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Cover Story

Jodi Foster, star of the Warner Brothers movie *Contact*, in front of the 600 ton instrument platform at the world's largest radio astronomy dish in Puerto Rico. In addition to looking for SETI signals from Arecibo, we have also sent our own messages for others to hear into space from here. (Photo courtesy of Warner Brothers studios)

The Worldwide, Backyard Search for ET

By H. Paul Shuch, Ph.D. Executive Director, The SETI League, Inc.

The Warner Brothers movie *Contact* starring Jodi Foster has renewed interest by amateurs and professionals alike in the search for extraterrestrial intelligence (SETI). SETI searchers spend their time looking for some ordered and therefore intelligent signal in the background chaos of the radio spectrum. The new equipment for this endeavor includes wideband receivers, dishes and personal computers now available to the general public. This means that even an amateur has an equal chance to hear ET from the backyard. Dr. Paul Shuch shows you how starting on page 10.

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There is a whole new crop of wireless satellite telephones which provide the consumer with the capability to send voice, data, or fax from almost anywhere on earth. In this month's ST Test author Steve Handler tests a new satellite telephone from Magellan called the World Phone. Our review starts on page 62.

DEPARTMENTS

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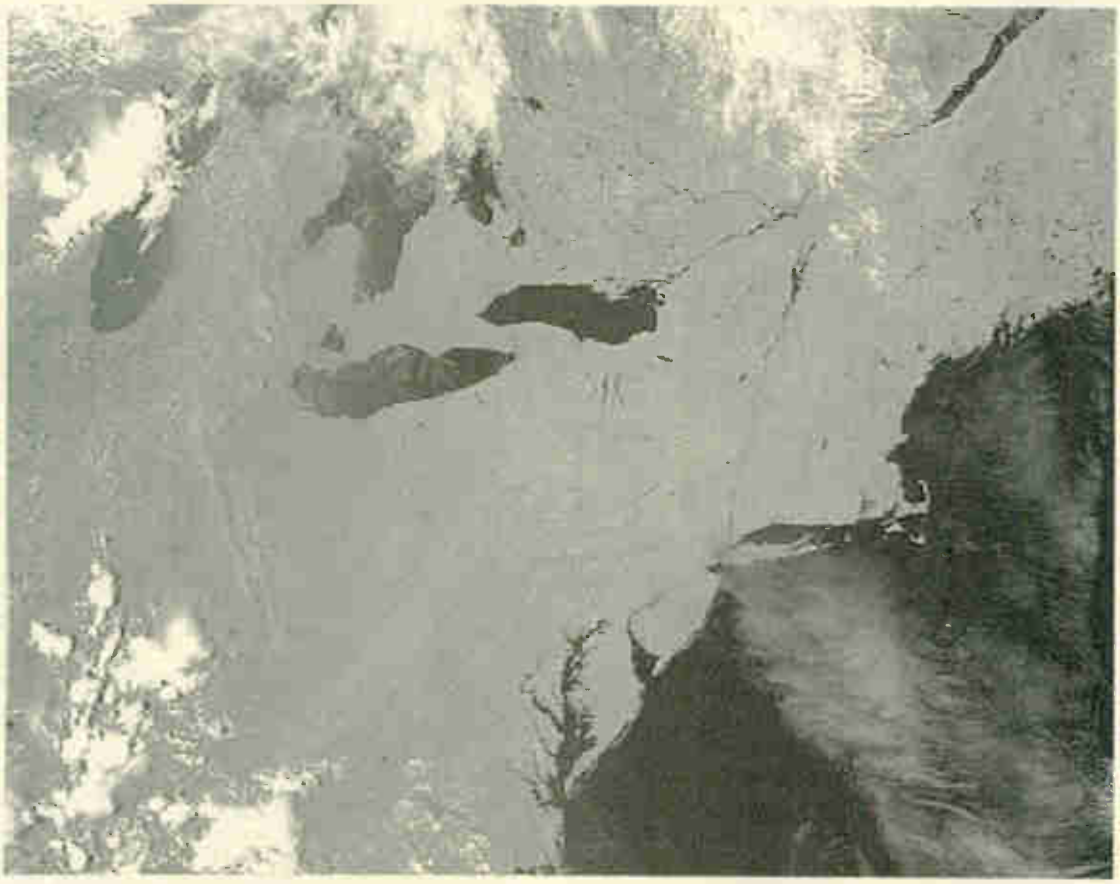

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World Radio History

DOWNLINK

By Larry Van Horn
Managing Editor
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Congress Strikes Again

House Commerce Committee Chair, U.S. Rep. Tom Bliley (R-VA), joined U.S. Rep. Edward J. Markey (D-MA) to introduce legislation (HR 1872) in the U.S. Congress to privatize and bring competition to intergovernmental satellite organizations.

"The Communications Satellite Competition and Privatization Act of 1997," is an effort by Chairman Bliley to privatize and reform the monopoly-like international satellite organizations–the International Telecommunications Satellite Organization (Intelsat) and Inmarsat, formerly known as the International Maritime Satellite Organization. Together, they own and operate the world's largest fleet of communications satellites.

"Competition, not government-run monopolies, gave America the greatest standard of living on earth. This bill brings competition to outer space, and the result will be better and cheaper international satellite communications," Bliley said.

"This legislation is designed to fully privatize Intelsat and Inmarsat on a model based on free and fair competition. As the nation most involved in the creation of these organizations 30 years ago and the world's greatest proponent of free enterprise, the United States should now take the lead in transforming these UN-like organizations into private entities ready to compete in the next millennium," Bliley said.

Key Provisions of the Legislation

• HR 1872 maintains the goal of creating a competitive marketplace of distinct satellite providers through the privatization of the intergovernmental satellite organizations, Intelsat and Inmarsat.

• Updates U.S. satellite policy to respond to the challenges presented by the need to open closed foreign markets, emerging competition and changes in technology;

• Contains pro-competitive criteria that will guide Federal Communications Commission and Executive Branch actions to attain full privatization of Intelsat and Inmarsat after an appropriate transition period.

• Works to stop the expansion of the intergovernmental satellite organizations into new services such as the Internet, hand-held satellite phones, and direct broadcast video services, which private companies are currently fighting to provide.

• Directs the Federal Communications Commission to take appropriate action to help create a "level playing field," to help make sure that Intelsat and Inmarsat are privatized in a manner which is pro-competitive, and to ensure that foreign governments and national telecommunications firms do not discriminate against private providers of satellite-based services and technologies.

• Requires the Commission to ensure that appropriate safeguards are in place to protect against unfair advantages and cross-subsidization by the international satellite organizations. These rules cover orbital slots, spectrum assignments, and other issues.

• Directs the administration and the FCC to oppose auctions of satellite orbital slots and spectrum for satellites, both home and abroad.

Rebuttal by Globecast

With recent developments in the telecommunications industry, many believe the move to privatization is the key to promoting competition and ensuring that both providers and users can compete and be profitable. But Congress' draft legislation H.R. 1872 which seeks to increase satellite communications competition by implementing sanctions against Intelsat if it does not meet US-imposed privatization deadlines will have the opposite effect, creating less, not more competition.

Intelsat via COMSAT, the only common carrier of international satellite services, is a government regulated provider of international space segment which must grant non-discriminatory access and tariffs for the use of its facilities. The sanctions proposed by Congress, i.e. prohibiting the use of Intelsat, will negatively affect an important section of the satellite industry: teleport operators and service providers. Employing thousands of people across the United States and generating substantial revenue, the satellite industry cannot afford to ignore the needs of teleport operators and service providers. The most pressing need is easy, consistent, affordable access to international space segment.

If sanctions are imposed and Intelsat is privatized, teleport operators' and service providers' access to international space segment is significantly hindered. While other separate satellite systems do have international space segment there have been instances when these providers have preferred to bypass the teleport service providers and sell directly to end-users. Without a common carrier like Intelsat, satellite providers will have no competitive need to provide non-discriminatory access to their facilities.

In this same scenario, one may wonder what will happen to the long-term contracts many providers now have with Intelsat? Can Congress guarantee that PANAMSAT, Columbia or Orion will provide equivalent capacity at the same price structure? As these carriers will have a captive market it is likely that costs will rise significantly, locking teleport operators and service providers out of the international space segment market. Also, will Congress indemnify teleport operators when they break their contract with Intelsat and its signatories?

Also under consideration at this time is a COMSAT petition for non-dominance. If granted, COMSAT would be allowed to provide earth station services from the same business unit that has the sole right to buy Intelsat space segment directly, providing a clear competitive advantage. This places COMSAT as a provider to and direct competitor of teleport operators and service providers.

Congress should include teleport operators and service providers in all discussions surrounding this draft legislation. Congress should directly address how the entire satellite industry is weakened if these providers are denied non-discriminatory access to international space segment. As an industry, we cannot afford to ignore the threat to teleport operators' and service providers' businesses. Within the satellite industry and the government we must represent all satellite segments in the debates surrounding what comprises "healthy competition."

—Timothy Shea, GlobeCast North America,
Senior Vice President, International Sales & Government Affairs

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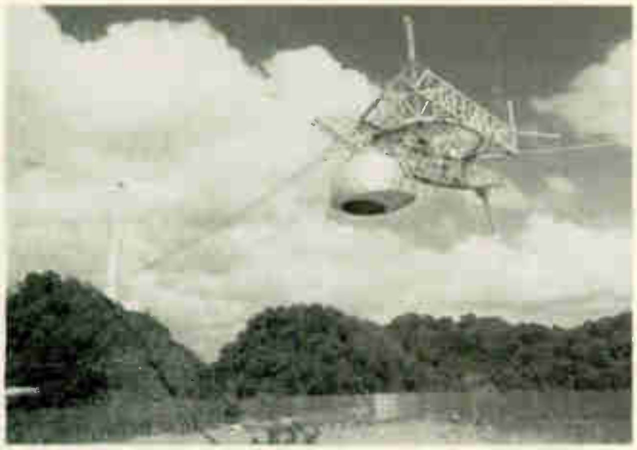
Satellite Monitor

By Wayne Mishler, KG5BI



The Arecibo Radio Telescope in Puerto Rico, operated by the National Astronomy and Ionosphere Center (NAIC) with headquarters at Cornell University.

Compromise eases RFI threat to radio astronomy

After five years of negotiations, business and science finally have compromised in what may be the most far reaching of all RFI (radio frequency interference) conflicts.

Motorola goes operational this fall with a system of 66 low orbit satellites, called Iridium, which promises to do wonders for worldwide portable telephone communications.

Astronomers fear that transmissions from Iridium will interfere with 1,612 MHz, the frequency at which Hydroxyl, one of the most common and most important interstellar molecules, emits radiation.

Hydroxyl is a gaseous molecule produced in the atmospheres of old stars. It also appears in interstellar clouds, which are seedbeds of young stars and solar systems. Tracing the path of this gas helps astronomers reconstruct the development of our own galaxy.

The RFI threat was a major concern for astronomers who use the Arecibo Radio Telescope in Puerto Rico, operated by the National Astronomy and Ionosphere Center (NAIC) with headquarters at Cornell University.

At press time, The National Science Foundation and Cornell University issued a joint press release stating that Motorola and the NAIC had signed an agreement guaranteeing astronomers eight hours of interference-free observing time daily.

"This agreement is a good compromise in protecting astronomers' ability to observe at this frequency," says Paul Goldsmith, Cornell University astronomer and NAIC director.

"Some radio astronomers felt they were entitled to 24 hours a day, but I'm glad that both sides could agree to eight. The agreement should help radio astronomy and communication's use of the spectrum to coexist productively," Goldsmith adds.

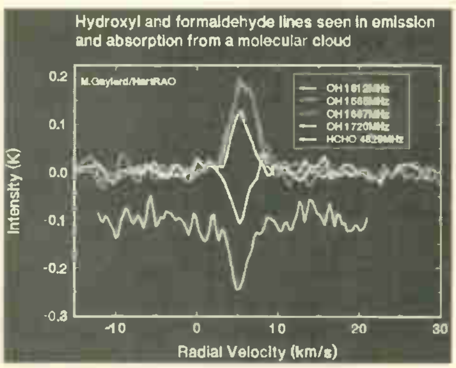
Hugh Van Horn, National Science Foundation director of astronomy, expressed approval of the agreement. "The telescope's ability to observe across a much greater range of frequencies, and its enhanced sensitivity will enable a vast new range of astronomical observations of sources (ranging) from asteroids to distant galaxies.

"Careful protection of the radio spectrum is absolutely essential to use the telescope to its fullest potential," he says.

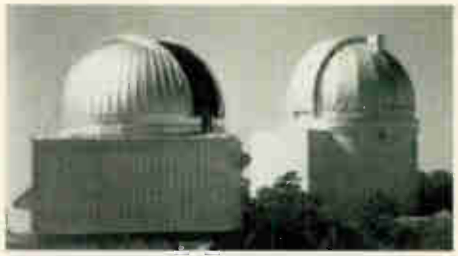
To prevent interference with Arecibo, Iridium will not transmit in the sensitive spectrum between 10 p.m. to 6 a.m., Eastern Time. The agreement also specifies that radio astronomers may be allotted additional protected times if needed.

"We must worry about interference with observations at other frequencies and other radio telescopes as well," says Michael Davis, chair of the National Research Council's committee on radio frequencies.

"This is vital to protect access to these very faint whispers of natural radiation that tell us so much about the universe," he adds.



Whew! Asteroid will miss Earth on this pass



Jim Scotti, using the University of Arizona's 36-inch telescope built 77 years ago, detected the asteroid.

New computations show that the mile-wide asteroid tumbling toward Earth will miss our planet by 600 thousand miles, astronomers now say.

The asteroid, known as 1997 XF11, was discovered by Jim Scotti in the Spacewatch program at the University of Arizona, using a 36-inch telescope built 77 years ago.

Early observations showed the minimum distance between the orbits of 1997 XF11 and the earth to be small enough to put it on the list of "potentially hazardous asteroids" (PHAs).

There are 108 PHAs destined to pass near the earth in the next several centuries.

Early data on 1997 XF11 indicated that it would pass within 500,000 miles of the earth in October 2028.

Observations on March 3 and 4 by Peter Shelus with a 30-inch telescope at the McDonald Observatory in western Texas indicated a high probably that the rock would pass within 30 thousand miles of the center of the earth. This raised eyebrows, since the earth's radius is about 4 thousand miles. Based on those computations, a close encounter of possibly the worst kind was predicted for about 1:30

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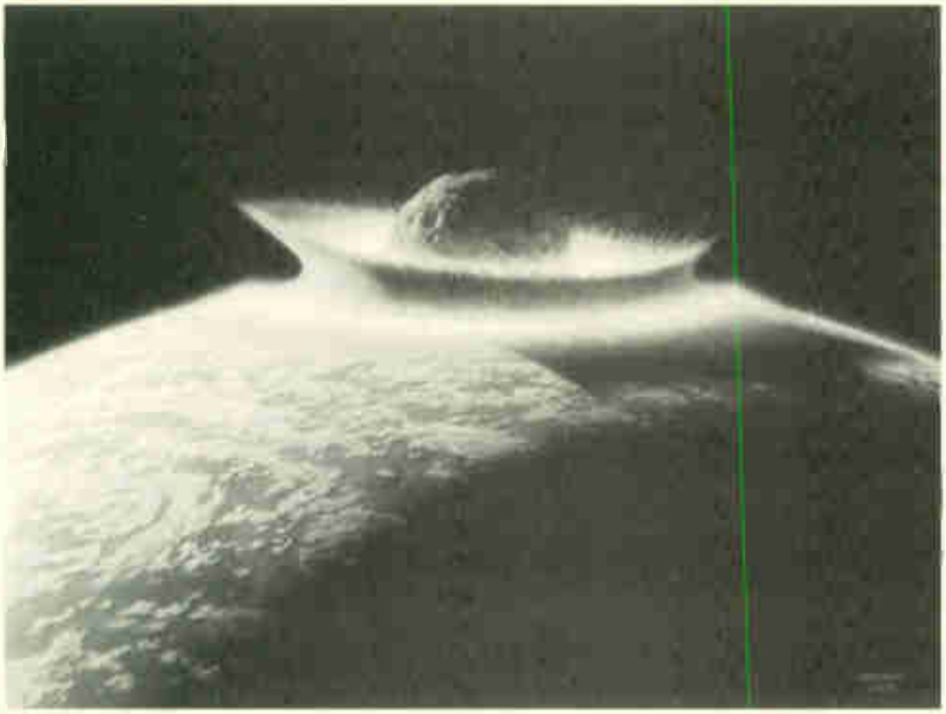


Artist's concept of a catastrophic asteroid impact with the Earth. Life near the impact would be instantly wiped out from the effects of high temperatures and pressures. Injection of huge masses of dust (and gases) into the atmosphere would effectively block out sunlight for long periods of time to the point that most life could not be sustained ("Nuclear Winter"). (Artist rendition by Don Davis and NASA)

p.m. Eastern Daylight Time on Thursday, October 26, 2028.

But the latest computations show the nominal miss distance to be 600 thousand miles on 2028 Oct. 26. This pass is to occur around 2:30 a.m. Eastern Daylight Time.

Although the chances for an actual collision with the earth in 2028 can now be discounted, Earth is not out of the woods yet. The asteroid could come dangerously close to Earth in future passes.

Close approaches are expected in 2002 (5.9 million miles), 2078 (7.5 million miles), 2090 (4.2 million miles) and 2095 (1.3 million miles).

The predicted 2028 approach distance of 600 thousand miles is the closest ever to date.

In 2086, a substantially smaller asteroid (2340) Hathor will pass within 550 thousand miles from the earth.

Prospector finds water ice at moon's poles

There is a high probability that water ice exists at both the north and south poles of the Moon, according to initial scientific data returned by NASA's Lunar Prospector.

The Discovery Program mission also has produced the first operational gravity map of the entire lunar surface, which should serve as a fundamental reference for all future lunar exploration missions, say scientists at NASA's Ames Research Center, Moffett Field, California.

Two months after the launch of the cylindrical spacecraft, mission scientists have firm evidence of lunar water ice, including estimates of its volume, location and distribution.

"We are elated at the performance of the spacecraft and its scientific payload, as well as the resulting quality and magnitude of information about the Moon that we already have been able to extract," says Dr. Alan Binder, Lunar Prospector Principal Investigator, from the Lunar Research Institute, Gilroy, California.

The presence of water ice at both lunar poles is strongly indicated by data from the spacecraft's neutron spectrometer instrument, according to mission scientists. Graphs of data ratios from the neutron spectrometer "reveal distinctive 3.4 percent and 2.2 percent dips in the relevant curves over the northern and southern polar regions, respectively," Binder says.

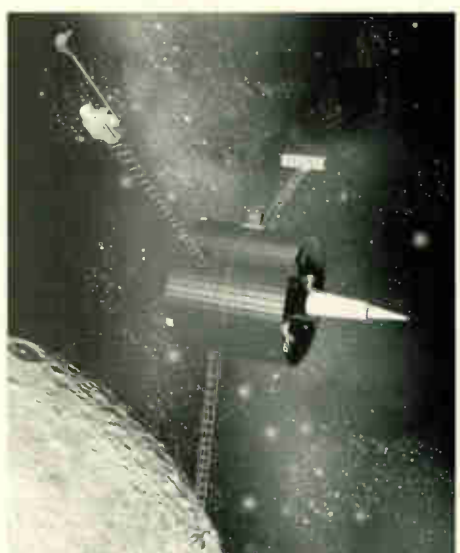
"This is the kind of data 'signature' one would expect to find if water ice is present."

However, the Moon's water ice is not concentrated in polar ice sheets, mission scientists point out.

"While the evidence of water ice is quite strong, the water 'signal' itself is relatively weak," says Dr. William Feldman, co-investigator and spectrometer specialist at the Department of Energy's Los Alamos National Laboratory, in New Mexico.

"Our data are consistent with the presence of water ice in very low concentrations across a significant number of craters."

Using models based on other Lunar



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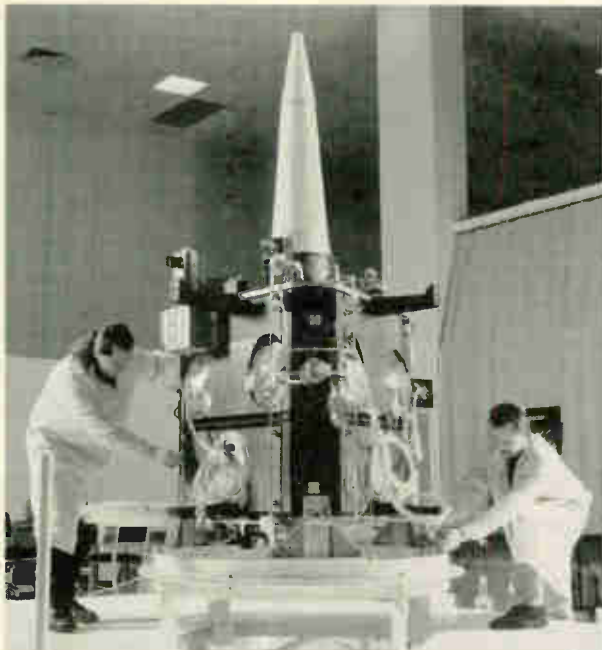
Prospector data, Binder and Feldman predict that water ice is confined to the polar regions and exists at only a 0.3 percent to 1 percent mixing ratio in combination with the Moon's rocky soil, or regolith.

Assuming a water ice depth of about a foot and a half (.5 meters)–the depth to which the neutron spectrometer's signal can penetrate–Binder and Feldman estimate an overall range of 11 million to 330 million tons (10-300 million metric tons) of lunar water ice, depending on the model used. This quantity is dispersed over 3,600 to 18,000 square miles (10,000-50,000 square kilometers) of water ice-bearing deposits across the northern pole, and an additional 1,800 to 7,200 square miles (5,000-20,000 square kilometers) across the southern polar region.



Twice as much of the water ice mixture was detected by Lunar Prospector at the Moon's north pole as at the south.

Dr. Jim Arnold of the University of California at San Diego previously has estimated that the most water ice that could conceivably be present on the Moon as a result of meteoritic and cometary impacts and other processes is 11 billion to 110 billion tons.

Arnold believes the amount of lunar regolith that could have been "gardened" by all impacts in the past 2 billion years extends to a depth of about 6.5 feet (2 meters).

On that basis, Lunar Prospector's estimate of water ice would have to be increased by a factor of up to four, to the range of 44 million to 1.3 billion tons (40 million to 1.2 billion metric tons).

Binder and Feldman caution that, due to the inadequacy of existing lunar models, their current estimates "could be off by a factor of ten in either direction."

The earlier joint Defense Department-NASA Clementine mission to the Moon used a radar-based technique that detected ice deposits in permanently shadowed regions of the lunar south pole. Scientists cannot compare the results from Lunar Prospector to Clementine because of differences in their sensors, measurement "footprints," and analysis techniques.

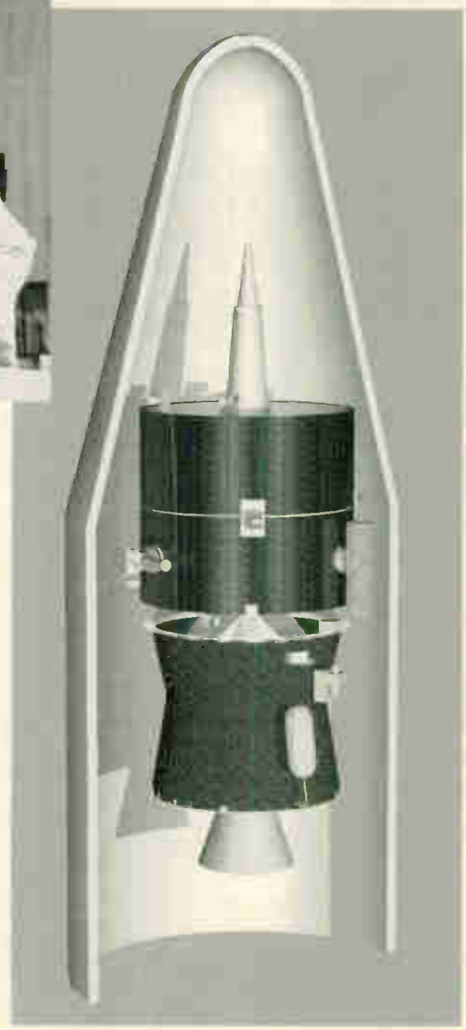
But the Clementine science team say its radar signal detected from 110 million to 1.1 billion tons (100 million to 1 billion metric tons) of water ice, over an upper area limit of 5,500 square miles (15,500 square kilometers) of south pole terrain.

There are various ways to estimate the economic potential of the detected lunar water ice as a supporting resource for future human exploration of the Moon.

One way is to estimate the cost of transporting that same volume of water ice from Earth to orbit. Currently, it costs about $10,000 to put one pound of material into orbit. NASA is conducting technology research with the goal of reducing that figure by a factor of 10, to only $1,000 per pound. Using an estimate of 33 million tons from the lower range detected by Lunar Prospector, it would cost $60 trillion to transport this volume of water to space at that rate, with unknown additional cost of transport to the Moon's surface.

From another perspective, a typical person consumes an estimated 100 gallons of water per day for drinking, food preparation, bathing and washing. At that rate, the same estimate of 33 million tons of water (7.2 billion gallons) could support a community of 1,000 two-person households for well over a century on the lunar surface, without recycling.

"This finding by Lunar Prospec-



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tor is primarily of scientific interest at this time, with implications for the rate and importance of cometary impacts in the history and evolution of the Solar System," says Dr. Wesley Huntress, NASA Associate Administrator for Space Science.

"A cost-effective method to mine the water crystals from within this large volume of soil would have to be developed if it were to become a real resource for drinking water or as the basic components of rocket fuel to support any future human explorers."

Before the Lunar Prospector mission, historical tracking data from various NASA Lunar Orbiter and Apollo missions had provided evidence that the lunar gravity field is not uniform. Mass concentrations caused by lava which filled the Moon's huge craters are known to be the cause of the anomalies. However, precise maps of lunar mass concentrations covering the moon's equatorial near-side region were the only ones available.

Lunar Prospector has dramatically improved this situation, according to co-investigator Dr. Alex Konopliv of NASA's Jet Propulsion Laboratory, Pasadena, California. Telemetry data from Lunar Prospector has been analyzed to produce a full gravity map of both the near and far side of the moon. Konopliv also has identified two new mass concentrations on the Moon's near-side that will be used to enhance geophysical modeling of the lunar interior. This work has produced the first-ever complete engineering-quality gravity map of the moon, a key to the operational safety and fuel-efficiency of future lunar missions.

"This spacecraft has performed beyond all reasonable expectations," says NASA's Lunar Prospector mission manager Scott Hubbard of Ames. "The findings announced today are just the tip of the iceberg compared to the wealth of information forthcoming in the months and years ahead."

Lunar Prospector is scheduled to continue its current primary data gathering mission at an altitude of 62 miles (100 kilometers) for a period of ten more months. At that time, the spacecraft will be put into an orbit as low as six miles (10 kilometers) so that its suite of science instruments can collect data at much finer resolution in support of more detailed scientific studies.

In addition, surface composition and structure information developed from data returned by the spacecraft's Gamma Ray Spectrometer instrument will be a crucial aspect of additional analysis of the polar water ice finding over the coming months.

The third launch in NASA's Discovery Program of lower cost, highly focused planetary science missions, Lunar Prospector is being implemented for NASA by Lockheed Martin, Sunnyvale, California, with mission management by NASA Ames. The total cost to NASA of the mission is $63 million.

Watchdog satellites track felons

Global Positioning Satellites technology is enabling corrections officials to track released violent felons and sex offenders to within five feet of their location on the ground, according to a report in the Ohio *Plain Dealer* newspaper.

A commercial system known as Comtrak requires the subject to wear a wristband and remain within a few feet of a device about the size of a laptop computer which maintains contact with GPS satellites.

Other possible uses for the technology include tracking the subjects of investigations, but placing units to the underside of a car or the side of a boat, and to notify victims of crime if an offender is approaching their location.

And finally. . .

You may soon be able to send your hair to an alien in outer space for fifty bucks.

Really.

A company called Encounter 2001 is planning to launch human hair samples into interstellar space for whomever to find and study.

Think of it: an alien could someday use the DNA from your hair to clone you in a place where no man or woman has gone before.

Your clone might even walk the streets of a distant planet, or end up behind transparent aluminum in an alien museum in another galaxy.

"Individuals will be charged $50 to submit hair samples along with their pictures and small messages for launch," says Charles Chafer, president of Encounter 2001.

Provided that all goes as planned, the Encounter 2001 spacecraft will be launched in the year 2001 aboard Ariane 5, at Kourou Space Center, French Guiana. There'll be room on board for hair samples from about 4.5 million people.

According to the plan, Ariane 5 will put the spacecraft in orbit around the earth, awaiting an optimum window. When Earth and Jupiter are aligned just so, Encounter 2001's escape engine will fire and send it zooming toward Jupiter's atmosphere, which will sling it out of the solar system into interstellar space.

The decision to proceed or abort will come later this year. If all systems are go, construction of the spacecraft will begin in early 1999, Chafer says.

The launch is to be preceded by a radio telescope transmission announcing to the Universe that your hair is on the way. Your name will of course be included in the transmission, so the aliens will be expecting you. Provided, of course, that you participate and pay the $50.

The project could generate as much as $225 million from people who want to send their essence into outer space.

There are two catches. One, there has to be enough participants to make the project worth while. And two, you can't send hair from your pet. It's not allowed. You can understand why. Nobody wants to give aliens the idea we're a bunch of dogs down here.

"This is for humans only," Chafer affirms. ST

Sources: Celestis, Inc., Cornell University, Johnson Space Center, NASA, National Science Foundation, The Plain Dealer courtesy of William Hearty

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World Radio History

By H. Paul Shuch, Ph.D.
Executive Director, The SETI League, Inc.

The Worldwide, Backyard Search for ET

FIGURE 1

Searchers spent their time looking for some ordered and therefore intelligent signal in the background chaos. The new equipment for this endeavor includes dishes and personal computers, which mean that nearly anyone has an equal chance to hear ET.

Perhaps ET is not phoning home after all. Maybe he's trying to call us ...

As reported in *Satellite Times* (Sept/Oct 1997, page 8), the Search for Extra-Terrestrial Intelligence (SETI), once a multi-million dollar NASA venture, is now in private hands. In 41 countries on six continents, hundreds of dedicated experimenters are now using their backyard SETI stations to seek out that elusive needle in the interstellar haystack. You can't buy a radio telescope at your local Radio Shack store. But if you're reasonably handy with tin-snips, know which end of the soldering iron is the handle, and have a few hundred (to a few thousand) dollars to invest, you too can join the search for our cosmic companions.

What We're Looking For

Our Earth is surrounded by a telltale sphere of artificial radiation, now extending out to about 50 light years, and still

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traveling outward at the fastest possible speed: the speed of light. This radio, TV, radar and microwave pollution is readily detectable to any local civilization which has radio astronomy. We figure that some of the countless beings living in the light of distant suns may also pollute their radio environment, and we stand a reasonable chance of detecting them.

But don't expect to tune in alien *I Love Lucy*. Interstellar signals will be so weak that our eyes and ears will never recognize them. The most we can hope for is order in the cosmic chaos, patterns which could not have been produced by any natural mechanism which we know and understand. These hallmarks of artificiality are evident to computers, and it is your home computer which will sift through the cosmic static in search of ET (see Figure 1).

Now, where on the dial should we look? It's highly unlikely that ET honors the FCC's band plans, so we can only guess as to their likely channel lineup. There may well be many good frequencies for SETI, but what they have in common is their ability to pass unimpeded through the interstellar medium. Since the space between the stars is most transparent in the microwave spectrum, that's where we'll start our search.

Satellite TV is broadcast in the microwave region. So are radar, cellular telephone, and much of Earth's telecommunications relay signals. There are also navigation signals from the swarm of Global Positioning Satellites (GPS) surrounding our planet. If we're going to seek out weak signals from the stars, we need to search in the gaps between our own transmissions. One such interesting gap (there are others) is the resonant frequency of hydrogen atoms, 1420 MHz, and many amateur and professional SETI stations start out there.

What You'll Need: The Antenna

Although other configurations are sometimes used, the hands-down favorite for snagging alien photons is the parabolic reflector, or dish antenna. A 3 to 5 meter diameter dish (that is, 10 to 16 feet) is just about the right size to stand a reasonable chance of SETI success. The classic C-band backyard satellite TV dish is ideal. These have high gain, narrow beamwidth, work over a wide range of frequencies, and are readily available for next to nothing. And if you're a satellite TV fan, chances are you already have one.

Around the country millions of TV viewers are upgrading to Ku-band Direct Broadcast Satellite (DBS) reception. Its half-meter dishes are very appealing. That leaves millions of C-band BUDs (Big Ugly Dishes) sitting around gathering rust. Many SETI enthusiasts have found neighbors anxious to have these eyesores taken off their hands (see Figure 2).

You can use your satellite TV dish to focus 1420 MHz energy, but not its C-band feedhorn. Plan on building or buying a larger tin can to capture these longer wavelengths. A commercial feed which will directly replace your TVRO horn (see Figure 3) can be purchased for around $150. If you want to use your BUD to watch TV and do SETI in the background, you can mount your SETI feedhorn next to your TVRO one, and multi-task (see Figure 4).

Without a doubt, the 1997 movie, "Contact," starring Jodie Foster, rekindled the public's interest in the search for extraterrestrials. The movie was based on a best selling book by Carl Sagan.

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World Radio History

Tool Chest for

What You'll Need: The Preamp

The purpose of a preamplifier is to take an impossibly weak signal from space, and turn it into merely a ridiculously weak one. You used one of these for satellite TV (it may have been called an LNA, LNB, or LNC), but it probably doesn't work on ET's channel. Fortunately, radio astronomy preamps for the desired frequency range (see Figure 5) are readily available from a number of sources. Price varies from about $50 for a kit preamp up to perhaps $200 for the top of the line, assembled and tested one. The preamp mounts directly to the feedhorn with a coax connector, and drives the coaxial feedline which runs inside to your receiver. You'll also need to run juice from a 12-volt power supply up to your preamp, either through the feedline or on a separate length of lamp cord or speaker wire.

What You'll Need: The Receiver

Once you've amplified your weak alien signal, you need to break it down to audio components which your computer can analyze. This is the job of a microwave receiver. The earliest amateur SETI stations employed ham radio's old standard, the venerable Icom model R-7000 microwave scanner, and its successors, the IC R-7100 and R-8500 (see Figure 6). These highly capable receivers are still a good bet if you can find them, though their $2000-plus price tag exceeds the cost of all other parts of your SETI station combined. Fortunately, some less costly alternatives are just beginning to emerge.

For years ham radio operators have been converting microwave signals down to frequency regions which their existing short-wave receivers can process, and SETI is no exception. For just over a hundred dollars in kit form (twice that if already assembled), you can today buy a downconverter which will shift the most interesting radio astronomy frequency down to the popular two meter band, for reception in your existing VHF rig (see Figure 7). And by adding a $100 2-meter SSB receiver kit to that downconverter (see Figure 8), enterprising experimenters have been building their own complete SETI receivers for a small fraction of the cost of commercial units. We hope such packaged special-purpose receivers will come on the market as manufacturers recognize the market potential of SETI.

Lately, receivers-on-a-card are all the rage. For example, Rosetta Labs of Australia makes its WinRadio scanning receiver card (Figure 9) to plug directly into the motherboard of your personal computer. Though the stock WinRadio is not ideal for the SETI application, look for Rosetta Labs and other vendors to come out with special purpose SETI receiver cards in the months ahead. Integrated directly into the computer (see below), they promise ever improving performance at significantly reduced cost.

What You'll Need: The Computer

The purpose of the SETI computer is to run the software which recognizes ET amid the cosmic din. A good bit of number-crunching power is required. The technique is called Digital Signal Processing, or DSP, and is the one part of the SETI task which has grown in power at an amazing rate. Raw computer horsepower seems to double every year or so, which means today's home computers are 1000 times more powerful than those of just ten years ago, and 1,000,000 times more powerful


FIGURE 2

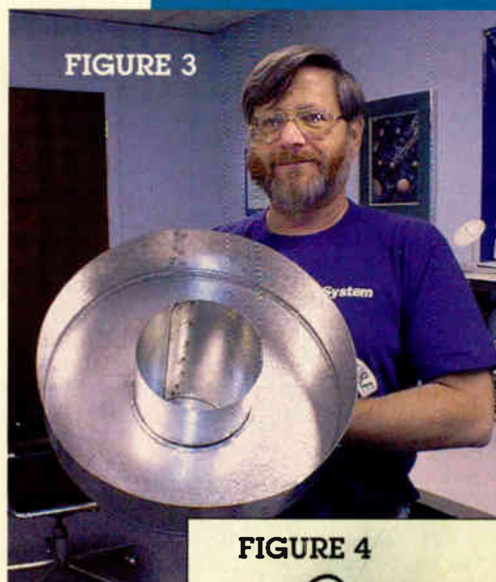
FIGURE 3

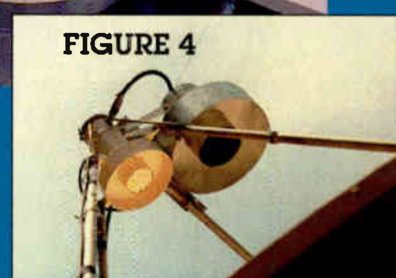
FIGURE 4

FIGURE 5


World Radio History

FIGURE 6

FIGURE 7

FIGURE 8

FIGURE 9

than those of two decades past!

We start by breaking down the receiver's audio into ones and zeroes, using a circuit called an Analog to Digital Converter or ADC. There's a very capable ADC in your garden-variety $29 sound card, and that's what most of us are using.

DSP software comes in a variety of flavors, with the most popular varieties being shareware for the DOS and Windows environments. As for the computer on which this software runs, a high-speed Pentium is nice, but not essential. Many a SETI enthusiast has used the old 486, which his or her Pentium recently replaced, as a dedicated signal processing machine. And a few SETIzens have even resurrected their old 386 and 286 machines for DSP use. The rule seems to be, any computer you can get your hands on will be more sensitive than your own eyes and ears, in separating the alien wheat from the cosmic chaff.

Putting It All Together

All the bits and pieces can be a tad intimidating, but you won't be going it alone. The SETI League is the world's leading grass-roots SETI organization, with hundreds of members in dozens of countries on six continents, and growing. Our website (http://www.setileague.org/), technical manuals and volunteer regional coordinators have already helped hundreds of individual experimenters to get their stations up and running, and stand ready to assist you as well. SETI league members come from all professions, educational levels and walks of life. We share a common curiosity about the beyond, as well as a conviction that we can make a difference.

What We've Heard So Far

Organized SETI has been going on for nearly forty years. About once or twice a year, we detect something strange, a signal which we just can't explain away. Unfortunately, none of these tantalizing candidate signals has yet proven conclusive. SETI demands the most stringent level of proof, if it is to answer the fundamental question which has haunted humankind since first we realized that the points of light in the night sky are other suns: Are We Alone?

The granddaddy of all SETI candidate signals was detected at the Ohio State University radio telescope in 1977. It is universally known as the "Wow!" signal, after the word scribbled in the margin of the computer printout when investigator Dr. Jerry Ehman first noticed it (see Figure 10). The "Wow!" was even mentioned in an episode of Fox TV's "The X-Files." After over 100 follow-on studies, the "Wow!" has never repeated. But today's amateur SETI stations are *just as powerful* as the Ohio State facility was twenty-one years ago, when the "Wow!" was detected. Thus it is our hope that, when enough private SETIzens are up and running, the next "Wow!" will prove less elusive.

We've already had a few close encounters. The SETI League's *Project Argus* search of the heavens went on the air in April 1996, initially with just five observing stations (our overall plan calls for 5,000). Only three weeks later, two radio amateurs in England detected the anomaly seen in Figure 11. At first glance, this seemed to be just the sort of signal we'd expect from Beyond. It turned out to be a classified military satellite–beyond Earth

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to be sure, but hardly the ET we were seeking.

Our next interesting signal (see Figure 12) came from the 1.3 Watt beacon transmitter aboard the Mars Global Surveyor satellite, clearly detectable at several million kilometers from Earth. Such detections give us ample encouragement that our systems are up to the task of alien detection. Now all we need is enough participants around the world, coordinated through the Internet, so that no direction in the sky shall evade our gaze. You can be a part of a global net we're stretching to snag that slippery fish in the cosmic pond.

Finding Out More

Check out The SETI League, Inc., a membership-supported, nonprofit educational and scientific organization, on the Internet at **http://www.setileague.org/**. Leaders in the privatized search for life in space, The SETI League offers technical support, coordination, books, conferences, and a host of related activities for the aspiring SETIzen. Our extensive web site (over 1100 documents totaling more than 36 MBytes, and growing every week) is aimed at the dedicated amateur radio astronomer who's willing to learn. There you'll find sources for the hardware and software discussed above, along with hundreds of pictures showing how others have put their stations together. We have a technical manual to help you build, and even our own songbook for those who wish to sing SETI's praises. For membership information, email your postal address to **join@setileague.org**, or drop us a line at P.O. Box 555, Little Ferry NJ 07643 USA. We Know We're Not Alone!

ST

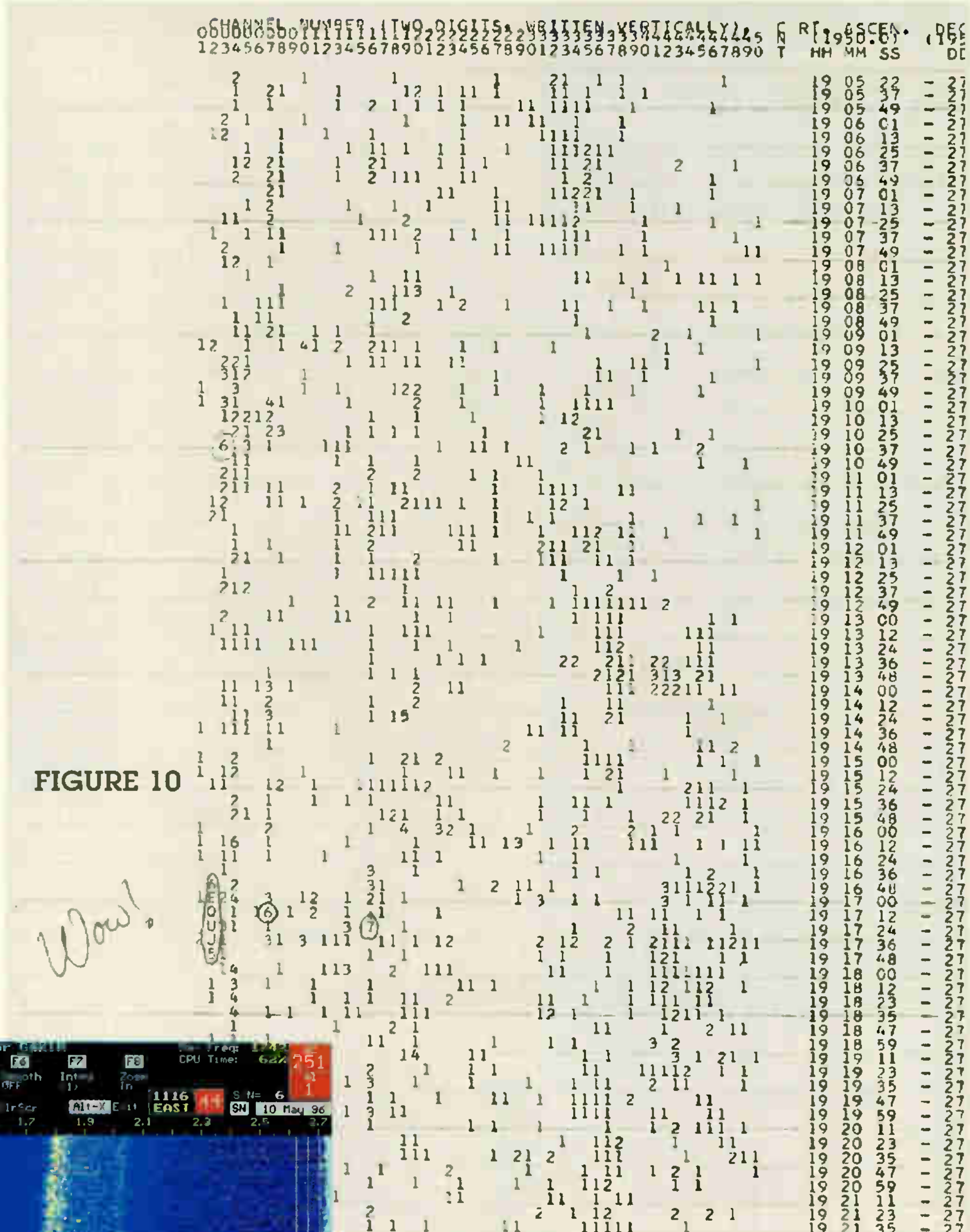

FIGURE 10

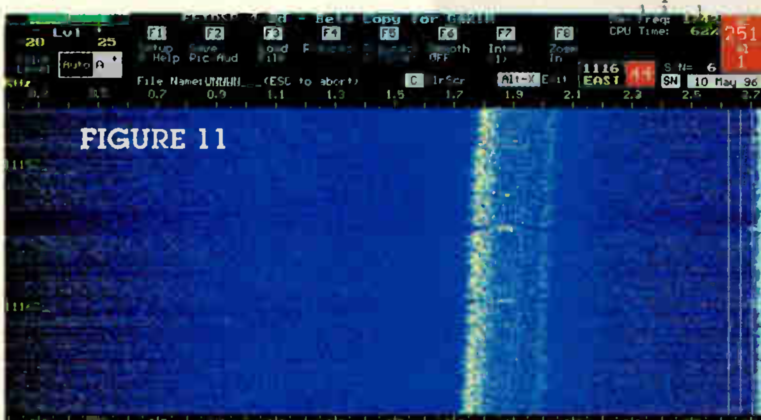

FIGURE 11

FIGURE 12

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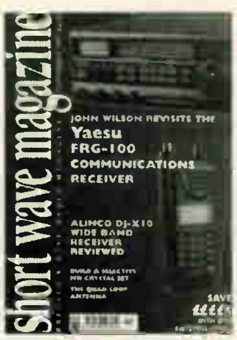
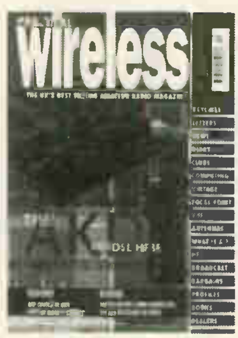


Every month *Short Wave Magazine* has essential information on scanning, decoding, maritime beacons, propagation, satellites, broadcasting and much more. In fact it has all the information a short wave listener could possibly want.



Practical Wireless has features on new products, antennas, packet radio, HF band, vintage radio construction and many other topics as well. It's the monthly magazine no radio amateur should be without.

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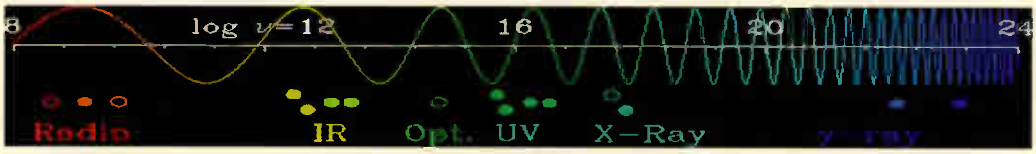
Whispers from the CosmoS



By Larry Van Horn
Managing Editor

It's a warm summer evening and you have some spare time to do a little radio listening. You walk into your radio room and sit down in front of your modest rack of equipment. Slowly you turn the dial of your favorite VHF/UHF communications receiver looking for something new to monitor.

Suddenly you notice an increase in the noise level on your receiver's S-meter. You quickly run through your computer frequency database to see what local or satellite targets are in the vicinity of your received signal. Finding nothing, you now swing your dish antenna a few degrees off its original position and notice that the noise source fades away.

Where is this increased noise level coming from? What kind of signal has your dish antenna captured? The chances are good that you are hearing a signal from a distant galaxy or quasar–a whisper from the cosmos.

In the Beginning

Many of the great discoveries of science have been made by accident. It was just such a discovery which launched the science of radio astronomy.

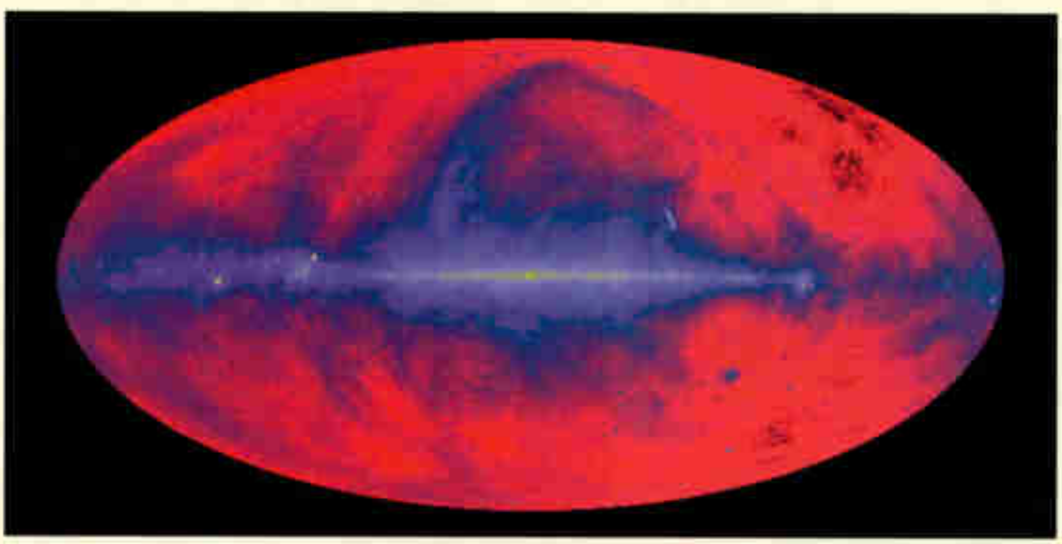
It all began more than half century ago when Bell Telephone assigned a noise-finding task to one of their engineers and physicist, Karl Jansky. The noise was a periodic disruption to the company's transatlantic radio links in the high frequency spectrum around 20.6 MHz.

Jansky constructed an elaborate rotatable directional antenna array (called the Bruce Curtain) and immediately discovered that all the noise originated from two sources: thunderstorms (local and distant) and an area of the sky near the center of the Milky Way Galaxy in the Sagittarius constellation.

These sources of terrestrial and cosmic noises were noted, and subsequent experiments by individuals occasionally took place. In 1937 another engineer, Grote Reber, built a parabolic reflector (dish antenna) in his back yard in Wheaton, Illinois, and began mapping the sky for radio emissions at 160 MHz. He later determined that our own sun was a major source of radio emissions.

Over the next several decades, radio emanations (noise) from the Crab Nebula, Cygnus A, interstellar hydrogen, quasars (quasi-stellar radio sources), stars in the Milky Way and other galaxies, and even our own solar system (the planet Jupiter) have been pinpointed by radio astronomers.

But it is still noise, and who wants to listen to that?! Radio astronomers do, and in recent years, amateur radio astronomers have also joined in the hunt. Receiving equipment costs have come way down, making it much more affordable for the amateur to join in on the fun. In fact, for



This survey is a mosaic of data taken at Jodrell Bank, Effelsberg and Parkes telescopes. The data was distributed in the "NRAO Images from the Radio Sky" CDROM. This image was generated by SkyView. Energy= 1.69x10^-6 eV Frequency= 408x10^6 Hz (408MHz) Wavelength= 73.5 cm. (Credit: Max Planck Institute for Radio Astronomy, generated by Glyn Haslam)

World Radio History

the first time ever, a company called Radio Astronomy Supplies has turnkey radio astronomy systems for sale to the general public.

The single largest contributing factor in the increased number of amateurs entering into the radio astronomy field is the power of home personal computers. The personal computers of today have the power and speed that are needed in order to do meaningful radio astronomy work.

Where Do You Listen

The single most common question I get asked is, "where do you listen for cosmic signals and what are you listening for?" In the many references I have read over the years, they really never answer that question. Looking at official ITU and FCC tables of allocations, you will find radio astronomy bands scattered throughout the radio spectrum. But what are the radio astronomers listening to on these frequencies?

Table one (see p. 61) gives you a complete breakdown of those radio astronomy bands and what is being heard on them. With this resource, the amateur will find quite a few interesting targets to observe and explore in the invisible universe of radio astronomy world.

Radio Astronomy Sources

Would you like to set up your own radio astronomy listening post? Compared to just 10 years ago, information, equipment and resources are much more available to the amateur radio astronomer. Table three is a partial list of sources for radio astronomy books and equipment.

An excellent source of radio astronomy information can be found here in the pages of *Satellite Times*. The *Radio Astronomy* column authored by Jeff Lichtman is the only regular source of information currently available on the magazine racks.

What Can the Amateur Contribute?

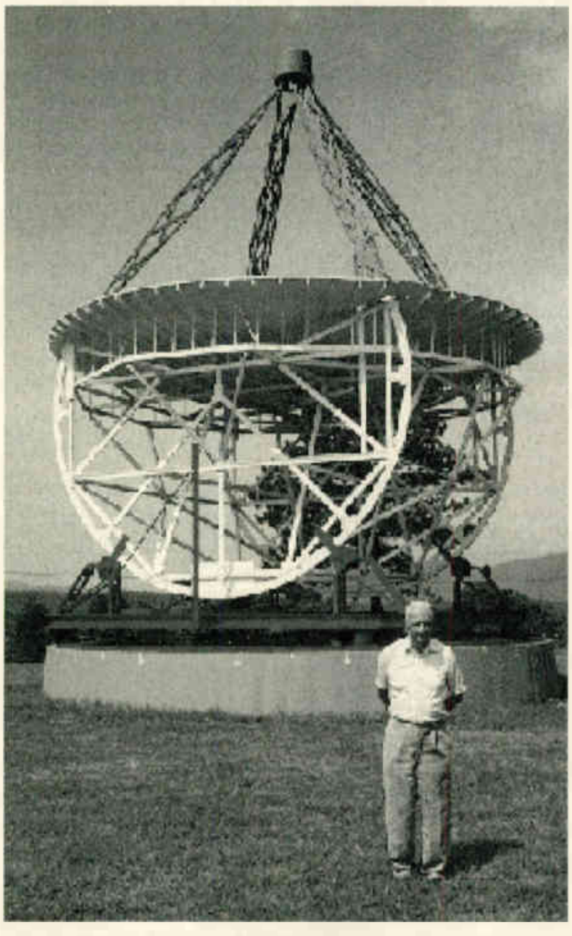
Answer: The answer to this is that the opportunities for significant discovery are practically infinite. But how can this be so?

- Large observatories, to justify their huge cost, usually look at very remote sources with very narrow beams for very short periods of time. They cannot–by virtue of their design–monitor large sky areas like amateur radio astronomers can.

- The amateur has something going for him that the professionals lack–unlimited time that he can devote to a single observing program.

- Modern state of the art equipment and inexpensive computers enable amateurs to do useful and viable work, when it is pursued with intelligence and attention to detailed data.

- Just as the patient visual amateur astronomer is likely to discover a new comet or asteroid, likewise the amateur radio astronomer is most likely to discover a new radio source or one whose flux output has changed radically.



Grote Reber poses with his original dish antenna at the National Radio Astronomy Observatory in Green Bank, West Virginia. (Photo courtesy of the NRAO)

Some Opportunities for the Amateur

Our own solar system offers all sorts of interesting exploration. Emissions from Jupiter are quite easy to monitor and this work has by no means been "mined out" by the professionals. Equipment as simple as a shortwave receiver, a quiet spot in the 20 MHz band, and a dipole antenna are all that is required to hear the Jovian planet.

Our own sun, as close as it is to us and as vital as it is to our existence, isn't fully understood in all of its mechanisms. Every single bit of information we have gathered about the sun has been derived from events occurring on its surface. Aside from the idea that the power source involves a nuclear furnace in its interior which converts hydrogen to helium, we haven't the foggiest notion of what's really going on. Valuable radio observations of the sun may be done with minimal and inexpensive radio receivers and antennas.

On average, a supernova can occur in our own galaxy every 10 to 30 years. If such an event occurred right now, would we see it? Probably not. If the nova occurred along the galactic equator, it would not be visually seen due to interstellar dust. However, the nova would stand out as a new radio source, radiating powerfully in the radio spectrum. It would be easily detected with a simple interferometer radio telescope.

Even strong signals from the center of our galaxy are quite easily detected with minimal radio equipment. These signals remain a mystery. There could quite possibly be from a black hole at the heart of our galaxy. These strong pulses have been recorded by amateur radio astronomers.

So turn on that radio and aim that antenna toward the sky. A whole new universe awaits you–the invisible universe of radio astronomy. You could be part of an ever larger group of amateurs looking for "Whispers from the Cosmos" if you are willing to take up the challenge. ST

The author is deeply indebted to the Committee on Radio Astronomy Frequencies and Jeffrey Lichtman for their assistance in preparing this feature article.

(Note: See p. 61 for Table 1)

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Find Those *Hidden Signals* on the Birds

By Ken Reitz, KS4ZR

When it comes to satellite television entertainment, most consumers believe that what they see is all they get. But that's not the whole picture. Unlike their direct broadcasts satellite (DBS) counterparts, C- and Ku-band satellites are the industry's workhorses. Here, in addition to typical cable fare, the network feeds, syndicated programming, and educational distance learning, are all manner of analog and digital transmissions which have no ties to any on-screen video. In many cases you can't even tell they're there! Some of these signals require expensive equipment and subscriptions, but, with a minimum of receiving gear you can still tune in to some very interesting broadcasts.

So, what are these transmissions and why are they there? They are various media companies taking advantage of the relatively cheap, full, coast-to-coast coverage offered by satellite. They are hundreds of networks beaming their signals to affiliate radio and TV stations all over North America, including Canada and Mexico. Those lucky enough to live near the east coast will find similar action on the international satellites which bridge the Atlantic as well.

Among the signals you can hear are those from FM transmissions below the tuning range of most satellite TV receivers known as FM Squared* (FM); very narrowband FM transmissions called Single Channel Per Carrier (SCPC); data streams from a variety of commercial data services specializing in market, farm and weather information; and digital TV signals from satellites you may not know exist.

Searching The Clarke Belt

In the case of monitoring communications satellites, our work is made simple by the fact that all of these satellites are in geosynchronous orbit 23,000 miles high in a plane directly over the equator. This belt of satellites is known as the Clarke Belt in honor of Arthur C. Clarke, a world renowned visionary who first put forth the theory of communications via satellites in geosynchronous orbit in the 1940's, well before the starting gun of the space race.

Once a C/Ku-band satellite TV receiving system is properly installed its polar mount tracking mechanism moves the dish

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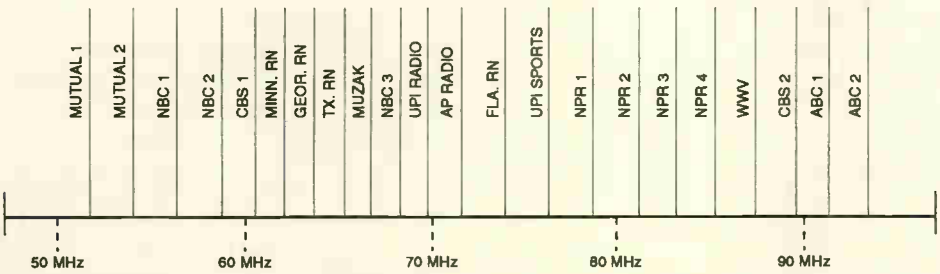


Typical (not actual) FM/SCPC single transponder service assignments on a full transponder.

from east to west precisely on the Clarke Belt and allows the viewer to stop at any point along the way and tune in. Satellites in our region (the U.S. domestic arc) of sky stretch from Galaxy 6 at 74 degrees west to Satcom C1 at 137 degrees west.

Our job of locating these unseen signals is made easier still by virtue of the fact that the location of all satellites in geosynchronous orbit is well documented. This is nothing like trying to track low earth orbit satellites for which you need orbital tracking programs for your computer hooked up to azimuth/elevation rotors on the antenna. Most satellite TV receivers can store dozens of satellites in the onboard memory and return to them every time you require.

In order to find the unseen signals you'll need as much current information as you can find on the various transmission modes. It happens that you are reading the only magazine available today with the most up-to-date information on all manner of satellite communications. In the *Satellite Services Guide* of *ST* you'll find the *Satellite Radio Guide*, a listing of about 100 analog FM radio services; in the *Satellite Radio SCPC Services Guide* you'll find another 100 or so FM and SCPC services all listed by satellite and transponder. It couldn't be easier. Even so, there are some things not listed there which would be useful to know, notably the location of the many SCPC services on Solidaridad 1, where the unencrypted digital TV signals are, and what video and audio services are on the satellites over the Atlantic.

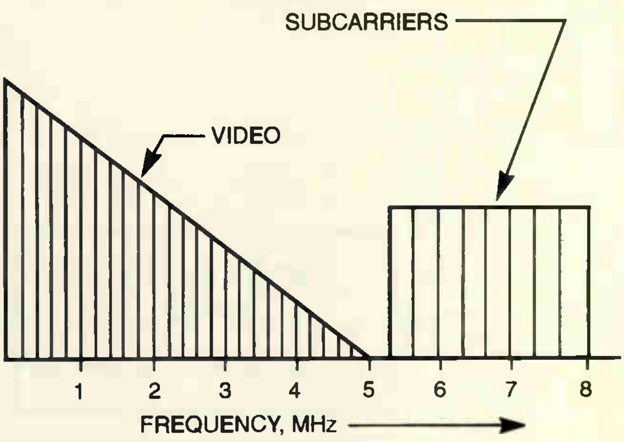
A Side Less Seen

When satellite television broadcasting first began in the U.S. it was done solely in the C-band. By the early 1980's Ku-band only satellites were being used and by the mid 1980s C/Ku-band combination satellites were regularly built.

Most satellites launched today are C/Ku-band in which there are typically 24 C-band and 24 Ku-band transponders. If you look at the *Ku-band Transponder Services Guide* in this issue of *ST* you'll notice that this band is different from C-band in one particular way. The Ku-band side of most satellites tend to be dedicated to a particular service. For example, GE-3 (87 degrees west) is predominately PBS; GE-1 (103 degrees west) is predominately NBC; the entire Ku-band side of Galaxy 3 (95 degrees west) is used to transmit Galaxy Latin America, a Direct-To-Home programming service; the entire Ku-band side of GE-2 (85 degrees west) is where Primestar programs originate.

Still, there are many other users of Ku-band transponders ranging from Satellite News Gathering (SNG) found on virtually every Ku-band satellite, to a variety of Asian programming found mostly on Galaxy 4 (99 degrees west).

Many sporting events, transmitted directly from



The standard subcarrier frequency plan. 6.8 MHz for video sound with 8 more 15 kHz audio channels.

The Versatile Feed Horn

Adding Ku-band to your home satellite system is easy. All you need is a C/Ku-band feed horn as well as C and Ku-band LNBs. Virtually all new satellite system installations have an extra run of RG/6 coaxial cable to attach to the Ku-band LNB. An "F" connector for the Ku-band feed line is provided on the back of all new receivers. If you're planning on buying a satellite system, it's cheaper to pay for the Ku-band gear up-front since you'll have to replace the C-band feed with a C/Ku-band feed if you decide to add it later.

If you have an older system and wish to add Ku-band, simply take your C-band LNB off the C-band feed horn. Install the C/Ku-band feed horn and attach the old C-band LNB and the new Ku-band LNB. This whole process takes about 15 minutes. You may have to run an extra length of RG/6 if it's a really old system and only one feed line was provided. If your receiver is very old it will not have a Ku-band "F" connector on the back in which case a heavy duty A/B switch (Radio Shack #15-1249) works well.

If your satellite receiver is an older model it may not be Ku-band capable. Ku-band transmissions are sent with the video inverted compared to C-band video. This means that if your receiver cannot invert video the picture will appear to be scrambled when you feed a Ku-band signal to it while the audio will be fine. Many older receivers have a "video invert" switch, usually on the back, which will do the job nicely. Newer receivers have the switch built-in and when you press the C/Ku switch on your remote control it toggles between the video formats.

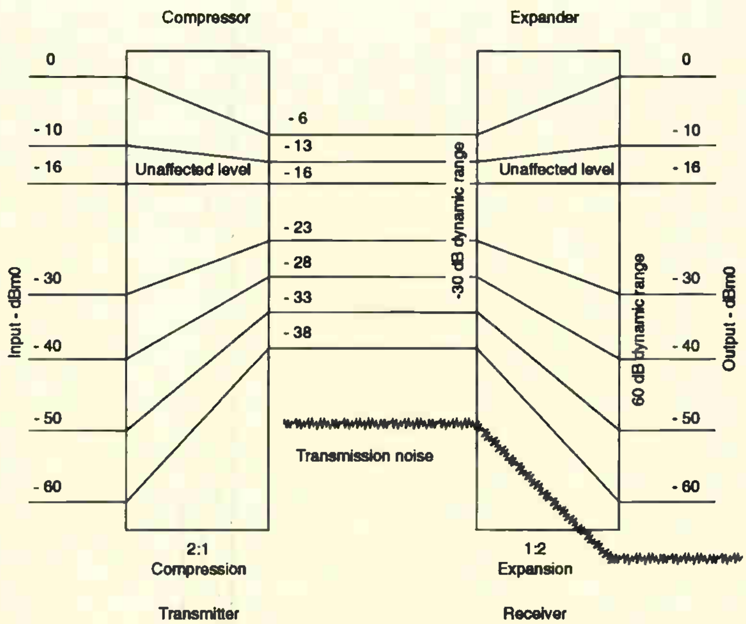
You can save money by looking for a used feed horn and LNB. Many dealers have used equipment they'll sell, but, don't pay more than half the cost of new and ask for a 30 day warranty. If an LNB is still working after 30 days you'll likely get several years use out of it.

To have a truly versatile system you may consider adding a C/Ku/DSS feed. This product has room for C and Ku-band LNBs and has a DSS LNB attached to the feed horn. You'll have to run yet another length of RG/6 out to the dish and feed it to a separate DSS receiver. A different LNB would be required for DirecTV/USSB or DISH network reception.

World Radio History

the site (called "back hauls"), abound on Ku-band. You'll see NASCAR races, PGA and LPGA golf tournaments, and college football, basketball and baseball games as well. These are all transmitted on different satellites and transponders and it may take some hunting to track them down. Professional football and baseball games are encrypted via a number of different methods and not viewable. In addition, there are a few "wild feeds" which make for interesting viewing such as "Enigma Theater" which runs cheesy Sci-Fi movies on Saturday nights on Galaxy 7 channel 17.

Ku-band is also where you'll find many analog FM signals as well as the digital music service DMX Direct which transmits over 90 channels of CD quality commercial-free music to its subscribers. Many digital data services catering to those involved in the stock market and agricultural markets are also found here. As you can see, if you don't have Ku-band capability, you're not getting the full use out of your system.



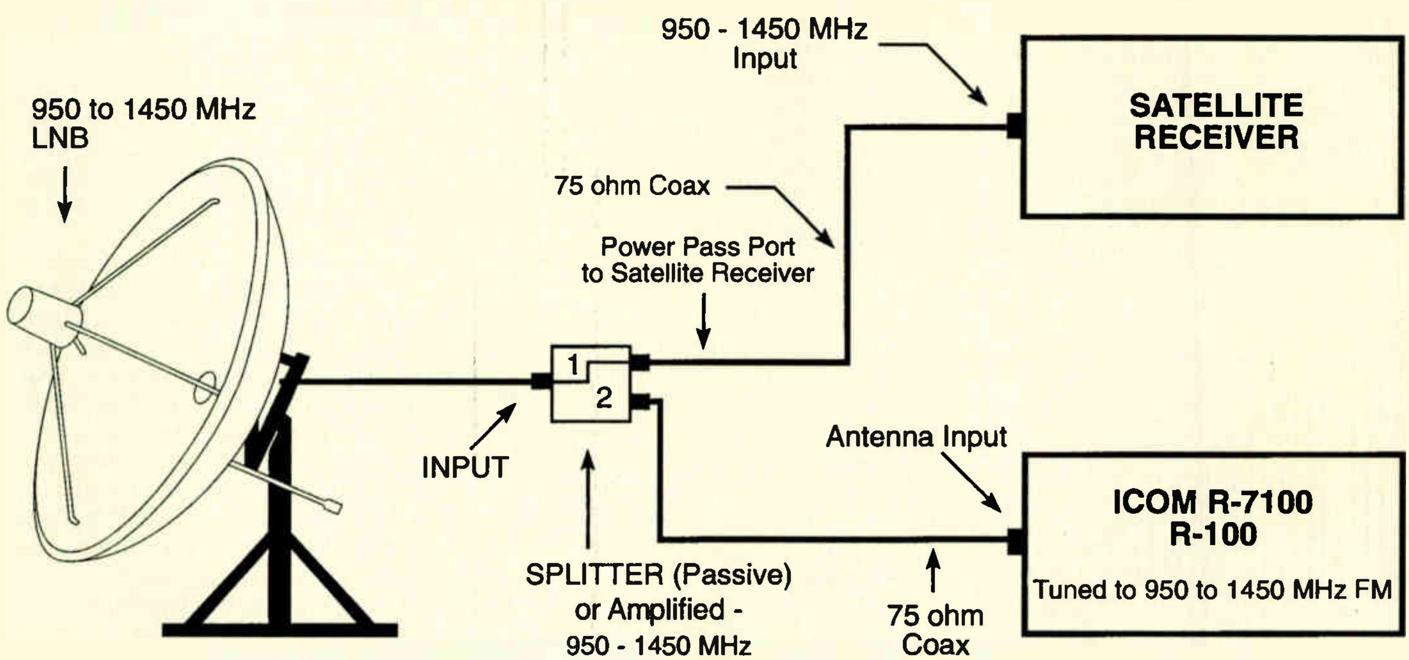
"Companding" showing 2:1 and levels of compression and re-expansion to original levels.

Listening To Your Dish

The bandwidth of a satellite transponder is so wide that it's possible to transmit the video with two audio subcarriers (for stereo or for a special audio channel for the sight impaired) and still have plenty of room for extra pairs of audio signals. A prime example of this is Channel 21 on Galaxy 5 which transmits the video of Knowledge TV and one subcarrier for the audio, and yet, still has room for no fewer than seven pairs of stereo frequencies to transmit their line-up of music formats. These channels are all between 5.00 MHz and 9.00 MHz in the transponder bandwidth.

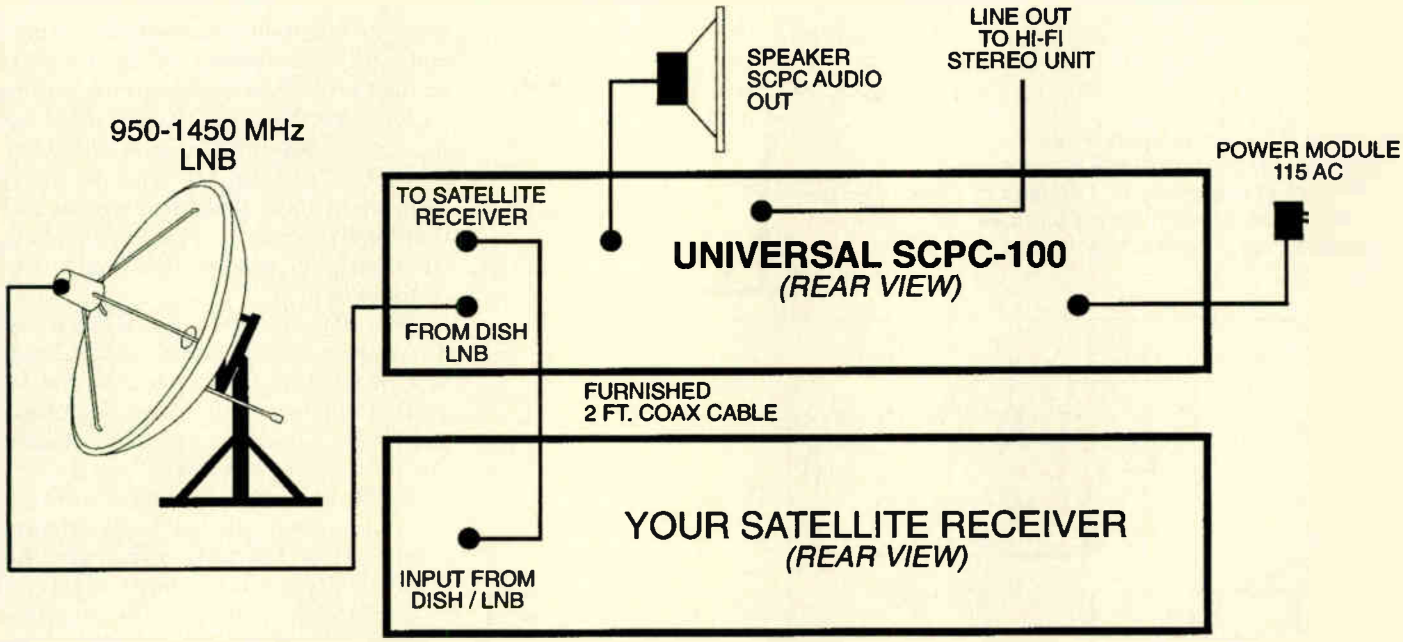
If you like music, as I do, you can't beat the variety available on the audio subcarriers of the C and Ku-bands. Best of all, it's free! Studying the *Satellite Radio Guide* a little more you'll become aware of the amazing spectrum of audio services. From ethnic broadcasters such as Antenna Radio (Greece), Appa Sangeet Radio (India), big time all-news radio stations such as WCBS-AM New York, and specialty stations like Yesterday U.S.A. (nostalgia radio), you'll find a dozen or more favorites. There are commercial-free public radio stations such as KLON-FM, Long Beach, and WUSF-FM, Tampa; international shortwave broadcasters like the BBC and Deutsche Welle; religious broadcasters; news stations such Cable Radio Network, CNN Radio News, Business Radio Network, and dozens more.

Did I mention the reading services for the sight impaired? There's country, rock, classical, and jazz music! Even if you never



SCPC equipment hookup using the ICOM R-7100 Receiver, or other high-quality scanner with 50 to 1450 MHz fequency coverage plus FM, wide and narrow bandwidth feature. Splitter is HFS-2 high frequency type, power pass one port only or amplified speaker.

World Radio History



System hookup of the SCPC-100 audio receiver to the home satellite system (TVRO). 3 minutes.

hooked a TV set up to your dish you would still be getting your money's worth in audio services alone!

By using an outboard subcarrier tuner you can tune below the 5 MHz limit of your present receiver and pick up several dozen more services. There's only one consumer grade receiver available which does this, the Universal SC-50 from Universal Electronics, and it does this very nicely. But, to hear stereo you will need two SC-50s. The SC-50 uses the composite output of your receiver to tune the lower subcarriers.

SCPC Reception

As mentioned earlier, SCPC is another type of FM transmission you'll find on the satellites. SCPC differs from audio subcarriers in two distinct ways. First, these are very narrowband transmissions and are not receivable on any standard satellite TV receiver. Second, these transmissions, unlike the subcarriers mention earlier, arrive at the transponder via their own carrier and are not tied to any video.

Now, with the addition of an SCPC receiver to your system you can have access to all of the stations and services listed in *ST*'s *SCPC Services Guide.* Virtually every college and professional sports network is broadcasting from the stadium to affiliates via satellite. Grand old broadcasters such as WGN Chicago, WSB Atlanta, KOA Denver, KJR Seattle, and many more have a full time presence on satellite via SCPC. When there's not a game on, their regular daily programming is transmitted.

There are plenty of ethnic services on SCPC as well. You can tune in to daily programming from XEPRS-AM Tijuana; Western Arctic service of the CBC; the Russian-American Radio Network; or Voice of Free China from Taiwan. There are reading services for the sight impaired, Soldier's Radio Network, nearly every radio news network on the air today as well as the U.S. government's Radio Marti which broadcasts to the island of Cuba.

Universal SCPC 200.

There are several sources of SCPC receivers including the aforementioned Universal Electronics company which makes the SCPC-200 receiver. Long-time satellite equipment maker Avcom also makes an excellent consumer grade SCPC receiver. It's possible to find other makes on the used market at hamfests. Look for the Heil SC-1 and the Universal SCPC-100 as good used receivers.

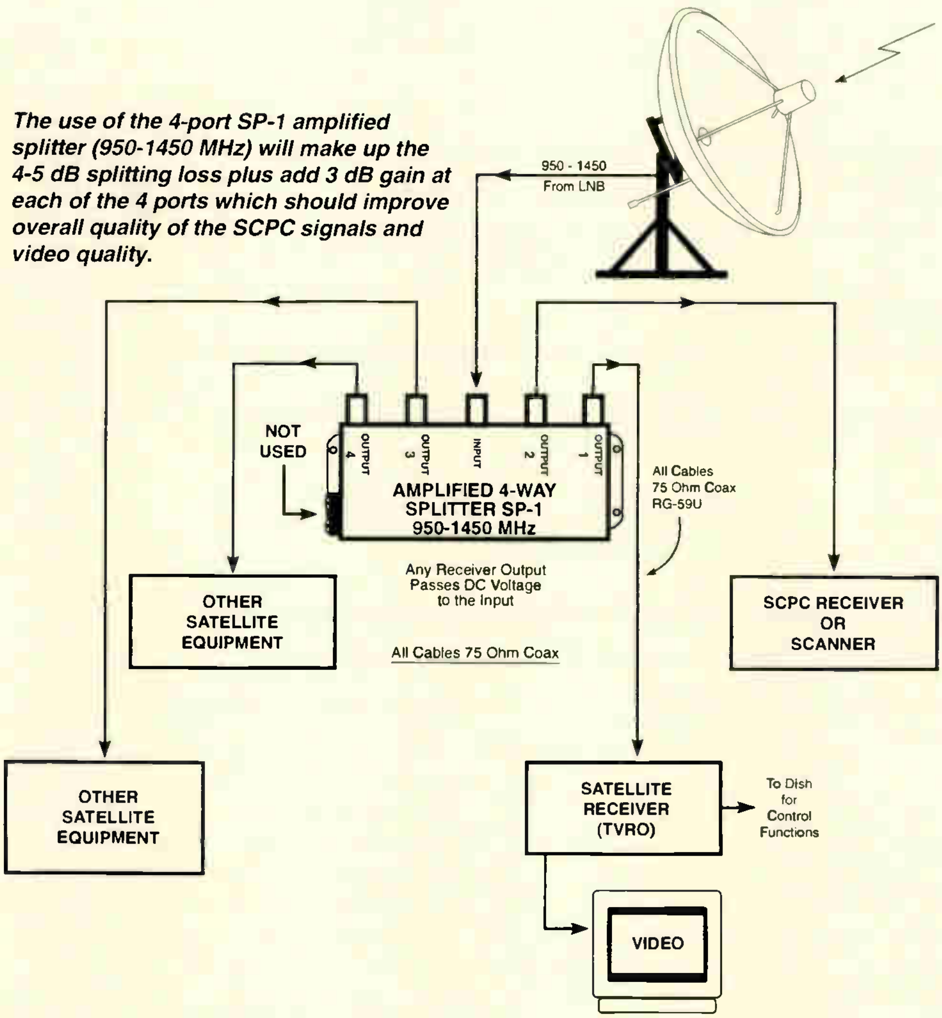
Digital Data Services

Data services have been delivered via satellite for nearly 20 years. Among the first was Teletext, in which a slow-speed data stream was fed on the Vertical Blanking Interval (VBI) of a satellite transponder. A Teletext decoder would decode the information and store it in on-board RAM. Display was done via a channel 3/4 modulator on your TV set. The beauty of the system was its simplicity. An A/B switch on the Teletext remote control would toggle between the text and video of the channel on which the signal was sent. Teletext was widely popular in Europe in the 70s and 80s, but never caught on in the U.S.

Today most digital services are business or industry related, but a few are designed to attract the consumer market as well. One service, X*Press Information, which provided 24 hour a day delivery of wire services from around the world to its customers via a data stream on Galaxy 5 channel 6, folded its tents at the end of February after over 10 years in the marketplace. A combination of poor product promotion and unwise market strategies proved too much for an otherwise excellent idea.

Some of the services currently slugging it out in the market place include Data Transmission Network (DTN), Broadcast Partners, Future Link and Zephyrus. All

World Radio History



The use of the 4-port SP-1 amplified splitter (950-1450 MHz) will make up the 4-5 dB splitting loss plus add 3 dB gain at each of the 4 ports which should improve overall quality of the SCPC signals and video quality.

these services are carving out niche markets by offering customers Ku-band delivered data products such as market data and analysis, a full range of weather products as well as sports and business news services. Some companies lease the equipment to subscribers while others require an outright purchase.

Broadcast Partners covers a broad range of interests with their stand-alone services including PILOTbrief II, FarmDayta, Contractor Dayta, Golflink, and the Packer Produce Network. PILOTbrief has some very interesting data available including Jet Stream Analysis, and NEXRAD weather radar imagery updated every 15 minutes.

DTN has a wide range of stand-alone systems which receive data from Ku-band, store it in the data terminal and display it on their own monitor. The advantage of a stand-alone system is that your computer and satellite system are both free for other uses. Various data streams are designed to serve specific customers such as agriculture and financial interests.

FutureLink is also a stand-alone system, but confines itself to the world of finance. For under $100 a month FutureLink provides current prices for futures and options trading on all major North American exchanges every 10 minutes. They also include Futures World News, an on-line international news wire.

Zephyrus has stand-alone Ku-band systems designed to receive the EMWIN data transmissions on Galaxy 4. EMWIN (the Emergency Managers Weather Information Network) is a product of the National Weather Service and includes so much data that your entire computer could be dedicated to just EMWIN processing. The EMWIN data stream is also found on the GOES geostationary weather satellite.

Digital TV Signals

The digital signals of the DBS satellites are well known, but less known are all the other digital TV signals on C- and Ku-band. Many large corporations maintain their own digitally transmitted networks and many C-band transponders carry horse racing for the benefit of off track betting parlors which jealously guard their signals. Some networks, such as PBS, have switched to digital via General Instrument's (GI) Digicipher scheme and there is a gradual trend toward making GI's Digicipher a satellite delivered broadcast standard.

But, GI is not alone and will have to deal with some heavyweight powers such as Scientific Atlanta (SA) which is promoting its own PowerVu digital system. SA has been making significant in-roads in the satellite delivery business.

Digital TV signals are similar to analog scrambling systems in that the data stream is addressable. When the signals are universally addressed anyone with the proper receiver will be able to see the programming. There are many Digicipher channels "in the clear" which can be seen by anyone equipped with a GI 4DTV receiver. There are also many PowerVu channels which can be viewed by using a Hyundai HSS-100C or similar MPEG2/DVB receiver.

Eyes Across the Atlantic

Truly hidden from the view of most of

THE DIGITAL DATA SERVICES

Broadcast Partners
11275 Aurora Avenue
Des Moines, IA 50322
800-508-7365

Offers several stand-alone data terminals for many products including those for professional pilots (PILOTbrief II), golf course managers (Golflink), farmers (Farm Dayta), and producers (The Packer Produce Network).

Data Transmission Network Corp.
9110 West Dodge Road
Omaha, NE 68114
800-610-0777 (weather service)
Provides numerous stand-alone Ku-band data terminals for many products including weather, Wall Street, and commodity markets.

Future Link
219 Parkade, Box 6
Cedar Falls, IA 50613
800-553-2910
Ku-band based market data service.

Zephyrus Electronics, Ltd.
171 S. 122 E. Avenue
Tulsa, OK 74128-2405
918-437-3333 FAX: 918-438-7322
Ku-band based EMWIN weather receiving gear.

World Radio History

North America are the C and Ku-band satellites positioned over the Atlantic and serving as a news and entertainment bridge from the Old World to the New. Most of these satellites are below the horizon of about three quarters of the U.S. Still, many along the East Coast and as far west as parts of the Midwest are able to peer at these least known satellites.

Few will be able to see as far east as Intelsat K at 21.5 degrees west where there are occasional news feeds and a full time feed of Deutsche Welle TV. More likely is Intelsat 605 at 27.5 degrees west which has a full time ABC News back haul, on channel 14, which carries the BBC 9 O'clock news between 5:00 and 7:00 p.m. Eastern Time. When there is not a news feed, they carry Jazz FM from London, a truly great commercial jazz station where, between the classic and current jazz, you can hear commercials for Harrod's!

Intelsat 605 is circularly polarized and while our linearly polarized feed horns will work, the signals are diminished by several dB. Circular feed horns are available, but are expensive. A cheap substitute is to use a dielectric insert made of Teflon in the throat of the feed horn. These are available from Skyvision for about $20.

Hispasat at 30 degrees west carried two analog channels of programming from Spain until just recently. They have switched to the MPEG2/DVB system and deliver five services and four radio stations to Latin America. Hispasat has a very strong signal and can be received over the eastern third of the U.S.

TDRS-4 at 41 degrees west has Greek programming on channel 13 in a analog transmission with a very strong signal on the East Coast.

Panamsat 5, the newest and closest Atlantic satellite, has a lot of digital programming beamed at Latin America and maintains color bars and a tone on channel 23 in analog video which makes this bird easy to find. There are occasional sports back hauls on this satellite and I have found some SCPC signals here, too.

Once you've explored the varied world of audio/video/analog/digital transmissions on the dozens of satellites perched over your house, you'll wonder how you ever sat through boring sitcoms and tedious chat shows. You'll never look at television the same way again when you search the sky for the hidden signal on satellites! ST

AUDIO SUBCARRIER/SCPC SOURCES

Avcom
500 Southlake Boulevard
Richmond, VA 23236
804-794-2500 FAX: 804-794-8284
Makes the SCPC-1000D (reviewed in May/June 1996 *ST*)

SatScan Corporation
P.O. Box 1109
Sultan, WA 98294
360-793-7533
http://www.satscan.com
Makes the SCPC Explorer

Universal Electronics
4555 Groves Road, Suite 12
Columbus, OH 43232
614-866-4605 FAX: 614-866-1201
Makes the SCPC-200 (reviewed in Nov/Dec 1996 *ST*) and the SC-50 (reviewed in July/Aug 1997 *ST*). Also made the SCPC-100 (reviewed in the Jan/Feb 1995 *ST*).

Grove Enterprises
P.O. Box 98, 7540 Highway 64 West
Brasstown, NC 28902
800-438-8155, 828-837-9200, Fax 828-837-2216
http://www.grove-ent.com
Grove carries the Universal SCPC-200 and SC-50 receivers

DIGITAL SATELLITE RECEIVERS

Digiear
Sales: 800-484-3156
Tech info: 716-622-0770
FAX: 716-639-7779
Sells Hyundai HSS-100C via Internet only at **http://www.digiear.com.**

Skyvision
1010 Frontier Drive
Fergus Falls, MN 56537
800-543-3025 FAX: 218-739-4879
http://www.skyvision.com
Carries the General Instrument's 4DTV receiver

*FM is a registered trademark of Spacecom Systems

World Radio History

THE VIEW FROM ABOVE

By Lawrence Harris
lawrenceh@peverell.demon.co.uk
http://www.peverell.demon.co.uk

SICH-1 Wakes Up

My weather satellite receiver(s) operate almost continuously while I work on the computer or do repairs to the plethora of dishes and antenna that reside in my backyard. Even so, they had continued scanning for months before finally locking on the 137.400 MHz signal from SICH-1 in mid-February. Although there have been a few reports of rare transmissions from this oceanographic radar-imaging satellite, both SICH-1 and OKEAN-4 (aka 1-7) have remained mostly silent. I was pleased to receive a recent image from SICH-1, by e-mail for inclusion in *View from Above* this month.

Meteor 3-5 Transmitting Again

Following the switching back on of Meteor 3-5 (on 137.850 MHz) on March 10, reports came in from people in many countries hearing the signal. Many spoke of hearing a tone superimposed on the subcarrier. As of mid-March I have only heard this tone when the satellite is rising and setting at low elevations. I have found the signal itself to be stronger than NOAA-12 and NOAA-14 received on a standard

Figure 1 shows a section at full resolution from the first picture I received from Meteor 3-5 on March 10. The area shown is that of the Gulf of Bothnia, between Sweden and Finland, at least part of which regularly freezes over during the winter months. In this image the upper section of the Gulf is seen covered in ice.

Meteor image synchronization

The image content (that is, the bright and dark content of the scene below) of both NOAA and Meteor transmissions rides on an amplitude modulated 2.4 kHz subcarrier. This sub-carrier then frequency modulates the main 137.850, 137.500 or 137.620 MHz signal. One difference between the two series of weather satellites is that the Meteor 2.4 kHz sub-carrier is somewhat unstable.

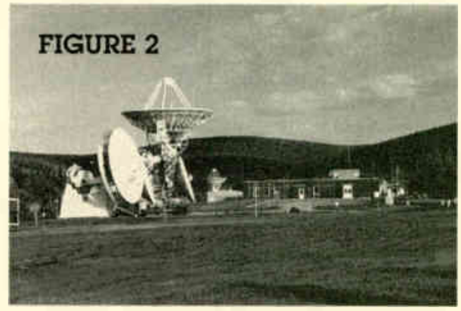
As a result, image decoding software which attempts to form a synchronized image using the 2.4 kHz carrier may show a steady drift across the screen. The better method of decoding is to have the software seek out a marker within the picture. This is normally accomplished by the programmer including an un-synchronous setting for Meteor images, in which the side bars are used to define the start of each scan line. If your Meteor images display a slope, check the software for this option.

The NOAA Satellites–Behind the Scenes

The Fairbanks Command and Data Acquisition (CDA) Station

We all monitor the NOAA satellites and appreciate reception during each pass of any of several frequencies–perhaps forgetting what goes on behind the scenes to keep the satellites in an efficient operating condition.

FIGURE 2



Recently, I took an online tour of NOAA's main ground station at Fairbanks, Alaska. Nestled in a valley about 13 miles from Fairbanks, at 65 deg north and 147.5 deg west, is NOAA's primary ground station for the reception of data from polar orbiting weather satellites. Fairbanks provides support for the imaging satellites of several countries, including France, Spain, Europe, India, Canada and Japan.

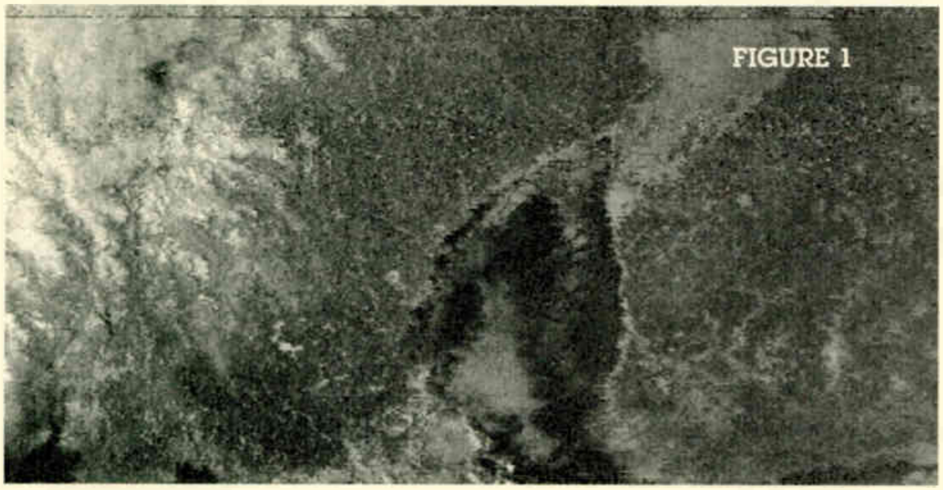
The large antennas on the left of the picture (see figure 2) are the 26-meter and the 12-meter antennas, both having a parabolic prime feed and autotracking monopulse system. Both antennas are engineered for 2200-2300 MHz, 1670-1710 MHz and 136-138 MHz band reception with optimum polarizations.

Uplink Antennas

There are three antennas used for uplink. A 6-meter with parabolic prime feed can be adjusted for either right and left polarizations, and can transmit in the 2025 to 2120 MHz band. The 4 meter transmits in either the 2025 to 2035 MHz or the 2097 to 2107 MHz bands. The SATAN mount can use either of two transmitters in the 148 to 154 MHz band, and the transmitters can themselves be switched between the SATAN and SCAMP mounts.

Fairbanks' other activities include support for the NOAA Search and Rescue (SARSAT) project, NASA Very Long Base Interferometer (VLBI) and GPS studies.

FIGURE 1



World Radio History

Nestled in a valley about 13 miles from Fairbanks, at 65 deg north and 147.5 deg west, is NOAA's primary ground station for the reception of data from polar orbiting weather satellites. Fairbanks provides support for the imaging satellites of several countries, including France, Spain, Europe, India, Canada and Japan.

FIGURE 3

My thanks to Don Reinke and Richard Oehrig for the use of this information. The Fairbanks station can be visited on the web at:

http://www.fcdas.noaa.gov/fcdasite.map.

Correspondence

An e-mail from David Barfodyne, K6RTA, of Los Angeles, California, shows what can be viewed from an image from a typical NOAA-14 pass over the western United States. David uses a quadrifilar helical antenna to feed a Hamtronics R-139 receiver. Using a soundcard in his computer, the program WXSAT produces the final image. David's tracking program is LogSat Pro, the registered version of the LogSat shareware program.

In David's picture, Vancouver Island is shrouded in cloud cover, and the San Joaquin Valley of California shows prominently; further south, the Gulf of California appears cloudless. Just inside at the bottom right is Hurricane Linda.

David intends to remount his antenna above the roof peak "which should buy me an additional minute or two at each end of a pass."

FIGURE 5

February Solar Eclipse–GOES view

The huge shadow of the Moon sweeping across the south of North America was captured perfectly by the GOES weather satellites–each showing its own perspective. After collecting images from GOES-9 and 10, I visited Dennis Chester's web site where I found the perfect montage (see figure 4).

Dennis' site is at: **http://climate-f.gsfc.nasa.gov/~chesters/text/goesnew.html**

Dennis is the GOES Project Scientist

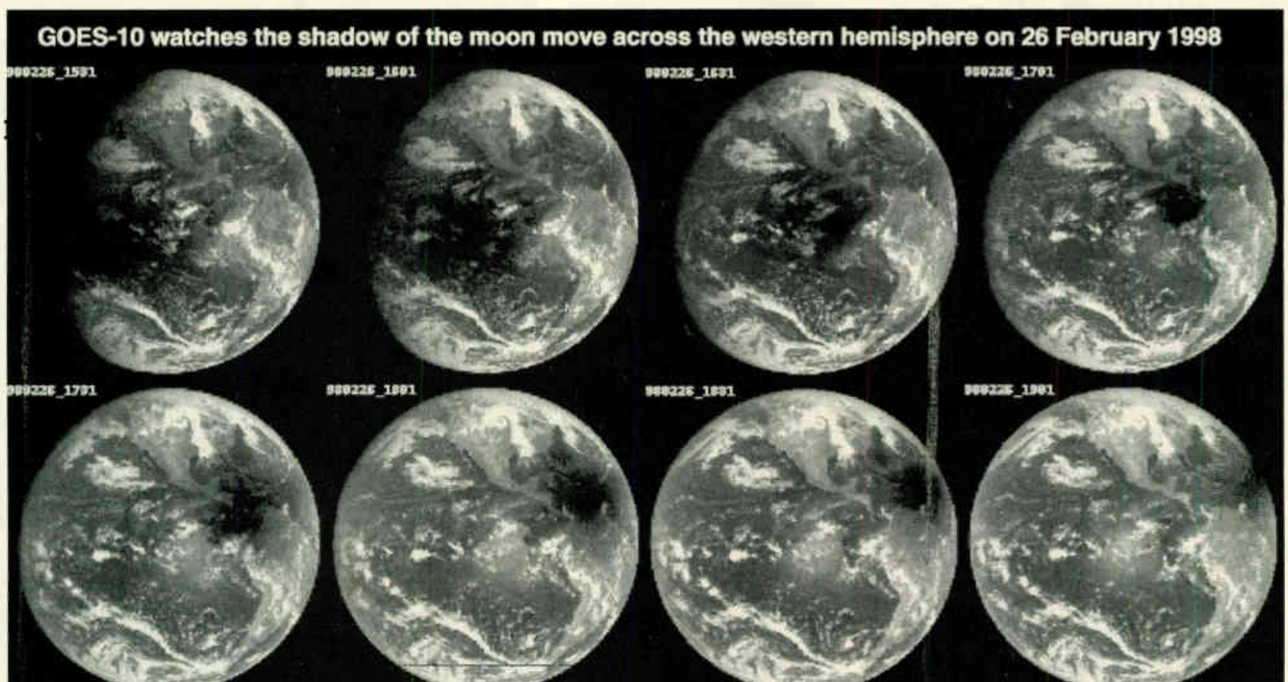


FIGURE 4

Montage of GOES-10 eclipse images

World Radio History

Web sites in Europe, America and Australia provide interestingly different weather satellite views from NOAA-14 and the local geostationary satellites. Markus Brylka's site in Essen, Germany includes the visible images from two daily passes of NOAA-14 (including links to the full resolution images).

Visible-light image March 15 at 0501UTC.

and I find his web site to be very well laid out. During the eclipse GOES-10 produced earth scans every 30 minutes, from which his picture is produced. The GOES-10 image taken at 1731UTC is shown in detail in figure 5.

The GOES-10 image from 1731 UTC on March 26 shows the total solar eclipse (figure 5, previous page).

FENGYUN-2

The flow of image data from FENGYUN-2 via the Internet has continued. Dr. James C Dodge is Program Manager at Global Data Integration and Validation, NASA, and has made regular images available at: **http://rsd.gsfc.nasa.gov/goesg/earth/Weather/.** (See fig. 6).

INTERNET site update–CIRA

Colorado State University (at the Foothills Campus at Fort Collins) incorporates the Cooperative Institute for Research in the Atmosphere–CIRA–which has a ground station for monitoring satellites. Their website is located at **http://www.cira.colostate.edu/**.

CIRA operates a high technology infrastructure to support meteorological research. This infrastructure consists of a sophisticated computer network and satellite earthstation, and provides worldwide satellite and conventional weather data to scientists, collaborators and students, in real time.

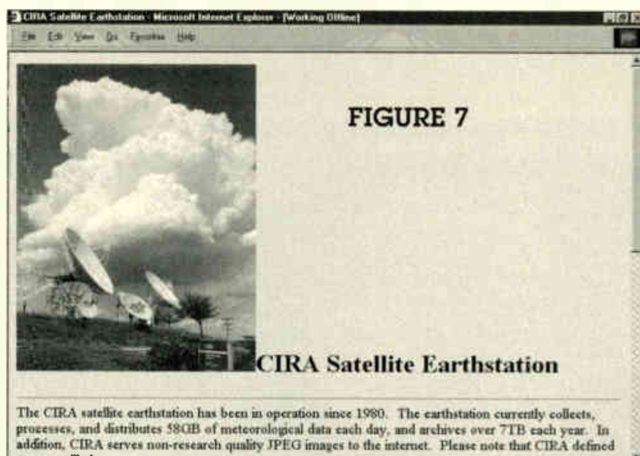
Amateur European web site

Web sites in Europe, America and Australia provide interestingly different weather satellite views from NOAA-14 and the local geostationary satellites. Markus Brylka's site in Essen, Germany includes the visible images from two daily passes of NOAA-14 (including links to the full resolution images), together with the two evening passes of NOAA-12: **http://www.castrop-rauxel.netsurf.de/~markus.brylka/wxsat/**

General view of Markus' web page.

I asked Markus whether the pictures on his site were processed automatically, or individually coloured? He confirmed that he does spend a considerable amount of time manually processing each one, normally during the afternoon. A colored Meteosat-6 image of the local format (C03) is also shown, together with a recent SICH-1 image. (See fig. 10).

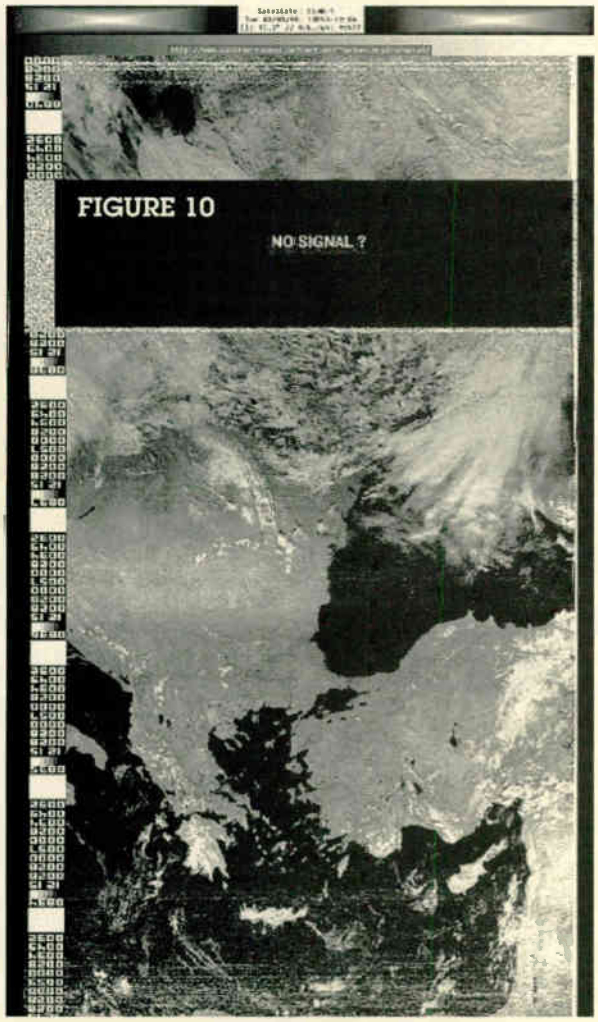
Close examination of the original SICH-1 image reveals a sequence of numbers along the length of the image (inverted in this instance). Over a period of several minutes, one of the numbers (0835, 0836.. in this image) can be seen to be incrementing, increasing by one each minute. Following this is a small greyscale, and the numbers in the remaining se-



CIRA homepage and CIRA ground station

World Radio History

OFS is planning to produce a similar, but digital product for LRPT–likely to be called Viking LRPT. Jerry [Dahl] tells me that it will also be designed as a portable laptop and PC system. Jerry is very optimistic about the prospects for LRPT because he believes it will dramatically lower the cost of a satellite station.



SICH-1 transmission on March 3, 1100 UTC.

quence indicate the state of the onboard equipment. This analysis was originally performed by Geoff Perry, MBE, of the Kettering Group in Britain.

Markus uses a 137 MHz quadrifilar antenna (Kreuzdipol-Antenne in German, he tells me!), a 137 MHz preamplifier, and WRAASE MR-9202 receiver for 137.300, 137.400, 137.500, 137.620 and 137.850 MHz. A Soundblaster compatible soundcard is used in his computer for recording and decoding the signal, running the WAVSAT (freeware) program.

Featured company–OFS WeatherFAX

It's time for a look at another company involved in the manufacture of weather satellite and associated products–so I contacted Jerry Dahl, the senior engineer at OFS WeatherFAX.

The company manufactures the Viking portable satellite system, a marine-quality product designed for laptops and PCs. An open frame quadrifilar antenna is used for signal reception.

The digital satellite receiver is very small (4 inches by 2.5 inches by 1 inch) and operates under software control, powered by the laptop or PC. An 8-pin cable connects to the decoder. The receiver has a spectrum analyzer facility and will scan the whole satellite band and display the signals. The PC Card decoder plugs into the laptop or PC, and runs 32-bit Windows software. Because the receiver is designed for use in high RF noise environments, OFS incorporate about twice the number of RF filtering stages often used elsewhere.

The company currently ships with DOS software, but are testing 32-bit Windows software. Shipments are currently made to a large marine company which markets the hardware with the Windows 95 software under their own brand name. Jerry told me that the OFS Viking hardware is used on probably all the commercial marine ships, and they have translated the software into several Pacific Rim languages.

OFS is planning to produce a similar, but digital product for LRPT–likely to be called *Viking LRPT*. Jerry tells me that it will also be designed as a portable laptop and PC system. Jerry is very optimistic about the prospects for LRPT because he believes it will dramatically lower the cost of a satellite station. All the analog circuitry will be eliminated and replaced with no more than one or two low cost digital modules. The design is simpler than the analog APT system, so the consumer is the real winner, getting a new source for low cost equipment. (See fig. 11).

The Space Monitoring and Information Support Laboratory in the Commonwealth of Independent States produced this picture of the ice cover on the Aral Sea.

Weather Satellite Frequencies

NOAA-14 transmits APT on 137.620 MHz
NOAA-12 transmits APT on 137.500 MHz
NOAAs transmit beacon data on 137.770 or 136.770 MHz
METEOR 3-5 transmits APT on 137.850 MHz when in sunlight
OKEAN-4 and SICH-1 sometimes transmit briefly on 137.400 MHz
GOES-8 and GOES-9 use 1691.0 MHz for WEFAX ST

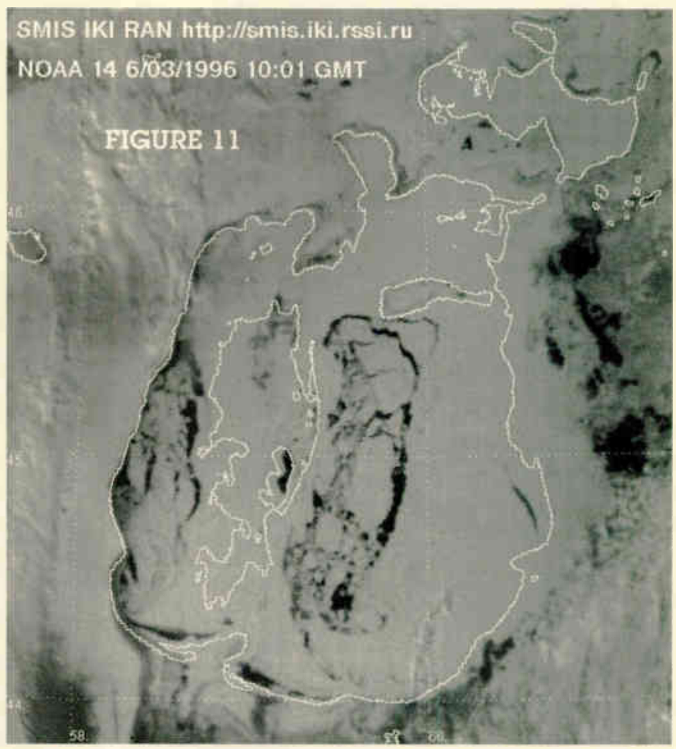


Fig 11 Aral Sea NOAA-14 image on March 6th at 1001UTC from SMIS

World Radio History

By John Magliacane, KD2BD
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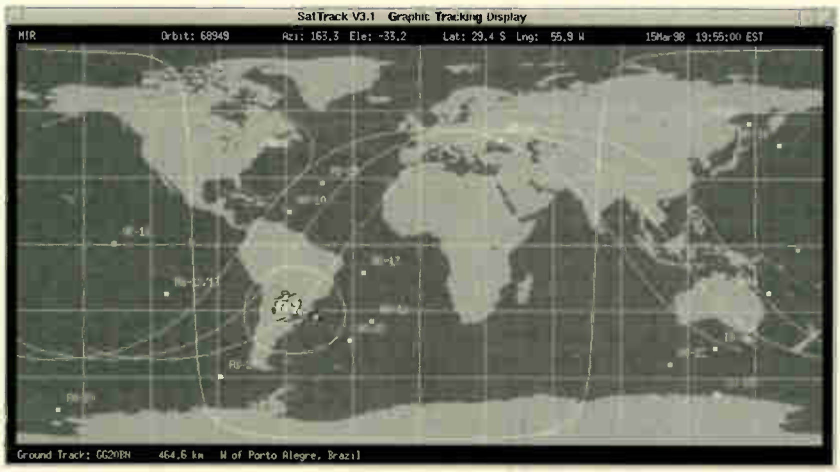
Amateur Radio's Future is Looking Up

It's hard to believe, but the amateur satellite program will celebrate its 37th birthday this year with the anniversary of the launch of the OSCAR-1 satellite on December 12th. What the program has accomplished thus far is nothing short of incredible, and those involved have strong reasons to feel proud. When the program started, designers and builders of amateur satellites learned about the field of space and communication satellites from industry professionals. Today, NASA and the commercial space industry as a whole are taking lessons from the amateur satellite program. We have indeed come full circle, and the best is yet to come.



SatTrack v3.1.5 running under the Linux operating system shows all 16 currently active orbital satellites carrying amateur radio equipment, including the space station Mir.

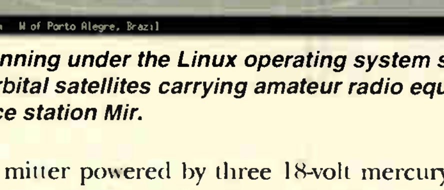
To better understand this great accomplishment, let's take a look at how simply the program got started, where we stand now, and how advances in technology are making it easier and less expensive than ever before to become involved in amateur satellite communications.

It started with $26 worth of parts

The amateur space program got its start when OSCAR-1, the world's first non-governmental satellite, was launched on December 12, 1961. This tiny spacecraft was built by a group of amateur radio operators working on their own behalf. The satellite was built using just $26 worth of surplus parts. It was carried to an orbital altitude of 430 kilometers along with the Discoverer 36 spacecraft by a Agena-Thor rocket launched from Vandenberg Air Force Base, California.

OSCAR-1's only payload was a 140 milliwatt CW Morse telegraphy beacon transmitter powered by three 18-volt mercury batteries connected in a parallel arrangement. The beacon sent the letters "HI" in Morse code. "HI," an internationally recognized friendly salutation greeting used by amateur radio operators, was chosen as an identifier because it was relatively easy to generate using basic logic circuits and because it also carried a low duty cycle (period between on and off cycles), which was an important consideration for the design of a satellite operating under expendable battery power.

OSCAR-1's beacon transmitter operated on a carrier frequency of 144.983 MHz in the lower portion of the amateur 2-meter band, and the speed of the telegraphy was controlled by an internal temperature sensor on board the spacecraft. This novel form of telemetry allowed OSCAR (Orbiting Satellite Carrying Amateur Radio) satellite designers, as well as others who received the beacon transmissions from the spacecraft, their first taste at the "living conditions" on-board a tiny spacecraft in low earth orbit.



Volunteers associated with the SAREX and MIREX programs are responsible for coordinating and planning amateur radio activities taking place from the US Space Shuttles and the Russian space station Mir.

OSCAR-1 continued to operate for 21 days until its internal battery power was exhausted. The spacecraft later decayed in the earth's atmosphere on January 31, 1962. However, OSCAR-1's successful mission, coupled with overwhelming support from over 570 amateur radio operators in 28 countries around the world who logged transmissions made by the tiny satellite, gave spacecraft designers all the encouragement they needed to move toward designing and building larger and more capable satellites carrying amateur radio communications equipment.

The rest, as they say, is history!

Today, the constellation of operational amateur satellites has grown to 16 spacecraft, the majority of which are in low altitude circular orbits. The current fleet includes satellites that carry a myriad of scientific experiments of interest to amateur radio operators, educators, and researchers from all walks of life. The fleet also includes satellites that carry analog communication transponders that make reliable long distance communications possible on frequencies where only line-of-sight communications would normally be possible. There are also satellites that carry digital store-and-forward communication transponders capable of passing large quan-

World Radio History

Today, the constellation of operational amateur satellites has grown to 16 spacecraft, the majority of which are in low altitude circular orbits. The current fleet includes satellites that carry a myriad of scientific experiments of interest to amateur radio operators, educators, and researchers from all walks of life.

tities of data between ground stations around the world without the need for the Internet, and still others that carry earth imaging cameras that provide fantastic views of their home planet from their vantage point high above the earth's surface.

The amateur space program has grown even further than this in recent years. Manned communications have been taking place between the space station *Mir* and amateur radio operators on earth for nearly 10 years. Amateur radio communication experiments have also been flown on-board many the U.S. space shuttles, and a growing number of U.S. astronauts are earning amateur radio operators licenses as part of their astronaut training at NASA. There are even plans to include a permanently manned amateur radio station on-board the International Space Station. Amateur radio's future is certainly looking up.

A new direction for amateur radio

Amateur satellites are certainly a fascinating aspect of the amateur radio service. While communications taking place in the amateur radio service have typically been thought of by many as taking place on the shortwave bands or on VHF-FM frequencies, it is clear that not much is being done on those bands that hasn't been done already. While participating in contests and earning the coveted DX Century Club (DXCC) award on the high frequency (HF) bands are worthwhile endeavors for some, these activities have gone on for years and have been accomplished by many using communications equipment far less advanced than what is available today. So, where's the challenge? What do HF contests, DXCC awards, and discussing breakfast on the local 2-meter repeater contribute to the advancement of the radio art and the future of the amateur radio service? Not much, at least by today's standards.

The amateur satellite program may be thought of as being a "salad bowl" of communication technologies. Amateur radio operators have traditionally been a very diverse group of individuals from vastly different backgrounds. As it turns out, this unique diversity may actually be its greatest strength. There are amateurs whose interests lie in creating new digital communication protocols, others who enjoy developing digital signal processing techniques and applying those techniques to weak signal communications, others who enjoy software development, and some who enjoy antenna system design and video communication techniques. There are facets to the amateur satellite program that appeal to people having these interests as well as others. Amateur satellites have something for everyone.

Let's take a brief look at what is currently available to amateurs who wish to become involved in satellite communications today. Specific operating frequencies for these satellites may be found in the *Satellite Services Guide* section of this issue of *Satellite Times* magazine.

AMSAT-OSCAR-10

AMSAT-OSCAR-10 is the oldest and the largest operating amateur satellite in orbit. Launched in 1983, AMSAT-OSCAR-10 offers a sensitive mode B (70-cm up, 2-meters down) linear communications transponder. Although the satellite suffered an on-board computer malfunction in December 1986, the satellite is still quite usable if care is taken by ground stations.

UoSAT-OSCAR-11

UoSAT-OSCAR-11 is a scientific, research, and educational satellite. UoSAT-OSCAR-11 does not contain any real-time communication transponders that are available for general use. However, the satellite does carry a digital store-and-forward communications experiment (precursor to today's "Pacsat" or packet satellites), a charge-coupled device (CCD) earth imaging camera, a National Semiconductor "digitalker" voice synthesizer system, and is currently supplying a wealth of scientific data regarding the near-earth environment on a downlink frequency of 145.826 MHz FM.

Monthly news reports are transmitted by the satellite on its downlink beacon using a standard ASCII transmission format at a rate of 1200 bits-per-second, and can be easily decoded using an FM receiver, simple audio frequency shift keying (AFSK) data demodulator, and personal computer, dumb terminal, or serial printer. UoSAT-OSCAR-11 also carries an S-band propagation beacon transmitter which has partially failed, but is useful for ground stations testing S-band receiving equipment.

AMSAT-OSCAR-16

AMSAT-OSCAR-16 is a digital store-and-forward communications microsatellite that communicates with groundstations at 1200 bits-per-second. Measuring just nine inches on each side, AMSAT-OSCAR-16 carries four independent uplink receivers as well as a single phase shift keying (PSK) downlink transmitter operating on the 70-cm band. The satellite functions as a file server in space, and supports the Pacsat Broadcast Communications Protocol used by all modern "Pacsat" satellites. The satellite can service the download requests of as many as ten groundstations under its footprint at any one time. AMSAT-OSCAR-16 also carries an S-band beacon transmitter that operates on 2401.143 MHz.

TABLE 1

AMSAT-OSCAR-10
http://www.amsat.org/amsat/sats/n7hpr/ao10.html
UoSAT-OSCAR-11
http://www.amsat.org/amsat/sats/n7hpr/uo11.html
AMSAT-OSCAR-16
http://www.amsat.org/amsat/sats/n7hpr/ao16.html
DOVE-OSCAR-17
http://www.amsat.org/amsat/sats/n7hpr/do17.html
WEBERSAT-OSCAR-18
http://www.amsat.org/amsat/sats/n7hpr/wo18.html
LUSAT-OSCAR-19
http://www.amsat.org/amsat/sats/n7hpr/lo19.html
FUJI-OSCAR-20
http://www.amsat.org/amsat/sats/n7hpr/fo20.html
UoSAT-OSCAR-22
http://www.amsat.org/amsat/sats/n7hpr/uo22.html
KITSAT-OSCAR-23
http://www.amsat.org/amsat/sats/n7hpr/ko23.html
KITSAT-OSCAR-25
http://www.amsat.org/amsat/sats/n7hpr/ko25.html
ITAMSAT-OSCAR-26
http://www.amsat.org/amsat/sats/n7hpr/io26.html
AMRAD-OSCAR-27
http://www.amsat.org/amsat/sats/n7hpr/ao27.html
FUJI-OSCAR-29
http://www.amsat.org/amsat/sats/n7hpr/fo29.html
RS Satellites
http://www.amsat.org/amsat/sats/n7hpr/rs.html
MIREX Program
http://www.geocities.com/~ik1sld/mirex.htm
SAREX Program
http://www.ccsds.org/sarex/

Internet web pages with information on various amateur satellites currently in operation.

World Radio History

DOVE-OSCAR-17 is physically identical to the AMSAT-OSCAR-16 satellite, but instead of providing a digital communications transponder, DOVE-OSCAR-17 carries a digital voice encoder capable of reciting messages of peace to anyone monitoring its FM downlink on 145.825 MHz.

Earth imaging cameras carried on-board amateur satellites return many interesting views of the earth as seen from space. In this view taken by UoSAT-OSCAR-22 in 1991, a smoke plume from burning oil wells is visible over the Persian Gulf area during the war with Iraq. (NK6K Photo)

DOVE-OSCAR-17

DOVE-OSCAR-17 is physically identical to the AMSAT-OSCAR-16 satellite, but instead of providing a digital communications transponder, DOVE-OSCAR-17 carries a digital voice encoder capable of reciting messages of peace to anyone monitoring its FM downlink on 145.825 MHz. A hardware problem has hampered the satellite's ability to be programmed with software capable of addressing the on-board speech synthesizer. As a result of this, most of the time the satellite may be heard transmitting spacecraft telemetry information using the AX.25 packet radio communications protocol, the same as is used for terrestrial packet radio communications on the VHF and UHF bands. DOVE-OSCAR-17 also carries an S-band beacon transmitter that has proved to be a valuable signal source for those building 2400 MHz antennas, preamplifiers, and frequency downconverters.

WEBERSAT-OSCAR-18

WEBERSAT-OSCAR-18 is a microsatellite that carries a color CCD earth imaging camera that returns digital photographs of the earth capable of being displayed on a personal computer with appropriate software. The satellite also carries an amateur television (ATV) uplink receiver, a spectrometer experiment, a particle impact detector, and a digital store-and-forward communications transponder. The transponder, however, is not expected to be commissioned until the primary mission of taking digital color images of the earth is fully exhausted.

LUSAT-OSCAR-19

LUSAT-OSCAR-19 is a pacsat satellite very much like the AMSAT-OSCAR-16 satellite except that instead of carrying an S-band beacon transmitter, LUSAT-OSCAR-19 carries a 70-cm CW beacon transmitter that operates on 437.127 MHz.

FUJI-OSCAR-20

FUJI-OSCAR-20 is a "peach basket sized" satellite with a dual personality. FUJI-OSCAR-20 carries both an analog mode J (2-meters up, 70-cm down) communication transponder as well as "flying mailbox" digital transponder. Unlike the other OSCAR satellites carrying digital communication transponders, FUJI-OSCAR-20 carries mailbox software to permit the exchange of short electronic messages between groundstations, and does not require any special groundstation software for access. Despite its dual personality, FUJI-OSCAR-20 has been spending most of its time in analog mode J (also known as mode JA).

UoSAT-OSCAR-22

UoSAT-OSCAR-22 is a high-speed pacsat satellite that is primarily used as a gateway between terrestrial packet radio bulletin board systems. UoSAT-OSCAR-22 operates at 9600 bits-per-second, supports two uplink receivers, and can handle the download requests for as many as 20 groundstations under its footprint at any one time. UoSAT-OSCAR-22 also carries a CCD earth imaging system (EIS) camera that produces images with a resolution of 578 by 576 pixels.

KITSAT-OSCAR-23

KITSAT-OSCAR-23 is another high-speed pacsat satellite like that of UoSAT-OSCAR22, but is placed in a higher altitude orbit that permits more data to be passed to the satellite in a given pass. KITSAT-OSCAR-23 also offers an improved earth imaging system camera that provides resolution down to less than 2-kilometers in a field of view that measures 1600 by 1800-kilometers.

KITSAT-OSCAR-25

KITSAT-OSCAR-25 is very similar to the KITSAT-OSCAR-23 satellite and offers some improved performance over its older sibling. KITSAT-OSCAR-25's primary mission is to take both narrow and wide-angle image of the earth in both monochrome and color, process numerical information, measure radiation, and act as a file server in space for groundstations around the world.

ITAMSAT-OSCAR-26

ITAMSAT-OSCAR-26 is a microsat-class satellite carrying a digital store-and-forward communication transponder similar to the AMSAT-OSCAR-16 and LUSAT-OSCAR-19 satellites. The satellite is off the air as this column went to press, but is expected to return once its new on-board computer software is successfully reloaded by ground control.

AMRAD-OSCAR-27

AMRAD-OSCAR-27 carries a "bent pipe" analog FM transponder capable of relaying voice transmissions heard on a single channel on the 2-meter band to the 70-cm band. AMRAD-OSCAR-27's exceptional sensitivity makes it possible to be heard by the satellite with nothing more than a 2-meter FM hand-held transceiver and rubber duck antenna. AMRAD-OSCAR-27's UHF downlink, however, is a bit weak and requires a gain antenna and a sensitive receiver for adequate reception.

Despite the weak downlink, some enterprising individuals have been able to demonstrate successful two-way communications through AMRAD-OSCAR-27 using little more than a dual band FM hand-held transceiver and a whip antenna. AMRAD-OSCAR-27 is primarily active on weekends when the satellite is in sunlight.

FUJI-OSCAR-29

FUJI-OSCAR-29 is similar to the FUJI-OSCAR-20 satellite except that in addition to an analog and digital transponder operating at 1200 baud, FUJI-OSCAR-29 is also capable of mailbox operation at 9600 bits-per-second. FUJI-OSCAR-29 also has a "digitalker" mode that is capable of transmitting digital audio files uplinked to the satellite by spacecraft controllers. These voice transmissions have proven to be easily heard using even modest FM receivers tuned to 435.910 MHz. The digitalker messages are primarily used for demonstration or educational purposes, and are always interesting to listen to.

World Radio History

Recent advances in semiconductor technology are making it easier than ever before to take amateur communications to higher and higher frequencies that are ideally suited for line-of-sight communications with satellites in earth orbit.

RS-12/13

The Russian RS-12/13 satellite combination supports several analog communication transponders as well as a "robot" CW autotransponder. Like previous Radio Sputnik satellites, RS-12/13 contains transponders possessing a great deal of sensitivity. Seldom is anything more than several watts of uplink power and a simple whip antenna required for strong downlink returns through the satellite. The autotransponder can usually be accessed using nothing more than a 2-meter hand-held transceiver working into a rubber duck antenna.

RS-15

The Russian RS-15 satellite carries a mode A (2-meters up, 10-meters down) linear communications transponder that is capable of providing long distance, two-way communications between widely separated groundstations. The satellite is in a relatively high circular orbit, and enjoys a large footprint as a result of its high altitude. Downlink signals tend to be a bit of a challenge to copy, but those who take the time and effort to optimize their downlink receiving stations report excellent results in using the RS-15 satellite to make long distance contacts.

RS-16

The Russian RS-16 satellite contains several linear transponders and beacon transmitters, although only the beacon transmitters appear to be active at this time. Spacecraft telemetry information may be gathered from the beacons, which transmit their data using Morse code.

SAREX/MIREX

The SAREX (Shuttle Amateur Radio Experiment) and MIREX (*Mir* International Amateur Radio Experiment) programs are responsible for making possible real-time voice, data, and video communications with astronauts and cosmonauts living in space. With the cooperation of NASA, AMSAT and the ARRL, these programs have delivered amateur radio communications equipment to the *Mir* space station and NASA's shuttle orbiters, and have exposed the world of space communications to thousands of school children, as well as many others worldwide.

Many NASA astronauts have become licensed amateur radio operators because of the success of the SAREX program and because of the positive experiences the program has brought to astronauts who participated in past SAREX experiments. In fact, astronaut/hams Scott Parazynski, KC5RSY, and Pedro Duque, KC5RGG will operate a SAREX operation during the STS-95 space shuttle mission.

Dispelling myths

There are some powerful myths regarding amateur satellite communications that are basically due to a lack of knowledge or understanding of the communications technology involved in modern OSCAR satellite communications. Satellites with analog transponders are much more than "repeaters in the sky," and satellites with digital transponders are much more than a "poor man's Internet." While repeater technology has changed little over 30 years, today's OSCAR satellites are nothing like their distant relatives. And the last time I checked, the Internet was not capable of returning scientific research data and detailed images of the earth directly from high above the planet's surface in realtime.

Recent advances in semiconductor technology are making it easier than ever before to take amateur communications to higher and higher frequencies that are ideally suited for line-of-sight communications with satellites in earth orbit. Technology advances have also reduced the cost of ground station radio equipment and allow uncomplicated software control of downlink receivers, uplink transmitters, and azimuth/elevation (AZ/EL) antenna rotators. Things are a lot easier than they used to be.

The future is here today

Space is clearly amateur radio's final frontier. While commercial telecommunication companies are realizing that wireless technologies hold the key to the future when it comes to personal communications and are beginning to capitalize on space-based technologies, amateur radio operators are enjoying space-age communications today, years ahead of anything available to anyone else.

The future is here today with amateur radio satellites. Why not join us? ST

What is Amateur Radio?

The Federal Communications Commission defines the amateur radio service as a radiocommunication service for the purpose of self-training, intercommunication, and technical investigations to be carried out by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest. The Amateur satellite service is a radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service.

In the United States, amateur radio operators are licensed by the Federal Communications Commission. There are six classes of operator licenses: Novice, Technician, Technician Plus, General, Advanced and Amateur Extra. An operator license authorizes the holder to be the control operator of a station with the privileges of the operator class specified on the license. A Technician Class license or higher is required to communicate on those frequencies which are also used by amateur satellites.

An amateur radio license may be obtained after successfully passing a multiple choice written exam covering FCC rules and regulations, communication electronics theory, and radio operating practices. All classes of license except Technician also require successful passing a Morse code proficiency exam.

Study material to help those interested in gaining the knowledge necessary for becoming a licensed amateur radio operator is available in written (book) form, as computer software, and on videotape. Study guides are also available at Radio Shack stores.

Practice exams for any class of amateur radio license are available on the worldwide web at: **http://www.biochem.mcw.edu/Postdocs/Simon/radio/exam.html**.

A list of examination schedules and locations are also available on the worldwide web at **http://www.arrl.org/arrlvec/examsearch.phtml**.

World Radio History

By Keith Stein
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Where is Mission Control for Spy Satellites?

On January 29, a Lockheed Martin Atlas 2A (AC-109) rocket was successfully launched a classified satellite from Cape Canaveral Air Station, Florida. The vehicle carried a secret experimental payload for the U.S. National Reconnaissance Office (NRO) based in Chantilly, Virginia.

The classified satellite, known as "Capricorn," was injected into a 12-hour Molniya orbit (40000 by 300 km) with a 63 degree inclination. Capricorn is believed to be a new experimental data transmission relay satellite for NRO's radar and optical observation satellites operating at high latitudes.

High resolution imaging photo recon satellites return their secret products almost instantly to a ground station located at Fort Belvoir, Virginia. For years these secret pictures have been relayed by another high flying Hughes communications satellite similiar to Capricorn called the Satellite Data System (SDS), according to Larry Van Horn's book *Communications Satellites*, third edition, which is no longer in print.

Fort Belvoir has some interesting tenant commands. Ft. Belvoir is a major DSCS III military communications satellite ground station. It is also the home of the Defense Mapping School, U.S. Army Intelligence and Security Command, and the Defense Communications Electronics Evaluation and Test Activity or Defense CEETA. It is Defense CEETA that we shall focus on in the rest of this article.

Capricorn's Ground Link

It is widely believed that Capricorn's ground station is the Defense CEETA complex, also known as Area 58. It is also widely believed that this very secretive organization appears to have direct ties to the NRO. One recently study cinducted by the Federation of American Scientists showed a direct correlation between increasing floorspace at CEETA and increasing on-orbit ops of the NRO spy birds.

Area 58, the Defense CEETA compound, is located about 20 miles south of Washington D.C. (approximate coordinates: 38 degrees 45 minutes 00 seconds north latitude, 77 degrees 07 minutes 30 seconds west longitude).

It is interesting to note that public street maps published in 1991 by ADC of Alexandria, Inc. (Alexandria, Virginia) shows Defense CEETA as a point of interest on page 33, map 29. But the same maps published in 1997 removed any trace of the Defense CEETA buildings and only showed a gate/barrier marking. The facility is still there and very active. There is also new construction of buildings and gate/barriers.

Effectively obscured by a heavily wooded area at the corner of Beulah Road and Telegraph Road in Newington, Virginia, are two large golf ball-like structures which rise above the tree tops. These two 35-meter domes hold very large satellite dish antennas. One is close to the main building. It has a red aircraft warning light on top due to all the low flying Army helicopters from Davison Army Airfield. There is a second dome north of the complex.

These domes can be seen for many miles within the local area. There are also about four 15-meter domes and two 8-meter domes placed around the grounds. The complex also has its own satellite TV dish and, yes, even a cafeteria.

An innocent jogger along the perimeter fence line along Beulah or Telegraph Road is enough to alert security forces on site and monitor the pedestrian's progress down the road.

Defense CEETA VHF Frequency Assignments

Paging System	141.425 MHz (simplex)
Security	142.400 MHz (simplex)
Maintenance	166.750 MHz (Maintenance for all of Fort Belvoir)

Defense CEETA Security Callsigns

Main Dispatch="40"	
Other Units:	ALPHA 1-9, 21; BRAVO 1-7; CHARLIE 1-4/7/9; DEI; DELTA 1-8; ECHO 2-4/6-7/9-10; PAPA 9/21/188/301

Dispatch Terminology

Lima Charlie	Loud and Clear
Tango Yankee	Thank You
Tango Yankee Victor Mike	Thank You Very Much

10-codes used at Defense CEETA

10-4	Ok, Message Received.
10-9	Repeat Message.
10-10	Go to ______.
10-14	Radio check, loud and clear.
10-58	You have a telephone call.

The whole complex is a bizarre jumble of very large windowless buildings with electromagnetic shielding. According to Commerce Business Daily, all procurement for CEETA is handled through the Department of the Army, Baltimore District, Corps of Engineers in Baltimore, Maryland.

In 1991, a contract was awarded to W.M. Schlosser, Hyattsville, Maryland, for the construction of a new block "P" wing. Cray Research, Inc. of Calverton, Maryland, was awarded a contract for two rotary uninterruptable power supply (UPS) systems at CEETA in 1994. A new block "R" building was announced in March 1996 as an addition to the main facility at the north end of the block "P" extension.

World Radio History

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Defense CEETA Building Identifications

Building	Blocks
2573	F, G and J
????	P
????	R

If you want to learn more about Defense CEETA including some fuzzy pics of the complex and signage, checkout the Federation of American Scientists website at **http://www.fas.org.** John Pike and the FAS have an area dedicated to understanding the mysterious Defense CEETA facility, including detailed maps of the facility.

Last Three Crews Named for Mir

Russia's *Mir* space station is likely to be closed down and deorbited in 1999 after the last crew leaves the orbiting outpost. The last U.S. astronaut to stay aboard *Mir,* Andrews Thomas, will return to earth this month.

There is some discussion that until deorbit, the space shuttle may be asked to provide two logistics support flights and then help deorbit the station. In February, there was some talk of moving Soyuz communications into the 400 MHz range. But that option was abandoned in March when the program could not afford to shoulder the expense of re-engineering the Russian spacecraft and sites. There was also some discussion of moving the Russian spacesuit communications into the 136-138 MHz range, also abandoned.

NASA Network Directors announced February that VHF communications support for *Mir* from NASA's Wallops Flight Facility (WFF), Dryden Flight Research Center (DFRC), and White Sands Complex (WSC) will continue for at least five more months. The current plan calls for the last crew to leave *Mir* in November 1998, but that may be extended into 1999.

SNOE Mission in Orbit

After a two year delay, the Student Nitric Oxide Experiment (SNOE) payload for the University of Colorado at Boulder was successfully launched (dropped from an L-1011 aircraft) after departing Vandenberg Air Force Base (VAFB) on Thursday, February 26. Drop time was 2:05 a.m. EST (0705 UTC) at coordinates 18.5 degrees north latitude /135 degrees west longitude (due west of Mexico City and east-south-east of Hawaii).

Five seconds after release from the L-1011 aircraft, the Pegasus XL successfully fired its first stage engines and started its climb into orbit. At nine minutes and 35 seconds into powered flight, the SNOE spacecraft started its five second spin-up before separation occurred at nine minutes and 40 seconds into the flight. At this time the payload was officially inserted into orbit.

A tracking station in Poker Flat, Alaska (PKR), was the first ground site to acquire the 128-kbps high bit rate dump data from SNOE. The data was later played back to SNOE Mission Operations Center in Boulder, Colorado, and reported to be excellent. The spacecraft is healthy and transmitting a -88 dBm downlink signal on 2272.900 MHz in the S-band.

The only problem during the launch was centered around the lack of usable data received and relayed from a Navy P-3 Orion aircraft through NASA's Tracking and Data Relay Satellite System (TDRSS). NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland received "no usable telemetry or tracking data thru the P-3/TDRSS configuration," according to NASA Mission Managers. The Navy P-3 aircraft, stationed at Naval Air Station Point Mugu, California, had intermittent lock on Pegasus downlink data, although this was not a mandatory requirement.

Pegasus XL	Downlink Frequency Assignments
S-band	2269.500 MHz
S-band	2288.500 MHz
C-band	5765.000 MHz

VAFB provided excellent data to GSFC's Flight Dynamics Facility, who updated the nominal orbit and transmitted new predict data to all stations. The tapes recorded on the P-3 will be analyzed and a determination made as to whether this was a P-3 problem or a TDRS coverage problem.

In future Pacific Missile Range launches from Vandenberg, keep an ear on these frequencies for the Navy P-3 aircraft.

Pacific Missile Range

3162 4486 4760 5700 5822 6820 6889 7705 9029 9212 10272 10352 10510 10660 10804 11510 13218 13756 13900 14987 15021 15763 15793 17428 19303 19640 20261 22760

X-33 Program Update

Just after finishing the small X-33 item in the last month's *SLP* column, I obtained some updates on the program.

The X-33 program will demonstrate, in flight, new technologies needed for a single stage to orbit (SSTO) reusable launch vehicle (RLV). The X-33, a half-scale prototype of the "VentureStar" RLV, will be an unpiloted vehicle which launchs vertically like a rocket and lands horizontally like a airplane. The goal of the program is to demonstrate advanced technologies to increase reliability and lower the cost of placing payloads in space.

Lift capability will be 50,000 lbs to low earth orbit (LEO); 25,000 lbs to the International Space Station (ISS); and 18,000 lbs to geostationary transfer orbit (GTO).

World Radio History

Five flights [of the X-33] are planned to MAAF at Mach 7 and two planned for MAFB at Mach 13. Mountain Home AFB will be used as a overflight site. The low-mach flights to Silurian Lake are no longer being considered. The seven flights will occur between July 26, 1999, and December 25, 1999, with roll-out of the vehicle on July 4.

X-33 Development Schedule

February-April 1999	System checkout and integration
May-July 1999	Site integration and checkout
July-October 1999	Five flights to Michael Army Air Field (MAAF), Utah
November-December 1999	Two flights to Malmstrom Air Force Base (MAFB), Montana

The X-33 vehicle is a 53 percent scale reusable launch vehicle (RLV). The vehicle will be launched from Edwards Air Force Base, California, and land at Michael Army Air Field. MAAF is also known as Dugway Proving Grounds. Flights to Malmstrom AFB are also scheduled late in the test program. A total of seven flights are planned between July 26, 1999, and December 25, 1999. Flights will reach altitudes up to 260,000 feet.

Five flights are planned to MAAF at Mach 7 and two planned for MAFB at Mach 13. Mountain Home AFB will be used as a overflight site. The low-mach flights to Silurian Lake are no longer being considered. The seven flights will occur between July 26, 1999, and December 25, 1999, with roll-out of the vehicle on July 4. Pre-launch, launch and post-launch activities will be approximately 10 hours in duration on flight days.

Since the flight profile extends beyond the Edwards AFB defined airspace, the program will use an Extended Test Range Alliance (ExTRA) network to coordinate range assets and airspace beyond the capabilities of DFRC and the Air Force Flight Test Center (AFFTC). All flights will be controlled from the X-33 range operations center (ROC), building 4800 at Dryden. Two mobile flight termination systems (FTS) are also required during each flight.

The X-33 range will use a 18-foot telemetry system and 10-foot command uplink station for tracking support.

After each flight, the vehicle will be transported back to Edwards Air Force Base by truck. The dry weight of the vehicle is currently 73,437 lbs, an increase of 10,000 lbs. Additional weight increases are being considered. Weight is a concern for towing the vehicle from the runway.

X-33		Frequency Assignments
UHF	Uplink	421.0 MHz (Flight Termination System-FTS)
L-band	Uplink	1804.5 MHz
S-band	Downlink	2205.5 MHz
C-band	Downlink	5585.0 MHz

Satellite Listening Post Intercepts

AFB	Air Force Base
BATSAT	Broadband Advanced Technology Satellite
Defense CEETA	Defense Communications Electronic Elevation and Test Activity
K	kHz
NASA	National Aeronautics and Space Administration
NFM	Narrow FM
SNOE	Student Nitric Oxide Experiment
USB	Upper Side Band

All times in UTC.

K5700.0	Vandenberg AFB working Navy P-3 aircraft tracking launch of Pegasus/SNOE/Teledesic 1 (known as BATSAT before launch) mission, 0344, USB. Also used K5739.3 as primary. (Keith Stein-Woodbridge, VA)
K7672.0	Cape Radio up with King 1 (USAF HC-130) at 1552, USB, advising the "launch" is a go for 12 noon. (Rick Baker-Ohio)
M133.750	NASA 4 (Gulfstream I, G-159 aircraft, tail number N4NA) 2255, landing on Runway 02, AM mode. (Al Stern-Satellite Beach, FL)
M134.950	NASA 955 (T-38 aircraft tail number N955NA) from Johnson Space Center inbound to Shuttle Landing Facility (SLF) very rapid descent, AM mode. Switched to M128.550, SLF Tower. (Stern-FL)
M142.400	Defense CEETA security heard, 1558, NFM mode. (Stein-VA)
M149.975	Just testing out an antenna for 140-150MHz band and at 1940 heard musical tones on 149.975 MHz. (Lawrence Harris-Plymouth, UK)
M150.300	Cosmos 2349 heard (PCM-FM TM 1 sec frame rate). Also on 400.8 MHz (CW) between 0616-0620. (Sven Grahn-Sollentuna, Sweden)
M166.000	Signals from Progress M-38 heard between 0321-0324. Also heard on M922.750. (Grahn-Sweden)
M253.650	Touzla calling Sarajevo at 1655. (Magnus Hammarstedt-Ostersund, Sweden)
M255.400	NASA 921 (T-38 aircraft, tail number N921NA), activating flight plan Amarillo-Ellsworth. (Sandy-Denver, CO)
M258.450	Milsatcom "AirZeroSouth" working "Zero" (both had British accent) at 1345. Zero mentioned going to channel "preset 1" several times. Zero also tried to call Air 22A and Charlie 22A with no joy. (Hammarstedt-Sweden)
M261.650	"10" (British accent) calling "0" at 1050. (Hammarstedt-Sweden)
M272.000	NASA 918 (T-38 aircraft), female pilot. (Southern Calif)
M351.900	NASA 850 (F-18 aircraft), flight level 41,000 feet. Also heard on M279.600. (Southern Calif)

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World Radio History

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. **Satellite Transponder Guide** — This guide lists 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.

4. **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.

5. **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.

6. **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.

7. **Amateur Satellite Frequency Guide** — This guide lists 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.

8. **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.

World Radio History

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

AUDIO SUBCARRIERS

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

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

Classical Music

SuperAudio–Classical Collections	G5, 21	6.30/6.48 (DS)
WFMT-FM (98.7) Chicago, IL–Fine Arts	G5, 7	6.30/6.48 (DS)
WQXR-FM (96.3) New York, NY	S4, 14	6.20/6.80 (DS)

Satellite Computer Services

Planet Connect, Planet Systems, Inc 19.2 kbps service	G4, 6	7.398
Skylink, Planet Systems, Inc	G4, 6	7.264
Superguide	G5, 7	5.48

Contemporary Music

DWRR-FM (101.9) from the Philippines	G4,24 (Ku)	6.80
Radio Desjardins 1	T5, 14	6.80
Radio Desjardins 2	T5, 14	6.20
SuperAudio–*Light and Lively Rock*	G5, 21	5.96, 6.12 (DS)
WPHZ-FM (96.9) Bremen, IN (South Bend market)	G4, 15	6.48, 7.30 (DS)

Country Music

SuperAudio–*American Country Favorites*	G5, 21	5.04/7.74 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, TN., ID-*The Hit Kicker*	G6, 7	6.20
WSM-AM (650) Nashville, TN	C4, 24	7.38, 7.56

Easy Listening Music

IAM Radio-easy listening music	G4, 6	7.69
SuperAudio–*Soft Sounds*	G5, 21	5.58/5.76 (DS)
FCC mandated safe-harbor program audio-easy listening music	G3R, 9	6.80
	G5,2	6.80
United Video–easy listening music	C4, 8	5.895 (N)

Foreign Language Programming

Antenna Radio (Greek)	S4, 14	7.80
Apna Sangeet Radio India	GE1, 16	7.38
Arab Network of America radio network	GE2, 22	5.80
DZMM-AM (630), from the Philippines	G4, 24 (Ku)	6.20
La Cadena CNN Radio Noticias (CNN Radio News in Sp.)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA–Asian Radio	GE1, 22 (Ku-band)	5.80
Radio Maria (Italian)–religious programming	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Tropical	GE1, 4	7.60
SRC AM Network	E2, 1	7.38
SRC FM Network	E2, 1	5.41/5.58 (DS)
Unidentified station-foreign language	GE-1,22 (Ku-band)	7.78
WCRP-FM (88.1) Guyama, PR (Spanish)–religious	G4, 6	6.53
XEWA-AM (540) San Luis Potosi, Mexico (Spanish)	M2, 8	7.38
XEW-AM (900) Mexico City, DF Mexico (Spanish), ID-*La Voz de la America Latina*–contemp. music	M2, 14	7.38

Jazz Music

KLON-FM (88.1) Long Beach, CA., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio–*New Age of Jazz*	G5, 21	7.38/7.56 (DS)

News and Information Programming

Broadcast News	E2, 1	5.78
Business Radio Network	C4, 10	8.06 (N)
Cable Radio Network	G5, 2	7.24 (N)
	C1, 21	7.30
CNN Headline News	G5, 22	7.58
CNN Radio News	GE3, 9	5.62
	G5, 5	7.58
	G5, 22	6.30
The News Station– all news format	GE3, 24	7.38, 7.56
USA Radio Network–news, talk and information	GE3, 13	5.01 (ch 1), 5.20 (ch 2)
Virginia News Service	G5,11	5.94
WCBS-AM (880) New York, NY–news	G7, 19	7.38
WCCO-AM (830) Minneapolis, MN	G6, 15	6.20

Religious Programming

Ambassasor Inspirational Radio	GE3, 15	5.96, 6.48
Brother Staire Radio	G5, 6	6.48
KHCB-FM (105.7) Houston, TX	C1, 10	7.28
Salem Radio Network	GE3,17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WHME-FM (103.1) South Bend, IN, ID-*Harvest FM*	G4, 15	5.58/5.78
WROL-AM (950) Boston, MA (occasional Spanish)	GE3, 3	6.20
Z-music–Christian rock	G1R, 6	7.38/7.56

Rock Music

SuperAudio–*Classic Hits*-oldies	G5, 21	8.10/8.30 (DS)
SuperAudio–*Prime Demo*-mellow rock	G5, 21	5.22/5.40 (DS)

Shortwave Broadcasters via Satellite

C-SPAN Audio 1: Various shortwave broadcasters	C3, 7	5.20
C-SPAN Audio 2: British Broadcasting Corporation (BBC)	C3, 7	5.41
Deutsche Welle	GE1, 22	7.38, 7.56, 7.74, 7.92
Radio Dubai United Arab Emirates (Arabic)	G7, 10	7.48
RAI Satelradio Italy (Italian)	G7, 14	7.38
WEWN–Worldwide Catholic Radio, Vandiver, AL	G1R, 11	5.40 (English), 5.58 (Spanish)
WHRA Africa/Middle East–World Harvest R., South Bend, IN	G4, 15	7.82
WHRI Americas–World Harvest Radio, South Bend, IN	G4, 15	7.46
WHRI Europe –World Harvest Radio, South Bend, IN	G4, 15	7.55
KWHR Asia–World Harvest Radio, South Bend, IN	G4, 15	7.64
KWHR South Pacific–World Harvest R., South Bend, IN	G4, 15	7.73
World Radio Network: WRN1 North America	G5, 6	6.80
World Radio Network: WRN2 North America	G5, 6	6.20 (Multi-lingual)

Sports

New York Yankees Spanish Language S.A.P. (occ)	C4, 6	6.20
Prime Sports Radio–sports talk and information	GE3, 24	5.80

Speciality Formats

Aries In Touch Reading Service	C4,10	7.87
California State Legislature audio	S4, 24	6.80
Colorado Talking Book Network	C1,3	5.60
Ozarkana Radio Network	G4, 6	7.96
SuperAudio–Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
Weather Channel–background music	C3, 13	7.78
Wisdom Radio Network	GE1, 12	7.10
Yesterday USA–nostalgia radio	G5, 7	6.80
	G1R, 24	7.38

Talk Programming

American Freedom radio network	GE1, 7	5.80
Amerinet Broadcasting	G1R, 17	5.58
For the People radio network	C1, 6	7.50
Friday Night Live (Friday 9 p.m.ET)	SBS6, 13B (Ku)	6.20
Omega Radio Network	GE1, 6	7.56
Orbit 7 Radio Network	C1, 14	7.48
Radio America Network	C1, 2	5.58
Republic Radio International	G7, 14	7.70
Talk America Radio Network #1–talk programs	GE3, 9	6.80
Talk America Radio Network #2–talk programs	GE3, 9	5.41
Truth Radio	GE1, 7	7.56
TVRO.NET (featuring Keith Lamonica)	S4, 16	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network–tech talk	SBS6, 13B (Ku)	6.20 (network is active when Megabingo is present)
WWTN-FM (99.7) Manchester, TN–news and talk	G5, 18	7.38, 7.56

Variety Programming

CBM-AM (940) Montreal, PQ Canada–variety/fine arts	E2, 1	6.12
KBVA-FM (106.5) Bella Vista, AR., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSL-AM (1160) Salt Lake City, UT–news/talk/country (*Road Gang*-overnight)/BYU Sports	C1, 6	5.58
West Virginia Public Radio	GE1, 12	7.74
WHVN-AM (1240) Charlotte, NC–religious/WIST-AM (550) Statesville, NC–country (The two stations above are on at varous times)	G1R, 17	7.92
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public R), ID-*Concert 90*	C4, 10	8.26 (N)

World Radio History

Satellite Radio Guide/SCPC Services Guide

FM SQUARED (FM²) AUDIO SERVICES

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

GE-3 Transponder 13 (C-band)

Ambassador Inspirational Radio	1.410, 4.470 and 4.650 MHz
Blank audio carriers	1.050 and 3.570 MHz
Focus on the Family	1.230 MHz
Information Radio Network	3.390 MHz
International Broadcasting Network (IBN)	4.830 MHz
USA Radio Network	5.010 (ch 1) and 5.200 MHz (ch 2)
Various Religious Programs (no common ministry)	.330 and 3.750 MHz
VCY/America (channel 1)	.510 MHz
VCY/America (channel 2)	.780 MHz

GE-3 Transponder 17 (C-band)

Blank audio carriers	1.770 and 3.570 MHz
Data Transmission	.800 MHz
Focus on the Family	1.050 and 1.400 MHz
In-Touch–religious	4.470 MHz
Salem Satellite Network	4.650, 4.840 and 5.010 MHz
SRN News	.330 MHz
KDMM-AM (1150) Highland Park, TX–Indian, Vietnamese and Chinese multi-ethnic format	1.280 MHz

Galaxy 4 Transponder 3 (Ku-band)

Blank Audio Carriers	1.000, 2.060, 3.250, 3.620, 4.200 and 4.450 MHz
Data transmissions	2.950, 3.070 and 3.190 MHz
AP Network News	3.530 MHz
In-Store audio network ads (various companies)	.710, .810, .910, 1.150, 1.260, 3.440, 3.700, 3.800, 3.880 and 3.970 MHz
Muzak Services	.150, .270, .390, .510, 1.360, 1.480, 1.600, 1.720, 1.840, 1.960, 2.190, 2.310, 2.440, 2.560, 2.680, 2.800, 3.340, 4.080, 4.200 and 4.340 MHz

Galaxy 4 Transponder 4 (Ku-band)

Blank Audio Carriers	.960 and 1.350 MHz
Data Transmissions	.255, .300, .350, .470, .575, .650, .710, .740, .765, .845, .890, .930, 1.120, and 1.225 MHz

Galaxy 4 Transponder 16 (Ku-band)

Blank audio carriers	2.280 MHz
Data transmissions	.645, 2.140, 2.350, 2.730, 3.205, 3.245, 3.265, 3.475, 3.735 and 3.970 MHz
In-Store audio networks	.150, .270, .390, .755, .870, .990, 1.110, 1.230, 1.350, 1.470, 1.590, 1.710, 1.965 and 2.070 MHz

Anik E1 Transponder 6 (Ku-band)

Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

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

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

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

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

1204.90 (75.1)	*Radio Marti*–U.S. Information Agency Spanish language radio service to Cuba

GE-2 Transponder-Vertical 13 (C-band)

1178.70 (81.3)	NASA space shuttle audio

GE-3 Transponder-Horizontal 13 (C-band)

1207.90 (52.1)	Wisconsin Voice of Christian Youth (VCY) America Radio Network–religious programming
1204.45 (55.55)	KJAV-FM (104.9) Alamo, Tex–Spanish language religious programming/ *Nuevo Radio Christiana Network*
1204.25 (55.75)	Wisconsin Voice of Christian Youth (VCY) America Radio Network–religious programming
1204.00 (56.0)	SRN (Salem Radio Network) News
1201.50 (58.5)	Wisconsin Voice of Christian Youth (VCY) America Radio Network–religious programming
1201.30 (58.7)	Wisconsin Voice of Christian Youth (VCY) America Radio Network–religious programming

Galaxy 4 Transponder 1-Horizontal (C-band)

1443.80 (56.2)	Voice of Free China (International Shortwave Broacaster) Taipei, Taiwan
1443.60 (56.4)	KBLA-AM (1580) Santa Monica, CA–*Radio Korea*
1443.40 (56.6)	Voice of Free China (International Shortwave Broadcaster) Taipei, Taiwan
1438.30 (61.7)	WWRV-AM (1330) New York, NY–Spanish religious programming and music, ID–*Radio Vision Christiana de Internacional*
1436.50 (63.5)	West Virginia Metro News–network news feeds

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0)	Illinois News Network–network news feeds
1404.80 (55.2)	KOA-AM (850)/KTLK-AM (760) Denver, Colo–news and talk radio/Colorado Rockies MLB radio network
1404.60 (55.4)	WGN-AM (720) Chicago, IL–news and talk radio/Chicago Cubs MLB radio network
1404.40 (55.6)	Illinois News Network–network news feeds
1404.20 (55.8)	Tribune Radio Networks/Wisconsin Radio Network
1402.70 (57.3)	WLAC-AM (1510) Nashville, TN–news and talk/*Road Gang* trucker program (overnight)
1402.00 (58.0)	Occasional Audio
1401.80 (58.2)	Michigan News Network–network news feeds
1401.50 (58.5)	Occasional audio/Agrinet–Agriculture news/USA Radio Network–network feeds
1399.60 (60.4)	Talk America Radio Network 1–talk radio
1399.20 (60.8)	Talk America Radio Network 2–talk radio
1399.00 (61.0)	Sports Byline USA/Sports Byline Weekend/ *On Computers* radio show
1398.80 (61.2)	United Broadcasting radio network–talk radio
1398.50 (61.5)	Occasional audio

(Continued on Page 38)

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Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

(Continued from Page 37)

1398.30 (61.7)	WJZK-FM (104.1) La Grange, GA– smooth jazz format/WSB-AM (750) Atlanta, GA–news/talk/Atlanta Braves MLB radio network
1398.00 (62.0)	Occasional audio
1397.80 (62.2)	Occasional audio
1397.50 (62.5)	Minnesota Talking Book Radio Network–reading service for the blind
1397.30 (62.7)	Occasional audio
1397.10 (62.9)	WTMJ-AM (620) Milwaukee, WI–talk radio/Wisconsin Radio Network/Milwaukee Brewers MLB radio network
1396.90 (63.1)	KRLD-AM (1080) Dallas, TX–news/talk/Texas Rangers MLB radio network
1396.70 (63.3)	Radio America/American Entertainment Network
1396.40 (63.4)	Georgia Network News (GNN)–network news feeds
1396.20 (63.8)	WCNN-AM (680) Atlanta, GA–all sports talk radio
1396.00 (64.0)	WHO-AM (1040) Des Moines, IA–talk radio/Iowa News Network–network news feeds
1395.80 (64.2)	WTMJ-AM (620) Milwaukee, WI–talk radio/Wisconsin Radio Network–network news feeds/Milwaukee Brewers MLB radio network
1395.60 (64.4)	WGST-AM/FM (640/105.7) Atlanta, GA ID *Planet Radio*–news and talk radio
1395.40 (64.6)	Michigan News Network–network news feeds
1395.00 (65.0)	Occasional audio
1394.70 (65.3)	WJR-AM (760) Detroit, MI–news and talk radio/Michigan News Network/Detroit Tigers MLB radio network
1394.50 (65.5)	XEPRS-AM (1090) Tijuana, Mexico–Spanish language programming/California Angels MLB Network (Spanish)
1394.30 (65.7)	Michigan News Network
1384.40 (75.6)	KOA-AM (850)/KTLK-AM (760) Denver, CO–news and talk radio/Colorado Rockies MLB radio network
1384.20 (75.8)	WSB-AM (750) Atlanta, GA–news and talk radio/Atlanta Braves MLB radio network
1383.70 (76.3)	Motor Racing Network (occasional audio) NASCAR racing
1383.40 (76.6)	Occasional audio
1383.10 (76.9)	KIRO-AM (710) Seattle, WA–news and talk radio/Seattle Mariners MLB radio network
1382.90 (77.1)	Michigan News Network–network news feeds
1382.60 (77.4)	Soldiers Radio Satellite (SRS) network–U.S. Army information and entertainment radio
1382.00 (78.0)	Tennessee Radio Network–network news feeds
1381.80 (78.2)	WHO-AM (1040) Des Moines, IA–news and talk radio/Iowa News Network–network news feeds
1381.60 (78.4)	KEX-AM (1190) Portland, OR–news and talk radio
1381.40 (78.6)	Occasional audio
1381.20 (78.8)	KJR-AM (950) Seattle, WA– sports talk radio
1377.10 (82.9)	In-Touch–reading service for the blind
1376.00 (84.0)	Kansas Audio Reader Network–reading service for the blind
1375.40 (84.6)	USA Radio Network/Agrinet Agriculture news service

Galaxy 4 Transponder 4-Vertical (C-band)

1376.00 (64.0)	Data Transmissions

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1)	WCRP-FM (88.1) Guayama, PR–Spanish language religious programming

Anik E2 Transponder 1-Horizontal (C-band)

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

Anik E2 Transponder 7-Horizontal (C-band)

1326.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio–North (Eastern Arctic) service

Anik E2 Transponder 13-Horizontal (C-band)

1206.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio–North (MacKenzie) service
1205.00 (54.5)	Canadian Broadcasting Corporation (CBS) Radio–Occasional feeds/events

Anik E2 Transponder 17-Horizontal (C-band)

1126.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio–North (Western Arctic) service
1125.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio–North (Newfoundland and Labrador) service

Anik E2 Transponder 23-Horizontal (C-band)

1006.00 (54.0)	Societe Radio-Canada (SRC) Radio–AM Network
1005.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio-North (Yukon) service

Anik E1 Transponder 21-Horizontal (C-band)

1036.70 (63.3)	In-store music
1037.00 (63.0)	In-store music
1037.50 (62.5)	In-store music

SBS5 Transponder 2-Horizontal (Ku-band)

1013.60 (80.4)	Wal-Mart in-store network (English)
1013.20 (80.8)	Wal-Mart in-store network (English)
1012.80 (81.2)	Sam's Wholesale Club in-store network (English)
1004.00 (90.0)	Wal-Mart in-store network (English)
1003.60 (90.4)	Wal-Mart in-store network (English and Spanish ads)
1003.20 (90.8)	Sam's Wholesale Club in-store network (English)
1002.80 (91.2)	Wal-Mart In-Store Network (English)

SBS5 Transponder 12-Vertical (Ku-band)

1095.00 (91.0)	Russian-American Radio Network

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2)	RFD Radio Service
1404.60 (55.4)	Wyoming News Network–network news feeds/Colorado Rockies MLB radio network
1400.60 (59.4)	Learfield Communications
1400.40 (59.6)	Learfield Communications/Missouri Net
1400.20 (59.8)	Occasional audio/Data transmissions
1400.00 (60.0)	Learfield Communications
1396.60 (63.4)	Kansas Information Network/Kansas Agnet–network news feeds
1396.20 (63.8)	Missouri Network/St. Louis Cardinals MLB radio network
1396.00 (64.0)	Occasional audio/Red River Farm Network
1395.70 (64.3)	Missouri Net/WIBW-AM (580) Topeka, KS–country music/Kansas City Royals MLB radio network
1386.40 (73.6)	Learfield Communications
1386.20 (73.8)	Radio Iowa
1386.00 (74.0)	United broadcasting Network–talk radio
1384.60 (75.4)	Capitol Radio Network
1384.00 (76.0)	Occasional audio/ABC Direction Network–network news feeds
1383.80 (76.2)	Occasional audio
1383.40 (76.6)	Capitol Radio Network
1382.90 (77.1)	Missourinet
1382.50 (77.5)	Virginia News Network–network news feeds
1382.10 (77.9)	Learfield Communications/Missourinet

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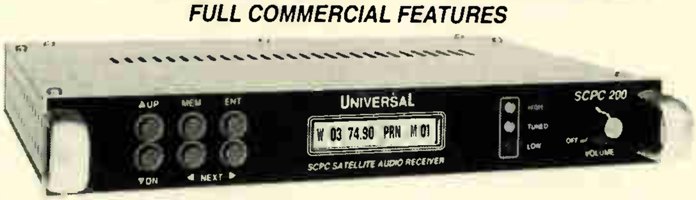

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World Radio History

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

EchoStar 3 61.5°West

This direct-to-home satellite operates in the 12.2-12.7 GHz BSS band and delivers local television channels and international channels.

SBS 6 (SBS6) 74° West

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

SBS 4 (SBS4) 77° W. (Inclined orbit)

Transponders 2-10 on this satellite are used for NBC feeds.

1	11725-H	Data transmissions

Satcom K2 (K2) 82° West

1	11729-H	Data transmissions
15	12142-H	GE Americom K2 ID slate

Spacenet 3R (S3R) 83° West

19	11740-H	Unknown user [digital video]
22	11980-H	NY Network (occ)/SUNY (occ)
23	12060-H	Oregon Educational Network (occ)

GE-2 (GE2) 85° West

Primestar direct-to-home programming uses trasponders 1-24 (11.7-12.2 GHz FSS band). These transmissions are encrypted and compressed using the Digicipher system.

GE-3 (GE3) 87° West

1	11720-H	Data transmissions
2	11740-V	Data transmissions
3	11760-H	Occ video
4	11780-V	Occ video
5	11800-H	Unknown user [digital video]/ Data transmissions
6	11820-V	Unknown user [digital video]/ Data transmissions
7	11840-H	Occ video
8	11860-V	Occ video
9	11880-H	CNN Newsource [LEITCH]
10	11900-V	National Technology University (NTU) [Spectrumsaver]
11	11920-H	Data transmissions
13	11960-H	Occ video
14	11980-V	CNN Newsource (secondary feeds) (occ)
15	12000-H	Occ video
16	12020-V	Occ video
17	12040-H	Occ video
18	12060-V	PBS leased digital services (High Definition TV testing)
19	12080-H	PBS leased analog services (occ) /PBS *The Business Channel (occ)*
20	12100-V	PBS adult learning service (ALS)
21	12120-H	PBS leased analog services (occ)
22	12140-V	PBS leased digital services/ Indiana Higher Education [Spectrumsaver]
23	12160-H	PBS stations/regionals 1, 2 and 3 [Digicipher 2 SCPC]
24	12180-H	PBS six-channel affiliate feeds [Digicipher 2] [4DTV]

Telstar 4 (T4) 89°West

1	11730-V	Loral Skynet services [digital]
2	11743-H	Loral Skynet services [digital]
3	11790-V	Loral Skynet services [digital]
4	11803-H	Loral Skynet services [digital]
5	11850-V	Loral Skynet services [digital]
6	11863-H	Georgia Public TV [4DTV]
7	11910-V	Data transmissions/Unknown user [digital video]
8	11923-H	Data transmissions
9	11971-V	Occ video (half-transponders common)
10	11984-H	Occ video (half-transponders common)
11	12033-V	South Carolina Educational TV [4DTV]
12	12046-H	Occ video (half-transponders common)
13	12095-V	Occ video (half-transponders common)
14	12108-H	Louisiana Public TV [Digicipher]/ LeHigh University [Spetrumsaver]
15	12157-V	DMX for Business [digital data]/ Muslim TV Ahmadiyya (Powervu)

Galaxy 7 (K7) 91° West

TCI Headend in the Sky [digicipher] uses transponders 1, 4, 6-7, 9-10, 12-13, 15, 19, and 21-22. Using a 4DTV receiver, an unidentified digital audio service (40 channels: 820-859) has been observed on this satellite.

2	11750-H	Data transmissions/Unknown user [digital video]
5	11810-H	Data transmissions
8	11870-H	Data transmissions
11	11930-H	Westcott Communications? [Spectrumsaver]
14	11990-H	Occ video (half transponders common)
16	12020-V	Occ video
17	12050-H	Westcott Communications [Spectrumsaver] (lower half transponder)
17	12050-H	National Weather Networks (upper half transponder occasional)
18	12050-H	Westcott Communications [Spectrumsaver]
20	12110-H	Data transmissions
23	12170-H	Data transmissions/Unknown user [digital video]
24	12170-V	Data transmissions

Galaxy 3R (G3R) 95° West

Currently being re-pointed towards the Continental United States. The Ku-band (11.450-11.750 GHz) side will provide some additional DirecTV United States capacity to be used for international programming and other services that are to be announced.

Telstar 5 (T5) 97° West

1	11728.5-V	Data transmissions
2	11735.0-H	Data transmissions
3	11789.5-V	Occ video (half transponders common)
4	11796.0-H	Data transmissions
5	11836.0-V	Unknown user [digital video]
7	11867.0-V	Unknown user [digital video]
8	11873.5-H	Unknown user [digital video]
9	11898.0-V	Occ video
10	11904.5-H	Unknown user [digital video]
11	11929.0-V	Occ video
12	11935.5-H	Occ video
13	11960.0-V	Occ video
15	11991.0-V	Unknown user [digital video]
17	12022.0-V	Occ video
18	12028.5-H	Occ video
19	12053.0-V	Occ video
20	12059.5-H	Occ video
21	12084.0-V	Unknown user [digital video]
23	12115.0-V	Unknown user [digital video]
24	12121.5-V	Occ video
25	12148.0-V	Occ video
26	12152.5-H	T.C.I. [Digicipher]
27	12177.0-V	Asian TV Network/Business TV [MPEG2/DVB]

Galaxy 4 (K4) 99° West

1	11720-H	Data transmissions
2	11750-V	Data transmissions
3	11750-H	FM² services/Muzak/Data transmissions
4	11780-H	FM²/FM³ services/Planet Connect computer service (19.2 kbps)/ Other data transmissions
5	11810-V	Data transmissions
6	11810-H	Unknown user [digital video]
7	11840-H	Unknown user [digital video]
8	11870-V	Data transmissions
9	11870-H	Data transmissions
10	11900-H	CNN Airport Network [Powervu]/ Data transmissions
11	11930-V	Occ video (half-transponders common)/The Asian Network (TAN) (occ)
12	11930-H	Occ video
13	11960-H	CCTV-4 (China)
14	11990-V	Data transmissions
15	11990-H	Fordstar [Digicipher 2]
16	12020-H	FM² services
17	12050-V	CBS Newsnet and affiliate feeds (half-transponders)–mixture of digital SNG and analog feeds
18	12050-H	Honk Kong TVB Jade Channel (Chinese) [videocrypt]
19	12080-H	DirectPC [digital]
20	12110-V	Data transmissions
21	12110-H	Bob Jones University home education (occ)/Occ video
22	12140-H	Data transmissions/Unknown user [digital video]
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)–mixture of digital SNG and analog feeds
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

Transponders 19 (11740-H), 21 (11900-H), and 23 (12060-H) have failed on this satellite.

20	11820-H	Data transmissions
22	11980-H	Data transmissions
24	12140-H	E.M.G. courses [Digital video] (upper half)

DBS-1 101.2° W./DBS-2 & DBS-3 100.8° W.

These satellites provide direct-to-home entertainment and operate in the 12.2-12.7 GHz BSS range.

GE-1 (GE1)103° West

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

GSTAR-4 (GST4) 105° West

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

Anik E2 (A1) 107.3° West

Expressvu DBS service uses transponders 1, 2, 11, 13-14, 22-26, and 31-32. Star Choice DBS service uses transponders 9-10, 16 and 27-29.

3	11778-V	CanCom [digital video]
4	11804-V	Shaw [digital video]
5	11839-V	Canadian Parliamentary Access Channel, Youth TV E&W, Vision TV, CHSC Shopping [digital video]
6	11865-V	Moviepix!; The Movie Network [digital video]
7	11900-V	Rogers Network [digital video]
8	11926-V	Rogers Network [digital video]
12	12048-V	Saskatchewan CommunicaNetwork [digital]
15	12144-V	Telesat Canada stationkeeping (GLACS)
17	11730-H	Bravo Canada, MuchMusic Canada [digital video]
18	11756-H	Discovery Channel Canada/Life Network/The Sports Network/ CBC Newsworld [digital]
19	11791-H	Showcase E&W [digital video]
20	11817-H	Superchannel, Moviemax, Family Channel [digital video]
21	11852-H	TV Ontario, TFO (French), Ontario Legislature [digicipher]
30	12122-H	Telesat Canada stationkeeping (GLACS)

Solidaridad 1 SD1 109.2° West

No video has been seen on any Solidaridad 1 Ku-band transponder.

Anik E1 (A2) 111° West

Note: Due to the loss of the south solar panel on March 26, 1996, Anik E1 Ku-band transponders 7-8, 11-16, 21-26, and 29-32 are off indefinitely according to Telesat officials.

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Data transmissions
5	11839-V	DirectPC [digital]
6	11865-V	NovaNet FM² Services
9	11961-V	Occ video
10	11987-V	Occ video
17	11730-H	Woman's Television Network E&W [digital video]
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	New Country Network, Access Network of Alberta, Knowledge Network [digital video]
28	12061-H	RDI feeds

Solidaridad 2 (SD2) 112.9° West

Sky TV direct-to-home service uses transponders 1-4, 6-10, 14-16 on Solidaridad 2.

Anik C3 (C3) 114.9° W. (Inclined Orbit)

This satellite rarely has any Ku-band video transmissions.

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

No video has been seen on any Morelos 2 Ku-band transponder.

Anik C1 (C1) 118.6° West

32	12183-H	Occ video

EchoStar 1/2 & Tempo 1 119°W

These direct-to-home satellites operate in the 12.2-12.7 GHz BSS band.

SBS 5 (SBS5) 123° West

1	11725-H	Unknown user [digital video]
2	11780-H	SCPC services/Data transmissions
3	11823-H	Data transmissions
5	11921-H	Data transmissions
6	11970-H	Data transmissions
7	12019-H	Data transmissions
8	12068-H	Data transmissions/Unknown user [digital video]
9	12117-H	Data transmissions/Unknown user [digital video]
10	12166-H	Occ video
11	11748-V	Data transmissions
12	11898-V	WMNB Russian-American TV [inverted video]
13	11994-V	Data transmissions
14	12141-V	Data transmissions/USC TV [digital]/CSU-Chico [digital]

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Satellite Transponder Guide

By Robert Smathers

	Galaxy 6 (G6) 74°	Spacenet 3R (S3R) 83°	GE-2 (GE2) 85°	GE-3 (GE3) 87°	Telstar 4 (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 5 (T5) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	GE-1 (GE1) 103°
1	Tokyo BS New York feeds	(none)	o/v	Associated Press TV [MPEG/DVB]	Natl Jewish TV/o/v	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	Telequest DBS [Digicipher]	SCPC services	Data Transmissions	o/v
2	o/v	(none)	o/v	American Independent Network (AIN) [CLI Spectrumsaver]	Data Transmissions	CBS West [occ VC1]	TVN Theatre 2 [V2+]	Telequest DBS [Digicipher]	Buena Vista TV distribution	STARZ! 2 [V2+]	Data Transmissions AFRTS [Powervu]
3	Gospel Music Television	(none)	o/v	WSBK-UPN Boston [V2+]	XXXplore TV (adult) [V2+]	Action PPV [V2+]	TVN Theatre 3 [V2+]	Telequest DBS [Digicipher]	SCPC services	Data Transmissions	PBS Alaska/Caribbean 7-channel [4DTV]
4	Horse Racing [digital video]	(none)	La Cadena de Milagro	Nebraska Educational TV (NETV) [4DTV]	Shop at Home	fX East [V2+]	TVN Theatre 4 [V2+]	Telequest DBS [Digicipher]	Data Transmissions	Encore- Westerns [V2+]	FOX Sports Ohio/FOX Sports Cincinnati [V2+]
5	CNN feeds (o/v)	(none)	NASA Contract Channel	Univision [V2+]	FOX feeds	fX East/West [Wegner]	TVN Theatre 5 [V2+]	Telequest DBS [Digicipher]	4 Media Company feeds	Data Transmissions	Hero Teleport (GEMS/HTV) [4DTV]
6	NHK (TV Japan) feeds	(none)	Kuwait TV	(none)	Oui TV (adult) [V2+]	Game Show Network [V2+]	TVN Theatre 6/TVN Promo [V2+]	Telequest DBS [Digicipher]	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	WNBC-NBC New York (PT24E) [V2+]
7	Video Catalog Channel (VCC)	(none)	Data Transmissions	Data Transmissions	Adam and Eve/Spice (adult)/Hot Spice [Digicipher]	The Golf Channel [V2+]	Guthy-Renker TV (infomercials)/TVN Theatre 7 [V2+]	El Comandante Horse Racing/o/v	o/v	(none)	Cornerstone TV (Rel)
8	Horse Racing [digital video]	(none)	Data Transmissions	(none)	ABC feeds East [LEITCH]	o/v	Pandamerica Home Shopping/TVN Theatre 8 [V2+]	ABC NewsOne Channel	Telemundo/Telenoticias [PowerVu]	KOMO- ABC Seattle (PT24W) [V2+]	Fox Sports Chicago [V2+]
9	MuchMusic U.S. [V2+]	(none)	NASA TV	WPIX-Ind New York [V2+]	Horse Racing [digital video]/o/v	CBS Eye on People Network [PowerVu]	TVN Theatre 9-adulTVision (adult) [V2+]	FOX Feeds	WB Dom TV/Network	Data Transmissions	Fox Sports South [V2+]
10	Horse Racing [digital video]	(none)	Data Transmissions	(none)	FOX News Edge	United Arab Emirates TV Dubai	Horse Racing [digital video]/o/v	FOX Feeds	o/v	FOXNet (PT24E/W) [V2+]	WKRN-ABC Nashville, TN (PT24E) [V2+]
11	o/v	(none)	o/v	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	o/v	Exxxtasy (adult) [V2+]	o/v	STARZ! East [V2+]	Univision [digital video]
12	TV Asia [PowerVu]/Horse Racing [digital video]	(none)	Data Transmissions	Data Transmissions	Horse Racing [digital video]	Romance Classics [V2+]	RAI TV/Infomercials	Exotica (adult) [V2+]	o/v	Infomercials	Wisdom Network
13	RTPi (Portugal)	DayStar TV Network	Data Transmissions	SCPC/FM2 services	FOX feeds West	Ovation/CSN/Kaleidoscope/Bloomberg/-Box [Digicipher]	Horse Racing [digital video]/o/v	FOX feeds East	o/v	Data Transmissions	Fox Sports South/Sports Alternate (occ)/o/v
14	Horse Racing [digital video]	(none)	USIA Worldnet TV/VOA radio [PowerVu]	CNN feeds	ABC feeds East [LEITCH]	Independent Film Channel [V2+]	X!/XXXplore Promo (adult)	True Blue (adult) [V2+]	o/v	WWOR-UPN New York [V2+]	Fox Sports New England [V2+]
15	Midwest Sports Channel [V2+]/MSC Alt [Powervu]	(none)	Data Transmissions	KTLA-Ind Los Angeles [V2+]	The X! Channel (adult) [V2+]	Your Choice TV [Digicipher]	Infomercials/o/v	Paramount Syndication/o/v	World Harvest TV (Rel)	Data Transmissions	Southern Entertainement TV (SET)
16	Horse Racing [digital video]/o/v	(none)	Data Transmissions	CNN International/CNN fN [V2+]	Eurotica (adult) [V2+]	Access Television/The Recovery Network [Digicipher]	HBO 2 East [V2+]	UPN Network/o/v	CBS West [occ VC1]	NPS Promo Channel	Fox Sports Bay Area [V2+]
17	o/v	(none)	Data Transmissions	FM2 services	FOX feeds	Unknown user [digital video]	Cinemax 2 East [V2+]	o/v	CBS feeds [occ VC1]/WB Network (occ)	Data Transmissions	Fox Sports Alternates (occ)/o/v
18	EWTN International/Alabama Cable Network [Powervu]	(none)	o/v	fXM-Movies from Fox [V2+]	PBS National Schedule	Teleport Minnesota/CBS feeds/o/v	Inforamerica TV (Informercials)	o/v	CBS feeds/ Eyemark syndicated feeds	STARZ! West [V2+]	Fox Sports New York [V2+]
19	University Network-Dr. Gene Scott (Rel)	HTS Alternate	Data Transmissions	Fox Sports Detroit [V2+]	X! Promo (adult)	CBS East [occ VC1]	HBO 3 [V2+]	America's Collectibles Network	CBS East [occ VC1]	(none)	America's Voice TV
20	o/v	(none)	o/v	Gem Shopping Channel	Worldwide TV New (WTN) feeds	FOX News Channel	HBO 2 West [V2+]	o/v	CBS East [occ VC1]	(none)	AFRTS [Powervu]
21	o/v		o/v	Fox Sports World [V2+]	ABC feeds West [LEITCH]	BET on Jazz	Superstar Programming Promo/o/v	ABC West Hot Backup [LEITCH]	CBS feeds/o/v	Data Transmissions	Univision feeds (occ)
22	Horse Racing [digital video]	(none)	Arab Network of America (ANA)	(none)	ABC feeds East [LEITCH]	(none)	Horse Racing [digital video]	ABC East Hot Backup [LEITCH]	o/v	(none)	Deutsche Welle TV
23	Worship TV/Praise TV (Rel) [MPEG2/DVB]	Home Team Sports (HTS)	NHK Secondary Feeds	(none)	o/v	fXM-Movies from Fox [V2+]	3 Angels Broadcasting	o/v	SCOLA [Wegener]/LDS TV (occ)/B&W Network	Data Transmissions	Outlaw Music Channel
24	Horse Racing [digital video]/o/v	(none)	o/v	America One	o/v	Intl Channel/Encore Themed Channels [4DTV]	Horse Racing [digital video]/o/v	o/v	CBS Newspath	KPIX-CBS San Francisco (PT24W) [V2+]	WSEE-CBS Erie, PA (PT24E) [V2+]

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Satellite Transponder Guide

By Robert Smathers

Anik E2 (A1) 107.3°	Solidaridad 1 (SD1) 109.2°	Telesat E1 (A2) 111°	Solidaridad 2 (SD2) 112.9°	Morelos 2 (M2) 116.8°	Galaxy 9 (G9) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133°	Satcom C4 (F4) 135°	Satcom C1 (F1) 137°	
CBC-H English Eastern	Data Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	o/v	Disney East [V2+]	Family Channel-E/W/FIT TV/IFE [PowerVu]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Various Fox Sports Nets [V2+]	1
o/v	Data Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	o/v	Playboy (adult) [V2+]	The Learning Channel [V2+]	Univision/Galavision [PowerVu]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
Unknown user [digital]	SCPC services	Data Transmissions	Data Transmissions	Data Transmissions	NHK TV	Trinity Broadcasting (Rel)	Viewer's Choice PPV [digital video]	Encore Themed Services [4DTV]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
Cancom [PowerVu]	Data Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	General Communication [digital video]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food/Outdoor Life Networks [Digicipher]	Lifetime East [V2+]	Data Transmissions	4
CBC feeds o/v	(none)	Data Transmissions	o/v	Data Transmissions	Showtime/TMC/SD-C(W) [4DTV]/VH-1(W)[Powervu]	CNN [V2+]	Odyssey (Rel)	Classic Arts Showcase	Product Information Network	KDVR-Fox Denver [V2+]	5
o/v	Data Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	o/v	WTBS-Ind Atlanta [V2+]	Court TV/NW Cable News [4DTV]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
CBC-M feeds o/v	Unknown User [digital video]	Data Transmissions	Unknown user[digital]/Data Transmissions	Data Transmissions	TVN Digital Theaters 1-8 [4DTV]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN FOX Sports West [V2+]	7
o/v	Data Transmissions	(Inactive)	Data Transmissions	XHGC canal 5	General Communication [digital video]	HBO West [V2+]	Q2	Cartoon Network [V2+]	Prevue Channel	NBC-East	8
CBC-B English Atlantic	Multivision DBS [Digicipher]	(Inactive)	(none)	Unknown User [digital video]	TVN Digital Theaters 9-16 [4DTV]	ESPN [V2+]	Music Choice [4DTV]	ESPN2 Blackout [V2+]/SAH	QVC Network	FOX Sports Net Base 1	9
Cancom [PowerVu]	Mexican Government Channel	(Inactive)	(none)	XEIPN canal 11	TVN Digital Theaters 17-24 [4DTV]	MOR Music	America's Store	MSNBC [V2+]	Home Shopping Network (HSN)	SSN FOX Sports SW [V2+]	10
CBC-A French [Powervu]	Multivision DBS [Digicipher]	(Inactive)	Data Transmissions	Unknown User [digital video]	TVN Digital Theaters 25-32 [4DTV]	Family Channel East [V2+]	Fox Sports Net Base [V2+]	Eternal Word TV Network (Rel)	SpeedVision	o/v	11
Cancom [PowerVu]	(none)	o/v	(none)	(none)	General Communication [digital video]	Discovery West [V2+]	History Channel [V2+]	Valuevision	(none)	Data Transmissions	12
CBC-C English Pacific	(none)	(Inactive)	(none)	Unknown User [digital video]	TVN Digital Theaters 33-35/GRTV [4DTV]	CNBC [V2+]	The Weather Channel [V2+]	Encore Themed Services [4DTV]	Travel Channel [V2+]	Fox Sports Midwest [V2+]	13
Cancom [PowerVu]	Data Transmissions	o/v	Data Transmissions	XEW canal 2	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Alternate [V2+]/SAH	California Channel [PowerVu]/IFE o/v	KUSA-NBC Denver [V2+]	14
o/v	Multivision DBS [Digicipher]	(Inactive)	Data Transmissions	Unknown user [digital video]	Showtime West [V2+]	HBO East [V2+]	(none)	CNNSI/CNN fn/CNN Intl/T.C.M./CNN Spanish [4DTV]	Animal Planet [V2+]	SC Florida [V2+]	15
[illegible] TV [PowerVu]	Data Transmission	(Inactive)	Data Transmissions	XEIMT Canal 22	General Communication [digital video]	Cinemax West [V2+]	M2 Music Television	Turner Classic Movies [V2+]	Request TV 1 [V2+]	FOX Sports Arizona/Americas [Digicipher]	16
CBC-D feeds o/v	o/v	(Inactive)	(none)	Unknown User [digital video]	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN FOX Sports (alternates) [V2+]	17
Data Transmissions/Unknown user [digital video]	o/v	(Inactive)	(none)	o/v	The Movie Channel West [V2+]	TNN [V2+]	TVLand	HBO/Cinemax [4DTV]	Viewer's Choice [Digicipher]	FOX Sports Rocky Mountain [V2+]	18
Telesat [PowerVu]	Data Transmissions	TV Northern Canada [PowerVu]/Data Transmissions	Data Transmissions	(none)	MTV West [V2+]	USA East [V2+]	Showtime/TMC/SDC (East) [4DTV]	Cinemax East [V2+]	C-SPAN 2 [analog]/CSPAN 3 [digital]	FOXNet [V2+]	19
(Inactive)	(none)	(Inactive)	(none)	Data Transmissions	General Communication [digital video]	BET [V2+]	Jones Computer/GAC/PIN [4DTV]	Home and Garden Network [V2+]	Showtime East 2 [V2+]	Unknown User [digital video]	20
Telesat [PowerVu]	(none)	SCPC services/ Data Transmissions	(none)	Mexican Cable [Digicipher]	ESPNews [V2+]	Knowledge TV	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	FOX Sports West 2 [V2+]	21
(none)	(none)	(Inactive)	Data Transmissions	XHIMT canal 7	o/v	CNN/HN [V2+]	Animal Planet/Discovery Channel Services [Digicipher]	Nostalgia-Good TV Channel [V2+]	FLIX [V2+]	SSN FOX Sports NW [V2+] (occ)	22
CBC-E English o/v	(none)	(Inactive)	Data Transmissions	Mexican Cable [Digicipher]	(none)	A&E [V2+]	E! Entertainment TV (East) [V2+]/E! (West) [PowerVu]	HBO/Cinemax [4DTV]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
CTV [PowerVu]	Unknown User [digital video]	(Inactive)	(none)	XHDF canal 13	General Communication [digital video]	Showtime (East) [V2+]	Digital Music Express Radio (DMX) [digital audio]	Outdoor Channel	CMT [V2+]	SSN Sunshine Network [V2+]	24

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

World Radio History

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

AMSAT OSCAR 10 (Phase 3B, AO-10)
1 14129U 83058B 98067.13245924 -.00000314 00000-0 10000-3 0 5394
2 14129 26.6908 98.6975 6003521 198.5820 123.7121 2.05884260 82826
UoSAT OSCAR 11 (UoSAT-B, UO-B, UoSAT 2, UO-2, UoSAT 11, UO-11)
1 14781U 84021B 98071.90632783 .00000261 00000-0 51724-4 0 420
2 14781 97.8686 47.8972 0010734 222.1339 137.9059 14.69684432750723
Russian *Mir* Space Station
1 16609U 86017A 98074.85319964 .00014684 00000-0 16584-3 0 3351
2 16609 51.6571 158.6054 0005140 120.3737 239.7834 15.62724473689450
Pacsat OSCAR 16 (Microsat-A/Pacsat)
1 20439U 90005D 98073.26284334 .00000047 00000-0 34804-4 0 1335
2 20439 98.5188 157.3745 0011608 130.6492 229.5698 14.30044961424836
DOVE OSCAR 17 (Microsat-B, DO-17)
1 20440U 90005E 98074.27107876 .00000029 00000-0 27711-4 0 1311
2 20440 98.5239 159.4233 0011531 125.4973 234.7287 14.30189271425018
Webersat OSCAR 18 (Microsat-C, WO-18)
1 20441U 90005F 98075.18486004 .00000043 00000-0 33197-4 0 1395
2 20441 98.5230 160.1823 0012056 123.5988 236.6348 14.30154358425143
Lusat OSCAR 19 (Microsat-D, LO-19)
1 20442U 90005G 98072.75135592 .00000039 00000-0 31692-4 0 1369
2 20442 98.5259 158.6273 0012571 130.1904 230.0372 14.30273482424829
Fuji OSCAR 20 (JAS-1B, Fuji-2, FO-20)
1 20480U 90013C 98071.70397334 -.00000042 00000-0 -28471-4 0 364
2 20480 99.0763 348.1742 0541740 129.6521 235.3697 12.83241269379143
Radio Sputnik-12/13 (Cosmos 2123, RS-12/13)
1 21089U 91007A 98074.53302121 .00000056 00000-0 44068-4 0 507
2 21089 82.9199 77.4167 0027551 262.8692 96.9331 13.74093516356427
UoSAT OSCAR 22 (UoSAT-F, UoSAT-5, UO-22)
1 21575U 91050B 98071.58134905 .00000044 00000-0 28681-4 0 8418
2 21575 98.2667 127.1088 0007252 161.1556 198.9904 14.37120312349031
KITSAT OSCAR 23 (Uribyol, KITSAT-A, KITSAT-1, KO-23)
1 22077U 92052B 98072.53671492 -.00000037 00000-0 10000-3 0 7307
2 22077 66.0794 301.2775 0006862 334.0340 26.0319 12.86307628262392
AMRAD OSCAR 27 (EYESAT-A, EYESAT-1, AO-27)
1 22825U 93061C 98075.25690352 .00000032 00000-0 30279-4 0 6277
2 22825 98.5154 148.0146 0008317 157.8274 202.3268 14.27760894232895
ITAMSAT OSCAR 26 (IO-26)
1 22826U 93061D 98074.22327183 .00000031 00000-0 29659-4 0 6227
2 22826 98.5181 147.3314 0008696 162.2248 197.9242 14.27871826232761
KITSAT OSCAR 25 (KITSAT-B, KITSAT-2, KO-25)
1 22828U 93061F 98074.19205976 .00000042 00000-0 33983-4 0 6014
2 22828 98.5136 147.3992 0009855 144.8411 215.3420 14.28220273200898
POSAT OSCAR 28 (PO-28) Not in amateur service at presstime
1 22829U 93061G 98074.21589580 .00000065 00000-0 43135-4 0 6176
2 22829 98.5125 147.5372 0009946 146.7023 213.4784 14.28208060232811
Radio Sputnik 15 (RS-15)
1 23439U 94085A 98074.12085341 -.00000039 00000-0 10000-3 0 2865
2 23439 64.8164 74.7385 0145769 79.3213 282.4059 11.27528411132483
Fuji OSCAR 29 (JAS-2, Fuji-3, FO-29)
1 24278U 96046B 98072.53608502 .00000003 00000-0 39746-4 0 1474
2 24278 98.5158 81.6486 0350654 207.9249 150.2679 13.52638538 77536
Radio Sputnik 16 (RS-16)
1 24744U 97010A 98075.23778679 .00010875 00000-0 33028-3 0 1640
2 24744 97.2571 340.3204 0006227 183.7264 176.3932 15.34227690 57752

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 2 (Standby spacecraft-US 136.860 MHz on continuously, high power)
1 10061U 77048A 98072.29675532 .00000040 00000-0 10000-3 0 9537
2 10061 13.1183 30.0528 0006937 187.3702 243.4040 1.00263834 20802
GOES 3 (Standby spacecraft-US 137.190 MHz on continuously, high power)
1 10953U 78062A 98074.90701597 -.00000102 00000-0 00000+0 0 9079
2 10953 12.1589 33.1567 0004981 235.1750 124.7921 1.00280277 25444
GOES 7 (Standby spacecraft-US)
1 17561U 87022A 98075.23415116 -.00000152 00000-0 10000-3 0 4832
2 17561 4.2860 65.3499 0001942 294.4376 160.7793 1.00280841 23696
GOES 8 (Operational East-US)
1 23051U 94022A 98071.20841834 -.00000273 00000-0 10000-3 0 700
2 23051 0.2192 272.7311 0001149 17.6491 239.3179 1.00280472 21712
GOES 9 (Operational West-US)
1 23581U 95025A 98074.27271631 .00000075 00000-0 00000+0 0 8414
2 23581 0.1716 97.1515 0003331 243.9681 154.3184 1.00277374 10308
GOES 10 (Standby spacecraft-US post launch testing continues)
1 24786U 97019A 98060.33155985 -.00000097 00000-0 00000+0 0 1678
2 24786 0.0463 285.0622 0001527 70.5278 175.3261 1.00270131 3138
ELEKTRO (Operational Russian spacecraft)
1 23327U 94069A 98065.98421594 -.00000130 00000-0 00000+0 0 5063
2 23327 1.3212 88.5358 0002685 253.7272 252.9000 1.00273115 12296
Feng Yun 2B (Operational Chinese spacecraft)
1 24834U 97029A 98073.78861111 -.00000344 00000-0 00000+0 0 1306
2 24834 0.6699 252.5663 0000255 355.0008 313.0607 1.00263920 2774
Meteosat 5 (Operational ESA spacecraft moving to 65 deg East, aka MOP-2)
1 21140U 91015B 98073.20589699 .00000129 00000-0 00000+0 0 4366
2 21140 1.8279 77.8331 0000274 200.3306 350.4897 1.00433785 27975
Meteosat 6 (Operational ESA spacecraft)
1 22912U 93073B 98068.25256366 -.00000030 00000-0 00000+0 0 369
2 22912 0.2156 326.4118 0001437 71.4447 219.9926 1.00278159 14173
Meteosat 7 (Operational ESA spacecraft)
1 24932U 97049B 98074.25664352 -.00000096 00000-0 00000+0 0 1122
2 24932 1.3775 290.6754 0003877 255.9855 68.5230 1.00274385 1951
GMS 4 (Standby Japanese spacecraft, aka Himawari 4)
1 20217U 89070A 98072.38386216 -.00000381 00000-0 10000-3 0 7309
2 20217 3.0395 71.3544 0001566 177.1676 180.4957 1.00278287 31778
GMS 5 Operational Japanese spacecraft, aka Himawari 5)
1 23522U 95011B 98070.36113645 -.00000305 00000-0 10000-3 0 6409
2 23522 0.4292 340.1964 0004202 332.4238 126.4656 1.00268138 10799

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning US spacecraft 137.500 MHz APT)
1 21263U 91032A 98074.89020633 .00000121 00000-0 72808-4 0 7393
2 21263 98.5330 85.7333 0011918 221.3302 138.6975 14.22797737354994
NOAA 14 (Operational afternoon US spacecraft 137.620 MHz APT)
1 23455U 94089A 98074.90746295 .00000190 00000-0 12949-3 0 3957
2 23455 99.0291 32.3253 0008611 249.9378 110.0867 14.11748351165287
Meteor 2-21(Russian spacecraft off at last report)
1 22782U 93055A 98072.43749258 .00000070 00000-0 50123-4 0 6305
2 22782 82.5488 204.4673 0022993 3.2399 356.8904 13.83093237228809
Meteor 3-5 (Operational Russia spacecraft 137.850 MHz APT)
1 21655U 91056A 98068.52693606 .00000051 00000-0 10000-3 0 483
2 21655 82.5504 235.2567 0014367 37.8355 322.3767 13.16859461315639
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 98074.83199372 .00000168 00000-0 11344-3 0 5872
2 23233 98.7412 132.3339 0012517 168.2657 191.8803 14.12895187182727
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 98074.90915214 .00000124 00000-0 90560-4 0 3372
2 23533 98.8526 80.6347 0008279 52.3838 307.8085 14.12843615153532
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 98074.87593915 .00000122 00000-0 89268-4 0 3889
2 24753 98.8970 123.0143 0009513 7.3946 352.7362 14.13044071 48752

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Russian Okean 4 137.400 MHz)
1 23317U 94066A 98074.81292899 .00000041 00000-0 27346-5 0 3139
2 23317 82.5450 193.2919 0026330 167.2982 192.8898 14.74213760184323
SICH-1 (Russian Oceanographic spacecraft 137.400 MHz)
1 23657U 95046A 98073.78725119 .00000281 00000-0 39352-4 0 2398
2 23657 82.5344 335.4567 0028178 142.6522 217.6652 14.73667033136438

World Radio History

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

1983-058B/14129 AMSAT OSCAR 10 (Phase 3B, AO-10)
Communications transponder (linear/inverting): Uplink 435.027-435.179 MHz (CW/LSB)/Downlink 145.825-145.977 MHz (CW/USB)/Beacon: 145.810 MHz (Steady unmodulated carrier)

1984-021B/14781 UoSAT OSCAR 11 (UoSAT-B, UO-B, UoSAT-2, UO-2, UoSAT 11, UO-11)
Downlink 145.825 MHz FM (1200 Baud PSK)/Beacon 2401.500 MHz. The operating schedule: ASCII status–210 seconds, ASCII bulletin–60 seconds, BINARY SEU–30 seconds, ASCII TLM–(90 seconds, ASCII WOD–120 seconds, ASCII bulletin–60 seconds, and BINARY ENG–30 seconds.

1990-005O/20439 Pacsat OSCAR 16 (Microsat-A, Pacsat)
Uplinks 145.900, 145.920, 145.940, and 145.960 MHz FM (1200 bps Manchester FSK) /Downlinks 437.0513 (1200 bps RC-BPSK) and 437.026 secondary (1200 baud PSK) MHz SSB/Beacon 2401.1428 MHz (BPSK). Connect Address: Pacsat-1.

1990-005E/20440 DOVE OSCAR 17 (Microsat-B, DO-17)
Downlink 145.825 MHz FM (1200 baud AFSK)/Beacon 2401.220 MHz. DOVE is presently sending 1200 baud AX.25 (standard packet) and ASCII telemetry about every minute on 2-meters. On S-band it transmits PSK flags continuously and also the same data that is sent on 2-meters. At presstime the 145.825 MHz beacon was reported down.

1990-005F/20441 Webersat OSCAR 18 (Microsat-C, WO-18)
Downlink 437.104 MHz SSB (1200 baud PSK AX.25). At presstime WO-18 was non-operational. WO-18 is in MBL mode after a software crash. Attempts are being made to find and correct the cause of these suspected seasonal crashes.

1990-005G/20442 Lusat OSCAR 19 (Microsat-O, LO-19)
Uplink 145.840, 145.860, 145.880 and 145.900 (1200 bps Manchester FSK)/ Downlinks 437.125 and 437.153 (secondary) MHz SSB (1200 bps RC-BPSK)

1990-13C/20480 Fuji OSCAR 20 (JAS-1B, Fuji-2, FO-20)
JA mode (linear/inverting): Uplink 145.900-146.000 MHz (CW/LSB)/Downlink 435.800-435.900 MHz (CW/USB). FO-20 in mode JA continuously. Callsign: 8J1JBS

1991-050B/21575 UoSAT OSCAR 22 (UoSAT-F, UoSAT-5, UO-22)
JD Mode: Uplink 145.900 or 145.975 MHz FM/Downlink 435.120 MHz FM (9600 baud FSK)

1992-052B/22077 KITSAT OSCAR 23 (Uribyol, KITSAT-A, KITSAT-1, KO-23)
JD Mode: Uplink 145.850 (may no longer be operational) and 145.900 MHz FM/ Downlink 435.175 MHz FM (9600 baud FSK), Callsigns: HL01-11 (Broadcast) and HL01-12 (BBS)

1993-061C/22828 KITSAT OSCAR 25 (KITSAT-B, KITSAT-2, KO-25)
JD Mode: Uplink 145.870 and 145.980 MHz FM/Downlink 435.175 and 436.5 MHz FM (9600 baud FSK). Callsigns: HL02-11 (Broadcast) and HL02-12 (BBS)

1993-061F/22826 ITAMSAT OSCAR 26 (IO-26)
Uplink 145.875, 145.900, 145.925 and 145.950 MHz FM/Downlink 435.822 MHz SSB (1200 baud PSK). Callsign: ITMSAT

1993-061G/22829 AMRAD OSCAR 27 (Eyesat-A, Eyesat-1, AO-27)
Uplink 145.850 MHz FM/Downlink 436.792 MHz FM

1996-046B/24278 Fuji OSCAR 29 (JAS-2, Fuji-3, FO-29)
JA Mode (Voice/CW): Uplink 145.900-146.000 MHz (CW/LSB)/Downlink 435.800-435.900 MHz (CW/USB).
JD mode (digital): Uplink 145.850, 145.870, 145.890 and 145.910 MHz FM/Downlink 435.910 MHz FM (9600 baud BPSK)

1991-007A/21089 Radio Sputnik 12/13 (Cosmos 2123, RS-12/13)
KA mode: Uplink 21.210-21.250 MHz and 145.910-145.950 MHz (CW/SSB)/Downlink 29.410-29.450 MHz (CW/SSB). The 15-meter ROBOT is operational. This communication package was carried by Cosmos 2123 as secondary payload.

1994-085A/23439 Radio Sputnik 15 (Radio-Rosto, RS-15)
Mode A: Uplink 145.858-145.898 MHz (CW/SSB)/ Downlink 29.354-29.394 MHz (CW/SSB)

1997-010A/24744 Radio Sputnik 16 (RS-16)
At press time only the beacons are operational. Communications transponder: Uplink 145.915-145.948 MHz/Downlink 29.415-29.448 MHz. Beacons: HF Beacons–29.408 and 29.451 MHz/ UHF Beacon 1–435.504 MHz/UHF Beacon 2–435.548 MHz

1986-017A/16609 *Mir* Space Station (*Mir*/SAFEX)
SAFEX II 70-cm repeater: Uplink 435.750 MHz FM with subaudible tone 141.3 Hz/ Downlink 437.950 MHz FM
QSO Mode: Uplink 435.725 MHz FM w/subaudible tone 151.4 Hz/Downlink 437.925 MHz FM
PMS: 145.985 MHz FM, 1200 Baud AFSK/Occasional FM voice contacts are made on this frequency.

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FAX: 301-608-3410

World Radio History

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 263 active geostationary/synchronous satellites at publication deadline. We are particularly grateful to the following individuals for providing payload information and analysis: Earth News: Philip Chien; Molniya Space Consultancy: Mr. Phillip Clark; Baylin Publications: Dr. Frank Baylin; Havard-Smithsonian Center for Astrophysics: Jonathan McDowell; U.S. Space Command/Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

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

Radio Frequency Band Key

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

Satellite Service Key

AOR	Atlantic Ocean Region
APR	Asia/Pacific Ocean Region
BSS	Broadcast Satellite Service
DARS	Digital Audio Radio Service
FSS	Fixed Satellite Service
Gov	Government
Intl	International
IOR	Indian Ocean Region
MSS	Mobile Satellite Service
MET	Meteorological Satellite Serv.
Mil	Military
POR	Pacific Ocean Region

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
22912	1993-073B Meteosat 6/MOP 3 (ESA)	0.0E#	MET (P/L/S) Operational Metsat
23730	1995-067A Telecom 2C (France)	2.9E	FSS-Gov/Mil (S/C/X/Ku)
23712	1995-060A USA 115/Milstar 2 (US)	4.0E/i	FSS-Milcomsat (P/S/K)
25049	1997-071A Sirius 2 (Sweden)	5.2E	BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1/BSB R1	5.8E	BSS (Ku)
22921	1993-076A USA 98/NATO 4B (NATO)	5.9E/i	FSS-Milcomsat (P/S/X)
25134	1998-002A Skynet 4D (UK)	6.0E	FSS-Milcomsat (P/S/X/Ka)
22028	1992-041B Eutelsat 2F4 (EUTE)	6.9E	FSS (S/Ku)
21056	1991-003B Eutelsat 2F2 (EUTE)	9.9E	FSS (S/Ku)
19596	1988-095A Raduga 22 (CIS)	11.0E/i	FSS-Gov/Mil (X/C)
22557	1993-013A Raduga 29 (CIS)	11.3E/i	FSS-Gov/Mil (X/C)
22269	1992-088A Cosmos 2224 (CIS)	11.9E#	FSS-Mil Early Warning (X)
24665	1996-067A Eutelsat 2F7/Hot Bird 2 (EUTE)	12.0E	BSS (Ku)
25237	1998-013A Hot Bird 4 (EUTE)	13.0E	BSS (Ku)
24208	1996-044A Italsat 2 (Italy)	13.1E#	FSS/MSS (L/S/K/Ka)
20777	1990-079B Eutelsat 2F1 (EUTE)	13.3E	FSS (S/Ku)
23537	1995-016B Eutelsat 2F6/Hot Bird 1 (EUTE)	13.6E	BSS (Ku)
21055	1991-003A Italsat 1 (Italy)	14.4E#	FSS/MSS (S/K/Ka)
24931	1997-049A Hot Bird 3 (EUTE)	15.9E	BSS (Ku)
21803	1991-083A Eutelsat 2F3 (EUTE)	15.9E	FSS (S/Ku)
19688	1988-109B Astra 1A (Lux)	19.1E	BSS (Ku)
21139	1991-015A Astra 1B (Lux)	19.1E	BSS (Ku)
23686	1995-055A Astra 1E (Lux)	19.1E	BSS (Ku)
25071	1997-076A Astra 1G (Lux)	19.1E	BSS (Ku)
23331	1994-070A Astra 1D (Lux)	19.2E	BSS (Ku)
23842	1996-021A Astra 1F (Lux)	19.2E	BSS (Ku)
22653	1993-031A Astra 1C (Lux)	19.4E	BSS (Ku)
19331	1988-063B Eutelsat 1F5/ECS 5 (EUTE)	21.4E/i	FSS (VHF/Ku)
22175	1992-066A DFS 3 (Germany)	23.5E	BSS (S/Ku/K)
25153	1998-006B Inmarsat 3 F5 (INMA)	25.0E	Intl MSS on-orbit spare (L/C)
18351	1987-078B Eutelsat 1F4/ECS 4 (EUTE)	25.3E/i	FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (CIS)	25.7E/i	FSS (C/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	25.9E	BSS/FSS (C/Ku)
20706	1990-063B DFS 2/Kopernikus (Germany)	28.6E	BSS (S/Ku/K)
24652	1996-062A Arabsat 2B (Arabsat)	30.8E	BSS/FSS (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	31.2E	FSS (Ku)
15629	1985-025A Intelsat 510 (ITSO)	32.9E/i	Intl FSS IOR (C/Ku)
20263	1989-081A Gorizont 19 (CIS)	33.7E/i	FSS (C/Ku)
21821	1991-087A Raduga 28 (CIS)	35.0E/i	FSS-Gov/Mil (X/C)
22963	1993-002A Gals 1 (CIS)	35.9E	BSS (Ku)
23717	1995-063A Gals 2 (CIS)	36.0E	BSS (Ku)
20929	1990-095A USA 65/DSP F15 (US)	37.4E#	FSS-Mil Early Warning IOR (S/X)
23775	1996-005A Gorizont 31 (CIS)	39.6E#	FSS (C/Ku) Statsionar 12
23949	1996-040B Turksat 1C (Turkey)	42.0E	FSS (Ku)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
22981	1994-008A Raduga 1-3 (CIS)	48.7E#	FSS-Gov/Mil (X/C) Statsionar 24
23880	1996-034A Gorizont 32 (CIS)	52.9E#	FSS (C/Ku) Statsionar 5
19687	1988-109A Skynet 4B (UK)	53.1E/i	FSS-Milcomsat (P/S/X/Ka)
21894	1992-010B Arabsat 1C	55E	BSS/FSS (S/C)
25045	1997-070A Kupon 1 (CIS)	55.0E	FSS (Ku)
20203	1989-069B USA 44/DSCS 3A2 (US)	57.0E/i	FSS-Milcomsat IOR (P/S/X)
23305	1994-064A Intelsat 703 (ITSO)	56.9E	Intl FSS IOR (C/Ku)
20667	1990-056A Intelsat 604 (ITSO)	60.0E	Intl FSS IOR (C/Ku)
22913	1993-074A USA 97/DSCS 3B10 (US)	60.0E/i	FSS-Milcomsat IOR (P/S/X)
20315	1989-087A Intelsat 602 (ITSO)	62.0E	Intl FSS IOR (C/Ku)
23839	1996-020A Inmarsat 3F1 (INMA)	63.8E#	Intl MSS IOR (L/C)
25110	1997-083A Intelsat 804 (ITSO)	64.0E	Intl FSS IOR (C/Ku)
24742	1997-009A Intelsat 801 (ITSO)	64.2E	Intl FSS IOR (C/Ku)
21814	1991-084B Inmarsat 2F3 (INMA)	65.0E#	Intl MSS IOR (L/C)
23461	1995-001A Intelsat 704 (ITSO)	65.9E	Intl FSS IOR (C/Ku)
23636	1995-040A PanAmSat 4/PAS 4 (US)	68.5E	FSS/BSS IOR (C/Ku)
23448	1994-087A Raduga 32 (CIS)	70.0E#	FSS-Gov/Mil (X/C) Statsionar 20
13595	1982-097A Intelsat 505 (ITSO)	71.0E/i	Intl FSS/MSS APR (L/C/Ku)
22787	1993-056A USA 95/UFO 2 (US)	71.1E/i	FSS-Milcomsat IOR (P/S)
10669	1978-016A Ops 6391/FltSatCom F1 (US)	72.7E/i	FSS-Milcomsat IOR (P/S)
23589	1995-027A USA 111/UFO 5 (US)	72.8E/i	FSS-Milcomsat IOR (P/S/K)
08882	1976-053A Marisat 2 (US)	73.0E/i	MSS IOR (P/L/C)
22027	1992-041A Insat 2A (India)	73.9E#	FSS/MET (S/C)
23327	1994-069A Elektro 1 (CIS)	76.1E#	MET (L)
25010	1997-062A Apstar 2R (PRC)	76.4E	FSS (C/Ku)
23680	1995-054A Luch 1-1 (CIS)	77.1E#	FSS-SDRN2 (Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.3E	FSS (C/Ku)
24768	1997-016A Thaicom 3 (Thailand)	78.5E	FSS/BSS (C/Ku)
23653	1995-045A Cosmos 2319 (CIS)	79.6E#	FSS-Data Relay (C)
21759	1991-074A Gorizont 24 (CIS)	79.6E/i	FSS (C/Ku) Statsionar 13
24435	1996-058A Express 2 (CIS)	79.9E	Intl FSS (C/Ku)
18922	1988-014A Zhongxing 1/DFH2-A1/ PRC 22 (PRC)	81.5E/i	FSS (C)
20643	1990-051A Insat 1D (India)	82.8E	BSS/FSS/MET (S/C)
22836	1993-062A Raduga 30 (CIS)	83.8E#	FSS-Gov/Mil (X/C) Statsionar 3
19548	1988-091B TDRS F3 (US)	85.7E/i	FSS-Gov (C/S/Ku)
22880	1993-069A Gorizont 28 (CIS)	90.1E#	FSS (C/Ku) Statsionar 6
23765	1995-003A Measat 1 (Malaysia)	91.4E	FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.3E	BSS/FSS/MET (S/C)
23731	1995-067B Insat 2C (India)	93.4E	BSS/FSS/MET (S/C/Ku)
22245	1992-082A Gorizont 27 (CIS)	96.7E/i	FSS (C/Ku) Statsionar 14
25050	1997-071B Indostar 1 (Indonesia)	96.7E	BSS/DARS (L/S)
20473	1990-011A Zhongxing 3/DFH2-A3/ PRC 26 (PRC)	97.8E#	FSS (C)
22210	1992-074A Ekran 20 (CIS)	98.4E/i	BSS (P) Statsionar-T
23723	1995-064A AsiaSat 2 (AC)	100.5E	BSS (C/Ku)
21922	1992-017A Gorizont 25 (CIS)	102.5E/i	FSS (C/Ku) Statsionar 21
24834	1997-029A Fengyun 2B (PRC)	104.8E#	MET (L)
20558	1990-030A Asiasat 1 (AC)	105.5E	BSS (C)
20570	1990-034A Palapa B2R (Indonesia)	107.7E	FSS (C)
23176	1994-040B BS 3N (Japan)	108.8E	BSS (Ku)
20771	1990-077A BS 3A/Yuri 3A (Japan)	108.8E	BSS (S/Ku)
21668	1991-060A BS 3B/Yuri 3B (Japan)	108.9E	BSS (S/Ku)
24769	1997-016B BSAT 1A (Japan)	109.0E	BSS (Ku)
19710	1988-111A Zhongxing 2/DFH2-A2/PRC 25 (PRC)	110.4E/i	FSS (C)
23864	1996-030A Palapa C2 (Indonesia)	112.9E	FSS (C/Ku)
23768	1996-003A Koreasat 2/Mugunghwa 2 (Korea)	114.9E	BSS/FSS (Ku)
14985	1984-049A Zhongxing 5/Chinasat 5/Spacenet 1 (PRC)	115.3E#	FSS (C/Ku)
23639	1995-041A Koreasat 1/Mugunghwa 1 (Korea)	115.9E	BSS/FSS (Ku)
21964	1992-027A Palapa B4 (Indonesia)	117.8E	FSS (C)
22931	1993-078B Thaicom 1 (Thailand)	120.0E	FSS (C/Ku)
20217	1989-070A GMS 4/Himawari 4 (Japan)	120.1E/i	MET (P/L/S)
23108	1994-030A Gorizont 30/Rimsat 2 (CIS)	122.2E#	FSS (C/Ku)
24798	1997-021A Zhongxing 8/DFH3-2 (PRC)	124.9E	FSS (C)
21132	1991-014A Raduga 27 (CIS)	127.5E/i	FSS-Gov/Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.9E	FSS/BSS (C/Ku)
23651	1995-044A N-Star 1 (Japan)	131.8E	FSS (S/C/Ku/K)
23943	1996-039A Apstar 1A (PRC)	134.0E	BSS (C)
23781	1996-007A N-Star 2 (Japan)	135.9E	FSS (S/C/Ku/K)
23185	1994-043A Apstar 1 (PRC)	138.0E	BSS (C)
23522	1995-011B GMS 5/Himawari 5 (Japan)	138.2E#	MET (P/L/S)
20953	1990-102A Gorizont 22 (CIS)	139.8E/i	FSS (C/Ku) Statsionar 7
17706	1987-029A Agila 1/Palapa B2P (Philippines)	140.5E#/d	FSS (C)
24880	1997-036A Superbird C (Japan)	143.9E	FSS (Ku/K)
20923	1990-094A Gorizont 21 (CIS)	144.8E/i	FSS (C/Ku) Statsionar 16
20066	1989-046A USA 39/DSP F14 (US)	145.4E/i	FSS-Mil Early Warning POR (S/X)

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25067	1997-075A JCSAT 5 (Japan)	149.0E	FSS (Ku)
24737	1997-008A USA 130/DSP F18 (US)	165.0E	FSS-Mil Early Warning POR (S/X)
24901	1997-042A Agila 2/Mabuhay 1 (Philippines)	145.8E	FSS (C/Ku)
24653	1996-063B Measat 2 (Malaysia)	147.9E	FSS (C/Ku)
24732	1997-007A JCSAT 4 (Japan)	150.0E	FSS (Ku)
23779	1996-006A Palapa C1 (Indonesia)	150.4E	FSS (C/Ku)
18350	1987-078A Optus A3/Aussat K3 (Australia)	151.9E#	FSS (Ku)
20402	1990-001B JCSAT 2 (Japan)	154.0E	FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	BSS/MSS (L/Ku)
12994	1981-119A Intelsat 503 (ITSO)	156.8E/i/d	Intl FSS APR (C/Ku)
22253	1992-084A Superbird A (Japan)	157.9E	FSS (Ku/K)
22087	1992-054A Optus B1 (Australia)	159.9E	BSS/MSS (L/Ku)
22907	1993-072A Gorizont 29/Rimsat 1 (CIS)	160.8E#	FSS (C/Ku)
21893	1992-010A Superbird B (Japan)	162.0E	FSS (Ku/K)
16275	1985-109C Optus A2/Aussat 2 (Australia)	163.9E/i	FSS (Ku)
23175	1994-040A PanAmSat 2/PAS 2 (US)	169.0E	Intl FSS POR (C/Ku)
12046	1980-087A OPS 6394/FltSatCom F4 (US)	171.5E/i	FSS-Milcomsat POR (P/S/X)
25258	1998-016A UHF-F8 (US)	172.0E	FSS-Milcomsat (P/S/K/Ka)
24846	1997-031A Intelsat 802 (ITSO)	174.1E	Intl FSS POR (C/Ku)
22719	1993-046A USA 93/DSCS 3B9 (US)	175.0E/i	FSS-Milcomsat WPAC (P/S/X)
23124	1994-034A Intelsat 702 (ITSO)	177.0E	Intl FSS POR (C/Ku)
24674	1996-070A Inmarsat 3F3 (INMA)	177.9E#	Intl MSS POR (L/C)
20918	1990-093A Inmarsat 2F1 (INMA)	178.9E#	Intl MSS POR (L/C)
16117	1985-092C USA 12/DSCS 3B5 (US)	180.0E/i	FSS-Milcomsat WPAC (P/S/X)
22871	1993-066A Intelsat 701 (ITSO)	180.0E	Intl FSS POR (C/Ku)
23467	1995-003A USA 108/UFO 4 (US)	177.6W/i	FSS-Milcomsat POR (P/S/K)
19121	1988-040A Intelsat 513 (ITSO)	177.0W#	Intl FSS POR (C/Ku)
21639	1991-054B TDRS F5 (US)	174.3W	Intl FSS-Gov (C/S/Ku)
23613	1995-035B TDRS F7 (US)	171.3W#	FSS-Gov (C/S/Ku)
20499	1990-016A Raduga 25 (CIS)	170.0W/i	FSS-Gov/Mil (X/C)
21392	1991-037A Aurora II/Satcom C5 (US)	138.8W	FSS (C)
20945	1990-100A Satcom C1 (US)	137.3W	FSS (C)
23581	1995-025A GOES 9 (US)	135.0W	MET (P/L/S)
21873	1992-006A USA 78/DSCS 3B14 (US)	135.0W/i	FSS-Milcomsat EPAC (P/S/X)
22096	1992-057A Satcom C4 (US)	134.9W	FSS (C)
23016	1994-013A Galaxy 1R (US)	132.9W	FSS (C)
22117	1992-060B Satcom C3 (US)	130.9W	FSS (C)
13637	1982-106B DSCS 3A1 (US)	129.9W/i	FSS-Milcomsat EPAC (P/S/X)
21906	1992-013A Galaxy 5 (US)	125.0W	FSS (C)
23877	1996-033A Galaxy 9 (US)	122.9W	FSS (C)
19484	1988-081B SBS 5 (US)	122.8W	FSS (Ku)
22988	1994-009A USA 99/Milstar 1 (US)	120.0W	FSS-Milcomsat (P/S/K)
15826	1985-048D Telestar 303/3D (US)	119.9W/i	FSS (C)
23754	1995-073A EchoStar 1 (US)	118.8W	BSS (Ku)
24313	1996-055A Echostar 2 (US)	118.5W	BSS (Ku)
24748	1997-011A Tempo 2 (US)	118.4W	BSS (Ku)
16274	1985-109B Morelos 2 (Mexico)	116.7W	FSS (C/Ku)
23313	1994-065A Solidardad 2 (Mexico)	113.0W	FSSMSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.0W	FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.1W	FSS/MSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.2W	FSS (C/Ku)
23846	1996-022A MSAT M1 (Canada)	106.4W	MSS (L/X)
24786	1997-019A GOES 10 (US)	105.8W	MET (P/L/S) In-orbit spare
03029	1967-111A ATS 3 (US)	105.4W/i	Experimental communications (VHF/C)
08747	1976-023B LES 9 (US)	105.2W/i	Experimental Milcomsat (P/Ka)
15677	1985-035A Gstar 1 (US)	104.9W#	FSS (Ku)
20946	1990-100B Gstar 4 (US)	104.9W	FSS (Ku)
19483	1988-081A Gstar 3 (US)	104.6W/i	FSS/MSS (L/Ku)
23696	1995-057A USA 114/UFO 6 (US)	104.5W/i	FSS-Milcomsat CONUS (P/S/K)
24315	1996-054A GE 1 (US)	103.0W	FSS (C/Ku)
23435	1994-084A USA 107/DSP F17 (US)	103.2W#	FSS-Mil Early Warning AOR-W (S/X)
22930	1993-078A DBS 1 (US)	101.1W	BSS (Ku)
21227	1991-028A Spacenet 4 (US)	101.0W	FSS (C/Ku)
23553	1995-019A AMSC 1 (US)	100.9W	MSS (L/X)
23598	1995-029A DBS 3 (US)	100.8W	BSS (Ku)
23192	1994-047A DBS 2 (US)	100.7W	BSS (Ku)
22796	1993-058B ACTS (US)	99.9W	Experimental communications (S/C/K)
17181	1986-096A USA 20/FltSatCom F7 (US)	99.1W/i	FSS-Milcomsat CONUS (P/S/X/K)
22694	1993-039A Galaxy 4 (US)	98.9W	FSS (C/Ku)
17561	1987-022A GOES 7 (US)	98.3W/i	MET (P/L/S)
24812	1997-026A Telstar 5 (US)	97.0W	FSS (C/Ku)
08746	1976-023A LES 8 (US)	95.4W/i	Experimental Milcomsat (P/Ka)
25086	1997-078A Galaxy 8i (US)	95.0W	BSS (Ku)
23741	1995-069A Galaxy 3R (US)	94.9W	FSS (C/Ku)
16650	1986-026B SBTS A2 (Brazil)	91.9W#	FSS (C)
22205	1992-072A Galaxy 7 (US)	91.0W	FSS (C/Ku)
23670	1995-049A Telstar 402R (US)	88.9W	FSS (C/Ku)
24936	1997-050A GE 3 (US)	87.2W	FSS (C/Ku)
24713	1997-002A GE 2 (US)	84.8W	FSS (C/Ku)
18951	1988-018A Spacenet 3R (US)	82.9W	FSS (L/C/Ku)
16276	1985-109D Satcom K2 (US)	80.9W#	FSS (Ku)
15561	1985-015B SBTS 1 (Brazil)	79.0W/i	FSS (C)
15235	1984-093B SBS 4 (US)	76.9W/i	FSS (Ku)
12309	1981-018A Comstar D4 (US)	75.8W/i	FSS (C)
23051	1994-022A GOES 8 (US)	75.2W#	MET (P/L/S)
20873	1990-091B Galaxy 6 (US)	73.8W	FSS (C)
20872	1990-091A SBS 6 (US)	73.7W	FSS (Ku)
24714	1997-002B Nahuel 1A (Argentina)	71.7W	FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.0W	FSS (C/X)
25152	1998-006A Brasilsat B3 (Brazil)	65.0W	FSS (C/X)
23536	1995-016A Brasilsat B2 (Brazil)	65.1W	FSS (C/X)
25004	1997-059A Echostar 3 (US)	61.4W	BSS (Ku)
24916	1997-046A PanAmSat 5/PAS 5 (US)	58.0W	BSS (C/Ku)
16101	1985-087A Intelsat 512 (ITSO)	55.5W/i	Intl FSS AOR (C/Ku)
21149	1991-018A Inmarsat 2F2 (INMA)	54.8W/i	Intl MSS AOR-W (L/C)
24819	1997-027A Inmarsat 3F4 (INMA)	54.5W	Intl MSS AOR-W (L/C)
23571	1995-023A Intelsat 706 (ITSO)	53.0W	Intl FSS AOR (C/Ku)
23628	1995-038A USA 113/DSCS 3B4 (US)	52.5W/i	FSS-Milcomsat WLANT (P/S/X)
23915	1996-035A Intelsat 709 (ITSO)	49.9W	Intl FSS AOR (C/Ku)
13969	1983-026B TDRS 1 (US)	49.4W/i	FSS-Gov (S/C/Ku)
22314	1993-003B TDRS F6 (US)	46.9W	Intl FSS-Gov (S/C/Ku)
19217	1988-051C PanAmSat 1/PAS 1 (US)	44.8W	FSS AOR (C/Ku)
24891	1997-040A PanAmSat 6/PAS 6 (US)	43.4W	FSS AOR (C/Ku)
23764	1996-002A PanAmSat 3R/PAS 3R (US)	43.1W	BSS (Ku)
16116	1985-092B USA 11/DSCS 3B7 (US)	42.5W/i	FSS-Milcomsat ATL (P/S/X)
19883	1989-021B TDRS F4 (US)	40.9W#	FSS-Gov (C/S/Ku)
25239	1998-014A Intelsat 806 (ITSO)	40.5W	Intl FSS AOR (C/Ku)
12089	1980-098A Intelsat 502 (ITSO)	40.5W/i	Intl FSS AOR (C/Ku)
23413	1994-079A Orion 1 (US)	37.5W	Intl FSS (Ku)
21765	1991-075A Intelsat 601 (ITSO)	34.5W	Intl FSS AOR (C/Ku)
20401	1990-001A Skynet 4A (UK)	34.0W/i	FSS-Milcomsat (P/S/X/Ka)
14077	1983-047A Intelsat 506 (ITSO)	31.4/i	Intl FSS/MSS AOR (L/C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	BSS/FSS (S/Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	BSS/FSS (S/Ku)
21653	1991-055A Intelsat 605 (ITSO)	27.5W	Intl FSS AOR (C/Ku)
15386	1984-114B Marecs B2	26.1W/i	MSS AOR (L)
20523	1990-021A Intelsat 603 (ITSO)	24.5W	Intl FSS AOR (C/Ku)
19772	1989-006A Intelsat 515 (ITSO)	23.7W#/d	Intl FSS AOR (C/Ku)
23967	1996-042A USA 127/UFO 7 (US)	23.7W/i	FSS-Milcomsat AOR (P/S/K)
20253	1989-077A USA 46/FltSatCom F8 (US)	22.8W/i	FSS-Milcomsat AOR (P/S/X/K)
21989	1992-032A Intelsat K (ITSO)	21.5W	Intl FSS AOR (Ku)
24957	1997-053A Intelsat 803 (ITSO)	21.4W	Intl FSS AOR (C/Ku)
15391	1984-115A NATO 3D (NATO)	18.3W/i	FSS-Milcomsat (P/S/X)
23528	1995-013A Intelsat 705 (ITSO)	17.9W	Intl FSS AOR (C/Ku)
21047	1991-001A NATO 4A (NATO)	17.7W/i	FSS-Milcomsat (P/S/X)
21940	1992-021B Inmarsat 2F4 (INMA)	16.9W/i	Intl MSS AOR-E (L/C)
23426	1994-082A Luch 1 (CIS)	15.9W#	FSS-Gov CSDRN (Ku)
24307	1996-053A Inmarsat 3F2 (INMA)	15.4W#	Intl MSS AOR-E (L/C)
23132	1994-035A USA 104/UFO 3 (US)	14.4W/i	FSS-Milcomsat AOR (P/S)
23319	1994-067A Express 1 (CIS)	14.0W	Intl FSS (C/Ku) Statsionar 4
23267	1994-060A Cosmos 2291 (CIS)	13.4W#	FSS-Data Relay (C)
22009	1992-037A USA 82/DSCS 3B12 (US)	12.0W	FSS-Milcomsat ELANT (P/S/X)
22041	1992-043A Gorizont 26 (CIS)	11.4W/i	FSS (C/Ku) Statsionar 11
24932	1997-049B Meteosat 7/MOP 4 (ESA)	10.2W#	MET (P/L/S) In-orbit spare
21140	1991-015B Meteosat 5/MOP 2 (ESA)	9.2W#/d	MET (P/L/S) Relocating to 65E
21805	1991-080B USA 75/DSP F16 (US)	8.9W#	FSS-Mil Early Warning AOR-E (S/X)
21813	1991-084A Telecom 2A (France)	8.0W	FSS-Gov/Mil (S/C/X/Ku)
21939	1992-021A Telecom 2B (France)	5.0W	FSS-Gov/Mil (S/C/X/Ku)
24209	1996-044B Telecom 2D (France)	5.0W	FSS-Gov/Mil (S/C/X/Ku)
23865	1996-030B Amos 1 (Israel)	3.9W	FSS (Ku)
20776	1990-079A Skynet 4C (UK)	1.1W#	FSS-Milcomsat (P/S/X/Ka)
23816	1996-015A Intelsat 707 (ITSO)	1.0W	Intl FSS AOR (C/Ku)
24808	1997-025A Thor 2A	0.6W	BSS (Ku)
20762	1990-074A Thor 1/Marcopolo 2/BSB R2	0.6W	BSS (Ku)
20168	1989-062A TV Sat 2 (Germany)	0.5W	BSS (Ku)

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Satellite Launch Schedules

By Keith Stein

Chinese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
May 1998	Long March 3B	Xichang	Chinastar 1
May 1998	Long March 3B	Xichang	Sinosat-1

Chinastar-1	Frequency Assignments
C-band	3.7-4.2/5.925-6.425 GHz 18 transponders
Ku-band	12.25-12.75/14.0-14.5 GHz 20 transponders
TLM Beacons	3.7005 (V), 4.1995 (H), 12.2505 and 12.7595 GHz (H)

Will be located at 87.5° east longitude and also called Zhongwei-1.

Sinosat-1	Downlink Frequency Assignments
C-band	3.625-4.200/5.85-6.425 GHz 24 transponders
Ku-band	12.25-12.75/14.0-14.5 GHz 14 transponders.
TLM Beacons	4193, 4198, 12260, and 12260.4 GHz
CMD Beacons	6412 and 6418 GHz

Will be located at 88° east longitude.

European Expandable Launch Vehicles

Launch Date	Launch Number	Launch Vehicle	Launch Site	Payload
May 98	V109	Ariane 44P	Kourou ELA2	ST-1 (Singapore)

ST-1	Downlink/Uplink Frequency Assignments
C-band	14 transponders
Ku-band	16 transponders. Will be located at 88.0° east longitude

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
May 1998	Proton	Baikonur	Echostar 4
May 1998	Proton	Baikonur	Astra 2A
May 1998	Soyuz	Baikonur	Progress M-39
June 1998	Proton	Baikonur	PanAmSat 8 (PAS-8)

Astra 2A	Downlink Frequency Assignments
Ku-band	11.7-12.5 GHz (28 transponders). Will be located at 28.2° east.

Echostar 4	Downlink Frequency Assignments
Ku-band	12.2-12.7 GHz (32 transponders). Will be located at119° west.

PAS-8	Downlink Frequency Assignments
C-band	3.7-4.2 GHz (24 transponders)
Ku-band	12.25-12.75 GHz (24 transponders). Will be located at 166° east.

Progress	Downlink Frequency Assignments
VHF-band	166.000 MHz
UHF-band	922.750 MHz

Proton	Downlink Frequency Assignments
VHF-band	132.400, 136.750 and 192.000 MHz
UHF-band	232.0 and 240.0 MHz

L-band	915-930.0 MHz
S-band	2800-2810.0 MHz

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
May 1998	Titan IV	CCAS	Milstar-3
May 1998	Titan II	VAFB	NOAA-K
May 1998	Pegasus XL	WFF	Orbcomm-2
May 1998	Athena	VAFB	Ikonos-1
May 1998	Delta II	VAFB	Iridium (MS10)
Jun 1998	Pegasus XL	WFF	Orbcomm-3
Jun 1998	Delta II	CCAS	Thor III
Jun 1998	Atlas		CCAS Intelsat 805
Jun 1998	Delta II	CCAS	Galaxy 10
Jun 1998	Delta II	VAFB	Iridium (MS11)

Athena	Downlink Frequency Assignments
S-band	2208.500 & 2210.500 MHz
C-band	5765.000 MHz

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

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

Galaxy 10	Downlink Frequency Assignments
C-band	3.7-4.2 GHz 24 transponders
Ku-band	11.7-12.2 GHz 24 transponders

Will be located at 127° west replacing Galaxy 9.

Intelsat 805	Downlink/Uplink Frequency Assignments
C-band	3.625-4.2/5.850-6.425 GHz 28 transponders
Ku-band	10.95-12.75/14.0-14.5 GHz 3 transponders
TLM beacons	3.9475-3.9525 GHz/11.198-12.501 GHz

Will be located at 55.5° west.

Iridium	Downlink/Uplink/Inter-Satellite Frequency Assignments
L-band	1616-1626.500 MHz (FDMA/TDMA)
Ka-band	19.4-19.6 GHz (satellite to gateway/earth terminals)
	23.18-23.38 GHz (inter-satellite links)
	29.1-29.3 GHz (gateway/earth terminals to satellite)

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

Milstar-3	Downlink/Uplink Frequency Assignments
UHF	240-270/292.825-311.175 and 316.587-317.318 MHz
S-band SGLS	2262.5 (SGLS channel 13) and 2267.5 (SGLS channel 14)
EHF	20.2-212/43.5-45.5 GHz

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NOAA-K	Downlink Frequency Assignments
VHF	136.770 (beacon) and 137.500 (APT) MHz
L-band	1544.500 (SARSAT), 1698.000 (HRPT) MHz
S-band SGLS	2247.500 (SGLS channel 10) MHz

Orbcomm-2	Downlink Frequency Assignments
VHF-band	137.000-138.000 MHz
UHF-band	400.100 MHz

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

Thor 3	Downlink Frequency Assignment
Ku-band	11.77-12.106 GHz (5 BSS transponders: 4, 8, 12, 16 and 20)

Will be located at 0.8° west

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

Space Transportation System (STS-NASA)

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

Mission Number	Launch Date/ Orbiter	Inclination/ Altitude/Pad	Mission Duration	Mission/Cargo Bay/Payloads
STS-91	May 1998 Discovery**	51.6/190/ SLC-39A	10	S/MM-9***

**STS-91 Crew Assignment: CDR: Charles Precourt, PLT: Dominic Pudwill Gorie, MS: Wendy Lawrence, MS: Franklin Chang-Diaz, MS: Janet Kavandi, MS: Andrew Thomas (D).

***S/MM-9 Crew Assignment: CDR: Talgat Musabayev, FE: Nikolai Budarin, U.S. Astronaut: Andrew Thomas (D).

STS	Downlink Frequency Assignments:
UHF Voice	243.0 (AM), 259.7 (AM), 279.0 (AM), and 296.8 (AM)
UHF Boosters	240.0, and 242.0 MHz (recovery beacons)
S-band TLM	2217.5, 2250.0, and 2287.5 MHz.
C-band TRK	5400-5900.000 MHz

Mir	Downlink Frequency Assignments:
VHF Voice	143.625 MHz (Daily Operations)
VHF Voice	145.985 MHz (Amateur Radio)
UHF Voice	437.925, 437.950 and 437.975 MHz (Amateur Radio)

List of Abbreviations and Acronyms

A/C	Aircraft
Astra 2A	Geostationary direct broadcast (BSS) satellite (Hughes HS-601HP) being launched for the Societe Europeenne des Satellites (SES) of Betzdorf, Luxembourg.
BSS	Broadcast Satellites Service
C-band	3700 to 6500 MHz
CCAS	Cape Canaveral Air Station, FL
CDR	Commander
CMD	Command
Chinastar-1	Geostationary FSS communications satellite (Lockheed Martin A2100 space bus) being launched for the China Orient Telecomm Satellite Company.
Echostar-4	Geostationary direct broadcast (BSS) satellite (Lockheed Martin A2100) being launched for Echostar.
FSS	Fixed Satellite Service
Galaxy	Hughes telecommunications satellite with principal applications including network TV, radio, VSAT, business video and data services.
GHz	Gigahertz
Ikonos	This earth imaging satellite will have capability of resolving objects on the ground as small as one meter in diameter. Owned by Space Imaging EOSAT.
Intelsat	Satellite for the International Telecommunications Satellite Organization based in Washington DC.
Iridium	The Iridium system is a planned commercial communications network comprised of 66 low earth orbiting satellites. The system will use L-band to provide global communications services through portable handsets.
K-band	10.90 to 17.15 GHz
L-band	500 to 1549 MHz
MHz	Megahertz
Milstar	Department of Defense geostationary military communications satellite (Lockheed Martin). A telephone switchboard in space to route all military message traffic and conversations around the world.
MS	Mission Specialist
NOAA	Polar orbiting U.S. weather satellite operated by the National Oceanic and Atmospheric Administration (NOAA).
Orbcomm-3	Orbcomm will provide low-cost alpha numeric data communications and position determination for emergency assistance, data acquisition and messaging services using pocket portable and mobile subscriber terminals.
PanAmSat-8	Geostationary FSS communications satellite (Space Systems/ Loral FS-1300) being launched for PanAmSat Corporation.
PLT	Pilot
Progress	An unmanned cargo ship for crew aboard Mir space station.
S-band	2000 to 2300 MHz
SGLS	Space Ground Link Segment
Sinosat-1	Geostationary FSS communications satellite (Spacebus 3000) being launched for the Sino Satellite Communications Company
S/MM-9	Last shuttle mission to the Russian Space Station Mir to support design and assembly of the International Space Station (ISS).
ST-1	Geostationary FSS communications satellite (Eurostar bus) launched for Singapore Technologies Telemedia.
Thor 3	U.S. built Hughes telecommunications satellite for Telenor in Norway.
TLM	Telemetry
TRK	Tracking
UHF	Ultra High Frequency (390 to 499 MHz)
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
X-band	8000 and 10999 MHz
XL	Extra Large

Keith Stein is the Associate Technical Editor for Launchspace Publications, Inc. (http://www.launchspace.com), (703) 749-2324.

World Radio History

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 February 1998. 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 maneuvered, 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, 25 Redfern Avenue, Whitton, Middx TW4 5NA United Kingdom.

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 4/2329	1998-006A		BRASILSAT B3	1,780 kg
1998 Feb 4.78	6.81 deg	630.38 min	217 km	35,734 km
1998 Feb 20.00	0.03	1,436.14 min	35,780 km	35,795 km
1998 Feb 4/2329	1998-006B		INMARSAT-3 5	2,000 kg
1998 Feb 5.53	6.94 deg	631.06 min	218 km	35,768 km
1998 Feb 25.04	2.80	1,436.08 min	35,747 km	35,826 km

BRASILSAT B3 is a telecommunications satellite, launched for EMBRATEL (Brazil). Mass quoted is at launch: mass on-station at the beginning of operations is 1,052 kg, dry mass is 856 kg. Satellite located over 295 deg east.

INMARSAT-3 5 is a maritime mobile communications satellite, launched for INMARSAT (UK). Mass quoted is at launch: mass on-station at the beginning of operations 1,149 kg, dry mass 895 kg. Satellite initially located close to 28 deg east, but to be operated over 25 deg east.

Both satellites launched from Kourou using an Ariane-44LP.

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 10/1320	1998-007A		GEOSAT Follow-On	347 kg
1998 Feb 11.16	107.98 deg	101.49 min	780 km	878 km
1998 Feb 10/1320	1998-007B		Orbcomm FM 3	43 kg
1998 Feb 10.88	107.99 deg	101.47 min	781 km	876 km
1998 Feb 10/1320	1998-007C		Orbcomm FM 4	43 kg
1998 Feb 11.16	107.99 deg	101.46 min	781 km	874 km

GEOSAT Follow-On (GFO) is a radar altimeter satellite, operated by the Navel Meteorology and Oceanographic Command. Orbcomm satellites operated by Orbcomm Global LP. First launch of full Taurus vehicle, using first stage based upon Castor 120 motor: launch site was Vandenberg AFB.

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 14/1434	1998-008A		Globalstar FM 1	450 kg
1998 Feb 14.67	52.00 deg	110.54 min	1,244 km	1,259 km
1998 Feb 14/1434	1998-008B		Globalstar FM 2	450 kg
1998 Feb 14.67	52.01 deg	110.53 min	1,245 km	1,258 km
1998 Feb 25.79	52.00 deg	110.42 min	1,237 km	1,254 km
1998 Feb 14/1434	1998-008C		Globalstar FM 3	450 kg
1998 Feb 14.67	52.01 deg	110.48 min	1,242 km	1,256 km
1998 Feb 25.79	52.01 deg	110.51 min	1,240 km	1,260 km
1998 Feb 14/1434	1998-008D		Globalstar FM 4	450 kg
1998 Feb 14.67	52.00 deg	110.49 min	1,244 km	1,254 km
1998 Feb 25.87	52.01 deg	110.51 min	1,244 km	1,256 km

First launch of four satellites in the Globalstar system, launched for the Globalstar Ltd Partnership. Mass quoted is at launch: dry mass is 400 kg. The complete Globalstar network will comprise six satellites (plus one spare) in each of eight orbital planes: at the end of operational it is planned that each satellite should boost itself out of the operational altitude band. Launched from Cape Canaveral, maiden flight of 7420 variant of the Delta-2 launch vehicle: it is a Delta-2 Lite with 4 strap-ons attached to the first stage.

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 17/1035?	1998-009A		Cosmos 2349	6,600 kg?
1998 Feb 17.68	70.38 deg	89.13 min	195 km	268 km
1998 Feb 18.30	70.37 deg	89.41 min	212 km	278 km

Yantar-1KFT/Kometa topographic and mapping photo reconnaissance satellite. Planned lifetime is 45 days with the descent module being recovered at the end of the mission. Launched from Baikonur using a Soyuz-U vehicle: launch time not included in launch announcement and the figure shown above is an estimate.

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 18/1358	1998-010A		Iridium 50	657 kg
1998 Feb 18.75	86.58 deg	97.40 min	612 km	657 km
1998 Mar 8.94	86.46 deg	99.28 min	723 km	726 km
1998 Feb 18/1358	1998-010B		Iridium 51	657 kg
1998 Mar 9.41	86.40 deg	100.25 min	768 km	773 km
1998 Feb 18/1358	1998-010C		Iridium 52	657 kg
1998 Mar 8.50	86.54 deg	98.60 min	689 km	694 km
1998 Feb 18/1358	1998-010D		Iridium 53	657 kg
1998 Mar 9.54	86.39 deg	100.21 min	766 km	771 km
1998 Feb 18/1358	1998-010E		Iridium 54	657 kg
1998 Mar 9.21	86.40 deg	100.39 min	774 km	780 km

Tenth launch of a cluster of Iridium satellites, seventh to use a Delta-2. Dry mass of each satellite is 556 kg. Launched into the same orbital plane as Iridium Cluster 2 (1997-030). Launched from Vandenberg AFB using a Delta-2 (7920).

Launch Date/Time Ref Epoch	Intl Designator Inclination	Period	Satellite Name Perigee	Mass Apogee
1998 Feb 21/0755	1998-011A		Kakehashi (COMETS)	3,960 kg
1998 Feb 21.75	30.05 deg	106.51 min	247 km	1,883 km

Kakehashi (COMETS before launch, COMmunications and Broadcasting Engineering Test Satellite) is a research and development satellite, intended to develop the new technology for future communications and broadcasting fields. The satellite was planned to enter geosynchronous orbit over 121 deg east, with a planned operational lifetime of three years. Launched from Tanegashima using an H-2

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vehicle. Due to a launch vehicle malfunction–reportedly due to the premature shutdown 44s into second burn of the H-2 second stage–the satellite failed to reach a geosynchronous transfer orbit. It is planned to maneuver Kakehashi from the orbit shown above.

1998 Feb 26/0707	1998-012A		SNOE	132 kg
1998 Feb 26.67	97.76 deg	95.81 min	535 km	581 km

1998 Feb 26/0707	1998-012B		BATSAT (Teledesic T-1)	45 kg?
1998 Feb 26.67	97.75 deg	95.81 min	535 km	580 km

Student Nitric Oxide Explorer (SNOE) is a science satellite operated and manufactured by the University of Colorado. It is planned to measure the nitric oxide density as a function of altitude and is the first satellite in the Student Explorer Demonstration Initiative (STEDI).

Before launch the second payload was identified as BATSAT, a small technology satellite from the Texas Space Grant Consortium said to transit Ka- and X-band signals to test signal attenuation with JPL's Deep Space Network. After launch the satellite was identified as a test payload for the planned Teledesic communications satellite system, and using OCS's MicroStar bus.

Launched from Vandenberg AFB using a Pegasus-XL: Pegasus third stage carried second Celestis cluster of cremated human remains.

1998 Feb 27/2238	1998-013A		Hot Bird 4	2,885 kg
1998 Feb 27.74	7.02 deg	630.49 min	217 km	35,739 km

Hot Bird 4 is a telecommunications satellite launched for EUTELSAT (France). Mass quoted is at launch: mass in geosynchronous orbit at the beginning of operations is 1,770 kg, dry mass 1,310 kg. To be operated over 13 deg east. Launched from Kourou ising an Ariane-42P.

1998 Feb 28/0021	1998-014A		INTELSAT 806	3,400 kg?
1998 Feb 28.00	27.81 deg	89.88 min	149 km	387 km
1998 Feb 28.70	22.98 deg	626.83 min	168 km	35,600 km
1998 Mar 1.15	16.98 deg	674.31 min	2,449 km	35,739 km
1998 Mar 7.95	3.71 deg	1,030.83 min	19,134 km	35,715 km

Telecommunications satellite to be operated by INTELSAT. Mass quoted is at launch. Launched from Cape Canveral using an Atlas-2AS.

Updates for Previous Launches

International Designation	Comment
1978-094A	Cosmos 1043 decayed from orbit Feb 27.
1981-054A	Molniya-3 16 decayed from orbit Feb 10.
1993-076A	NATO 4B was maneuvered off-station over 5 deg east approximately Jan 18.
1996-021A	USSPACECOM orbital data now shows Astra 1F over its correct longitude of 19 deg east.
1997-009A	INTELSAT 801 was maneuvered off-station over 64 deg east approximately Feb 6.
1997-038A	Soyuz-TM 26 carrying cosmonauts Solovyov and Vinogradov and French spationaut Eyharts undocked from the Mir Complex Feb 19 at 0553 at the time of undocking the mass of the spacecraft was 6,644 kg. The spacecraft landed 31 km south east of Arkelyk Feb 19 at 0910.
1997-075A	JCSAT 5 had its longitude re-stabilized over 149 deg east approximately Jan 29.
1997-078A	Galaxy 8I had its orbital longitude stabilized over 265 deg east approximately Feb 18.
1997-081A	Progress-M 27 re-docked at the rear (-X) port of the Mir complex Feb 23 at 0942.
1998-001A	The LOI-3 burn applied to Lunar Prospector started Jan 13 at 1138.
1998-002A	Add the following orbital data for Skynet 4D: 1998 Feb 25.00 4.12 deg 1,436.10 minutes 35,760 km 35,813 km The satellite is located over 6 deg east.
1998-004A	Soyuz-TM 27 carrying cosmonauts Musabayev and Budarin and NASA astronaut Thomas undocked from the rear (-X) port of the Mir complex Feb 20 at 0847 and re-docked at the front (+X) port of the complex at 0932.

Orbital Data for Galileo

The following are the orbital data for Galileo while in heliocentric orbit. Distances are measured in astronomical units, AU. One AU=149,597,870 km.

Galileo Jupiter Orbiter

1993 Oct 8.93	1.52 deg	2,033.0 days	0.9872 AU	5.2942 AU
1995 Jul 14.31	1.77 deg	1,990.1 days	0.8965 AU	5.2961 AU

Galileo Jupiter Probe

1995 Jul 14.31	1.71 deg	2,004.1 days	0.9235 AU	5.2982 AU

The following orbital data are for the Galileo Jupiter orbiter after reaching orbit around Jupiter. The data have been derived using a Jupiter mass 317.9 times that of the Earth and an equatorial radius of Jupiter of 71,400 km. Altitudes are the exact arithmetical results, but because the Jovian radius is only accurate to +/- 50 km, it should be born in mind that the last two digits in the altitudes are not accurate.

1995 Dec 8.02	5.30 deg	198.64 days	210,939 km	19,275,638 km
1996 Mar 16.28	5.36 deg	207.11 days	765,160 km	19,275,647 km
1996 Jun 27.27	4.15 deg	71.59 days	717,607 km	9,080,212 km
1996 Aug 2.81	4.18 deg	71.46 days	705,819 km	9,080,213 km
1996 Sep 6.79	2.27 deg	60.00 days	690,905 km	8,003,490 km
1996 Oct 7.58	2.29 deg	59.91 days	681,679 km	8,003,490 km
1996 Nov 4.56	1.97 deg	42.52 days	579,327 km	6,302,165 km
1996 Nov 27.87	1.97 deg	42.56 days	583,457 km	6,302,138 km
1996 Dec 19.29	1.96 deg	31.91 days	576,510 km	5,081,862 km
1997 Jan 4.07	1.96 deg	31.90 days	574,666 km	5,081,864 km
1997 Jan 20.05	1.97 deg	31.88 days	574,554 km	5,079,986 km
1997 Feb 4.96	1.97 deg	31.87 days	572,839 km	5,079,988 km
1997 Feb 20.71	1.48 deg	42.57 days	580,483 km	6,306,777 km
1997 Mar 14.17	1.89 deg	42.54 days	576,496 km	6,306,786 km
1997 Apr 5.30	2.53 deg	34.08 days	562,856 km	5,355,344 km
1997 Apr 21.48	2.68 deg	34.04 days	558,207 km	5,355,348 km
1997 May 7.66	2.32 deg	50.03 days	591,817 km	7,093,720 km
1997 Jun 2.52	2.33 deg	50.00 days	588,410 km	7,093,722 km
1997 Jun 25.57	2.19 deg	83.27 days	697,305 km	10,154,355 km
1997 Aug 8.23	2.19 deg	83.25 days	695,839 km	10,154,346 km
1997 Sep 17.01	1.97 deg	49.02 days	583,519 km	6,996,923 km
1997 Oct 13.50	1.93 deg	49.01 days	582,317 km	6,996,926 km
1997 Nov 6.91	3.12 deg	42.57 days	580,336 km	6,306,702 km

The data used to derive these orbits were obtained from the Jet Propulsion Laboratory worldwide web page.

Orbital Data for Mars Global Surveyor

The following list continues the orbital data lists contained in earlier issues of *Satellite Times.*

1998 Feb 9.65	93.60 deg	1,059.37 min	103 km	25,833 km
1998 Feb 14.69	93.61 deg	1,000.48 min	103 km	24,609 km
1998 Feb 19.81	93.59 deg	964.35 min	103 km	23,846 km
1998 Feb 24.39	93.61 deg	920.75 min	102 km	22,913 km
1998 Feb 1.39	93.59 deg	880.57 min	102 km	22,040 km
1998 Feb 6.75	93.58 deg	834.62 min	103 km	21,023 km

The data used to derive these orbits were obtained from the Jet Propulsion Laboratory worldwide web page. ST

World Radio History

By Ken Reitz, KS4ZR
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How to be an Amateur Radio Pioneer

You've probably heard stories about the early days of radio and thought how interesting it must have been to live at a time when wireless was the cutting edge technology. Maybe you've wished you had the opportunity to live in those exciting times and not these days where all the interesting things have already been invented.

Back in the early days of this century amateur radio was at the forefront of communications technology. New modes and frequencies were being explored and, while the average person was still listening to crystal sets, hams were building regenerative receivers with unimaginable signal amplification. Well, maybe it's time you took another look at amateur radio, because at this end of the century, hams are still leading the way.

Old-time New Technology

By now you're most likely aware of the new satellite cell phone systems currently being launched. These systems fly anywhere from a dozen to hundreds of satellites in low earth orbit (LEO) with the purpose of handling phone and data traffic from small hand-held cell-type phones. This whole concept was pioneered over 30 years ago when AMSAT (Amateur Radio Satellite Corp.) built and launched its first satellite, Oscar-3, in March of 1965. Operating in the 2-meter amateur radio band (144-148 MHz) its one watt output was active all of 18 days. (Hey, you have to start somewhere!)

It wasn't until 1972, with the launch of Oscar-6 operating in the same band, that AMSAT finally got their money's worth. This satellite lasted four and a half years. Since then the all-volunteer designers and builders of these satellites have built upon their skills and have launched dozens of satellites operating in five amateur radio bands from High Frequency (HF) at 21 MHz (15 meters) to Ultra High Frequency (UHF) at 2.4 Gigahertz (GHz). In fact, the oldest AMSAT still functioning is Oscar 11, launched in March of 1984 and still sending data at 2.4 GHz. Now, that's a record any national space agency would be proud of!

Meanwhile, technology has paved more than a few lanes to the communications future and the result is that you no longer have to be a techno-wizard to get involved in listening to some of the action on the AMSATs. Solid state technology has made more equipment smaller and cheaper. Computers have broadened the operating capabilities by providing newer and faster data communications. Some AMSATs allow operators to send e-mail back and forth with an ingenious system by which operators on one part of the globe send "packet" messages, addressed to another ham on the other side of the world. Ninety minutes later, when the satellite zips over the other ham's shack he, or she, downloads the message. Most of this technology is available "off-the-shelf" and relatively cheap; all you have to do is put it together.

All AMSATs have onboard "beacons" which are a Morse code identifier which plays over and over as it travels through space. Since they're always transmitting these beacon frequencies are the easiest to tune in when they're over your house. You can tune in some of these beacons using a simple shortwave radio or public service band scanner. Some of these beacons also transmit data pertaining to the condition of the satellite including a thermometer which tells listeners the temperature of the spacecraft. Others relay information regarding transponder schedules.

AMSAT's New Frontier

The original Oscar-1 satellite cost virtually nothing to build and launch as it was done by volunteers using donated parts and was launched piggyback on a U.S. Air Force rocket which sent a military photo recon satellite into orbit. Now AMSAT's dreams are considerably more extensive and expensive.

The latest satellite, dubbed "Phase-3D," is to launch later this year and is the culmination of tens of thousands of man-hours in the design and construction of the most ambitious amateur satellite to date. The level of sophistication in this satellite is so great that AMSAT has racked up donations totaling several million dollars for its construction. After years of effort the expected launch of this satellite will usher in a new era in the amateur radio hobby.

Phase-3D will showcase no fewer than seven bands of amateur radio frequencies including a special downlink-only frequency in the 10-meter band (29.330 MHz) which will transmit special voice bulletins in the AM mode. These voice bulletins will be uplinked by Phase-3D controllers and stored in a digital recording device to be replayed in a continuous "loop" on that frequency. This means that using a simple, cheap, portable shortwave radio you'll be able to monitor this frequency wherever you are. You can bet that there'll be a special voice bulletin right after launch day and I hope you'll be among the first to hear it!

One of the other interesting things about Phase-3D is that it will travel in an elliptical orbit. This orbit will take it from a perigee of 4,000 km to an apogee of more than 47,000 km. LEO satellites have very small "footprints," that area of earth below them which makes it possible for operators to access a satellite. The elliptical orbit allows a much greater area to be in the satellite's footprint. This means that not only will more hams be able to use the satellite but that it will appear to remain in view for a much longer time than LEO satellites. Now hams will be able to have more extensive conversations than they are allowed on the fast moving LEOs.

Look at the *Amateur Satellite Frequency Guide* section of the *Satellite Services Guide* in this issue of *ST* for details on which satellites are operating and in what modes. For the very latest information on all amateur satellites, including SAREX and *Mir* amateur radio activities, as well as latest launch schedules and news concerning AMSAT, visit the

World Radio History

AMSAT web site at **http://www.amsat.org**. This is a large and very well organized site, and you could easily spend a hour just browsing around.

AMSAT also has some great introductory material regarding proper amateur satellite operating procedure and techniques. An excellent place to start is the latest edition of Keith Baker's *How to Use the Amateur Radio Satellites* This 35 page booklet is written in an easy to understand style, has a thorough glossary, explains all basic satellite functions and lets you in on all the action. It is available for a modest fee from AMSAT headquarters.

Two astronauts, Charles Bolden, amateur radio call sign KE41QB, (top left) and Linda Godwin, N5RAX, (top right) communicate with students throughout the United States using the Shuttle Amateur Radio EXperiment (SAREX). The top center picture shows a launch of space shuttle Columbia, which has carried the SAREX payload with regularity. The two student groups are SAREX participants from the Clear Creek Independent School District of Houston, Texas, who communicated with space shuttle Atlantis on the STS-37 mission (bottom left) and Challenger Middle School of Huntsville, Alabama, who contacted the shuttle Endeavour during STS-47 (bottom right).

Listening In

The best part about getting involved with amateur satellites is that you don't have to be a ham to participate. All of the frequencies listed in the above mentioned section of *ST* show "down link" or receive frequencies. This is where the satellite is transmitting to ground. You don't need a license to listen and the equipment can be amazingly simple.

Basically, you'll need three components: an antenna, a radio and the cable to connect the two. For some monitoring you'll actually only need a radio. For instance, listening to beacons on RS-12/13, a Russian satellite, you can tune 29.4081 or 29.4543 MHz on a shortwave receiver with a built-in beat frequency oscillator (BFO). You can also listen to the 2-meter beacon on 145.9125 or 145.9587 on a scanner. If the satellite is over your house you won't even need an external antenna. I've received excellent signals from a 2 meter hand-held transceiver tuned to the frequencies of the DoveSat, Mir, and SAREX downlinks.

To expand your listening horizons you can add a simple dipole for the HF bands or a simple ground plane for the VHF/UHF bands. Omni-directional vertical antennas work best for just listening. Transmitting requires far more effort and more complicated antennas. Even if you're "just listening" use a high quality coaxial cable with factory fittings for best results. Radio Shack and Grove Enterprises, among others, sell excellent antennas and cable for use in these bands.

The cheapest way to listen is to tune a receiver to the frequency you hope to hear. The problem with this is that you'll have to endure the unmodulated hiss of the unused frequency until the spacecraft comes over your horizon. The most effective way to monitor amateur space activities is to know which satellites are passing over your area and when. To do this you'll need a tracking program and many are available in the pages of this magazine and through AMSAT.

These programs will require a computer of some sophistication. There's also a very cheap way of tracking satellites using a Commodore C-64 computer and the Super VR85 tracking program. This is a slow and limited program, but it does the job for very little investment.

Getting Your Ham Ticket

It may not be long after you've listened to some of the action and done a little tinkering on your own before you might start thinking about transmitting your own signal into space. You might also think that getting your amateur radio license is a process of mind-numbing studying and learning the dreaded Morse Code. If so, I have some very good news for you. To access many of the AMSATs you need only a Technician Class amateur license which is an entry level ticket requiring *no code*!

There are many good study guides in print which will help you pass your test including those from the American Radio Relay League (ARRL) and Radio Shack. There's even a video study course which makes it so easy that, if you can watch TV, you can become a ham. I know this because two members of our family are Technician Class licensees because they watched those tapes and passed with flying colors! You can, too.

If you want to get involved in bands which require higher grade licenses you can study for those later. In the meantime you can get your feet wet and explore outer space without leaving your home in what may later be called the Golden Days of amateur radio satellite communications.

And, in another couple of decades you can amaze your grandchildren by displaying QSL cards received by working some of the first amateur radio satellites. You will indeed be a amateur radio space pioneer.

Here are some sources to continue your own personal journey of space exploration:

AMSAT
850 Sligo Avenue Suite 600
Silver Spring, MD 20910
Phone 301-589-6062, FAX: 301-608-3410
http://www.amsat.org
Publishes *How to Use the Amateur Radio Satellites* and sells satellite tracking program (Orbits II).

American Radio Relay League (ARRL)
225 Main Street
Newington, CT 06111-1494
860-594-0355, FAX: 860-594-0303
http://www.arrl.org
Has Technician Class study guides including video course and sells satellite tracking programs.

Grove Enterprises
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Brasstown, NC 28902-0098
800-438-8155, FAX: 704-837-2216
http://www.grove-ent.com
Sells shortwave radios, scanners, antennas and cable, satellite tracking programs.

Radio Shack
To find the Radio Shack nearest you call:
800-THE-SHACK or visit their web site at:
http://www.radioshack.com
Sells shortwave radios, scanners, antennas, cable and Technician Class study guides.

Super VR85
Satellite tracking program for Commodore 64 computers. Requires a disk drive.
RLD Research
McCloud, CA 996057-0888

World Radio History

By Doug Jessop

DBS Watch

Congress is poised to rescind some of the increase in fees that satellite broadcasters pay to retransmit some broadcast programming. "We'll get at least that part of [satellite reform legislation] done" Senate Commerce Committee Chairman John McCain (R-Arizona) commented recently. Ken Johnson, spokesperson for the House Telecommunications Subcommittee Chairman Billy Tauzin (R-Louisiana), stated "We are very confident of getting the [Copyright Office] decision stayed."

The U.S. Copyright Office decision he is referring to ruled that DBS companies would need to pay 27 cents per month to transmit network and superstation signals over their birds. Previously DBS providers had been paying 6 cents per subscription for network signals and about 16 cents per subscriber for superstations. Cable stations pay around 9.5 cents per subscriber to retransmit similar signals.

According to the satellite research group, SkyTrends, in the quarter ending March 1997 DBS penetration surpassed 10 percent of all TV households in about half of the 50 states (see chart A). Regionally, satellite penetration is the greatest in the Upper Plains states as well as the South. Five of the top ten growth areas were in the Northeast: Rhode Island, Massachusetts, Maryland, New Jersey and Washington, D.C.

Those market shares may see a big rise with the new partnerships formed by DirecTV and USSB with Bell Atlantic and SBC Communications. In a move that is described as everything the DirecTV's deal with AT&T wasn't," the deals with SBC will offer both USSB and DirecTV programming to apartment dwellers as part of a package of telecommunications and entertainment services.

USSB

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Top Ten States in DBS Penetration

Montana	22%
Vermont	21%
Wyoming	17%
Mississippi	15%
Maine	15%
Arkansas	14%
Idaho	13%
South Dakota	13%
West Virginia	13%
Alabama	13%

New Programs and Channels Coming to a Bird Near You

The Jim Henson Co. announced that it would start a family-oriented cable television network. Heading up the project will be Margaret Loesch, former head of Fox Kids Network, who has been named president of Jim Henson Television Group.

The Disney Channel has contracted to use PowerVu MPEG-2 digital compression from Scientific Atlanta to launch a new 24-hour cartoon channel called Toon Disney. The new channel debuted on April 18, the 15th anniversary of The Disney Channel. Toon Disney will be broadcast to cable systems as a companion to its parent channel of Galaxy VII.

UPN has ordered 13 episodes of an animated series based on the popular comic strip, *Dilbert*.The strip, created by Scott Adams, is about a regular guy working in an office cubicle. According to my sources, the show will premiere on Tuesday nights some time next season.

MTV confirmed that is has approved 20 new pilots for the 1998 season. Among the pilots will be *Artist's Cut*, in which a featured band member comments on his/her band's music video and *Videographies*, which will provide information on various musicians. Currently in development are *Diary of a Horny Young Man*, from *Barney Miller* writer Jordan Moffett and *D.U.M.B.O.*, from *Die Hard* writer Seven de Souza. The folks at MTV have obviously gathered the finest minds available to provide you this plethora of high brow programming!

Executives at the FX cable channel said that comedian Bobcat Goldthwait is currently developing a variety show for them. The program is tentatively titled "Bobcat's Big-A Show."

Spokespeople for NBC confirmed that the network has hired former OJ Simpson prosecutor Marcia Clark to serve as a legal analyst. In her new position, Clark will provide commentary on legal cases for the network and its cable counterpart, MSNBC. Clark will also appear occasionally on CNBC as a guest host on primetime programs.

Wild Feed Frenzy

One of the fun things about a satellite dish is getting to see all the behind-the scenes stuff. Wild feeds are the nature of the beast when it comes to television. With the recent "Zippergate" frenzy in Washington, D.C. the frequency of wild feeds has greatly increased. I get press releases quite often for what are called VNR's, or Video News Releases. Essentially you have a live satellite feed with television stations lined up on a time schedule and they all get to ask questions of the "expert" on some issue. The poor person usually ends up answering the same question a dozen times. Some are rather mundane, but occasionally you get some cutting edge stuff.

Here's an example from the gang at World Satellite Television News, NY–"Local, network and international news teams seeking access for interview and photo-ops at the site of the discovery of the world's first blood substitute, just approved by the FDA, can contact the below listed people for one-ones and private taping sessions.

"The prime site is in Cambridge, Massachusetts; however, clinical studies were conducted at sites around the nation. Good opportunity to localize national story. B-Roll available, including bites with former Surgeon General C. Everett Koop, who was a leading force on this project, which many consider to be among the top-ten medical breakthroughs of the 20th Century. For

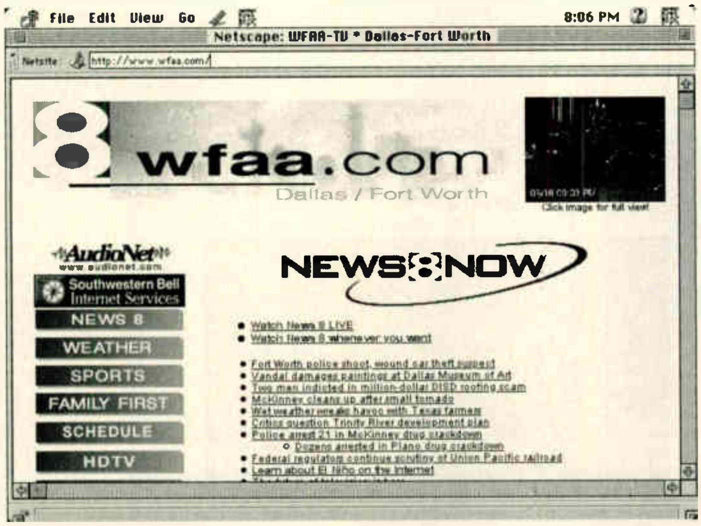
World Radio History

more information on this week's biggest Medical Story go to **http://www.whatsup.com/blood.**"

CNN Newsource, the world's most extensively syndicated television news feed service, has added Saturday and Sunday 4 p.m. (ET) CNN/SI Newsource Sports feeds to its existing comprehensive weekend feed schedule. These new 30-minute, sports-only feeds began Saturday, March. 14.

The additional feeds will provide stations with significantly more sports material at an hour that allows greater editing time for newscasts in all time zones. Like all sports material fed to CNN Newsource affiliates, the footage contained in these feeds will be produced by CNN/SI, the sports news network from CNN and *Sports Illustrated.*

Besides solar flares and space debris, the weather can sometime pose problems to your favorite satellite feed. Fierce rainstorms in Los Angeles cut off satellite transmission of *The Rosie O'Donnell Show* to several stations on the East Coast recently. According to sources at WABC/Channel 7 (New York), the station was forced to pull a pre-taped edition of Rosie just a few minutes prior to its scheduled broadcast.



WFAA-TV in Dallas became the nation's first TV station to begin permanent operation of a digital transmitter, but not without a hitch. Just after beginning its digital transmission, some of the 60 wireless heart monitors at nearby Baylor University Medical Center stopped sending data to nurses' stations.

Technology Keeps Pushing Forward

On Friday, February 27, WFAA-TV in Dallas became the nation's first TV station to begin permanent operation of a digital transmitter, but not without a hitch.

Just after beginning its digital transmission, some of the 60 wireless heart monitors at nearby Baylor University Medical Center stopped sending data to nurses' stations. Despite rigging up a back-up system that seemed to work Friday night, interference with the machines started up again on Saturday.

When a colleague mentioned to Steve Juett, Baylor's senior clinical engineer, that WFAA had started using Channel 9 for digital TV, he knew just what the problem was. The hospital's unlicensed, low-power transmitters had been using portions of the radio spectrum equivalent to TV Channels 7 and 9. The interference would stop when WFAA's transmissions stopped at night. Juett contacted the station Sunday morning and WFAA sent 10 engineers to evaluate.

It hasn't transmitted a digital signal since. "It's their problem but we feel a large obligation to a hospital," said Craig Harper, Asst. Manager of Engineering at the station. Although the interference didn't cause any harm, WFAA said it would wait until the hospital installed a new system before resuming digital broadcasts. The good side?

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BRK 8	Dash mount bracket	$31.80
DCC 9	Cigarette lighter adaptor	$23.30
CAS 05	Carrying case	$12.69

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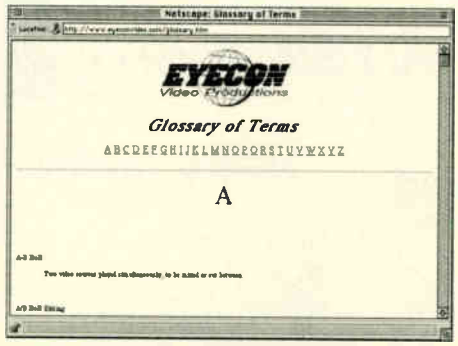

TABLE 1: U. S. Domestic Arc Status Report As of March 24, 1998

By Larry Van Horn

Long West	Name	Downlinks GHz (No transponders)	Year Launched	Projected End of Life	Type Satellite
61.5	Echostar 3	12.2-12.7 (11)	1997	2012 (15)	LM A2100
74.0	Galaxy 6	3.7-4.2 (24)	1990	2002 (12)	Hughes HS-376
	SBS 6	11.7-12.2 (19)	1990	2000 (10)	Hughes HS-393
77.0	SBS 4	11.7-12.2 (10)	1984	2005 (inclined)	Hughes HS-376
79.0	Brazilsat A1	3.7-4.2 (24)	1986	Inclined orbit	Hughes HS-376
81.0	Satcom K2	11.7-12.2 (16)	1985	Inclined orbit	GE Astro-Space
83.0	SpaceNet 3R	3.7-4.2 (18)/11.7-12.2 (6)	1988	1998 (10)	GE Astro-Space
85.0	GE-2	3.7-4.2 (24)/11.7-12.2 (24)	1997	2012 (15)	LM A2100
87.0	GE-3	3.7-4.2 (24)/11.7-12.2 (24)	1997	2012 (15)	LM A2100
89.0	Telstar 4	3.7-4.2 (24)/11.7-12.2 (16)	1995	2008 (13)	LM Series 7000
91.0	Galaxy 7	3.7-4.2 (24)/11.7-12.2 (24)	1992	2004 (12)	Hughes HS-601
95.0	Galaxy 3R	3.7-4.2 (24)/11.7-12.2 (24)	1995	2007 (12)	Hughes HS-601
97.0	Telstar 5	3.7-4.2 (24)/11.7-12.2 (28)	1997	2012 (15)	SS/Loral FS-1300
99.0	Galaxy 4	3.7-4.2 (24)/11.7-12.2 (24)	1993	2007 (14)	Hughes HS-601
101.0	Spacenet 4	3.7-4.2 (18)/11.7-12.2 (6)	1991	2001 (10)	GE Astro-Space
	DBS-1	12.2-12.7 (16)	1993	2005 (12)	Hughes HS-601
	DBS-2	12.2-12.7 (16)	1994	2006 (12)	Hughes HS-601
	DBS-3	12.2-12.7 (16)	1995	2007 (12)	Hughes HS-601
103.0	GE-1	3.7-4.2 (24)/11.7-12.2 (24)	1996	2011 (15)	LM A2100
105.0	GStar 4	11.7-12.2 (16)	1990	2000 (10)	MM Series 3000
107.3	Anik E2	3.7-4.2 (24)/11.7-12.2 (32)	1991	2003 (13.5)	GE Astro 5000
109.2	Solidaridad 1	3.7-4.2 (18)/11.7-12.2 (16)	1993	2007 (14)	Hughes HS-601
111.1	Anik E1	3.7-4.2 (24)/11.7-12.2 (32)	1991	2004 (13.5)	GE Astro 5000
113.0	Solidaridad 2	3.7-4.2 (18)/11.7-12.2 (16)	1994	2008 (14)	Hughes HS-601
116.8	Morelos 2	3.7-4.2 (18)/11.7-12.2 (4)	1985	1998 (13)	Hughes HS-376
118.6	Anik C1	11.7-12.2 (16)	1985	1998 (13)	Hughes HS-376A
118.8	Tempo 2	12.2-12.7 (16)	1997	2007 (10)	SS/Loral FS-1300
119.0	Echostar 1	12.2-12.7 (16)	1995	2010 (15)	LM Series 7000
	Echostar 2	12.2-12.7 (16)	1996	2011 (15)	LM Series 7000
120.0	Telstar 303	3.7-4.2 (24)	1985	1998 (inclined)	Hughes HS-376
123.0	Galaxy 9	3.7-4.2 (24)	1996	2008 (12)	Hughes HS-376
	SBS 5	11.7-12.2 (14)	1988	1998 (10)	Hughes HS-376
125.0	Galaxy 5	3.7-4.2 (24)	1992	2002 (10)	Hughes HS-376
131.0	Satcom C3	3.7-4.2 (24)	1992	2004 (12)	MM Series 3000
133.0	Galaxy 1R	3.7-4.2 (24)	1994	2006 (12)	Hughes HS-376
135.0	Satcom C4	3.7-4.2 (24)	1992	2004 (12)	MM Series 3000
137.0	Satcom C1	3.7-4.2 (24)	1990	2000 (10)	MM Series 3000
139.0	Satcom C5 (Aurora 2)	3.7-4.2 (24)	1991	2001 (10)	MM Series 3000

Total Domestic Communications Satellites	38
Total Dedicated DBS satellites	7
Total C-band transponders	492
Total FSS Ku-band transponders	491
Total BSS Ku-band transponders	107

Abbreviations

GE	General Electric
LM	Lockheed Martin
MM	Martin Marietta
SS	Space Systems

WFAA isn't losing any viewers as digital TV sets aren't yet sold in stores.

Net Watch

Eyecon Video has assembled a web site that gives Internet surfers video production tips from A - Z. With tips for the novices all the way to the pros, **http://www.eyeconvideo.com** has information for everyone interested in video production. The tips are categorized into sections that include tips for lighting, audio, shooting, editing, location shooting, hint for those who have their own video business and even an extensive glossary of terms. These tips include quick pointers that share an idea to longer articles giving advice about concepts. All are aimed to assist anyone in the video production process.

Here's a new interactive game for TV station websites, *Trivialink*, currently in production only for FOX affiliates, includes 8 questions each week and is customized on-the-fly to look like each station's website. You can play the game by logging onto the **http://www.fox5atlanta.com** website, clicking the *Trivialink* button and enter your name and e-mail address. FOX stations in Philadelphia and Oklahoma City will be online shortly, and dozen stations are considering adding the game to their websites.

While you are searching around on the Internet, you might as well win some prizes. The Internet Treasure Hunt(tm) is a monthly online scavenger hunt where prizes from software and CDs to a night's stay in a suite hotel are given away. Check it out at **http://www.InternetTreasureHunt.com**

Sources for this months article include friends in the business as well as *Los Angeles Times, USA Today, Wall Street Journal, New York Daily News* and *New York Post.* As always, your comments are welcome at **http://www.searcher.com/STcomments.html**.

ST

Doug Jessop has been in the broadcasting industry since 1979. He was the original creator and editor of the North American Satellite Guide.

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Even the Earth's electrical disturbances which produce the auroras (shown here in this NASA photo) can be monitored by the WR-3E VLF receiver.

Now you can hear the ethereal sounds of the earth and its environment. Distant lightning discharges, the aurora borealis, and even solar winds produce "whistlers," "hisses," "wavers," "tweeks," "swishers," and even a medley called the "dawn chorus!" And with the solar cycle on the increase, these radio phenomena are on the increase! Electrical applicances produce a symphony of their own, and even swarms of insects can be detected by this sensitive receiver!

Since its development in 1991, many of these tiny receivers have been used by universities for atmospheric ("sferics") and geological research. As you walk through sand or over gravel, you will hear the piezoelectric discharges of the granuals as they rub together. Strolling through your home or office, you can audibly detect the panorama of electromagnetic radiations from nearly anything with a power cord on it!

You can even use this unique product as an electrical interference probe, walking around your home or office looking for sources of electrical discharge, pulse, or spark interference affecting radio and TV reception. A 3-position filter selects best reception as you listen through the earphone, while an RCA phono jack permits connection to your tape recorder.

You can't hear all of these sounds on your shortwave receiver or scanner, but the very low frequency (VLF) spectrum comes alive with special listening tools like the new WR-3E handheld receiver. Now you can monitor approaching electrical storms, nearby electrical appliances, motors, power lines, and other emitting devices in the 100-8,000 Hz range! **Order RCV 23, only $139.95 plus $9.50 UPS 2nd Day Air.**

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World Radio History

By George Wood
wood@rs.sr.se

The Mouse's Tale — Out of Scandinavia

Country Music Television Europe went off the air on March 31, the first of a small number of American stations reversing the trend and leaving the European market. While its departure opens up some prime analog transponder real estate on Astra, it's also left an interesting vacuum to Scandinavia among the channels offered by Telenor at 1 degree west. CMT has been part of the "Sky Entertainment" channel that British Sky Broadcasting (owned by Rupert Murdoch's News Corp) distributes to Scandinavia (on 11.667 GHz). Ironically, none of the Sky Entertainment programming actually comes from BSkyB. Besides CMT the rest of the package comes from Granada.

But CMT's disappearance left a hole in the Sky Entertainment package, and rather than actually put any of programming from other parts of the Rupert Murdoch empire there, Sky has been negotiating with CMT to include the American version of the channel in Sky Entertainment.

Murdoch has also moved into Sweden on another front. The Stockholm commercial radio station Classic FM was originally started by the British company of the same name, which carried its round-the-clock classical music format as well to Finland and the Netherlands, before some retrenching a couple of years ago. At one point a top BBC World Service official assured me that he had signed a contract with Classic FM to carry BBC news on the hour (in English) to Stockholm. That never happened, and Stockholm's Classic FM has had a hard time breaking even. It did outlast a rival classical station from the Kinnevik media empire, Classic Radio, which finally switched to a more successful dance music format.

But the British owner finally gave up, and Stockholm's Classic FM been sold a couple of times, and since March 3, the frequency now belongs to Murdoch's Dutch-based Sky Radio. The programming is similar to the regular Sky Radio, light rock and pop, but is not in parallel with Sky Radio's Dutch service on Astra. It's non-stop music, with occasional mixed English and Swedish IDs. Classic FM was the last Stockholm commercial FM station playing anything other than rock and pop. Now Sky Radio is on 107.5 MHz, and sounds like the rest of the commercial dial.

But while Rupert Murdoch is moving in, the world's number one media empire is trying to get out. Disney, through its purchase of ABC, owns the largest stake (19.6 percent) of the Scandinavian Broadcasting System, which has satellite TV stations in Sweden, Denmark, and Norway, among other interests (such as VT4 in Belgium and SBS6 in the Netherlands). But according to press reports, Disney wants to divest itself of ABC's foreign holdings, which are not consistent with its goal of marketing Disney and ESPN channels. While Kanal 5, having carried Disney cartoons daily for many months, suddenly switched to Warner Brothers' cartoons instead recntly, according to another report, Disney's distribution subsidiary Buena Vista International is in discussions to extend its current agreement with SBS.

Meanwhile, the three SBS TV stations have agreed to leave the free world of uncoded transmissions, and are coming under the umbrella of the Canal Plus/Canal Digital pay system. Sweden's Kanal 5 and Norway's TV Norge have been just about the only Scandinavian satellite stations using the conventional (and uncoded) PAL broadcast system, while Danish partner TV Danmark has used uncoded D2-MAC. Now all that will change, and viewers will only be able to watch the SBS station aimed at their country, rather than all three. Besides joining Canal Digital's MPEG-2 package, all three will also become coded D2-MAC channels.

Disney is making news on another front. The Mouse has finally been freed from the prison Disney let Murdoch build around the Disney Channel. British broadcast regulators said February 27 that BSkyB had agreed to stop bundling the Disney Channel with its two subscription movie channels. The Independent Television Commission had investigated the matter after British cable operator Videotron complained that its viewers were required to purchase two BSkyB movie channels before they could get the Disney Channel. Beginning, March 2, the Disney Channel has been available to cable operators on a stand-alone basis.

BBC Prime has left Intelsat 707, 11.014 GHz (MPEG-2), a Canal Digital package it shared with TV Danmark, TV1 Estonia. Eurosport, CNBC, and Totoline. It continues in D2-MAC on 11.679 GHz, and as part of the Telia digital packages on rival Sirus 2.

The international BBC World and the new domestic BBC News 24 are to merge their overnight programming from April 1. A combined bulletin, led by an international story, will be broadcast in the first half of each hour between 1:00 and 5:00 a.m. British time. (One wonders why the BBC needs two 24 hour news channels, and why it needs two channels featuring virtually identical programming from the archives (UK Gold for the domestic audience and BBC Prime abroad?)

British culture secretary Chris Smith has urged rival television broadcasters to work together to ensure that digital TV is

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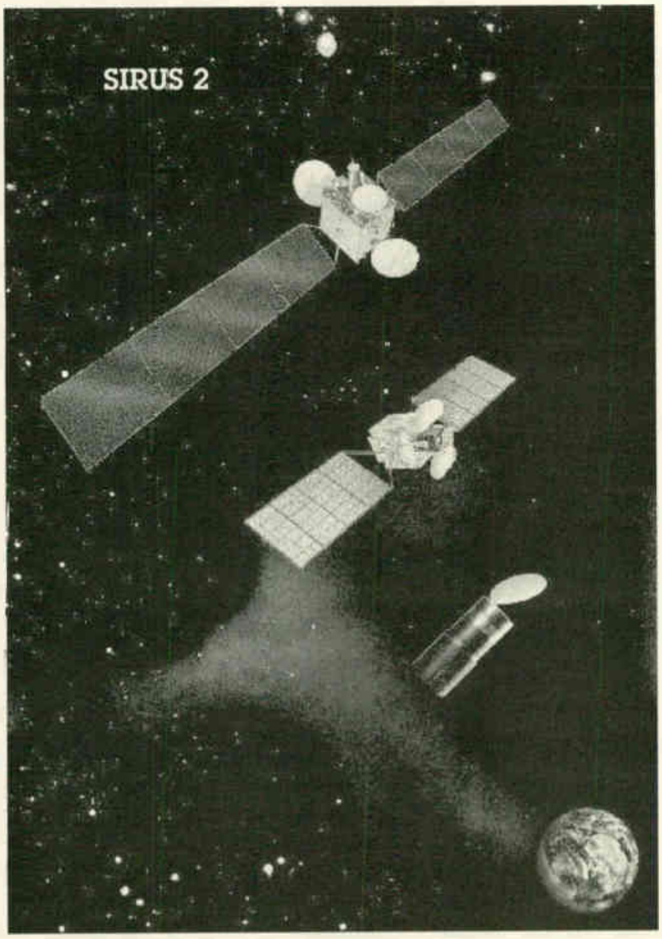

successfully launched in Britain this year. British broadcasters are competing to offer viewers digital TV via three systems, terrestrial, cable, and satellite. Smith says it is more important to focus on the service consumers would get rather than the on which platform delivers it. Satellite broadcaster BSkyB plans to lead the way in June, while terrestrial broadcasters British Digital Broadcasting (Carlton and Granada) plan to follow suit this Fall. Cable groups are also planning to offer rival services this year. It's a bit unclear what Smith means here....he doesn't seem to want them to use the same set-top boxes.

Meanwhile, BDB has risked the wrath of Rupert Murdoch and BSkyB by awarding a major technology contract to the rival Franco-German group SECA (owned by Canal Plus and Bertelsmann). BDB says it chose SECA set-top box over that of Murdoch's News Datacom, because the system is well tested across Europe with 1.5 million SECA set-top boxes in use. BSkyB has expressed concerned the digital decoders will not be compatible with its coming digital satellite service, and insists that BDB has an obligation to compatibility.

On the other hand, for its coming digital service, BSkyB has actually rejected the MPEG-2 receiver system used across the rest of Europe, which means that normal European MPEG-2 receivers, which have been sold in Britain for months, won't work with Sky's rather tardily introduced system. BSkyB has turned News Datacom's PAL encryption system Videocrypt into a virtual monopoly for anyone wanting to broadcast to Britain, so it must come as a shock that British viewers will be offered a European standard instead of a Murdoch standard.

In other Rupert news, News Corp and Austria's biggest building tycoon are planning to establish a private satellite TV channel. The monthly magazine *Trend* says talks have been underway between News Corp and Hans Haselsteiner, main shareholder in Bau Holding, with representatives from both Fox and the Fox Kids Channel visiting Vienna. The magazine says Austrian satellite TV (OFS) would transmit digital broadcasts for 24 hours a day, via Eutelsat.

The Granada Good Life channel is to be renamed Home and Garden TV from April, when Granada Sky Broadcasting makes some changes in an attempt in improve ratings. At the same time, the general enter-

tainment channel Granada Plus will get a new logo, and a what *What Satellite TV* magazine describes as a "fresher" onscreeen identity.

The Pan-European news channel Euronews will be revamped with more hard news coverage and in-depth reports from Britain's Channel Four, following the recent acquisition of editorial control of the station by Independent Television News. ITN has labelled the existing output as "Europudding," and wants to introduce longer ITN-produced features during the afternoon and primetime schedule to compete against CNN, Sky News, and CNBC, and BBC World. It will also increase sports coverage to seven days a week, and reduce the number of magazine programs.

Like its far more successful sister station Eurosport, Euronews has a common picture with soundtracks in a variety of languages. There have been no studio anchors, which has probably weakened its impact.

A new channel offering Asian language entertainment launched in Britain on March 1. Initially Sony Entertainment Television Asia will be offered on via cable, but it plans to launch a digital satellite service later this year.

While digital television is still just getting started in Europe, many countries have

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already begun regular broadcasts using Digital Audio Broadcasting. (The only problem is that the receivers still aren't in the shops.) DAB uses a chunk of spectrum to multiplex a shifting number of stereo or mono audio signals, along with a variety of data services, including text and images on small display screens.

Now BBC engineers have developed a new approach to satellite uplinking, which hopefully will improve the chances of DAB satellite delivery. Satellite DAB, using the Eureka 147 system, is seen by many as the future of international radio, but one of the arguments against it is that all of the service contributions (audio and/or data) would have to be uplinked from a common point.

Engineers at the BBC's Kingswood Warren research station have used a new technique called Time Division Multiplexing (TDM), which allows each broadcaster to uplink their output directly to the satellite, using a low-power Earth station. Recent trials using the Eutelsat II-F4 satelllite, uplinked from two mobile Earth stations, showed that the TDM system works well.

Eureka 147 has been adopted as the digital radio system for all of Europe, as well as Canada, Australia, and South Africa, and is expected to be on the air as well in India, China, and most of the rest of the world. The only market that has resisted the system is the US, since Eureka's method of having several stations share a datastream, while it fits in well with European public broadcasting, is less suitable for the American system of independent local stations.

However, despite all the opposition to the European standard, the American Consumer Electronics Manufacturers Association, after examining nine different digital alternatives, concluded that the only one viable as an advanced radio system is Eureka 147. So there's a chance we all may be using the same DAB receivers everywhere in the world soon, including for satellite reception.

CLT-UFA (owned by Luxemburg's CLT and Germany's Bertelsmann) has sold its 20 percent stake in the French digital satellite television venture Television Par Satellite. The French holding group Suez-Lyonnaise des Eaux is buying 15 percent and M6-Metropole Television (which is one-third owned by Suez-Lyonnaise) bought the remaining five percent. The other shareholders in TPS are the French domestic TV channel TF1 and French Television Enterprises, a combination of state-owned France Television and France Telecom.

EUTELSAT

Eutelsat's Hot Bird 4 was successfully launched from French Guiana on February 27. It wll be the fifth satellite located at 13 degrees east, and carries 20 transponders in the bands 10.719-10.949 and 12.615-12.731 GHz. On April 1 the Hungarian channel Duna Television is moving from Eutelsat II-F3 (16 degrees east) to Hot Bird 4, 10.815 GHz. Afro-Caribbean Satellite Television will start broadcasting to Europe from April. It will broadcast from Eutelsat II-F3 for two hours every evening.

DUNA
TELEVÍZIÓ

France's Fashion TV is ending all analog transmissions from Eutelsat's 13 degrees east. Only digital transmissions from Astra 1F 12.245 GHz will continue. Replacing Fashion TV on Eutelsat is a new German channel called BOB-TV, which will also be in clear PAL.

Croatia's HRT has stopped analog transmis-

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sions on Eutelsat II-F3 10.987 GHz. From April 15, HRT2 and HRT3 will be broadcasting as part of a Croatian/Slovenian package on Hot Bird 3 on 12.303 GHz, in Viaccess-coded MPEG-2. Radio stations and HRT1 will be carried uncoded.

A digital package of ESPN and the Arabic Orbit News is on Intelsat-K 11.494 GHz, but has changed from MPEG-2 to clear MPEG-1.5 (SR 20150, FEC 3/4).

A German version of Bloomberg Television will start on Astra in June, reportedly sharing transponder 11 with the British Bloomberg channel.

Asia/Pacific

A Japanese H-2 rocket failed to launch a communications and broadcasting satellite called Comets or Kakahashi (Bridge) on February 21, after its second stage burned for too short a time. The satellite, which cannot be put into a geostationary orbit, at 2.2 tons is one of the world's largest. It was to be used for experiments in new satellite broadcasting services, such as wide-band high definition TV and regional broadcasting.

DirecTV Japan has announced its new channel line-up from April 1. New programming includes:

Sports: Exciting Sports (tentative name), international sports channel (ESPN programming), QuesTV, Golf Network, J-Sports. WOWOW Sports and Music (tentative name)

Movies: Comin' Soon TV, SF Channel (science fiction), MOMO Channel, WOWOW Movie Channel (tentative name), Power Movie

Music and Culture: TVK Yokohama, Music Movie Channel, BET on Jazz, M-BROS, Music Japan Network TV, CoCoRo TV

News: JNN News Bird, MX-TV, BBC World

Education and Lifestyle: She-TV, Outdoor Channel

Adult: Satisfaction Channel

The service will also be launching a 29-channel audio service.

Sony Entertainment TV (mentioned above with a service to Europe) has started in PAL on Thaicom 3 (78.5 degrees east) on 3.520 GHz.

New Zealand's Sky Network, another part of the far-flung Murdoch empire, says it will launch its digital satllite service in the second half of 1998. An agreement has been signed with another Murdoch company, NDS Asia Pacific Pty (which used to be News Datacom Pty) to supply a smartcard system and digital compression equipment. NDS is the supplier of smartcards for Sky's existing analog service. What remains is to choose the supplier of the digital decoder hardware. Intelsat 806 was successfully launched with Atlas AC-151 on February 28. The launch was carried live on the Internet using RealVideo, and if you missed it, you can watch a recording on Intelsat's website at **http://www.intelsat.int.**

Intelsat 806 will be located at 40.5 degrees west, and will mainly serve South America. The satellite was originally due for launch on a Chinese Long March rocket. However, following a series of problems with the Long March, Intelsat switched to the American-built Atlas.

In other Internet news, as Sweden's *Sydsvenska Dagbladet* newspaper has a new URL, the location of Thorsten Koch's excellent *Internet Guide to International Broadcasters* and the Nordic Shortwave Center have changed:

Nordic Shortwave Center: **http://swl.sydsvenskan.se**
Internet Guide: **http://swl.sydsvenskan.se/iguide**

And while I'm at it, Radio Sweden's website has a new look, and a brand new URL at **http://radio-sweden.com.**

Thanks to this month's contributors. Besides regulars like *SATCO DX*, *SatNytt*, Curt Swinehart, Richard Karlsson, Michael Murray, Richarad Buckby, Martyn Williams (back on the scene with a new e-mail newletter from the otherwise moribund *Telesatellit News* called *TS-Asia*), and the excellent British magazine *What Satellite TV*, we have new contributors in Richard Buckby, and in Stefan Hagedorn from Germany, who's *Transponder News* can be viewed at: **http://www.hagedorn.komtron.com.**

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By Donald E. Dickerson N9CUE

The Secret of Planet One

The smallest commercially available satellite communication terminal in the world is Planet-1—the latest venture by a very familiar name in satellite communications. Planet-1 has revolutionized satellite communications with a terminal the size of your laptop computer (8.3 x 9.5 x 1.6 inches) which gives you access to any one of four geostationary satellites. This is the first user-friendly, lighweight, truly portable satellite terminal, and it is produced by none other than COMSAT Mobile Communications (CMC).

COMSAT is the only licensing agent for all Inmarsat services in North America. This, of course they still do, but Planet-1 is their proprietary program. They not only provide the Inmarsat satellite service for Planet-1, but they have developed the hardware and infrastructure for the system as well. Expectations are high that Planet-1 will become COMSAT's best seller.

The International Mobile Satellite Organization (Inmarsat) was organized by 22 member nations in 1979 (including the US) and began operation in 1982. COMSAT, with headquarters in Bethesda, Maryland, is a global provider of satellite services and digital networking technologies which use Inmarsat's nine geostationary satellites.

COMSAT provides a variety of mobile communication services to maritime, aeronautical and land mobile industries worldwide. Services include voice, fax, data, and telex services which are used for commnications by ships at sea, emergency response teams, news gathering organizations, natural resource exploration companies, shipping, oil rigs, governments, humanitarian agencies, private yachts, boats, and airplanes, as well as commercial airline and other international travelers.

Maritime services traditionally use COMSAT-A and COMSAT-B communication terminals. The A terminal is analog and the B is digital. Both are used for voice, fax, high-speed data and telex through the Inmarsat satellites. The B terminal operates at data rates of up to 64 kbps.

Smaller vessels use the COMSAT-C terminal. This terminal is portable, lightweight, and has a small antenna. It can be used for store-and-forward messaging via electronic mail telex networks. It can also be used for position reporting, remote monitoring, and control and internet E-mail access.

Land Mobile Satellite Services are able to utilize COMSAT-A, B and C terminals. In addition, the COMSAT-M service provides digital voice, fax and data services with through a very small terminal. COMSAT is the only company to offer all these services globally through their own earth stations, which are located in California, Connecticut, Turkey and Malaysia.

COMSAT Aeronautical Services provides a low and high speed data, voice and fax service to both private and commercial aircraft owners, government agencies, and the general aviation community. COMSAT also provides flight support for international flights in the form of traffic control services, airline operations support and passenger communications. They also provide the services for such companies as ARINC, AT&T Wireless, GTE Airfone and In Flight Phone on United, Delta and Air Canada flights. Other in flight services include, news, weather, sports and business ports and other entertainment.

Next Generation Inmarsat

Planet-1 will be supported by the newest generation Inmarsat III spacecraft. These satellites are much more powerful than their predecessors and use five separate high gain spot beam antennas. The spot beams allow much more efficient management of the spacecraft systems and traffic flow. Spot beams can be repositioned over land mass areas where there is the greatest demand for services, and they will permit a distinction between national and international calls, enabling new pricing strategies to be devised. Together, the four Inmarsat III spacecraft can provide over 2,200 channels.

Inmarsat terminals use frequencies between 1530 and 1560 MHz. Ships downlink on 1530-1544 MHz, Land Mobile use 1544-1545 MHz, and Aeronautical Services use 1545-1560 MHz. The uplinks are all located between 1626 and 1646 MHz. Gateway stations operate on an uplink frequency of 6.4 GHz and a downlink of 3.6 GHz.

The Inmarsat III fleet of satellites has been the first to be launched and controlled entirely by commercial and nongovernmental entities. The launches were controlled from Inmarsat headquarters in London, as was the orbit portion of the trajectory. The satellites were then turned over to leased ground stations in China, Italy, and two in Canada.

Personal Satellite Telephone

This system is able to provide worldwide roaming, voice mail, short messaging, call forwarding, caller ID and internet access—all in a package the size of your laptop computer. The high gain antenna is located in the lid of the terminal. The data stream for voice is 4.8 kbps and 2.4 kbps for fax, using Hayes compatible modems. Gateway stations for the Planet-1 system are located in Australia, Greece, Norway, France, Turkey and Japan.

According to Virginia Brooks, Manager of Network Access Technologies, "Planet-1 is an important step in the development of the infomaion skyway—a wireless public information highway that brings the power of our communications technologies for voice and data down to a personal level throughout the world."

Planet-1 is the world's first personal satellite telephone. It comes with its own Customer ID card the size of a credit card, which you slide into the side of the terminal when you make a call. Planet-1 communications can also be secured through the use of NSA approved STU-III encryption units, as can all other COMSAT terminals.

The Planet-1 terminal's Smart Card tells you at the beginning and at the end of each call how much time remains on the card. And it will tell you in any one of nine different languages!

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(Continued from page 17)

TABLE 1: Radio Astronomy Bands

Unless otherwise indicated all frequencies are in MHz.

13.36-13.41	This band is very important for observations of decametric radiation from the planet Jupiter and from the Sun.
25.55-25.67	This band is very important for observations of decametric radiation from the planet Jupiter and from the Sun.
37.00-38.25	This band is very important for research of radiation from Jupiter. Long after all the decametric frequency bands have been allocated and widely used by active services Jovian decametric radiation was discovered. The allocations to the radio astronomy service are extremely narrow since the interesting Jovian phenomena can cover the entire spectrum from 3-40 MHz.
73.00-74.60	ITU Region 2: Observations of emissions from the Sun (solar wind), Jupiter, stars, galaxies and interstellar clouds.
79.25-80.25	This band is used for monitoring the interplanetary "weather" structure in the solar wind by an international network of instruments.
150.05-153.00	ITU Region 1: This band is widely used in the United Kingdom and is a major band for the Giant Meter wave Radio Telescope (GMRT) in India. Also used for pulsar observations and solar observations.
322.0-328.6	Observations of pulsars (not allocation as passive only band): This band has the desired octave-spacing relation with the 150.05-153 MHz and 608-614 MHz bands, which is needed for continuum observations and in addition it contains an important atomic spectral line–the hyperfine- structure spectral line of deuterium at 327.384 MHz.
406.1-410.0	Observations of pulsars (not allocation as passive only band)
420.0-450.0	Arecibo Observatory, Puerto Rico radar and astronomy observations (not allocation as passive only band)
430.0000	National Astronomy and Ionospheric Center and Cornell University planetary research radar (part of Arecibo Radio Astronomy Observatory in Puerto Rico).
608.0-614.0	Very Long Baseline Interferometry (VLBI) for observing sources such as pulsars. (US TV channel 38 receive only scientific band)
1330-1400	Observations of Doppler-shifted radiation from hydrogen in galaxies
1420-1427	This band is the most important band for studies of the hydrogen line at 1420.4060 MHz and for continuum observations. 1420-1660 MHz also used for SETI survey programs.
1610.6-1613.8	This band is an important band for Hydroxyl radical (OH) line observations and is used in conjunction with the main OH bands in the next higher OH-band (1660-1668.4 MHz).
1660.0-1668.4	Observations of the Hydroxyl radical (OH) spectral line which is important for understanding interstellar medium and star formation in galaxies. In addition this band is used for continuum observations and also for VLBI.
1718.8-1722.2	Secondary allocation internationally for observation of hydroxyl radical spectral line.
2290.0-2300.0	Very Long Baseline Interferometry and NASA Deep Space Network
2320.0000	NASA's Solar System Radar in Goldstone, California
2655.0-2700.0	This band is primarily of interest for the study of continuum emission of radio sources. The spectral region 2655.0 to 2700.0 MHz is a good band for continuum measurements partly because the galactic background radiation is low, and also because radio astronomy receivers are of excellent quality and have very low noise at such frequencies.
2690.0-2700.0	Observations of galactic and extragalactic radio sources. Solar observations by the Air Force Solar Telescope Network.
2800.0000	Daily solar flux index is measured from Ottawa, Ontario, Canada on this frequency.
3260-3267	Three molecular lines of the CH molecule have been detected at 3263, 3335 and 3349 MHz. The study of interstellar CH is considered to be extremely important in understanding the chemistry of the interstellar material. The presence of CH suggests the existence of the molecule CH4 (methane) which is considered one of the basic molecules for the initial stages of the formation of life.
3332-3339	Three molecular lines of the Methyladyne molecule (CH) have been detected at 3263.794, 3335.481 and 3349.193 MHz.
4800-5000	The spectral region around 5 GHz has been one of the widely used frequency ranges in radio astronomy during the last decade. One of the most important uses of the band around 5 GHz is the study of the formaldehyde (H_2CO) interstellar clouds at 4829.66 MHz. The H_2CO line at this frequency is considered to be one of the most important radio lines in the entire spectrum, primarily because it can be detected in absorption in almost any direction where there is a continuum radio source.
4990-5000	Used to observe the distributions of brightness of objects in our galaxy and others, radio maps of interstellar clouds and supernova remnants. This area of the spectrum has a low level of galactic background continuum radiation. This band is also used for Very Long Baseline Interferometry (VLBI).
6650-6675.2	This band is important for observations of Methanol (CH_2OH) which is an important tracer of star formation activity.
8510.000	NASA's Solar System Radar in Goldstone, California (1 Megawatt of power)

All frequencies below this point are measured in GHz.

10.60-10.70	The frequency band 10 to 15 GHz provides some of the best angular resolutions (~2 arc minutes) using many large and accurate radio telescopes.This high-frequency range is also important for monitoring the intensity variability of the enigmatic quasars. The energy emitted during any one burst from a quasar is equivalent to completely destroying a few hundred million stars in a period of a few weeks or months.
14.47-14.50	At 14.4885 GHz, an important formaldehyde (H_2CO) line exists, which has been observed in the direction of many galactic sources.
15.1365-15.35	Radio astronomy band (shared)
15.35-15.40	Observations of quasars (passive receive only band): The small sizes of the quasars are revealed from the VLBI observations mentioned earlier (10.6-10.7 GHz). Such observations are also being made in the frequency band 15.35-15.40 GHz. The higher frequencies provide us with better angular resolution and enable us to determine more accurately the sizes and structure of quasars.
22.21-22.50	Used by radio astronomers to measure distances to far galaxies and Very Long Baseline Interferometry (VLBI). The band 22.01-22.21 GHz is of importance in conjunction with the adjacent band (22.21-22.5 GHz) for observations of redshifted H_2O.
22.81-22.86	This band is of importance for studies of a non-metastable ammonia line and two lines of methylformate.
23.07-23.12	This band is of special importance for studies of ammonia lines. There is a highly interesting methanol maser line immediately above the protected band at 23.121 GHz.
23.60-24.00	The band is used for observations of the main ammonia band in the interstellar medium and also important for continuum observations and for observations of a number of other spectral lines.
30.00-106.00	The new Millimeter Array (MMA) will help scientists understand the age of the universe; image distant galaxies/pre-planetary structures; measure the properties of subsurface layers of asteriods; and probe the outflows from thousands of stars, among other possibilities. The US-Mexican Large Millimeter Wave Telescope (LMT) will also use this frequency range.
31.10-31.80	This band is a continuum band.
36.43-36.50	This band is of importance for the search for HC_3N and OH lines.
42.50-43.50	The frequency region between 42.5 and 49 GHz contains important spectral lines of some diatomic and other molecules. The lines of SiO indicate maser emission. Other molecules detected in this frequency range include H2CO, CH3OH and OCS.
47.20-50.20	(See 42.50-43.50 GHz above)
48.94-49.04	Observations of molecular material in galaxies
51.40-54.25	This is an important radio astronomy band in the series of continuum bands.
58.20-59.00	(See 51.40-54.25 GHz above)
64.00-65.00	(See 51.40-54.25 GHz above)
86.00-92.00	This is an important radio astronomy band for continuum measurements and contains several natural lines, two of which are considered of special importance (see Table 2 for a complete list)
92.0-95.0	The band is important for many spectral lines including diazenylium (HNN+) (rest-frequency = 93.174 GHz).
95.0-100.0	This frequency range is important for its "forest" of molecular spectral lines: The primary allocation for the band 97.88-98.08 Ghz has the carbon monosulphide (CS) spectral line (rest-frequency = 97.981 GHz).
100-102	Radio astronomy band
101-120	SETI survey programs
105-116	This is one of the most important bands in the radio frequency spectrum, at least equal in importance to the hydrogen line band 1400-1427 MHz. The band contains many spectral lines, in particular the lines of carbon monoxide and its isotopes (CO) at 109.782, 110.201, 112.359 and 115.271 GHz which are not only the most powerful tool in the study of isoptope ratios, but are also essential in the study of cool clouds, regions of star formation and structure of our Galaxy and other galaxies.
116-126	Observations of ozone, carbon monoxide and nitrous oxide
140.69-140.98	This band is 300 MHz wide centered on 140.839 GHz, which is the rest-frequency of Formaldehyde (H_2CO).
144.68-144.98	This band is 300 MHz wide centered on 144.827 GHz, which is the rest-frequency of Deuterated Hydrogen cyanide (DCN).
145.45-145.75	This band is 300 MHz wide centered on 145.603 GHz, which is the rest-frequency of Formaldehyde (H2CO).
146.82-147.12	This band is 300 MHz wide centered on 146.969 GHz, which is the rest-frequency of Carbon monosulphide (CS).
150.0-151.0	This band is 300 MHz wide centered on 150.498 GHz, which is the rest-frequency of Formaldehyde (H_2CO).
160.0000	Cosmic background radiation from the Big Bang peaks around this frequency
164.0-168.0	This band is used for continuum observations.
174.42-175.02	Frequencies in the 174.0-182.0 GHz range contain useful lines for radio astronomy at 174.6, 174.85, 177.26, 178.4 and 181.2 GHz.
177.0-177.4	(See 174.42-175.02 GHz above)
178.2-178.6	(See 174.42-175.02 GHz above)
181.0-181.46	(See 174.42-175.02 GHz above)
182.0-185.0	This band contains important lines of water vapour at 183.31 GHz and ozone at 184.75 GHz.
186.2-186.6	In the band 185-200 GHz, the subband 186.2-186.6 GHz is used for observations of a spectral line of diazenylium.
197.0-220.0	SETI survey programs
217.0-231.0	The most important millimeter wave radio astronomy band. Observations of carbon monoxide, nitrous oxide and other complex molecules in gas within galaxies. Also used for observations of broadband noise from cosmic background radiation associated with the Big Bang (peaks around 160 GHz). The relevance of the band 217-231 GHz is that lines of carbon monoxide (CO) at 219.560, 220.399 and 230.542 GHz need to be observed in conjunction with CO lines in the band 105-116 GHz.
265.0-275.0	This band contains a very important series of spectral lines of the molecules C2H (262.5 GHz), HCN hydrogen cyanide (265.9 GHz), HCO+, formalyl (272.0 GHz).
300 and above	Not yet allocated but supposedly widely used for radio astronomy work.
500.000	NASA's Submillimeter Wave Astronomy satellite will observe astrochemical phenonmena near this frequency.

World Radio History

By Steven J. Handler

Around The World Phone

Magellan's World Phone is one of a new crop of wireless phones using satellites to provide voice, data, and fax communications from almost anywhere on the globe.

Compared to the large and complicated satellite phones of yesteryear, World Phone is small and lightweight. Measuring 10.2 inch (w) x 10.2 inch (d) x 2.2 inch (h), it's about the size of a laptop computer. It weighs in at 5.5 pounds including its battery and case.

Of prime concern to any user is how long you can go without having to recharge the battery. Magellan rates the rechargable 3000 mAh Nickel Metal Hydride battery to deliver up to 3.5 hours of talk time or 50 hours of standby time. For those using the phone where a conventional power supply is available, World Phone can also operate using 100-240 volt AC and 10-32 volt DC power. This allows the battery to be saved for those times when a local power supply isn't handy.

The list of those who might benefit by using World Phone to solve their communications needs is extensive. International business travelers, relief workers, search and rescue teams, disaster response crews, journalists, reporters and members of the media, those who travel to far flung places on short notice, as well as anyone traveling out of range of traditional wired and wireless communications systems might appreciate World Phone's convenience.

How Does it Work?

World Phone transmits calls up to one of the four operational Inmarsat 3 satellites orbiting 22,223 miles above the earth along the equator. The satellite in turn beams the calls back down to one of several earth stations which almost instantaneously connects it to the public telephone network, allowing the call to reach its destination. Calls to the satellite phone follow the reverse path.

The Inmarsat 3 satellites offer several types of communication services. These include the service Inmarsat calls "Mini-M" which is used by World Phone, as well as by a number of similar products. Inmarsat 3 satellites provide the Mini-M service using a series of seven spot beams to concentrate and maximize signals to specific geographic area of earth. This provides coverage to about 98 percent of the world's land masses.

Where can you roam and find no Mini-M coverage? Not many places. According to Inmarsat's coverage map, areas without service include New Zealand, Antarctica, some of the southern areas of the Pacific and Indian Oceans as well as the far North portion of Greenland, and portions of the Arctic Circle.

The Satellite System

Five satellites comprise the Inmarsat 3 system, four operational birds and an on-orbit spare. Inmarsat used launch facilities and rockets from the United States, Russia and the European Space Agency (ESA) to deliver their satellites into orbit.

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The first satellite in this constellation known as Inmarsat 3F1, covers the Indian Ocean Region and is often referred to by the initials IOR or Indian Ocean Region. Launched April 3, 1996, on an Atlas IIA rocket from Cape Canaveral, it entered service on May 11, 1996.

Inmarsat's 3F2 satellite was launched from Baikonur, Kazakhstan, onboard a Proton rocket on September 6, 1996. It became operational on October 13, 1996, and covers the Atlantic Ocean East region or AOR-E.

Shortly thereafter, on December 18, 1996, 3F3 shot skyward onboard an Atlas IIA rocket from Cape Canaveral. It is designated POR, it entered service on January 26, 1997, and covers the Pacific Ocean region.

Inmarsat 3F4 was hurled aloft by an Ariane 4 rocket from ESA's launch facility in Kourou, French Guyana, on June 3, 1997. It entered service on July 26. This bird is designated AOR-W, because it covers the Atlantic Ocean West region. The last satellite in this constellation Inmarsat 3F5 and it was launched from ESA's launch facility in Kourou, French Guiana, earlier this year on-board on Ariane 4 rocket. It is an operational spare. It orbits Earth, ready to take the place of any of the Inmarsat 3 satellites that fail.

The Inmarsat 3 constellation of satellites is controlled by Inmarsat's Network Control Center (NCC) and four Network Coordination Centers (NCS). One NCS is located in each of the four regions (AOR-E, AOR-W, POR and IOR).

Making Calls

We found using the phone simple and feel that even those with little or no technical training should have no problem learning how to use the phone and place calls. After opening the case, the first step is to remove the phone. Next you position the lid of the case, which contains the antenna, and the attached base of the case which acts a stand allowing elevation adjustments, in an unobstructed location facing toward the equator. The antenna needs to face the equator because that is where all of the Inmarsat 3 satellites are located. For those in the northern hemisphere including the United States, this is generally a southerly direction. For those in the southern hemisphere, this is generally a northerly direction. Since travelers may not immediately recognize which direction is north or south,

Magellan includes a compass embedded in the case.

We found that placing the antenna next to a window inside a building provided good reception. However, moving the antenna outdoors might be required depending on your location. World Phone, like most satellite phones, needs a clear path between its antenna and the satellite. Obstructions such as large trees, tall buildings, and mountains may block the path between the phone and satellite and prevent communications. Magellan provides a three meter cable to connect the antenna to the phone. A longer optional 80 meter cable can be purchased for those who need to place the antenna a considerable distance from the phone.

Once turned on, the phone goes through an internal procedure to locate and lock onto a satellite. If the antenna is not properly pointed at an available satellite, it will need to be moved to allow communications. World Phone's eight line by 40 character LCD screen displays the details of the search, including a bar graph indicating the relative signal strength of satellites it locates. When searching for a satellite, we like activating the phone's optional audio tone. It helps properly aim the antenna by allowing us to "hear" when the antenna is properly aligned, without having to look at the screen. After turning the antenna in the direction that provides the best signal strength, a simple key press stops the search process and selects that satellite for use.

We like the phone's large display screen with its easy-to-read characters. A signal strength meter alerts you to the strength of the satellite's signals while the elapsed time indicator helps control phone costs by providing you with a continuous readout during calls. In addition to the battery charge icon one expects to find on a display which graphically displays the battery charge, World Phone can also provide more detailed information, including the predicted amount of talk and standby time and percent of battery charge remaining.

The on-screen instructions and a "Help" function key are excellent features that help guide us through the task of locating and locking onto a satellite, as well as making calls. Don't let this long winded description intimidate you. With only a little practice we were typically able to locate and lock onto a satellite in about a minute. Once the satellite is locked in, calls can be placed or received.

We also like the phone's large keypad, which is similar to that found on wired phones. We think it's easier to use than the smaller buttons often found on cellular phones, especially for those with larger hands.

The phone's handset is lightweight and comfortable to hold against your ear. In general it delivers crisp and clear voice quality, comparable to many digital cellular phones. Although we find the sound quality very good, some users may not find the "digital" sound as pleasing as the analog calls experienced on traditional wired telephones.

A slight, but noticeable delay, was observed between the time we spoke and

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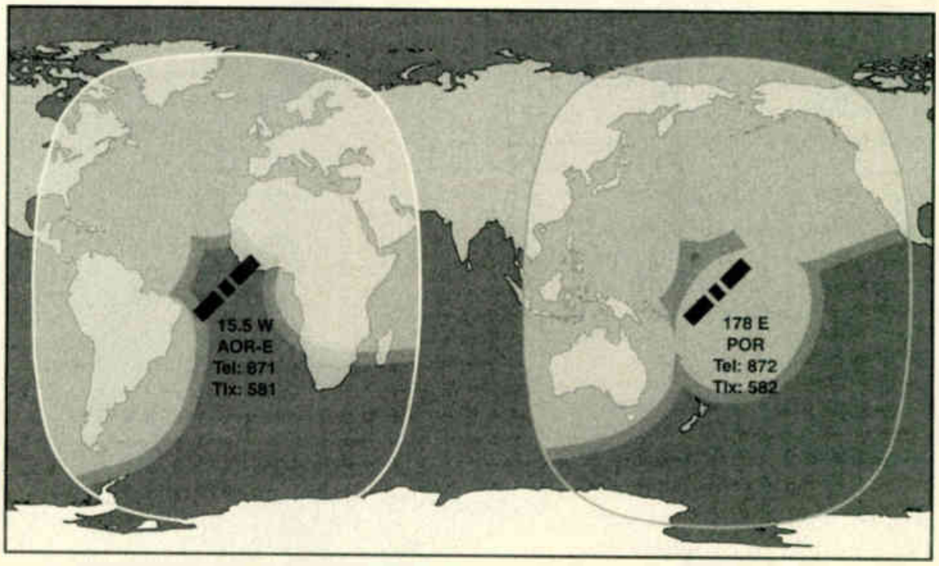
when our voice was heard by the other party. This is to be expected, and occurs because radiowaves, traveling at the speed of light, take about a quarter of a second to make the trip up to the satellite and then back down again.

The rear of the phone sports two RJ-11 jacks. These allow connection of a standard DTMF phone, cordless base station, PABX, or a Group III fax machine. In addition a DB9, a nine pin RS-232 plug, allows connecting to a laptop or desktop computer for data communications and can also be used to connect the phone directly to a printer. The 2.4-kbps data speed may seem slow for those who normally use 56-kbps modem.

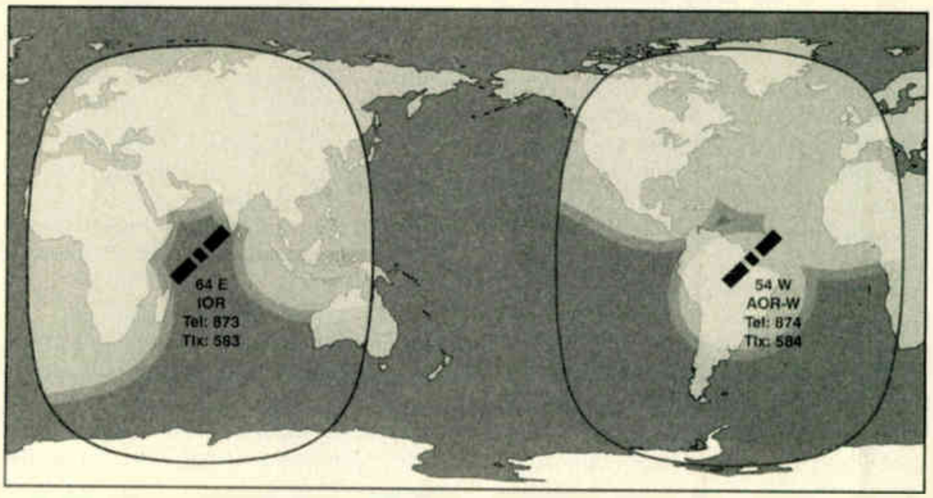
For those who routinely communicate confidential information, optional STU-III or STU-IIB secure communications interfaces are available.

The phone has other features too numerous to name, but we would like to comment on its memory. Most should find its 99 memory slots more than sufficient for storing frequently called numbers as well as name of up to 29 characters. In addition, when the phone is used in combination with a SIM card, an additional 100 entries with names of up to 10 characters can be stored directly on the SIM card. The phone also stores the last 10 numbers called (up to 22 digits each), allowing you to quickly recall and re-dial previously called numbers.

As is often the case, national politics gets in the way of technology and progress. Despite the fact that phones using the Inmarsat 3 Mini-M system may be capable of operating almost globally, some countries may restrict or prohibit their use. At the time of writing this review, here in the United States Inmarsat Mini-M is not authorized (with certain exceptions) for general public use. However, we understand that approval from the FCC has been requested.



Inmarsat Atlantic Ocean region (east) and Pacific Ocean region.



Inmarsat Indian Ocean region and Atlantic Ocean region (west).

World phone is designed for stationary use. However, according to Magellan, although the World Phone is designed primarily for stable platform land use, the phone's "forgiving" antenna does allow some individuals to use the phone on ships and aircraft. But if your needs include shipborne communications, consider checking out the specially designed World Phone system called World Phone Marine, which uses an auto-tracking antenna.

Overall we are very impressed with World Phone. It appears to be a solid performer. For those who are familiar with cellular and PCS wireless services and have come to expect inexpensive equipment prices and low cost usage charges, World Phone might provide sticker shock. Its suggested price is $3995, with service billed at $2.99 per minute. However, considering the scope of its coverage and the cost of comparable communications, the price can seem very reasonable. This may be especially true for those traveling off the beaten path or in areas where conventional landline phones and cellular phones are either not available, unreliable, or not convenient. If you're one of those people who needs virtual global communications, World Phone might be the answer.

The Magellan World Phone (PHN02) is available from Grove Enterprises for US$4,000.00. Contact (800) 438-8155 from within the U.S. and Canada or (828) 837-9200 from the rest of the world. You can order a World Phone via internet email at **order@grove.net**.

ST

For more information about WORLD PHONE contact:

Magellan Systems Corporation, 960 Overland Court, San Dimas, CA 91773
(800) 669-4477, (909) 394-5000
Website address:
http://www.magellangps.com

Grove Enterprises, 7540 Highway 64 West, Brasstown, NC 28902
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http://www.grove-ent.com

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Get Global E-mail in a Handheld Package: The Magellan GSC-100 is Shipping Soon!

Customers have clamored for the **GSC-100** from the time we first introduced it in *Satellite Times* more than a year ago. Now, 12 of the planned 36 ORBCOMM satellites are in low earth orbit, and the system is scheduled to be switched on around the middle of June. **The era of handheld global communications will begin soon!**

Magellan says users who activate their GSC 100 units with ORBCOMM by Sept. 30, 1998, will receive special pricing for the first six months of service, featuring **no monthly access fee and no limit on the size of the first 10 messages.** See What's New on p. 68 for more information!

The GSC 100 gives you the ability to **send and receive e-mail messages to and from anywhere on Earth**. It lets you stay in touch wherever life takes you. And, with its **integrated GPS receiver**, the GSC 100 not only lets you know where you are, it guides you anywhere you want to go. You can also relay that position to anyone, anywhere—no matter how remote you may be—with a GSC 100 e-mail message.

The GSC 100 utilizes the **ORBCOMM network**—the world's first wireless, two-way satellite personal communications system, providing true global coverage. Because the GSC 100 uses standard e-mail protocols, sending and receiving messages is easy. Communicate to any e-mail (Internet) address or another GSC 100. **Additional services will allow you to send your message via fax or voice.**

The GSC 100 communicates with the satellites on a standard narrow-band VHF frequency. Your e-mail message goes up to an ORBCOMM satellite and then down to a gateway station and is routed to its final destination via traditional methods. Retrieving your incoming e-mail is just as easy.

Unlike traditional land-line, cellular, and paging systems, the space-based ORBCOMM network offers global coverage, eliminating dead zones and providing seamless worldwide communications. The GSC 100 is a **convenient, reliable, and affordable solution for your global communication and navigation needs.**

*The first hand-held global satellite communicator with integrated **e-mail** and **GPS** is available from Magellan and Grove Enterprises. Winner of the 1997 Consumer Electronics Manufacturers Association's Innovations '97 Award at the Winter CES Show in Las Vegas.*

Twelve of the planned 36 ORBCOMM satellites (shown below) are now in place. Read Satellite Times for updates on future launches.

Order yours today—only $1499.95 from Grove

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World Radio History

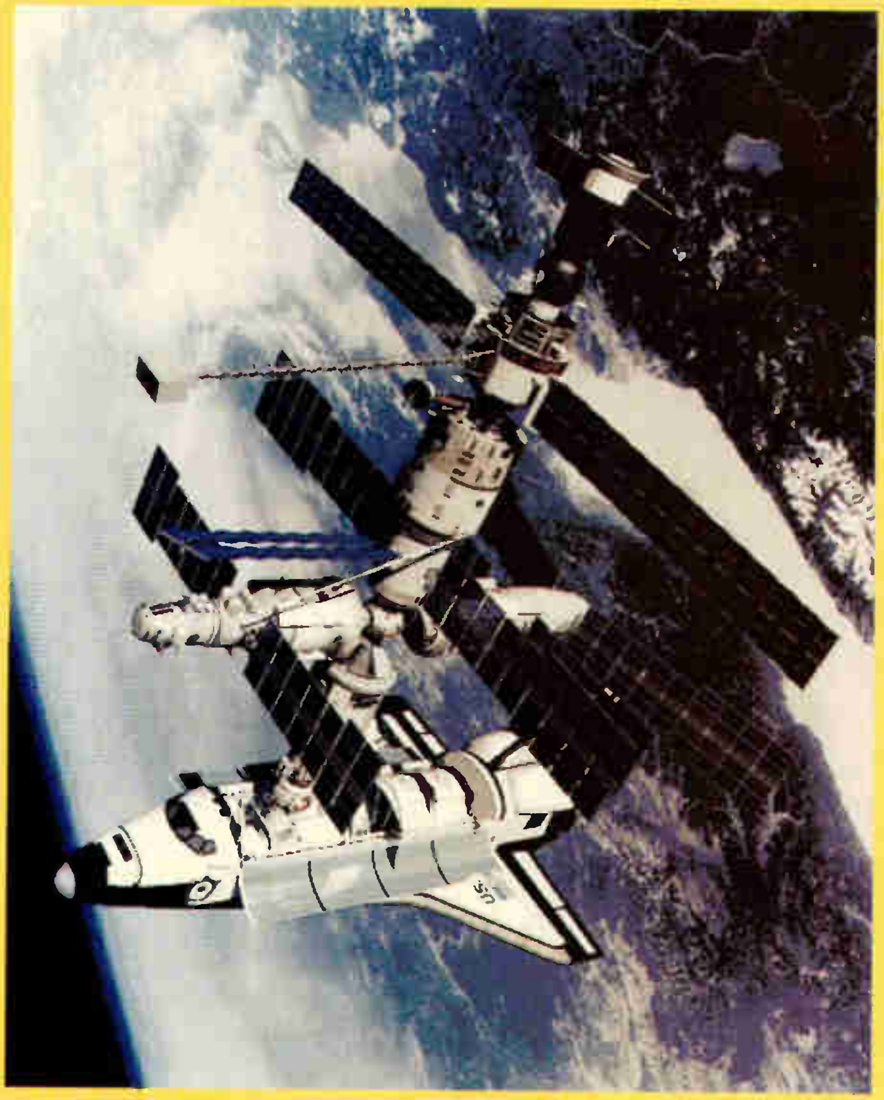
FINAL FRONTIER

By Philip Chien

Finishing up on *Mir*

Many people thought it would never happen in the first place. Others predicted that a disaster would occur before the end. But the light's finally visible at the end of the tunnel. NASA is completing its first long-term stint of joint activities aboard the Russian *Mir* space station, completing over two years of U.S. astronauts in space. Astronaut Andy Thomas is scheduled to return to Earth on the STS-91 mission at the end of May, completing the Phase 1 program.

In March Andy was aboard *Mir* for the second anniversary of continuous American presence in space. That started with astronaut Shannon Lucid's arrival aboard *Mir* in 1996. Shannon was followed by John Blaha, Jerry Linenger, Mike Foale, and Dave Wolf. Wolf was replaced by Thomas in January. Before Shannon, Norm Thagard spent three months aboard *Mir*. The seven U.S. astronauts have spent as much time in space as all of the 89 shuttle flights to date.



In comparison there have always been two Soviet/Russian cosmonauts in space since 1989.

The current *Mir* 25 crew is rather unusual in that it only has one native Russian onboard–flight engineer Nikolai Budarin. Commander Talgat Musabayev was born in the ex-Soviet republic of Kazakhstan. Kazakhstan is not, and has never been part of Russia - in fact unlike Russia Kazakhstan is completely located in Asia. Kazakhstan is, however the location of the Russian launch site for all of its crewed spacecraft. (It makes a great bar bet to declare that noone has ever been launched into space from Russia.)

In 1990, the Soviet Union was beginning to break up and efforts were being made to show cooperation with the various republics. The Slavic-European republics had been fairly well represented in the cosmonaut corps, but very few cosmonauts from the Asian republics had ever flown (imagine if the U.S. had over 90 percent of its astronauts selected from one region, with others barely represented and most states not at all). Tensions were high, with Kazakhstan actually sending Russia a "litter bill" for all of the discarded rocket stages which had landed in designated unpopulated drop zones in Kazakhstan!

So the Russian Space Agency went to the extraordinary step of specifically selecting a Kazakh cosmonaut, just as if it was a foreign country paying to fly its passenger to *Mir*. In U.S. terms this would be roughly the equivalent of hiring a southern recruit in 1859 as a Union army captain before the Civil War broke out.

The Kazakh cosmonaut selection had a limited number of candidates due to Kazakhstan's position within the Soviet hierarchy. The Kazakh cosmonaut-passenger was Toktar Ongarbayevich Aubakirov, born on July 17, 1946. He eventually flew a simple one-week token spaceflight, but is hailed in Kazakhstan as the first Kazakh space traveler.

His backup, Talgat Amangel'dyevich Musabayev was a different situation. Musabayev's background was a civilian engineer and commercial airline pilot–not

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the test pilot or military background of most cosmonauts, but certainly enough to qualify as a flight engineer. Talgat was transferred to the actual cosmonaut corps on March 6, 1991, five months before Aubakirov made his token spaceflight.

Talgat spent four months aboard *Mir* on the *Mir* 16 crew in 1994. He was the flight engineer, roughly the equivalent of a shuttle mission specialist in terms of responsibilities. His dedication and perseverance convinced Russian space officials to upgrade him to commander–a first for the Russian space program. By this point there was no doubt that he was a truly qualified cosmonaut–not just a token political selection. Talgat is now a Russian Air Force officer, and a naturalized Russian citizen. So he's a Russian cosmonaut and a Russian citizen, but ethnically a Kazakh from Asia.

It turns out that Talgat and his American colleague Andy Thomas have at least one hobby in common–both are enthusiastic fans of the "Beatles." During his first spaceflight Talgat was heard singing "We all live in a Russian space ship" to the tune of *Yellow Submarine*. His commander indicated that he was quite good on the guitar. Andy Thomas kidded before he flew to *Mir* that his musical tastes were the classical three Bs–Beethoven, Bach, and the Beatles. A recent Progress resupply ship brought up a CD player and three two-volume sets of "Beatles" music for the two space travelers to share.

While Talgat's native language was Kazakh he's fluent in Russian and can also speak a fair amount of English. During press conferences aboard *Mir* he spends a fair amount of time translating American questions into Russian for Nikolai, and has occasionally answered questions from U.S. reporters in English without bothering to use a translator.

Talgat and Nikolai are scheduled to remain on *Mir* until August. When Andy Thomas leaves *Mir* it will revert to a two-person permanent crew, occasionally supplemented by a third guest passenger.

Last Mission to Mir

The final shuttle mission to *Mir* will be commanded by astronaut Charlie Precourt. Charlie's no stranger to *Mir*, he was the pilot for the first shuttle-*Mir* docking mission (STS-71), and also the commander for the sixth (STS-84). In addition he spent several months stationed in Star City Russia as the NASA Director of Operations Russia, the astronaut-manager who handles the day-to-day interfacing with Russian space officials. Charlie is highly regarded in the astronaut corps as one of its most talented multi-lingual experts–fluent in French and Russian.

The pilot for STS-91 will be rookie Dominic Gorie, flying his first shuttle flight. The U.S. mission specialists will include Franklin Chang-Diaz making his sixth spaceflight, Wendy Lawrence making her third spaceflight and second visit to *Mir*, and rookie Janet Kavandi.

The crew will also include an unique passenger, Russian space official and ex-cosmonaut Valeri Ryumin. Ryumin was a flight engineer and spacecraft designer. His first spaceflight was Soyuz 25 in 1979, an aborted mission which spent only two days in orbit. For his second spaceflight he spent 175 days aboard the Salyut 6 space station in 1979. At that point Salyut 6 was reaching the end of its operating lifetime and only one long duration mission was remaining. The flight engineer for that mission broke his arm while exercising, and the decision was made to fly Ryumin again since he was familiar with Salyut 6's systems.

Russian crews aboard Salyut 6 traditionally left notes for the next crew inviting them aboard the Soviet outpost in space and hoping that they had a successful stay in space. Since Ryumin ended up flying back-to-back missions he ended up reading the note he had written for his planned successor! On that flight Ryumin spent 185 days in space, and for a while held the world space duration record of 362 days.

In 1981 Ryumin became the director of the Salyut 7 program and in 1992 he became the Russian director of the shuttle-*Mir* program. When the U.S. offered seats for Russian cosmonauts aboard some of the shuttle-*Mir* flights Ryumin recommended that it would be useful for him–both as a spacecraft designer and manager–to visit *Mir* and see how things had changed over time. The Russian managers agreed and NASA assigned Ryumin to the STS-91 crew. Ryumin has had to lose over 50 lbs to meet the shuttle physical requirements. He relies heavily on interpreters and quickly admits that his English skills are poor. However, he notes that he's flying with Charlie Precourt and Wendy Lawrence who both speak Russian quite well and will rely on them to help interpret things for him in space.

Unlike the recent shuttle-*Mir* missions STS-91 is only returning a crewmember from *Mir*. The shuttle's cargo bay will only carry a single length Spacehab module, with about half of the logistics space. It will be the last planned opportunity to return large amounts of cargo from *Mir* and many U.S. and Russian scientists are anxious to use the opportunity to return one-of-a-kind instruments, experiments, and other cargo. After the shuttle undocks it will not be coming home immediately. The second payload for the flight is the Alpha Magnetic Spectrometer (AMS). AMS is an extremely sophisticated particle detector for astrophysics and cosmology studies. AMS is flying as a prototype on the shuttle before the permanent unit is mounted aboard the space station. The shuttle will spend several days with AMS pointed toward deep space before coming home.

The original Shuttle-*Mir* program called for just one American to fly to *Mir* aboard a Soyuz and spend three months aboard *Mir*, returning on the shuttle. In exchange two Russians would fly aboard shuttle missions. NASA received approval from Congress for a more extensive program involving three additional U.S. astronauts aboard *Mir* in exchange for US$400 million. Later that contract was extended for an additional two astronaut stays.

Nobody denies that the primary purpose for the shuttle-*Mir* activities is politics–learning how to deal with Russia and the Russian Space Agency. It's been a learning experience for both sides–in terms of language, culture, engineering standards, different approaches, and how each country does business. Somewhere far down on the list is science. But while the science isn't the first priority and there haven't been any earth-shattering breakthroughs, a significant amount of science has been performed.

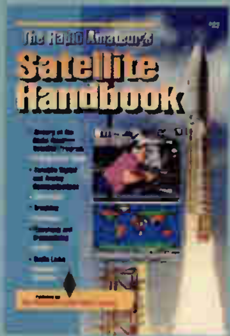
Russia plans to continue to operate *Mir*, hopefully until the first permanent crews arrive aboard the International Space Station. The Russian Space Agency is examining how to deorbit the *Mir* complex safely, to avoid a potential disaster if it has an uncontrolled reentry over a populated area. NASA has also investigated methods for deorbiting *Mir* in a controlled manner, and it's quite possible the space shuttle could be asked to help out. One of the more unusual proposals under consideration is to use the shuttle as a cosmic tow-truck with a tether to *Mir* to lower its altitude enough so it can be commanded to deorbit itself safely. ST

World Radio History

by Wayne Mishler, KG5BI

ARRL announces new book on amateur satellites

The Radio Amateur's Satellite Handbook is billed as the most comprehensive book ever written on the subject of amateur radio satellites. It is the standard for ham radio operators who want to experience the thrill of contacting other stations through an orbiting spacecraft.



Author Martin Davidoff, K2UBC, also wrote the League's previous satellite book, *Satellite Experimenter's Handbook*, an invaluable source of practical and theoretical information on ham satellites.

The Radio Amateur's Satellite Handbook covers tracking (with emphasis on software, station equipment and antennas), the unique aspects of analog and digital ham satellites, operating tips and techniques, and details on current and future ham satellites. There is extensive coverage of AMSAT's Phase 3D.

The handbook also covers the SAREX (U.S. Shuttle amateur in space) program and operation from the Russian space station *Mir*.

Appendices include a list of dates and frequencies of all amateur spacecraft beginning with Oscar I in 1961, a summary of amateur operation from space, detailed profiles on all the active amateur spacecraft, computer programs to aid in tracking, Internet sites of interest, amateur-satellite-related FCC rules and regulations, and graphic tracking aids. Sample problems help the reader solve exercises involving satellite orbits and tracking.

This handbook is a must buy and is useful for beginners and experienced satellite operators, and others interested in space communication. Get your copy of this book by calling the ARRL toll free 888-277-5289.

Low-cost converter kit turns ham shack into SETI station

The non-profit Search for Extra-Terrestrial Intelligence (SETI) League for three years has been designing low-cost equipment to enable amateur radio operators to join with them in a worldwide search for life in space.

Based on those designs, a New Jersey-based electronics kit supplier, Down East Microwave Inc., in March began offering radio astronomy converter kits specifically for seeking out new life forms.

This converter shifts microwave radio astronomy frequencies down into the VHF spectrum for reception on two-meter ham equipment. It reduces the cost of an amateur SETI station or radio telescope from thousands of dollars to a few hundred or even less, depending on how well you can use a soldering iron.

"For under $200 you can equip an existing amateur radio station for SETI operation," says Down East Microwave president Steve Kostro. "The cost will be much less if you build the kit yourself."

SETI scientists seek to determine through microwave measurements whether humankind is alone in the universe.

Congress terminated funding for the program in 1993. Those involved with the program formed the SETI League and continued its research operation as a private institution.

Amateur radio skills and equipment are ideally suited to SETI operation. Additional information is available via SETI's toll free voice line: 800-TAU-SETI.

New book shows how radio opens door to science

Radio science observing is a phrase given to the practice of observing science with the assistance of radio frequencies. It includes radio astronomy, spheric hunting, and meteor detection by radio. Now there is a book for enthusiasts of this fascinating field.

RadioScience Observing, Volume 1, written by Joseph Carr, introduces the field and lays the groundwork for additional volumes that will follow.

Hot topics include propagation studies, whistler and spheric hunting, and searching for solar flares using very low frequency (VLF) radio.

This new book includes chapters on these topics and more. The main focus of the book is the amateur scientist who has a special interest in radio.

The book was written with the amateur radio operator, shortwave listener, scanner monitor, and other radio hobbyists in mind.

It comes with a CD-ROM containing numerous examples of radio frequencies so you can learn to identify them.

Astronomers will like the book's detailed information about the sun, planets, and other planetary bodies. It will teach you more about the natural radio signal generators of our solar system and beyond.

Author Joseph J. Carr has published more than 80 books and 600 magazine articles since 1968. He writes monthly columns for several popular electronics and radio magazines, and previously wrote the four-part *Electronic Circuit Guidebook*.

Price of *RadioScience Observing* Volume 1 is $29.95. It is available from PROMPT Publications, 800-428-7267.

World Radio History

You can build it!

A new book offered by the American Radio Relay League, entitled *UHF/Microwave Projects Manual*, Volume 2, is an anthology of the best of microwave projects previously published by the ARRL.

Packed within the 160 pages of this book you will find numerous high performance antennas and transverters you can build without a room full of test equipment and machine tools.

This hot new title opens up the world of UHF and microwave, and offers a smorgasbord of practical projects for the experimenter.

You will find articles on how to use a TVRO feed, update a no-tune transverter, converting a radar detector, two-watt 10 GHz amplifiers, and a lot more.

To find out why hams are jumping into UHF/microwave project building, get your copy of this book by calling the ARRL toll free 888-277-5289.

New World Satellite Yearly rolling off presses

Baylin Publications has announced the publication of the *1998/2000 World Satellite Yearly* reference book.

With 864 pages, this massive volume has been updated with information necessary to determine satellite programming available at any receive site on the globe. It covers the required reception equipment including satellite dish and associated electronics.

Author Dr. Frank Baylin has written the book for the educated layman. Content is well organized into four main sections: technical, satellites, programming, and reference.

The technical section describes how to read footprint maps and explains the role of polarity in the downlink signal, among other essentials. The Satellites section presents a full data page on each of the world's operational geostationary broadcast satellites. Programming includes the video programming available on these satellites, and reference includes a complete directory of equipment and service providers.

You really have to see this book to appreciate it; there is no way to fully describe it in this limited column.

Price of the book is $90 plus $5 shipping and handling, in the U.S. and Canada. Air shipping outside of North America is $40. You can order the book from Baylin Publications, 1905 Mariposa, Boulder CO, 80302 USA, telephone 303-449-4551 (voice), 303-939-8720 (fax).

$200 Video Sync Generator restores scrambled signals

It is a tool for evaluating video difficulties. It is called the Video Sync Generator. And it provides internal synchronization for a full range of video signals needed for trouble shooting and or adjusting video monitors, satellite receivers, video camera cameras and television systems.

R. C. Distributing Company offers the device and warns against using the device for decoding scrambled TV signals, which violates federal law.

The generator is capable of restoring all horizontal and vertical sync lines from standard or distorted analogue video formats. All that is required is a color burst or reference signal located in the video source you are evaluating. The device will lock to color bursts of most any video signal, clamped or unclamped, normal or inverted, or even DC shifted. The device really doesn't care.

For more information, you can get in touch with the distributor at 219-236-5776.

TMI brings wireless services to U.S. and beyond

TMI Communications has announced plans to serve all 50 states plus Canada, Mexico, the Caribbean and up to 250 miles offshore with a complete portfolio of wireless digital data, voice, fax, and dispatch radio services using MSAT communications satellite.

"Our aim is to be North America's leading provider of mobile satellite communications solutions," says TMI president and CEO Larry Boisvert.

"TMI can bring advanced digital wireless communications to anyone, anywhere."

TMI offers the power of a digital network that meets the information needs of anyone outside wired urban areas who needs to communicate with the rest of the world. This includes oil and gas, transportation, maritime, mining, forestry, utility, construction, and leisure industries and, of course, government and law enforcement agencies.

Services include packet, circuit-switched data, voice, paging, faxes, email, LAN, file transfer, Internet access, digital broadcast dispatch, mobile messaging, position reporting, and more.

"TMI is very much in the capacity sales business," says general manager Wayne Clarke. "We're providing bandwidth-on-demand for companies that need a platform on which to build their own business solutions."

California firm will broadcast two live radio shows

GlobeCast North America has signed an agreement with Global Satellite Network to broadcast two live radio shows to radio stations throughout the United States and Canada.

One of the programs, *Modern Rock Live*, is an alternative music program which features live guests and call-ins. The other, *Rockline*, is a music and call-in show that features current bands and takes live questions and comments from listeners.

GlobeCast is capable of reaching 7,000 radio stations instantly.

Buying DSS equipment gets easier

DIRECTV is allowing its retailers to sell equipment and subscriptions to consumers on two simplified plans. Installation now costs $99; installation bundled with a DSS system sells for $299.

"We are responding to the requests of consumers and retailers for a more simple and affordable retail offer," says Bill Casamo, executive vice president of DIRECTV.

With the installation offer, retailers can also educate customers on the benefits of installing an off-air antenna to receive local broadcast channels. Installers can do both.

The existing offer for a free self-installation kit will continue to be available.

The new, simpler retail offers complement recently announced additions to the DIRECTV programming lineup.

More than 3.3 million customers now own DSS systems, which include the 18-inch dish, and subscribe to DIRECTV's services with access to more than 175 channels of entertainment and information programming.

The equipment and subscription services are available at more than 26,000 retail outlets nationwide, including Circuit City, Best Buy, Sears, Radio Shack, K-Mart stores, WalMart, and Wards. ST

World Radio History

By Larry Van Horn

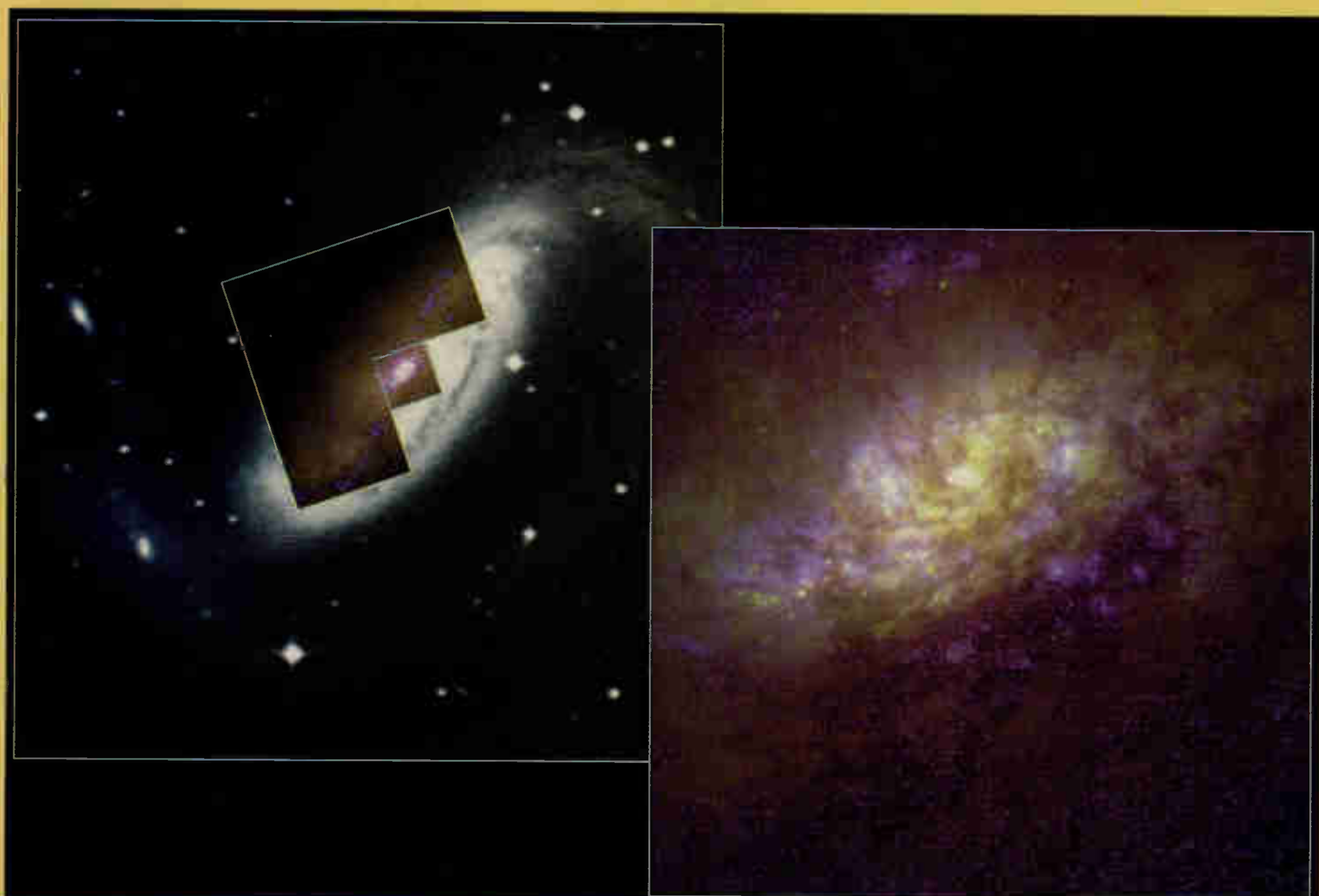
Hubble Captures the Heart of Star Birth

NASA Hubble Space Telescope's Wide Field and Planetary Camera 2 (WFPC2) has captured a flurry of star birth near the heart of the barred spiral galaxy NGC 1808.

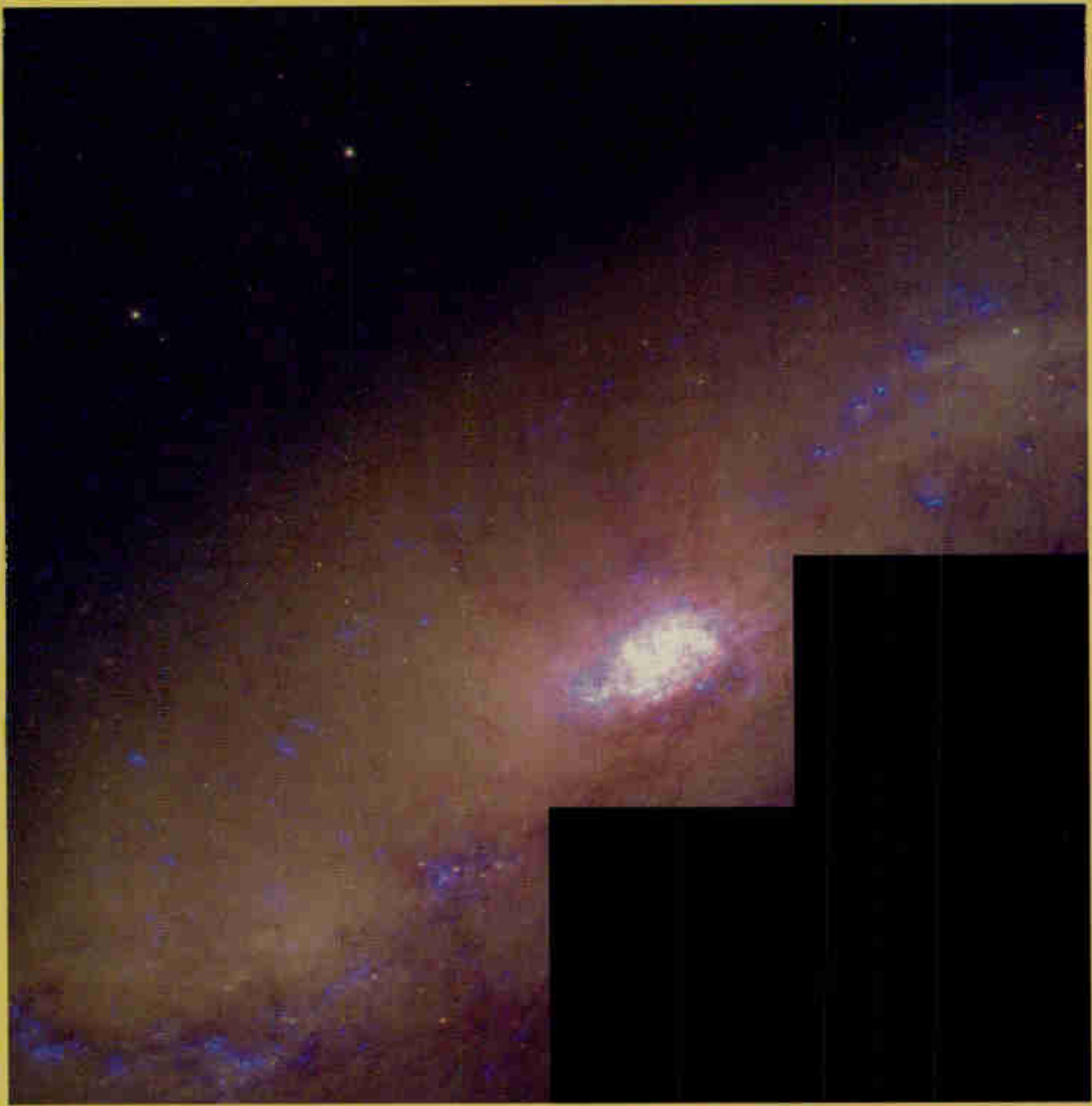
Below on the left are two images, one superimposed over the other. The black and white picture is a ground-based view of the entire galaxy. The color inset was taken with the Hubble telescope's Wide Field and Planetary Camera 2 (WFPC2). provides a close-up view of the galaxy's center, the hotbed of vigorous star formation.

The ground-based image shows that the galaxy has an unusual, warped shape. Most spiral galaxies are flat disks, but this one has curls of dust and gas at its outer spiral arms (upper right-hand corner and lower left-hand corner). This peculiar shape is evidence that NGC 1808 may have had a close interaction with another nearby galaxy, NGC 1792, which is not in the picture Such an interaction could have hurled gas towards the nucleus of NGC 1808, triggering the exceptionally high rate of star birth seen in the WFPC2 image.

The WFPC2 color picture is a composite of images using colored filters that isolate red and infrared light as well as light from glowing hydrogen. The red and infrared light (seen as yellow) highlight older stars, while hydrogen (seen as blue) reveals areas of star birth. Colors were assigned to this false-color image to emphasize the vigorous star formation taking place around the galaxy's center.



World Radio History



NGC 1808 is called a barred spiral galaxy because of the straight lines of star formation on both sides of the bright nucleus. This star formation may have been triggered by the rotation of the bar, or by matter which is streaming along the bar towards the central region (and feeding the star burst).

Filaments of dust are being ejected from the core into a faint halo of stars surrounding the galaxy's disk (towards the upper left corner) by massive stars that have exploded as supernovae in the star burst region. The portion of the galaxy seen in this "wide-field" image is about 35,000 light-years across.

The image on this page, taken by WFPC2, provides a closer look at the flurry of star birth at the galaxy's core. The star clusters (blue) can be seen (and many more are likely obscured) amid thick lanes of gas and dust. This image shows that stars are often born in compact clusters within star bursts, and that dense gas and dust heavily obscures the star burst region. The brightest knot of star birth seen here is probably a giant cluster of stars, about 100 light-years in diameter, at the very center of the galaxy. The other star clusters are about 10 to 50 light-years in diameter. The entire star burst region shown here is about 3,000 light-years across.

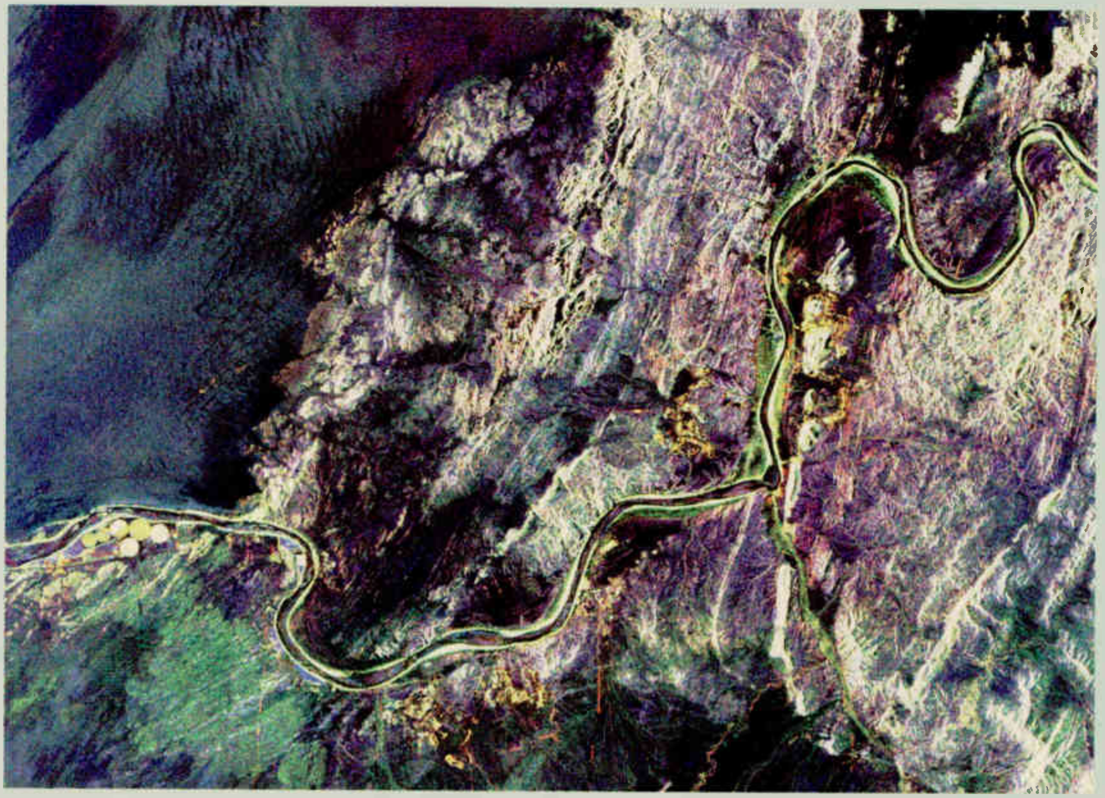
Credits: Jim Flood, an amateur astronomer affiliated with Sperry Observatory at Union College in New Jersey, and Max Mutchler, a member of the Space Telescope Science Institute staff who volunteered to work with Jim. ST

World Radio History

Earth Watch

By Larry Van Horn

South Africa, Namibia Diamond Deposits



This radar image covers a portion of the Richtersveld National Park and Orange River (top of image) in the Northern Cape Province of the Republic of South Africa. The Orange River marks the boundary between South Africa to the south and Namibia to the north. This is an area of active mining for diamonds, which were washed downstream from the famous Kimberley Diamond Area, millions of years ago when the river was much larger.

The mining is focused on ancient drainages of the Orange River which are currently buried by think layers of sand and gravel. Scientists are investigating whether these ancient drainages can be seen with the radar's ability to penetrate sand cover in extremely dry regions.

A mine, shown in yellow, is on the southern bank of the river in an abandoned bend which is known as an "oxbow." The small bright circular areas (left edge of image) west of the mine circles are fields of a large ostrich farm that are being watered with pivot irrigation.

The large dark area in the center of the image is the Kubus Pluton, a body of granite rock that broke through the surrounding rocks about 550 million years ago.

North is toward the upper right. The area shown is about 55 by 60 kilometers (34 by 37 miles) centered at 28.4 degrees south latitude, 16.8 degrees east longitude.

Colors are assigned to different different radar frequencies and polarizations as follows: red is L-band horizontally transmitted and horizontally received; green is L-band horizontally transmitted and vertically received; blue is C-band horizontally transmitted and vertically received. The image was acquired on April 18, 1994 by the Spaceborne Imaging Radar-C/X-band Synthetic Aperture (SIR-C/X- SAR) imaging radar when it flew aboard the space shuttle *Endeavour.* SIR-C/X-SAR is a joint mission of the U.S./German and Italian space agencies.

Spaceborne Imaging Radar-C and X-band Synthetic Aperture Radar (SIR-C/X-SAR) is art of NASA's Mission to Planet Earth. The radars illuminate Earth with microwaves allowing detailed observations at any time, regardless of weather or sunlight conditions. SIR-C/X-SAR uses three microwave wavelengths: L-band (24 cm), C-band (6 cm) and X-band (3 cm).

The multi-frequency data will be used by the international scientific community to better understand the global environment and how it is changing. The SIR-C/X-SAR data, complemented by aircraft and ground studies, will give scientists clearer insights into those environmental changes which are caused by nature and those changes which are induced by human activity. SIR-C was developed by NASA's Jet Propulsion Laboratory.

X-SAR was developed by the Dornier and Alenia Spazio companies for the German space agency, Deutsche Agentur fuer Raumfahrtangelegenheiten (DARA), and the Italian space agency, Agenzia Spaziale Italiana (ASI), with the Deutsche Forschungsanstalt fuer Luft und Raumfahrt e.v.(DLR), the major partner in science, operations, and data processing of X-SAR.

ST

World Radio History

The Satellite Sleuth

By *Larry Van Horn*

Preamplifiers for the Satellite Sleuth

Over the last couple of months I have discussed some of the various components you would need in order to set up a satellite monitoring post. We have talked about receivers and coax. The next component in our monitoring station's food chain, so to speak, is a good quality preamplifier.

In most applications, the sensitivity of the receiver is the limiting factor in receiving a suitable downlink signal from the satellite. At all radio frequencies, noise arriving via the antenna ultimately limits our ability to receive weak signals. On frequencies above 30 MHz, the dominant source of external noise is cosmic in origin. In practice, however, noise generated in the receiving system itself often masks weak satellite downlink signals.

Our ultimate goal is to design our listening post so that the internally generated noise levels in our equipment is below that of the incoming cosmic noise level for the frequency we are trying to hear. In reality, we usually don't reach that goal, but new technology in our receivers and preamplifiers has allowed most hobbyists to approach that goal at a relatively lower cost over technology from five years ago. Besides using a sensitive receiver, another method of achieving this goal is through the use of a quality preamplifier mounted on the antenna mast.

A preamplifer or "preamp" is an active device placed between the antenna and the receiver that amplifies the incoming signal. A preamplifer should be used in all antenna systems where the receiver gain is in question and noise prevents receiving a clean image. However, there are trade-offs. Not only will a preamplifier amplify the incoming satellites signal, but it will increase any ground-based noise, as well.

The required preamp and noise figure for a given downlink signal will depend on sky noise as seen by the antenna, feed-line length, and noise figure of the following stages. If you keep lowering the noise figure of the system, you'll eventually reach a point where further reduction won't provide any discernible improvement in your ability to hear that weak satellite signal.

Ready-made preamps are available from a wide variety of sources. Table one gives a list of some of the dealers that sell preamplifiers and equipment usuable in the various satellite bands.

If you'd like to homebrew your own preamp and amateur satellite frequency ranges are your interest, a number of preamp projects can be found in the new *Radio Amateur's Satellite Handbook* by Martin Davidoff and published by the American Radio Relay League (ARRL). This is a "must" book on the reference shelve of every satellite monitoring enthusiasts and ham radio satellite operator. You can order your copy (publication number 232) from the ARRL at the address listed in table one.

So pick up that writing stick or telephone or fire up the computer on the internet and call the companies listed in table one. Get those catalogs to check out what is available in the bands you are interested in receiving. While you're at it, be sure to tell them you saw it in the pages of *Satellite Times* magazine.

Till next month, good hunting. ST

TABLE 1: List of Equipment Suppliers

Advanced Receiver Research
Box 1242, Burlingon, CT 06013
(860) 485-0310

American Radio Relay League (ARRL)
225 Main Street, Newington, CT 06111-1484
Tel (860) 594-0200, Fax (860) 594-0303
http://www.arrl.org

Angle Linear
P.O. Box 35, Lomita, CA 90717-0035
Tel (310) 539-5395, Fax (310) 539-8738
http://www.anglelinear.com

Dartcom
Powdermills, Postbridge,
Yelverton PL20 6SP, United Kingdom
Tel (+44) 1822 880253, Fax (+44) 1822 880232
http://www.dartcom.co.uk

Down East Microwave Inc.
954 Rt. 519, Frenchtown, NJ 08825
Tel (908) 996-3584, Fax (908) 996-3702
http://www.downeastmicrowave.com

Grove Enterprises
P.O. Box 98, 7540 Highway 64 West
Brasstown, NC 28902-0198
Tel (800) 438-8155, Fax (828) 837-2216
Outside the U.S. and Canada (828) 837-9200
http://www.grove-ent.com

Hamtronics, Inc.
65 Moul Rd., Hilton, NY 14468-9535
Support & Orders (716) 392-9430, Fax (716) 392-9420
http://www.hamtronics.com

Kantronics
1202 E. 23rd St, Lawrence, Kansas 66046-5099
Sales (785) 842-7745, Fax (785) 842-2031
http://www.kantronics.com

Microwave Solutions, Inc
3200 Highland Avenue, Suite 3A, National City, CA. 91950
Tel (619) 474-6906, Fax (619) 474-7003
Toll Free (800) 967-4267 (9-MSI-AMP)
http://mwsolns.connectnet.com

Mirage Communications
116 Willow Road, Starkville, MS 39759
Technical Information (601) 323-8287, Fax (601) 323-6551
http://www.mirageamp.com/

MultiFAX
30 Steele Road, Victor, NY 14564
Tel (716) 425-8759, Fax (716) 223-6198
BBS: (716) 425-8759 (5pm to 8 am ET)
http://www.frontiernet.net/~multifax/

OFS WeatherFAX
6404 Lakerest Court, Raleigh, NC 27612 USA
Tel (919) 847-4545

Quorum Communications, Inc.
8304 Esters Boulevard, Suite 8501, Irving, TX 76051 USA
Tel (972) 915-0256 within USA (800) 982-9614
Fax (972) 915-0270
http://www.qcom.com

Radio Astronomy Supply
190 Jade Cove Drive, Roswell, GA 30075
Tel. (770) 992-4959
http://www.nitehawk.com/rasmit/ras.html

Ramsey Electronics, Inc.
793 Canning Parkway, Victor, NY 14564 USA
Tel (716) 924-4560, Fax (716) 924-4555
http://www.ramseyelectronics.com

Software Systems Consulting
615 South El Camino Real, San Clemente, CA 92672 USA
Tel (714) 498-5784, Fax (714) 498-0568
http://www.ssccorp.com

Swagur Enterprises
PO Box 620035, Middleton, WI 53562 USA
Tel (608) 592-7409, Fax (608) 592-7409
http://www.execpc.com/~swagur

Terrestrial Power Systems
405 Union Ln, Brielle, NJ. 08730
Tel (732) 223-5067 (after 2100 UTC), Fax (732) 223-0901
http://www.signalONE.com/kb2ah/

Timestep
PO Box 2001, Newmarket CB8 8XBUnited Kingdom
Tel (+44) 1440 820 040, Fax (+44) 1440 820 281
http://www.time-step.com

Vanguard Electronic Labs
196-23 Jamaica Ave., Hollis, NY 11423
Phone and FAX (718) 468-2720
http://www.cyberpad.com/

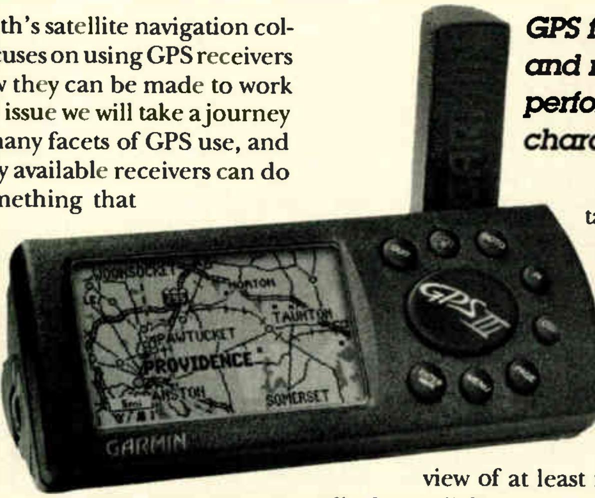
World Radio History

NAVIGATION SATELLITES

By Steve Dye, *gpsyes@aol.com*

Making GPS Work for You

This month's satellite navigation column focuses on using GPS receivers and how they can be made to work for you. In this issue we will take a journey through the many facets of GPS use, and see how readily available receivers can do the job of something that was formerly more costly and complex.



I will start by reminding readers that two months ago I reviewed an incredible GPS receiver from Garmin that represented a real break-through in GPS technology–the Garmin GPS III. The GPS III is a receiver with a built-in map of North America's major highways, freeways, railroads, lakes and rivers.

If there is one thing you should bring along with your standard GPS receiver (apart from a spare set of batteries) it's a map. Imagine being stranded in low visibility while hiking or straying off the beaten track when mountain biking across the countryside. If you can locate your GPS coordinates on a map, you will know your position relative to a town, village, your start point or perhaps a mountain range or some other obstacle that may impede your safe return.

It's never the easiest thing to do–converting degrees, minutes and seconds of latitude and longitude to a point on a map, and it's not every hiker's idea of fun either. However, the GPS III will shoulder the load on this one for you, and locate your position on its digital map. In reality, the GPS III is a map that tells you where you are. Leave your maps at home and bring some spare batteries instead. The GPS III will cost you less than US$400 now, and it's worth every penny.

GPS frequency and receiver performance characteristics

One important point to make here is GPS receivers cannot be operated in buildings, caves or under thick, dense foliage. GPS requires a clear view of at least four satellites to display a reliable reading. When a reading is attempted under tree cover, only a portion of the sky is visible at any one time and thus the satellites will move in and out of sight quite rapidly. The problems with frequencies in the L-band, particularly in the upper portion, is that moisture in the leaves absorb RF energy very efficiently, reducing the strength and reliability of the signal. Building attenuation is too severe for a GPS receiver to make use of the signal once it has traveled through a brick wall.

There are occasions when brief periods of satellite visibility are insufficient to obtain a position fix that can be relied upon, but this can also impede position finding, so do be warned. If a reading in wooded areas can be obtained for around ten minutes or so, it can be considered reliable enough to use.

GPS Receiver Antennas

GPS receivers have either built-in or external antennas. This alone can play a large role in the type of application for which a particular GPS receiver should be purchased. A receiver that employs just an external antenna can be a burden as it would be a hindrance for such activities as hiking, cycling and flying a micro light or glider. However, an external antenna would be needed if the receiver were to be used in a vehicle, in all types of weather or perhaps used below the deck in a boat. Ideally, a receiver would feature a built-in antenna, with the option of using an externally mounted antenna when the need arises.

Using a receiver with a built-in antenna inside a vehicle is possible if a clear view of the required four satellites are in view. This is best achieved by placing the receiver against the windshield–it's the largest, unobstructed area with the widest view of the sky.

This measure unfortunately won't work for all vehicles since some vehicle models incorporate a windshield defogger made of transparent metallic film. This film also acts as a perfect block for GPS signals demanding the use of an externally mounted antenna.

Having discussed the main issues with GPS operation, let's look at some of the practical uses of a GPS receiver.

Search and Rescue

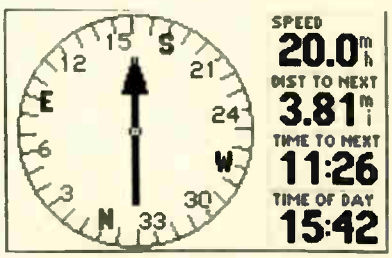
Imagine a scenario where a friend is injured while skiing, snowmobiling, gliding or similar. Simply take a GPS reading, mark the spot where you left him or her. The location can be entered in to memory as a waypoint, and off you go to find help

Once you have help, use the generic GOTO command to make the GPS receiver guide you back to the waypoint at which your friend is located.

Should you be within range of CB, cellular or private radio services you could call in your co-ordinates to someone, who would then dispatch a rescue service–straight to your location! This method seems to work well for Sunday afternoon hikers, orienteers, mountain bikers and the occasional downed jet fighter pilot behind enemy lines.

Sailing and Water Activities

When sufficiently far out, shorelines appear featureless and pretty much the



World Radio History

same. GPS, in conjunction with a map will enable mariners to pinpoint their location. The position of docks, navigation buoys and destinations can be entered as waypoints, providing twenty-four hour-a-day, worldwide navigation information in all kinds of weather.

Most marine units incorporate a man overboard feature (MOB) which operates as a one-touch waypoint store allowing the operator to save the position quickly and spare time for alerting rescuers. Favorite fishing spots can be saved as waypoints as can areas presenting a possible hazard for future reference.

Traveling by Car and RV

A vacation route can be easily planned by noting the locations of potential rest stops and points of interest. Using the mapping software and GPS receivers that can be hooked up to portable computers (or even easier–the Garmin GPS III) you can see your position relative to landmarks as you travel–ideal for vacationers or traveling salespersons in unfamiliar places.

Hiking, Backpacking, Climbing

By using a topographical map, turns, rest stops and campsites can be programmed as waypoint locations into your GPS unit as a route to follow. The beauty of putting these points in the memory allows you to perform a periodic check on your progress, telling you your average speed and distance to the next waypoint. Figure 1 illustrates a screen shot indicating the important navigational information.

The GPS receiver should also have your start point location entered as well. This allows use of the generic "backtrack" feature enabling you to trace the "digital breadcrumb" trail made. This gives the peace of mind and the ability to explore with confidence, knowing you can always find your way back.

Hunting, Fishing, Gold Prospecting, Ornithology, Outdoor Photography.

Use a GPS receiver to help you return to difficult-to-locate spots such as successful fishing holes, wildlife refuges, and remote vistas. Simply use the backtrack feature to find your way back, or share the location with a friend who has a GPS so they can find the spot as easily as if they'd been there themselves.

To return to a point where you perhaps buried a pot of gold or had a good view for photography may require the use of a compass as well. The accuracy of GPS can be to 300 feet, leaving a lot of room for error. To return to your buried treasure, the easiest thing to do is to store in memory the location of a landmark such as a big tree, a boulder, etc., reasonably close to the spot. Take a compass bearing from the landmark to the buried treasure, and count the number of paces to it. Upon return, the landmark will be easily found since GPS will easily guide you to a large, visible object. You then take a bearing and walk towards the spot!

Mountain and Road Biking

Hitting the trail or road on a bike? GPS can be used for occasional progress reports while en route. The next leg can be planned and logged to get an accurate position report of where you have been and where you are going. This is especially useful for the long haul, competitive racing, or off-road trips where maintaining an accurate position could prove critical to a successful outing.

Ballooning, Sail Planes, Hang Gliders, Small Aircraft

A GPS receiver is a lightweight, cost-effective means of obtaining 24 hour-a-day global position and navigation information. GPS receivers with a tracking facility allow you to record your destination, bearing, distance, ground speed, ground course and deviation. When you pre-plan your route, you can input route waypoints–most GPS receivers have a "time to next" or "distance to next" feature–basically providing real time progress of each segment of a journey.

A glider or light aircraft pilot, should never use a standard handheld GPS receiver's altitude reading to land with or to fly over unfamiliar mountainous or hilly terrain in low visibility. The accuracy of an altitude reading is generally two to three times worse than the latitude and longitude–a three hundred meter error is quite possible. Latitude and longitude are adequate for navigation by pleasure and hobby aviators, however, since any GPS receiver will provide an instant readout of the aircraft's position, bearing and speed. This will save the pilot time and effort in working out the position, estimated time of arrival, and aid in communicating with air traffic control (ATC).

Glider pilots who never make it back to the airfield, having to land in fields due to a lack of thermal lift or other factors, can communicate their position information back to the ATC to be easily spotted and collected.

The GARMIN GPSMAP 195 shown in figure 2 is aviation's largest moving map handheld that boasts a large, high-resolution, 4-gray scale display. I like the advanced vertical navigation feature that lets you specify your desired altitude at a given distance from a selected target. This allows you watch your progress every step of the way on a very high resolution 38,400 pixel display

The GPSMAP 195 also includes final segments of all published approaches, 250 waypoints, 20 reversible flight plans of 30 waypoints each, fuel and trip planning, weight and balance calculator, making it an extremely useful cockpit instrument.

Snowmobiling, Cross-Country Skiing, Snowshoeing.

Snowfall tends to obscure trail signs and disguise landmarks, and if you are still on the trail after sunset or during inclement weather it could prove difficult to find your way back. GPS can be there to help, telling you right where you are, and pointing the way back home.

In the event of heavy snowfall obscuring land and trail marks that may serve as a route back reminder, GPS waypoints could be used instead. As with any outdoor activity, injury can occur and a GPS location will expedite rescuers to the accident scene. (Be aware of your GPS unit's minimum operating temperature and keep it close to your body in extreme conditions).

The Garmin GPS 38 shown in figure 3 is a great little device for some of these applications. Using the waypoints, a favorite fishing spot or camp sites can be entered into memory. In this small, 9 ounce unit, there is also a resettable trip odometer, graphic compass and highway steering guidance. It features 250 waypoints and 20 routes to give you the navigation capability needed.

Well, that is all for this month, please keep sending the emails; I appreciate the positive comments, and look forward to hearing more!

ST

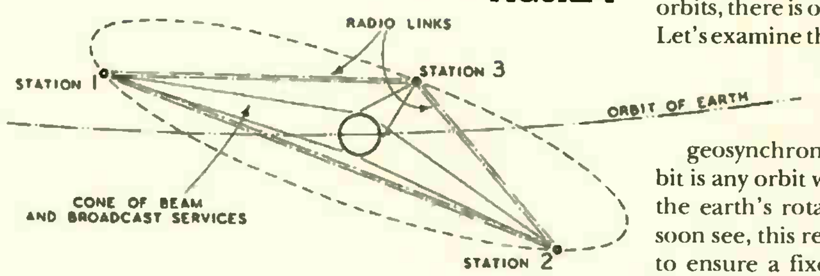
World Radio History

Dr. T.S. Kelso

Basics of the Geostationary Orbit

Few aspects of the Space Age have had as much impact on our everyday lives as the invention of the communications satellite. In just a few short decades, they have brought together even the most far-flung reaches of the globe in ways that not that long ago were barely imaginable. In fact, today it is possible to talk directly to climbers at the top of Mount Everest or communicate via the Internet with virtually any computer system on the face of the planet—all with the help of communications satellites.

FIGURE 1



Original figure from Clarke's article in the October 1945 edition of Wireless World[2].

While communications satellites perform their missions in many types of orbits, from near-earth constellations like Iridium and Globalstar to the highly-inclined, eccentric Molniya orbits used by the Russian Federation, one of the more important classes of orbits for these satellites is the geostationary orbit. In this column, I'd like to examine the unique aspects of this class of orbit which make it suitable for not only satellite communications, but early warning and weather observations, too.

History

The concept of the geostationary orbit has been around since the early part of the twentieth century. Apparently, the concept was originated by Russian theorist Konstantin Tsiolkovsky—who wrote numerous science and science-fiction articles on space travel at the turn of the century. In the 1920s, Hermann Oberth and Herman Potocnik—perhaps better known by his pseudonym, Herman Noordung—wrote about space stations which maintained a unique vantage over the earth.[1] Each author described an orbit at an altitude of 35,900 kilometers whose period exactly matched the earth's rotational period, making it appear to hover over a fixed point on the earth's equator.

However, the person most widely given credit for the concept of using this orbit for communications is Arthur C. Clarke. In an article he published in *Wireless World* in October 1945 titled "Extra-Terrestrial Relays: Can Rocket Stations Give World-wide Radio Coverage?" Clarke extrapolates from the German rocket research of the time to a day when communications around the world would be possible via a network of three geostationary satellites spaced at equal intervals around the earth's equator (see Figure 1).

In this article, Clarke not only determines the orbital characteristics necessary for such an orbit, but also discusses the frequencies and power needed for communications to and from space and how to use solar illumination for power—he even calculates the impact of solar eclipses around the vernal and autumnal equinoxes. What makes this article all the more remarkable is that Clarke wrote it more than a dozen years before the first satellite was even launched.

It wasn't until 1963 that NASA set out to test Clarke's concept with the Synchronous Communications Satellite program. Unfortunately, Syncom 1—launched 1963 February 14—while successfully reaching geosynchronous orbit in an inclined, eccentric orbit was unsuccessful due to an electronics failure. Syncom 2—launched 1963 July 26—became the first operational geosynchronous communications satellite. Syncom 3—launched 1964 August 19—became the first geostationary satellite, finally fulfilling the prediction made by Clarke almost twenty years earlier.

Theory

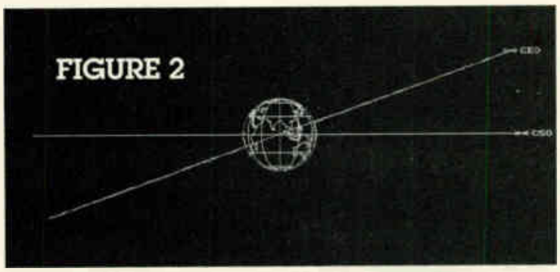
So just what is a geostationary orbit? In general terms, it is a special orbit for which any satellite in that orbit will appear to hover stationary over a point on the earth's surface. Unlike all other classes of orbits, however, where there can be a family of orbits, there is only one geostationary orbit. Let's examine this orbit's unique characteristics.

For any orbit to be geostationary, it must first be geosynchronous. A geosynchronous orbit is any orbit which has a period equal to the earth's rotational period. As we shall soon see, this requirement is not sufficient to ensure a fixed position relative to the earth. While all geostationary orbits must be geosynchronous, not all geosynchronous orbits are geostationary. Unfortunately, these terms are often used interchangeably.

Before continuing, it is necessary to clarify what is meant by "the earth's rotational period." For most timekeeping, we consider the earth's rotation to be measured relative to the sun's (mean) position. However, since the sun moves relative to the stars (inertial space) as a result of the earth's orbit, one mean solar day is not the rotational period that we're interested in. A geosynchronous satellite completes one orbit around the earth in the same time that it takes the earth to make one rotation in inertial (or fixed) space. This time period is known as one sidereal day and is equivalent to $23^h56^m04^s$ of mean solar time (for more information, see "Orbital Coordinate Systems, Part I" in the September/October 1995 issue of *Satellite Times*). Without any other influences, the earth will be oriented the same way in inertial space each time a satellite with this period returns to a particular point in its orbit.

To ensure that a satellite remains over a particular point on the earth's surface, the orbit must also be circular and have zero inclination. Figure 2 shows the difference between a geostationary orbit (GSO) and a geosynchronous orbit (GEO) with an inclination of 20 degrees. Both are circular orbits. While each satellite will complete its orbit in the same time it takes the earth to rotate once, it should be obvious that the geosynchronous satellite will move north

World Radio History



Geostationary and Geosynchronous Orbits

and south of the equator during its orbit while the geostationary satellite will not.

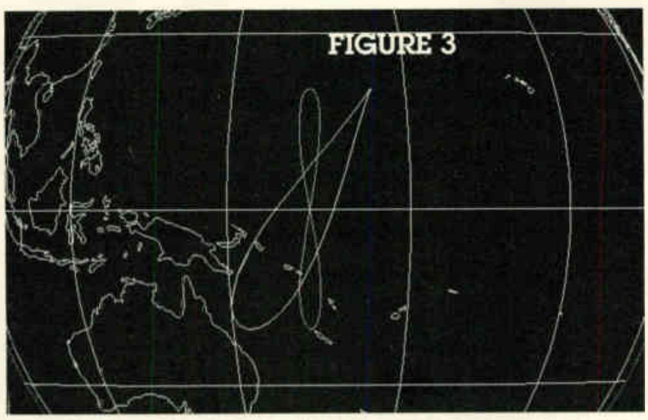
Orbits with non-zero eccentricity (i.e., elliptical rather than circular orbits) will result in drifts east and west as the satellite goes faster or slower at various points in its orbit. Combinations of non-zero inclination and eccentricity will all result in movement relative to a fixed ground point.

Figure 3 shows some typical results. The figure-eight ground track is that of the geosynchronous orbit (GEO) shown in Figure 2. The geostationary satellite (GSO) sits fixed at the crossover point of the figure eight (over the equator). If we now give the geosynchronous satellite an eccentricity of 0.10, the slanted teardrop shape results. Typically, eccentric geosynchronous orbits will result in a slanted figure eight—this one just happens to have the crossover point at the northern apex of the ground track.

It should now be apparent that only satellites which orbit with a period equal to the earth's rotational period and with non-zero eccentricity and inclination can be geostationary satellites. As such, there is only one geostationary orbit—a belt circling the earth's equator at an altitude of roughly 35,786 kilometers.

It should also be clear that it is not possible to orbit a satellite which is stationary over a point which is not on the equator. This limitation is not serious, however, since most of the earth's surface is visible from geostationary orbit. In fact, a single geostationary satellite can see 42 percent of the earth's surface and a constellation of geostationary satellites—like the one Clarke suggested—can see all of the earth's surface between 81° S and 81° N.

Of course, the advantage of a satellite in a geostationary orbit is that it remains stationary relative to the earth's surface. This makes it an ideal orbit for communications since it will not be necessary to track the satellite to determine where to point an antenna. However, there are some disadvantages. Perhaps the first is the long distance between the satellite and the ground. With sufficient power or a large enough antenna, though, this limitation can be overcome.



Geosynchronous Ground Tracks

The fact that there is only one geostationary orbit presents a more serious limitation. Just as in putting beads on a loop of string, there are only so many slots into which geostationary satellites can be placed. The primary limitation here is spacing satellites along the geostationary belt so that the limited frequencies allocated to this purpose don't result in interference between satellites on uplink or downlink. Of course, we also want to make sure the satellites aren't close enough to run into one another since they will have some small movement.

While new communications satellites may be placed in a true geostationary orbit initially, there are several forces which act to alter their orbits over time. Since the geostationary orbital plane is not coincident with the plane of the earth's orbit (the ecliptic) or that of the moon's orbit, the gravitational attraction of the sun and the moon act to pull the geostationary satellites out of their equatorial orbit, gradually increasing each satellite's orbital inclination. In addition, the noncircular shape of the earth's equator causes these satellites to be slowly drawn to one of two stable equilibrium points along the equator, resulting in an east-west libration (drifting back and forth) about these points.

To counteract these perturbations, sufficient fuel is loaded into all geostationary satellites to periodically correct any changes over the planned lifetime of the satellite. These periodic corrections are known as stationkeeping. North-south stationkeeping corrects the slowly increasing inclination back to zero and east-west stationkeeping keeps the satellite at its assigned position within the geostationary belt. These maneuvers are planned to maintain the geostationary satellite within a small distance of its ideal location (both north-south and east-west). This tolerance is normally designed to ensure the satellite remains within the ground antenna beamwidth without tracking.

Once the satellite has exhausted its fuel, its inclination will begin to grow and it will begin to drift in longitude and may present a threat to other geostationary satellites. Oftentimes, geostationary satellites are boosted into a slightly higher orbit at the end of their planned lifetime to prevent them causing havoc with other geostationary satellites. This final maneuver assumes that no unplanned failure has occurred which would prevent it (such as a power or communications failure).

Summary

This initial article on geostationary and geosynchronous orbits should give you a basic understanding of some of the fundamental orbital concepts. In our next column, I would like to continue this topic by examining the relationship among the observer, satellite, and the sun to determine a geostationary satellite's longitude, the look angles from a terrestrial observer, and how the position of the sun can affect onboard power management and interference with satellite communications.

As always, if you have any questions, please feel free to write me at **tskelso@celestrak.com**. Until next time, keep looking up!

[1] Oberth, Hermann. *Die Rakete zu den Planetenraumen (The Rocket into Interplanetary Space)*, 1923. Noordung, Herman. *Das Problem der Befahrung des Weltraums (The Problem of Space Travel)*, 1929.

[2] Clarke, Arthur C. "Extra-Terrestrial Relays: Can Rocket Stations Give World-wide Radio Coverage?" *Wireless World*, October 1945, p. 306.

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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.

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UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

Reinventing the Wheel

I like ol' Al Gore, I really do. In spite of his stony demeanor, I think he has heart. And in a malignant political cesspool, he certainly seems to be one of the most benign. But an item just crossed my desk that makes me shake my head in disbelief.

It seems that Mr. Gore wants to launch a satellite to look back at the earth. Ummm...haven't we done that before? He points out the historic and evocative images of Apollo 17's "Blue Marble," and the Christmas of 68's "Earth Rising." Hasn't it occured to him that there must have been a satellite or two up there already doing this?

Acronyms like GOES, TIROS, LANDSAT, and METEOSAT immediately spring to mind, not even mentioning equivalents from other countries watching the globe, from around the globe, we might say. And even without earth terminals, individuals can "tune in" these images on the Internet.

Apparently blissfully unaware that the educational and lifesaving aspects of watching "fires ravage wilderness areas" and "hurricanes and typhoons form and threaten coastlines..." are already met daily by the other orbiting platforms, our Vice President thinks "it is important to inspire young minds, provide new perspectives on the planet for our scientific community, and perhaps provide commercial applications as well."

Not too surprisingly, NASA thinks it's a great idea. With severe budget cuts in the program, our space agency can get right on that plum with little risk–or imagination. If someone said to me, "Hey, Bob, do you suppose you could build a radio?" I think I might reply in the affirmative. Sure, there are plenty of them out there, but if someone's willing to pay for another one...

NASA's Adminsistrator, Daniel S. Goldin, enthusiastically told the press that "Vice President Gore has given us an exciting challenge" with "down to earth" applications. He also thinks that we could easily do it in less than two years. I'll bet they could, probably with a $99.95 CCD video camera and a $29.95 wireless mike module aboard a $49.95 Estes rocket kit!

But NASA's estimate is a little higher–about $50 million higher. It seems to me that this amount of money could be better spent on more pressing, and more productive, issues. How about setting up an untouchable. independent panel to study practical solutions to astronomical medical costs, campaign finance reform, reducing the crime rate, our public education system, and income tax inequities? I'm sure our readers could add many more.

In my opinion, Gore's proposal is a fatuous and unjustifiable extravagance. His heart may be in the right place, even if his head isn't. But I still like him.

ST

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