5.80
	T2, 9	8.00
Radio Sedeye Iran (Farsi)	S3, 15	6.20 (N)
Radio Sonora-Mexico (Spanish)	SD1, 6	6.80
Radio Tropical (Haitian Creole)	S2, 11	7.60
Religious music (unid language)	G7, 10	8.03
Russian-American radio network	SBS5, 14 (Ku)	6.20
The Clanny Channel (Spanish) — Anti-Castro Cuban clandestine programming-occasional audio	S2, 4	5.80
The Weather Network-Canada (French)	E1, 9	5.94
Trinity Broadcasting radio service (Spanish) SAP — religious	G5, 3	5.96
WCMQ-FM (92.3) Hialeah, Fla. (Spanish), ID-*Mega 92* — contemporary hit radio	S2, 4	7.74, 7.92
WCRP-FM 88.1, Guyama, P.R. (Spanish) — religious	G4, 6	6.53
WLIR-AM (1300) Spring Valley, N.Y. (Ethnic)	S2, 1	7.60
WNTL-AM (1030) Indian Head, Md./Arab Network of America radio network (Arabic)	G6, 10	5.80
WNWK-FM (105.9) Newark, N.J.(Ethnic)	S2, 11	8.30
XEW-AM (900) Mexico City, Mexico (Spanish), ID-*LV de la America Latina*	M2, 8	6.80
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
XEX-AM (730) Mexico City, Mexico (Spanish), ID-*Frecuencia Libre*	M2, 14	6.80

JAZZ

KLON-FM (88.1) Long Beach, Calif., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio — *New Age of Jazz*	G5, 21	7.38/7.56 (DS)
WQCD-FM (101.9) New York City, N.Y., ID-*CD 101.9, Cool FM*	C4, 6	6.20

Satellite Radio Guide

NEWS AND INFORMATION

Arkansas Radio Network	G4, 6	6.20
Business Radio Network	C4, 10	8.06 (N)
Cable Radio Network	C3, 23	7.24 (N)
CNN Headline News	G5, 22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
O.J. Radio Network (trial hours only)	G5, 5	6.30
	G5, 22	7.58
USA Radio Network — news, talk and information	S3, 13	5.01 (Ch 1), 5.20 (Ch 2)
WCBS-AM (880) New York, N.Y. — news	G7, 19	7.38
WCCO-AM (830) Minneapolis, Minn.	G6, 15	6.20
WGN-AM (720) Chicago, Ill./Interstate Radio Network (overnight) — talk	E1, 2	5.22

RELIGIOUS

Ambassasor Inspirational Radio	S3, 15	5.96, 6.48 (DS)
American Spirit Network/KYND-AM (1520) Houston, Tex. - Religious/variety (weekends)	S3, 24	7.40
Brother Staire Radio	G5, 6	6.48
CBN Radio Network/Standard News	G5, 11	6.12
	C3, 1	6.20
Heaven Radio Network	G1, 17	7.92
KILA-FM (90.5) Las Vegas, Nev. — SOS radio network	C4, 8	7.38/7.56 (DS)
	G5, 7	5.58/6.12 (DS)
Salem Radio Network	S3, 17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WCIE-FM (91.1) Lakeland, Fla.	S2, 21	6.20,7.60
WHME-FM (103.1) South Bend, Ind, ID-*Harvest FM*	G4, 15	5.58/5.78
WROL-AM (950) Boston, Mass. (occasional Spanish)	S3, 3	6.20
Z-music — Christian rock	G1, 6	7.38/7.56

ROCK

CHOZ-FM (94.7) St. John's, Newfoundland Canada, ID-*Oz FM*	E2, 20	5.76/5.96 (DS)
CILQ-FM (107.1) Toronto, Ontario Canada, ID-*Q-107*	E1, 2	5.76/5.94 (DS)
Safeway In-Store — oldies	S3, 18	5.20, 5.40, 7.58
Seltech Radio Syndicated service — classic rock	E1, 2	5.40/5.58 (DS)
SuperAudio — *Classic Hits* - oldies	G5, 21	8.10/8.30 (DS)
SuperAudio — *Prime Demo* - mellow rock	G5, 21	5.22/5.40 (DS)

SPECIALITY FORMATS

Aries In Touch Reading Service	C5, 24	6.48
	C4,10	7.87
Colorado Talking Book Network	C1, 2	5.58
C-SPAN I ASAP (program schedule)	C3, 7	5.58
C-SPAN II ASAP (program schedule)	C4, 19	5.58
Georgia Radio Reading Service	T401, 14 (Ku)	5.76
Nebraska Talking Book Network	S3, 4	6.48
Starsound Gold Radio Network	S3, 24	5.80
SuperAudio — Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
The Weather Channel-USA — occasional audio	C3, 13	6.80
The Weather Channel-USA — classical music	C3, 13	7.78
The Weather Network-Canada (English)	E1, 9	5.41, 5.58, 5.76, 6.80, 7.78
Voice Print Reading Service	E1, 16	7.44 (N)
Yesterday USA — nostalgia radio	G5, 7	6.80
	T2, 12	5.80

TALK

AEN Michael Reagan (0100-0700 UTC)	C3, 1	6.20
Burlington Broadcast Network	G2, 14	7.56
For the People radio network — (Chuck Harder) talk and information	C1, 2	7.50
Mutual Broadcasting Network — talk show feeds	E1, 2	7.54
One on One Sports radio network — sports talk	E1, 2	7.45
Prime Sports Radio — sports talk and info.	C1, 10	7.20
	S3, 24	7.78
Sun Radio Network — talk programs (Tom Valentine 9p-12a ET)	C1, 15	7.58
Talk America — talk programs	S3, 9	6.80
Talk Radio Network — talk programs	C1, 5	5.80
Tech Talk Network	T2, 21	5.80

(Note: TTR Network will follow Skyvision Channel video uplink to G7 or other occasional video spots in the arc that Skyvision will use in the future)

USA Patriot Radio Network	G6, 14	5.80

VARIETY

American Urban Radio — news/features/sports	S3, 9	6.30/6.48 (DS)
CBC Radio (English)	E1, 16	5.40/7.58, 5.58
CBC Radio (occasional audio)	E1, 20	5.78
CBC-FM Atlantic (English)	E1, 16	6.12/6.30 (DS)
CBC-FM Eastern (English)	E1, 16	5.76/5.94 (DS)
CBM-AM (940) Montreal, Quebec Canada — variety/fine arts	E1, 20	6.12
CBU-AM (690) Vancouver, British Columbia Canada	E1, 10	7.42
CBU-FM (105.7) Vancouver, British Columbia Canada	E1, 10	5.76/5.94 (DS)
CFR-FM	E2, 19 (Ku-band)	6.12/6.30
CJRT-FM (91.1) Toronto, Ontario Canada — fine arts/jazz-nights	E1, 26 (Ku-band)	5.76/5.94 (DS)
CKLB-FM (101.9) Yellowknife, NWT Canada — country/ethnic	E1, 14	5.41
KBVA-FM (106.5) Bella Vista, Ark., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSKA-FM (91.1) Anchorage, Alaska — variety/fine arts	C5, 24	7.38/7.56 (DS)
KSL-AM (1160) Salt Lake City, Utah — news/talk/country-overnight	C1, 6	5.58
Peach State Public Radio (Georgia PBS)	T401, 14 (Ku)	5.40/5.58 (DS)
WUSF-FM (89.7) Tampa-St. Petersburg, Fl. (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

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

Spacenet 2 Transponder 12-Vertical (C-band)

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

Galaxy 6 Transponder 3-Horizontal (C-band)

1405.60 (54.4)	KIRO-AM (710) Seattle, Wash — news, talk, and sports talk radio/Seattle Seahawks NFL radio network
1405.40 (54.6)	Sports Byline USA/Sports Byline Weekend
1404.60 (55.6)	Talk America radio network
1404.00 (56.0)	Occasional audio
1403.80 (56.2)	Occasional audio/Free Enterprise radio network/University of Wisconsin college sports/Green Bay Packers NFL radio network
1403.20 (56.8)	Motor Racing Network (occasional audio)
1400.80 (59.2)	WBAL-AM (1090) Baltimore, Md
1398.30 (61.7)	WGN-AM (720) Chicago, Ill — talk radio/ Chicago Bears NFL radio network
1397.20 (62.8)	WTMJ-AM (620) Milwaukee, Wis — talk radio/Green Bay Packers NFL radio network/ Univ. of Wisconsin college sports
1394.70 (65.3)	Sun Radio Network
1394.50 (65.5)	WSB-AM (750) Atlanta, Ga. — news and talk/Univ. of Georgia college sports
1393.40 (66.6)	WGN-AM (720) Chicago, Ill — talk radio/ Chicago Bears NFL radio network/Interstate Radio Network/Other occasional audio
1393.20 (66.8)	Wisconsin Radio Network/Illinois radio network/Tribune radio networks
1393.00 (67.0)	USA Radio Network/WCXL-FM (104.1) Kill Devil Hills, NC — adult contemporary, ID - *Beach 104*
1392.70 (67.3)	WGN-AM (720) Chicago, Ill — talk radio/ Chicago Bears NFL radio network/Interstate Radio Network
1391.60 (68.4)	XEPRS-AM (1090) Tijuana, Mexico — Spanish language programming, ID - *Radio Express*
1390.60 (69.4)	Occasional audio
1390.40 (69.6)	Occasional audio
1389.70 (70.3)	Occasional audio/data transmissions (burst)
1389.50 (70.5)	Data transmissions (burst)
1388.90 (71.1)	Occasional audio
1387.50 (72.5)	KWKW-AM (1330) Los Angeles, Calif — Spanish language programming, ID - *Radio Lobo*/Spanish Information Service
1387.00 (73.0)	Michigan News Network/Univ. of Michigan college sports
1386.70 (73.3)	Michigan News Network/Detroit Lions NFL radio network
1386.50 (73.5)	WJR-AM (760) Detroit, Mich — talk radio
1386.30 (73.7)	Illinois News Network
1385.80 (74.2)	WMAQ-AM (670) Chicago, Ill — news
1385.10 (74.9)	For the People radio network
1384.20 (75.8)	KMPC-AM (710) Los Angeles, Calif — talk radio
1383.80 (76.2)	KJR-AM (950) Seattle, Wash — sports talk radio/Washington State college sports
1383.40 (76.6)	KFRC-AM (610) San Francisco, Calif. — adult pop music
1383.20 (76.8)	KDKA-AM (1020) Pittsburgh, Penn. — talk radio
1376.70 (83.3)	Occasional audio
1375.40 (84.6)	USA Radio Network
1374.10 (85.9)	Northwest Direct — news and talk/Oregon State college sports

Satcom K2 Transponder 2-Vertical (Ku-band)

1010.60	Foreign language audio service identifying as *Radio Tejan*

Satcom K1 Transponder 12-Vertical (Ku-band)

1313.10	Customized IGA spots

Spacenet 3 Transponder 1-Horizontal (C-band)

1437.20 (62.8)	Associated Press (AP) 3 radio network
1435.00 (65.0)	Associated Press (AP) 2 radio network
1433.40 (66.6)	Associated Press (AP) 1 radio network

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
1206.55 (53.45)	ABC Satellite Music Network — adult contemporary *Starstation*
1206.30 (53.7)	ABC Satellite Music Network — adult contemporary *Starstation*
1206.00 (54.0)	ABC Satellite Music Network — modern country *Country Coast-to-Coast*
1205.85 (54.15)	ABC Satellite Music Network — modern country *Country Coast-to-Coast*
1205.65 (54.35)	ABC Satellite Music Network — traditional music format *Stardust*
1205.40 (54.6)	ABC Satellite Music Network — traditional music format, *Stardust*
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
1202.25 (57.75)	ABC Satellite Music Network — golden oldies format *Pure Gold*
1202.10 (57.9)	ABC Satellite Music Network — golden oldies format *Pure Gold*
1201.90 (58.1)	Occasional audio
1201.70 (58.3)	ABC Satellite Music Network — modern rock *The Heat*
1201.50 (58.5)	Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious
1201.30 (58.7)	Wisconsin Voice of Christian Youth (VCY) America Radio Network — religious

Spacenet 3 Transponder 17-Horizontal (C-band)

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

Galaxy 4 Transponder 1-Horizontal (C-band)

1445.00 (55.0)	WPGC-FM (95.5) Morningside, Md. — R&B format
1444.45 (55.55)	Data transmissions
1443.80 (56.2)	Voice of Free China (ISWBC) Taipei, Taiwan
1443.60 (56.4)	WYFR (ISWBC) Oakland, Calif. — religious programming and talk, ID - *Family Radio Network*
1443.40 (56.6)	Voice of Free China (ISWBC) Taipei, Taiwan
1438.30 (61.7)	WWRV-AM (1330) New York, N.Y. — Spanish religious programming and music, ID - *Radio Vision Christiana de Internacional*
1436.50 (63.5)	Radio Labio, Los Angeles, Calif — spanish talk radio
1436.30 (63.7)	KOJY-AM (540) Costa Mesa, Calif/KJQI-AM (1260) Beverly Hills, Calif — nostalgia
1436.00 (64.0)	KUSC-FM (91.5) Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1435.70 (64.3)	KUSC-FM (91.5) Los Angeles, Calif — fine arts, National Public Radio (NPR) affiliate
1435.20 (64.8)	National Public Radio (NPR) feeds
1429.00 (71.0)	Occasional audio

Galaxy 4 Transponder 2-Vertical (C-band)

1402.60 (77.4)	WVAQ-FM (101.9) Morgantown, W Va — West Virginia Metro News
1402.00 (78.0)	WVAQ-FM (101.9) Morgantown, W Va — West Virginia Metro News/West Virginia college sports
1399.00 (81.0)	Oklahoma News Network/Texas A&M college sports/Univ. of Oklahoma college sports
1398.80 (81.2)	Progressive Farmers Network
1398.20 (81.8)	Occasional audio/Texas A&M college sports/
1398.00 (82.0)	Oklahoma News Network
1397.20 (82.8)	Oklahoma News Network/Univ. of Oklahoma college sports

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0)	Mutual Broadcasting System/Georgia Southern college sports/Atlanta Falcons NFL radio network
1404.80 (55.2)	KOA-AM (850)/KTLK-AM (760) Denver, Colo — news and talk/Denver Broncos NFL radio network/Univ. of Colorado college sports
1404.60 (55.4)	Occasional audio/ABC Direction Network
1404.40 (55.6)	Tennessee Radio Network/Univ. of Tennessee college sports
1404.00 (56.0)	South Carolina Radio Network/South Carolina State college sports
1403.50 (56.5)	International Broadcasting Network — Lutheran religious programming/Home Front program (Sat 10a-2p Eastern Time)
1403.00 (57.0)	Minnesota Public Radio Network
1402.40 (57.6)	KNOW-FM (95.3) St. Paul, Minn — fine arts, Minnesota Public Radio (occasional audio)
1402.10 (57.9)	KNOW-FM (95.3) St. Paul, Minn — fine arts, Minnesota Public Radio
1401.80 (58.2)	BBC World Service (ISWBC)
1398.00 (62.0)	Tennessee Radio Network/Vanderbilt college sports
1397.50 (62.5)	Minnesota Talking Book network
1397.10 (62.9)	WORD-AM (910) Spartanburg, SC — news/talk/Clemson college sports
1396.90 (63.1)	Spanish Information Service (SIS) radio network (Spanish)
1396.70 (63.3)	Tennessee Radio Network
1396.40 (63.4)	Georgia Network News
1396.20 (63.8)	WCNN-AM (680) Atlanta, GA — all sports talk radio/Georgia Tech college sports
1396.00 (64.0)	WHO-AM (1040) Des Moines, Iowa — talk/ Iowa News Network/Iowa college sports
1395.80 (64.2)	Kentucky News Network/Univ. of Kentucky college sports
1395.50 (64.5)	American Public Radio (APR) - Monitor Radio programming
1395.10 (64.9)	National Public Radio (NPR) channel 12
1394.60 (65.4)	WHAS-AM (840) Louisville, Ky — adult contemporary music/Univ of Louisville sports radio network
1394.40 (65.6)	National Public Radio (NPR) channel 11
1394.00 (66.0)	National Public Radio (NPR) channel 10/ American Public Radio (APR) carrying Monitor Radio programming
1393.50 (66.5)	Univ. of Georgia college sports
1392.90 (67.1)	Occasional audio
1392.60 (67.4)	National Public Radio (NPR) channel 9/ American Public Radio (APR)
1392.30 (67.7)	National Public Radio (NPR) channel 8
1392.00 (68.0)	Minnesota Public Radio
1391.70 (68.3)	National Public Radio (NPR) channel 7
1388.90 (71.1)	Data transmissions (burst)
1388.40 (71.6)	KSJV-FM (91.5) Fresno, Calif — spanish programming, ID - *Radio Bilingue* (network serves Spanish stations in several western states)
1388.10 (71.9)	National Public Radio (NPR) channel 6

Single Channel Per Carrier (SCPC) Services Guide

1387.80 (72.2)	Data transmissions (constant)
1387.50 (72.5)	National Public Radio (NPR) channel 5
1387.20 (72.8)	National Public Radio (NPR) channel 4
1386.80 (73.2)	National Public Radio (NPR) feeds
1386.20 (73.8)	KSJV-FM (91.5) Fresno, Calif — Spanish programming, ID - *Radio Bilingue* (network serves Spanish stations in several western states)
1385.80 (74.2)	National Public Radio (NPR) channel 3
1385.40 (74.6)	U.S. Naval Observatory Master Clock and National Public Radio (NPR) channel 2
1385.10 (74.9)	National Public Radio (NPR) Special Events Channel
1384.70 (75.3)	National Public Radio (NPR) channel 1
1384.40 (75.6)	KOA-AM (850)/KTLK-AM (760) Denver, Colo — news and talk/Denver Broncos NFL radio network/Univ. of Colorado college sports
1384.20 (75.8)	WSB-AM (750) Atlanta, Ga. — news and talk/Univ. of Georgia college sports
1383.70 (76.3)	Minnesota Network News (MNN)/Midwest Radio Sports
1383.10 (76.9)	VSA Radio Network — Ag news
1382.90 (77.1)	Minnesota News Network (MNN)/Minnesota Vikings NFL radio network
1382.60 (77.4)	Soldiers Radio Satellite (SRS) network — U.S. Army information and entertainment/ Army college sports
1382.30 (77.7)	Motor Racing Network (occasional audio)
1382.00 (78.0)	WFAE-FM (90.7) Charlotte, N.C. — NPR affiliate/Univ. of South Carolina college sports
1381.80 (78.2)	WHO-AM (1040) Des Moines, Iowa — talk radio/Iowa News Network/Iowa college sports
1381.60 (78.4)	Alabama Radio Network/Univ of Alabama-Birmingham college sports
1381.40 (78.6)	Various talk shows (No network ID)
1377.40 (82.6)	Data transmission (packet burst/tones)
1377.10 (82.9)	In-Touch — reading service for blind
1376.00 (84.0)	Kansas Audio Reader Network

Galaxy 4 Transponder 4-Vertical (C-band)

1387.50 (52.5)	Dakota Sports network/Dakota News network
1381.80 (58.2)	Data transmissions
1379.00 (61.0)	Louisiana Network/Louisiana Ag Network/ New Orleans Saints NFL radio network
1378.80 (61.2)	WLAC-AM (1510) Nashville, Tenn. — news and talk/Road Gang truck driver radio network (overnight)/Louisiana State Univ. college sports
1378.60 (61.4)	Arkansas Radio Network/Univ. of Arkansas college sports
1378.10 (61.9)	Data transmissions
1377.50 (62.5)	Mid-America News Network/Mid-America Ag Network
1377.30 (62.7)	WLAC-AM (1510) Nashville, Tenn. — news and talk/Road Gang turck driver radio network (overnight)/Univ. of Tennessee college sports
1376.00 (64.0)	Data transmissions
1375.60 (64.4)	KISN-AM (570) Salt Lake City, Utah — sports talk

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1)	WCRP-FM (88.1) Guayama, P.R. — religous/educational (Spanish)

Galaxy 4 Transponder 1-Horizontal (Ku-band)

959.20	ABC Satellite Music Network — country and western *Real Country*
959.00	ABC Satellite Music Network — country and western *Real Country*
957.50	Russian-American Radio Network — Russian language audio service

Anik E2 Transponder 19-Horizontal (C-band)

1086.00 (54.0)	TV Northen Canada network program audio

Anik E1 Transponder 11-Horizontal (C-band)

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

Anik E1 Transponder 12-Vertical (C-band)

1226.00 (54.0)	CKRW-FM (90.5) Whitehorse, Yukon Territory, Canada — adult contemporary music
1225.50 (54.5)	CHON-FM (90.5) Whitehorse, Yukon Territory, Canada — variety

Anik E1 Transponder 13-Horizontal (C-band)

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

Anik E1 Transponder 14-Vertical (C-band)

1185.50 (54.5)	CKLB-FM (101.9) Yellowknife, NWT Canada — country music

Anik E1 Transponder 15-Horizontal (C-band)

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

Anik E1 Transponder 17-Horizontal (C-band)

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

Anik E1 Transponder 19-Horizontal (C-band)

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

Anik E1 Transponder 21-Horizontal (C-band)

1024.30 (75.7)	Canadian weather conditions and warnings
Note:	This transponder also has 62 other carriers consisting of data transmissions and six blank audio carriers.

SBS5 Transponder 2-Horizontal (Ku-band)

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

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2)	RFD Radio Service
1404.60 (55.4)	Wyoming News Network/Univ of Wyoming sports radio network
1400.60 (59.4)	Indiana Radio Network
1400.40 (59.6)	Missouri Net/St. Louis Rams NFL radio network
1400.20 (59.8)	Occasional audio
1400.00 (60.0)	Indiana Radio Network/Purdue college sports
1396.60 (63.4)	Kansas Information Network/Kansas Agnet/ Kansas State college sports
1396.40 (63.6)	Nebraska Ag Network/Univ of Nebraska college sports/S.W. Missouri State college sports
1396.20 (63.8)	Missouri Network/Univ. of Illinois college sports
1396.00 (64.0)	Occasional audio
1395.70 (64.3)	Missouri Net/WIBW-AM (580) Topeka, Kan — news and talk
1387.30 (72.7)	WPTF-AM (680) Raleigh, N.C. — news and talk/North Carolina News Network
1386.40 (73.6)	ABC Direction Network/Brownfield Network/ Occasional audio/Univ. of Kansas college sports/Kansas City Chiefs NFL radio network
1386.20 (73.8)	Radio Iowa
1386.00 (74.0)	People's Radio Network
1384.60 (75.4)	North Carolina News Network/Capitol Sports Network
1384.40 (75.6)	Capitol Sports Network/Univ of Duke college sports
1384.20 (75.8)	Capitol Sports Network/East Carolina college sports
1384.00 (76.0)	Occasional audio/ABC Direction Network
1383.80 (76.2)	Occasional audio
1383.60 (76.4)	WPTR-AM (1540) Albany, N.Y. — talk radio/Univ. of Albany college sports/New York Jets NFL radio network
1383.40 (76.6)	Capitol Sports Network/Univ. of North Carolina college sports/Carolina Panthers NFL radio network
1382.90 (77.1)	Missouri Network/Univ. of Missouri college sports
1382.60 (77.4)	North Carolina News Network
1382.30 (77.7)	Virginia News Network/Univ. of Virginia college sports
1378.70 (81.3)	Radio Pennsylvania Network/Philadelphia Eagles NFL radio network
1378.50 (81.5)	Radio Pennsylvania Network
1378.30 (81.7)	Radio Pennsylvania Network
1374.60 (85.4)	Iowa State college sports

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 — *Original Hits*
1042.60 (57.4)	Unistar Music Radio — *Original Hits*
1042.40 (57.6)	Unistar Music Radio — *Good Times and Great Oldies*
1042.20 (57.8)	Data transmissions
1042.00 (58.0)	Unistar Music Radio — *Good Times and Great Oldies*
1041.80 (58.2)	CNN Radio Network
1034.80 (65.2)	Unistar Music Radio — *Country and Western*
1034.60 (65.4)	Unistar Music Radio — *Country and Western*
1034.40 (65.6)	Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*
1034.20 (65.8)	Data transmissions
1034.00 (66.0)	Unistar Music Radio — *Hits from 60s, 70s, 80s, and Today*
1033.70 (66.3)	Occasional audio
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*
1029.00 (71.0)	Occasional audio

International Shortwave Broadcasters via Satellite

By Larry Van Horn and Robert Smathers

AFRICA NO. 1

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

ARAB REPUBLIC OF EGYPT RADIO

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

ARMED FORCES RADIO & TELEVISION SERVICE (AFRTS)

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

BRITISH BROADCASTING CORPORATION (BBC)

Bush House, London, WC2. Telephone: +44 171 240 3456 (voice), +44 171 240 8760 (fax)
English BBC World Service transmissions can be found on the following satellites: Astra 1B (19.2 east) 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.

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

C-SPAN Audio 2

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

DEUTSCHE WELLE (DW)

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

ISLAMIC REPUBLIC OF IRAN BROADCASTING (IRIB)

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

ISRAEL RADIO

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

LA VOIX DU ZAIRE

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

RADIO ALGIERS INTERNATIONAL

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

RADIO AUSTRALIA

GPO Box 428G, Melbourne, Vic. 3001, Australia. Telephone: +61 3 616 1800 (voice), +61 3 626 1899 (fax)
Palapa B2P (133.0 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)
Eutelsat II F3 (16.0 east) Tr 33 (11596 MHz H) 7.02 MHz audio from 2300-0330 UTC

RADIO EXTERIOR DE ESPANA (REE)

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

RADIO FRANCE INTERNATIONAL (RFI)

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

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 +31-35-724211 (voice), +31-35-724352 (fax)
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-105 10 Stockholm, Sweden.. Telephone: +46 8 6676283 (voice), +46 8 6676283 (fax).
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 F2 (10.0 east) Tr 26B (11095 MHz V) 7.56 MHz audio. This is a feed to the BBC Atlantic relay station on Ascension Island. Satcom C1 (137.0 west) Tr 15 (4000 MHz V) 7.38 MHz audio.

International Shortwave Broadcasters via Satellite

RADIO VLAANDEREN INTERNATIONAL

P.O. Box 26, B-1000, Brussels, Belgium. Telephone: +32 2 741 3802 (voice), +32 2 732 6295 (fax)
Astra 1C (19.2 east) 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, Telstar 302 (85 west) Tr 5 (3880 MHz V) 8.00 MHz audio to North America.

SWISS RADIO INTERNATIONAL

Casa Postale, CH-3000 Bern 15, Switzerland. Telephone: +41 31 439222 (voice), +41 31 439544 (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 F1 (13.0 east) Tr 26 (11080 MHz V) 7.74 MHz. audio, Intelsat K (21.5 west) Tr 7 (11605 MHz H) 8.10 MHz audio, Satcom C4/F4 (135.0 west) Tr 5 (3800 MHz V) 8.10 MHz audio.

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 II F1 (13.0 east) Tr 32 (11554 MHz H) 7.74 MHz audio. Reports at presstime indicate that Vatican Radio will be downlinking on two Intelsat C-band birds (34.5 wesr and 66 east) by the fourth quarter of 1995.

VOICE OF AMERICA (U. S. Information Agency)

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

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

NTSC system baseband subcarrier frequencies

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

PAL system baseband subcarrier frequencies

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

VOICE OF THE ARABS

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

VOICE OF SAHEL

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

VOICE OF THE IRAQI PEOPLE (CLANDESTINE)

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

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

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

WORLD RADIO NETWORK

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

North American Service Schedule

Galaxy 5 (125.0 west) Tr 6 (3820 MHz V) 6.80 MHz audio. All broadcasts are daily unless otherwise indicated. WRN program information can be heard daily on North American service at 1025 and 1725 UTC. * indicates program also carried by C-SPAN 1 audio service Monday-Friday. + indicates program also carried by C-SPAN 1 audio service Saturday-Sunday.

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

European Service Schedule

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

YLE RADIO FINLAND

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

DBS/Primestar Channel Guide

By Robert Smathers

DirecTV™ Channel Guide

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

100	DirecTV Previews	Previews
102-190	Direct Ticket Pay Per View	PPV
200	Previews	Previews
201	Special Events Calendar	Promo
202	CNN	News
203	Court TV	Speciality
204	CNN Headline News	News
206	ESPN 1	Sports
207	ESPN Alternate	Sports
208	ESPN 2	Sports
212	TNT	TV programming
213	Home Shopping Network	Home Shopping
214	Home and Garden TV	Home Improvement
215	E! Entertainment TV	Speciality
216	MuchMusic	Music Videos
217	Black Entertainment TV (BET)	Entertainment
219	American Movie Classics (AMC)	Movies
220	Turner Classic Movies (TCM)	Movies
222	The History Channel	History
223	The Disney Channel (East)	Movies/Kids
224	The Disney Channel (West)	Movies/Kids
225	The Discovery Channel	Science/TV documentary
226	The Learning Channel (TLC)	Science/TV documentary
227	Cartoon Network	Cartoons
229	USA Network	TV
230	Trio	TV
232	The Family Channel	TV
233	WTBS-Ind, Atlanta, Ga.(TBS)	Superstation
235	The Nashville Network (TNN)	Country/Outdoors
236	Country Music TV (CMT)	Country Music Videos
240	The Sci-Fi Channel	Science Fiction
242	C-Span 1	Congress-House
243	C-Span 2	Congress-Senate
245	Bloomberg Direct	News
246	CNBC	Financial/Talk
247	America's Talking	Talk
248	The Weather Channel (TWC)	Weather
250	Newsworld International	News
252	CNN International	News
254	The Travel Channel (TTC)	Travel Shows
256	Arts & Entertainment	TV
258	Bravo	Arts
266	Independent Film Channel	Movies
268	Previews	Previews
269	STARZ! - West	Movies
270	STARZ!	Movies
271	Encore	Movies
272	Encore-Love	Movies
273	Encore-Westerns	Movies
274	Encore-Mystery	Movies
275	Encore-Action	Movies
276	Encore-True Stories	Movies
277	Encore-WAM!	Movies
278	Encore	Movies
282	WRAL-CBS, Raleigh, N.C.	Network TV
284	WXIA-NBC, Atlanta, Ga.	Network TV
286	PBS	Network TV
287	WABC-ABC, New York, N.Y.	Network TV
289	WFLG-FOX, Chicago, Ill.	Network TV
297	Information Channel	Promos
298	TV Asia	Ethnic Programming
299	In-store dealer info channel	Retailers only
300-399	Regional and PPV Sports	Sports
301	Special Events Calendar	Promo
302	Sunday Ticket 95 Promo/World League of American Football	Sports
304	The Golf Channel	Sports
305	SportsChannel New England	Sports
306	Madison Square Garden	Sports
307	New England Sports Network	Sports
308	SportsChannel New York	Sports
309	SportsChannel Philadelphia	Sports
310	Prime Sports KBL	Sports
311	Home Team Sports (HTS)	Sports
312	SportsSouth	Sports
314	Sunshine	Sports
316	Pro AM Sports (PASS)	Sports
317	SportsChannel Ohio	Sports
318	SportsChannel Cincinnati	Sports
319	SportsChannel Chicago	Sports
320	Midwest SportsChannel	Sports
322	Prime Sports Southwest	Sports
323	Prime Sports Midwest/Upper Midwest/ Rocky Mountain/Intermountain West	Sports
324	Prime Sports Northwest	Sports
325	Prime Sports West	Sports
326	SportsChannel Pacific	Sports
328	Newsport	Sports
330-348	NFL Sunday Ticket	Sports
350	NFL Sunday Ticket/NBA League Pass	Sports
356	NFL Sunday Ticket/NBA League Pass	Sports
401	Spice	Adult
402	Playboy	Adult
501	Music Choice — Hit List	Audio
502	Music Choice — Dance	Audio
503	Music Choice — Hip Hop	Audio
504	Music Choice — Urban Beat	Audio
505	Music Choice — Reggae	Audio
506	Music Choice — Blues	Audio
507	Music Choice — Jazz	Audio
508	Music Choice — Jazz Plus	Audio
509	Music Choice — Contemporary Jazz	Audio
510	Music Choice — New Age	Audio
511	Music Choice — Electric Rock	Audio
512	Music Choice — Modern Rock	Audio
513	Music Choice — Classic Rock	Audio
514	Music Choice — Rock Plus	Audio
515	Music Choice — Metal	Audio
516	Music Choice — Solid Gold Oldies	Audio
517	Music Choice — Soft Rock	Audio
518	Music Choice — Love Songs	Audio
519	Music Choice — Progressive Country	Audio
520	Music Choice — Contemporary Country	Audio
521	Music Choice — Country Gold	Audio
522	Music Choice — Big Bands Nostalgia	Audio
523	Music Choice — Easy Listening	Audio
524	Music Choice — Classic Favorites	Audio
525	Music Choice — Classics in Concerts	Audio
526	Music Choice — Contemporary Christian	Audio
527	Music Choice — Gospel	Audio
528	Music Choice — For Kids Only	Audio
529	Music Choice — Music of the Season	Audio

DBS/Primestar Channel Guide

USSB

USSB Channel Guide

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

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

PRIMESTAR®

Primestar Channel Guide

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

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

New Services to appear in October:

Cinemax Selecciones; Classic Sports Network; 8 channels of DMX audio; E! Entertainment TV; ESPN2; Faith and Values Network; HBO en Espanol; Lifetime; MTV; Nickelodeon/Nick at Nite; Univision

Ku-band Satellite Transponder Services Guide

By Robert Smathers

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

Spacenet 2 (S2) 69° West

19	11740-H	Data Transmissions
20	11820-H	Occ video
21	11900-H	TV ASAHI [Leitch]
22	11980-H	Empire Sports Network [video compression]
23	12060-H	Kentucky Educational Television (half-transponders)
24	12140-H	Occ video

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

(no video reported since traffic movedto SBS 4)

SBS 6 (SBS6) 74° West

1	11717-H	Occ video/BBC 9pm News [PAL]
2	11749.5-V	SCPC transmissions
3	11774-H	Occ video
4	11798.5-V	Occ video/IBM TV [B-MAC]
5	11823-H	Occ video
6	11847.5-V	Occ video
7	11872-H	Occ video
8	11896.5-V	Occ video
9	11921-H	Occ video
10	11945.5-V	Occ video
11	11963-H	CONUS Communications - occ video
12	11994.5-V	CONUS Communications - occ video (full & half-transponders)/Megabingo
13	12019-H	CONUS Communications - occ video/Catholic Telecommunications Network
14	12043.5-V	CONUS Communications - occ video (full & half-transponders)/G.O.P. TV (occ video)
15	12075-H	CONUS Communications - occ video
16	12092.5-V	Occ video/Massachusetts Educational Network
17	12110-H	Occ video
18	12141.5-V	Occ video (half transponders)
19	12174-H	Occ video

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

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

Satcom K2 (K2) 81° West

1	11729-H	NBC-East
2	11758.5-V	Pagesat computer service/Data Transmissions
3	11788-H	NBC-Pacific (West spot beam)
4	11817.5-V	Cyclesat/occ video
5	11847-H	NBC contract channel
6	11876.5-V	Occ video
7	11906-H	NBC contract channel (network feeds)
8	11935.5-V	North American Chinese TV Network [Oak]
9	11965-H	NBC-Mountain
10	11994.5-V	[Compressed video]
11	12024-H	NBC contract channel (network feeds)
12	12053.5-V	FM² services
13	12083-H	NBC NewsChannel
14	12112.5-V	Occ video
15	12142-H	Data transmissions
16	12171.5-V	[Compressed video]

Satcom K1 (K1) 85° West

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

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

Spacenet 3R (S3) 87° West

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

Telstar 402R (T402) 89°West

(Testing-operational by December 1995)

Galaxy 7 (K7) 91° West

1	11720-V	Occ video
2	11750-H	Data Transmissions
3	11750-V	Indiana Higher Education [Compressed video]
4	11780-V	Occ video
5	11810-H	Occ video
7	11840-V	Occ video
8	11870-H	Data Transmissions
9	11870-V	Data Transmissions
10	11900-V	Muslim TV/Hospitality TV [B-MAC]/Occ video
11U	11945-H	[Compressed video]
12	11930-V	Occ video
13	11960-V	Occ video
14	11990-H	Occ video
15	11990-V	Occ video
16	12020-V	Occ video/Microsoft TV (occasional)/Real Estate TV Network (occasional)/The People's Network (TPN)
17	12050-H	Westcott Communications ASTN [B-MAC]/ANTN (Half-transponders)/National Weather Networks (occasional)
18	12050-V	Occ video
19	12080-V	The Asia Network/Occ video
20	12110-H	Data Transmissions
21	12110-V	TCI Promo Channel [B-MAC]
22	12140-V	Classic Sports Network
23	12170-H	Data Transmissions
24	12170-V	Occ video

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

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

Telstar 401 (T401) 97° West

1	11730-V	SCPC transmissions
2	11743-H	AT&T Skynet TV [compressed video]
3	11790-V	South Carolina Educational TV State Network [Digicipher]
4	11798-H	National Tech University [compressed video]
5	11845-V	PBS [Digicipher]
6	11855-H	SERC/PBS regionals/stations (half-transponders)
7	11902-V	PBS educational services (half-transponders)
8	11915-H	PBS stations/regionals and backhauls
9	11957.5-V	PBS digital video [Digicipher]/VSAT traffic
10	11962.5-H	Louisiana Public TV State Network [Digicipher]
11	12040-V	Occ video
12	12046-H	DMX for Business/occ video (half-transponders)
13	12095-V	Spectradyne Hotel Hotel In-room movies [compressed video]
14L	12093-H	Peachstar Educational Network (Distance Learning)
14U	12123-H	Georgia Public TV State Network (GPTV)
15	12147-V	ABC network and affiliate feeds (half-transponders)
16	12167-H	ABC network and affiliate feeds (half-transponders)

Galaxy 4 (K4) 99° West

1	11720-H	SCPC services/Data Transmissions
2	11750-V	Data transmissions
3	11750-H	FM² services/MUZAK/Data Transmissions
4	11780-H	FM² services/Planet Connect computer service (19.2 kbps)/Data Transmissions
5	11810-V	Data Transmissions
6	11810-H	Occ video
7	11840-H	*Jong Ten* - Chinese/Taiwan all-news service

8	11870-V	Occ video
9	11870-H	Occ video
10	11900-H	CNN Airport Network [SA MPEG]
11	11930-V	Occ video (half-transponders common)
12	11930-H	Occ video/Channel One (occ video)
13	11960-H	Occ video
14	11990-V	Occ video (half-transponders common)
15	11990-H	Occ video
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) [scrambled unknown system]
19	12080-H	Data transmissions
20	12110-V	Occ video (half-transponders common)
21	12110-H	Asian-American TV Network
22	12140-H	Family Net [Digicipher]
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

20	11820-H	Occ video
22	11980-H	Occ video
24	12140-H	Occ video/E.M.G. courses [digicipher]

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.

GSTAR-1 (GST1) 103° West

1	11730-H	Data Transmissions
2	11791-H	Data Transmissions
3	11852-H	Fed-X - occ video [B-MAC] /Occ video
4	11913-H	Data Transmissions
5	11974-H	O.J. TV (CourtTV)/CourtTV feeds (half transponders)
6	12035-H	Data Transmissions
7	12096-H	Healthcare Satellite [video compression]
8	12157-H	Data Transmissions
9	11744-V	Data Transmissions
10	11805-V	Data Transmissions
11	11866-V	Data Transmissions
12	11927-V	Data Transmissions
13	11988-V	Old Dominion University EdNet/Occ video
14	12049-V	Data Transmissions
15	12110-V	Data Transmissions
16	12171-V	Data Transmissions

GSTAR-4 (GST4) 105° West

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

Anik E2 (A1) 107.3° West

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Occ video
5	11839-V	Canadian Parliamentary Access Channel [video compression]
6	11865-V	Moviepix!; The Movie Channel [video compression]
7	11900-V	Rogers Digital Video Compression
8	11926-V	Rogers Digital Video Compression
9	11961-V	Data Transmissions
10	11987-V	Musique Plus
11	12022-V	Showcase TV (West)
12	12048-V	Saskarchewan CommunicaNetwork
13	12083-V	Data Transmissions
14	12109-V	Data Transmissions
15	12144-V	Telesat Canada stationkeeping (GLACS)
16	12170-V	MovieMax! — movies [Oak]
17	11730-H	Discovery Channel Canada [Oak]
18	11756-H	New Country Network (NCN)
19	11791-H	Bravo! Canada
20	11817-H	Life Network
21	11852-H	Musique Plus
22	11878-H	Meteo Media
23	11913-H	Showcase TV (East)
24	11939-H	Ontario Legislature
25	11974-H	La Chaine
26	12000-H	TV Ontario (English)
28	12061-H	Canal D — French arts channel
29	12096-H	RaiUno
30	12122-H	Telesat Canada stationkeeping (GLACS)
31	12157-H	Super Ecran [V2+]
32	12183-H	Canal Famile [V2+]

Solidaridad 1 SD1 109.2° West

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

Anik E1 (A2) 111° West

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Data transmissions
5	11839-V	MuchMusic
6	11865-V	NovaNet FM² Services
7	11900-V	Rogers Digital Video Compression
8	11926-V	Occ video
9	11961-V	Access Network of Alberta (distant learning) [video compression]
10	11987-V	(none) — possible Expressvu
11	12022-V	(none) — possible Expressvu
12	12048-V	R eseau de l information (RDI)
13	12083-V	CBC Newsworld feeds/Occ video
14	12109-V	RDI feeds/Occ video
15	12144-V	Knowledge Network
16	12170-V	Woman's Television Network — East and West feeds [video compression]
17	11730-H	Data transmissions
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	SCPC/Data transmissions
21	11852-H	Radio Quebec
22	11878-H	SuperChannel, Family Channel — East and West feeds [video compression]
23	11913-H	Expressvu
24	11939-H	Expressvu
25	11974-H	(none) — possibly Expressvu
26	12000-H	(none) — possibly Expressvu
27	12035-H	Occ video
28	12061-H	(none) — possibly Expressvu
29	12096-H	Reseau des Sports [V2+]
30	12122-H	(none) — possibly Expressvu
31	12157-H	(none) — possibly Expressvu
32	12183-H	Atlantic Satellite Network

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

(This satellite rarely has video transmissions)

Morelos 2 (M2) 116.8° West

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

SBS 5 (SBS5) 123° West

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

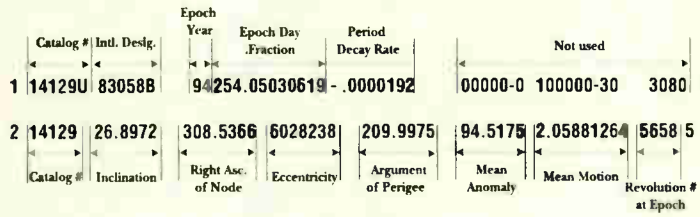
GSTAR-2 (GST2) 125° West

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

Amateur and Weather Satellite Two Line Orbital Element Sets

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

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



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

AMATEUR RADIO SATELLITES

OSCAR 10 (AMSAT OSCAR 10, AO-10)
1 14129U 83058B 95261.00004520 -.00000463 00000-0 10000-3 0 3740
2 14129 26.4622 247.8460 5984110 310.7505 10.7663 2.05882538 64241
OSCAR 11 (UoSAT 2, UoSAT 11, UO-11)
1 14781U 84021B 95271.01334558 +.00000113 +00000-0 +26901-4 0 08401
2 14781 097.7862 268.7471 0010784 209.0868 150.9735 14.69379410619000
COSMOS 1861 (Carries Radio Sputnik-10/11, RS-10/11)
1 18129U 87054A 95271.14433328 +.00000042 +00000-0 +29381-4 0 01240
2 18129 082.9270 342.9669 0011442 157.6089 202.5569 13.72356634414095
OSCAR 13 (AMSAT OSCAR 13, AO-13)
1 19216U 88051B 95269.10277333 -.00000021 00000-0 33589-4 0 940
2 19216 57.4504 162.4183 7329760 19.7069 358.0549 2.09722128 24280
OSCAR 14 (UoSAT 3, UoSAT 14, UO-14)
1 20437U 90005B 95271.08609707 +.00000008 +00000-0 +20145-4 0 01324
2 20437 098.5639 353.7820 0010291 261.3485 098.6537 14.29897633296454
OSCAR 16 (PACSAT, AMSAT OSCAR 16, AO-16)
1 20439U 90005D 95271.19391387 +.00000001 +00000-0 +17403-4 0 09504
2 20439 098.5742 355.6969 0010476 258.6658 101.3354 14.29951717296488
OSCAR 17 (DOVE, DO-17)
1 20440U 90005E 95271.17223361 .00000008 00000-0 20055-4 0 9278
2 20440 98.5771 356.1845 0010647 259.2838 100.7147 14.30093174296500
OSCAR 18 (WEBERSAT, WO-18)
1 20441U 90005F 95271.08661394 -.00000018 +00000-0 +10103-4 0 09401
2 20441 098.5762 356.0627 0011116 259.3367 100.6563 14.30063857296492
OSCAR 19 (LUSAT, LU-19)
1 20442U 90005G 95271.10201065 +.00000009 +00000-0 +20537-4 0 09276
2 20442 098.5771 356.4718 0011585 258.1271 101.8635 14.30168131296516
JAS 1B (FUJI 2, Fuji Oscar 20, FO-20)
1 20480U 90013C 95271.16949811 -.00000046 +00000-0 -27969-4 0 08279
2 20480 099.0683 340.6006 0540979 000.3062 359.8248 12.83230608264155
COSMOS 2123 (Carries Radio Sputnik 12/13, RS-12/13)
1 21089U 91007A 95270.80457284 +.00000011 +00000-0 -42743-5 0 08490
2 21089 082.9204 024.6640 0027488 247.5417 112.2827 13.74060092232864
OSCAR 22 (UoSAT F, UoSAT 5, UoSAT 22, UO-22)
1 21575U 91050B 95271.13063974 +.00000019 +00000-0 +20876-4 0 06413
2 21575 098.3865 339.8616 0008013 340.4991 019.5892 14.36991113220285
OSCAR 23 (KITSAT A, KITSAT 1, KO-23)
1 22077U 92052B 95270.75535731 -.00000037 +00000-0 +10000-3 0 05503
2 22077 066.0794 021.0142 0001412 157.5116 202.5961 12.86292537146928
OSCAR 25 (KITSAT B, KITSAT 2, KO-25)
1 22825U 93061C 95271.19390335 +.00000003 +00000-0 +18895-4 0 04235
2 22825 098.6096 346.1215 0008107 286.4803 073.5483 14.27672918104460
OSCAR 28 (POSAT 1, PO-28)
1 22826U 93061D 95271.21012137 -.00000017 00000-0 10899-4 0 4209
2 22826 98.6111 346.2524 0008782 287.9734 72.0493 14.27780824104473
OSCAR 26 (ITAMSAT, IO-26)
1 22828U 93061F 95271.18278322 -.00000004 +00000-0 +16113-4 0 04039
2 22828 098.6070 346.2679 0009481 270.0940 089.9160 14.28112611072576
OSCAR 27 (EYESAT A, AMSAT OSCAR 27, AO-27)
1 22829U 93061G 95271.19587285 +.00000009 +00000-0 +21036-4 0 04216
2 22829 098.6067 346.3203 0009464 272.2789 087.7307 14.28092983104498
RADIO ROSTO (Radio Sputnik 15, RS-15)
1 23439U 94085A 95270.94367755 -.00000039 +00000-0 +10000-3 0 00905
2 23439 064.8155 088.8017 0166534 244.6279 113.7322 11.27524919031108

WEATHER SATELLITES

NOAA 9
1 15427U 84123A 95271.14669220 +.00000028 +00000-0 +38988-4 0 04211
2 15427 098.9878 330.4364 0015163 341.8597 018.2041 14.13732579556460
GOES 7
1 17561U 87022A 95266.54879291 .00000079 00000-0 10000-3 0 5561
2 17561 2.5281 71.4325 0001892 319.9624 32.6393 1.00273645 14612
HIMAWARI 4 (GMS 4)
1 20217U 89070A 95270.76493677 -.00000375 00000-0 10000-3 0 2463
2 20217 1.2426 75.7006 0000552 324.1742 1.5964 1.00262312 22779
NOAA 12
1 21263U 91032A 95271.01936898 +.00000092 +00000-0 +60357-4 0 06529
2 21263 098.5825 292.4205 0012695 324.5058 035.5273 14.22560871227043
METEOR 3-5
1 21655U 91056A 95271.09172962 +.00000051 +00000-0 +10000-3 0 08595
2 21655 082.5554 146.2918 0014406 104.0356 256.2373 13.16841455198043
METEOR 2-21
1 22782U 93055A 95271.15683045 +.00000037 +00000-0 +20271-4 0 04316
2 22782 082.5523 195.5860 0023128 359.5076 000.6053 13.83038693104770
METEOSAT 6
1 22912U 93073B 95270.67105688 -.00000097 00000-0 10000-3 0 3650
2 22912 0.6114 278.8744 0001393 306.1832 12.1997 1.00273319 5212
METEOR 3
1 22969U 94003A 95271.00712663 +.00000051 +00000-0 +10000-3 0 02020
2 22969 082.5551 086.1907 0014791 171.9750 188.1611 13.16731864080418
GOES 8
1 23051U 94022A 95271.10473383 -.00000266 +00000-0 +10000-3 0 03893
2 23051 000.2344 083.9121 0003681 109.9001 135.9732 01.00276493012722
NOAA 14
1 23455U 94089A 95271.09711458 +.00000100 +00000-0 +79827-4 0 03349
2 23455 098.9111 212.8384 0008523 268.9076 091.1122 14.11535901038337
GOES 9
1 23581U 95025A 95271.13461924 -.00000194 00000-0 10000-3 0 635
2 23581 0.3391 269.8189 0002884 325.6873 89.4477 1.00267294 1287

Satellite Transponder Guide

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	Spacenet 2 (S2) 69º	Galaxy 6 (G6) 74º	Telstar 302 (T2) 85º	Spacenet 3 (S3) 87º	Galaxy 7 (G7) 91º	Telstar 401 (T1) 97º	Galaxy 4 (G4) 99º	Spacenet 4 (S4) 101º	Anik E2 (A1) 107.3º	Soli (SD
1	SC New York [V2+]	o/v	XXXplore (adult) [V2+]	SCPC/FM2 (AP) services	Sega Channel [digital]	Exxxtasy (Adult) [V2+]/VTC	SCPC services	Data Transmissions	Spice (adult) [V2+]	(
2	GEMS TV (Spanish) [V2+]	(none)	A.I.N.	Nebraska Educational TV [digital]	CBS West [VC1]	Data Transmissions	SCPC services	WHDH-NBC Boston (Atlantic 3) [V2+]	Adam and Eve (adult) [V2+]	(
3	USIA Worldnet TV	SCPC services	o/v	WSBK-Ind Boston [V2+]	Action PPV [V2+]	Parmount Syndication feeds/o/v	SCPC services	Data Transmissions	Data Transmissions	SCP(
4	Canal de Canales SUR (Spanish)	o/v	o/v	Nebraska Educational TV (NETV)	fX East	Fox feeds	SCPC services	WUSA-CBS Washington (Atlantic 3) [V2+]	TVN Cable Video Store [V2+]	(
5	NASA Contract Channel [Leitch]	NHK New York feeds	o/v	Univision [V2+]	fX West	4MC Syndicated feeds/o/v	o/v	Data Transmissions	Data Transmissions	(
6	Data Transmissions	NHK TV Japan feeds	o/v	(none)	Game Show Network [V2+]	Buena Vista TV feeds	Sheperd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	o/v	T(
7	o/v	o/v	TurnerVision Infomercials/o/v	Data Transmissions	The Golf Channel [V2+]	Fox feeds-East	o/v	Data Transmissions	ABC East [Leitch]	XEQ-
8	Data Transmissions	(none)	o/v	Data Transmissions	HBO East 2 [V2+]	PBS X	Telemundo [GI Digicipher]	KOMD-ABC Seattle (PT24W) [V2+]	Global TV [Leitch]/Global feeds	(
9	NASA TV	MuchMusic U.S. [V2+]	Radiotelevisao Portuguesa Internacional (RTPi)	WPIX-Ind New York [V2+]	MCI (Andover) contract channel/o/v	Fox feeds East	o/v	Data Transmissions	Empire Sports Network [V2+]	
10	Data Transmissions	Arab Network of America (ANA)	ABC West [Leitch]	Data Transmissions	United Arab Emirates TV Dubai	Fox feeds West	WABC-ABC New York (PT24E) [V2+]	WFLD-Fox Chicago (PT24E) [V2+]	Channel America	Mexica
11	SC Philadelphia [V2+]	FOX News Feeds/o/v	XXXpose (adult) [V2+]	CNN feeds	Estacion Montellano (Spanish rel)/o/v	ABC feeds	o/v	STARZ! Encore 8 [V2+]	Canadian Horse Racing/o/v	(
12	Data Transmissions	TV Asia [V2+]	The Outdoor Channel	Data Transmissions	International Channel [V2+]	ABC NewsOne feeds	o/v	Hero Teleport Contract Channel/H.TV	CTV (Blue)/o/v	Data Tr
13	Data Transmissions	Independent Film Channel [V2+]	o/v	SCPC/FM2 services	CSN/Kaleidoscope/P-SS [Digicipher]	Fox East	o/v	Data Transmissions	Canadian Horse Racing/o/v	(
14	Data Transmissions	Cornerstone TV WPCB-TV (Rel)	NPS Promo Channel	CNN [Leitch]	HBO West 2 [V2+]	Fox West	WRAL-CBS Raleigh (PT24E) [V2+]	Data Transmissions	adulTVision - adult [V2+]	Data Tr
15	HERO Teleport [Digicipher]	Midwest Sports Channel [V2+]	Exxxtreme/ Climaxxx TV promos [V2+]	KTLA-Ind Los Angeles [V2+]	TV! [V2+]	Exxxtasy 2 (adult) [V2+]	World Harvest TV (Rel)	Data Transmissions	Global feeds/Exxxtasy promos/o/v	Multi Dig
16	Data Transmissions	o/v	o/v	CNN International [Leitch]	(none)	o/v	CBS West [VC1]	Data Transmissions	CTV (Green)	Data Tr
17	Data Transmissions	Tokyo BS New York feeds	XXXotica [V2+]	FM2/SCPC services	Via TV - home shopping	o/v	CBS East [VC1]/o/v	Data Transmissions	Climaxxx (adult) [V2+]	(
18	(none)	Merchandise and Entertainment TV (MET)	XXXotica promos	Shop at Home/ In-store audio	CBS feeds [VC1]/ Hign Tech Channel/o/v	o/v	CBS feeds [VC1]/o/v	WPLG-ABC Miami (Atlantic 3) [V2+]	Video Catalog Channel	
19	Data Transmissions	University Network/Dr. Gene Scott (Rel)	XXXplore/ XXXpose promos	SSN Sportsouth [V2+]/ American Collectables Network	CBS East [VC1]	United Paramount Network/o/v	CBS East [VC1]/o/v	Data Transmissions	TV Northern Canada (TVNC)	Multi Dig
20	Armed Forces Radio & Television Service [B-MAC]	CNN Headline News Clean Feed [V2+]	ABC East (contingency channel) [Leitch]	Shop at Home	National Empowerment TV (NET)	ABC East [Leitch]	CBS East [VC1]	Data Transmissions	CJON-TV Newfoundland TV (NTV)	(
21	SC New England [V2+]	o/v	Skyvision	SSN Pro Am Sports (Pass) [V2+]	La Cadena de Milagro (Spanish rel)	ABC East [Leitch]	Warner Brothers Syndication-Network/ CBS feeds/o/v	Data Transmissions	TV 5 (French)	(
22	Newsport [V2+]	o/v	o/v	Data Transmissions	NewsTalk Television	ABC West [Leitch]	WXIA-NBC Atlanta (PT24E) [V2+]	Data Transmissions	3 Angels Broadcasting (Rel)	(
23	NHK TV Japan secondary feeds	Worship TV (Rel)	o/v	SSN Home Teams Sports (HTS) [V2+]	fX Movies [V2+]	ABC East [Leitch]	SCOLA [Wegener compression]	Data Transmissions	Exxxtreme TV/The Cupid Network (adult) [V2+]	Imagen S X
24	SC New York Plus-o/v [V2+]	o/v	o/v	America One	HBO East 3 [V2+]	NASA TV highlights/o/v	CBS Newspath feeds	KPIX-CBS San Francisco (PT24W) [V2+]	CTV (Red)	(

Key: ☐ Unscrambled/non-video; light grey = Subscription; black = Not available in U.S.; o/v = occasional video

Satellite Transponder Guide

By Robert Smathers

ad 1 9.2º	Telesat E1 (A2) 111º	Morelos 2 (M2) 116.8º	Telstar 303 (T3) 123º	Galaxy 5 (G5) 125º	Satcom C3 (F3) 131º	Galaxy 1R (G1) 133º	Satcom C4 (F4) 135º	Satcom C1 (F1) 137º	Satcom C5 (F5) 139º West	
)	Data Transmissions	Data Transmissions	TVN 1 PPV [V2+]	Disney East [V2+]	Family Channel West [V2+]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	SC Hawaii/ SC Chicago Plus [V2+]/ o/v	(none)	1
)	The Sports Network [Oak]	Data Transmissions	TVN 2 PPV [V2+]	Playboy (Adult) [V2+]	The Learning Channel	Spanish language networks [SA MPEG]	Request TV PPV [GI Digicipher]	KMGH-ABC Denver [V2+]	(none)	2
vices	Data Transmissions	Data Transmissions	TVN 3 PPV [V2+]	Trinity Broadcasting (Rel)	Viewer's Choice PPV [V2+]	Encore [V2+]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	SCPC services	3
)	Data Transmissions	Data Transmissions	TVN 4 PPV [V2+]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food Network [GI Digicipher]	Lifetime East [V2+]	SC Pacific [V2+]	(none)	4
)	Data Transmissions	Data Transmissions	TVN 5 PPV [V2+]	CNN [V2+]	Faith and Values Channel/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]	Data Transmissions	5
x	WDIV-NBC Detroit [Oak]	Data Transmissions	TVN 6 PPV [V2+]	WTBS-Ind Atlanta [V2+]	Court TV [Digicipher]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	(none)	6
nal 9	Data Transmissions	Data Transmissions	TVN 7 PPV [V2+]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN Prime Sports West [V2+]	Data Transmissions	7
)	Cancom (CHCH City TV WUHF CFTM) [SA MPEG]	XHGC canal 5/Q-CVC	TVN 8 PPV [V2+]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	(none)	8
	The Weather Network	(none)	TVN 9 PPV/CVS [V2+]	ESPN [V2+]	Music Choice [digital]	ESPN2 Blackout [V2+]/SAH	QVC Network	Prime Sports Alt/o/v	Data Transmissions	9
liament	WXYZ-ABC Detroit [Oak]	SEP	Ostrich Emu TV/Superior Livestock Auction/o/v	MOR Music	Home Shopping Club 2	America's Talking [V2+]	Home Shopping Network (HSN)	Prime Sports SW [V2+]	(none)	10
)	CBC-North Pacific feed	XEIPN canal 11	Data Transmissions	Family Channel East [V2+]	Prime Network [V2+]	Eternal Word TV Network (Rel)	The Box [Digicipher]	Network One 'N1'	Data Transmissions	11
issions	WTOL-CBS Toledo [Oak]	Data Transmissions	Data Transmissions	Discovery West [V2+]	History Channel [V2+]	Valuevision	Nustar (Promo Channel)	Data Transmissions	(none)	12
)	CBC feeds/o/v	(none)	(none)	CNBC [V2+]	The Weather Channel [V2+]	Encore [GI Digicipher]	Travel Channel [V2+]	SC Chicago [V2+]	o/v	13
issions	WTVS-PBS Detroit [Oak]	XEW canal 2	(none)	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Blackout [V2+]/SAH	Fit TV	KUSA-NBC Denver [V2+]	(none)	14
n [GI er]	CBFT-CBC (French)	Data Transmissions	Data Transmissions	HBO East [V2+]	Showtime East [V2+]	CNN International [V2+]	WWOR-Ind New York [V2+]	SC Cincinnati/Ohio [V2+]	DART Services	15
nission	CBC Newsworld [Oak]	Canal 22 o/v	Flix [V2+]	Cinemax West [V2+]	MTV West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Newsport [V2+]	(none)	16
)	CBC feeds/o/v	o/v	PandaAmerica - Home Shopping	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN Prime Sports (various) [V2+]/Cal-Span/o/v	Data Transmissions	17
	(none)	Clara Vision (rel)	Showtime 2 [V2+]	TNN [V2+]	Nickelodeon West [V2+]	HBO Multiplex [GI Digicipher]	Viewer's Choice [GI Digicipher]	Prime Sports Showcase	o/v	18
n [GI er]	CBC feeds/o/v	(none)	(none)	USA East [V2+]	Showtime/MTV [GI Digicipher]	Cinemax East [V2+]	C-SPAN 2	FoxNet	SEDAT Services	19
	CBMT-CBC (English)	Data Transmissions	adultVision/TVN 10 PPV (Adult) [V2+]	BET	Jones Intercable [GI Digicipher]	Home and Garden Network	Showtime West [V2+]	(none)	(none)	20
	SCPC services/ Data Transmissions	(none)	(none)	MEU	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	Prime Sports West [GI Digicipher]	SCPC services	21
	(none)	XHIMT canal 7	Antenna TV [V2+]	CNN/HN [V2+]	Your Choice TV [Digicipher]	Nostalgia Channel	Movie Channel West [V2+]	SSN PSNW [V2+]/o/v	(none)	22
tal/Cine s	CBC-North Atlantic feed	(none)	(none)	A&E [V2+]	E! Entertainment TV [V2+]	Cinemax East 2 [V2+]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	SEDAT Services	23
	Cancom (BCTV CITV) [SA MPEG]	XHDF canal 13	TVN Preview/TVN PPV o/v [V2+]	Showtime/Movie Channel [SA MPEG]	Digital Music Express Radio [Digital]	ESPN International [B-MAC]	CMT [V2+]	SSN Sunshine [V2+]	Alaska Rural TV Project	24

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

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of active (223) geostationary satellites at publication deadline. 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 for providing satellite background information: Molniya Space Consultancy—Mr. Phillip Clark; Kaman Sciences Corporation—Dr. Nicholas Johnson; University of New Brunswick—Mr. Richard B. Langley; U.S. Space Command/Public Affairs—Major Don Planalp; Naval Space Command/Public Affairs— Gary Wagner; NASA NSSDC/WDC-A, Goddard Space Flight Center; NASA Headquarters—Mr. Keith E. Stein; Social Security Administration—Ed Rosen; Chief D.R. Hill-Fla.; Gary Dunn-Calif. and *Satellite Times* staff.

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

Service Key

BSS	Broadcasting 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

"i" indicates orbital inclination greater than 1 degree and "#" indicates satellite has started into an inclined orbit. "d" indicates the satellite is drifting—moving into a new orbital slot or at end of life.

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
21140	1991-015B Meteosat 5 (MOP 2)	0.1E	Met (L)
18952	1988-018B Telecom 1C (France)	3.0E	Dom FSS/Gov-Mil (C/Ku)
19919	1989-027A Tele X (Sweden)	5.0E	Reg DTH/FSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.2E	Reg DTH (Ku)
22921	1993-076A USA 98 (NATO 4B)	5.9E/i	Mil-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	7.1E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg FSS (Ku)
19876	1989-020B Meteosat 4 (MOP 1)(ESA)	10.6E/#/d	Met (L)
19596	1988-095A Raduga 22 (Russia)	11.3E/i	Dom FSS/Gov-Mil (X/C)
22269	1992-088A Cosmos 2224 (Russia)	11.8E/#	Mil-Early Warning (X)
22557	1993-013A Raduga 29 (Russia)	12.3E/#	Dom FSS/Gov-Mil (X/C)
23537	1995-016B Hot Bird 1 (Eutelsat II F6)	12.8E	DTH (Ku)
21055	1991-003A Italsat 1 (Italy)	13.0E	Dom-Telephone (S/K/Ka)
20777	1990-079B Eutelsat II F1	13.3E	Reg FSS (Ku)
21803	1991-083A Eutelsat II F3	15.9E	Reg FSS (Ku)
23331	1994-070A Astra 1D	19.3E	Reg DTH (Ku)
21139	1991-015A Astra 1B	19.3E	Reg DTH (Ku)
22653	1993-031A Astra 1C	19.4E	Reg DTH (Ku)
19688	1988-109B Astra 1A	19.5E	Reg DTH (Ku)
14234	1983-077A Telstar 3A (301) (USA)	20.2E/#	Dom FSS-Saudi Arabia (C)
19331	1988-063B Eutelsat 1 F5	21.5E/#	Reg FSS (VHF/Ku)
13010	1981-122A Marecs 1 (ESA)	23.0E/i	Int Mar-EUR (L/C)
22175	1992-066A DFS 3 (Germany)	23.4E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.6E/#	Reg FSS (VHF/Ku)
20359	1990-054A Gorizont 20 (Russia)	25.6E/i	Dom/Gov FSS (C/Ku)
20706	1990-063B DFS 2 (Germany)	28.4E	Dom BSS (S/Ku/K)
21894	1992-010B Arabsat 1C	31.2E	Reg FSS/BSS (S/C)
20041	1989-041B DFS 1 (Germany)	33.5E	Dom BSS (SKu/K)
21821	1991-087A Raduga 28 (Russia)	34.8E/#	Dom FSS/Gov-Mil (X/C)
20953	1990-102A Gorizont 22 (Russia)	40.0E/i	Dom/Gov FSS (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	42.4E	Reg FSS (Ku)
14421	1983-105A Intelsat 507	47.0E/i	Int FSS/Mar (L/C/Ku)
22981	1994-008A Raduga 1-3 (Russia)	48.8E/#	Dom FSS/Gov-Mil (X/C)
21038	1990-116A Raduga 1-2 (Russia)	49.3E/i	Dom FSS/Gov-Mil (X/C)
22245	1992-082A Gorizont 27 (Russia)	52.7E/#	Dom/Gov FSS (C/Ku)
19687	1988-109A Skynet 4B (UK)	53.0E/i	Mil-Comm (P/S/X/Ka)
15629	1985-025A Intelsat 510	56.9E/i	Int FSS (C/Ku)
20667	1990-056A Intelsat 604	59.9E	Int FSS (C/Ku)
14675	1984-009A DSCS III A2 (USA)	60.0E/i	Mil-IOR primary (P/S/X)
20315	1989-087A Intelsat 602	62.9E	Int FSS (C/Ku)
20918	1990-093A Inmarsat 2 F1	64.4E/#	Int Mar-IOR (L/C)
13595	1982-097A Intelsat 505	64.9E/i	Int FSS/Mar (L/C/Ku)
13636	1982-106A DSCS II F16 (USA)	65.3E/i	Mil-IOR reserve (S/X)
23461	1995-001A Intelsat 704	66.0E	Int FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	69.1E/#	Dom FSS/Gov-Mil (X/C)
20083	1989-048A Raduga 1-1 (Russia)	69.9E/i	Dom FSS/Gov-Mil (X/C)
22963	1993-002A Gals 1 (Russia)	70.8E	Dom BSS (Ku)
20410	1990-002B Leasat 5 (USA)	71.6E/i	Mil-IOR reserve (P/S/X)
22787	1993-056A USA 95 (UFO-2)	71.9E/i	Mil-IOR primary (P/S)
23589	1995-027A USA 111 (UFO-5)	72.0/i	Mil-IOR reserve (P/S/K)
08882	1976-053A Marisat 2	72.3E/i	Int Mar-IOR (P/L/C)
22027	1992-041A Insat 2A (India)	73.8E	Dom FSS/BSS/Met (S/C)
23646	1995-040A PanAmSat 4 (PAS-4)	75.3E	Int FSS (C/Ku)
23327	1994-069A Elektro 1 (Russia)	75.9E/#	Met (L)
23314	1994-065B Thaicom 2 (Thailand)	78.3E	Reg FSS (C/Ku)
22931	1993-078B Thaicom 1 (Thailand)	78.4E	Reg FSS (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	79.9E/#	Dom/Gov FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	80.0E/#	Data Relay (C)
21111	1991-010A Cosmos 2133 (Russia)	80.0E/#	Mil-Early Warning (X)
20643	1990-051A Insat 1D (India)	82.9E	Dom FSS/BSS/Met (S/C)
19548	1988-091B TDRS F3 (USA)	84.6E/#	Gov (C/S/Ku)
22836	1993-062A Raduga 30 (Russia)	85.7E	Dom FSS/Gov-Mil (X/C)
18922	1988-014A PRC 22 (China)	87.8E/#	Dom FSS (C)
23653	1995-045A Cosmos 2319 (Russia)	89.3E/#	Data Relay (C)
22880	1993-069A Gorizont 28 (Russia)	89.7E	Dom/Gov FSS (C/Ku)
12474	1981-050A Intelsat 501	91.3E/i	Int FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.3E	Dom FSS/BSS/Met (S/C)
21016	1990-112A Raduga 26 (Russia)	95.0E/i	Dom FSS/Gov-Mil (X/C)
23426	1994-082A Luch 1 (Russia)	95.0E/i	Tracking & Relay CSDRN (Ku)
20263	1989-081A Gorizont 19 (Russia)	96.8E/i	Dom/Gov FSS (C/Ku)
20473	1990-011A PRC 26 (China)	98.2E	Dom FSS (C)
19683	1988-108A Ekran 19 (Russia)	98.3E/i	Dom BSS (P)
22210	1992-074A Ekran 20 (Russia)	99.1E/#	Dom BSS (P)
21922	1992-017A Gorizont 25 (Russia)	103.0E/#	Dom/Gov FSS (C/Ku)
20558	1990-030A Asiasat 1	105.4E	DTH (C/Ku)
20570	1990-034A Palapa B2R	108.0E	Reg FSS (C)
23176	1994-040B BS-3N (Japan)	109.6E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.7E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	109.9E	Dom BSS (Ku)
19710	1988-111A PRC 25 (China)	110.8E	Dom FSS (C)
17706	1987-029A Palapa B-2P	112.6E	Reg FSS (C)
23651	1995-044A N-Star a	113.2E/d	Dom FSS (S/C/Ku/Ka)
14985	1984-049A Chinasat 5 (Spacenet 1)	115.6E	Dom FSS (C/Ku)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	115.8E	Dom FSS (Ku)
21964	1992-027A Palapa B4	117.0E	Reg FSS (C)
21132	1991-014A Raduga 27 (Russia)	128.1E/i	Dom FSS/Gov-Mil (X/C)
22907	1993-072A Gorizont 29 (Rimsat 1)	129.8E	Reg FSS (C/Ku)
18877	1988-012A CS 3A (Sakura 3A)(Japan)	131.8E	Dom FSS (C/K)
14134	1983-059C Palapa B1 (Indonesia)	133.4E/i	Reg FSS (C)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	135.9E	Dom FSS (C/K)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
23185	1994-043A Apstar A1 (China)	137.9E	DTH (C)
13969	1983-026B TDRS F1 (USA)	138.2E	Gov (Ku)
20107	1989-052A Gorizont 18 (Russia)	140.1E/i	Dom/Gov FSS (C/Ku)
23522	1995-011B GMS-5 (Himawari 5)	140.1E/#	Met (P/L)
23108	1994-030A Gorizont 30 (Rimsat 2)	142.2E/#	Reg FSS (C/Ku)
20923	1990-094A Gorizont 21 (Russia)	144.6E/i	Dom/Gov FSS (C/Ku)
19874	1989-020A JCSAT 1 (Japan)	149.8E	Dom FSS (Ku)
18316	1987-070A ETS V (Japan)	150.1E/i	Experimental (L/C)
18350	1987-078A Optus A3 (Aussat K3)	152.3E	DTH (Ku)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	DTH/Mob (L/Ku)
22253	1992-084A Superbird A (Japan)	158.0E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	160.1E	DTH/Mob (L/Ku)
21893	1992-010A Superbird B (Japan)	161.9E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	163.9E/#	DTH (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	169.0E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(USA)	172.1E/i	Mil-POR reserve (P-Bravo/S/X)
22871	1993-066A Intelsat 701	173.9E	Int FSS (C/Ku)
20202	1989-069A DSCS III B9 (USA)	175.0E/i	Mil-WPAC primary (P/S/X)
23305	1994-064A Intelsat 703	177.0E	Int FSS (C/Ku)
21814	1991-084B Inmarsat 2 F3	177.9E/#	Int Mar-POR (L/C)
15873	1985-055A Intelsat 511	180.1E/i	Int FSS (C/Ku)
16117	1985-092C DSCS III B5 (USA)	180.0E/i	Mil-WPAC reserve (P/S/X)
15236	1984-093C Leasat 2 (USA)	177.7W/i	Mil-POR primary (P/S/X)
09478	1976-101A Marisat 3	177.1W/i	Int Mar-POR (P/L/C)
19121	1988-040A Intelsat 513	177.0W	Int FSS (C/Ku)
12994	1981-119A Intelsat 503	176.9W/i	Int FSS (C/Ku)
23467	1995-003A USA 108 (UFO-4) (USA)	176.8W/i	Mil-POR (P/S/K)
21639	1991-054B TDRS F5 (USA)	174.3W	Int FSS/Gov (C/S/Ku)
20499	1990-016A Raduga 25 (Russia)	170.1W/i	Dom FSS/Gov-Mil (X/C)
18631	1987-100A Raduga 21 (Russia)	169.8W/i	Dom FSS/Gov-Mil (X/C)
23613	1995-035B TDRS F7 (USA)	150.4W	Int FSS/Gov (C/S/Ku)
21392	1991-037A Satcom C5 (Aurora II)(USA)	139.1W	Dom FSS (C)
20945	1990-100A Satcom C1 (USA)	136.8W	Dom FSS (C)
17561	1987-022A GOES 7 (USA)	135.3W/i	Met (P/L/S)
22096	1992-057A Satcom C4 (USA)	135.0W	Dom FSS (C)
22915	1993-074A DSCS III B14 (USA)	135.0W/i	Mil-EPAC primary (P/S/X)
23016	1994-013A Galaxy 1R (USA)	132.9W	Dom FSS (C)
22117	1992-060B Satcom C3 (USA)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (USA)	129.6W/i	Mil-EPAC reserve (P/S/X)
21906	1992-013A Galaxy 5 (USA)	125.1W	Dom FSS (C)
16649	1986-026A Gstar 2 (USA)	125.0W/#	Dom FSS (Ku)
15826	1985-048D Telestar 3D (USA)	123.1W/#	Dom FSS (C)
19484	1988-081B SBS 5 (USA)	123.0W	Dom FSS (Ku)
16274	1985-109B Morelos B (Mexico)	116.8W	Dom FSS (C/Ku)
13652	1982-110C Anik C3 (Canada)	114.8W/i	Dom FSS (Ku)
23313	1994-065A Solidardad 2 (Mexico)	113.0W	Dom FSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.1W	Dom FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.2W	Dom FSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom FSS (C/Ku)
03029	1967-111A ATS 3 (USA)	106.5W/i	Exp comm (VHF/C)
08697	1976-017A Marisat 1	106.4W/i	Int Mar-AOR (P/L/C)
15643	1985-028C Leasat 3 (USA)	105.8W/i	Mil-CONUS reserve (P/S/X)
20946	1990-100B Gstar 4 (USA)	105.1W	Dom FSS (Ku)
08747	1976-023B LES 9 (USA)	104.3W/i	Mil-Exp comm (P/Ka)
15677	1985-035A Gstar 1 (USA)	103.0W	Dom FSS (Ku)
22930	1993-078A DBS 1 (USA)	101.3W	DTH (Ku)
23598	1995-029A DBS 3 (USA)	101.1W	DTH (Ku)
21227	1991-028A Spacenet 4 (USA)	101.1W	Dom FSS (C)
23553	1995-019A MSAT-2 (USA)	101.0W	Mobile (L/X)
23192	1994-047A DBS 2 (USA)	100.9W	DTH (Ku)
17181	1986-096A USA 20 (FltSatCom F7)(USA)	100.3W/i	Mil-CONUS primary (P/S/X/K)
22796	1993-058B ACTS (USA)	100.1W	Exp Comm (C/K/Ka)
22694	1993-039A Galaxy 4 (USA)	99.1W	Dom FSS (C/Ku)
08746	1976-023A LES 8 (USA)	98.0W/i	Mil-Exp comm (P/Ka)
22927	1993-077A Telstar 401 (USA)	97.0W	Dom FSS (C/Ku)
19483	1988-081A Gstar 3 (USA)	93.3W/i	Dom FSS/Mob (L/Ku)
16650	1986-026B SBTS 2 (Brazil)	91.9W	Dom FSS (C)
22205	1992-072A Galaxy 7 (USA)	91.1W	Dom FSS (C/Ku)
23581	1995-025A GOES 9 (USA)	89.8W	Met (P/L/S)
22988	1994-009A USA 99 (Milstar 1)	90.0W	Mil-Comm (P/S/K)
18951	1988-018A Spacenet 3R (USA)	87.1W	Dom FSS (L/C/Ku)
15237	1984-093D Telestar 3C (302) (USA)	85.3W/#	Dom FSS (C)
16482	1986-003B Satcom K-1 (USA)	85.0W	Dom FSS (Ku)
16276	1985-109D Satcom K-2 (USA)	81.0W	Dom FSS (Ku)
15235	1984-093B SBS 4 (USA)	77.1W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (USA)	76.5W/i	Dom FSS (C)
14133	1983-059B Anik C2 (Argentina)	75.9W/i	Dom FSS (Ku)
23051	1994-022A GOES 8 (USA)	75.3W	Met (P/L/S)
16650	1986-026B SBTS 2 (Brazil)	74.8W/d	Dom FSS (C)
20873	1990-091B Galaxy 6 (USA)	74.1W	Dom FSS (C)
20872	1990-091A SBS 6 (USA)	74.0W	Dom FSS (Ku)
15385	1984-114A Spacenet 2 (USA)	72.3W	Dom FSS (C/Ku)
15642	1985-028B Anik C1 (Argentina)	72.0W	Dom FSS (Ku)
12855	1981-096A SBS 2 (USA)	71.2W/i	Dom FSS (Ku)
19215	1988-051A Meteosat P2 (ESA)	70.9W/i	Met (L)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom FSS (C)
23536	1995-016A Brasilsat B2 (Brazil)	65.1W	Dom FSS (C/X)
15561	1985-015B SBTS 1 (Brazil)	63.2W/#	Dom FSS (C)
21940	1992-021B Inmarsat 2 F4	53.9W/i	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	53.1W	Int FSS (C/Ku)
20203	1989-069B DSCS III B10 (USA)	52.5W/i	Mil-WLANT primary (P/S/X)
23528	1995-013A Intelsat 705	50.0W	Int FSS (C/Ku)
22314	1993-003B TDRS F6 (USA)	46.2W/i	Gov (C/S/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Int FSS (C/Ku)
16116	1985-092B DSCS III B4 (USA)	42.5W/i	Mil-ATL reserve (P/S/X)
19883	1989-021B TDRS F4 (USA)	41.0W	Int FSS/Gov (C/S/Ku)
12089	1980-098A Intelsat 502	40.4W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (USA)	37.8W	Int FSS (Ku)
20523	1990-021A Intelsat 603	34.7W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A	34.0W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.6W/i	Int FSS/Mar (L/C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	Dom BSS/FSS (Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	Dom BSS/FSS (Ku)
13083	1982-017A Intelsat 504	29.7W/i	Int FSS (C/Ku)
21765	1991-075A Intelsat 601	27.6W	Int FSS (C/Ku)
21653	1991-055A Intelsat 605	24.6W	Int FSS (C/Ku)
22112	1992-059A Cosmos 2209 (Russia)	24.4W/#	Mil-Early Warning (X)
23168	1994-038A Cosmos 2282 (Russia)	23.9W/#	Mil-Early Warning (X)
20253	1989-077A USA 46 (FltSatCom 8)	22.5W/i	Mil-AOR primary (P-Charlie/S/X/K)
21989	1992-032A Intelsat K	21.8W	Int FSS (Ku)
16101	1985-087A Intelsat 512	21.3W/#	Int FSS (C/Ku)
15391	1984-115A NATO III D	21.1W/i	Mil-Comm (P/S/X)
19621	1988-098A TDF 1 (France)	19.0W	DTH (Ku)
20705	1990-063A TDF 2 (France)	18.9W	DTH (Ku)
19772	1989-006A Intelsat 515	18.1W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.8W/i	Mil-Comm (P/S/X)
20391	1989-101A Cosmos 2054 (Russia)	16.0W/i	Tracking & Relay WSDRN (Ku)
21149	1991-018A Inmarsat 2 F2	15.4W/i	Int Mar-AOR-E (L/C)
15386	1984-114B Marecs B2	15.2W/i	Int Mar-AOR (L)
10669	1978-016A Ops 6391 (FltSatCom 1) (USA)	14.6W/i	Mil-AOR reserve (P-Alpha/S/X)
23132	1994-035A USA-104 (UFO-3)(USA)	14.4W/i	Mil-AOR primary (P/S)
23319	1994-067A Express 1 (Russia)	14.2W	Int FSS (C/Ku)
21789	1991-079A Cosmos 2172 (Russia)	13.6W/#	Data Relay (C)
22009	1992-037A DSCS III B12 (USA)	12.0W	Mil-ELANT primary (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	10.7W/#	Dom/Gov FSS (C/Ku)
22912	1993-073B Meteosat 6 (ESA)	10.4W/#	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom FSS/Gov-Mil (X/C/Ku)
21939	1992-021A Telecom 2B (France)	5.0W	Dom FSS/Gov-Mil (X/C/Ku)
20776	1990-079A Skynet 4C (UK)	1.1W/#	Mil (P/S/X/Ka)
23124	1994-034A Intelsat 702	1.0W	Int FSS (C/Ku)
20762	1990-074A Thor/Marcopolo 2 (BSB R-2)	0.9W	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 13 (AO-13) (Notes 1 & 13)	B (u/V)	Dn	145.828	838	848	858	868	878	888	898	908	918	928	938	948	958	968	145.978
		Up	435.570	560	550	540	530	520	510	500	490	480	470	460	450	440	430	435.420
	Bcns	145.812 (RTTY, CW, PSK)																145.985
	S (u/S)	Dn	2400.711	720	730	740	2400.747											
		Up	435.601	610	620	630	435.637											
	Bcn	2400.650 (RTTY, CW, PSK)																
OSCAR 10 (AO-10) (Notes 2 & 13)	B (u/V)	Dn	145.825	835	845	855	865	875	885	895	905	915	925	935	945	955	965	145.975
		Up	435.179	169	159	149	139	129	119	109	099	089	079	069	059	049	039	435.029
	Bcn	145.810 (Steady unmodulated carrier)																145.987
RS 10/11 (Notes 3, 4, 5 and 13)	A (v/A)	Dn	29.360	370	380	390	29.400					29.403						
		Up	145.860	870	880	890	145.900				Robot (CW)	145.820						
	Bcn	29.357 (CW)																
RS-12/13 (Notes 3, 6 & 7)	K (h/A)	Dn	29.410	420	430	440	29.450					29.454						
		Up	21.210	220	230	240	21.250				Robot (CW)	21.129						
	Bcn	29.408																
RS-15 (Note 13)	A (v/a)	Dn	29.354	29.364	29.374	28.384	29.394											
		Up	145.858	145.868	145.878	145.888	145.898											
UoSat 11 (UO-II) (Note 14)	Bcns	Dn	145.826	435.025	2401.500													
		Up	None															
PACSAT (AO-16) (Notes 8, 9 & 11)	[a]	Dn	437.025 (Sec) 437.050															
		Up	145.900	145.920	145.940	145.960												
DOVE (DO-17) (Notes 10 & 11)	[b,c]	Dn	145.825	2401.220														
		Up	None															
WEBERSAT (WO-18) (Note 11)	[a]	Dn	437.075	437.100 (Sec)														
		Up	None															
LUSAT (LO-19) (Notes 8 & 11)	[a]	Dn	437.125	437.150 (Sec)														
		Up	145.840	145.860	145.880	145.900												

NOTES

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

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

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

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

Satellite Launch Schedules

By Keith Stein

Space Transportation System (STS-NASA)

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

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-74	November 1995/ Atlantis*	51.60/220	8 days	Mir Docking #2
STS-72	January 1996/ Endeavour**	28.45/184	9 days	SFU-Retrieval & OAST-Flyer

*Crew Assignment: CDR-Ken Cameron; PLT-James Halsell; MS-Jerry Ross; MS-William McArthur;MS-Chris Hadfield.

**Crew Assignment: CDR-Brian Duffy; PLT-Brent Jett; MS-Leroy Chiao; MS-Daniel Barry; MS-Winston Scott; MS- Kolohi Wakata (Japan).

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

MIR Downlink Frequency Assignment: VHF band 121.125, 121.750, 130.167, 139.208, and 143.625 MHz. UHF band 231.0, 233.0, 247.0, 249.0, 417.0, and 463.0 MHz. S-band 2025-2100 and 2200-2290 MHz. Ku-band 13 and 15 Ghz.

SFU Downlink Frequency Assignment: S-band TLM 2263.6018 MHz

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
November 1995	Molniya-M	Plesetsk	INTERBALL-AURORA MAGION
December 1995	Proton	Baikonur	PRIRODA
December 1995	Soyuz	Baikonur	PROGRESS M
December 1995	Molniya	Plesetsk	IRS-C / Skipper
December 1995	Proton	Baikonur	SPECTRUM X
January 1996	Soyuz	Baikonur	SOYUZ TM-23
January 1996	Cosmos	Plesetsk	COSMOS FAISAT 2V

MAGION Downlink Frequency Assignment: 137.850 Mhz
PROGRESS Downlink Frequency Assignment: 165.000, 166.000 and 922.755 MHz.
SOYUZ TM-23 Downlink Frequency Assignment: 121.750 MHz (WBFM)
COSMOS Downlink Frequency Assignments: 149.910-150.030 MHz,
FAISAT 2V Downlink Frequency Assignments: 400-401 Mhz

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
November 1995	Delta II	CCAS	XTE
November 1995	Titan 4	CCAS	MILSTAR 1-2
November 1995	Atlas	CCAS	UHF F/O F6
November 1995	Pegasus XL	VAFB	SEASTAR/SEAWIFS
November 1995	Pegasus	VAFB	MSTI-3
November 1995	Pegasus XL	VAFB	TOMS
December 1995	Atlas IIAS	CCAS	SOHO
December 1995	Delta II	VAFB	POLAR
December 1995	Titan 4	VAFB	CLASSIFIED
December 1995	Atlas 2A	CCAS	Galaxy III-R
December 1995	Delta II	CCAS	KOREASAT II
January 1996	Atlas IIA	CCAS	PALAPA C-1
January 1996	Titan 4	VAFB	CLASSIFIED

Delta II Downlink Frequency Assignments: S-band TLM 2244.5,2241.5 and 2252.5 MHz, C-band TRK 5765.0 MHz.
XTE Downlink Frequency Assignments: S-band TLM 2287.5 MHz.
MILSTAR 1-2 Downlink Frequency Assignments: 20220.0 MHz
UHF F/O F6 Downlink Frequency Assignments: (See September/October issue of ST page 14).
SEASTAR/SEAWIFS Downlink Frequency Assignments: L-band TLM 1702.5 MHz, and S-band TLM 2272.5 MHz.
TOMS Downlink Frequency Assignments: S-band TLM 2273.500 MHz
SOHO Downlink Frequency Assignments: S-band TLM and TRK 2245.0 MHz
POLAR Downlink Frequency Assignments: S-band TLM and TRK 2265.0 MHz

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
November 1995	Ariane 4	Guiana	INFARED SPACE OBSERVATORY
December 1995	Ariane 4	Guiana	ASTRA-1E
December 1995	Ariane 4	Guiana	MSAT 1
December 1995	Ariane 4	Guiana	PAS-3R
January 1996	Ariane 5	Guiana	CLUSTER (4)
January 1996	Ariane 4	Guiana	AMOS
January 1996	Ariane 4	Guiana	TELECOM 2-D

Ariane 4 Downlink Frequency Assignments: S-band TLM 2203.0, 2206.0 and 2218.0 MHz.
ISO Downlink Frequency Assignments: S-band TLM and TRK 2266.5 MHz.
CLUSTER Downlink Frequency Assignments: CLUSTER 1-2242.0 MHz, CLUSTER 2-2249.0 MHz, CLUSTER 3-2277.0 MHz, CLUSTER 4-2270.0 MHz, SPARE-2256.0 MHz.
TELECOM 2-D Downlink Frequency Assignments: S-band TLM & TRK 2207.130 MHz

China Expandable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
November 1995	Long March 2E	Xichang	ASIASAT 2
November 1995	Long March 2E	Xichang	ECHOSTAR 1
November 1995	Long March 3B	Xichang	INTELSAT 70

Satellite Launch Schedules

India Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
January 1996	PSLV	Shar	IRS-P3

List of Abbreviations and Acronyms

AMOS — Israel telecommunications satellite for domestic & regional links.
ASIASAT — Asia Satellite Telecommunications Company will provide services to China, Thailand, and Pakistan.
ASTRA — These satellites will establish a medium-power system for TV distribution from geostationary orbit.
C-band — 3700 to 6500 MHz
CCAS — Cape Canaveral Air Station.
CDR — Commander.
CLUSTER — The four spacecraft will study the bow shock, dayside cusp, magnetopause, and the geomagnetic tail of Earth's electromagnetic field.
COSMOS — Russian navigation satellite.
ECHOSTAR — Echostar will begin a direct home TV system working through 45cm satellite dishes.
FAISAT 2V — The system will provide data acquisition services, remote monitoring, tracking, personal and business non-voice messaging, and emergency communications/distress calls.
GALAXY 3R — Principal applications include network TV, radio, VSAT, business video and data services.
GHz — Gigahertz.
INTELSAT — The International Telecommunications Satellite Organization is a non-profit commercial co-operative of 133 member nations.
INTERBALL — Study of magnetosphere and plasmasphere under a 14-nation international program using two spacecraft. A Russian Prognoz, and a Czech Magion spacecraft.
IRS-1C — Indian earth observation satellite.
IRS-P3 — Indian earth observation satellite.
ISO — The Infrared Space Observatory will conduct imaging, photometric, spectroscopic and polarimetric observations of selected sources.
K-band — 10.90 to 17.15 Ghz.
KOREASAT — Telecommunications satellite for South Korea.
MAGION — Study of magnetosphere and plasmasphere under a 14-nation international program using two spacecraft. A Russian Prognoz, and a Czech Magion spacecraft.
MHz — Megahertz.
MILSTAR — A telephone switchboard in space to route all military message traffic and conversations around the world.
MS — Mission Specialist.
MSAT — MSAT (a joint Canada-NASA project) will provide voice, message, and data communications.
MSTI-3 — Planned to be launched into the same orbit as MSTI-2, MSTI-3 will conduct dynamic stereo observations of tactical missile launches and Earth backgrounds.
OAST-FLYE — Office of Aeronautics and Space Technology-Flyer. A free flyer deployed from the Shuttle containing several space technology experiments.
PALAPA C1 — A telecommunications satellite for Indonesia.
PAS-3R — U.S. telecommunications satellite for Pan American Satellite of Connecticut.
PLC — Payload Commander.
PLT — Pilot.
POLAR — Polar auroral plasma physics spacecraft.
Priroda — A new module for the Russian space station Mir, planned for remote sensing of land, oceans and atmosphere.
Progress — Unmanned cargo flight to resupply manned space station.
PS — Payload Specialist.
RNG — Ranging.
S/MM-2 — Shuttle mission to the Russian Space Station MIR to support design and assembly of the international space station.
S-band — 2000 to 2300 Mhz
SEAWIFS/SEASTAR — The spacecraft will conduct global ocean observations to estimate ocean color, and derive from these measurements, various biological indicators and other useful scientific products.
SFU-RETR — A reusable, retrievable unmanned free flyer launched aboard a Japanese H-II rocket and retrieved by the Shuttle.
SKIPPER — U.S. military payload designed to investigate aerothermochemistry & aerobraking by dipping into the atmosphere.
SOHO — Solar Heliospheric Observatory, a European Space Agency spacecraft to provide optical measurements as well as plasma field and energetic particle observations of the sun system for studies of the solar interior, atmosphere and solar wind.
SOYUZ TM — Manned spacecraft for flight in Earth orbit.
SPECTRUM — Will conduct high-energy astronomical observations.
TELECOM2D — TC 2-D will provide high-speed data link applications, telephone, and television service between France and overseas territories.
TDRSS — Tracking & Data Relay Satellite System.
TLM — Telemetry.
TOMS — Total Ozone Mapping Spectrometer, designed to study Stratospheric ozone.
TRK — Tracking.
TT&C — Tracking, Telemetry and Command.
TTC&V — Tracking, Telemetry, Commanding and Voice.
UHF F6 — U.S. Navy communications satellite replacing Fleet Satellite Communications Network.
VAFB — Vandenberg Air Force Base, Calif.
VHF — Very High Frequency (30 to 300 Mhz)
XTE — Xray Timing Explorer. A payload to be used in Earth orbit to investigate the physical nature of compact X-ray sources by studying fluctuations in X-ray brightness over time-scales ranging from microseconds to years.

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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 July and August 1995. The format of the listing is as follows:

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

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

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

Launch Date/Time		Int Des		Satellite	Mass
Epoch	Incl		Period	Perigee	Apogee
1995 Jul/0513		1995-032A		Cosmos 2315	825 kg *
1995 Jul 6.21	82.91 deg		104.94 min	970 km	1,014 km

"Musson"-class navigation satellite operating in the civilian "Tsikada" system, co-planar with Cosmos 2230: built by NPO Prikladnoi Mekhaniki. Cosmos name used rather than "Nadezhda" or the recently-introduced "Tsikada" (see 1995-002A) because the satellite carries a new "Kurs" marine traffic location and control system. Operating lifetime expected to be about four years. Launched from Plesetsk using Cosmos vehicle. Estimated launch time given above as decimals of a day (approximately 0310 UTC)

1995 Jul 7/1624		1995-033A		Helios 1A	2,537 kg
1995 Jul 14.17	98.07 deg		98.37 min	680 km	682 km
1995 Jul 7/1624		1995-033B		CERISE	50 kg
1995 Jul 11.16	98.07 deg		98.17 min	667 km	675 km
1995 Jul 7/1624		1995-033C		UPM/SAT	47 kg
1995 Jul 10.07	98.07 deg		98.15 min	665 km	676 km

Helios 1A is the first French reconnaissance satellite. As well as undertaking photographic work the satellite also reportedly carried an ELINT payload. Satellite is based upon the civilian SPOT remote sensing satellite bus built by Matra Marconi Space France.
CERISE ("Caracterisation de l'Environnement Radioelectrique par un Instrument Spatiale Embarque") is studying the Earth's radio environment in support of research connected with the proposed French Zenon ELINT satellite programme: prime contractor for CERISE is Alcatel Espace.
UPM/SAT 1 is a microgravity and telecommunications research satellite, built by the Polytechnic University of Madrid in Spain. Launched from Kourou using an Ariane 40 vehicle: third stage of Ariane is in an orbit similar to the satellites.

Launch Date/Time		Int Des		Satellite	Mass
Epoch	Incl		Period	Perigee	Apogee
1995 Jul 10/1238		1995-034A		USA 112	8,000 kg *
1995 Jul 31	64 deg?		720 min?	1,300 km?	39,200 km?

Classified payload, launched for the Department of Defense: payload is believed to be a SIGINT satellite, possibly in the Advanced Jumpseat series similar to shuttle-deployed payloads 1989-061B (USA 40 deployed from STS-28R), 1992-086B (USA 89 deployed from STS-53) and the Titan- 4/Centaur—launched 1994-026A (USA 103). No orbital data from the mission has been released and the orbit quoted above is estimated: an initial 57 deg, 185 km parking orbit might have been used. Launch from Cape Canaveral using a Titan-4/Centaur: third stage is probablyt in an orbit similar to the satellite.

1995 Jul 13/1342		1995-035A		Discovery (STS-70)	88,540 kg
1995 Jul 14.12	28.46 deg		90.99 min	316 km	331 km
1995 Jul 15.25	28.47 deg		90.54 min	287 km	315 km
1995 Jul 13/1342		1995-035B		TDRS 7	2,225 kg
1995 Jul 31.40	0.03 deg		1,436.27 min	35,790 km	35,790 km

Shuttle carried five astronauts: T T Henricks (commander), K R Kregel (pilot), D A Thomas (mission specialist, MS-1), N J Currie [nee Sherlock] (MS-2) and M E Weber (MS-3). Mass quoted above is that projected for the time of landing. Various biological, and technical experiments undertaken by the crew inside the shuttle orbiter. Launched from and landed at the Kennedy Space Center (landing July 22 at 1202 UTC).
TDRS 7 ("Tracking and Data Relay Satellite", TDRS G before launch) and the Inertial Upper Stage stack deployed from orbiter's payload bay Jul 13 at 1955 UTC. Satellite to be stationed over 189 deg E but was apparently initially located over 210 deg E. Expected operating period is ten years.
IUS lower stage left in the following orbit: 26.31 deg, 632.48 min, 306-35,753 km. Orbit for upper stage is: 1.98 deg, 1,432.31 min, 35,666-35,759 km.

Launch Date/Time		Int Des	Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Jul 20/0304		1995-036A	Progress-M 28	7,250 kg *
1995 Jul 22.12	51.64 deg	90.96 min	293 km	351 km
1995 Jul 23.07	51.65 deg	92.48 min	394 km	398 km

Unmanned cargo freighter, carrying supplies to the cosmonauts aboard the Mir Complex. Spacecraft docked at the front (+X) port of Mir 1995 Jul 22 at 0440 UTC. Launched from Tyuratam using a Soyuz vehicle: no orbital data was issued via the Goddard Space Flight Center during the first 48 hours in orbit.

1995 Jul 24/1552		1995-037A	Cosmos 2316	1,300 kg *
1995 Jul 25.13	64.85 deg	675.26 min	19,101 km	19,135 km
1995 Aug 8.21	64.87 deg	675.74 min	19,084 km	19,176 km
1995 Jul 24/1552		1995-037B	Cosmos 2317	1,300 kg *
1995 Jul 25.13	64.84 deg	675.37 min	19,110 km	19,132 km
1995 Aug 9.21	64.85 deg	675.75 min	19,037 km	19,223 km
1995 Jul 24/1552		1995-037C	Cosmos 2318	1,300 kg *
1995 Jul 25.13	64.86 deg	675.26 min	19,101 km	19,135 km
1995 Aug 14.37	64.84 deg	675.73 min	19,037 km	19,223 km

Three "Uragan" navigation satellites in the GLONASS system, built by NPO Prikladnoi Mekhaniki: launched into plane 2 of the system. Operational lifetime of each satellite is expected to be about five years. Launched by a four-stage Proton from Tyuratam. Third stage was in a low Earth orbit inclined at 64.8 degrees but no orbital data was issued before orbital decay within about a day of launch: fourth stage in an orbit similar to the first one listed for the satellites.

1995 Jul 31/2330		1995-038A	DSCS-3B 4 (USA 113)	1,040 kg *
	Geosynchronous orbit			

Improved DSCS-3 ("Defense Satellite Communications System") satellite, built by Martin Marietta Astro Space. Mass quoted above includes propellant. Operating lifetime is expected to be about ten years. No orbital data issued for this mission. Satellite should be in a geosynchronous orbit. Launch vehicle was an Atlas 2AS with the second stage being left in a geosynchronous drift orbit: IABS ("Integrated Apogee Boost Subsystem") was discarded in a geosynchronous drift orbit.

Launch Date/Time		Int Des	Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Aug 2/2359		1995-039A	Interball 1	1,250 kg *
1995 Aug 6.87	62.90 deg	5,458.17 min	870 km	191,752 km
1995 Aug 2/2359		1995-039F	MAGION 4 (C-2T)	58.7 kg
1995 Aug 3.39	63.27 deg	5,454.22 min	761 km	191,762 km

Also called Interball Tail Probe, Interball 1 is the first flight of the new Prognoz-M2 scientific satellite "bus". Major international scientific research programme investigating the magnetosphere and plasmasphere: countries involved are Austria, Bulgaria, Canada, Cuba, Czech Republic, ESA, Finland, France, Germany (former GDR), Hungary, Poland, Romania and Sweden. Associated Interball Auroral Probe is planned for a 1996 launch. MAGION 4 is provided by the Czech Geophysical Institute's Ionosphere Department: satellite systems were developed and manufactured under international collaboration with Austria, France, Germany, Hungary, Poland, Slovakia, Romania and Russia. The satellite is studying solar wind energy. Launched from Plesetsk using a Molniya-M vehicle: third stage left in an orbit with the following parameters: 62.83 deg, 94.61 min, 233-766 km. fourth stage in an orbit similar to the satellites.

Launch Date/Time		Int Des	Satellite	Mass
Epoch	Incl	Period	Perigee	Apogee
1995 Aug 3/2358		1995-040A	PAS 4	3,043 kg
1995 Aug 4.49	4.17 deg	635.61 min	500 km	35,719 km
1995 Aug 18.83	0.02 deg	1,434.74 min	35,722 km	35,798 km

PAM 4 (PanAmSat 4) is a communications satellite built by Hughes Space and Communications for the PanAmSat Corporation, Greenwich, Connecticut. Mass of satellite quoted above is at launch: in geosynchronous orbit it is 1,868 kg at the beginning of its life and 1,671 kg dry. Planned location of the satellite is 69 deg E. Operational lifetime should be 15 years. Launched from Kourou by and Ariane 42L: third stage in an orbit similar to the first one listed for the satellite.

1995 Aug 5/1110		1995-041A	Mugunghwa 1	1,459 kg
1995 Aug 5.88	20.57 deg	532.34 min	1,371 km	29,389 km
1995 Aug 10.65	0.22 deg	1,074.12 min	26,911 km	29,817 km
1995 Aug 31.33	0.06 deg	1,436.53 min	35,781 km	35,809 km

Mugunghwa 1 (also called KOREASAT 1) is a communications satellite built by Martin Marietta Astro Space as prime contractor for Korea Telecom in Seoul. Mass of the satellite quoted above is at launch: on station at the beginning of its life it should have been 833 kg and the dry mass is 641 kg. Planned operational life was to be ten years plus two years in-orbit storage. After launch from Cape Canaveral one of the nine solid-propellant Hercules GEM strap-on boosters failed to separate from the Delta 2 first stage and as a result the third stage failed to reach its planned orbit: 20.37 deg, 1,354-35,786 km, but in making up for the added mass of the GEM the vehicle could only reach an orbit about 6,000 km lower. As a result, Mugunghwa 1 had to use its own propellant to raise not just the perigee altitude to geosynchronous orbit (as planned), but also raise the apogee altitude. Because of this unplanned propellant use, the operational lifetime of the satellite is now expected to be approximately 5 years. Orbital location 116 deg E. Delta second stage left in a 26.67 deg, 108.47 minutes, 938-1,374 km orbit: third stage in an orbit similar to the first one listed for the satellite.

1995 Aug 9/0221		1995-042A	Molniya-3 47	1,750 kg
1995 Aug 9.14	62.82 deg	736.94 min	421 km	40,875 km
1995 Aug 16.31	62.80 deg	718.62 min	427 km	39,969 km

Communications satellite, co-planar with Molniya-3 31, manufactured by NPO Prikladnoi Mekhaniki: expected operational lifetime is about five years. Launched from Plesetsk using a Molniya-M vehicle. Third stage left in the following orbit: 62.82 deg, 90.56 min, 209-395 km. Fourth stage in an orbit similar to the first one listed for the satellite.

1995 Aug 15/2230		GEMstar	1127 kg
	Failed to reach orbit		

Maiden flight of Lockheed Launch Vehicle 1 (LLV 1). GEMStar 1 ("Global Electronic Messaging" satellite) was built by CTA Incorporated, Rockville, Maryland and planned to provide communications for CTA and VITA ("Volunteers in Technical Assistance"). Planned orbit was 88 deg, 670 km circular altitude. After launch from Vandenburg when the LLV 1 second stage began to fire the launch vehicle veered off-course and had to be destroyed.

Launch Date/Time		Int Des	Satellite		Mass
Epoch	Incl	Period		Perigee	Apogee
1995 Aug 29/0053		1995-043A	JCSat 3		1,820 kg
1995 Aug 30.79	23.22 deg	1,685.13 min		261 km	80,799 km

JCSat 3 is a Hughes HS-601 communications satellite launched for Japan Satellite Systems Inc, Tokyo and planned to enter geosynchronous orbit. Design lifetime of the satellite is 12 years. Launched from Cape Canaveral using an Atlas 2AS vehicle: second stage in a similar super-synchronous orbit to the one listed above for the satellite.

1995 Aug 29/0641		1995-044A	N-STAR a		3,410 kg
1995 Aug 29.95	7.03 deg	630.32 min		172 km	35,775 km
1995 Aug 30.79	0.09 deg	1,391.64 min		34,091 km	35,733 km

N-STAR a (lower-case "a" is the correct designation) is a telecommunications satellite built by Space Systems/Loral and to be operated by Space Systems/Loral for Nippon Telegraph and Telephone Corporation, Tokyo. Satellite to be deployed over 132 deg E and the planned operational life is ten years. Launched from Kourou using an Ariane 44P: third stage is in an orbit similar to the first one listed for the satellite.

1995 Aug 30/1930		1995-045A	Cosmos 2319		2,300 kg *
1995 Aug 31.65	1.48 deg	1,441.02 min		35,806 km	35,960 km

"Geizer" communications and data relay satellite, launched as part of the Potok system. Believed to be used primarily for military communications, including space-to-space-to-ground communications with photoreconnaissance satellites. Manufactured by NPO Prikladnoi Mekhaniki. To be operated over 80 deg E. Expected operating lifetime is about five years. Launched from Tyuratam using four-stage Proton. Third stage was left in an orbit with the following parameters: 51.65 deg, 88.34 minutes, 190-195 km. Fourth stage in an orbit similar to the satellite.

1995 Aug 31/0650		1995-046A	Sich 1/FASat-Alfa		1,960 kg *
1995 Sep 1.36	82.53 deg	97.73 min		632 km	669 km

Sich 1 is an oceanographic satellite built by NPO Yuzhnoye and a modification of the bureau's Okean-O1 satellite design: mass approximately 1.9 tonnes. Satellite carries infra-red sensors plus a radar system. Operating lifetime is probably about five years. FASAT-Alfa is a microsatellite built by Surrey Satellite Technology Ltd for the Chilean Air Force: mass of 57 kg. Carries cameras to image the ozone layer over Chile and a communications package for electronic mail. After launch the satellite should have separated from Sich 1 about six hours after launch, but the separation failed, although the separation command was received by the satellite. Launched from Plesetsk using a three-stage Tsyklon: third stage in an orbit similar to that of the satellites.

Updates and Additions

1978-062A: The last orbital manoeuvre for GOES 3 took place during Dec 22-25, 1994 with the satellite being located over 184 deg E. Since then the satellite has been allowed to drift in longitude. By the end of July 1995 it was located over 200 deg E in an orbit with a period of 1,435.20 minutes. Although confirmation of the satellite's status has not been received, it is possible that it has been retired.

1979-098B: DSCS-2 14 was manoeuvred out of the geosynchronous orbit band approximately Apr 12, 1995: at the time the satellite had been over 84 deg E. In fact the satellite had been drifting in longitude for at least nine months: at the beginning of August 1994 it had been over 70 deg E and was drifting at that time. The manoeuvres initiated in April 1995 probably marked the actual retirement of the satellite. The following is the retirement orbit:1995 Jun 29.27, 10.40 deg, 1,464.14 minutes, 36,313-36,355 km

1982-110B: SBS 3 manoeuvred off-station over 286 deg E approximately Jun 1, 1995. At the end of July the satellite was still drifting in a 1,441 minutes orbit, and it is unclear whether the satellite has been retired or whether it is being relocated to a fresh longitude.

1983-026B: Approximately Aug 3, 1995 TDRS 1 stabilised its orbital longitude over 220-221 deg E.

1984-023A: INTELSAT 508 was manoeuvred off-station over approximately 180 deg E during approximately Dec 17-18, 1994 and has been retired. The following is the retirement orbit: 1995 Jan 3.17, 3.14 deg, 1,480.12 minutes, 36,545-36,743 km

1984-080A: Himawari 3 was manoeuvred off-station over 119-120 deg during the final week of June 1995. It was still drifting in orbit at the end of July and it might have been retired. The following is the post-manoeuvre orbit:1995 Jul 19.70, 6.02 deg, 1,442.20 minutes, 35,900-35,912 km

1984-114A: Spacenet 2 manoeuvred off-station over 290 deg E during the first week of August 1995 and was still drifting slowly to the west at the end of the month.

1986-017A: On Jul 17, 1995 the Kristall module (1990-048A) was relocated from the +X longitudinal axis of the Mir core module to the -Z axis.

1986-026B: BRASILSAT A2 re-stabilised its orbital location over 267-268 deg E approximately Aug 16-17, 1995.

1987-078A: Optus-A 3 was manoeuvred off-station over 155-156 deg E approximately Aug 14, 1995 and was still drifting slowly to the west at the end of the month.

1987-084A: Cosmos 1888 stopped performing orbital corrections in December 1994 and has drifted off-station over 345-346 deg E. It is believed that the satellite is no longer operating.

1988-040A: INTELSAT 513 was manoeuvred off-station over 306 deg E during Jul 8-11, 1995: it had its orbital longitude re-stabilised over 182-183 deg E approximately Aug 25, 1995.

1988-091B: The date that TDRS 3 was manoeuvred off-station was not reported in the last issue of "Satellite Launch Report": the manoeuvre took place at the end of April 1995.

1989-030A: Raduga 23 was manoeuvred off-station over 335 deg E approximately Aug 16, 1995 and was still drifting to the east at the end of the month.

1989-070A: Himawari 4 was manoeuvred off-station over 139 deg E approximately Jun 9, 1995. The satellite was still drifting at the end of July 1995 and it is possible that it has been retired, although confirmation of the satellite's status has not been forthcoming. Add the following orbital data for the satellite: 1995 Jun 13.89, 1.02 deg, 1,437.88 minutes, 35,781-35,862 km

1989-084B: The Jupiter Entry Probe separated from the Galileo Jupiter Orbiter Jul 12, 1995 at 0530 UTC and has been designated 1989-084E, but no catalogue number has been assigned.

1992-090A: Combined Optus-B 2 core/CZ-2E third stage decayed from orbit Jun 29, 1995.

1993-060A: Cosmos 2264 decayed from orbit Aug 7, 1995.

1994-012A: Raduga 31 has not performed any orbital corrections since mid-May 1995 and has now drifted off-station over 44-45 deg E. It is unclear whether or not the satellite is still operating.

1995-027A: At the beginning of July 1995 UFO 5 was manoeuvred away from 189 deg E and drifted until approximately Jul 22 when the orbit was stabilised over 73 deg E.

1995-029A: DBS 3 was relocated from 249-250 deg E and relocated over 260 deg E during Jul 15-28, 1995: insufficient orbital data are available to pin-point the actual manoeuvre dates.

1995-030A: Atlantis (STS-71) landed at the Kennedy Space Center Jul 7, 1995 at 1454 UTC. Add the following orbital data:
1995 Jul 4.25, 51.65 deg, 92.48 minutes, 394-398 km
1995 Jul 5.29, 51.65 deg, 92.44 minutes, 391-398 km

Masses of Tseline-2 Satellites

Tselina-2 is the Russian programme name for the large ELINT satellites which have been launched using the Cosmos cover name into 71 deg, 850 km orbits: there were two payload tests using the Proton-4 launch vehicle before the Zenit-2 launches commenced. Calculations suggest that the Proton-4 payloads were approximately 3,250 kg at a maximum", and therefore the virtually identical Zenit-2 payloads will have approximately the same mass: this is far less than the approximately 9 tonnes which the Zenit-2 could theoretically launch into these orbits. Therefore, the masses of the following satellites should be amended to "3,250 kg ?":

Proton-4 launches: 1984-106A Cosmos 1603 1985-042A Cosmos 1656
Zenit-2 launches: 1985-097A Cosmos 1697 1985-121A Cosmos 1714
1987-027A Cosmos 1833 1987-041A Cosmos 1844 1988-039A Cosmos 1943
1988-102A Cosmos 1980 1990-046A Cosmos 2082 1992-076A Cosmos 2219
1992-093A Cosmos 2227 1993-016A Cosmos 2237 1993-059A Cosmos 2263
1994-023A Cosmos 2278 1994-077A Cosmos 2297

Cosmos 1714 failed to reach its intended orbit due to a malfunction with the Zenit-2's second stage propulsion system.

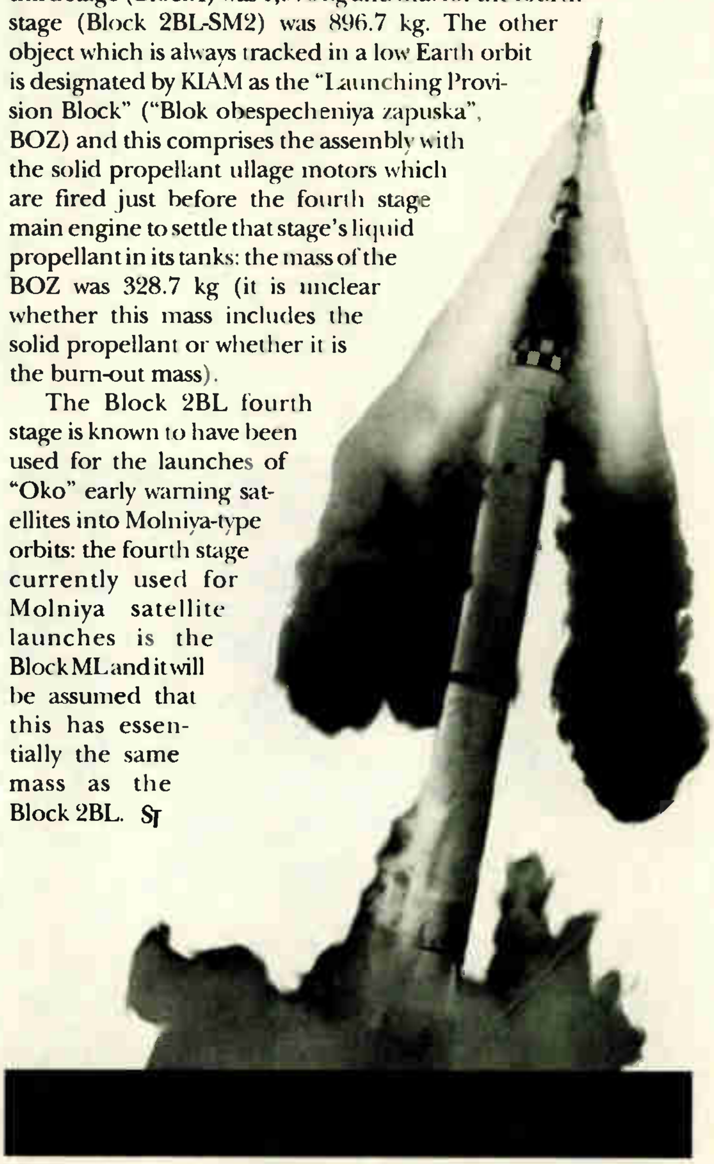
"Strela-1" Communications Satellites

"Strela-1" is the name given by the Russians to the small communications satellites which were launched in groups of eight using the Cosmos launch vehicle into near-circular 1,400-1,500 km orbits inclined at 74 deg to the equator starting in 1970. Nicholas L Johnson of Kaman Sciences Corporation was shown one of the satellites during a recent trip to Russia. The satellite is a spheroid with an "equatorial" belt of solar cells and further strips of solar cells running from the "equator" to the "poles": the top of the satellite carries an array of antennae. The size of the satellite is about 1 metre diameter and the description of the satellite states that the mass is 61 kg.

Molniya-M Launch Vehicle Upper Stages

The Worldwide Web Home Page for the Keldysh Institute of Applied Mathematics (KIAM) carried detailed numerical data for the Molniya-M launch vehicle used for the Interball 1 mission (see 1995-039 launch detailed above). The dry mass of the third stage (Block I) was 1,976 kg and that for the fourth stage (Block 2BL-SM2) was 896.7 kg. The other object which is always tracked in a low Earth orbit is designated by KIAM as the "Launching Provision Block" ("Blok obespecheniya zapuska", BOZ) and this comprises the assembly with the solid propellant ullage motors which are fired just before the fourth stage main engine to settle that stage's liquid propellant in its tanks: the mass of the BOZ was 328.7 kg (it is unclear whether this mass includes the solid propellant or whether it is the burn-out mass).

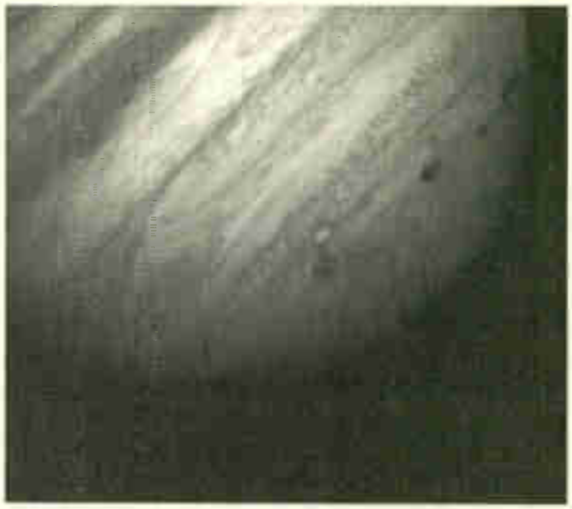
The Block 2BL fourth stage is known to have been used for the launches of "Oko" early warning satellites into Molniya-type orbits: the fourth stage currently used for Molniya satellite launches is the Block ML and it will be assumed that this has essentially the same mass as the Block 2BL. ST



ST NASA SPACE NEWS

By John A. Magliacane, KD2BD

Hubble's Greatest Hits

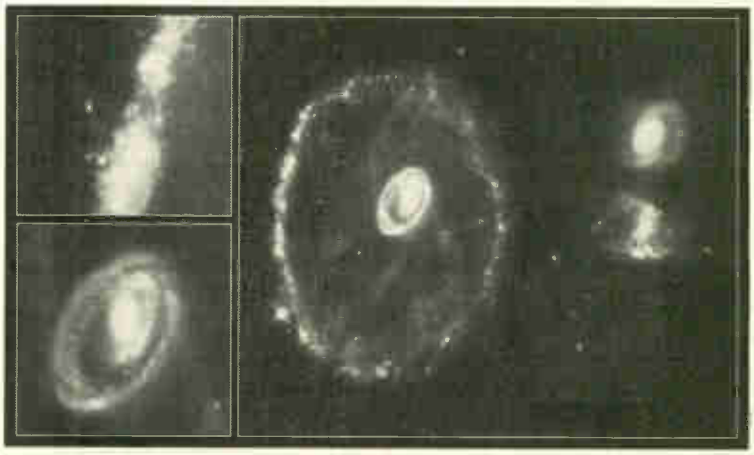


Comet P/Shoemaker-Levy 9 Bombards Jupiter
This image of Jupiter was taken with the HST Planetary Camera. Right impact sites made by the comet are visible. The smallest features in this image are less than 200 kilometers across. (Photo Credit: HST Comet Team and NASA)

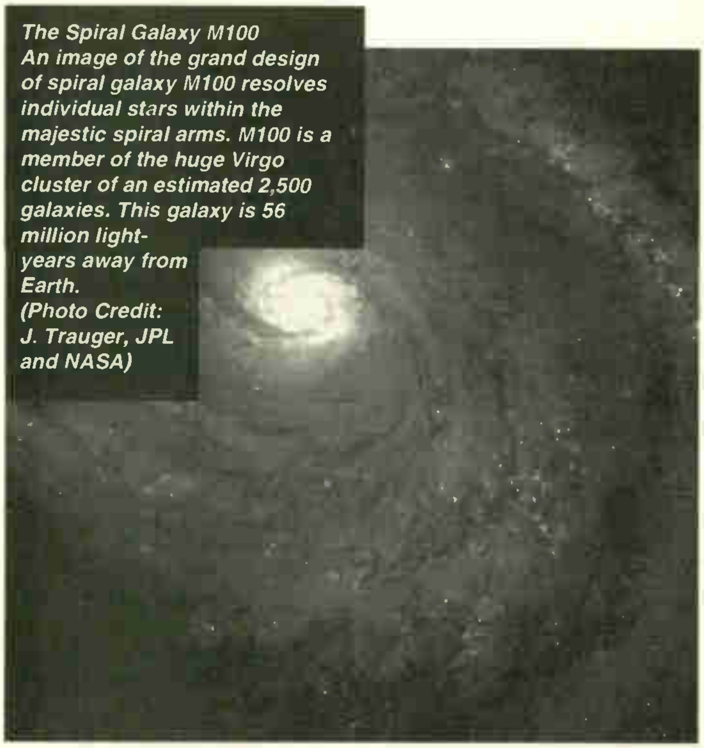
Launched on April 24, 1990, NASA's Hubble Space Telescope was designed to be the most powerful astronomical observatory ever built. And indeed, HST far surpasses the capabilities of ground-based optical telescopes for many types of research. The keys to Hubble's power are its operation in space, far above the interference of Earth's atmosphere, and to the unique instruments it carries as it orbits the planet.

December marks the second anniversary of the first Hubble service mission by the shuttle crew of Endeavor. The crew of STS-61 repaired Hubble blurred vision caused by a focusing defect with the telescope's primary mirror. The results so far have been fantastic. In this edition of *NASA News, ST* presents ten of Hubble's most spectacular celestial images (including cover) taken over the last three years.

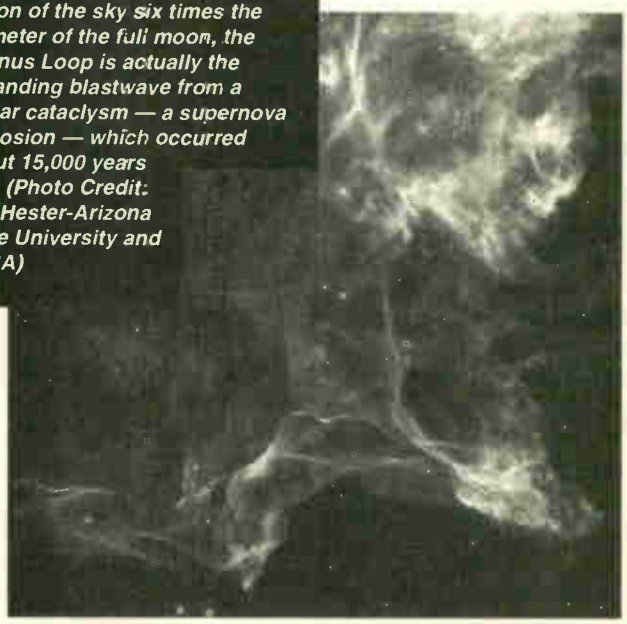
Cartwheel Galaxy
A rare and spectacular head-on collision between two galaxies appears in this NASA HST image of the Cartwheel Galaxy, located 500 million light-years away in the constellation Sculptor. (Photo Credit: Kirk Borne-ST ScI and NASA)



The Spiral Galaxy M100
An image of the grand design of spiral galaxy M100 resolves individual stars within the majestic spiral arms. M100 is a member of the huge Virgo cluster of an estimated 2,500 galaxies. This galaxy is 56 million light-years away from Earth. (Photo Credit: J. Trauger, JPL and NASA)

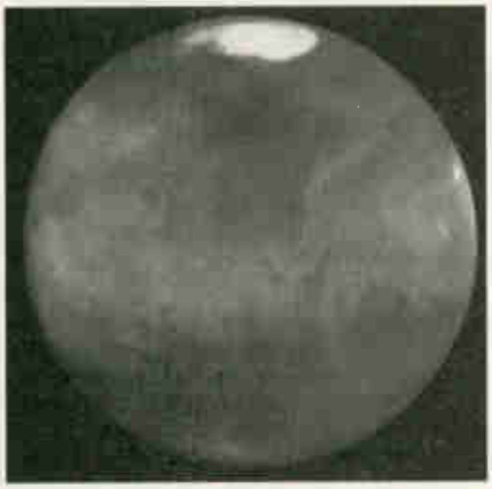


Cygnus Loop
This image shows a small portion of a nebula called the "Cygnus Loop." Covering a region of the sky six times the diameter of the full moon, the Cygnus Loop is actually the expanding blastwave from a stellar cataclysm — a supernova explosion — which occurred about 15,000 years ago. (Photo Credit: Jeff Hester-Arizona State University and NASA)



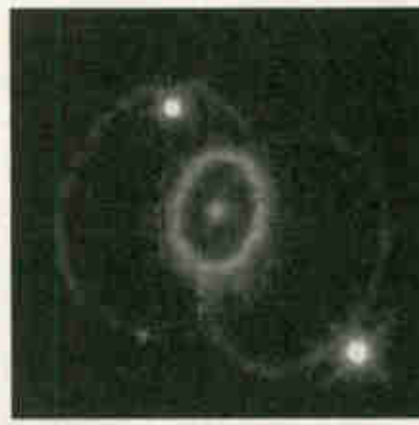
Springtime on Mars

This NASA HST view of the planet MARS is the clearest picture ever taken from Earth, surpassed only by close-up shots sent back by visiting space probes. The picture was taken on February 25, 1995, when MARS was at a distance of approximately 103 million kilometers (65 million miles) from Earth. (Photo Credit: Philip James-University of Toledo, Steven Lee-University of Colorado and NASA)



Saturn Storm

An image of the ringed planet Saturn shows a rare storm that appears as a white arrowhead-shaped feature near the planet's equator. The east-west extent of this storm is equal to the diameter of the Earth (about 7,900 miles). The storm is generated by an upwelling of warm air, similar to an Earth thunderstorm. (Photo Credit: Reta Beebe-New Mexico State University, D. Gilmore, L. Bergero-ST Sci and NASA)



Supernova 1987A Rings

This striking HST picture shows three rings of glowing gas encircling the site of supernova 1987A, a star which exploded in February 1987. Though all the rings appear to be inclined to our view (so that they appear to intersect) they are probably in three different planes. This supernova is 169,000 light-years away, and lies in the dwarf galaxy called the Large Magellanic Cloud, which can be seen from the southern hemisphere. (Photo Credit: Dr. Christopher Burrows-ESA/ST Sci and NASA)

The Orion Nebula-Stellar Birthplace

This is one of the nearest regions of very recent star formation (300,000 years ago). The nebula is a giant gas cloud illuminated by the brightest of the young hot stars at the top of the picture. Many of the fainter young stars are surrounded by disks of dust and gas that are slightly more than twice the diameter of our Solar System. (Photo Credit: C.R. O'Dell-Rice University and NASA)

Elliptical Galaxy NGC4261

A giant disk of cold gas and dust fuels a possible black hole at the core of this elliptical galaxy. Estimated to be 300 light-years across, the disk is tipped enough (about 60 degrees) to provide astronomers with a clear view of the bright hub, which presumably harbors the black hole. (Photo Credit: ST Sci and NASA)

By John A. Magliacane, KD2BD

Hams In Space

Amateur space communications usually involves communications between terrestrial amateur radio stations using a satellite high above the earth or the moon as a communications relay. Over the past decade, however, direct radio contacts between amateur radio operators on the ground and amateur radio operators in earth orbit have been possible through Shuttle Amateur Radio Experiments (SAREXs) and the permanent amateur radio station carried on-board the Russian space station Mir. Ham in space missions bring a new level of excitement to amateur space communications, and provide a fascinating recreation activity for the hams in space.

The first time amateur radio equipment was carried into space was during the U.S. space shuttle mission STS-9 in late November 1983. During this mission, astronaut/ham Dr. Owen Garriot, W5LFL, carried a modified Motorola MX-300 handheld 2-meter FM transceiver into orbit on the space shuttle Columbia. Owen made contacts with over 250 amateur radio operators worldwide. Some of the most memorable ones were those made by hams who made two way contact with the astronaut from mobile stations in their cars, and children who were able to ask questions of the astronaut from their schools.

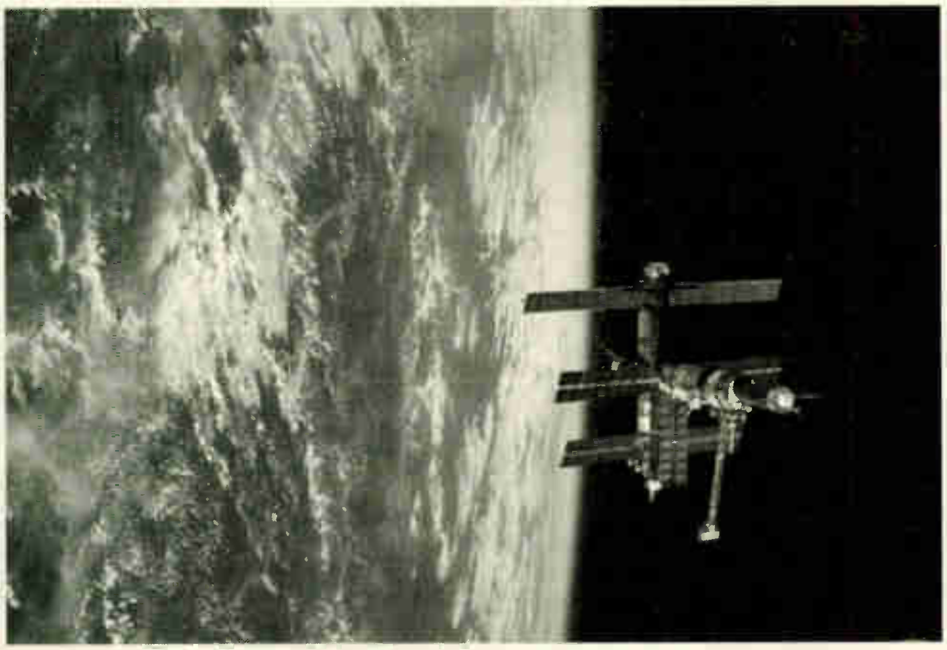
The first SAREX mission was a great success, and it inspired further expansion of the SAREX program. It also encouraged other astronauts to get their ham licenses so they could operate from space. Consideration was given to adding 10-meter FM capability, a cross-band FM repeater, two-way slow-scan television (SSTV) image exchange, fast-scan amateur television (FSTV) and packet radio communications. Plans of operating on the 10-meter band were abandoned because of the difficulty in mounting an external antenna on the space shuttle for SAREX purposes. Packet radio and SSTV communications, however, had the advantage of being somewhat automated, leaving the operator on-board free to conduct his scientific work on the spacecraft while amateur radio contacts were made with groundstations around the globe and around the clock.

Video From Space

The first SAREX mission to use slow-scan television communications was space shuttle flight STS-51F in August 1985. During this mission, astronaut/ham Dr. Tony England, W0ORE, took snapshots of shuttle video and transmitted them on an almost continuous basis as slow-scan television images on 2-meters. The scan conversion between the video on the shuttle and the slow-scan television format was handled by a Robot Research model 1200C digital color scan converter. Several different image formats were supported by the shuttle in an effort to be compatible with the majority of SSTV monitors and scan converters of the world. Figure 1 shows a low-resolution black-and-white SSTV image copied from the space shuttle Challenger by KD2BD in New Jersey in August 1985. The image shows the earth through the windows of the space shuttle "Challenger" and astronaut Gordon Fullerton sitting to the right while a book floats in zero gravity above his head. Slow-scan television images transmitted by groundstations to the space shuttle during this mission represented the first time television pictures were actively received by astronauts in space. The ability of being to receive images from the ground was viewed as a great asset to NASA managers who continue to bless SAREX missions to this day.

In 1991, space shuttle "Atlantis" flying on mission STS-37 carried a total of five astronauts with amateur radio licenses on a historic SAREX mission that included the first reception of 70-cm fast-scan amateur television signals from the earth by the space shuttle. FSTV uses the same transmission protocol as broadcast television in the United States—NTSC. The signal level to reach the space shuttle on amateur TV,

Astronaut Dr. Owen Garriott (W5LFL) used an ordinary Amateir radio hand-held transceiver during preliminary tests inside the shuttle simulator at the Johnson Space Center in Houston, Texas. Garriott operated W5LFL during the first ham SAREX mission STS-9. (NASA Photo)



The Russian space station Mir carries a multi-mode Amateur Radio station that has been active by every crew of the spacecraft since November 1988. (Photo courtesy of NASA)

however, is very high. One of the stations successful in transmitting a recognizable full-motion video picture to the space shuttle on mission STS-37 was WA3NAN, the club station of the Goddard Space Flight Center, in Greenbelt, Maryland. WA3NAN used 1 kilowatt of transmitter power and 30 foot (9 meter) dish at the Naval Academy in Annapolis, Maryland to accomplish this historic event. Not enough power is available from the space shuttle to permit transmission of amateur television video to groundstations, but for single frame images, slow-scan television works extremely with a large savings in transmitter power.

Packet Radio and SAREX

Packet radio equipment was used on the space shuttle Columbia for the first time by astronaut/ham Dr. Ron Parise, WA4SIR, during the STS-35 mission in 1990. The packet radio terminal node controller (TNC) used during the mission had an automatic mode called a ROBOT. The ROBOT was able to make packet contacts with groundstations, issue contact numbers, and keep a log of contacts without any user intervention. Keyboard to keyboard contacts were also possible with the astronauts through the use of the laptop computer connected to the TNC on the space shuttle, and the TNC was able to send beacon transmissions containing short text messages from the astronauts.

SAREX Configurations

SAREX flies in one of several different configurations depending on what capabilities are desired for a particular mission. SAREX configuration A has the ability to communicate with groundstations using FM voice (attended), packet radio (attended/unattended), and SSTV (attended/unattended). Configuration B carries FM voice capabilities only. Configuration C adds packet radio capability to the FM voice capability of Configuration B, while Configuration D adds fast-scan television capability to Configuration C. Configuration E has the same communications capabilities as Configuration D, but accomplishes this with different hardware as that used for Configuration D.

SAREX Operating Frequencies

Most SAREX operations take place on separate transmit and receive frequencies to prevent groundstations attempting to contact the shuttle from interfering with the SAREX downlink. Groundstations should listen to the SAREX downlink frequency and transmit on an appropriate uplink frequency only when the shuttle is in range and the astronauts are on the air. Groundstations should **NOT** transmit on the SAREX downlink frequency in an attempt to contact the astronauts.

Packet radio communications usually take place using an uplink frequency of 144.490 MHz and a downlink of 145.550 MHz. 145.550 MHz is also used as downlink for voice communications. Voice uplink frequencies are varied and depend on geography. Groundstations in Europe use uplink frequencies of 144.700, 144.750, and 144.800 MHz. Groundstations in other parts of the world use 144.910, 144.930, 144.950, 144.970, and 144.990 MHz as SAREX uplink frequencies. The selection of the uplink frequency used by the astronauts is random making anyone's chance of contacting the shuttle "the luck of the draw".

Many things have changed since the first SAREX contacts flew on the U.S. space shuttles. Most importantly, many of the frequencies used on early SAREX missions have become occupied by terrestrial Amateur Radio stations for packet radio communications. As a result, the SAREX radio equipment on the space shuttles experience intense interference from packet radio users, especially those operating on designated SAREX uplink frequencies. While it is relatively easy for a groundstation to change operating frequencies during a space shuttle mission carrying SAREX equipment with the twist of a knob, the same cannot be said for the astronauts operating the SAREX equipment on the space shuttle. The frequencies used by shuttle amateur radio experiments are those that have met approval by NASA for operation by licensed amateurs flying on space shuttle missions, and were selected many years ago before terrestrial 2-meter packet radio communications achieved the high popularity it enjoys today. In addition, the handheld Motorola 2-meter transceiver is the only transceiver approved by NASA for use during SAREX missions, and has limited 2-meter band coverage. The window mounted indoor antenna used during SAREX operations has also been reported to exhibit a narrow operating bandwidth.

American astronauts have not been the only people to carry amateur radio equipment into the space shuttle. In November 1985, several Dutch and German amateurs operating from the European SPACELAB-D1 carried onboard space shuttle Challenger during mission STS-61A made crossband (70-cm uplink, 2-meter downlink) contacts with groundstations using a 10-watt transmitter and an external 1/4-

wave aluminum whip antenna. Some of the amateur transmissions made by the astronauts were part of a space propagation experiment sponsored by the Dutch Veron Society. Two-way voice contacts were made as time permitted, otherwise signals received on the 70-cm uplink frequency were logged using a tape recorder while the 2-meter transmitter acted as a powerful CW beacon from space.

The SAREX program is made possible through the hard work and dedication of volunteers and the cooperation and financial backing of NASA, the Radio Amateur Satellite Corporation of North America (AMSAT-NA), and the American Radio Relay League (ARRL). The primary goals of SAREX are to share the spaceflight experience with the largest community possible, and to encourage youth's interest in science, technology, and amateur radio. 6,000 students participated in SAREX activities during the STS-51F mission alone.

Today, contacts between schools and astronauts are common, and can be scheduled through the educational activities department of the ARRL. The more a groundstation can offer in terms of media publicity and student involvement, the greater the chances of being scheduled a time, date, and frequency to talk to the astronauts. Obviously, the shuttle's orbital mechanics will play an important role in choosing which schools with be given a scheduled contact, but there have been cases where schools in medium to high latitudes have been given the opportunity to communicate with the shuttle astronauts during low-inclination flights through a telebridge connection that linked a northern school to a southern amateur radio station that actually provided the air-to-ground communications link.

Amateur Radio on Mir

Amateur radio operations from the Russian space station Mir began in November 1988. Using the call sign U1MIR, cosmonaut Vladimir Titov used a Yaesu FT-290R 2-meter FM transceiver, 2.5 watts of power, and an external ground plane antenna on the Mir spacecraft to make voice contacts with amateur radio operators on the earth. Titov's colleagues Musa Manarov and Valery Polyakoav also made radio contacts with groundstations using call signs of U2MIR and U3MIR, respectively. A total of eleven cosmonauts used the Yaesu FT-290R to make radio contacts with groundstations during the non-working (recreational) periods of their days in space. In February 1991, an ICOM IC-228A/H 2-meter transceiver was brought to Mir in addition to a PacComm "Handi-Packet" packet radio terminal node controller and a lap top computer. The new equipment gave the Mir cosmonauts the ability to make packet radio contacts with groundstations, operate a personal electronic message system on the spacecraft, and operate with up to 25-watts of transmitter power anywhere within the bounds of the 2-meter amateur band.

The cosmonauts on Mir have traditionally been very active the 2-meter band, especially those who spoke English. The cosmonauts made regular voice contacts with groundstations during their recreational periods, and left their TNC on during their working hours. The TNC allowed groundstations to use Mir as a packet radio digital repeater system (digipeater), as well as a maildrop for the cosmonauts or other groundstations in other parts of the world. However, the station's single user capabilities severely limited the number of stations who could access the TNC, and the high volume of groundstations fighting to connect with the TNC's mailbox made automated contacts with the Amateur station on Mir less than recreational for groundstations. Others located in less populated areas of the world, however, had great success in accessing the personal message system (PMS) on Mir, and even managed to schedule voice contacts with the cosmonauts by coordinating their activities in advance through the Mir PMS.

Interestingly enough, the amateur radio equipment carried on Mir has been reported to have been used by the cosmonauts for official communications with ground control on their VHF-FM air-to-ground frequency of 143.625 MHz. The packet radio hardware has also been used as it has been found to offer improved performance over the baudot teletype links that have been used from the mission control center to Mir. The amateur radio station on Mir has also been used to make voice contacts with American astronauts flying the space shuttles during SAREX missions.

SSTV image showing astronaut Gordon Fullerton sitting in the front seat of the Space Shuttle "Challenger" copied by KD2BD during mission STS-51F in August 1985. (Photo courtesy of KD2BD)

Mir Operating Guidelines

The personal message system on Mir can only support a single connection at a time. It only takes one station operating improperly to ruin an entire pass for a populated area such as the continent of North America. In general, the packet radio call sign used on Mir that does not contain a secondary station identifier (SSID) is the keyboard port of the lap top computer on Mir. The keyboard port is used 145.550 MHz as a simplex communications frequency with groundstations, however as a result of the International Amateur Radio Union (IARU) meeting held at the AMSAT-UK International Space Colloquium this summer, Mir will begin using 145.800 MHz as a downlink frequency and 145.200 MHz as an uplink frequency. Mir is not abandoning its use of 145.550 MHz, but rather is simply adding to the number of frequencies upon which it may be heard operating.

The EUROMIR '95 mission also brings with it new 70-cm amateur radio equipment as well a 9600 baud FSK packet radio modem, and a new slow-scan television imaging system. The SSTV system will transmit pictures taken by a still video camera aboard Mir as packet radio data. Groundstation software designed by Eberhard Backeshoff, DK8JV, the author of the popular JVFAX program, will allow reception of SSTV images from Mir using a permanent presence on the Mir Space Station in its various forms speak clearly of its versatility and value to a crew of a manned spacecraft. The large number of astronauts who now hold amateur radio licenses almost guarantees that every space shuttle flight will carry a licensed ham radio operator. Be prepared for more amateur radio activity from space as shuttle amateur radio experiments continue, as the Mir station expands its capabilities, and a permanent amateur radio station becomes integrated into the U.S. space station Freedom. ST

TABLE 1

Typical SAREX equipment configurations and capabilities.

Configuration A: FM Voice (attended), Packet (attended/unattended), SSTV (attended/unattended)
Configuration B: FM Voice
Configuration C: FM Voice, Packet
Configuration D: FM Voice, Packet, SSTV, FSTV
Configuration E: FM Voice, Packet, SSTV, FSTV (different hardware)

TABLE 2

SAREX packet radio beacon from STS-70 copied on July 14, 1995 contained a short message from astronauts Don Thomas, KC5FVF, and Nancy Sherlock Curie, KC5OZX onboard space shuttle "Discovery".
W5RRR-1>QST <UI>:

Greetings from the STS-70 Crew aboard the space shuttle DISCOVERY!! We had a fantastic launch yesterday and a successful deploy of the Tracking and Data Relay Satellite. It was spectacular watching it move out of the payload bay. We look forward to making contact with as many people as possible during the next week. Thanks for your interest in our mission.
73's
Don and Nancy
(KC5FVF and KC5OZX)

TABLE 3

A text message from a Mir cosmonaut relayed to groundstations using packet radio equipment carried on the Mir space station.

Stat: PR
Posted: 91/10/09 11:35
To: ALL
From: U5MIR
@ BBS :
BID :
Subject: FROM FRANZ

Hi folks!
I'm sending my best regards from the Soviet space station MIR. Today I finished my work and experiments here. I'm very happy that so far everything was very successful. I had lots of experiments to do, and without my friends here on board (Sergeij, Anatoli, Toktar and Sascha) probably I wouldn't be so successful. Thanks a lot to them. As a scientist I want to send a message to all my colleagues that space-research is a wonderful field, and a lab in space is just extraordinary. Anatoli, Toktar and I are going to leave the station at night and tomorrow morning we will have our landing.

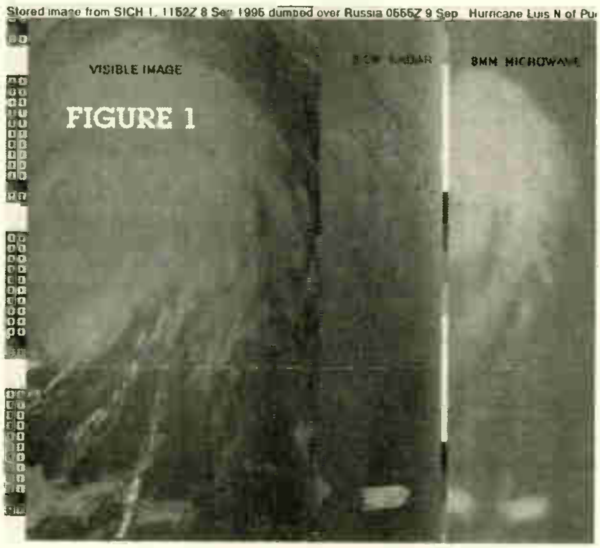
Thanks also to you and all the best!
Franz Viehboeck, Austrian Kosmonaut
from MIR station.
9.Oct.1991,11.35

ST THE VIEW FROM ABOVE

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

A New Launch!

A new Russian ocean-surveillance satellite was launched on August 31, 1995 from the Plesetsk cosmodrome atop a SL-14 Cyclone booster. It was the SICH-1 spacecraft. This bird is a one ton ocean surveillance platform, in a 650 mile high orbit inclined at 82.6 degrees to the equator. It has IR, radar, microwave, and visible imagery. We first thought this was the first of a new OKEAN-O series spacecraft, but in fact SICH-2 will be launched in early 1996. Note the similarity of the SICH imager to the OKEAN series. It is a store-and forward platform that transmits on 137.400 Mhz. Figure 1 shows the imagery of Hurricane Luis it captured over Puerto Rico on September 9, 1995.



Hurricanes....

Those *ST* readers who monitor the NOAA polar-orbiters and GOES weather satellites have been treated to a very active hurricane season in 1995! No less than seventeen hurricanes/tropical depressions have been imaged by members of the Dallas Remote Imaging Group (DRIG) at presstime, starting with Hurricane Allison and ending with Hurricane Noel and TD17. This has been an excellent opportunity to hone your satellite tracking skills and image enhancement toolkits.

Dr. Steve Padar has imaged Hurricane Marilyn on his home HRPT groundstation at 1.1 km. resolution (see Figure 2). An image of Hurricane Allison was obtained from the Defense Support Meteorological Program Satellite (DMSP) archives by DRIG on June 5th. (see Figure 3). Note the superb detail available on both the HRPT (1.1 km.) and DMSP (0.6 km) imagery. A future *View from Above* column in *ST* will discuss how to construct your own home HRPT image groundstation and receive these 1.1 km. images.

Weather satellite imaging has most certainly come a long way since the 'early days' of 1960 when on April 1, 1960, TIROS I captured this sequence of images over the St. Lawrence River and Gaspe' Peninsula. Speaking of the early days, this month we will conduct a brief review of the history of the United States weather satellite program and the evolution of direct-reading imaging using low-cost groundstation equipment.

In The Beginning....

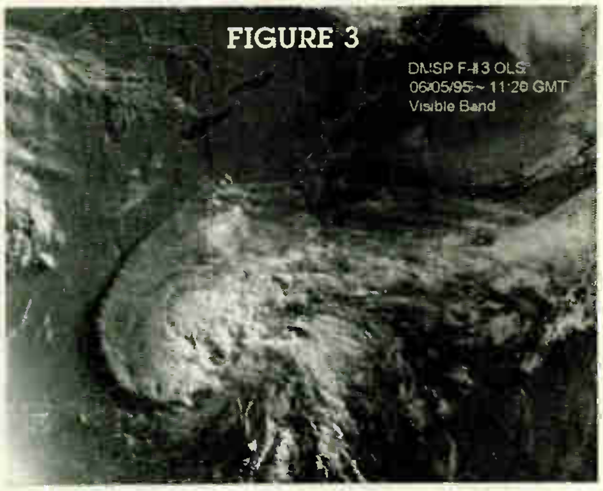
Earlier this century, aircraft were used to begin gathering data to enhance our understanding of the atmosphere. High-flying balloons used radiosondes for upper atmospheric research and measurements. After WW II (the Big One), captured German V-2 rockets and United State Viking rockets used cameras to determine the craft's orientation at specific points in the flight path. These cameras gave scientists the first upper atmosphere images of cloud patterns, and hinted at the future of meteorology. In 1954, new Aerobe rockets were specifically launched to return high altitude motion pictures of the Earth and cloud cover weather patterns.

Vanguard and Explorer....

Although TIROS 1 is considered to be the first satellite specifically designed for meteorological imagery, three other satellites carried weather experiments in the late 1950's: Vanguard II, Explorer VI, and Explorer VII.

Vanguard II, part of the early United States satellite program, was to use InfraRed photocells to detect reflectivity (or albedo) of the Earth below. The theory was that clouds, ice crystals, snow, and ground ice would be more reflective than typical land areas or even the oceans. Ground personnel could therefore use the telemetered reflectivity data to construct a 'picture' of the weather over a specified area. The spinning orbit of Vanguard II would allow the spacecraft to 'image' a strip along its orbit. Successive orbits would allow building up a mosaic picture from the combined reflectivity data. Unfortunately, as was often the case in the early days of the space program, Vanguard II wobbled badly in its orbit, and no useful data was obtained from this mission.

Explorer VI was launched in August, 1959 and carried an optics system that trans-



mitted television pictures to groundstations. This time, due to instrument malfunctions, the pictures were very blurry, but scientists were able to correlate ground-based observations of clouds with the images returned from the satellite. Explorer VII was launched in October, 1959, and sent back useful data from a set of temperature sensors that measured the Earth-Sun heat balance.

The TIROS Program Succeeds....

The TIROS (Television and Infrared Observation Satellite) spacecraft was the first 'true' weather satellite. The TIROS project was begun as an outgrowth of several U.S. Air Force contracts with the RAND Corporation in the 1950's to investigate the use of television in space for weather and 'other' reconnaissance from space (remember the Cold War?..see September/October 1995 issue of *ST* on CORONA spy satellites).

The first TIROS satellite was launched on April 1, 1960 by the Thor-Able rocket, with a primary objective of demonstrating remote-sensing of cloud cover by the use of a slow-scan television on an Earth-orbiting, spin-stabilized satellite. The spacecraft was an eighteen-sided, drum shaped cylinder covered in solar cells on all sides except the bottom plate. It carried both wide-angle and narrow-angle TV cameras, and was placed in a circular orbit at 400 miles, inclined 48 degrees to the Equator.

Interestingly enough, TIROS 1 did NOT carry any InfraRed instruments! The U.S. Army Signal Corps was in charge of building the IR sensors in late 1958 when NASA was formed, and became responsible for the TIROS project. The IR sensors were not ready to fly in April, 1960, so the spacecraft was launched without an IR capability!. Most of the later TIROS spacecraft did carry IR experiments, but these launches were not delayed if the IR sensors did not pass the engineering tests (which happened all too often back then).

Other instruments were carried on TIROS, including scanning five channel radiometers, non-scanning radiometers, and omnidirectional radiometers. TIROS 1 took pictures for three months and then failed.

TIROS II-X were orbited from November 23, 1960 through July, 1965 and provided a total of 649,077 pictures of the Earth's weather systems. Each system included a bit more sophistication with a goal of providing an operational system for the National Weather Service and the U.S. military.

A major milestone in the TIROS series (particularly for *ST* weather satellite enthusiasts) was TIROS VIII, launched in December, 1963. This was the first U.S. satellite to carry the Automatic Picture Transmission (APT) camera. This first APT camera utilized a very slow-scan vidicon that required 200 seconds to scan 800 TV lines of the Earth below (this equates to 240 lpm). TIROS VIII was the first weather satellite to transmit direct, real-time television images to relatively inexpensive groundstation terminals for the user community.

TIROS IX was the first 'wheel-mode' satellite and was launched in January 1965. TIROS IX was the forerunner of future TIROS spacecraft, and differed from its predecessors. TIROS I-VIII carried two TV cameras mounted on the baseplate of the satellite with the optical axes parallel to the inertially stabilized spin axis. The vidicon camera was thus pointed parallel to the orbital plane and viewed the Earth about one quarter of each orbit. TIROS IX had the TV camera mounted radially perpendicular to the spin axes and diametrically opposite one another and looked out through the sides of the spacecraft rather than through the baseplate. The satellite was also boosted to a higher inclination orbit, and 'rolled' in a spin-stabilized attitude along its orbital path. The field of view of each camera passed through the local vertical once during each spin or 'roll'. The cameras could continuously take pictures when the camera was pointing at the Earth, providing a sequence of over-lapping pictures. Placed into a near-polar, sun-synchronous orbit, TIROS IX could image the entire Earth on a daily basis. TIROS X was the last of the research and development platforms, and was launched in July, 1965 to provide hurricane and tropical storm observations worldwide.

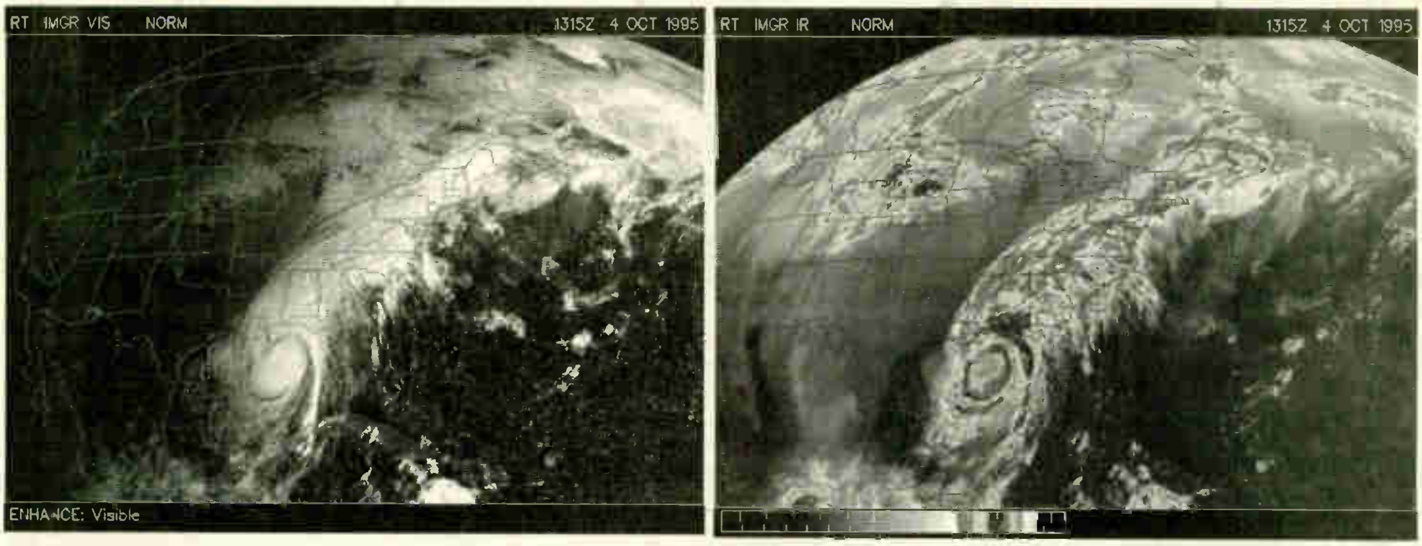
ESSA and the Operational System

NASA's pledge to provide a real-time, operational weather satellite system was realized in February, 1966 with the TIROS Operational System (TOS). This system used a pair of Environmental Science Services Administration (ESSA) satellites starting with ESSA 1.

Launched February 3, 1966, this satellite used two 1/2 inch vidicon cameras systems producing a pair of images with a 'swath' of the Earth 2200 miles wide and 800 miles along the satellite's orbital track. From its 400 mile high altitude, orbiting 14.5 times a day, a total of 450 TV photos were available each day. The ESSA birds (ESSA 1-9) utilized 'wheel-mode' configurations similar to TIROS IX. As the platform rolled along in its orbit, cameras mounted on their sides imaged the Earth below from their sun-synchronous, near polar orbits. The provided global daytime coverage of the Earth's weather systems. The data from ESSA was given out internationally. In fact, the U.S. actually shared this weather satellite data with the Soviet Union! The U.S. provided ESSA images, and the Soviet Union provided COSMOS 122 pictures of the Earth over a land-line facsimile circuit (which often did not work properly!). ESSA had nine satellite in use for this first, operational system.

Improved TIROS Operation System (ITOS)....

The third-generation weather satellites were designed to meet NOAA's require-



GOES 8 Visibile and IR images of the eastern U.S. taken October 4, 1995 showing Hurricane Opal off the southeast U.S. coastline in the Gulf of Mexico. (Photos courtesy of the University of Minnesota)

ment for a systematic, world-wide, day and night weather observations from space. The Improved TIROS Operational Satellites (ITOS) were launched atop Delta rockets into a sun-synchronous, near polar orbit at 908 miles. During its 115 minute orbital period, the Earth rotated 28.5 degrees each orbit. thus, the imagers view an assured continuous coverage (except for part of the Poles) between adjacent orbits in its 12.5 orbit/day configuration. The ITOS-I series of spacecraft carried both the APT TV and scanning radiometers. The ITOS-D configuration carried new Very-High Resolution Radiometers (VHRR), Vertical Temperature Profile Radiometers (VTPR), Scanning Radiometer (SR), and Solar Proton Radiometer (SPR).

TIROS-N...

TIROS-N (1978-79) was the fourth generation polar-orbiting satellites and used 11 satellites in this series from 1978-79. New instruments, including the Advanced Very High Resolution Radiometer (AVHRR), TIROS Operational Vertical Sounder (TOVS), High-Resolution InfraRed Sounder (HIRS/2), Stratosphere Sounding Unit (SSU), Microwave Sounding Unit (MSU), the Data Collection System (DCS), and Space Environment Monitor (SEM) were flown. The TIROS-N AVHRR instrument is the forerunner of today's Advanced TIROS-N (NOAA E-K) AVHRR instrument which provides *ST* readers with the APT and HRPT image products we see.

The Current Series....Advanced TIROS-N...

The last six spacecraft in the TIROS-N series (NOAA E-J) have been designed for a larger payload and additional sensors, including a Search and Rescue (SAR) system for downed planes and ships, a Solar Backscatter Ultraviolet Instrument (SBUV) to measure the Earth ozone distribution, the Earth Radiation Budget Experiment (ERBE) used to determine the radiation loss and gain to and from the planet.

The Future...

A new series of NOAA Advanced TIROS-N spacecraft is currently being built. They will employ new Low Resolution Picture Transmission (LRPT) digital direct-readout systems to enhance the APT mode, as well as other upgraded sensors. Better resolution for the AVHRR instrument is also on the boards. Future columns of the *View From Above* will detail these exciting new data products that you will be able to capture in your own monitoring station!

DRIG Internet Connectivity Changes

Just when things were stable....To provide better service to the DRIG membership, we have switched Internet service providers and upgraded to a new 128-kbps ISDN digital link. Due to this change, we also had to change our class C Internet address range. Please make a note of the new addresses:

Hostname	IP Address	
ftp.drig.com	206.104.84.2	ftp ftp.drig.com
www.drig.com	206.104.84.2	http://www.drig.com/
bbs.drig.com	206.104.84.208	telnet bbs.drig.com

The 128-kbps line will give better performance and connectivity for your FTP, WWW, and Telnet sessions with DRIG!

Until the InterNIC changes their database to reflect our new Domain Name Server machines, you may want to use the IP address instead of the hostname (i.e-Use ftp 206.104.84.2 rather than ftp ftp.drig.com or http://206.104.84.2/ rather than http://www.drig.com/). InterNIC should have all of the DRIG hostnames pointing to the new DNS servers by the time you read this issue.

Weather Satellite Status

NOAA-9	137.620 MHz	Off
NOAA-10	137.500 MHz	Off
NOAA-11	137.620 MHz	Off - AVHRR instrument failed
NOAA-12	137.500 MHz	On
NOAA-13	137.620 MHz	Spacecraft failed two weeks after launch
NOAA-14	137.620 MHz	On
NOAA-K (15)	137.500 MHz	To be launched in early 1966
Meteor 2-21	137.400 MHz	Off since April
Meteor 3-5	137.850 MHz	On
Meteor 3-7		To be launced in 1996.

Meteor 3M spacecraft will be launched in 1998 and will be in 98 degree orbits and carry a HRPT-like system.

OKEAN 4 (1-7)	137.400 Mhz	On over Europe and CIS.
SICH-1	137.400 Mhz	On - store and forward over groundstations

Chinese Feng Yun-1 C is being designed and will be launched in 1997. Resolution of the ten channel multispectral visible and IR radiometer at nadir will be 1100 meters. HRPT will be BPSK/Bi-phase with a bit rate of 1.3308-Mbps.

Geostationary Orbiters Status

Meteosat 3	Standby mode
Meteosat 4	Off in November, 1995
Meteosat 5	Operational at 0 degrees longitude
Meteosat 6	Off - software errors (backup for Meteosat 5)
GOES 7	135W will be replaced by GOES 9
GOES 8	75W operational
GOES 9	90W will be moved to 135W later this year
GMS5	140E
GOMS1	Russian Goestationary Weather Satellite (GOMS) - still in testing phase

Donald E. Dickerson, N9CUE

Geostationary Cellular

Personal communications took a major leap forward this year as the American Mobile Satellite Corporation (AMSC) launched its first spacecraft AMSC 1. Lift off from Cape Canaveral took place on the April 7, 1995 .The satellite was riding on an Atlas 2A launch vehicle and was placed in a geostationary orbit at 101 degrees west. This is the first geostationary satellite based system that integrates cellular phone service into its basic communications terminals.

AMSC is located in the Washington D.C. area and has its main ground station in Reston Virginia. American is owned by a group of four companies; McCaw Cellular Communications, Hughes Communications, Mtel Corporation, and Singapore Telecomm.

The AMSC group foresaw the need for a satellite-based telecommunications network in the late 70's and by the early 80's were planning just such a network. NASA had discovered that our land-based phone system was vulnerable to natural and manmade disasters, largely do to high volume lines such as fiber optics. Satellite-based systems are immune to natural and manmade disasters and would provide the government and business with a secure back up system in time of large scale emergencies. By the late 80's NASA was conducting mobile satellite experiments using its Advanced Communications Technology Satellites (ACTS). The AMSC system is based on this research.

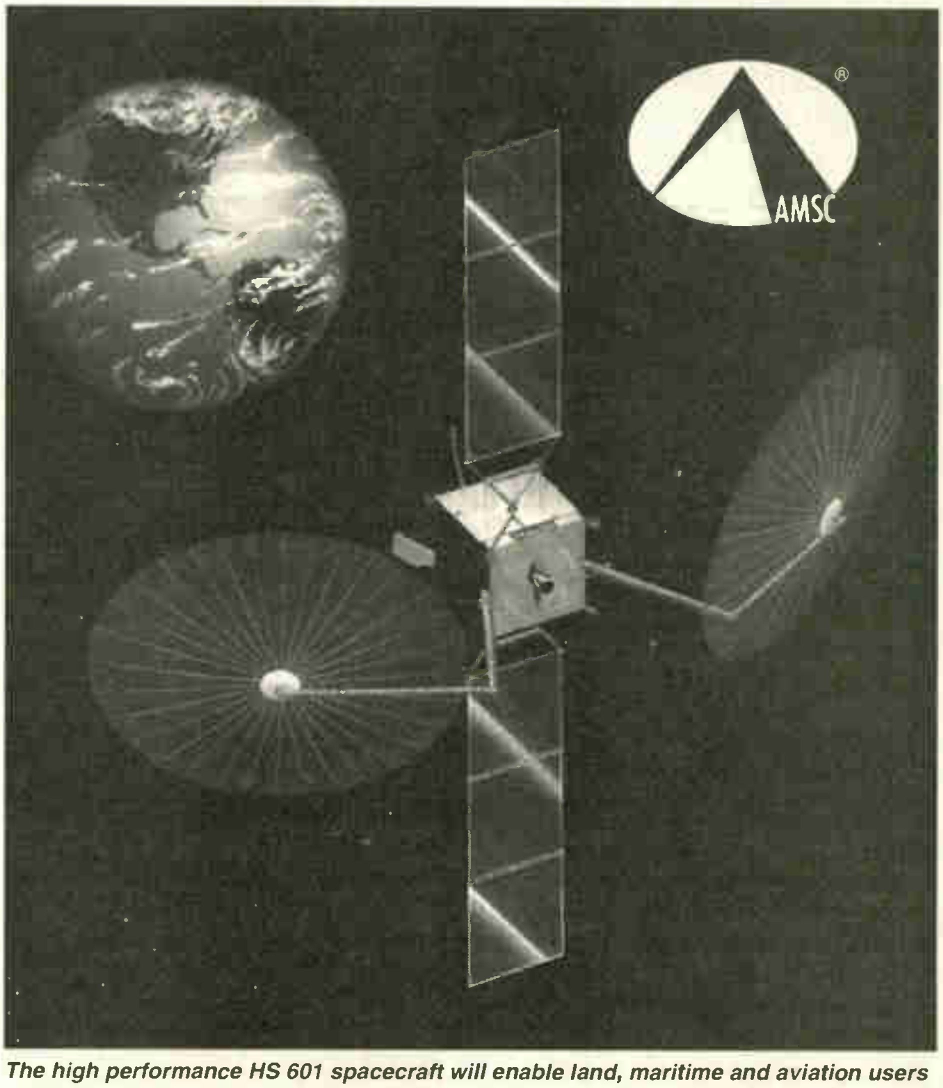
The AMSC system is expected to be used widely in rural and remote areas of the country that are now served or are under served by conventional telephone service.

Canada has a twin program being developed along side AMSC. Telesat Mobile, Inc (TMI) of Canada will provide a duplicate satellite for service to our neighbors to the north. Both AMSC and TMI will provide backup service for each other as the spacecraft and their capabilities will be virtually the same. Both can be pressed into service in either country. Canada's MSAT spacecraft is due to be launched in early 1996. Eventually, additional satellites will be located at 106 and 113 degrees West in the Clarke Belt.

Mobile satellite services will include mobile radio, mobile telephone, mobile data terminals, wide-area paging, data collection, voice mail, two-way messaging and emergency signaling. These services will be available to virtually every mode of transportation, ship, car, truck, trains, commercial and private aircraft.

The ground terminals can operate in full or half duplex in radio or a telephone style. They can be portable, transportable, mobile and operate in data mode. L-band fixed base stations can also be integrated into the system. Both the AMSC-1 and MSAT spacecraft will be able to access conventional telephone systems through a series of gateway stations.

The spacecraft, built by Hughes and SPAR Aerospace, are based on the HS 601 bus. Each will carry two large 5 meter (15 foot) dish antennas. They produce 58 dBW with 38 watts of RF. Circular polarization



The high performance HS 601 spacecraft will enable land, maritime and aviation users to send and receive transmissions on small, low-powered terminals. The spacecraft was manafactured for AMSC by Hughes Aircraft Co.

The Trimble Galaxy GPS mobile data terminal (left) and the Westinghouse Series 100 satellite/cellular mobile telephone are two of the latest entries into the personal communications field.

will be used. AMSC-1 carries 16 L-band transponders and 1 Ku-band transponder for telemetry. Each satellite will support 500 voice channels (6 kHz) and 32 data channels. Data rates on voice channels will be 4.8 kbits. This should support between 26,000 and 80,000 customers using a DAMA transmission format according to AMSC.

The ground terminals will be built by Westinghouse and Mitsubishi. Car and truck mounted units are expected to be the most popular, but you can buy units for aircraft, ships or a briefcase mounted terminal for personal use. The mobile and personal terminals will be capable of direct satellite access with relatively low power, or access local ground based cellular systems.

Westinghouse is building the ground stations or hubs for the AMSC and TMI satellite system. The network operations center (NOC) and network communications controller (NCC) will be located near Washington D.C. Most calls will be controlled and routed through these control centers regardless of their point of origin. Feederlink earth stations will also be built on or near conventional cellular phone sites. It is expected that the primary distribution channel for AMSC services will be cellular phone companies. They will be able to offer their customers satellite enhanced cellular service. This would give the customer cellular service anywhere in North American. Satellite service also extends up to 200 miles off shore of the coast of North America.

The AMSC-1 spacecraft and ground terminals have been tested and are ready for full operation. The satellite did lose one of its 8 matrix output ports due to an overheating incident in testing. This is not expected to effect the service or operation of the satellite.

TMI and AMSC will offer a unique satellite service to the transportation industry, law enforcement and other providers of routine and emergency services. It is called Fleet*Star. This service is designed to allow trucking companies to manage their cargoes and keep close tabs on their location. Fleet*Star will allow real-time updates on vehicle location, allow two-way messaging and fax type services for the exchange of information. This type of radio location service has a wide range of applications for anyone who needs to locate or keep track of vehicles and cargo.

Brian Pemberton, President AMSC recently said, "Everything looks great for the rollout of our services."

With the successful launch of AMSC 1, we now enter a new phase in the era of PCS communications. The PCS concept doesn't exist on just the engineers drawing table, but it is now a reality at 101 degrees West and AMSC 1 is providing PCS services right now.

RADIO ASTRONOMY

By Jeffery M. Lichtman

On the Front Line for Radio Astronomy

Since 1984, the Society of Amateur Radio Astronomers (SARA) have been holding their annual conference at the National Radio Astronomy Observatory (NRAO), located in the town of Green Bank, in the beautiful state of West Virginia.

I remember my first view of this magnificent facility. It was like coming home after an extended trip, the view of the Karl Jansky Antenna, the Grote Reber Dish, and the 140- and 300-foot antennas looming like giants behind the distant trees. It is an overwhelming experience to one who has only read about this place of radio astronomy magic.

Since its founding in 1956, the NRAO has been the primary force in the development of radio astronomy. Among the notables who have visited and worked at NRAO are: Grote Reber, Dr. Frank Drake, and Dr. John Kraus (W8JK).

NRAO is operated by Associated Universities Inc. (AUI), an independent, non-profit research management corporation, under the terms of contract between the National Science Foundation (NSF) and AUI. There are four major facilities operated by NRAO and they are located at Charlottesville, Virginia: Green Bank, West Virginia; Socorro, New Mexico; and Tucson Arizona.

NRAO Green Bank is situated in a natural, bowl-type valley, virtually cut off from any manmade interference. The site is directed by Dr. Felix J. Lockman and all of the business activities and construction coordination are done by Mr. Richard L. Fleming. Assisting him are Mrs. Becky Warner and Mrs. Carol Ziegler.

The Green Bank observatory observes cosmic signals in the frequency range of 25 MHz to 25 GHz. These signals are extremely weak. It has been estimated that all the power collected by all the radio telescopes on earth since radio waves were discovered would not have enough power to light a single light bulb. The reality of nature explains why radio astronomers need a protection from manmade and local interference.

Wes Sizemore (NRAO) with interference patrol van.

Green Bank is considered by law as a national quiet zone. To make sure that this is observed, an interference patrol is headed by Mr. Wes Sizemore. Wes gets a call from a telescope operator when some strange interference is present during or prior to observations. Equipped with a specially equipped truck, Wes tracks down the interfering culprit. The interference is usually tracked down to a noisy oscillator from a TV or a noisy ignition from a farm tractor. Both of which are promptly fixed compliments of Green Bank.

Large Antennas

The NRAO has several large radio astronomy telescopes at its disposal The 140-foot fully steerable telescope, the past 300-foot meridian transit, the future GBT (Green Bank Telescope) are all located at Green Bank, West Virginia. The 27 VLAs (Very Large Array) antennas are located at Socorro, New Mexico and finally, the 12-meter diameter antenna is at the Kitt Peak Observatory in Tucson, Arizona.

The concept of NRAO was very unique when first proposed in 1954. NRAO was the first national astronomical observatory. Today it serves as a visitor oriented facility while also providing a research environment to scientists.

One of the programs conducted at Green Bank is the science teachers summer program. The program is headed by Sue Ann Heatherly. Every year, a small group of teachers from around the country are chosen to participate in a two week hands-on radio astronomy course. When completed, these teachers take their knowledge back to the students, who hopefully will find this area of science interesting. Ms. Heatherly, in addition to this program, is also responsible for the Green Bank bulletin board (telephone 304 456-2172).

Lets talk about some of the awesome sights you would see during your visit to NRAO.

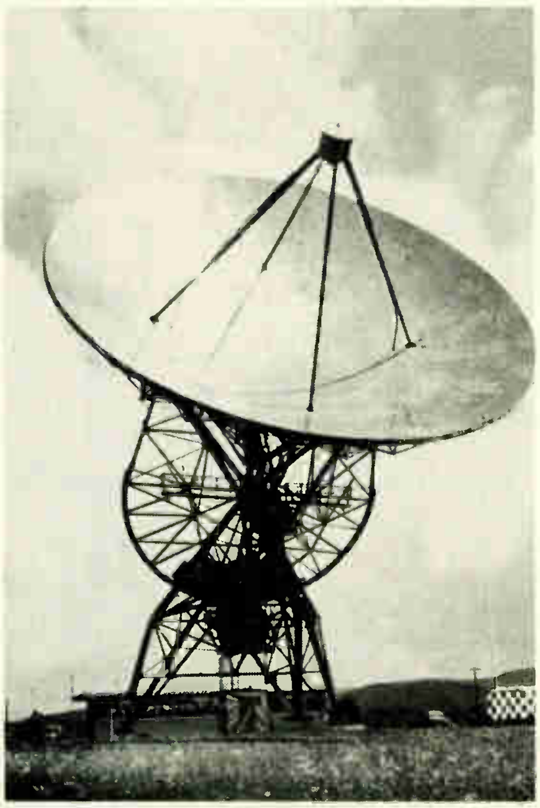
Up until the late 1980s, you would have seen the world's largest antenna — the 300-foot meridian transit antenna built by the U.S. Navy (1962). This $850,000 giant antenna has contributed to many exciting surveys, one of which was a 1,400 MHz sky survey and the SETI (Search for Extraterrestrial Intelligence) Serendip research. The antenna collapsed in 1988, one year after its 25th birthday. The antenna is now being replaced by the GBT telescope with a collecting area of 100 meters. When completed in late 1996, this will be largest movable antenna in the world.

The 140-foot antenna was completed in 1965 and is the largest equatorial mounted telescope in the world. The frequency range of this giant is from 50 centimeters to 2 centimeters. The 140 footer has been associated with several other radio astronomy telescopes doing VLBI (Very Long Baseline Interferometry). These other facilities; are the Hat Creek, California; Owens Valley, California; Ft. Davis Texas; Haystack, Massachusetts; and Bonn, Germany.

The interferometer system is made up of three 85-foot antennas which are moved up and down a one mile long baseline. Used like a small VLA, these antennas have mapped radio sources and have discovered radio emitting stars. The majority of the operating time is now spent measuring the positions of Quasars and other radio sources.

The 85-foot Howard Tattel antenna is also used in VLBI research. This antenna was originally used by Dr. Frank Drake for Project Ozma. This was the first real search for extraterrestrial life. In addition, it is also used in the NRAO interferometer system.

The 40-foot antenna was built as the original survey instrument for radio studies of the area, prior to the commitment to build the existing facility. At present, this antenna is used for student, science teachers, and SARA activities under the direction of Ms. Heatherly.



The 85-foot Tattle antenna.

On the other side of the facility, if one knows where to look, you will see the Little Big Horn. Seldom used now, this giant was used to make radio power measurements of the Cassiopea A supernova (an exploding star that suddenly attains a luminosity up to 100 million times the suns brightness). Over the past few years, SARA members such as Jim Sky and Carl Lyster have used the horn to make hydrogen line measurements.

One will also find that this facility is a city within itself! Among the many things to see are the machine shop. Supervised by Mr. Martin Barkley, this facility makes all the exotic antennas, amplifier cases, etc. Truly an amazing place.

In the Jansky Lab, you can witness engineers working on giant receivers and feed sections. Included in the Jansky building are the offices of many other engineers, summer students, the technical library and a large meeting room that SARA fills to the brim during our annual visits.

The 140-foot antenna is the largest equaequatorial mount telescope in the world.

On the Green Bank site, one will also find a large comfortable housing facility. Most of the rooms have space for two people, similar to the accommodations you would find in a motel. In addition, there is a cafeteria, (with a great staff and lots of great food), a large lounge for relaxing, an exercise room, ping pong and pool tables. All the comforts of home.

Another NRAO facility worth visiting (prior permission required) is the central development laboratory located in Charlottesville, VA. After the 1984 SARA conference, Charlie Osborne and I visited Bill Lakatosh (engineer) and Dr. Marian W. Pospieszalski (head of development). This is the place where intricate RF amplifiers are assembled under microscopes. We were shown how the HEMTs (High Electron Mobility Transistor) are die bonded, how the miniature feed horns are molded and machined, and how they are dipped in gold.

If you want to visit the site at Green Bank take route 250 heading west from Monterey, Virginia and you come across route 92, head south (10 miles) or if you are coming from the south, get off I-64 and go to the little town of White Sulphur Springs, West Virginia, then head north on route 92 (65 miles).

If you are interested in radio astronomy, I strongly suggest a visit to Green Bank and all the other NRAO facilities. Visitor tours are conducted during the summer starting in June. For more information, contact

Jeff Lichtman in the control room of the 40-foot NRAO antenna (below).

Carol Ziegler at (304) 456-2011, Monday-Friday, 0900-1600 Eastern Time. A visit to Green Bank will leave a lasting impression.

Whats Up?

Around 1975, the same year Robert Sickels and I wrote the original *Amateur Radio Astronomers Notebook*, an amateur radio astronomer with a flare for publishing started a publication called *The Radio Observer*. This gifted writer was Richard R. Peterson of Santa Barbara, CA. This quarterly publication produced 10 issues which were packed with great articles by Richard Flagg, David Heiserman, (author of *Radio Astronomy for the Amateur*, Tab Books #714 1975-now out of print) and other amateur radio astronomers. Publication ceased in 1978 for lack of money.

There are a few articles on radio astronomy that should be studied by readers. A few of these articles were done by Peterson. These were a series of articles called; *Whats Up?* These articles picked a well known radio astronomy source and gave background and specifications on it.

Over the years, I have tried to contact Robert Peterson, but to no avail. He appears to have left the Santa Barbara area for parts unknown, according to a phone contact (relative). So, this piece is dedicated to him, wherever he may be.

The first radio object we will cover is SGR A (Sagittarius A). The summer and autumn months brings the Sagittarus arm of our galaxy into our antenna patterns during prime observing hours. Next to the sun, our own galaxy is the most observed of all radio astronomy targets.

SGR A is at the center of our galaxy — the nucleus, to be exact. With a standard star map found in many astronomy texts or the maps published monthly in *Sky and Telescope* magazine, you will find the location to be between Antares (constellation of Scorpius) and Ascella (constellation of Sagittarius). Grote Reber, a radio astronomy amateur mapped this area in 1944.

Figure 1 shows the meridian crossing times for SGR A and other important radio sources for the summer and autumn months (times given are for 75, 90, 105 and 120 degrees, the standard meridians).

SGR A is a source of small angular extent coinciding with the galactic nucleus. The great angular extent of the Milky Way causes it to fill the aperture of the radio telescope antenna, so that it is easily detectable. Not only does the antenna pick up SGR A, but also picks up collectively other radio objects in the same area. This explains why the amateur can detect this source (4500 Janskys at 86 MHz) more easily than CAS A (11,000 Janskys). On the other hand, an antenna with a narrow pencil sized beam would produce a larger output from CAS A than SGR A. Figure 2 illustrates the Jansky power at different frequencies.

SGR A exhibits a peaking Jansky value due to a combination of synchrotron (the continious polarized radiaton emitted by fast moving electrons spiraling around the magnetic lines of force in the presence of a magnetic field) and thermal emission.

All objects at temperatures above 0 degrees K (Kelvin) emit electromagnetic radiation in the form of "Thermal Emission". The spectrum of radiation at radio frequencies is defined by the Raleigh-Jeans law where:

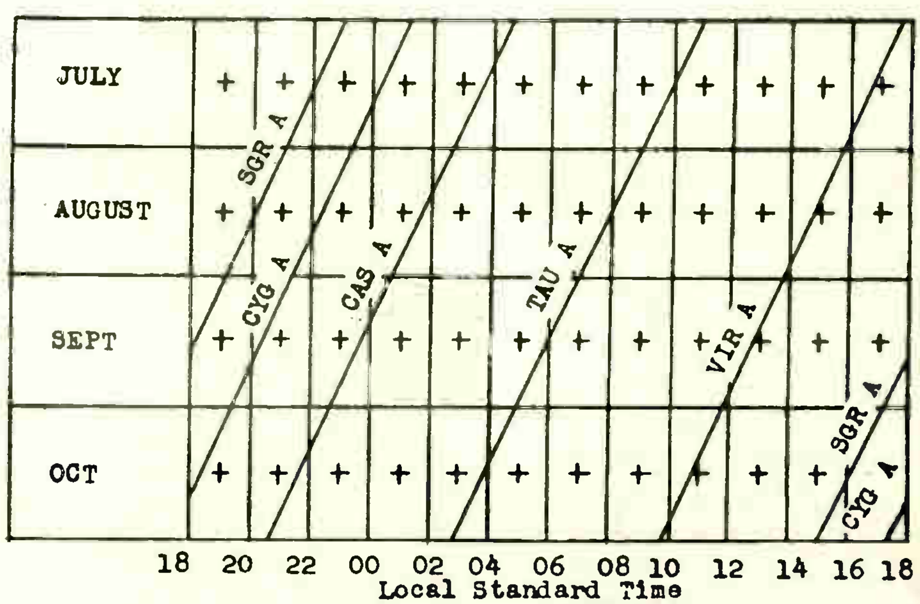


FIGURE 1

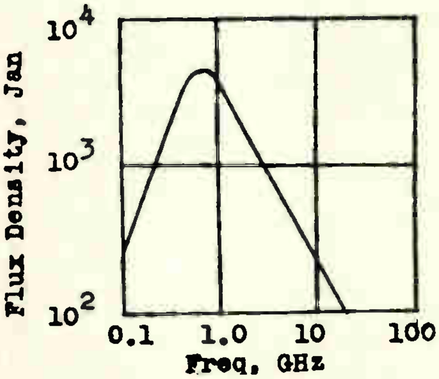


FIGURE 2

B is brightness of the source in watts m^-2 Hz^-1 rad^-2

k is Boltzmann's constant (=1.38 x 10^{-23} joule degrees K^{-1})

T is temperature in degrees K

w is the wavelength in meters

Thus a straight line with a positive slope is obtained when B is plotted vs. frequency on log-log paper for thermal emission, while a straight line of negative slope is obtained for synchrotron emission, in the radio spectrum.

What do we find at the very center of our galaxy, and does it shed light on the origin of our galaxy? The galactic center is obscured from optical instruments by vast dust clouds. However, careful study of SGR A at 1420 MHz reveals the structure shown in figure 3 (Galactic Nucleus).

Another strong radio source is Cassiopeia A (CAS A). This source is also a suitable object for study in the autumn and winter months.

CAS A has a Jansky rating of 11,000 at 178 MHz. Next to our sun, this source is the strongest. Referring to figure 4, you will notice other sources which cross the meridian at the same longitudes mentioned previously.

CAS A is located at declination 58.6 degrees midway between the constellations of Cassiopeia and Cephus.

This object is believed to be a supernova remnant. Viewed through an optical instrument, one would see a wispy gaseous remnant indicating the remains of a cataclysmic event. This supernova is belived to have occurred around 1700 A.D. but it was not viewed by astronomers of that day. On the other hand, the supernova that occurred in the Crab Nebula was well documented by Chinese astronomers in 1054 A.D. The CAS A event appears to have gone unoticed possibly to low luminosity or clouds of interstellar dust.

CAS A was first identified as a discrete radio source by Ryle and Smith in 1948. In 1944, CAS A appeared on a radio map constructed by amateur radio astronomer, Grote Reber, at 162 MHz.

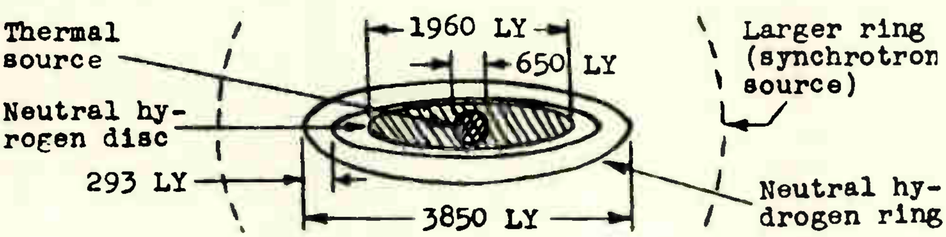


FIGURE 3

Positive identification of CAS A was confirmed by the Mt. Palomar observatory in 1954. The distance of this source is 10,000 light years (the distance that light travels in one year, = 9.46 x 10^{12} kilometers or 5.88 x 10^{12} miles), in our own Milky Way galaxy, and beyond the two arms of our galaxy known as the Orion and Perseus arms. CAS A exhibits the non-thermal characteristics shown in figure 5.

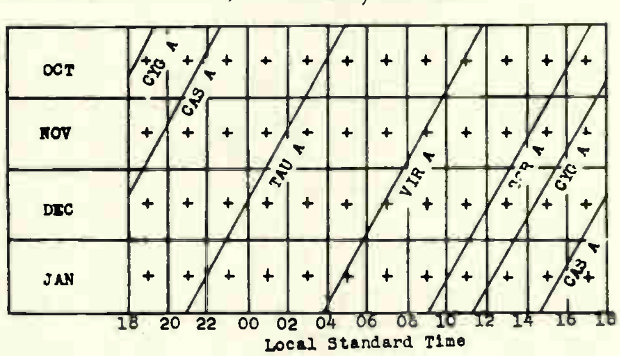


FIGURE 4

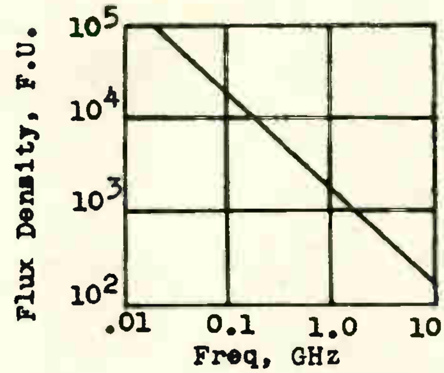


FIGURE 5

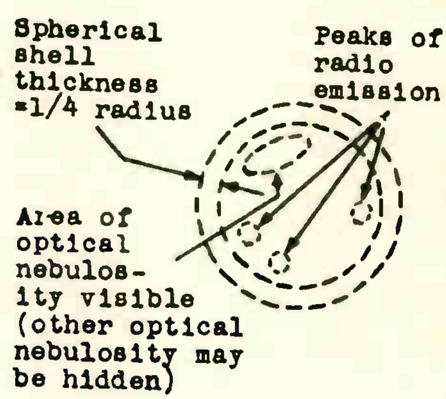
The Jansky rating is fairly constant and only exhibits a 1-2% rate of decrease annually. This has been measured with the use of the 120-foot long Little Big Horn at the National Radio Astronomy Observatory (NRAO) in Green Bank, WV.

The structure of CAS A at 1420 MHz has been studied at Cambridge using an aperture synthesis array with three 60-foot parabolic antennas, one of which is moveable. The movement feature, together with the earth's rotation, are used to change the effective interferometer baseline orientation; and very high resolution is thus obtained. Figure 6 shows the radio structure at 1420 MHz is a spherical shell with localized peaks. Note that the peaks of radio emissions do not coincide with the areas of optical nebulosity at these points hidden by opaque clouds.

SGR A and CAS A and the surrounding Milky Way provide an ideal first object for amateur observation. One may observe this object with relatively simple equipment.

Information for this article was taken from *The Radio Observer* (out of print), issue 4-July 1976 and issue 5-November 1976. ST

FIGURE 6



ST WHAT'S NEW

by Wayne Mishler, KG5BI

Windows on the World

Coming Soon: Laptop Window to the World!

A laptop communicator the size of a notebook computer will soon bring voice and data transmission via satellite to any location in the world. Details were not available at press time, but *ST* will continue to follow the development of this new technology and pass information to you as it becomes available.

The communicator is a new idea announced by the Maryland-based Comsat Corporation, who plans to put it on the market sometime next year. The unit weighs six pounds. It will have a list price of $3,500, and the service will cost $3 a minute.

Global handheld phone service moves forward

Inmarsat

The London-based Inmarsat-P affiliate, established earlier this year to provide a global handheld phone service by the end of the decade, has selected Hughes Space and Communications International to build its 12 satellites for a price tag of $1.3 billion.

When it goes into operation in 1999, the new system promises a low-cost voice, data, fax and paging via pocket size terminals smaller and lighter than many of today's cellular handsets. The system is to be compatible with cellular services and will bring mobile communications to anyone anywhere in the world.

"We have always said that we were going to team with world-class industry to build the Inmarsat-P system," says the company's chief executive officer. "And with such a strong partner as Hughes to build the satellites, I am confident that we will make handheld mobile phone service global in a just a few more years."

The planned system comprises ten operational satellites in two intermediate circular orbital planes at 10,400 kilometers above earth. Two or more satellites will be visible at relatively high angles to avoid blocking of signals by terrain, buildings or other obstacles. The satellites relay calls between users and terrestrial access nodes within the satellites' view. The nodes are connected in a network, known as the P-Net, linked through gateways owned and operated by third parties.

After a hard day of counting fish at sea...Monday night football!

Oceanographers aboard the 184-foot steel research vessel "Endeavor" are enjoying a luxury previously available only to passengers aboard luxury cruise ships: seagoing television entertainment. It's made possible by a new satellite television tracking antenna, called TracVision, which can lock onto satellite signals from a moving platform such as a ship. The targets of choice are the popular USSB and DirecTV satellites which feature strong signals, a smorgasbord of programming, and digital quality video and audio reception.

TracVision uses earth-referenced compass and attitude sensors to continually measure pitch, roll and azimuth of the ship on which it is mounted. Sensors are stabilized by special, patented gyroscopes. Measurements go to the system's computer. Using special software, the computer calculates rate of movement, translates the results into stable land-based coordinates, and feeds them to the antenna motorized control unit.

Two motors in the unit control a patented robotics arm and its adjoining antenna in exactly the opposite direction of the movement of the boat. This keeps the antenna aligned with the targeted satellite. The company claims the result is clear, stable, uninterrupted television reception. Sailors aboard the Endeavor seem to agree.

"We've gotten no negative reports," says the science officer. "The system works great."

Which is important after a hard day of counting fish. Scientists and technicians aboard the Endeavor are doing a fisheries assessment of Georges Banks, a popular commercial fishing ground about 160 miles off the coast of Massachusetts. From there they head toward deeper waters to study the transmission of sound waves at various depths. But that won't keep them from enjoying their favorite TV shows.

Woodhouse back in the news!

The antenna company, Woodhouse Communication, is back in the news again with their announcement of a new, omnidirectional, circular polarized antenna for APT satellites operating at 137 MHz.

They call their new innovation the APT-2CP and point out that it is built with the same rugged strength and craftsmanship of their other antenna models.

The APT-2CP offers dual, balanced driven elements for uniform performance. The driven elements are fed by a delay line to achieve true circular polarization which is essential for efficient reception of satellite signals. The entire antenna structure is at electrical ground level for protection

against lightning and static electricity – enemies of solid-state circuitry.

Engineers designed the antenna to overcome "holes" in signals from near overhead passes, and to pick up weak signals from satellites just peeking over the horizon.

Supplied with a unique aluminum mounting bracket and stainless steel clamps, the APT-2CP will clamp to any vertical pipe from 1 to 2 inches in diameter. It is priced at $119.95 and is available from Woodhouse (616) 226-8873 (voice) or 226-9073 (fax).

Drake introduces new high quality satellite receivers

DRAKE®

The R. L. Drake Company August 28 announced two new commercial-grade satellite receivers: the ESR 1440 and ESR 1450. Both receivers were designed for fixed-tuned applications or single-channel audio, video, or data reception. They are ideal for use in small cable systems, hospitals, schools, or other institutions.

These are rack mountable, multi-standard receivers for operation in both NTSC and PAL standards. They have a rear-panel switch for switching between 115 or 230 volts AC. They offer four audio de-emphasis choices, including a special mode for reception of Wegener audio, selected by front panel switches. These features make the receivers operable worldwide.

Capable of C- or Ku-band reception, their tuners cover 950 to 2050 MHz.

The two receivers differ in that the 1440 uses a single LNB input tuner, while the 1450 has a dual LNB input tuner. The 1450's dual IF bandwidths of 27 or 18 MHz with selectable and adjustable threshold allows the operator to tweak for maximum performance for a particular channel deviation and C/N ratio. This flexibility makes the 1450 usable with either large or small antennas.

Additional information is available from Drake (513) 866-2421.

AEA adds GPS firmware to packet controllers

The PK-96 and PK-12 packet controllers from Advanced Electronics Applications

now come with firmware for GPS operation.

A few months ago, AEA put GPS firmware in its 1200 baud PK-12 packet TNC. It worked so well that they improved the firmware in that controller and have added it to their dual speed 9600- and 1200-baud PK-96.

The firmware automatically senses on power-up whether or not it is connected to a GPS receiver. If so, an initialization string is sent and the TNC is immediately ready for GPS work. If not, the TNC will proceed with traditional packet data work.

The big news is that GPS commands can be remotely programmed, eliminating any need for removing and connecting the units to an external computer to change GPS parameters. All of this is now done remotely.

Another boon is that the units can be remotely polled for GPS information at any time. For example, users with weather stations in their back yards can poll each other's stations for information.

The capabilities of these packet controllers, with their built-in GPS firmware, is varied and sophisticated. Complete information on all AEA products is available from Eric Zackula, Advanced Electronics Applications Inc., P. O. Box C2160 (Dept. ST), Lynnwood WA 98036. Eric's telephone number is (206) 774-5554, ext. 306. If you call, tell AEA you read about them in Satellite Times.

Impress a client...save a life...with a satellite novelty

Play, band! You say its your favorite uncle's birthday. And everybody but you always gives him gifts he likes. And he's one of those guys who gets off on satellites and space and radios and stuff like that. And you saw his cat wearing the fluorescent green socks with pink polka-dots and chrome mud flaps you special ordered for him last year. And they actually fit the poor kitty. And some joker with connections in the humane society put out a contract on your life. And you think it was your aunt. Is that what's bothering you buddeee???

Well, cheer up! It's here! A unique new line of satellite and radio novelties from Interactive Industries...I didn't stutter...I said Interactive Industries from Waterbury, Connecticut. And they've got novelties for space and radio buffs you'll be hard pressed to find anywhere else. Stop playing, band.

Time for serious talk about how you can get a color catalog full of neat desk memorabilia like miniature satellites, antenna

dishes, televisions and even old-time microphones like they used in the early days of radio. Some of the microphones even work like dictation and message machines. A fella' by the name of Ron Phillips who works for the company says you can get a sure-nuff catalog and all the information you want about the company's line of advertising and promotional products just by calling (203) 755-2111, or faxing 755-3999.

Did I mention that the items can be personalized? Yep! Every item in stock can be custom imprinted with a name or a statement that you specify, within limits of course. No Gettysburg addresses or anything like that.

The company is in the business of selling large quantities to advertisers. So you might have to buy your uncle a lifetime supply of birthday presents. But that's no problem from the supply standpoint. Interactive Industries offers hundreds of advertising novelties for the communication industry. If you want to buy just one...well...give Ron a call and tell him it's a matter of life and death. For your favorite uncle and for your own longevity, it just might be worth a try.

See you in the next issue. Gotta run and make a phone call. ST

COMPUTERS & SATELLITES

By Dr. T.S. Kelso

Orbital Coordinate Systems, Part II

In our last column, we were working our way through the process of calculating the position and velocity of an observer on the Earth's surface in the Earth-Centered Inertial (ECI) reference frame. The goal, of course, was to be able to determine the position of the observer relative to an orbiting satellite to aid the process of visually acquiring or otherwise tracking the satellite from the ground.

At the end of the last column, we had seen that it would be impossible to determine an observer's position in the ECI reference frame without knowing that observer's local sidereal time, that is, the angle between the observer's meridian (longitude) and the vernal equinox. But because this time is measured relative to the stars and not the Sun, the equations to do the calculations are a bit complicated. Let's start off this column with a brief review of the equation for the local sidereal time and then explore, bit by bit, how to develop a computer routine to calculate this value for us. We will then continue the process by calculating the remaining information needed to determine an observer's position in the ECI reference frame.

As we saw last time, the local sidereal time, $\theta(\tau)$, can be calculated by adding the observer's *east* longitude, λ_E, to the Greenwich sidereal time (GST), $\theta_g(\tau)$. Using an equation from Page 50 of the *Explanatory Supplement to the Astronomical Almanac*, we can first determine $\theta_g(0^h)$, the Greenwich sidereal time at 0^h (midnight) UTC, from which

$$\theta_g(\tau) = \theta_g(0^h) + \omega_e \cdot \Delta\tau$$

where $\Delta\tau$ is the UTC time of interest and $\omega_e = 7.29211510 \times 10^{-5}$ radians/second is the Earth's rotation rate. Recalling that $\theta_g(0^h)$ is given as

$$\theta_g(0^h) = 24110^s.54841 + 8640184^s.812866\, T_u + 0^s.093104\, T_u^2 - 6.2 \times 10^{-6}\, T_u^3$$

where $T_u = d_u/36525$ and d_u is the number of days of Universal Time elapsed since JD 2451545.0 (2000 January 1, 12h UT1), we can now set about determing what we know and what we need to calculate.

Let's develop a top-down algorithm to see what we need to do. Our goal in this portion of the algorithm is to determine the value of θ_g at a particular time, τ. To do this, we need values of $\theta_g(0^h)$, ω_e, and $\Delta\tau$. The value of ω_e is fixed and $\Delta\tau$ is the fraction of the day since 0^h UTC or $\Delta\tau = fraction(\tau)$ in days. Therefore, we still need to know T_u, which depends upon d_u. But d_u depends upon knowing the number of days of Universal Time elapsed since JD 2451545.0. So, if we know the Julian Date[1] (JD) of τ, we have everything we need. Our top-down algorithm then looks something like this:

Calculate: θ_g which depends on ($\theta_g(0^h)$, ω_e, $\Delta\tau$); ω_e constant; $\Delta\tau = fraction(\tau)$

Calculate: $\theta_g(0^h)$ which depends on (T_u); $T_u = d_u/36525$

Calculate: d_u which depends on (JD(τ))

Calculate: JD(τ)

Therefore, our most basic calculation is the determination of the Julian Date. The Julian Date can be calculated from the equation in Section 12.95 (Page 606) of the *Explanatory Supplement to the Astronomical Almanac*, or using the approach on Page 61 of *Astronomical Algorithms* by Jean Meeus. This latter text is an excellent reference source for many relevant calculations in orbital mechanics and is highly recommended.

Using Meeus' approach, the Pascal code for calculating the Julian Date of January 0.0 of any year would be:

```
Function Julian_Date_of_Year(year : double) : double;
{ Calculate Julian Date of 0.0 Jan year }
  var
    A,B : longint;
  begin
  year := year - 1;
  A := Trunc(year/100);
  B := 2 - A + Trunc(A/4);
  Julian_Date_of_Year := Trunc(365.25 * year)
      + Trunc(30.6001 * 14)
      + 1720994.5 + B;
  end; {Function Julian_Date_of_Year}
```

To calculate the Julian Date of any calendar date, we simply combine the Julian Date of that year with the day of the year, where the day of the year can be calculated as:

```
Function DOY(yr,mo,dy : word) : word;
const
  days : array [1..12] of word =(31,28,31,30,31,30,31,31,30,31,30,31);
  var
    i,day : word;
  begin
  day := 0;
  for i := 1 to mo-1 do
    day := day + days[i];
  day := day + dy;
  if ((yr mod 4) = 0) and
    (((yr mod 100) <> 0) or ((yr mod 400) = 0)) and
    (mo > 2) then
  day := day + 1;
  DOY := day;
  end; {Function DOY}
```

As an example, the Julian Date of 0^h UTC on 1995 October 01 would be written as:

```
JD := Julian_Date_of_Year(1995) + DOY(1995,10,1);
```

with a result of 2449991.5 = 2449717.5 + 274. Therefore, d_u equals -1553.5 days and T_u equals -1553.5/36525. From this value of T_u, $\theta_g(0^h)$ can now be calculated to be -343378.2154 seconds. Since there are 86,400 seconds in a day, this is the same time (angle) as 2221.7846 seconds, so the equivalent GMST is 0^h 37^m $01^s.7846$ or an angle of 9.257 degrees.

Now, if the time of interest on 1995 October 01 was 9^h UTC, we would have to add $\omega_e \cdot \Delta\tau$ to the value of $\theta_g(0^h)$, where $\Delta\tau$ = 32,400 seconds (9 hours). Being careful to use the proper units, our new GMST is 9h 38m 30s.4928 or 144.627 degrees.

We can consolidate our calculation of the Greenwich Mean Sidereal Time into the following simple Pascal function where the input is the Julian Date of the time of interest (in our example of 9^h UTC on 1995 October 01, JD is 2449991.875) and the output is the GMST in radians. For our test case, this should be 2.524218 radians.

```
Function ThetaG_JD(jd : double) : double;
```

```
{ Reference: The 1992 Astronomical Almanac, page B6. }
    var
        UT,TU,GMST : double;
    begin
    UT   := Frac(jd + 0.5);
    jd   := jd - UT;
    TU   := (jd - 2451545.0)/36525;
    GMST := 24110.54841 + TU * (8640184.812866 + TU * (0.093104 - TU * 6.2E-6));
    GMST := Modulus(GMST + 86400.0*1.00273790934*UT,86400.0);
    ThetaG_JD := twopi * GMST/86400.0;
    end; {Function ThetaG_JD}
```

Now, we can complete our calculation of the ECI position of our observer. We'll start by assuming a spherical Earth and then go back and rework our solution, in our next column, using an oblate Earth. If our observer is located at 40° North latitude and 75° West longitude (near Philadelphia), we can easily calculate the z coordinate according to

$z = R_e \sin \phi$

where $R_e = 6378.135$ km and $\phi = 40°$. To calculate x and y, we use

$x = R \cos \theta$

$y = R \sin \theta$

where

$\theta = \theta_g + \lambda_E$

$R = R_e \cos \phi$.

Using our example, $\lambda_E = -75°$ and $\theta_g = 144°.627$, so $\theta = 69°.627$ (remember, this is the local sidereal time — the angle between the observer's meridian and the vernal equinox) and $R = 4885.935$ km. Therefore, the ECI position of our observer at the time of interest is:

$x = 1700.938$ km, $y = 4580.302$ km, $z = 4099.786$ km.

After all that work calculating the local sidereal time, the rest of the calculation was relatively easy! We can encapsulate this calculation using the following simple Pascal procedure:

```
    Procedure Calculate_User_Pos
(lat,lon,alt,time : double;
     var x,y,z : double);
{ Reference: The 1992 Astronomical Almanac, page K11. }
    const
        re = 6378.135;
    var
        theta : double;
    begin
    theta := Modulus(ThetaG_JD(time) + lon,twopi);
  r := (re + alt)*Cos(lat);
  x := r*Cos(theta);
  y := r*Sin(theta);
  z := (re + alt)*Sin(lat);
    end; {Procedure Calculate_User_Pos}
```

In the inputs for this routine, lat and lon are in radians, alt is in kilometers, and time is the Julian Date of interest. The outputs (x, y, and z) are in kilometers.

So, how do we now calculate the look angle to a satellite? If the satellite's position in the ECI coordinate system is defined as $[x_s, y_s, z_s]$ and the observer is $[x_o, y_o, z_o]$, then the range vector is simply

$[r_x, r_y, r_z] = [x_s - x_o, y_s - y_o, z_s - z_o]$.

This vector, however, is in the ECI system and to generate look angles, we need it to be in the topocentric-horizon system shown in Figure 1. That system has its z axis pointing toward the zenith, the x axis pointing South, and the y axis pointing East.

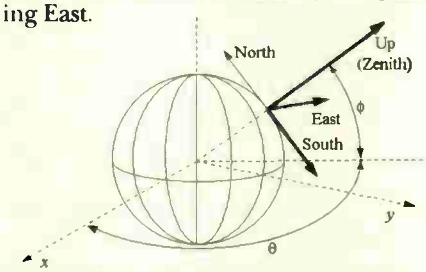


FIGURE 1: Topocentric-Horizon Coordinate System

To transform to the topocentric-horizon system, we must first rotate through an angle θ (the local sidereal time) about the z axis (Earth rotation axis) and then through an angle φ (the observer's latitude) about the y axis. The coordinates (r_S, r_E, r_Z) become:

$r_S = \sin\phi \cos\theta \, r_x + \sin\phi \sin\theta \, r_y - \cos\phi \, r_z$

$r_E = -\sin\theta \, r_x + \cos\theta \, r_y$

$r_Z = \cos\phi \cos\theta \, r_x + \cos\phi \sin\theta \, r_y + \sin\phi \, r_z$

The range to the satellite is

$r = \sqrt{[r_S^2 + r_E^2 + r_Z^2]}$,

the elevation is

$El = \sin^{-1}(r_Z/r)$,

and the azimuth is

$Az = \tan^{-1}(-r_E/r_S)$.

The minus sign is necessary because azimuth is measured clockwise from North instead of counter-clockwise from South (which would be standard for a right-handed orthogonal coordinate system). Care must be taken with the azimuth to ensure the proper quadrant is selected for the arctangent.

We can calculate the look angles using the procedure described with the Pascal procedure Calculate_Look, shown below. The inputs are the satellite's ECI coordinates (xs, ys, and zs) in kilometers, the observer's latitude and longitude (lat and lon) in radians and altitude (alt) in kilometers, along with the time of interest (time) as a Julian Date. The outputs are the azimuth and elevation (az and el) in radians and the range (rg) in kilometers.

```
    Procedure Calculate_Look
(xs,ys,zs,lat,lon,alt,time : double;
                       var az,el,rg : double);
    var
        xo,yo,zo,
        rx,ry,rz,
        theta,
        top_s,top_e,top_z : double;
    begin
Calculate_User_Pos
(lat,lon,alt,time,xo,yo,zo);
    theta := Modulus(ThetaG_JD(time) + lon,twopi);
    rx := xs - xo;
    ry := ys - yo;
    rz := zs - zo;
    top_s := Sin(lat)* Cos(theta)*rx
        + Sin(lat)* Sin(theta)*ry
        - Cos(lat)*rz
    top_e := - Sin(theta)*rx
        + Cos(theta)*ry;
    top_z := Cos(lat)* Cos(theta)*rx
        + Cos(lat)* Sin(theta)*ry
        + Sin(lat)*rz;
    az := ArcTan(-top_e/top_s);
    if top_s > 0 then
        az := az + pi;
    if az < 0 then
        az := az + twopi;
    rg := Sqrt(rx*rx + ry*ry + rz*rz);
    el := ArcSin(top_z/rg);
end; {Procedure Calculate_Look}
```

To sum things up, in order to calculate the look angles for a satellite relative to an observer on the ground, we must first calculate the satellite's position in the ECI coordinate system, then calculate the observer's ECI position, take the difference of the two vectors, and then transform (rotate) the vector from the ECI coordinate frame to the topocentric-horizon frame. The most difficult part of this process is in calculating the Earth's rotation angle when determining the observer's position.

As always, if you have questions or comments on this column, feel free to send me e-mail at **tkelso@afit.af.mil** or write care of *Satellite Times*. Until next time, keep looking up!

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[1] The interval of time in days and fraction of a day since 4713 B.C. January 1, Greenwich noon. Julian dates make it easy to calculate the time interval between two dates.

THE BEGINNER'S COLUMN

By Ken Reitz, KC4GQA

Listening To The Heavens

Scattered across these late fall evening skies are the contents of the universe's jewel box. We call it the Milky Way, but it's really just our own portion of the cosmic neighborhood. That insignificant speck perched out toward the end of an arm of our spiral galaxy doesn't amount to much. But we do call it home.

I know, you're thinking, "Well, Ken's been dipping into the summer wine stock long before it's time." But this is the Beginner's Column and it's my task to take the Big Dipper and wash the stardust from your eyes as we explore the strange world of radio astronomy.

The Sounds of Silence

Just about everyone understands the basic concept of astronomy. You go outside, you look into the sky and if it's nighttime, you see tens of thousands of stars. If you're lucky, a couple of planets and possibly the reflection of the Sun off the odd man-made satellite can be viewed. With a telescope you can see a whole lot more.

The reason you can see objects in the night sky at all is that they are all either emitting light or reflecting light. Which is to say that whatever it is that's being emitted, our eyes — which acts as a receiver — processes the light waves into images. This happens because these images are in the "visible" spectrum and our eyes are prepared to receive and analyze that wavelength.

As we look into the night sky, trying vainly to comprehend the unearthly silence which is the visible universe, there are enormous signals erupting from various portions of the universe that can be monitored. We can't hear them directly because human's are not equipped to hear these radio frequency sounds.

Radio To The Rescue

There came a time, after the science of radio was quite well established, that experimenters became familiar with the various non-manmade sounds which were routinely picked up on radio receivers of the early 1930's. Among the curious were the scientists at the Bell Telephone Laboratories in New Jersey whose task it was to try to determine the origin of some of the more persistent and obnoxious noises.

Assigned to this task was a young man named Karl Jansky. Using a shortwave rotating directional antenna array, nicknamed the "merry-go-round," Jansky made the first observations of radio waves of extraterrestrial origin at the Bell Labs field site in Holmdel, New Jersey from 1930 to 1932. Jansky's work at that time became the foundation for the scence of radio astronomy as it is known today.

Following closely on the heels of Jansky was Grote Reber. Reber, a youngster like Jansky, was working for a number of radio manufacturers in Chicago and conducting experiments in radio astronomy from his home in nearby Wheaton, Illinois.

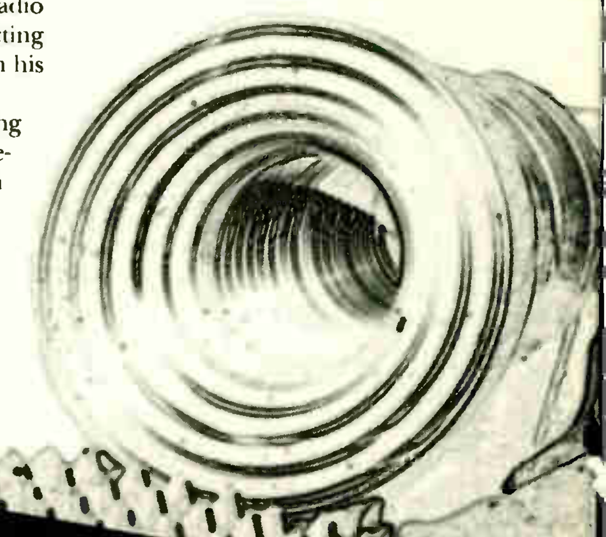
In 1937, at a time long before zoning restrictions and covenants which prevent hams and satellite enthusiasts from erecting modest antennas, Reber built a radio "telescope" in his backyard with a diameter of 31 feet. Working in the range of 137 MHz, Reber began mapping the sky by noting the location of the radio signals. He discovered that such emissions not only existed in the HF and VHF bands, but at higher frequencies as well.

Do-It-Yourself Radio Astronomy

I don't suppose you have a spare 31 foot radio telescope laying around the house so you'll have to make do with something a little smaller. Getting started in listening to the heavens can be done easily with a minimum of equipment. The trouble is that the results of your untutored study may not seem that impressive. The reason is that what you'll hear will sound more like static than the intelligence you've come to associate with radio listening. But, if you listen long enough you'll note that there's a pattern to the noise. Rather than the random static bursts and other earthly interference you've noticed before, this persistence is an indication of another world's transmissions.

Using a simple dipole antenna cut to a frequency of 22.2 MHz connected to your shortwave radio — tune around 22 MHz using the AM mode on your shortwave receiver this winter after midnight when Jupiter is known to be in your night sky. Wait and listen. What you might hear has been consistently described as the sound the surf makes as the waves crash and roll up the beach. What you're actually hearing are "noise storms" created by the movement of Jupiter's moon Io moving through that huge planets' large magnetic field.

An excellent article on the subject was published in the June 1994 issue of *Monitoring Times* entitled, "Countdown To The Crash" by *ST* Managing Editor, Larry Van Horn (available for $2.00 and a SASE from



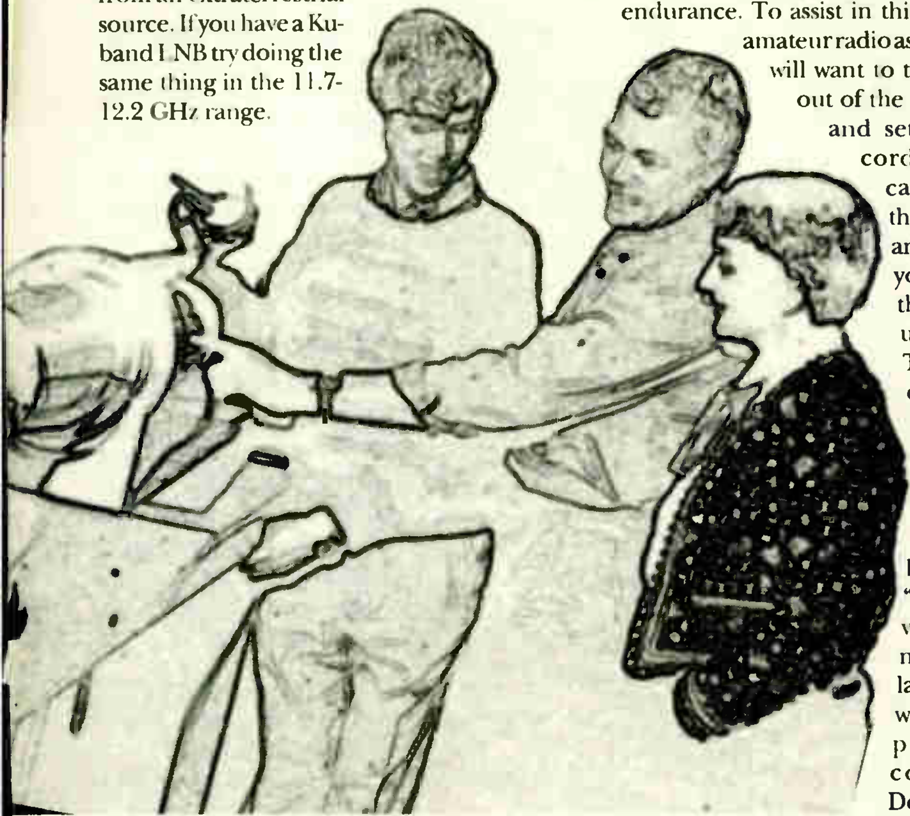
Feed-horn assembly at Parkes Observatory

Grove Enterprises). The article, while detailing the Shoemaker-Levy comet's encounter with Jupiter in July 1994, includes details on making a dipole antenna for regular Jupiter monitoring. There are also tips on receiving techniques and using a stereo cassette tape deck and another receiver to time stamp your recorded transmissions.

Your TVRO "Telescope"

If you have a home satellite TV dish which receives satellites in the C-band range you can also use it as a radio astronomy telescope. Between Galaxy 6 (74 degrees West) and Telstar 302 (85 degrees West) there are 11 degrees of arc with no satellites. On a nice winter's evening park you dish between the two birds and disable the screen blanker on your receiver so that you can use your TV screen to see "sky noise".

Turn up your receiver volume then watch and listen as the Milky Way progresses through the beamwidth of your dish. You may see a shift in the pattern of the sky noise on your TV and even hear a change in the audio. If you have an SCPC receiver which tunes the 950-1450 MHz band of the satellite you may be able to use it to tune in on these "unnatural" noise which could be from an extraterrestrial source. If you have a Ku-band LNB try doing the same thing in the 11.7-12.2 GHz range.



Low Down Radio Astronomy

Well below the AM radio band are the Very Low Frequencies (VLF) and Extra Low Frequencies (ELF). Lurking about among these long waves are the sounds of solar flares hurling charged particles into the Earth's magnetic field. These signals can be tuned in around 40 kHz. By monitoring WWV, the National Bureau of Standards time signal station on 5, 10 or 15 MHz at 18 minutes past each hour, reports of solar activity will be announced giving you some idea when to tune in.

Most shortwave receivers do not receive frequencies below 150 kHz so how can you take advantage of these hot listening opportunities? There are two companies which make radio receiving equipment for the VLF band. These are listed at the end of this article along with other interesting sources for various articles and further information. After you've done your homework you'll know the difference between a tweek and a whistler, or a solar flares and Jovian storm!

Final Analysis

To do any serious listening of the universe requires listening to untold hours of noise. This is normally beyond a human's endurance. To assist in this endeavor amateur radio astronomers will want to take a page out of the pro's book and set up a recorder which can record the goings-on and still allow you to lead the life of the unafflicted. This tape can then be fed into an analog-to-digital converter which allows the "data" to be viewed or manipulated by software on your personal computer. Details about such a setup are given in the reference articles listed at the end of this column.

If, somehow, you thought that monitoring the heavens was going to yield an earful of harp music or urgent communications from superior beings in flying saucers, you may be disappointed with the results of cosmic radio listening. If, on the other hand, your imagination is peaked by the very idea of listening to storms from another planet no matter how mundane they may sound, then you are a candidate for further forays into this uncrowded field of radio listening.

Mailbag

Al Lindner writes: "...is it possible for me, with the right equipment to receive BBC World, and BBC Prime Channels as broadcast to Europe..what equipment would I need and what would an estimate be of its cost...I live in Napa, California."

At this time the only BBC World TV broadcasts I know of can be found from 9:00 to 9:30 a.m. weekday mornings on Anik E2, transponder 15, 6.20 MHz audio. It is part of BBC World "News Hour" program, but for some reason we are treated to only 30 minutes of the broadcast. There are no other BBC World signals that I know of in the clear.

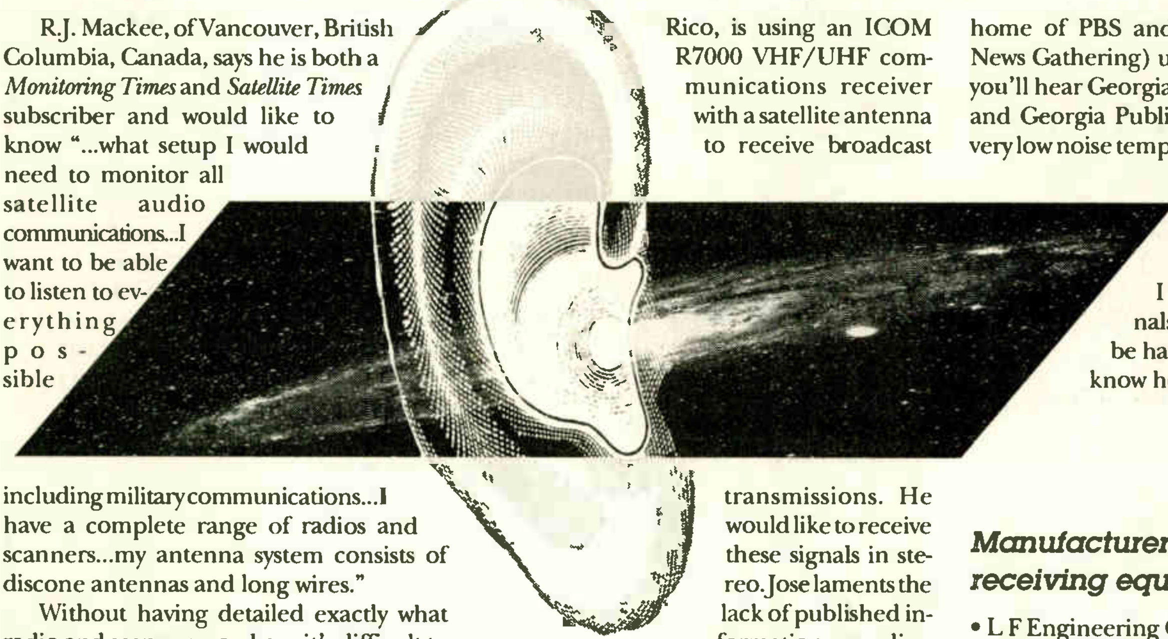
Fabian Husley, of Biloxi, Mississippi, is interested in SCPC reception. He wants to know if the Universal SCPC-100 receiver will do the job and what type of antenna he would need.

Briefly Fabian, here's what you would need for audio only SCPC reception: (items and prices are from the latest Skyvision catalog)

Universal SCPC-100 ($451); KTI XI-7 7.5' dish with mount ($399); programmable positioner and actuator motor ($262); Polarotor IE feedhorn ($65.95); 20 degree 950-1450 LNB ($129); cable package installation kit ($124 includes weather cover, installation aids and tools, aiming sheet and Baylin's "Install, Aim and Repair Your Satellite System").

Finally, you'll need a power inserter to power the LNB which is not available from Skyvision, but can be found for about $50. Now, if you were calculating as we went along you rang up a total of nearly $1,500. To make a serious dent in this price tag I'd like to refer you to the July/August issue of *ST* and this column. With a minimum of hunting you should be able to have SCPC reception for a third that price.

R.J. Mackee, of Vancouver, British Columbia, Canada, says he is both a *Monitoring Times* and *Satellite Times* subscriber and would like to know "...what setup I would need to monitor all satellite audio communications...I want to be able to listen to everything possible including military communications...I have a complete range of radios and scanners...my antenna system consists of discone antennas and long wires."



Without having detailed exactly what radio and scanners you have it's difficult to assess where the gaps are in your reception capabilities. On the surface, the antennas would appear to be where changes will have to be made. Discone antennas are fine for terrestrial reception from nearby VHF and UHF transmitters, but for amateur, military, weather and broadcast satellites you'll need high-gain, multiple-element or parabolic dish antenna systems for good reception.

For successful satellite reception it will also be advantageous to have a computer driven tracking program which will tell you where your target satellites are currently located. In addition, you'll need top quality coxial cable (Belden 9913 RG/8U) for VHF and UHF reception. For broadcast satellite audio you'll need a satellite receiver, dish, LNB, feedhorn, actuator motor and appropriate direct burial cable bundle. You'll also need a 950-1450 MHz splitter to use an SCPC receiver with your TVRO antenna for complete broadcast audio. For weather satellite reception you will need separate antennas for polar or geostationary orbit satellites and separate amplifiers, feeds, lead-in wire and receivers, in addition to computer programs for tracking the birds. Have we maxxed out your credit card yet?

For other readers who are contemplating an all-out assault on their credit rating, I recommend reading everything you can on the subject; pay attention to articles in all the monitoring hobby magazines (such as *ST*, *MT*, *QST*, *CQ*, and *73*, etc). Be on the look out for articles which might help you decide what to buy or how to "home-brew" equipment.

Jose Fernandez of Bayamon, Puerto Rico, is using an ICOM R7000 VHF/UHF communications receiver with a satellite antenna to receive broadcast transmissions. He would like to receive these signals in stereo. Jose laments the lack of published information regarding transponder frequencies and technical information about feedhorns, LNBS and other components.

I would like to think that those of us at *ST* hear your requests and will work to focus on matters of interest to our readers. As to your stereo question, I assume that you are talking about SCPC reception. To receive stereo you will need to have two separate receivers. This would require an additional splitter in order to feed two SCPC receivers. Each would be tuned to separate frequencies (i.e. left and right channels). I realize that this is an exorbitant expense, but it's how it's done in the broadcast world.

Mark Stappenbeck, N0PWZ of Wichita, Kansas, writes, "...The top of my patio looks like a Frisbee/porcupine farm with all my data and OSCAR antennas. Looks like it's time to add another!! I have access to a lot of .8 meter oval dishes and was wondering what type of signals I could pick up with these little fellas. I love NPR. Would I be able to set up a dedicated system to receive this or other audio sources?..."

I say: Go for it! My crude calculations indicate that a .8 meter dish is just under 32 inches in diameter. Since it's oval, I would imagine that it's an offset fed dish which means that the focal point is not directly over the center of the dish. After you find the focal point put the lowest noise temperature Ku-band feed/LNB you can scrounge (try not to pay for that $50 for the whole thing); using RG-6 cable, feed a receiver capable of receiving inverted signals at 950-1450 MHz and look first at Telstar 401 (97 degrees West) which is a new and very powerful Ku-band satellite and also the home of PBS and many SNG (Satellite News Gathering) units. On the audio side you'll hear Georgia Radio Reading Service and Georgia Public Radio. Try putting a very low noise temperature C-band LNB on next, shift the dish next door to Galaxy 4 (99 degrees West) and see what happens. I would imagine the signals would be noisy, but I'd be happy to be wrong. Let us know how it works out. ST

Manufacturers of VLF and ELF receiving equipment:

- L F Engineering Co., Inc. 17 Jeffry Road, East Haven, CT 06512 phone: 203-467-3590
- Conversion Research P.O. Box 535 Descanso, CA 91916.

Articles on radio astronomy:

- "DXing the Planet Earth" by Larry Van Horn, *Monitoring Times*, December 1992, pages 16-20.
- "Listen To Natural Radio" by Mike Mideke, *Science Probe*, July 1992
- "Countdown to the Crash" by Larry Van Horn, *Monitoring Times*, June 1994, pages 10-13.
- "Listening to the Cosmos" by Jeffery M. Lichtman, *Satellite Times*, September-October 1994, pages 68-69.

Other resources:

- Society of Amateur Radio Astronomers (SARA) 247 N. Linden Street, Massapequa, NY 11758.
- Outer Space Frequency Directory (Satellites, probes, shuttles, space stations, non-human signals) Tiare Publications P.O. Box 493 Lake Geneva, WI 53147
- Amateur Electronic Supply 5710 W. Good Hope Road, Milwaukee, WI 53223 Phone 414-358-0333 FAX 414-358-3337 BBS 414-358-3472.
- Grove Enterprises, Inc. P.O. Box 98 Brasstown, NC 28902 Phone 704-837-9200 Data/FAX 704-837-2216. For a free catalog e-mail: order@grove.net
- Ham Radio Outlet, 933 North Euclid Street, Anaheim, CA 92801, 800-854-6046.

SATELLITE TECHNICAL FORUM

Dishes, Eyes, Parabolas, Antennas and Other Things

By Tim Olin

A satellite dish is known by many terms including, antenna, parabola or even as the "eye" of a system. There's a great deal of truth to that last description because with a dish the "look angle" is very important. But, whereas an eye lets in objects it sees, a dish reflects back signals sent from distant satellites. Years ago the military and the phone company were the ones with dishes. There really wasn't anything the general public was interested in that they needed a dish. All that changed in the middle 70's when people found out there was entertainment and information that could be grabbed from the sky. It was then that ordinary citizens began the quest for a dish. A quest that continues today, however, the size and kind of antenna most people want has sure changed over time.

In the beginning, the avenue to obtain a dish pretty much boiled down to a surplus dish from Bell telephone or from the military. But, those early commercial antennas could cost as much as $9,000 a piece, so, people began to figure out ways to build their own. Oliver Swan built some of the first antennas. They were large screen mesh monsters that needed the feedhorn to be set several feet in front of it on a small pole or rod. In fact, you could set up more than one feed and could receive several satellites at once. These "spherical" giants were nearly flat in shape and were not used much after 1980 when people found it more practical to move an antenna from one satellite to another. Jim Vines made a version from Oak struts, steel cables and aluminum panels. These "Paraframe" antennas ranged in sizes from 12 to 15 foot and were hand made.

As the demand for more dishes increased, other people began to figure out ways to make them. In the beginning, fiberglass was the material most often used to build antennas for the mass market. Fiberglass is not an easy material to work with and is not a reflective material of itself. The ideal way to make a fiberglass dish was to flame spray or evenly apply a metallic coating such as zinc to the surface of the dish. Thus, the zinc or other metallic material would do the reflecting, or some kind of mesh material would be in-laid in the fiberglass. Initially, the approach to making a dish was to hand lay the fiberglass on a mold. Many of those pioneering dish companies also built boats or certain kinds of car bodies or something else that needed fiberglass. But, it was soon discovered that building a boat wasn't the same as building a dish. A dish has certain engineering requirements, not the least being that they adhere to their designed shape over a long period of time. It wasn't uncommon to see the bottom of a fiberglass dish droop or to see thin spots or uneven surfaces on the face of dish. Sometimes the hand-laid surface would separate or ultra violet rays would "bake" the fiberglass and it would crack.

However, well-made fiberglass dishes were good, durable antennas and many are still in use. When properly formed, they make excellent reflectors and can stand up to the beating a hail storm can render on an antenna. Those early fiberglass dishes were extremely heavy and required massive mounts and poles to hold them up. For the most part they were made in sections, because it was easier and cheaper to ship them that way. Eventually, M/A Com and Prodelin began to use a thermo-compression or thermo-injection molding process for making fiberglass dishes. They were also offered under the Channel Master name and many of those antennas are still around.

Other companies began to jump on the bandwagon. Hastings Irrigation, a company in Hastings, Nebraska manufactured 10 and 12 foot aluminum antennas. They came in sections that had to be bolted together with lots and lots of little nuts and bolts. It required several hours to assemble, but the important point here is the dish was

shipped in one crate. Every manufacturer wanted to build an antenna that could be cheaply transported to another place. Often this mission drove the process of designing and making an dish. The goal of antenna makers eventually boiled down to "can we ship it by UPS?"

Other antennas arrived on the market in the early eighties that were smaller and that were made from materials other than fiberglass and aluminum. They were also made by different manufacturing processes. One company offered a stainless steel, molded antenna. One problem with it was its shiny surface. A dish not only gathers signals from satellites, it also gathers the rays of the sun like a solar collector. This was a "hot" dish.

Another company began to offer dishes that were formed by a spinning process. These "spun" antennas could also be stacked one on top of the other, thus allowing many to be shipped at a time. Soon, the floodgates opened and dishes were being pumped out right and left. All kinds and shapes appeared. Some worked, some didn't and eventually only the strong and serious antenna makers with deep pockets survived. So, what did those surviving manufacturers learn about antennas and about the economics of making antennas? They learned the basics about shape, size, and the materials to make them.

Antennas can be various shapes, but remember that no matter what the shape the purpose of the antenna is to reflect signals to a central point called a "focal point." Ideally, 100 percent of the signals would reach that central point, but the laws of physics rule. Even if a dish had a perfectly contoured surface, no more than about 84 percent of the signal would reach the focal point. One of the terms that is used when talking about how much signal reaches the focal point is the "gain" of the antenna. Antenna gain is measured in dBi-decibels over an isotropic source. The remaining percentage of the signal that doesn't reach the focal point falls out in what are called "side lobes." In the antenna that would reach 84 percent at the focal point, there would be 16 percent that would fall into side lobe.

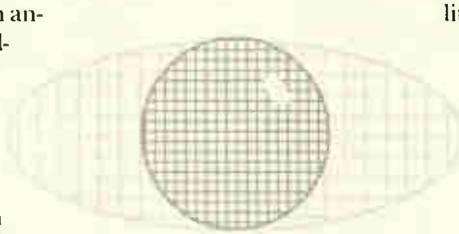
Side lobes have been described as little "burps" in your picture. Say you have an antenna that you can move. As you go from one satellite to another, the picture from the next satellite should come cleanly into focus while the one you are leaving doesn't linger. With side lobes the picture may appear before you actually center on the satellite or it may remain for a moment as you move off the satellite. In the beginning most satellites were spaced 3 degrees apart. As more and more satellite entered the satellite belt, some were moved closer together at 2 degrees. Antennas with side lobe problems will have difficulty separating signals on the satellites that are close to each other. They will "see" two signals at the same time.

So, in the search for the perfect antenna you want good gain and as little side lobe as possible. When a signal comes down, the feedhorn can block and can scatter some of the signal. In small dishes the feed can disrupt a greater percentage of the signal than with larger dishes. That's one of the reasons you see "offset" feeds on dishes that are smaller than 6 foot. Offset feeds are those feeds that are not placed right in the center of the dish. The new 18-inch DSS‡ dishes use this design.

Not only must a dish be shaped so that it directs the signal to the focal point, it must have a smooth face or surface. If the face is rough or uneven the signal will not reach the focal point. Back when fiberglass dishes first were made, there were some problems with the surface quality. There can be surface problems with spun antennas as well, if the spinning process isn't correct. It may leave ridges or grooves. However, that was then and this is now, most dishes today are good products.

One kind of antenna that seems to operate outside the parameters of most dishes is the "flat" antenna. The quest for the flat dish has been going on for years. The Japanese at one time were said to have developed one and from time to time American companies have tried their hand at building one. Kaul-Tronics, Inc. has one that reportedly will reach the mass market in late 1995 or sometime in 1996. Flat antennas are called "phased array" antennas. Flat antennas are attractive to the market place because of their low profile. They would meet many zoning laws that other styles of dishes won't. They would also work nice on motor homes and they would blend in with most architectural designs.

Mesh antennas followed the path of other antennas. They were developed because they were lightweight, were pleasant to look at and had a functional purpose in its design. Antennas are like sails, they catch lots of wind. Mesh antennas were manufactured with that in mind as they catch less wind. How do they work with all those little holes? The holes are close enough together that they "fool" the signal so that it bounces away just like it were a solid surface. Early mesh antennas were an adventure. An example of this fact was that some were made so that the mesh panels were held on with little clips that came unclipped quite often at the worst of times. Not that there was a good time for it to come apart.



Steel and aluminum were other materials of choice to make an antenna, especially mesh antennas. There is a problem though with steel. Corrosion is a big time enemy of an dish and steel corrodes. It was found that one of the major places of corrosion was where the mesh fastens onto the trusses. Also, if the surface of the dish was scratched it invited the corrosive process to begin. Steel was used because it was cheaper than aluminum and there was a time when aluminum prices were pretty unstable. Aluminum orders would have to be made 3-5 months in advance. It was during this era that it was hard to know from week to week how much aluminum would cost or how much was needed. Once again, economics drove the manufacturing process and some of the results were not positive.

In an effort to battle corrosion, most manufacturers eventually began to "powder coat" the mesh. Powder coating is a process of applying paint or a paint-like substance to the surface of the mesh. It can be baked on or applied by an ionization process. Not all powder coating processes are equal, thus not all antennas had the same opportunity to fight corrosion. Once again, that was then and this is now. There are some wonderfully built mesh antennas with great powder coating.

Other problems with antennas of old was metal fatigue. Name a part of the manufacturing process and you can name various ways that manufacturers approached that process. Some of the metal that was used just wasn't very strong or started out strong but as a result of the manufacturing process was weakened. Sometimes the trusses would break or at other times the mesh would tear away from the clips or screws that held them to the ribs. The metal would simply get "tired" and fall apart. Or, if there was welding involved, welds would break.

The quality of the mesh in those pioneering dishes varied a great deal. Some mesh panels were "rolled" out with little regard to the curve that was needed to form an accurate reflective surface. Some mesh was so flimsy that a minor hail storm would totally destroyed the dish or when hit with a strong wind the mesh would tear away from the trusses. Sections would not line up, clips would fall out, whole sections would blow out and on and on. Like I said, sometimes it was a real adventure.

Another manufacturing process is "hydroforming." This is an extremely accurate way to build a dish if done correctly. A sheet of material is pressed into the desired shape by water pressure. It's a seamless way to form a dish and the surface of the dish is very smooth. Not everyone can do this and the equipment to accomplish this is not cheap. In many cases a round sheet of aluminum is placed in a large press. The top part of the press contains a plastic bladder partially filled with water. The press is clamped shut and more water is pumped into the bladder which slowly pushes the aluminum sheet into a mold that is the desired shape of the dish. This may take 5 or so minutes and then the water is sucked back out so the next dish can be formed. Manufacturers also found out many things about the size of a dish. Originally it was thought a big dish was a must. If you didn't have a big dish you couldn't get a picture. For a while this was partly true. But, the key to this part of dish making had little to do with the dish itself. It depended on the power of the signal a satellite sent down to the dish. Most of the early satellites used for entertainment sent their signals in the 3.7 to 4.2 Ghz range. Eventually, higher frequencies were chosen, thus allowing smaller antennas to be used. However, a big dish has an advantage over a small one in it's ability to gather more signal strength. An example would be that if you have a long run from the dish to the receiver a big dish can help gather more signal than a smaller one. Digital signals are beginning to have an impact on the ability to use small antennas.

All-in-all the art and science of making a dish, antenna or parabola has come a long way. It appears that companies learned lots about making antennas. Manufacturers have reached their goal of building good, quality antennas that can stand up to the elements, are reasonable in price and can be shipped by UPS. Life is good in the dish business. ST

ST Fact Sheet - Selected Satellite Dishes Manufacturers

Andersen Manufacturing
3125 North Yellowstone Highway
Idaho Falls, ID 83401
(208) 523-6460

Antenna Development
P.O. Box 1178
Popular Bluff, MO 63901
(314) 686-1484

DH Satellite, Inc
600 North Marquette Road
Prairie du Chien, WI 53821
(608) 326-8406

Francis Enterprises Inc.
Box 906
Popular Bluff, MO 63901
(314) 989-3248

Kaul-Tronics, Inc-KTI
1140 Sextonville Road
Richland Center, WI 53581
(608) 647-8902

Odom Antennas, Inc
2502 DeWitt Henry Drive
Beebe, AR 72012
(501) 882-6198

Orbitron International
351 S. Peterson
Spring Green, WI 52588
(608) 588-2923

Paraclispe Inc
P.O. Box 686
Columbus, NE 68602-0686
(402) 563-3625

Perfect 10 Antenna Company
2301 North Redmond Road
Jacksonville, AR 72076
(501) 982-2354

U.S. Sat
4060 Morena Blvd. G-196
San Diego, CA 92117
(619) 278-2440

Wineguard Company
3000 Kirkwood Street
Burlington, IA 52601-2000
(319) 754-0600

Ask Satellite Times

Due to space constraints, we have not been able to run our regular column Q&A column, *Ask Larry*. We hope that *Ask Larry* will return very soon. In the meantime, we will try to answer interesting questions of a general interest in the *Satellite Technical Forum* as space permits. This month *ST* publisher, Bob Grove, tackles a technical question from Brian O'Brien.

Q. *How does a line voltage surge suppressor work? (Brian O'Brien, Windsor, Ont.)*

A. Alternating current in a power line is distinguished from direct current from a battery by the characteristic current reversals, 60 negative/positive exchanges per second in North America. Transformers and other components designed to operate from AC power lines expect to see this regular pattern and, if abruptly changed, may suffer catastrophic effects.

The most common equipment hazard on an AC line is the voltage transient, a sudden "spike" of voltage considerably in excess of the usual 120 nominally specified. Because the resistance of the attached equipment remains the same, a sudden increase in voltage is accompanied by a sudden increase in current. Solid-state equipment is especially vulnerable to these surges.

Current and voltage regulation may be provided by in-rush-preventive components like series inductors, surgistors and resistors, and parallel capacitors, diodes and gas-discharge tubes. Metal oxide varistors (MOVs) are probably the most common, low-cost spike protectors on the consumer market. They tolerate minor voltage spikes, but "crowbar" (short-circuit) high-voltage transients that could cause damage.

While it might seem that such a simple, inexpensive device could be used on an antenna line as an effective induced-lightning protector, MOVs have high capacitance which severely attenuate radio frequency signals.

SPACE INTEREST GROUPS

ST's Space Interest Groups list those local, national and worldwide groups you can join that promote space, astronomy, and space activities. Groups are selected for inclusion in this column by the staff of *Satellite Times* and run as editorial space permits.

Space Group Profile: Student Space Awareness, Inc

Student Space Awareness, Inc. is a non-profit organization whose purpose is to educate students and the general public as to the values and benefits of the space program. SSA hopes to bridge the infinite dreams of students with the current trends and realities of the aerospace industry and deliver a message to our elected officials in Washington on a regular basis.

Some of the goals of the SSA include:

- We intend to take technological advancement, space policy, industry contacts/ management/congressional contacts, and mix all these with the student pro-space message.
- We will offer the student perspective to educate Congress as to why we need a strong space program.
- We want every student in this country to think about the future of space exploration efforts at least once a day.
- The student interested in planetary science will sit next to the student interested in space station in a congressman's office, and together, they will be supporting space as a whole.

Student Space Awareness, Inc. has online documentation for prospective members or interested parties such as educators and educational institutions at their world wide web page located at seds.lpl.arizona.edu/ ssa.html.

If you want more information on the SSA send an e-mail message to: ssa@seds.lpl.arizona.edu

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Amateur Satellite Corporation (AMSAT)
P.O. Box 27
Washington, DC 20044
(301)-589-6062

Astronomical League
Science Service Building
1719 N. Street N.W.
Washington, D.C. 20030

British Interplanetary Society
27/29 South Lambeth Road
London SW8 1SZ
ENGLAND
Membership: No dues information available at present.

Canadian Space Society
43 Moregate Crescent
Bramalea, Ontario
CANADA L6S 3K9
Answering Machine: (416)-626-0505
CSS BBS: (905)-458-5907 (8N1, up to 2400 buad)
Membership: Annual dues are $25/year ($15/ year for full-time students, $100/year for corporate members).

National Space Society
Membership Department
922 Pennsylvania Avenue, S.E.
Washington, DC 20003-2140
(202)-543-1900
Membership: $20 (youth/senior) $35 (regular).

The Planetary Society
65 North Catalina Avenue
Pasadena, CA 91106
(618)-793-5100
email psociety@delphi.com
Membership: $5/year

Sky Report — Freehold, NJ
Night sky and bright satellite object information (pre-recorded)
The category for the "Sky Report" is 8888. There is no charge for this service.
(908) 866-8808, (908) 918-1000, (908) 957-8700, (908) 505-8011 and (908) 545-6000.

The Society of Amateur Radio Astronomers (SARA)
c/o Hal Braschwitz
3623 W. 139th Street
Cleveland, OH 44111.

Space Access Society
4855 E Warner Rd #24-150
Phoenix, AZ 85044
(602)-431-9283 voice/fax
hvanderbilt@bix.com
Membership: $30/year, $1000/lifetime; includes email updates. $50 for email plus mailed hardcopy ($25 extra outside the US).

Space Station Future Fighters
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SPACE GLOSSARY

The following are some terms used in the satellite business and are described in layman's terms.

ALTITUDE (ALT): The distance between a satellite and the point on the earth directly below it, same as height.

AQUISITION OF SIGNAL (AoS): The time at which a particular ground station begins to receive radio signals from a satellite.

APOGEE: The point in a satellite's orbit farthest from the Earth's center.

ARGUMENT OF PERIGEE: This value is the number of degrees from the ascending node the perigee point occurs. The perigee point is the point where the satellite is the closest to the earth (assuming an orbit which is elliptical to some degree). This number may be entered as a real value between 0.0 and 360.0.

ASCENDING NODE: Point at which the satellite crosses the equatorial plane from the southern hemisphere to the northern hemisphere. (See RIGHT ASCENSION OF THE ASCENDING NODE.)

AZIMUTH (AZ): The angle measured in the plane of the horizon from true North clockwise to the vertical plane through the satellite.

CATALOG NUMBER: A 5-digit number assigned to a cataloged orbiting object. This number may be found in the NASA Satellite Situation Report and on the NASA Two Line Element (TLE) sets.

COORDINATED UNIVERSAL TIME (UTC): Also known as Greenwich Mean Time (GMT). Local time at zero degrees longitude at the Greenwich Observatory, England. Uses 24 hour clock, ie. 3:00 pm is 1500 hrs.

CULMINATION: The point at which a satellite reaches its highest position or elevation in the sky relative to an observer. (Known as the Closest Point of Approach)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups polling resources for space exploration and development.

FOOTPRINT: A set of signal-level contours, drawn on a map or globe, showing the performance of a high-gain satellite antenna. Usually applied to geostationary satellites.

GROUND STATION: A radio station, on or near the surface of the earth, designed to receive signals from, or transmit signals to, a spacecraft.

INCLINATION (INC): The angle between the orbit plane and the Earth's equatorial plane, measured counter-clockwise. 0 (zero) degrees inclination would describe a satellite orbiting in the same direction as the Earth's rotation directly above the equator (orbit plane = equatorial plane). 90 degrees inclination would have the satellite orbiting directly over both poles of the earth (orbit plane displaced 90 degrees from the equatorial plane). An inclination of 180 degrees would have the satellite orbiting again directly over the equator, but in the opposite direction of the Earth's rotation. Inclination is given as a real number of degrees between 0.0 and 180.0 degrees.

INTERNATIONAL DESIGNATOR: An internationally agreed upon naming convention for satellites. Contains the last two digits of the launch year, the launch number of the year and the piece of the launch, ie. A-indicates payload, B-the rocket booster, or second payload, etc.

LATITUDE (LAT): Also called the geodetic latitude. the angle between the perpendicular to the Earth's surface (plane of the horizon) at a location and the equatorial plane of the earth.

LONGITUDE (LONG): The angular distance from the Greenwich (zero degree) meridian, along the equator. This can is measured either east or west to the 180th meridian (180 degrees) or 0 to 360 degrees west. For example, Ohio includes 85 degrees west longitude, while India includes 85 degrees east longitude. But 85 degrees east longitude could also be measured as 275 degrees west longitude.

LOSS OF SIGNAL (LoS): The time at which a particular ground station loses radio signals from a satellite.

MEAN ANOMALY (MA): This number represents the angular distance from the perigee point (closest point) to the satellite's mean position. This is measured in degrees along the orbital plane in the direction of motion. This number is entered like the argument of perigee, as a value between 0.0 and 360.0.

MEAN MOTION (MM): This is the number of complete revolutions the satellite makes in one day. This number may be entered as a value greater than 0.0 and less than 20.0. (See DECAY)

NASA: U.S. National Aeronautics and Space Administration.

ORBITAL ELEMENTS: Also called Classical Elements, Satellite Elements, Element Set, etc. Includes the catalog Number; epoch year, day, and fraction of day; period decay rate; argument of perigee, inclination, eccentricity; right ascension of ascending node; mean anomaly; mean motion; revolution number at epoch; and element set number. This data is contained in the TWO LINE ORBITAL ELEMENTS provided by NASA.

OSCAR: Orbiting Satellite Carrying Amateur Radio.

PERIOD DECAY RATE: Also known as Decay. This is the tendency of a satellite to lose orbital velocity due to the influence of atmospheric drag and gravitational forces. A decaying object eventually impacts with the surface of the Earth or burns up in the atmosphere. This parameter directly affects the satellite's MEAN MOTION. This is measured in various ways. The NASA Two Line Orbital Elements use revolutions per day.

PERIGEE: The point in the satellite's orbit where it is closest to the surface of the earth.

POSIGRADE ORBIT: Satellite motion which is in the same direction as the rotation of the Earth.

RETROGRADE ORBIT: Satellite motion which is opposite in direction to the rotation of the Earth.

REVOLUTION NUMBER: This represents the number of revolutions the satellite has completed at the epoch time and date. This number is entered as an integer value between 1 and 99999.

REVOLUTION NUMBER AT EPOCH: The number of revolutions or ascending node passages that a satellite has completed at the time (epoch) of the element set since it was launched. The orbit number from launch to the first ascending node is designated zero, thereafter the number increases by one at each ascending node.

RIGHT ASCENSION OF THE ASCENDING NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period, inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

Can You Find What You Need?

Although satellites have been in orbit for several decades, hardware for monitoring still seems to fall into two categories: high-end commercial and home-brew. Government agencies facing cuts, commercial aerospace companies feeling fiscal fallout, and home experimenters alike often express dismay at the short list of economical choices. A recent meeting with a small manufacturer of hobby-related accessories brought this point home.

Have you ever tried to find an inexpensive az-el (azimuth/elevation) antenna tracking motor for polar-orbiting satellites? How about low-noise, fixed-frequency converters, preamplifiers, antennas, data demodulators, and other accessories for GOES, NOAA polar orbiters, INMARSAT, PCS, UHF military, TDRSS, GPS, amateur satellites, and other birds? As I type this I had a call from a reader asking why no one made an antenna for monitoring the UHF military satellites. It seems as though you have two options: purchase a professional system or roll your own.

ST Managing Editor Larry Van Horn made an interesting observation which seems to have great validity: We are on the threshold of a new adventure, similar to where ham radio was just after World War II. At that juncture, ham radio was several decades old, and surplus equipment and parts were available at low cost to stalwart experimenters who wished to venture into higher frequencies and different modes of communications.

Now satellite communications is on that horizon, available to the stalwart experimenter who wishes to salvage satellite terminal hardware, build a few circuit boards and acquire inexpensive control software for his home computer.

With the soft economy and diminishing allure of amateur radio, many manufacturers and dealers would welcome other avenues of revenue. As I write this editorial, several amateur radio dealers are planning to go out of business. Look around. What don't you see? What would you like to have available at reasonable cost for the new era of communications and monitoring? Let us know at *Satellite Times*; we're listening. ST

Editors Note: If you would like to respond to this editorial you can send us e-mail at: steditor@grove.net or write us at Uplink, P.O. Box 98, Brasstown, NC 28902.

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