Satellite Times™

Volume 1, Number 1
September/October 1994

$3.50 US
$5.75 CAN

Premiere Issue

Shortwave Broadcasts from SPACE

Also in this Issue:

- Music of The Spheres
- DBS: It's *Here*

SDU100

SEE the Signals

You look to the left... you look to the right... all you see is spectrum. Instead of being forced to focus on the signal you're hearing, you can look much further, 5 MHz in EITHER direction! The SDU-100 brings the radio spectrum to you, instead of you searching the spectrum!

Unfair advantage for the satellite hunter! The Grove SDU-100, connected to an Icom R7100, is rapidly earning a reputation as a low-cost, high-quality alternative to expensive spectrum analyzers. It is a powerful spectrum surveillance tool, offering up to 10 MHz span allowing you to:

- Spot amateur satellite beacons and transponders as soon as they are in range
- Be instantly alerted when orbiting satellites emerge over the radio horizon
- Identify military satellite signals
- Find the hidden signals on TVRO transponders
- Locate weather satellite signals
- Prune satellite antenna systems for optimum performance
- Identify and monitor terrestrial 25-800, 900-2000 MHz VHF/UHF/microwave signals
- Monitor all audio modes: AM/CW/WFM/NFM/USB/LSB
- perform surveillance countermeasures sweeps (bug detection)
- Identify jammers and interference signals
- Study signal propagation and band conditions

...and much more!

Specifications:

SPAN: 10, 5, 2, 1 MHz; 500, 200, 100, 0 (Time) kHz
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RESOLUTION BANDWIDTH: 5, 30 kHz
SWEEP TIME: 0.1, 0.5, 2, 6 seconds
IF: 10.7 (others available by special order)
VIDEO OUTPUT: TTL to optional monochrome monitor
MINIMUM DETECTABLE SIGNAL (MDS): -130 dBm nom.
DISPLAY DYNAMIC RANGE: 80 dB

SDU-100 Spectrum Display Unit: $499*
SCN-15 ICOM R7100: $1349*
VID-100 9" CRT Monitor: $149*
*plus shipping

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Satellite Times

Cover Story

Shortwave Broadcasts From SPACE

By George Wood

Shortwave has always been the best way for international broadcasters to reach people in other countries. But satellites and the end of the cold war have changed all of that. Geostationary satellites like the Astra system (pictured) at 19.2 degrees east now carry a variety of international broadcasters from several novel radio services like World Radio Network One. Photo courtesy of Astra/SES. *See story starting on page 10.*

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September/October 1994

Music of The Spheres

By Kirk Kleinschmidt

Wouldn't it be nice if you could simply push a button on your car radio and choose between 30 stereo, CD-quality digital-music channels—broadcast to your vehicle via satellite. Kirk Kleinschmidt explores the technology, turf wars and politics of Digital Audio Broadcasting. *See story on page 16.*

DBS: It's Here!

By B.W. Battin

Direct broadcast satellite programming is like having cable without the cable. It deliver's ghost- and interference-free, laser-disk-quality pictures and CD-like sound. You can receive all of this on a satellite dish only 18 inches wide that remains stationary. B.W. Battin chronicles the first few days in operation of North America'a first DBS system, *See story on page 20.*

Fireworks on Jupiter

Fireworks this summer were not confined to the 4th of July. The third week of the month provided astronomers with an explosive show on the planet Jupiter as fragments of Comet Shoemaker-Levy 9 entered the Jovian atmosphere to a fiery end. *ST* presents some of the first photographs of this historic event taken by the Hubble Space Telescope. *See NASA News on pages 54 and 55.*

A Real Winner for Icom . . .

This month's "Satellite Times Tests" features a review of the Icom IC-820H all-mode, dual-band transceiver. Also, several new weather satellite monitoring accessories are announced in Wayne Mishler's "What's New" column.

DEPARTMENTS

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

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This year's "All-Star" Line Up includes (L to R):
Top row: IC-2340H, IC-Δ100H, IC-2700H
Middle row: IC-2GXAT, IC-820H, IC-T21A, IC-281H
Bottom row: IC-737A, IC-736
(Not pictured: IC-T41A UHF handheld and IC-481H UHF mobile)*

Get Your Mitts on an ICOM "All-Star" this Season!

IC-2340H 144/440 MHz Mobile
- Independent Controls
- Auto Repeater Functions
- Large Display
- Built In Duplexer
- 110 Memories
- 2.4 W Audio
- CTCSS Encode
- True Dual Band

IC-Δ100H Triple Band Mobile
- Triple Band Flexibility
- Full Remote Cntrl. Mic.
- 642 Memories
- High Performance
- Detachable Panel
- Voice Synth. (opt.)
- 8 Selectable Band Combinations

IC-2700H 144/440 MHz Mobile
- Detachable Panel
- V/V, U/U or V/U
- Full Remote Ctrl. Mic.
- Auto Repeater Functions
- CTCSS Encode
- Pager/Code Squelch
- Infrared Wireless Mic. (opt.)

IC-2GXAT 144 MHz Handheld
- Tone Scan
- Auto Repeater Functions
- 350 mW Audio
- 700 mAh Battery
- Selectable DTMF Speed
- 7 W (opt.)

IC-820H 144/440 MHz All Mode Base Station
- Auto Satellite Features
- High Stability Crystal
- New DDS (I-Loop)
- 9600 bps Ready
- 116 Memories
- Compact Size

IC-T21A 2 M w/440 MHz Rx Handheld
- 114 Memories
- 800 mAh Battery
- Tone Scan
- Auto Repeater Functions
- Selectable DTMF Speed
- 6 W (opt.)

IC-281H 2 M Mobile w/440 MHz Rx
- 80 Memories
- Large Display
- 9600 bps Ready
- Auto Repeater Functions
- Plug & Play
- Tone Scan (opt.)

IC-737A 100 W HF Transceiver
- New DDS (I-Loop)
- 100% Duty Cycle
- Built In Tuner
- Built In Keyer
- Dual Ant. Connectors
- VOX

IC-736 100 W HF & 6 M Transceiver
- VOX, RF Gain
- Built In Power Supply
- New DDS (I-Loop)
- Built In Tuner (6 M too)
- Built In Keyer
- 4 Function Display

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For free literature on ICOM radios call our Brochure Hotline: (206) 450-6088

ICOM

DOWNLINK

By Larry Van Horn
Managing Editor

From the Editor...

For many years, in spite of the explosive growth of the radio listening hobby, satellite monitoring enthusiasts have had to rely on amateur radio, shortwave/scanner magazines, space interest group bulletins and word of mouth for information useful to their hobby.

Now, *Satellite Times* answers that void. Covering the vast swath of radio spectrum from the lowest to the highest satellite frequency, *Satellite Times* will present articles of unusual interest with objectivity and authority.

Practical hints for more productive satellite listening, equipment tips for more effective installations, frequencies and identifications of all types of satellites in orbit, answers to questions submitted by our readers, equipment reviews of all types of satellite monitoring equipment and accessories as well as pertinent publications of particular interest. All these and more topics will be covered in future issues of *Satellite Times*.

For the first time in publishing history, active listeners to the satellite spectrum will be treated seriously, not simply as stepchildren of some other vogue hobby. And our publication will not be limited to the whims of the publisher and editor, but responsive in the needs and requests of our readers.

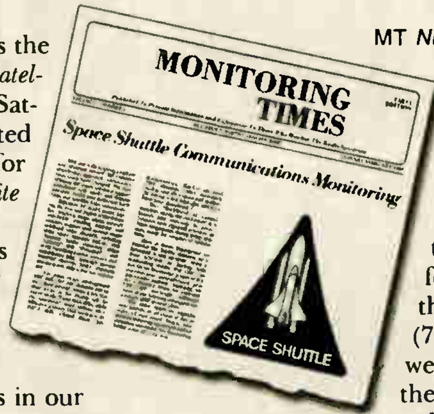
What would you like *Satellite Times* to be? What articles and information would be of particular interest to you? Would you like to learn more about equipment? Antennas? Theory? Frequency Allocations? Systems? Broadcast satellites? Utility satellites?

Let us know. We are looking forward to hearing from you and to serving you in the years to come.

* * *

If you were a charter subscriber to our sister publication, *Monitoring Times* magazine, the text above might look vaguely familiar. It is basically the same article Bob Grove penned over 12 years ago in Volume 1, Number 1 of *Monitoring Times* welcoming readers to *MT*. Bob's vision of *Monitoring Times* then, is the same vision he has for *Satellite Times* magazine now. Satellite listeners have wanted a magazine of their own for a long time and *Satellite Times* is that magazine.

I want to take Bob's editorial message of 1982 a few steps further. What satellite systems do you want to see covered in ST? Are there any holes in our current column coverage? What other items would be of value to you in the Satellite Services Guide?



MT *Number 1—remember?*

Speaking of the SSG, I think this section of *ST* has the potential to become an extremely popular and valuable resource for satellite monitoring enthusiasts. I would like to see the geographic coverage of the SSG's TVRO guides expand to include Europe, Africa, Asia and the Pacific regions. To do that, a monitor team consisting of individuals from those regions needs to be formed. If you are interested in joining the SSG monitoring team, send me a letter detailing a description of your equipment, frequency bands and modes your equipment covers, and what satellites/transponders are viewable from your location. You can send your letter to the SSG Monitoring Team, c/o *Satellite Times,* P.O. Box 98, Brasstown, NC 28902-0098. I'm especially interested in monitors that have multi-standard video, digital and exotic audio capabilities.

In order for any magazine to be successful, there are three key elements that must fall into place. First, a magazine needs advertisers. If you have a satellite product, *ST* is a great place to promote it. If you have a new product or book, our readers want to hear about it. You can contact our advertising manager, Beth Leinbach, weekdays at 704-389-4409.

Second, a magazine must have feature stories. New satellites are continually being launched and readers of this magazine want to listen in on the action. With U.S. and foreign satellite launch rates at high levels, prospective writers have a lot to write about. If you want to write an article or feature story for *ST*, contact me in the editorial offices at (704) 837-9200 during weekdays or via mail at the address given at the end of this column.

Stories accepted for publication in *Satellite Times* have two things in common: first, the story is a "good read" and second, it is of utility to the satellite radio monitor.

This means that your story should have broad appeal in a *Reader's Digest* or *National Geographic* sort of way. Anyone—satellite radio enthusiast or not—should find the story fascinating. Those that are satellite radio enthusiasts, on the other hand, should find within the article information of value--often specific frequencies--that they can use to participate in (by way of hearing) the topic you have addressed.

Third, a new magazine needs subscribers. We have sent complimentary copies of this premiere issue, free of charge, to thousands of radio hobbyist. Now that this first issue has wetted your appetite for satellite listening, I hope that you take a few minutes to fill it out and return the enclosed subscription card with your subscription request. We hope to see all of you return for the second issue of *Satellite Times*.

Finally, I would like to take this opportunity, on behalf of the entire staff of Grove Enterprises and editorial staff of *ST*, to welcome each you to the premiere issue of the first full-spectrum monitoring magazine for space, *Satellite Times*!

Letters to the editor of *Satellite Times* should be sent to the following address: Downlink, c/o *Satellite Times*, P.O. Box 98, Brasstown, NC 28902-0098.

The IC-Δ100H Takes The Magic Beyond 3 Wishes!

Buy an IC-Δ100H and **Save $100.00** Now through September 30, 1994!

Exclusive Triple Band Capability

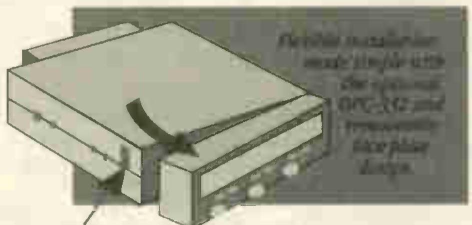
- Three independent band units for 2 M, 440 MHz and 1.2 GHz operation (simultaneous receive).
- Three independent displays can freely select the desired band unit.
- Each display indicates S/RF, volume and squelch levels.
- Each display is controlled by a separate volume and tuning knob.
- Select from 3 external speaker jacks.

8 POSSIBLE COMBINATIONS!

2m	440MHZ	1.2GHZ
2m	440MHZ	440MHZ
2m	2m	1.2GHZ
2m	2m	440MHZ
440MHZ	440MHZ	1.2GHZ
440MHZ	440MHZ	440MHZ
440MHZ	2m	1.2GHZ
440MHZ	2m	440MHZ

More than a tri-band radio, the IC-Δ100H gives you true freedom of choice!

- No removal or installation of additional band units required.
- Each operating band has a separate antenna connector to enable duplexer/triplexer use without any mismatching antenna loss (not one common antenna for multi-signal, one band operation like you see in competitive models).
- Cross band double duplex (transmit on one band while receiving on two others) and full crossband duplex (transmit on one band and receive on another) is possible. The one-touch PTT enables telephone-like conversations without having to continually press PTT.



Remote Installation Options

- **One Body** – install as a complete unit.
- **Separate** – detach the front panel and mount each separately (see illustration).
- **Remote** – Mount the main body in the trunk (OPC-333 and OPC-335 req.).

Incredible Performance

- AFC-RIT, AFC-VXO, manual RIT and manual VXO modes to compensate for "off frequency" of the Tx station (1.2 GHz).
- High Sensitivity – less than .16μV.
- Double-conversion superheterodyne receiver system.
- More than 2.4 W audio output power.

Memory Bank System

- Transfer call or memory channel contents to VFO. Particularly useful when searching for signals around a memory channel frequency and for recalling the offset frequency, tone frequency, etc.
- Priority Watch – Scans one (or more) memory channels per band while operating on a VFO frequency.
- 642 memory channels organized in two separate banks* (very convenient for two ham families).

[illegible]

Options	Bank/User #1			Bank/User #2			TOTAL
Bank	#1	#2	#3	#1	#2	#3	
Normal*	100	100	100	100	100	100	600
Scan Edge	6	6	6	6	6	6	36
Call	1	1	1	1	1	1	6
Total IC-Δ100H Memory Channels:							642

The memory bank system can even be customized for "his" and "hers" operation!

- 14 DTMF autodial memories for autopatching, accessing repeaters and controlling other equipment, etc.

* Stores operating frequency, duplex direction, offset frequency, subaudible tone frequency, encode on/off, tone squelch on/off and skip information.

Microphone Remote Controls

- A multi-function keyboard with complete control over the IC-Δ100H.
- The beep tones for each band are different and distinguishable so you can keep your eyes on the road.

IC-Δ100H Triple Band Mobile Transceiver (shown with the optional OPC-332)

- Over 22 functions are at your fingertips with the IC-Δ100's unique microphone keyboard!

Other Great Features

- Built in tone encoder
- Tri, dual or mono band operation
- External remote control via another transceiver (opt. UT-75)
- Sub band access/mute/busy beep
- Opt. pocket beep and tone squelch

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All stated specifications subject to change without notice or obligations. All ICOM radios significantly exceed FCC regulations limiting spurious emissions.

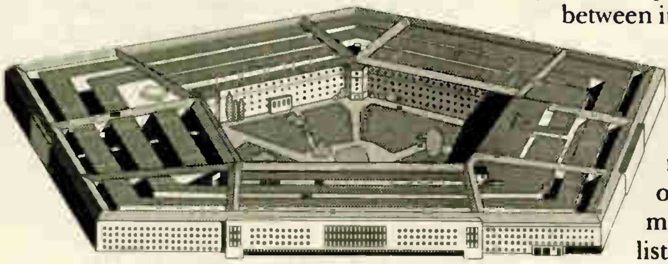
Δ100CPN794Y

ICOM®

SATELLITE MONITOR

By Wayne Mishler, KG5BI

MILITARY MAY MOVE TO NEW SATELLITE SYSTEM



The United States Army, Navy and Air Force are testing a new satellite system which may shift much of their communications beyond the reach of short-wave radio listeners, according to the Lockheed corporation.

All three military services simultaneously conducted inter-service communications for the first time this year via a 20-terminal Milstar network that uses the Milstar satellite as its processing hub. The satellite, launched earlier this year, has an Extremely High Frequency (EHF) uplink frequency of 44 GHz and a Super High Frequency (SHF) 20 GHz downlink. Try punching those into your scanner!

The new system is capable of multi-terminal and full-network voice and data communications, satellite antenna calibration, and multiple ground station operations.

The 20 terminals are located on ships, submarines, aircraft and vehicles; they use antennas as small as five inches in diameter. As network testing progresses, more terminals are to be added to the system.

Surprisingly, while the satellite transponders operate in the gigahertz range, they receive and transmit voice, data and fax information at 75, 150, 300, 600, 1200 and 2400 baud. This unusual combination of data rates and operational frequencies offers increased immunity to jamming and interception, Lockheed says.

For security purposes, the satellite hops signals across its 2 GHz bandwidth - first for communications satellites, according to Lockheed.

Milstar has a UHF uplink and downlink capability which it uses in a special way: It can produce and relay signals between its UHF and SHF/EHF systems. Lockheed says this technology, known as cross-banding, is unique to Milstar and will allow new Milstar terminals to operate with current UHF military equipment. Scanner listeners take heart.

This is the first of a series of Milstar satellites on the drawing board; two others are to be launched by 1995, and another four are to be in orbit by 1999. Each has a life of ten years.

This so-called "switchboard in the sky" will allow theater commanders to establish and control their own customized networks in minutes. Establishing a network with existing commercial and military systems can take weeks.

POLISH SATELLITE SERVICE TO U.S. FAILS

An attempt to relay television Polonia satellite programs to the United States has ended in fiasco, says Polonia director Leszek Wasiuta. The unanswered question is whether Polish Americans would tune in to TV Polonia, he says. "Production is (only) a third of the success which depends on (our) ability to sell the product," says Wasiuta.

Apparently there has been a breakdown in market research. "At TV Polonia we are all taking this as personal failure. It is not because of lack of goodwill from the Polish side. We failed because our American partner could not bear this burden on his shoulders," Wasiuta says.

The board of the Polish Television Company will now have to decide whether or not to continue this initiative. One option being considered by TV Polonia management is to hire a professional firm to find a partner "with the money and powers to sell this television," says Wasiuta. "We are trying to decide whether we should be looking for a partner by means of a Wall Street marketing bureau, or get in touch with a Pole who does not give guarantees but has goodwill."

Ultimately it will be up to the board to decide, Wasiuta adds.

SWISS RADIO GOES TO SATELLITE IN ENGLISH!

Swiss Radio International (SRI) will broadcast in English via satellite 24 hours a day beginning this year. This new service is to be transmitted via the Astra satellite on Teleclub Switzerland, transponder 9, with an up-link frequency of 11.332 GHz and a down-link of 7.38 MHz.

"On the hour we're going to have news and current affairs, and on the half-hour we'll have features that will be repeated in a staggered way so that we will have 24-hour coverage on the Astra satellite," says SRI deputy director Nick Lombard.

Meanwhile, SRI plans to continue beaming the same number of intercontinental short-wave programs as before by HF radio. "We won't be reducing our short-wave broadcasts, except in Europe," says Lombard. In Europe SRI was broadcasting short-wave 18 hours daily. This will be reduced to daytime and early evening hours.

The revised output will also bring a change in programming, says Lombardi. "We have all new programs introduced by new jingles. The whole l'habillage, as we call it, (that is, the continuity) will be different. The sounds of the programming will also be different," he says.

HCJB RADIO BEGINS SATELLITE TESTS

Radio HCJB in Ecuador and Trans World Radio at press time were testing a 24-hour satellite radio broadcasting service from their Latin-American headquarters. This new service is known as ALAS (America Latina via Satellite) and reportedly is the first Christian radio satellite network to be established in Latin America.

TWR was to begin the tests by putting six radio stations on the air in July, and then add three more each month through

December. They were to have 26 stations broadcasting by the end of this year.

CHINA NOW BROADCASTING TO U.S.

A Chinese television network, in cooperation with a Nebraska university satellite television station, now broadcasts news and cultural programs weekly to the United States and other parts of the world.

Officials of China's Huanghe television network and the Creighton University satellite educational network (SCOLA) are working together to promote Sino-U.S. cultural exchanges between the two nations.

Huanghe is the first China-based television network to broadcast news and cultural programs to the United States. It transmits 21 special topics to SCOLA every week. The focus of Huanghe programming is to help Americans and others understand Chinese history and geography. Other nations benefiting from Huanghe achievements include France, Germany, Japan and Russia, as well as China's Taiwan region.

Huanghe, with headquarters in Taiyuan, has production capabilities of news gathering, editing, shooting, broadcasting and recording. It shares programming with a pool of ten other local television stations.

The network broadcasts to 30 million people in China. There are in that nation more than 1,800 educational television stations and transponders, 6,000 ground stations for receiving educational television programs broadcast by satellite, and 50,000 recording and playback (VCR) units in use.

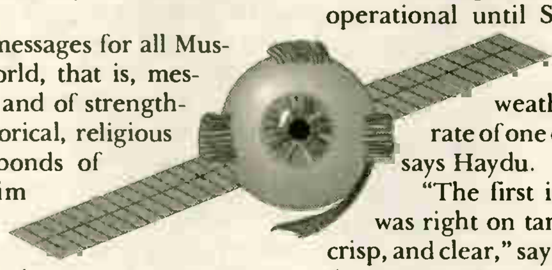
IRAN TO BROADCAST TV WORLDWIDE

The government of Iran is planning to broadcast radio and television programs worldwide via satellite technology. Meanwhile, the Islamic Majlis is proposing a ban on satellite receiving dishes in Iran.

A spokesman for the Voice and Vision of the Islamic Republic of Iran, Dr. Shahidi, announced plans to broadcast cultural and other programs worldwide during a recent meeting of university professors, journalists and political officials.

Shahidi cited the need for cooperation among Islamic nations in producing radio and television programs reflecting Muslim culture, inclinations, and interests for broadcasting via satellite networks.

"We have messages for all Muslims of the world, that is, messages of unity and of strengthening the historical, religious and cultural bonds of the Muslim people," Shahidi said.



Conversely, in an open session, a group of deputies of the Islamic Majlis introduced a bill that would ban satellite receiving dishes. The bill has been presented to the presidium of the Majlis for consideration.

NEW TECHNOLOGY DEVELOPED

A Japanese telecommunications company reports that it has developed technology for compression and digital transmission of high-definition television (HDTV) signals.

The Kokusa Denshin Denwa (KDD) company says the technology compresses HDTV signals by one thirtieth of the original size, and transmits them at 45 megabits per second via a Japan-U.S. submarine, optical-fiber cable.

This new technology--reportedly the first of its kind--is the leading edge of a coming wave of multimedia, interactive communications methodology, which will cut costs of international transmission of HDTV programs.

GOES-8 OPENS ITS EYES

The nation's newest weather satellite, GOES-8, which tracks Atlantic hurricanes, has begun transmitting pictures of weather patterns from the region including the mid-Pacific, continental United States and eastern Atlantic.

Scientists are elated at what they have seen during the 1994 hurricane season. "It's like putting on a pair of glasses. Everything comes into focus," says Kenneth Haydu, chief of the tropical satellite analysis forecast unit at the National Hurricane Center in Coral Gables.

Although GOES-8 will not be fully operational until September, weather forecasters are using it to receive weather pictures at the rate of one every six hours or so, says Haydu.

"The first image ever received was right on target and very sharp, crisp, and clear," says Gary Davis, geostationary programs manager for the National Oceanic and Atmospheric Administration. *(See Weather Satellites-The View from Above for a look at the first image from GOES 8-Editor).*

CIVILIAN AND MILITARY WEATHER SATELLITES COMBINED

America's civilian and military weather satellites are being combined into a single system to save money, according to government officials.

The National Oceanic and Atmospheric Administration will operate the Defense Department's polar-orbiting weather satellites in addition to its own, says White House science advisor John Gibbons.

A joint office to manage the national system is to be set up this year, although the two operations won't be combined until the year 2004, officials say.

The change is expected to save tax payers $300 million by the turn of the century by eliminating dual planning and development programs.

MOM, THE ENEMY'S ATTACKING. I'LL CALL YOU RIGHT BACK.

Not long ago, when warships went to sea, telephones stayed ashore.

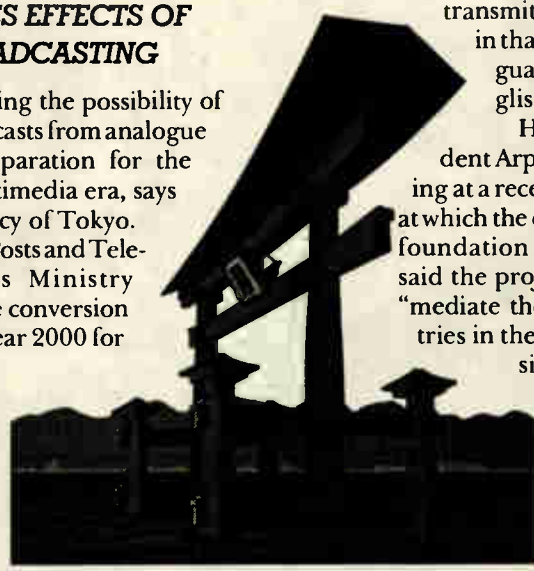
Today, thanks to new satellite technology, Sailors and Marines aboard the aircraft carrier USS George Washington (CVN 73) are calling home on the ship's pay phone.

U. S. Sprint, working in conjunction with the Navy's prototype communications system "Challenge Athena", offers shipboard phone service for 50 cents a minute from anywhere in the world.

Challenge Athena is a Navy communications package allowing the ship to transmit audio and video data to satellites. The phones were purchased for crew members from the ship's morale, welfare and recreation fund.

For the record, within a nine-hour period, crew members made more than 500 phone calls as the ship steamed toward the Mediterranean Sea to relieve the USS Saratoga battle group. Few of the calls were to Mom.

JAPAN STUDIES EFFECTS OF DIGITAL BROADCASTING



Japan is studying the possibility of converting broadcasts from analogue to digital in preparation for the forthcoming multimedia era, says Kyodo news agency of Tokyo.

That nation's Posts and Telecommunications Ministry plans to begin the conversion to digital by the year 2000 for broadcasting through communication satellites, and soon afterward for ground broadcasting. A study panel has been asked to prepare a detailed plan for conversion by next March, ministry officials say.

The proposal follows a International Telecommunications Union (ITU) mandate to standardize world digital technologies of satellite broadcasting systems by 1996, and ground broadcasting systems by 1998.

Japan lags other nations in shifting to digital broadcasting because doing so may interfere with "Hi-Vision", an advanced broadcasting technology developed by Japan's broadcasting industry, according to industry watchers.

The panel will study the possibility of coexistence with Hi-Vision. It will also try to determine the effects that conversion could have on audiences during the transitional period.

NEW EUROPEAN SATELLITE TV CHANNEL ANNOUNCED

Plans to initiate a new satellite television channel within the next three years were announced May 12 by a recently-formed European foundation, according to a report by Hungarian Radio in Budapest.

The channel, initiated by the newly-formed First Central and Eastern European Cooperation Foundation, will be transmitted to 25 countries in that region in five languages, including English.

Hungarian president Arpad Goencz, speaking at a reception in Budapest at which the creation of the new foundation was announced, said the project is intended to "mediate the culture of countries in the region and intensify friendship between its peoples." The satellite channel opens "direct dialogue between cultures," Goencz said.

The First Central and Eastern European Cooperation Foundation was initiated in March by artists, politicians, managers, engineers, teachers and journalists.

Members call their project the "channel of cooperation." It is to mirror the region's intellectual and economic lifestyle. Programming is to be prepared in national editorial offices and financed by national foundations.

The project has raised eyebrows and cooperative interests of numerous technical experts from Bulgaria, the Czech Republic, Estonia, Belarus, Finland, France, Georgia, Croatia, Poland, Lativia, Lithuania, Germany, Italy, Russia, Austrian, Armenia, Romania, Serbia, Slovakia, Slovenia and Ukraine.

NEW ARABIC TV STATION BROADCASTS FROM BELGIUM

A new television station identified as the European Arab Company for Radio and Television was recently seen broadcasting in Arabic on the Eutelsat-II-F2 satellite at 16.0 degrees east. It occupied the transponder at 10.987 GHz with horizontal polarization. This is the same transponder that carries the Eurostep educational channel at 1100 UTC and Croatian TV during evening hours.

The station gave its address as Euratel Bruxelles, Luchthavenlaan 22, 1800 Vilvoorde.

EGYPTIAN SATELLITE TV TO INCREASE OPERATION

The Egyptian international satellite television channel, Nile TV, will soon increase its air time from two to six hours daily, using the European satellite (currently Eutelsat-II-F2) at 16.0 degrees east. There are plans to expand this channel to cover African areas via Arabsat by the end of this year.

Egypt plans to launch a new satellite within two years which will carry 12 to 56 channels. Studies for the project have been completed by French and United States firms. Work is expected to begin this year, target launch date is 1996.

ARABSAT TO BUY OR HIRE SATELLITES

The Arab organization of communications via satellite (Arabsat) council is planning to buy or hire several telecommunications satellites to meet a growing demand for space telecommunications services, says the Tanjug news agency. Arabsat reportedly grossed a record $42 million in 1993 and anticipates earnings of $48 million this year.

The council, which also goes by the title, Arab Space Telecommunications Corporation, is encouraged by the success and is recommending that Arabsat be further developed to compete with top international space networks.

Council members include delegates from Qatar, Morocco, Egypt, Saudi Arabia, Kuwait, Libya, the United Arab Emirates, Bahrain and Tunisia. The council has reviewed progress on the manufacture of a second generation of Arabsat satellites by a French firm.

IRAN INAUGURATES NEW SATELLITE SYSTEM

Iran recently celebrated the dedication of a new IRNA satellite system and bureau building in Iran's Central Province this year with a volley of sharp words for western counterparts, possibly foreshadowing IRNA's editorial mission.

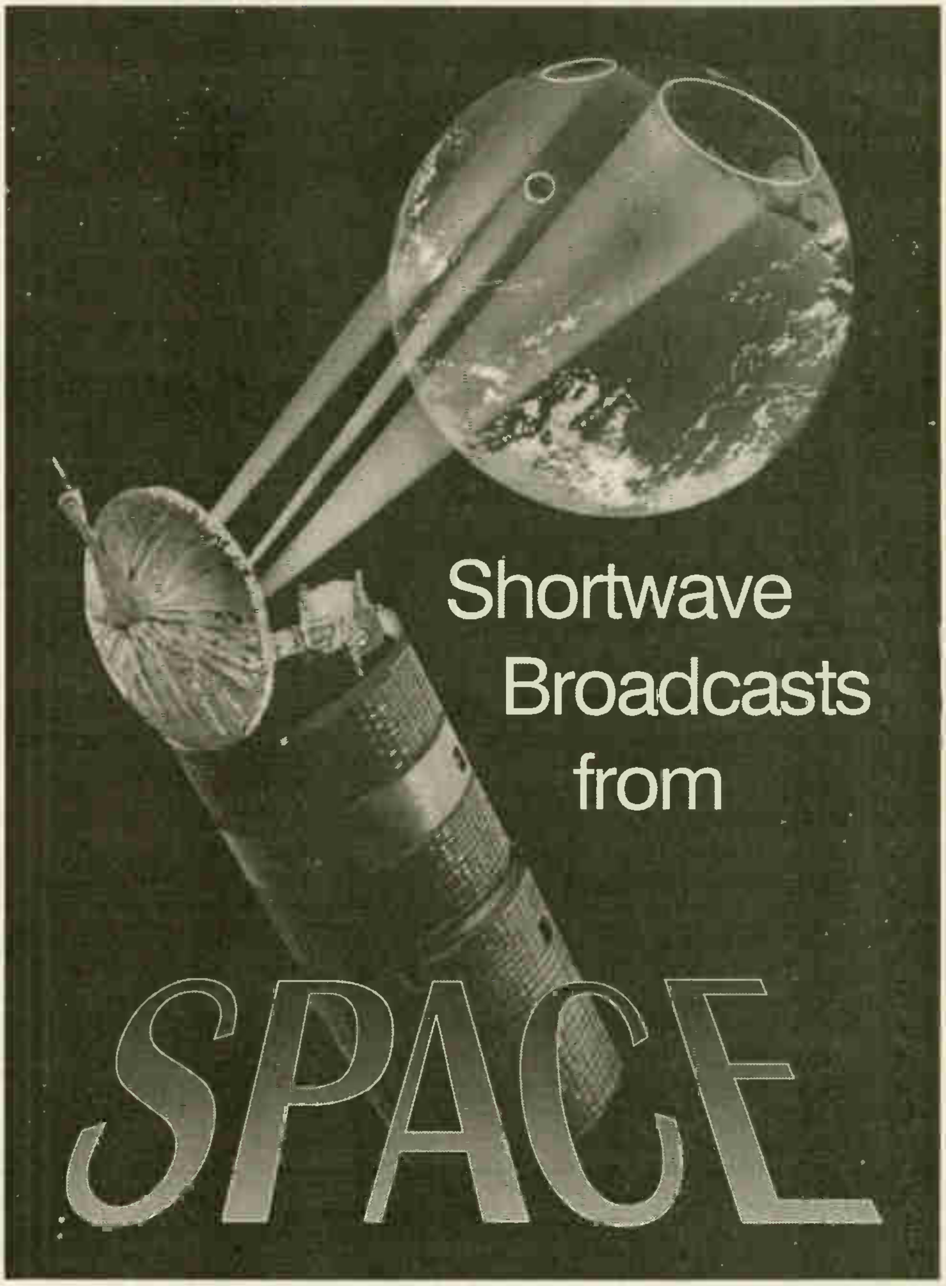
A spokesman for IRNA claims, "The enemies of Islam are attempting to mis-portray the Islamic Republic in the eyes of the world people. The arrogance (western) media circulate only a selection of the Iranian news in line with their political objectives. The main task of Iranian journalists is to introduce the real nature of the Islamic republic system," the spokesman said.

FAILING TV FOUNDATION SAVED

The Hungarian government has bailed out one of that nation's financially troubled television foundations, according to a national newspaper.

The official gazette *Magyar Kaoezloeny* reports that the government recently granted the Hungarian Television Foundation enough money to pay debts incurred in the launching of satellite channel Duna TV.

"Satellite Monitor" is written by Wayne Mishler from information provided by the following companies and publications: *Drilling Reservist Newsletter*, Lockheed media relations and *BBC Broadcast Information*.



How to hear international shortwave broadcasts on your home satellite dish

By George Wood

It's now possible to receive from satellites international broadcasters like the British Broadcasting Company (BBC) World Service, Radio Australia, Radio Netherlands, and Radio Sweden — all with FM quality. All you need is conventional satellite TVRO equipment, thanks to C-SPAN and the World Radio Network (WRN).

The stations that we usually call "shortwave broadcasters" are really "international broadcasters"; governments and churches fund these stations to reach listeners with a message, and as far as they are concerned, the more listeners the better. Shortwave has always been the best way to reach people in other countries via radio, but it is far from a medium of choice for broadcasters, with all the problems of propagation, shifting frequencies, and the lack of a mass audience.

Back during World War II, subsequent conflicts and civil wars, and the Cold War, there were reasons for people to sit glued to their receivers, listening to distant stations through static, fading, and jamming. Sometimes their lives depended on being able to hear news from outside their government's media monopoly.

But satellites and the end of the Cold War have changed all that. Why should most people listen to crackly and fading shortwave when they have dozens or even hundreds of TV and radio signals available on cable, or when the former government monopoly has been replaced by freewheeling private stations and local relays of foreign stations?

Many stations have turned to satellite, as a means, rather than as an end in itself. Four million American households and almost as many Europeans may have TVRO equipment, but most use it to watch TV, ignoring the abundance of radio channels available. Broadcasters, therefore, view satellites as a means to reach domestic FM stations and cable networks for rebroadcast. For a little station like Radio Sweden, a relay of a program on a local FM station in the US, even a small college station, probably means more listeners than their total shortwave audience.

But there's a problem facing small stations turning to satellite as a means of accessing FM and cable programs for rebroadcasting; large stations like the BBC World Service or Radio Australia may be able to afford a round-the-clock English service, but most small broadcasters can't.

Radio Sweden's satellite channel, for example, carries hours of relays in Swedish from their domestic service, along with regularly scheduled programs in English, German, Russian, Estonian, and Latvian. That's fine for satellite DXers, and even some FM stations, but no cable network is going to allocate one of its limited number of radio channels to relay such a hodge-podge, mostly in languages none of the listeners can understand.

But they might relay a 24 hour service in English from many stations. C-SPAN and the World Radio Network have stepped in to fill this void.

C-SPAN

C-SPAN, which relays programming from the United States Congress on two transponders on Satcom C3 and Satcom C4, opened two of its sound carriers on Satcom C4, transponder 7, to international broadcasters a few years ago. The subcarrier at 5.4 MHz carries the BBC World Service around the clock. The other subcarrier, at 5.22 MHz, carries a mixture of international broadcasters.

A number of Asian and Pacific broadcasters can be heard, including Radio Japan, Radio Korea, China Radio International, and Radio Australia. From Europe come Deutsche Welle, Radio Austria International, and Radio Sweden. Other offerings include "As It Happens" and "Sunday Morning" from the Canadian Broadcasting Corporation, as well as programs from Radio Havana Cuba and Kol Israel.

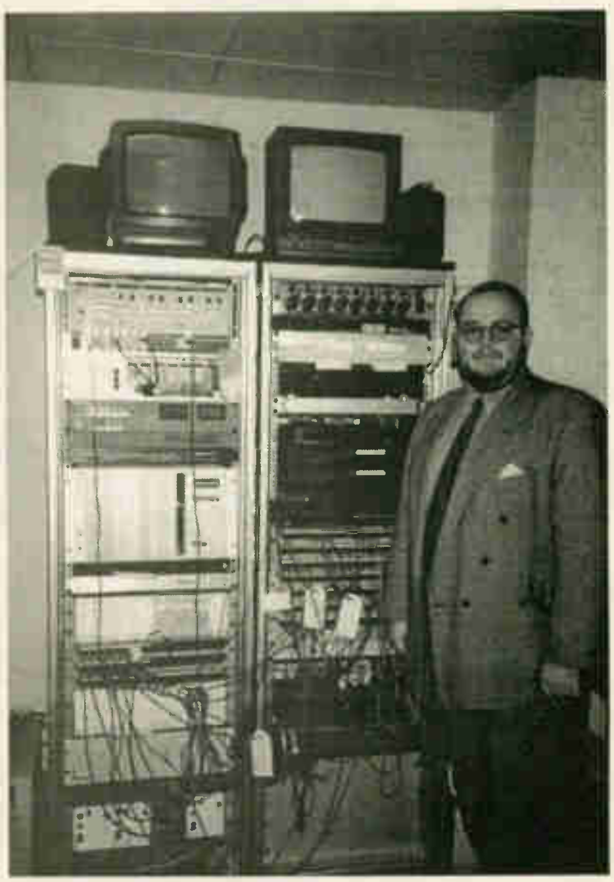
Some, which are available by satellite links, offer that same day's programming on a daily basis, but other stations, like Radio Sweden, lack such links and provide only taped transcription programs on a weekly or monthly basis. Unfortunately, although the sound is there behind the C-SPAN satellite signal, very few cable networks seem to have taken the opportunity to provide an FM relay.

World Radio Network

Enter the World Radio Network, organized by three former BBC employees who saw that international broadcasters needed a time-shared channel. They started in Europe, using Astra, which groups several medium-powered Ku-band satellites at one position in the sky. Viewers need only 60 to 90 centimeter (2 to 3 foot) antennas to receive what was at first 16, then 32, and now 50, channels of TV programming, with more to follow as new satellites are launched.

Astra is Europe's hottest satellite position, and WRN managed to acquire free use of an Astra sound channel for two weeks to test the concept of time-shared international broadcasting. They relayed a number of broadcasters, some from their existing dedicated satellite channels, some using the new ISDN digital telephone lines, and some, like All India Radio, straight off shortwave. They also discovered that National Public Radio's (NPR) 24 hour line from London to Washington was two-way, and used it in the other direction to relay NPR programs like "All Things Considered".

After that original test, the WRN organizers quietly went to work to develop a permanent system. One of the test stations, Vatican Radio, was in search of a permanent satellite channel for all its language services. WRN leased a radio channel on another satellite, Eutelsat II-



Karl Miosga of WRN Radio

F1, which is much cheaper than Astra, and provided the multi-lingual uplink for Vatican Radio. Later, Radio Canada International's Russian Service signed on as well.

WRN returned to Astra in October last year, with a 24 hour English language service called WRN Network One. Once again the foundation was NPR, which funds most of the costs of the new channel for relays of "Morning Edition", "Weekend Edition", "Fresh Air", "All Things Considered", and "Talk of the Nation" (which is now an international phone-in show). Other broadcasters on the subcarrier include Radio Sweden, Radio Finland, Radio Australia, Radio Korea, Kol Israel, Belgium's Radio Vlaadndern International, Austria's Blue Danube Radio, and RTE from Ireland.

To the great joy of DXers and shortwave listeners, Radio Netherlands also signed up, the first time that station has been accessible to home listeners on satellite. Radio Netherlands' European shortwave coverage has always been spotty, and the ability to listen to Jonathan Marks' popular "Media Network" in FM quality has obviously pleased many listeners.

In an audience survey, four months after launch, "Media Network" was rated as WRN's top program among British listeners, with more than 300,000 listeners. Listeners in all of Europe favored NPR's "Talk of the Nation", which attracted an audience estimated at 495,000.

Besides the direct-to-home satellite audience, WRN has lined up relays of NPR programming on FM transmitters belonging to Radio Finland in Helsinki and Radio Sweden in Stockholm. The entire output is on cable in Dublin, and a relay in Amsterdam is in the works. WRN has also received permission for an experimental FM license in London.

European listeners were recently treated to a first: an NPR fund-raiser. For a week in late April, Ray Dilly, head of NPR's International Service, and a colleague from Vermont Public Radio sat in WRN's London offices (on the Strand, a stone's throw from the headquarters of the BBC World Service) and broke into broadcasts of "Fresh Air", "Morning Edition" and "All Things Considered" to encourage listeners to call in and pledge support.

This may be a fairly normal exercise on public radio and television in the United States, but it was a totally new, and somewhat confusing, concept in Europe, where the powerful public broadcasting networks are funded by compulsory viewer license fees or from tax coffers. In fact, those fund-raising broadcasts were dropped from Radio Sweden's FM transmitter in Stockholm because they would have violated Swedish Radio's somewhat restrictive policy on advertising.

Funding for NPR's International Service will probably have to continue to rely on corporate sponsoring, and NPR's European audience may in the future miss the pledge drives that seem to be a constant feature of American public broadcasting.

North America

In January this year WRN expanded to North America, using transponder 23 on ASC-1 (128 degrees West), audio 6.2 MHz. This was an especially relevant choice, as the transponder belongs to SCOLA, which relays foreign language TV news programs from around the world. The service is largely the same as the European, with repeats of other broadcasters replacing the NPR programs.

In addition, WRN broadcasts Glen Hauser's long established DX news program - World of Radio. This, and many other programs aimed at radio enthusiasts, helps cement the link between the technologies of shortwave and satellite.

Several public radio stations are rebroadcasting WRN programs, and others have expressed interest in using the international broadcasters to fill their all-night schedules. Negotiations with cable networks continue, the first one to sign up is in Vancouver, British Columbia.

SCOLA has just started digital transmission on the Telstar 401 satellite and will discontinue ASC-1 feeds at the end of 1994. In order to retain the audience equipped for analog audio subcarrier transmission, WRN started transmitting on Galaxy 5 (WTBS), transponder 6, audio 6.80 MHz on August 1, 1994.

Future Plans

WRN continues to expand. Plans for a similar German-language service in Europe, WRN 2, are going ahead. This would use another subcarrier on the same Astra transponder currently carrying WRN 1. WRN is also looking into French and Spanish language channels. These new services will use existing and new program contributors.

An agreement has been signed to relay programming on a channel on Brazil's Radiosat service which reaches a large number of radio stations in that country. WRN is currently looking for interna-

TABLE 1: Shortwave Stations Broadcasting via Satellite

The stations currently contributing programs to WRN Network One are:

ABC Radio Australia
BBC Europe
Radio Canada International
C-SPAN - USA *
Central Europe Today - Budapest, Hungary *
Deutsche Welle +
Israel Radio
KBS Radio Korea International
National Public Radio - USA *
ORF Blue Danube Radio - Vienna, Australia
Radio France International
Radio Moscoe Internationa;
Radio Netherlands
Radio Sweden
Radio Telefis Eireann - Ireland
Radio Vlaanderen International - Belgium
Swiss Radio International
United Nations Radio
Vatican Radio
YLE Radio Finland

Other shortwave broadcast stations that have been monitored via satellite audio subcarriers include:

BBC World Service
China Radio International
Deutsche Welle
Radio Austria International
Radio Canada International
Radio France International
Radio Havana Cuba
Radio Japan
Radio Korea
Swiss Radio International
Voice of America
WHRI - South Bend, IN
WINB - Red Lion, PA

Complete information and schedules for shortwave broadcasters via satellite can be found in this issue of *Satellite Times* in the Satellite Services Guide.

* not distributed in North America + not distributed in North America

tional broadcasters interested in reaching the Brazilian market.

But the most ambitious plan is the upcoming launch of a Far Eastern service, over the Usen cable network in Tokyo, which is estimated to reach 12 million residential listeners and a large number of hotels and businesses through-out Japan. This system carries a staggering 440 audio channels.

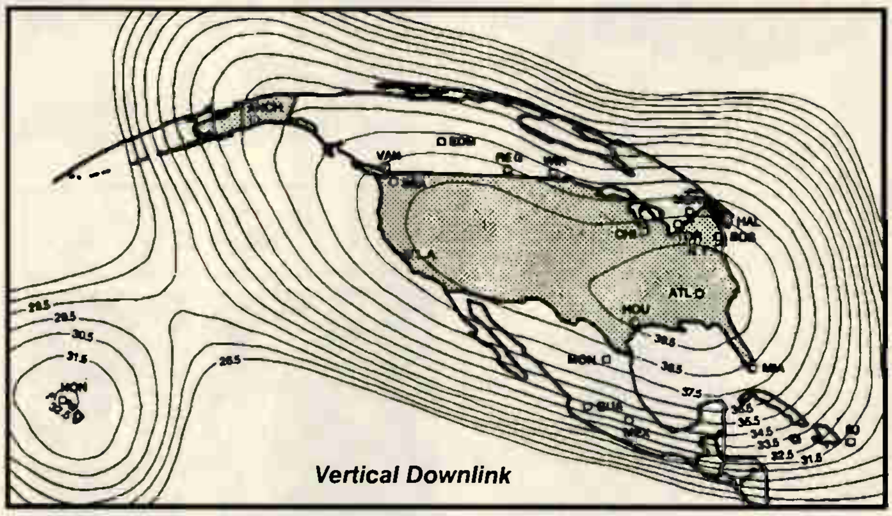
Among these are 40 channels of Japanese pop and folk music; 40 more channels of rock, pop, and classical music from around the world; instrumental and New Age music; film soundtracks; and various mood-setting nature and sound effects noises to play in workplaces; 12 channels of language lessons in 7 languages; 10 channels of children's programs, from bedtime stories and songs from TV cartoons to lullabies and the sound of a mother's heartbeat; whole channels devoted to spiritual messages, easing stress, and counting sheep; and 30 channels of international folk music. There are also several channels described in program schedules as "For alibis", apparently so a husband can call his wife and pretend to be at bar, a train station, or a phone booth when he's actually somewhere else.

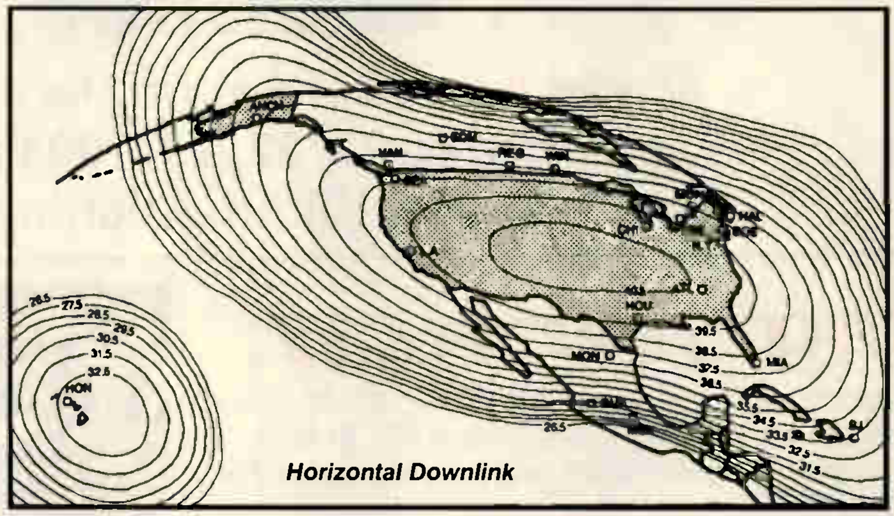
Among these titanic offerings are a number of international channels, including Z-100 radio from New York and KPWR from Los Angeles, channels from "USA Today" and "Newsweek", BBC World Service, and the Voice of America. WRN is to join this system shortly, and hopefully will attract a few listeners among these overwhelming offerings.

People listen to shortwave for many reasons. If you're interested in the content of the broadcasts from other parts of the world, a satellite receiver and dish can give you many stations in perfect FM quality right now. Soon, some of those same broadcasters might also be only as far away as the cable outlet on your wall. If you enjoy hunting for new stations, DX to your heart's delight in the Clarke Belt; where there are always new things happening!

George Wood is the International TVRO columnist for Satellite Times. *He's is also the host of 'Sweden Calling DX'ers', a weekly radio program heard on international shortwave broadcaster, Radio Sweden.*

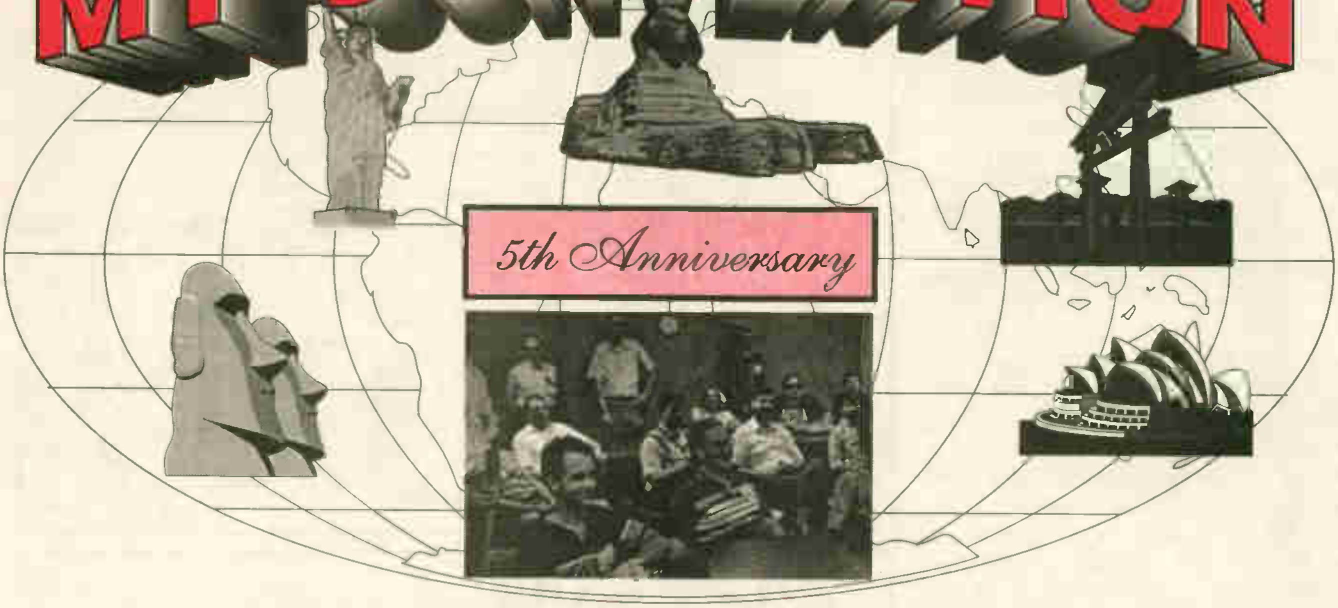
Galaxy 5 — EIRP Map





Satellite footprints courtesy of Baylin Publications, 1994 World Satellite Yearbook

MT CONVENTION



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➜A ***two-hour international broadcasters forum*** starts off the weekend Friday evening and is hosted by moderator Ian McFarland.
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➜Get your scanner charged and ready for the Saturday night "***Bug Hunt***"--a convention highlight.
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➜See the ***Portable Satellite System*** set up for the convention.

PRELIMINARY 1994 MONITORING TIMES CONVENTION SCHEDULE

FRIDAY

8AM - 7PM	Registration open
8:45 - 4PM	Tours of Delta Maintenance, Museum, Radio Room and Dispatch
12PM - 5PM	Exhibits and Listening Post open.
7PM - 9:15	International Broadcast Forum with host IAN MC FARLAND and panelists Tom Rodgers, International Radio Satellite Corporation; Dr. Bill Prichard, W.L. Prichard Co. of Bethesda, MD; Kim Elliott, VOA/USIA; Larry Magne, Passport to Worldband Radio;Karl Miosga, Managing Director World Radio Network, London, England.

SATURDAY

8AM - 2:30	Registration open
8:45 - 3	Exhibits open
9AM - 9:30	Welcome by Bob Grove

SEMINARS

9:45-10:45	Future of Satellite Broadcasting *Ken Reitz*	What Do Those S/W Specs Mean? *Larry Magne*	Federal Monitoring *John Fulford*	Scanning for Beginners *Skip Arey*
11-12	Rumblings in the Basement (Below 500kHz) *Kevin Carey*	Digital Monitoring Modes & Equipment *Bob Evans*	Antennas: Fact and Fiction *Bob Grove*	Shortwave for Beginners *Skip Arey*
3-4	TVRO, the Ideal Set-up -*Ken Reitz*	Pirates & More! *George Zeller*	Shortwave Intrigue *Larry Van Horn*	
4:15-5:15	Home Reception of INMARSAT *John Wilson*	AM/FM/TV Broadcast DXing *Joe Eisenberg*	Monitoring the Military *Larry Van Horn*	
7-9	Banquet - guest speaker IAN MC FARLAND			
9:30 - ?	Bug Hunt - John Fulford and Friends			

SUNDAY

9 - 10 AM	Aero UHF/VHF/HF *Jean Baker*	Weather Reception on HF FAX & SATS *Jacques D'Avignon*	Surveillance Techniques *John Fulford*
10:15-11:15	Advanced Antenna Design *Dick Austin*	Linking Technologies *Bill Grove*	All About Scanners *Bob Grove*
11:30-12:30	DXing the Satellite Spectrum *Larry Van Horn*	Radio-related Computer S/W *John Catalano*	Spy Number Stations *John Fulford*
12:45-1:15	CLOSING		

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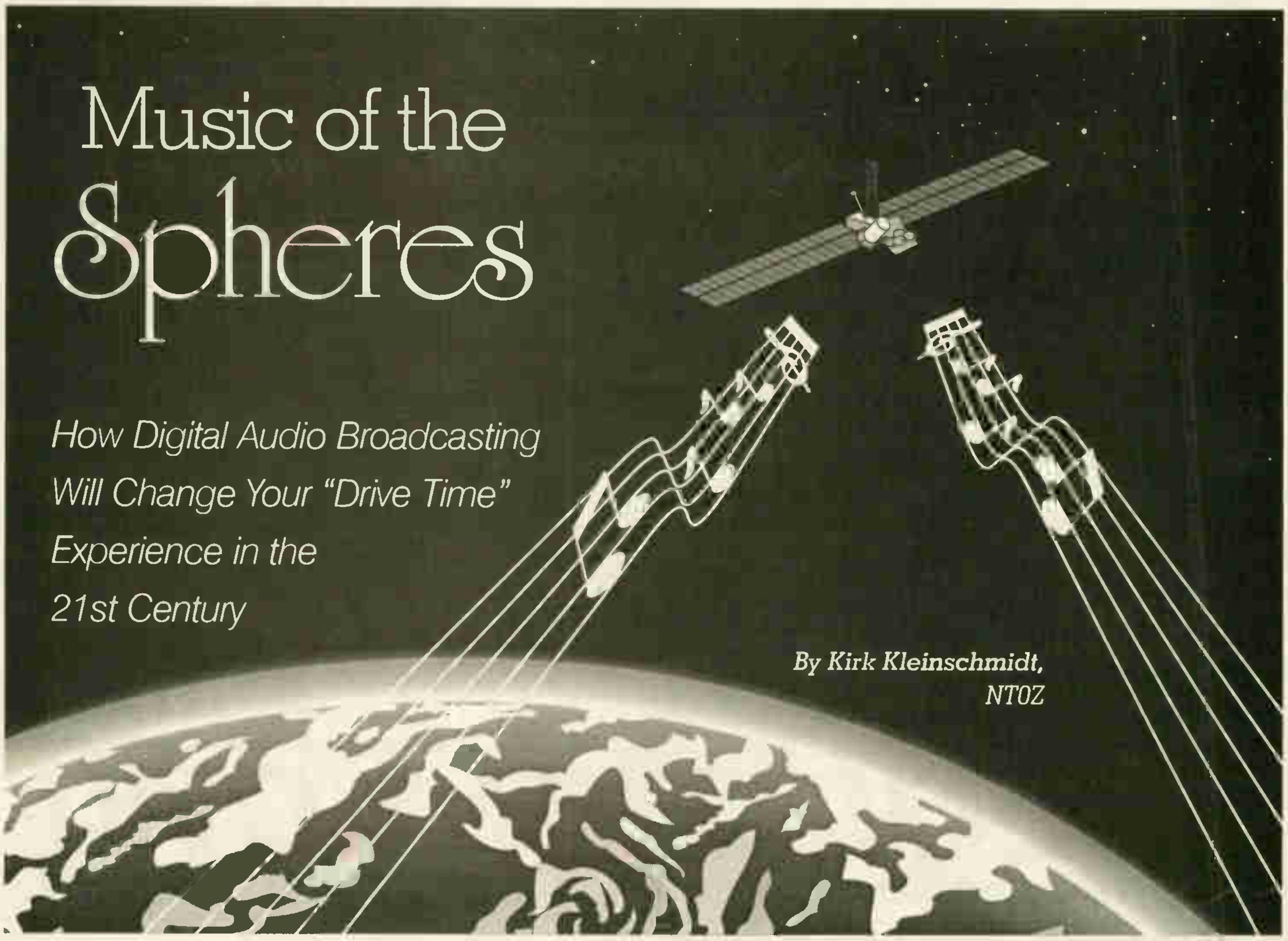


Music of the Spheres

How Digital Audio Broadcasting Will Change Your "Drive Time" Experience in the 21st Century

By Kirk Kleinschmidt, NT0Z

When digital audio broadcasting — inexpensive, nationwide, CD-quality music, talk and data via satellite — is okayed by the FCC, car audio will never be the same. It's as if Arthur C. Clarke had a classic Corvette in mind when he thought up the geosynchronous satellite!

You're driving between Fargo and Las Vegas. The roads are great — no potholes and no traffic. The wide open spaces and scenic expanse of the Badlands are as beautiful as they were in *Dances With Wolves*. But one problem plagues you almost all the way: You can't hear any FM radio stations — none you'd care to listen to, anyway!

Or, perhaps you're driving home — late at night — from your job in Manhattan's photo district to your house in one of the city's outlying suburbs. You tune your FM radio up and down the band. The city that never sleeps is living up to its reputation: There's talk radio; shock radio; all news radio; all sports radio; radio in Spanish, Greek and Polish; heavy metal, rap, beautiful music -- even Frank Sinatra! But nothing seems just right....

You might even be cruising down the highway near Los Angeles. It's morning Drive Time! Wake up you crazy commuters! Traffic is at a standstill — and you've got another hour of "blissful basin" highway hijinx before you pull up at the office. You've heard the local news and sports, and the local DJs *are* funny, but the endless commercial breaks and depressing traffic reports are taking their toll....

Wouldn't it be nice if you could simply push a button on your car radio and choose between 30 stereo, CD-quality digital-music channels — broadcast to your vehicle via satellite?

If the entrepreneurs pushing for such a system are given the go-ahead by the FCC, digital audio broadcasting could be a reality by as early as 1997. But as we'll see, it's not just a matter of technology (that's available today) — politics, tradition, big money and corporate maneuvering all play a part. In the behind-the-scenes arena of satellite radio, there's a war going on!

Technology Turf Wars

As the 21st century looms closer, technology marches forward at a relentless, unprecedented rate. Faster and faster, new technology sweeps aside the old. Existing players scramble to keep their hard-won ground as the newcomers side-step the status quo with every opportunity. The result is a "technology turfwar," the scope of which is still beyond the horizon.

The turfwar and technology discussed in this article involves digital audio broadcasting (DAB), sometimes called digital satellite broadcasting (DSB), digital satellite radio (DSR), and a variety of other names.

Broadcasting: The Same Old Stuff—Until Now!

Before we dig into new broadcasting technology, let's take a moment to remember that broadcasting -- whether AM, FM or TV; domestic or international -- hasn't changed all that much since its earliest days.

Technology has kept pace, but before the recent appearance of digital transmission modes, almost every broadcast transmitter worldwide put out an analog AM or FM signal (TV uses both). Whether the transmitter uses vacuum tubes or high-power switching transistors, an AM signal is still an AM signal.

The new digital radio transmission modes, most of which are similar to the spread-spectrum (SS) and time-domain multiple-access (TDMA) techniques being tested for second- and third-generation cellular telephone systems, offer CD-quality sound and the ability to compress several stereo programs on a single transmitted "channel."

This new technology is expected to replace conventional broadcasting techniques entirely before too long (let's face it, we'll probably have to go to a communications museum to hear or see analog AM and FM transmitters a hundred years from now).

In the meantime, however, designing, building, testing and legislating digital broadcasting systems is a "frontier town," full of intrigue, secret deals and megadollar speculation! Keeping that in mind, then, let's take a look at the likely future of broadcast radio.

DAB and DSR: How They Work

There are two main branches on the DAB tree, and each uses related technology. The first branch is CD-quality digital radio delivered to your car or house directly via satellite. The second involves existing terrestrial broadcasters switching to digital transmission systems, exclusively, or in addition to conventional AM or FM transmissions (see the sidebar "DAB: A Down-to-Earth Approach" for more information).

Car Radio Via Satellite

This is the original DAB concept: One or more high-power geosynchronous satellites beams CD-quality stereo signals directly to your auto or house. An AM/FM/cassette/satellite receiver would replace your existing car radio. The multi-function radio would receive satellite radio signals with a silver dollar-size "patch" antenna mounted somewhere on a flat, upward-facing surface on your car's body (see accompanying photos). AM and FM signals would still be received with a conventional whip or "in-glass" antenna.

Four US companies have petitioned the FCC for permission to set up DSB operations. Each would use one or more satellites to blanket the US with digitally compressed music and talk programming (using spread-spectrum and/or TDMA transmission techniques). The companies are CD Radio Inc., American Mobile Radio Corporation, Digital Satellite Broadcasting Corporation, and Primosphere Limited Partnership.

In the US, S-band frequencies from 2310 to 2360 MHz would be used; overseas, the use of two other bands is planned, one near 1500 MHz, another near 2500 MHz.

The FCC is considering the four proposals, but has not given its go-ahead to any of the petitioners. Technical standards, rules and regulations for the new broadcast service, and political considerations have slowed the process. Because its unlikely that the FCC would approve the operation of more than one or two DSB companies, the petitioning companies may have to merge to get things off the ground.

CD Radio Inc., headquartered in Washington, DC, is one of the four companies applying to the FCC for permission to begin operations. CD Radio Systems' (a division of CD Radio Inc.) President Robert Briskman says his company, which was first in the FCC-application race, would feature 30 CD-quality music channels beamed to all parts of the country via two satellites.

According to Briskman, the benefits would be many: nationwide coverage, no commercials and diverse programming. Some of these benefits are already available in big cities, and with DSB, they'd be available almost everywhere in the country (assuming you can "see" the satellites from your location!).

"Users would be able to subscribe to

A 2-inch satellite dish? That's all you'll need on your car or house when the DAB satellites are pumping out a million watts as EIRP! The flat disk at left is called a patch antenna and it's the size of a silver dollar (photo courtesy of CD Radio, Inc.).

A proposed DAB digital radio receiver (right) from CD Radio, Inc., will switch between AM/FM and satellite programming at the push of a button.

our service for five to ten dollars a month," Briskman says, "and the cost for a satellite receiver for your car should be about $250, once the units are mass produced."

With such small receive antennas (silver dollar-size), the satellites have to put out a lot of power. CD Radio Systems Vice President Richard Cooperman says his company's space-borne transmitters would pump out about a kilowatt each -- into high-gain antennas -- for an effective isotropic radiated power of nearly a million watts! (That's 57 dBW!)

Briskman says the technology to build the satellites is already available. "The cost to build and launch two satellites and maintain initial support services is expected to total about $400 million," he says. According to initial reports, costs for the three other companys' systems range from $400 million to $800 million.

Eureka 147: a Hybrid System

Developed in Europe and planned for use in Canada, Eureka 147 is a DSB system that does double duty: In addition to direct-to-vehicle transmissions, programming will be received by ground-based repeaters, which will rebroadcast the signals in a more conventional manner.

The Eureka system uses a 6-MHz-wide spread-spectrum signal that supports up to 20 CD-quality stereo "channels." Because the signal is spread spectrum, ground-based repeaters can operate on the same frequencies, keeping system costs and engineering problems to a minimum.

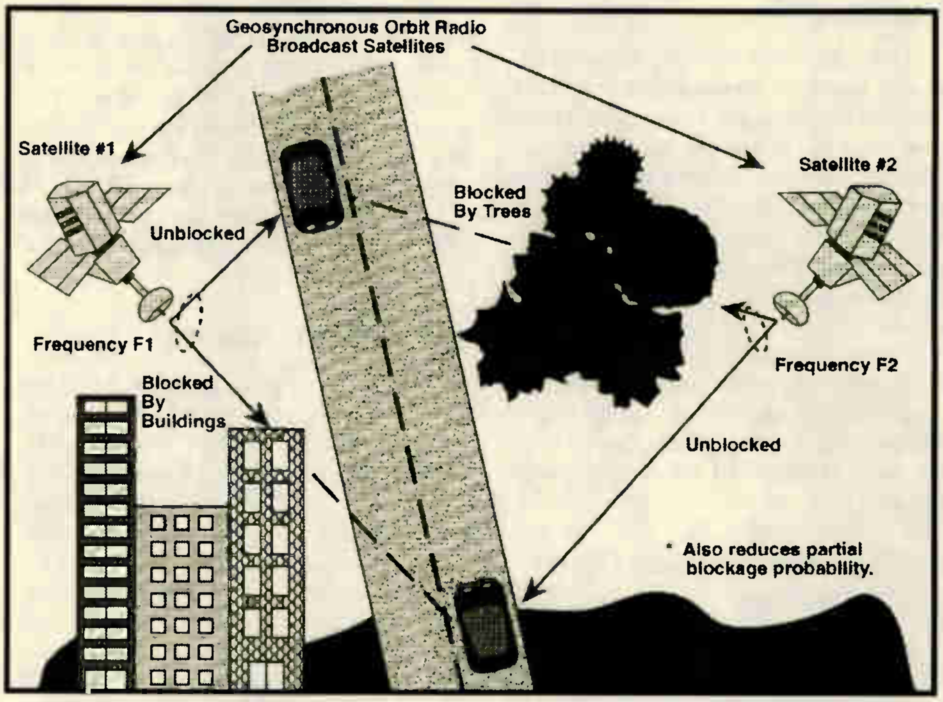


FIGURE 1: Reduction of signal blockages through the use of two radio broadcast satellites transmitting identical signals.

An Experimental DSR Research System That's Up and Running

To test the DAB concept, experts at the Voice of America, NASA and the Jet Propulsion Laboratory teamed up to create a working DAB test system.

Starting several years ago, spurred by the VOA's desire to explore leading-edge international broadcasting "delivery systems" (we couldn't exactly call 2.3-GHz international broadcasts "shortwave radio," could we?), the three agencies got together to set up an experimental (but functional) DSR system using time on a NASA tracking and data relay satellite.

Operating near 2 GHz at power levels below those necessary for future commercial DAB systems, initial tests were successful using the 7-watt NASA bird with its narrow, spot-beam antenna.

VOA Broadcast Satellite Programming Manager Don Messer says it's important "to remember that the VOA is not designing an operational system. We're not in competition with any existing companies. Everyone can benefit from our experimental work."

The VOA/JPL/NASA setup uses modern digital broadcasting technology: one "narrowband" 200-kHz-wide QPSK signal for each CD-quality stereo channel.

Two years ago, project engineers started developing a prototype satellite receiver for future use in cars and tabletop radios. It's called the VOA/JPL Digital Sound Receiver, and it's being tested now.

As with most digital audio systems, audio quality can be varied by reducing or increasing the digital signal's data rate.

Testing: The Race is On!

All of the DAB/DSR systems discussed here, and several others, are being evaluated at the NASA Lewis Research Center in Cleveland, Ohio. Heading up the tests is Thomas Keller, former vice-president

Cable-based "DAB" Already Exists!

If you want to get a "look" at what DAB will sound like, your local cable TV operator probably has satellite radio's terrestrial equivalent: Digital Cable Radio (DCR) or Digital Music Express (DMX).

These companies broadcast CD-quality audio (stereo) via satellite to cable companies, which feed it to your house or office via their regular cable TV feeds -- no talk, no commercials, just music.

To receive DCR or DMX, simply connect a decoder box to your cable feed, and the decoder will output audio to your stereo. A remote control lets you set volume, select favorite stations, etc. -- exactly like the proposed DAB systems. The cost? About $10 a month.

Cable-based digital audio systems are really catching on. DMX Vice President Chris Oake says his company has more than 350,000 subscribing households and 12,000 businesses as of June of this year.

DMX, launched in 1991, started offering its music programming to business users directly via satellite in July of this year (Ku band, businesses receive DMX with a "less-than-3-meter dish"). That's DAB in a more conventional sense. Oake says decoders for the home dish market may be available in the near future.

of engineering for PBS.

The tests could be finished as early as late this year or early next year. Two "winning techniques" are expected to emerge, at least for US markets: one for direct satellite broadcasting, the other for terrestrial IBOC and IBAC systems (see the sidebar).

As the finish line draws near, companies are jockeying for the home stretch position, tweaking and tuning their systems. There's a*lot* of money riding on the outcome.

Politics and Timelines

Exactly *when* these new systems will be in place depends more on politics than on technology.

When DSR became feasible several years ago, local broadcasters, rallying around the banner of the National Association of Broadcasters, "went crazy." Nationwide CD-quality radio, the NAB said, would leapfrog the existing broadcast industry, destroying markets and creating chaos.

When it comes to IBOC and IBAC techniques, however, the NAB is more embracing -- no doubt because those digital systems would ride along with local broadcasters' signals, drumming up "new money," maintaining local involvement, and so on.

CD Radio Systems President Robert Briskman disagrees with the NAB's outlook on direct satellite broadcasting, foreseeing a "peaceful coexistence," much like the relationship between local TV stations and pay programmers such as HBO.

"You would tune to local stations for funny DJs, local news and sports, and so on," he says, "and you would listen to your favorite CD-quality satellite music channel as your interests demand."

So, although this new technology has been successfully demonstrated — and many companies are "chomping at their bits" in anticipation — industry experts say it will be at least 1997, and possibly the end of the century, before you can go to your local electronics store to pick up a DAB/DSR/AM/FM/cassette super radio.

And, as if that's not enough, international political challenges loom on the horizon: Many countries are planning to implement DAB/DSR technologies on frequencies that may be incompatible with established radio services in neighboring countries.

A close-to-home example is Canada and the US. Canada wants to implement the Eureka 147 DSR/DAB system at 1500 MHz. The US has an aeronautical telemetry service there, and our government says it will play hardball to protect its turf.

If Canada goes ahead anyway, the US may choose to implement a new radio service on a frequency band that would mess up some established Canadian system. And you thought NAFTA was tough! Hey, it's a turf war....

Thanks

Putting together even this introductory article on DAB/DSR would have been impossible without the help of many industry experts. In addition to those quoted in the article, I'd like to thank John Reiser, WQ4L, of the FCC's Mass Media Bureau; consultant Ed Reinhart; Capitol Cities/ABC Engineering VP Al Resnick, K3PXR; and ARRL Technical Relations Manager Paul Rinaldo, W4RI.

Kirk Kleinschmidt *is a freelance writer and photographer who, just this summer, moved from Connecticut back to "Minnesota Lake Country." He's into ham radio (call sign NT0Z), satellites and shortwave listening. Kirk recently was assistant managing editor for QST magazine, and regularly writes on technology and business topics.*

DAB: A Down-to-Earth Approach

DAB's down-to-earth cousin would allow existing AM and FM broadcasters to keep things "business as usual" -- by transmitting a digital stereo signal "underneath" their existing analog AM and FM signals.

This technology is called in-band on-channel (IBOC) or in-band adjacent-channel (IBAC). A weak digital spread-spectrum signal is transmitted underneath (IBOC) or alongside (IBAC) an existing AM or FM signal.

The digital signal is so weak and spread out that regular receivers can't even "hear" it, but receivers designed to recover the digital data reproduce it without a hitch. With the touch of a button, users can switch between the analog and digital "programs."

In addition to providing a higher-quality stereo signal, spread-spectrum IBOC and IBAC digital systems also offer greatly increased protection from fading and multipath distortion -- an important consideration for terrestrial broadcasters, who have to deal with tall buildings, uneven terrain and so on.

If you've ever driven under an overpass or between tall buildings while listening to your favorite FM station, you've encountered fading and multipath distortion!

The benefits of digital radio are not universal, however; two potential problems are fading and signal degradation. When regular FM signals become weak, they degrade with increasing distance; the signals get "noisy." With digital signals, degradation is abrupt: One second everything's fine, then wham! -- the signal is gone! In fringe areas, digital signals could rapidly pop in and out. Imagine someone turning your radio on and off several times a second and you'll get the idea!

The Music You'd Hear

Here's a quick rundown of proposed DAB programming:

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

DBS It's Here

By B. W. Battin

The small satellite dish and related Direct Broadcast Satellite (DBS) equipment is coming soon to a vendor near you

It's only 18 inches wide, it has no motor because it never needs to be repositioned, it gets a flawless picture, and it will soon be able to pull in about 150 channels. And it's here.

In June, direct broadcast satellite (DBS) equipment went on sale in five American cities--Albuquerque, New Mexico; Jackson, Mississippi; Shreveport, Louisiana; Little Rock, Arkansas; and Tulsa, Oklahoma. It will be available nationwide in the fall.

DBS is like cable without the cable. Viewers receive the programming directly from two new powerful satellites: The first one was launched from French Guiana on December 17, 1993; the second bird went up on July 28. Unlike older satellites, most of which downlink with 10 to 45 watts of power, the new Ku-band DBS birds put out 120 watts, making reception possible with a dish that measures 18 by 20 inches and weighs only 10 pounds.

Each satellite has sixteen transponders. The signals are digitally compressed, allowing four to eight channels per transponder. Because the signals are digital rather than analog, the system should deliver ghost- and interference-free, laser-disk-quality pictures and CD-like sound. The satellites are positioned at 101 degrees west longitude, so the small dish can receive both of them from its fixed position.

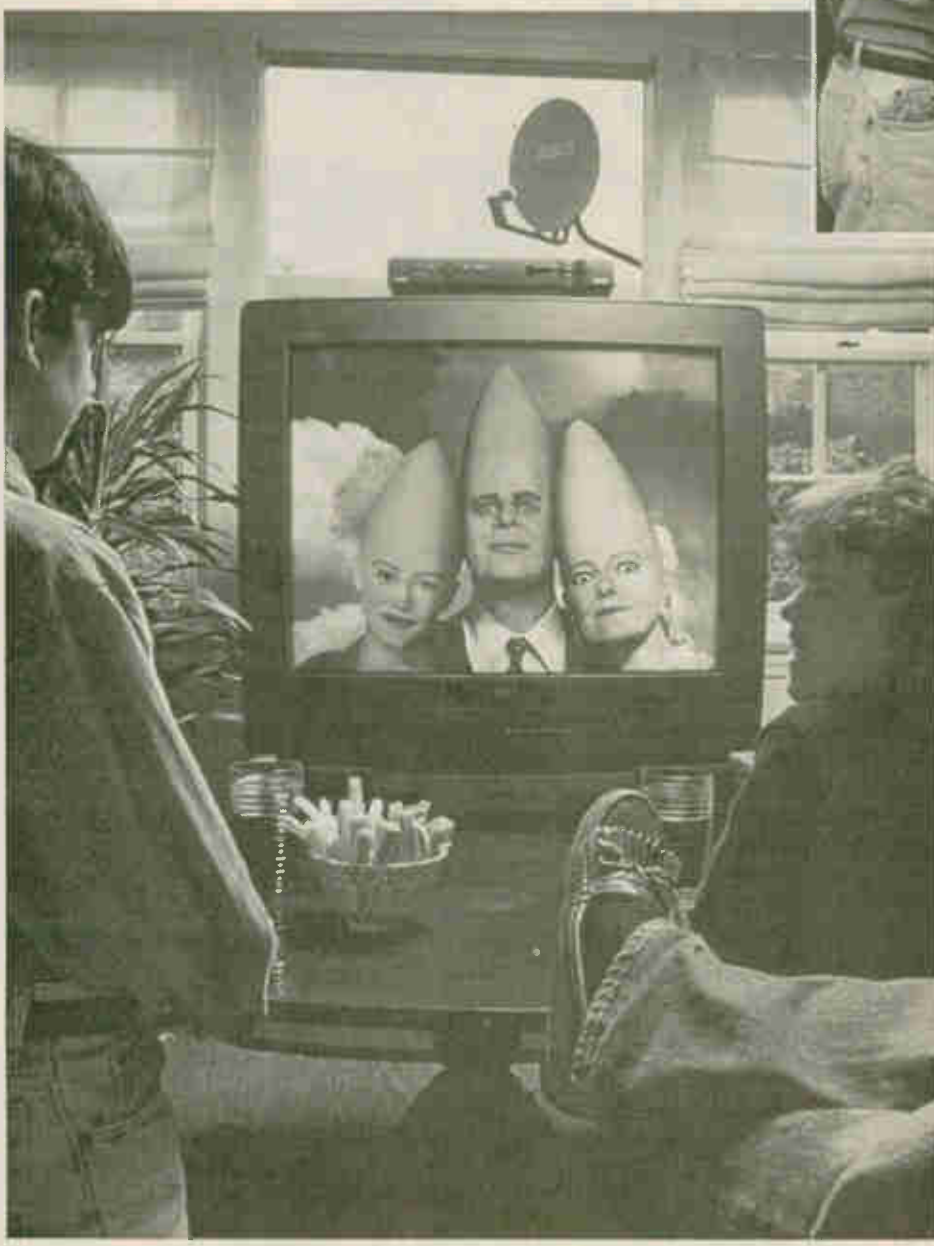
The companies that developed the new system have also coined a new name for it: DSS, which stands for Digital Satellite System and has been registered as a trademark. Three firms cooperated in the effort: Thompson Consumer Electronics, which makes RCA and GE products; DIRECTV, a division of GM Hughes Electronics; and United States Satellite Broadcasting Company (USSB), a division of Hubbard Broadcasting. According to Robert W. Hubbard, the executive vice-president of USSB, the three firms spent a billion dollars developing the system.

The basic DSS system sells for about $700; professional installation adds another $200 or so. A do-it-yourself kit sells for about $70. The basic system allows satellite reception on one TV set. To hook up additional sets, you have to buy the deluxe receiver for about $900. But that's not all; each additional set also requires its own receiver at a cost of about $650. Thus, while a DSS system for one set and an owner-installed dish would go for about $770, one system hooked to three TV sets and professionally installed would run about $2,400.

The cost does not seem to have deterred too many buyers. DSS equipment went on sale in Albuquerque on June 30. At Baillio's, one of the city's major purveyors of electronic equipment, one salesman said he'd sold 12 DSS systems an hour and a half after the store opened; two other salesmen reported selling fifteen apiece in the same time span. By the morning of July 5, five days later, West Coast Sound in Albuquerque reported having sold at least 300 to 400 DSS systems. "We're running real low," said Richard Chavez, the store's satellite installation supervisor. "We've already reordered."

Linda Brill, a spokesperson for DIRECTV, says Jackson, Mississippi, sold

The compact 18-inch RCA-brand DSS (Digital Satellite System) dish (shown on previous page with dedicated receiver and remote control) is easily installed on rooftops, in gardens or other out-of-the-way locations. Manufactured by Thomson Consumer Electronics and sold under the RCA brand name, DSS offers television viewers 175 channels of digital programming. (Photos courtesy of DirecTV).



all its available units the first weekend they were offered for sale. She declined, however, to give out any national sales figures, saying DSS's three developers had decided not to release specific numbers. Joseph P. Clayton, the executive vice-president of Thompson, has stated that he expects to have "a customer base of at least 10 million households by the year 2000," with retail sales "in the $20 billion range."

The initial availability of the systems in only five cities is strictly a marketing decision. The signal from the satellites can be received throughout the United States and in most of Canada. Chavez says West Coast Sound has received numerous orders from other parts of the country. He's shipped DSS units to a number of states including California, Colorado, Connecticut, Texas, Delaware, Utah, and Washington.

DIRECTV's Linda Brill says Canadians probably won't be offered DSS until early 1995. Details are still being worked out with the Canadian government.

With an initial outlay of $770 or more, it would seem most DSS buyers would be people who live where cable is unavailable. Not so, according to Chavez and employees of other Albuquerque stores selling the new satellite system. Most report that a majority of DSS buyers are people who currently have cable. Picture quality seems to be their main gripe. "It's the first comment they make," Chavez said. "They want a better picture."

DIRECTV and USSB are the only suppliers of DSS programming. They offer various packages, ranging in price from a few dollars to $34.95. There is one catch, however: getting all the channels most people will probably want requires signing up with both services, which can raise the price substantially above the figures cited above.

DIRECTV offers Disney and most of the programs usually considered basic cable channels--A&E, CNN, ESPN, TBS, USA, etc.--but not HBO, Cinemax, Showtime, or The Movie Channel. Those you have to get from USSB. There is no duplication of services; each company carries its programming exclusively.

Still, the rates are comparable to those charged by cable, and one can get some things most cable systems simply don't offer. For example, as owners of large satellite dishes know, there are many feeds of the various premium movie channels. HBO has five feeds, Showtime and Cinemax three, and The Movie Channel two. With DSS you can get all of them, which expands the programming available at any given moment and makes it a lot easier to catch your favorite flick at a convenient time.

The cost? If you take all the movie channels (including Disney) along with the familiar basic cable channels, and a few that may not be so familiar, your combined bill to both companies will be $56.90. You'll also have access to pay-per-view movies and sports events. The movies cost $2.99, you can add the Playboy Channel for $9.95.

DSS comes with a menu system that includes a program guide that can display everything that's on or just specific categories, such as sports or movies. Submenus can narrow the selections even further--baseball, tennis, golf, etc. The system can be programmed to show what's on specific groups of channels chosen by the viewer.

Using the DSS remote, which can also control most TV sets and VCRs, the viewer makes selections by moving a cursor. Pay-per-view choices are automatically transmitted through a phone line connection, using an 800 number.

The system even offers a special feature for setting up the dish: Enter your zip code, and the receiver displays the elevation of the dish in degrees, which are marked on the mounting bracket. Once the dish is set to the proper elevation, the installer pans the horizon, while the system provides signal-strength readings both on-screen and with a tone.

The 18" dish can be installed on a south-facing wall by the user or by professionals. David Hutson of Baillio"s Warehouse Showroom intalls this one at a home south of Albuquerque. How is this for a replacement of the huge dish you may now own? Photos by B. W. Battin.

If the cable companies are worried about the new competition from the sky, they're not showing it--at least not in Albuquerque. They are quick to point out that cable installation only costs about $35 and that hooking up additional sets is a simple and inexpensive procedure.

A spokesperson for Jones Intercable says the company is "actively aware" of the new kid on the block and "developing strategies" for meeting the challenge. Those include expanding service and improving picture quality through the increased use of fiber-optic cables. A representative of Valencia County Cable TV, which serves small communities south of Albuquerque, says, "We're ready for the competition."

Chances are, with the initial outlay being what it is, DSS won't put the cable companies out of business anytime soon. Still, like all new technologies, DSS will almost inevitably improve and get cheaper over the next few years. And when the competition between cable and DSS heats up, the consumer will the one who benefits.

DSS Fact Sheet

THE NEW 18" SATELLITE DISH

LNB input frequency	12.2-12.7 GHz
LNB output frequency	950-1450 MHz
LNB output	"F" type
LNB polarity	Dual
LNB feed	Circular
Dimensions	18" x 20" parabolic
Weight	10 pounds

THE DSS SATELLITES

Power	120 watts
Transponders	16 (each satellite)
Channel capacity	175 (combined)
Signal encryption	Digital, compressed Band Ku
Position	101 degrees west longitude, 22,300 miles above the equator

THE DEVELOPMENT OF DSS

1981— USSB applies to FCC for a Direct Broadcast Satellite permit.

1984— Hughes applies for and receives an FCC permit to build a high-power DBS system.

1989— Hughes begins system design.

1990— Hughes begins construction of a direct broadcast satellite.

1991— Hughes and USSB agree to develop a common distribution system for DBS. Hughes forms DIRECTV to operate its DBS business.

1992— Thompson Consumer Electronics chosen to manufacture consumer DBS equipment. Thompson and News Datacom to provide transmission and encryption systems. DIRECTV begins construction of its broadcast center in Castle Rock, Colorado.

1993— USSB begins construction of its broadcast center in Oakdale, Minnesota. First DBS satellite launched in December.

1994— DSS becomes available to consumers in five US cities in June. Second satellite launched in July. DSS to be available nationwide in the fall.

1995— DSS to be available in Canada. (Negotiations still under way. Canadian government has not yet granted permission.)

THE SATELLITE SLEUTH

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

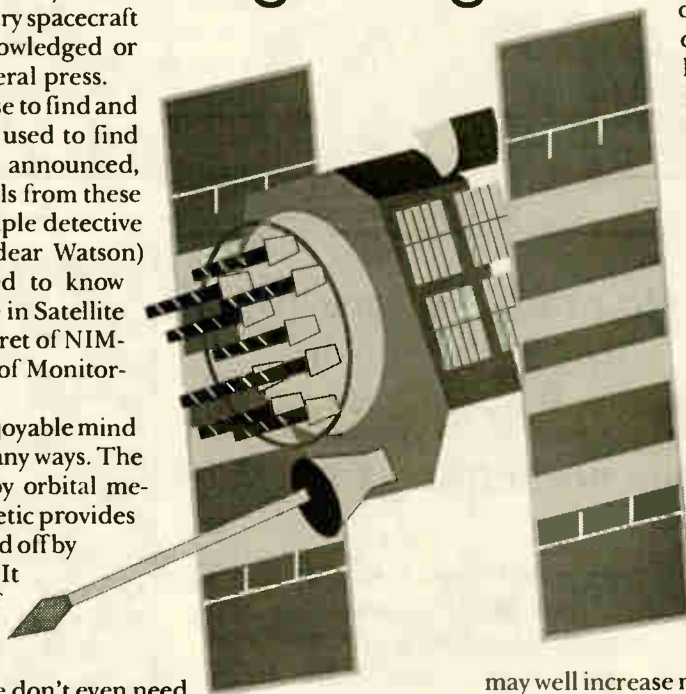
Starting at the Beginning

Radio satellite tracking is different from many other activities we could engage in. For one thing it's a pastime that anyone with a radio capable of receiving satellite transmissions can participate in. The intent is to find, track and identify signals that we hear coming from spacecraft orbiting the Earth.

There are thousands of satellites up there and most have transmitters on them. Some have died and may never come back on again, but some do start transmitting long after the satellite operator/owners have written them off and even sold the ground stations for scrap!

Spacecraft that die and then come back to life years later are called ImHoTeps. We also track many scientific, commercial, and military spacecraft that are not publicly acknowledged or ever mentioned in the general press.

The same methods we use to find and identify ImHoTeps can be used to find and track new, and as yet announced, launches. We listen to signals from these spacecraft and by using simple detective methods (elementary my dear Watson) piece together all we need to know about it. (For a short course in Satellite Tracking 101, see "The Secret of NIMBUS" in the April 94 issue of Monitoring Times.)



It's a challenging and enjoyable mind game that we can play in many ways. The rules of the game are set by orbital mechanics, and simple arithmetic provides the answers. (Don't be scared off by the term orbital mechanics. It merely means the rules of orbital motion which can be easily understood with grade school arithmetic. We don't even need to use high school mathematics.) You don't have to have a computer; you can sit at your radio and figure it all out in your head and by scribbling a few numbers on a piece of paper.

With our radios we listen to a satellite's signals and in our mind's eye follow the course of that object thousands of kilometers away in space. Satellites can be tracked day or night, weekday or weekend, workdays or holidays. They are always up there and at any time of the day or night something will be passing within range and transmitting.

Spacecraft transmit on many frequencies throughout the spectrum, but we will start with the 136-138 MHz satellite band as many radios cover this band and it is full of signals. If you have been following signals in the 200, 400, and 1200 MHz range and above, let us know how you are doing and with what equipment. I intend to include all signals heard in this column and we all want to share in your discoveries.

Tracking Basics

First of all, we need a radio to hear the rather weak signals these satellites sometimes put out. A tunable NBFM/SSB receiver that can accommodate 136-138 MHz, a scanner, or an HF receiver with a VHF converter will work fine.

Next we need an antenna, nothing fancy here, a simple omni-directional will do. It's hard to point a beam at a satellite moving 25,000 miles per hour when you don't know where it is! A VHF ground plane, scanner antenna or discone work well. If you have a quadrifilar helix for APT, it will work like a champ since it is made for these frequencies. Try to pick an antenna that uses N-type connector's, you can lose a lot of signal through UHF, BNC, Motorola and phono connectors.

How high? This band is line of sight so you need to be able to see the transmitter from your antenna. Since the transmitter (satellite) is already 200 to 2000 km above the earth, all you need do is get your antenna above the house roof, nearby trees or other obstacles between you and the horizon.

How about one of those preamps? Actually, unless we are talking about one of those $250 beauties, we are asking for more trouble than it's worth. Receivers like the R-7000\7100 already have 4 preamps built in; another external preamp may well increase noise, intermodulation and desensitization. Instead buy the best, low loss coax and quality N-type connectors.

To start with, use what you have available and if you get grabbed by this aspect of radio, you can upgrade later on.

The first test: Tune your receiver to 137.500 or 137.620 MHz, NBFM mode. When you hear an APT signal (strong bleepty-bleep) a NOAA weather satellite is within range. Next try 136.770 or 137.770 MHz and listen for a weak signal on NBFM or SSB. If you can hear a data signal, you have a very good system; if you don't, you need to make some improvements.

Discovering New Frequencies

Instead of searching immediately for more frequencies, you

"The same methods we use to find and identify ImHoTeps can be used to find and track new, and as yet announced, launches. We listen to signals from these spacecraft and by using simple detective methods (elementary, my dear Watson) piece together all we need to know about it."

FIGURE 1: Typical Log Entries

11 Oct 94

A o S 19:00:00	136.654 strong carrier mux + 5, 10, 15 KHz and -5, -10 nothing heard at -15KHz
L o S 19:11:00	136.641signal went over the hill
A o S 20:33:00	136.657 Very strong carrier + mux ± 5,10,15 Khz this time. May be data on ± 5 & 15. ± 10 has tones.
20:44:34	Signal became unstable. Mux stopped. Signal now weak.
L o S 20:46:00	137.639 Signal weak. was lost and returned for 30 seconds and then gone.

20:39:30 -19:05:30 = 1:34:00 or 94 min

should go out and buy one of those spiral-bound notebooks used by school kids, and get a nice, new black pen and clip it inside the spiral so you will never lose it. Next, set your UTC clock to a WWV or CHU time signal. All satellite timings must be in UTC because they don't exist in any Earth-bound time zone. Now you can turn on your radio!

Tune from 136.0 up through 138.0 MHz. If you have SSB, use that mode to detect any changs in frequency. Terrestrial signals like 136-137 MHz aircraft and commercial/industrial noise are heard in this band as well as a birdie or two in your radio, so you must ignore all those that don't have Doppler shift. If the shift is dropping in frequency, the satellite is going away from you; if you hear the signal going up in frequency it is still coming at you. Write down in your logbook "AoS (Acquisition of Signal) [time in UTC as hh:mm:ss] and [freq as 136.123 MHz]" also include a little arrow pointing up or down to indicate UP Doppler or DOWN Doppler. (See Figure 1, "Typical log entries").

Listen to the signal. Does it have data on it or is it just a carrier? Do you hear multiple tones or a complex signal like APT or do you hear a hash like sound of data? Write down what you hear. Try to characterize the sound of it so you can tell others how to find it. Does it make any sudden changes? Note the time and write down how it changed.

The first few times the satellite will come and go quickly--too quickly to note everything you want to remember. When you lose it write in your log, "LoS hh:mm:ss and [freq you last heard it on]; also note how it died out (i.e., "just went into the mud, stopped abruptly, burped a few times and was gone..."). Add any notes about how it sounded.

A typical LEO (low earth orbit) satellite pass will last anywhere from less than a minute to about 20 minutes. How long you hear a satellite depends on how close the spacecraft is to you in its orbit. When you hear a reasonably strong signal, try tuning up from it and see if you find some weaker signals 5, 10, 15 kHz or more from the primary signal. Tune down and see if there are any signals below. Note them in your log. These are multiplex or subcarriers normally used to carry telemetry or data.

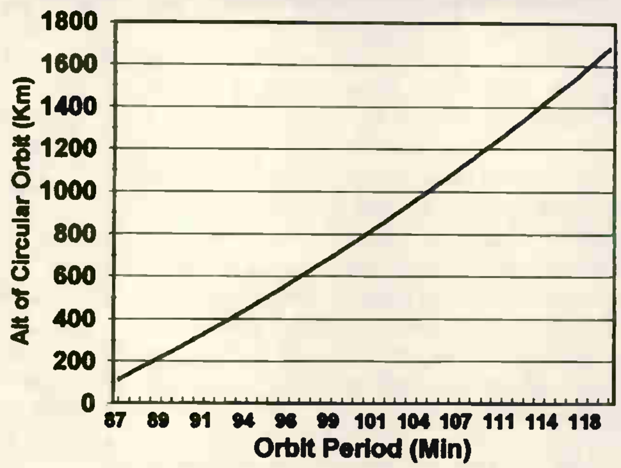
Is there any data on those secondary signals or are they just carriers? If you have a scanner, try stepping up and down by the smallest increments you can (2.5 or 5 kHz) to find the strongest signal. You may need to program several frequencies above and below your first frequency to follow the Doppler which may shift ± 2 kHz or so.

Catching the Next Pass

About 90 minutes after you heard your first signal, tune to the frequency where you first heard it, but about 2 kHz higher. Listen for the signal characteristics you heard before (aren't you glad you wrote down what it sounded like?). HINT: a little cassette recorder can be a big help here.

See how much better you can describe the signal this time? Does it sound like the one you first heard or is this another one? If this one sounds different, stick around--your first sat may not come around for up to 110 minutes. Write *everything* down in your logbook. (See Figure 1).

CHART 1:
Orbital Altitude Vs Orbital Period



OK, you are sure you heard the same sat twice, what do you do now?

Find the middle of your second AoS/LoS pass. For example, if your second pass times were 20:33:00 to 20:46:00, the mid-pass time would be 20:39:30. Do the same with your first pass AoS/LoS times (The mid-pass time for 19:00:00 to 19:11:00 for example, would be 19:05:30). Then subtract the *first* mid-pass time from the *second* midpass time (adding 24:00:00 if we went past midnight UTC) and we get: 20:39:30 - 19:05:30 = 1:34:00 or 94 minutes between passes.

Refering to Chart # 1 "Orbital Altitude Vs Orbital Period", *Listen to the signal. Does it have data on it or is it just a carrier? Do you hear multiple tones or a complex signal like APT or do you hear a hash like sound of data? Write down what you hear. Try to characterize the sound of it so you can tell others how to find it.*

we see that a satellite with a period of 94 minutes means it will be orbiting at almost 500 km above the earth.

For this computation to be accurate, both passes must be timed from first audibility until fade out. Other methods to help us identify the satellite's closest approach in any given pass would include signal strength (S-meter or squelch setting) and steady frequency (no doppler in SSB mode).

If we do this for all interesting signals, our log now becomes the means by which we can correlate these signals by their pass times and signal characteristics.

For those starting off with never having done anything like this before, and having only a scanner, try listening to the frequencies in Chart # 2 and put together at least three days of solid timings or at least a week of *three passes a day* for the same satellite.

In future columns we will discuss what you find by monitoring those frequencies, so keep notes and mail your logs to CNESS (Centre for Near Earth Satellite Studies). Tell me what you think you are hearing after pondering these questions:

- Are some satellites transmitting on more than one frequency?

CHART 2

Level of difficulty	Frequencies to try
Beginner	137.3 137.4 137.5 137.62 137.85
Advanced	149.940 136.80
Professional	137.08 136.50
Govt. Agency	375 to 400 MHz

- Are different modes being transmitted?
- Are some of the satellites in different orbits?
- What are the orbit(s) of the satellites?

Get your results to me as soon as possible so I can include them in the next column.

Try tuning to 149.940 MHz (not 150 MHz); what do you make of signals you hear there? Is there ONE signal out of all the others that seems more interesting than the others? Tell me all about it.

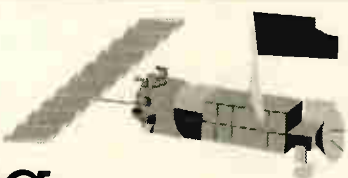
For the more adventurous, listen on 137.080 MHz for a signal there and send in your logs and deductions. What is it?

One to Ponder for Next Time

Gary Davis from Philadelphia has a good question. (Did you ever wonder how they get letters from readers in the *first* issue of a magazine? I know I always have.) He says, "I sometimes hear a satellite that has normal down-doppler suddenly go up in frequency before LoS, and sometimes I lose it before my computer program predicts LoS. How come?" Excellent question, Gary but we are out of time for this issue. We'll explain your satellite's anomalous behavior next issue.

Be sure to send in a copy of your log(s) and tell me all about what you have been hearing. Did you solve a puzzle and identify a satellite? Tell me all about it, how you figured it out. The most Sherlock-Holmes-like tale will earn a patch or sticker for a space mission. Got questions send them to the address above or get on the CNESS BBS @ 517-743-5077.

Alive and still transmitting ...



The UK Defence Research Agency's Satellite Test Facility at Defford in Hereford and Worcester County decided to check out an old satellite belonging to the UK Ministry of Defence, SkyNet 2B, (1974 094A, Cat # 7547), launched on November 23, 1974 on a ThorAD-Delta-Burner 2 from Cape Canaveral into a geosynchronous orbit. The original mission of SkyNet was to provide secure and reliable communications for British forces operating anywhere in the "Atlantic hemisphere".

Decommissioned long ago, it had drifted to an inclination of more than 12.5 degrees off the equator. Interest renewed when it was noted that the satellite had moved back "over" England and was above the horizon as it nears it's 20th anniversary.

When the engineers at Defford directed their antenna at the spacecraft they found out it was not only working, but the two transponders were still putting out 16 watts between 375-400 MHz.

If any of you adventurous souls out there are within range of it, let me know if you hear anything. Right now it is hovering near 0 degrees longitude, in range of all of Africa, most of South America, the east coast of the US and Newfoundland, as well as Europe and Asia as far east as India. It's heading east and will come in range of Japan, Micronesia and Australia in a year or so, but won't be back in range of the US until 1998.

By Dr. Frank Baylin

The New DBS Broadcasters

The first edition of Satellite Times could not occur at a more timely juncture, given the evolution now occurring in broadcasting. We are rapidly entering an exciting new era, the digital era of laser-disk video quality and CD-disc audio quality. Satellite television is the clear leader, at least for the time being, in this transition.

Large and small dish home systems, all described as direct-to-home (DTH) systems, will now thrive not only in rural but also in urban areas. Some of the esoteric buzz words such as "compressed digital video" and "high definition television" are now becoming common.

Modern DTH satellite systems convert analog audio and video signals to digital form and now share the language of computers. As a result the lines between the television, telephone and computer are vanishing. Some of the new consumer satellite receivers are as advanced, and have as much processing power, as modern PCs. With the transition to a digital broadcast systems, the signal can be compressed. In simple terms, redundant information can be eliminated so the available bandwidth is used more efficiently. A communication satellite that could previously typically deliver a total of 24 programs via 24 transponders can now deliver from four to eight times as many programs of interactive entertainment and information. And compression technologies will improve even further in the next few years.

During the 1980s and 1990s large "C-band" satellite dishes, the "eyes" of a satellite system that are typically 6 to 10 feet in diameter, have become a common sight. In mid-1994 approximately 3.5 million homes in the United States sported such large-dish, DTH satellite television systems, known as TVROs, an abbreviation "television receive-only" systems. These receive FM modulated signals in the 3.7 to 4.2 GHz range.

Now, those common large dishes have been joined by small-dish, direct broadcast systems. DBS receive dishes are typically 18 to 36 inches in diameter and operate in the higher-frequency 11.2 to 12.7 GHz "Ku-band" range. An additional three to four million subscribers are expected to purchase the new small-dish DBS systems by the end of the century, barely five years away.

The active DBS players now include Hughes, United States Satellite Broadcasting Company (USSB, a division of Hubbard Broadcasting), and PrimeStar Partners, offering the DirecTv, USSB and PrimeStar services. PrimeStar broadcasts digital signals via the medium-powered Satcom K1 bird orbiting at 85°W beaming its signals down to dishes 36 to 40 inches in diameter. DirecTv and USSB share the new DBS-1 and DBS-2 high power satellites that are co-located at 101°W. Excellent quality signals can be received with 18 inch dishes anywhere in the continental United States.

The new DBS industry is the first nationally-based competition to the powerful cable television industry. In fact, DirecTv's first satellite, DBS-1, has earned the nickname the "Death Star" in some quarters (perhaps in cable TV executive offices).

While the small-dish DBS service and the large-dish home TVRO industry both reach every nook and cranny no matter how isolated the location in the "footprint" of the signal, they differ in five important aspects:

First, Ku-band DBS broadcasts employ digital compression technology with the potential for near laser-disc quality pictures and CD-quality audio. It also allows four programs to be carried on one satellite transponder; this should be increased to eight programs within six to twelve months or sooner. In contrast, C-band current satellite transmissions for the cable industry and TVRO enthusiasts provide analog audio and video. Only in those cases where VideoCipher II+ technology has been employed is the audio digital.

Second, DBS has been designed exclusively for the home marketplace, while the grassroots TVRO industry developed on the heels of broadcasts aired primarily for cable television companies. There are no DBS legal questions like those that plagued the large-dish home TVRO market in its infancy. DBS has powerful financial backers playing a high stakes game--in excess of $120 million will be spend by industry participants on national advertising campaigns in 1994 alone!

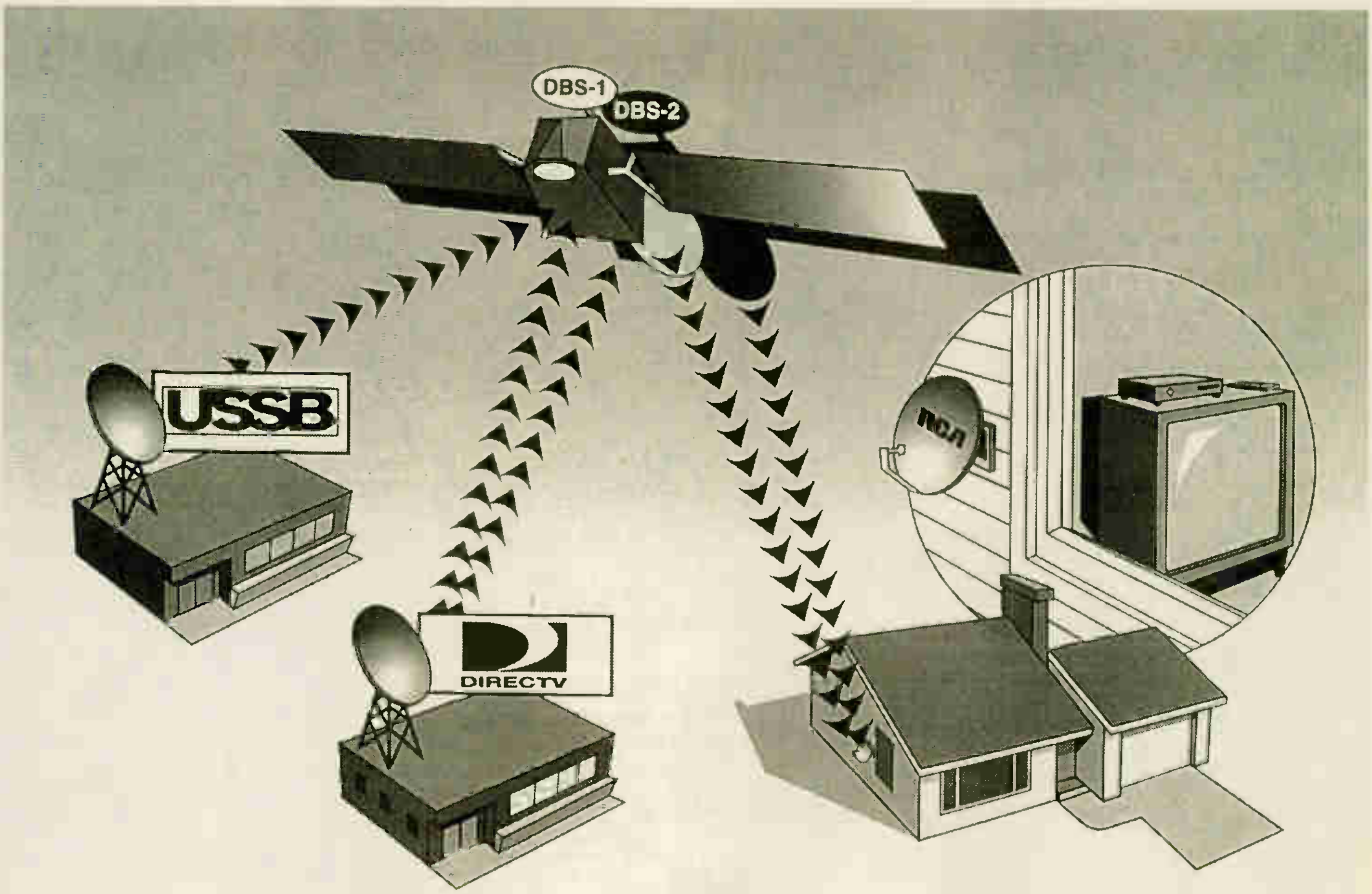
Third, tiny DBS dishes will be able to serve a whole new market, one that could not afford either the space or money to buy a large dish system. In Europe, where DBS is now firmly entrenched, it is a common sight to see small dishes attached to balconies or walls of apartment complexes. DBS will give cable television a run for its money.

Fourth, the variety of programming available on small-dish systems will, in the first few years, not match the fare that can be received by large dishes, especially in the Eastern portion of the continent, that can scan the skies and view channels from satellites as diverse as the Atlantic PanAmSat I, the Canadian Anik E1, the Mexican Morelos or the multitude of American communication spacecraft.

Home TVRO enthusiasts have long enjoyed the excitement of tuning into unusual feeds, both audio and video, often not intended for reception by the general public. The hundreds of single-channel-per- carrier audio broadcasts that can be received have alone been worth the investment to many.

The DBS channel line-up at first will be a more limited, cable-like, scheduled variety; however, as compression technology matures so that increasingly greater number of channels can be carried over each communication channel, this advantage will slowly disappear. In fact, DBS, along with cable

Modern DTH satellite systems convert analog audio and video signals to digital form and now share the language of computers. As a result the lines between the television, telephone and computer are vanishing. Some of the new consumer satellite receivers are as advanced, and have as much processing power, as modern PCs.



television broadcasting, will most likely become the birthplace and home of "narrow-casting" to special-interest audiences. National broadcasts in the United States alone can reach over 250 million people so a narrow, special interest audience in North America may still consist of tens or hundreds of thousands of customers, an economic proposition.

And fifth, while DBS dishes and the associated electronic components for various DTH services are and will be based on state-of-the-art technology, the satellite receiver and perhaps the LNB are designed to work with signals from just one broadcaster. Except for the Hughes DirecTv and USSB equipment being interchangeable, receivers designed for one DBS service are not be compatible with one another. For example, the PrimeStar receiver/decoder cannot decipher DirecTv transmissions, and vice versa. Furthermore, DBS receivers cannot receive analog broadcasts as can conventional dual band (C/Ku-band) TVRO systems.

How Do DBS Systems Differ from Cable TV?

DBS systems also differ from cable in a number of important respects. Cable TV networks can serve only those customers who are directly connected via their trunk and feeder coaxial lines. Forget about Ozark or Rocky Mountain residents who live far from these systems. DBS can provide service to anyone who has a view of the southern sky.

DBS is a unique technology at start-up; there are no massive amounts of capital yet invested in subscriber boxes or headends So the most advanced interactive technologies has been incorporated and implemented. Compressed digital video (CDV) and Videocrypt technology is the backbone of DirecTv/USSB and a combination of CDV and Digicipher for PrimeStar. These systems are high-definition-television (HDTV) ready, incorporate the latest anti-recording technology, and use renewable security "smart cards." When a standard for HDTV is decided within a year or two, these broadcasters will be able to uplink

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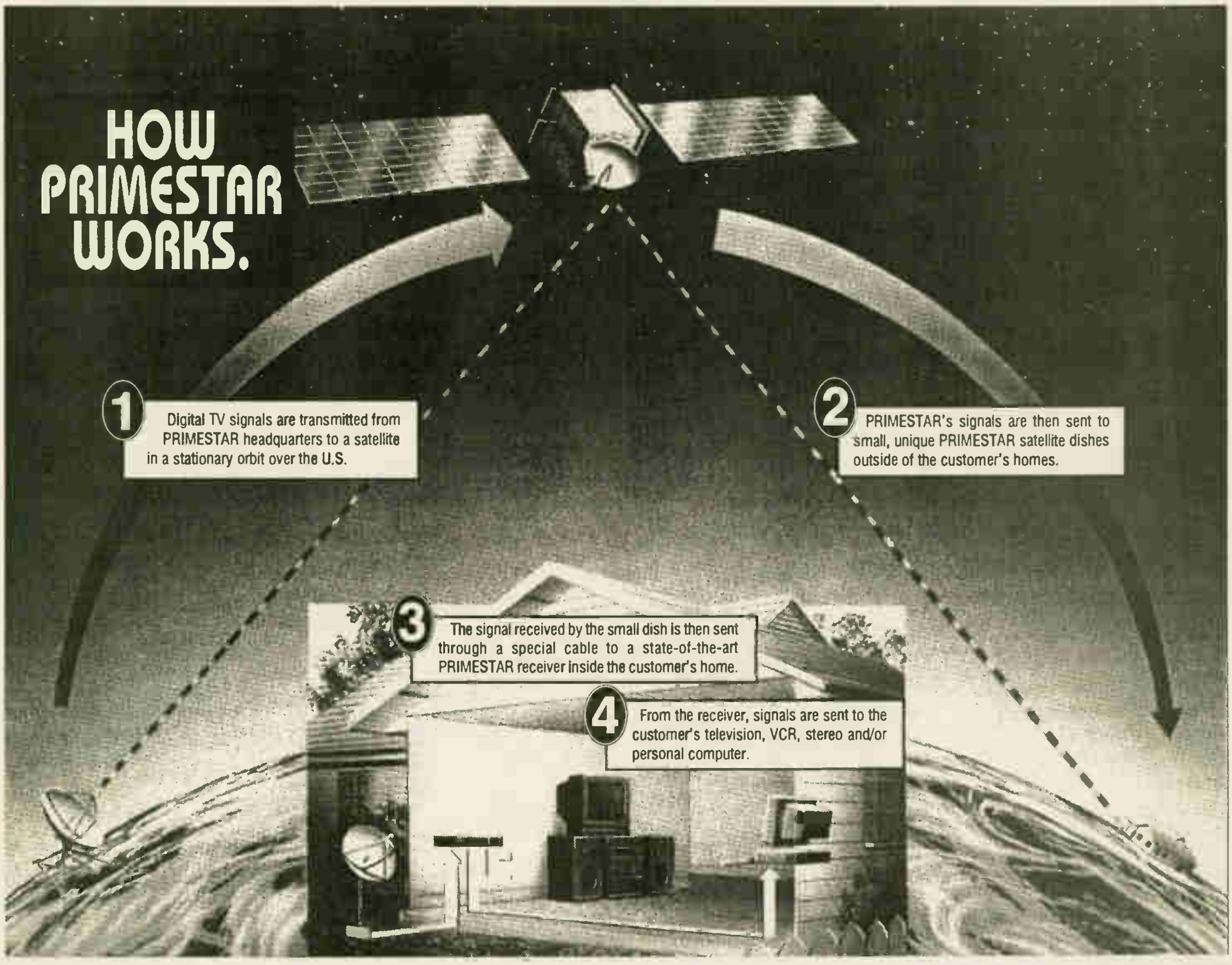


this new wide-screen format at any time.

In contrast, cable networks have massive investments in analog converters and headends. While new cable converter technology is by and large ready for market, it will take years and billions of dollars to replace equipment in existing headends and in the subscriber's homes.

The TVRO, DBS, cable TV and wireless industries (more about this technology in future issues) now by law have equal access to the programming that was developed hand-in-hand with cable TV. These program providers for years fought to keep their product exclusive for the cable industry. This is all changed today. DBS broadcasters not only have access to a cable-like menu but are first in line to transmit the new "narrowcast" programs.

Are We Alone?

While home satellite TVRO systems originally evolved in North America in the late 1970s, the higher frequency DBS systems are not new. At the beginning of 1994 there were nearly 12 million small-dish installations in Western Europe, while in Eastern Europe, a relatively new market, there were an estimated 1,800,000 installations.

In early 1994 in the U.K. alone, some 3.1 million homes sported "Astra" satellite dishes, typically as small as 18 inches in diameter. This compares with just 611,000 homes subscribing to cable television in the U.K. Experts predict that 45% of homes in the U.K. will receive satellite television by the year 2000. This strong presence of DBS in Europe has occurred in

The higher frequency DBS systems are not new. At the beginning of 1994 there were nearly 12 million small-dish installations in Western Europe, while in Eastern Europe, a relatively new market, there were an estimated 1,800,000 installations.

spite of the fact that their systems are all analog signals relayed from medium powered, 50 to 60 watt satellites.

The European DBS market drew upon the experience of the North American C-band market and leap-frogged directly to small-dish, analog (as opposed to digital), Ku-band delivery methods. With the advent of DirecTv, USSB, PrimeStar and, in the near future, other players offering digital DBS systems, it is the American turn to leap-frog to the next level.

DirecTv and USSB, launched in April of 1994, and PrimeStar are now the first all-digital multichannel services available to Americans, or for that matter, to anyone in the world. In the next issue we will explore the American DBS broadcasters in more detail as well as the cost and availability of these services.

Terminology

Direct Broadcast Satellites:

Direct-to-home broadcasting is the direct transmission of video and audio programming via satellite from a single satellite location to the home. Low-power C-band service which involves the use of large, relatively expensive "backyard dishes" is not a true form of DBS because it requires you to look at many different satellites. Medium to high-power Ku-band DBS enables the use of smaller satellite dishes that are less obtrusive and expensive because they are fixed on one satellite orbital location.

Digital Compression Technology:

Digital compression is a new technology for delivery of multiple channels of video and audio programming. Although today it is widely used for data and voice transmission, only recently has it been perfected for entertainment video delivery. Digital compression technology increases the number of channels which can be transmitted over a single satellite and can improve the quality of video and audio reception in a customer's home.

Digital Audio:

Digital audio delivered by satellite is the same quality as delivered on a CD. The process first involves the digitalization of music or sounds, which turns them into computer language. These "codes" are then transmitted, via satellite, to the customer's home where the customer's equipment converts them back into CD-quality sounds or music.

INTERNATIONAL
TVRO

By George Wood (SM0IIN/KA6BIN)

Welcome to the first International TVRO column. I've been compiling Sweden Calling DXers/MediaScan for Radio Sweden for the past 16 years, and in recent years the program has come to focus more and more on satellite broadcasting. In this first column I'll introduce satellite broadcasting here in Europe. We'll get to Asia and Africa in later columns.

There are many similarities between European and American TVRO, and some significant differences, as well. Our later start for satellite broadcasting has given us some important advantages—European TVRO is essentially Ku band only, permitting much smaller antennas, and for most people a fixed antenna aimed at one spot in the Clarke Belt is all they need for a wide variety of programming.

The first communications satellite over Europe was in C-band, however; the Soviet Gorizont-4 was placed at 14 degrees west in time to relay coverage of the Moscow Olympics in 1980. But for Western Europeans, things really got started with the European Space Agency's experimental OTS-2 satellite which was opened for commercial use in 1982. The first programmer to try satellite broadcasting was the British Satellite TV Ltd with its Sky program. After changing owners, this became the Sky Channel, switching to the first proper European TV satellite, ECS-1, after it was launched to 13 degrees east in June, 1983.

Eventually the European Space Agency turned the satellite over to Eutelsat, a new organization made up of the state-owned public telephone companies of Western Europe, and ECS-1 became Eutelsat I-F1; ECS-2, launched in July 1984, became Eutelsat I-F2. Eutelsat and the then-European Community had some definite ideas about how satellite broadcasting was to develop. Everything was in the Ku-band in two bands, 10.9-11.75 GHz and 12.5-12.75 GHz.

All these transmissions were intended for relay to television stations, or eventually to cable heads. Plans were also made for direct broadcast satellites (DBS); these were to be national affairs with each satellite carrying 3 to 5 high-powered transmitters aimed at one single country. Home viewers would be able to tune in with antennas only 18 inches in diameter. The band set aside for DBS was 11.75 to 12.5 GHz.

The European electronics industry, led by Phillips in the Netherlands and Thompson in France, managed to force through a ruling by the European Community that direct-to-home broadcasts should use a new half-digital television standard called D-MAC, or its variant D2-MAC, rather than the PAL and SECAM systems used by terrestrial broadcasters in Europe.

Eutelsat II (courtesy of Aerospatiale)

This short-sighted approach was to cause endless debates before it was recently formally abandoned. What made it all irrelevant was Astra.

ASTRA

Astra was built for a company in Luxembourg called Societe Europeenne des Satellites (SES). The Grand Duchy has a long tradition of flaunting its neighbors' restrictive media policies. Radio Luxembourg's rock music programs in English, laced with advertising, were popular from Britain to Scandinavia in the 50's and 60's, and the competition greatly irritated the staid public broadcasters in many neighboring countries.

In December, 1988, Astra 1A was launched and positioned at 19.2 degrees east. It was a medium-powered satellite, weaker than DBS, but strong enough so the viewers in most of Western Europe could use dishes 60 to 80 centimeters (24 to 32 inches) in diameter. But instead of a handful of channels intended for viewing in one country, Astra provided 16 channels for all of Western Europe, and because it didn't use the official DBS frequencies, Astra got around the rules requiring it to use the then-unfinished and unpopular D-MAC and D2-MAC standards.

Before it was launched, critics called Astra the "Coca-Cola satellite" because they expected it would shower American programming on Europe. They were right, and it caused a revolution.

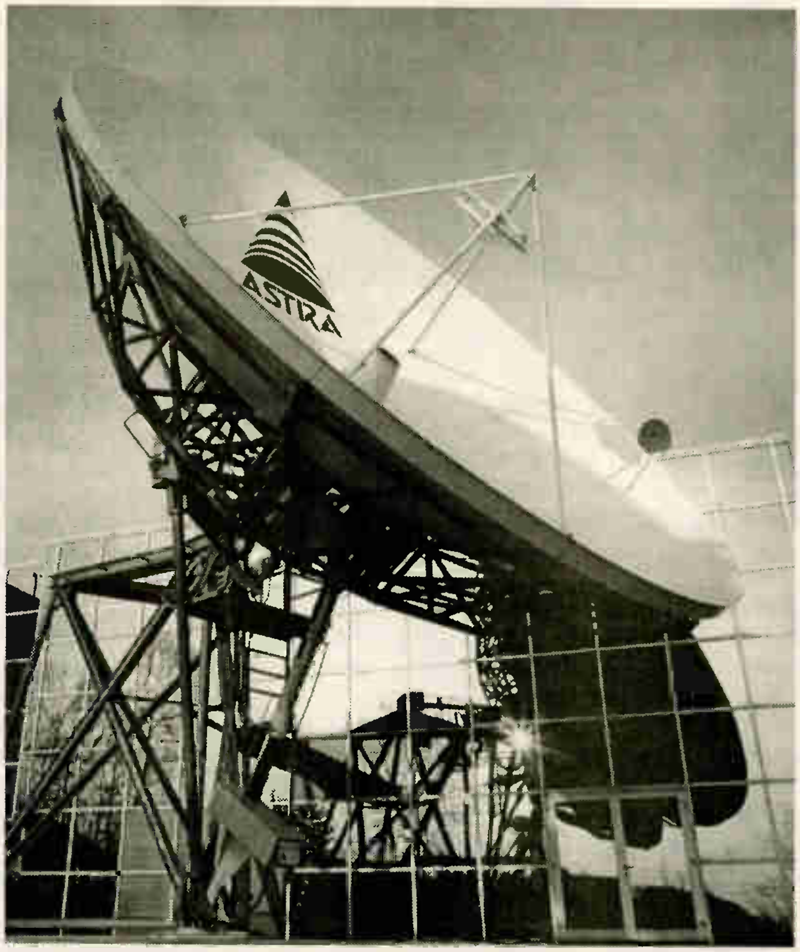
Astra has triumphed over Eutelsat because of one brilliant

"Because the system had been designed for expansion, owners of Astra receivers, with fixed antennas, suddenly had 32 channels instead of 16. When Astra 1C was launched in 1993 with 18 more transponders between 10.921 and 11.186 GHz, the number of channels available to fixed Astra systems rose to 50."

idea. The 1A satellite with its 16 transponders was placed at 19.2 degrees East in late 1988, using frequencies between 11.214 and 11.435 GHz. It was joined at the same position in the Clarke Belt by Astra 1B in March, 1991, with 16 more transponders between 11.464 and 11.686 GHz.

Because the system had been designed for expansion, owners of Astra receivers, with fixed antennas, suddenly had 32 channels instead of 16. When Astra 1C was launched in 1993 with 18 more transponders between 10.921 and 11.186 GHz, the number of channels available to fixed Astra systems rose to 50.

Another 18 transponders are on Astra 1D, due to be launched by the end of the year, and Astra 1E and 1F, carrying transponders for digital broadcasts, are on order for launch in 1995 and 1996.



Astra ground station (photo courtesy of AstraISES)

Meanwhile DBS was going nowhere. Germany and France were having technical problems with their satellites, co-located at 19 degrees West. A pan-European satellite called Olympus failed completely after about a year in orbit, and drifted all the way around the Earth before being put into a parking orbit. Spain's two Hispasat satellites haven't been in orbit long enough to fail, but the first satellite has already had major technical problems.

Britain's Marco Polo carried four channels from a company called British Satellite Broadcasting. But their dutiful adherence to the D-MAC system delayed the start, and potential viewers gave up waiting for receivers that never came, and bought Astra equipment instead. Eventually BSB was bought out by media magnate, Rupert Murdoch's Sky Television, which then became British Sky Broadcasting.

SCANDINAVIAN STAR WARS

Sweden has been more successful with its Tele-X satellite, but the attempt to bolster the Swedish position at 5 degrees east to create a Nordic alternative to Astra has turned into a bizarre "satellite war" between Sweden and Norway. The Swedish Space Corporation tried to buy the Marco Polo 2 satellite, the unused in-orbit reserve for BSB's closed down Marco Polo 1. But Norwegian Telecom bid higher, bought the satellite, and moved it to 1 degree west, alongside an Intelsat used for relaying programs to Norway.

Renamed Thor, the Norwegians sought to beat the Swedes by providing a Nordic package at one location. Unfortunately, the Norwegians were also enamored of the D-MAC standard, and an even more obscure scrambling system called Eurocrypt S, while (everyone else scrambles D2-MAC and D-MAC with Eurocrypt M, which is standard on MAC receivers.

The Norwegians managed to lure Cable Network News (CNN), the sports channel Eurosport, Discovery, the Children's Channel, and the pay-film channel FilmNet to Thor. After a few months the programming was switched from D-MAC to D2-MAC, which is available on most satellite receivers sold in Scandinavia, since that system is used for the popular TV3 and TV1000 channels to Sweden, Denmark, and Norway on Astra.

But the Norwegians have retained Eurocrypt S rather than switching to Eurocrypt M. As a result, there seem to be very few subscribers to Thor, especially outside of Norway. Why pay to subscribe to CNN or Eurosport and have to buy an expensive new decoder, many ask, when both channels are available for free on Astra with much cheaper equipment?

Following the Norwegians' purchase of Marco Polo 2, the Swedish Space Corporation continued negotiations to buy the unused Marco Polo 1 satellite. The Norwegians tried to fight the purchase in the British courts, arguing that allowing the Swedes to have the satellite would mean unfair competition for Norway, in violation of their contract to buy Marco Polo 2. The court rejected the argument, and the Swedes bought the satellite and moved it alongside Tele-X at 5 degrees East, renaming it Sirius.

"The satellite conflict between the two Scandinavian rivals can largely be summarized as, 'What if they gave a war and nobody came?'"

There were reports the only other prospective purchaser for Marco Polo 1 was a Malaysian consortium, which intended to use the satellite to broadcast to Southeast Asia. Since Rupert Murdoch also owns Asia's biggest satellite broadcaster, Star-TV, critics say he wanted to make sure Marco Polo 1 didn't wind up in the Far East.

The Swedish Space Corporation says it's planning to set up a Nordic package on Sirius, but all that has happened so far is that Sweden's TV 4 channel has moved from its fading Tele-X transponder to a Sirius transponder. Norway's public broadcaster NRK, which has used Tele-X, is reported to be moving to Thor.

The satellite conflict between the two Scandinavian rivals can largely be summarized as, "What if they gave a war and nobody came?"

Meanwhile, a new satellite, Intelsat 702, replaced the weaker Intelsat 512 at 1 degree west in June. Norway is using the satellite for many of its channels. But the major cable operators in Norway, Sweden, Finland, and Denmark have set up a joint organization to also provide a package on the new satellite, offering satellite viewers the same channels available to cable subscribers. Digital compression would be used to squeeze many stations into a handful of transponders. But as yet, not a single programmer for the package has been announced.

So Scandinavians are faced with rival packages from Sirus at 5 degrees east, from Intelsat 702, and from Thor at 1 degree west and at 1 degree west. The first two have no programs, while the third uses an encryption system no one has.

EUTELSAT STRIKES BACK

Eutelsat has tried to counter Astra by launching a series of higher-powered Eutelsat II birds, requiring antennas only slightly larger than those required for Astra, and covering more of Europe and with a wider frequency range as well. But the attempt has broken down over Eutelsat's philosophy of scattering satellites across the Clarke Belt, each carrying a mix of programming in various languages, along with feeds. For example, Turkish viewers have to tune to 4 satellites to view 10 channels.

Along the way the European Community (now the European Union) finally decided to abandon D-MAC and D2-MAC in favor of the future development of digital television, based on the MPEG-2 standard.

Recently Eutelsat realized it has to copy the Astra concept, and has decided to compete from the position of 13 degrees west, now the home of Eutelsat II-F1. Feeds are being moved off this satellite in favor of entertainment programming. Eutelsat II-F6, dubbed with the ridiculous name of "Hot Bird", is due to be launched into this position in October. "Hot Bird Plus", also called "Hot Bird 2", will carry digital transponders, and is scheduled for launch in August, 1996.

While this may supply some competition for Astra, it may also be "too little, too late". Today Astra already offers everything promised by Hot Bird, and the digital Astra 1E in 1995 will beat Hot Bird Plus by a year.

Eutelsat's big advantages is that it has a larger coverage area and may offer more digital capacity. During the recent Cable and Satellite Show in London, Eutelsat demonstrated that a 36 MHz-wide Eutelsat transponder can carry a regular analog signal with multiple audio subcarriers in 27 MHz of bandwidth, with a simultaneous digital signal in the remaining 9 MHz. CNN International successfully carried both analog and digital signals for a short period during the show on the Eutelsat II-F1 satellite.

This means Eutelsat can offer broadcasters an easy way to add a digital signal at no extra transponder cost. Astra is unable to counter, since Astra transponders are only 27 MHz wide. It's been suggested that Astra's only way to fight back is to offer four free transponders on the upcoming 1E satellite to carry 48 digital channels, giving each existing broadcaster on Astra 1A-1D an additional free digital channel. That would be an expensive proposition, but cheaper than losing broadcasters to Eutelsat.

Astra is also fighting back by preparing to offer digital radio channels. Until now the 6.5 MHz subcarrier was standard for mono TV signals on Astra, with 7.02 and 7.20 MHz used for TV stereo. Now Astra is trying to clear out the 6.5 MHz subcarriers and use them, as well as some of the higher ones above 8 MHz, for what is being called "Astra Digital Radio". Both DMX and DCR's European service, called "Multi-Choice Europe", have reportedly signed deals for Astra packages.

There are a number of other satellites over Europe, including several key Intelsats, France's three Telecom satellites, two Russian Gorizonts offering one Ku-band transponder each, and PanAmSat-1 over the distant Atlantic.

Next time we'll cover the programming found on all this hardware, especially the offerings of British Sky Broadcasting, and the hackers out in Europe who have cracked BSkyB's scrambling system over and over again, mainly so they can see their favorite science fiction program.

If you want to send a comment or a contribution to the column, you can send it by E-mail over the Internet to 70247.3516@compuserve.com or to the CompuServe mailbox 70247,3516. You can also send a fax. After the international access code from whatever country you may be in (010 from Britain, 011 from the US), the number is 468-667-6283. You can also use the mail, to George Wood, Radio Sweden, S-105 10 Stockholm, Sweden.

Satellite Launch Schedules

Space Transportation System (STS-NASA)

Space shuttles are launched from Cape Kennedy, Florida.

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-68	September 1994/ Endeavor*	57.0/120	9+1	SRL-02/GAS(5)
STS-64	September 1994/ Discovery**	57.0/140	9+1	Lite 1/ SPTN 201-02 ROMPS-01GBA(12)
STS-66	November 1994/ Atlantis***	57.0/164	11	Atlas-03/Crista-SPAS-01/SSBUV A-04/Escape-II

**Crew Assignment: CDR-Michael A. Baker, PLT-Terrence W. Wilcutt, MS(PLC)-Thomas D. Jones, MS-Daniel W. Bursch, MS-Steven L. Smith, MS-Peter J.K. Wisoff*

***Crew Assignment: CDR-Richard N. Richards, PLT-L. Blaine Hammond, MS-Susan J. Helms, MS-Mark C. Lee, MS-Jerry M. Linenger, MS-Carl J. Meade*

****Crew Assignment: CDR-Donald R. McMonagle, PLT-Curtis L. Brown, MS(PLC)-Jean-Francis Clervoy (France), MS-Scott E. Parazynski, MS-Joseph R. Tanner*

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
August 1994	Pegasus	Vandenberg AFB, CA	FAST
October 1994	Atlas E	Vandenberg AFB, CA	NOAA-J
November 1994	Delta II	Cape Canaveral AFS, FL	WIND

Arianespace

Ariane rockets are launched from French Guiana.

Launch Number	Launch Date	Launch Vehicle	Payload
Flight 67	August 1994	Ariane 42L	Telstar 402
Flight 68	September 1994	Ariane 44LP	Solidaridad II and Thaicom 2
Flight 69	October 1994	Ariane 42P	Astra 1D
Flight 70	November 1994	Ariane 44L	Brasilsat B2 and (Eutelsat II F6 or Telecom 2C)
Flight 71	December 1994	Ariane 42P	Panamsat 3

Note: The Arianespace launch manifest is still very tentative at press time due to the investigation and restart of their launch program. This is due to the Ariane Flight 63 mishap.

List of Abbreviations and Acronyms

AFB	Air Force Base
AFS	Air Force Station
Astra 1D	European geostationary communications satellite launched for SES. Will be located at 19.2 degrees east when operational.
Atlas-03	Atmospheric Laboratory for Applications and Science. Series of Spacelab flights that measure long term variability in the total energy radiated by the sun and determines the variability in the solar spectrum.
Atlas-E	DOD medium class expendable launch vehicle
Brasilsat B2	Brasilian geostationary communications satellite launched for Embratel. Will be located at 70 degrees west when operational.
CDR	Commander. Member of the Shuttle flight crew in command of the flight.
Crista-SPAS	Cryogenic Infrared Spectrometer Telescope for Atmosphere. A U.S./ German joint aeronomy payload intended to explore the variability of the atmosphere snf to provide measurements that will complement those provided by UARS.
Delta-II	Medium class expendable launch vehicle
DOD	Department of Defense
Escape-II	Experiment of the Sun for Complementing the Atmospheric Laboratory for Applications and Science (ATLAS) Payload and for Education-II. To collect solar data with solar imaging and UV solar irradiance experiments. The data will be correlative with the co-manifested Atlas-03 solar experiments for the understanding of the upper atmosphere photochemistry.
Eutelsat II F6	Geostationary communications satellite, part of the Eutelsat constellation of satellites. Will be located at 13 degrees east when operational.
FAST	Fast Auroral Snapshot Explorer. Spacecraft to investigate the processes operating within the auroral region.
GAS	Get Away Special. Alternate name for the Small Self-contained Payload (SSCP) program, providing canisters to accommodate lost-cost space experiments.
GBA(12)	GAS Bridge Assembly. (XX) denotes number of payloads on the GAS Bridge Assembly.
ISTP	International Solar Terrestrial Project
Lite-1	Lidar In-Space Technology Experiment systems. Project to measure the atmospheric parameters from a space platform utilizing laser sensors and to verify space-bom Lidar systems.
MS	Mission Specialist. A member of the Shuttle flight crew primarily responsible for Orbiter subsystem and payload activities.
NOAA	National Oceanic and Atmospheric Administration. Conducts research and gathers data about the global oceans, atmosphere, space and sun, and applies this knowledge to science and service that touch the lives of all Americans.
Panamsat 3	Geostationary communications satellite launched for Panamsat. Will be located at 43 degrees west when operational.
Pegasus	Small class air-launched expendable launch vehicle.
PLC	Payload Commander. A member of the Shuttle crew having overall crew responsblity for planning, integration and on-orbit coordination of payload mission activities.
PLT	Pilot. A member of the Shuttle crew whose responsibility is to pilot the Orbiter.
ROMPS-1	Robot Operated Materials Processing System. Investigates zero gravity anealing of semiconductor thin film and investigates robot handling of thin film samples.
Solidaridad 2	Geostationary communications satellite launched for Telecommunicaciones de Mexico. Will be located at 113.0 degrees west when operational (replace Morelos 2 at 116.8 degrees west).
SPAS-01	German Shuttle Pallet Satellite. Demonstrate the utilization of the MBB platform and systems as a carrier for science experiments.
SPTN 201-02	Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN). X-ray astronomy, medium energy survey mission using retrievable flyer.
SRL-02	Space Radar Laboratory. Series of flights to acquire radar images of the Earth's surface. The images will be used for making maps, interpreting geological features, and conducting resource studies.
SSBUV A-04	Shuttle Solar Backscatter Ultra-Violet Experiment A. Series of flights to measure ozone characteristics of the atmosphere. Platform has avionics and power connection with the orbiter.
STS	Space Transportation System (NASA Space Shuttle)
Telecom 2C	Geostationary communications satellite launched for France Telecom. Will be located at 3 degrees east when operational.
Telstar 402	Geostationary communications satellite launched for AT&T Skynet. Will be located at 89 degrees west when operational (replace Telstar 302 at 85 degrees west).
Thaicom 2	Geostationary communication satellite launched for Shinawatra Satellite Co., Ltd. Will be located at 78.5 degrees east when operational.
WIND	Satellite to measure solar wind input to magnetosphere. Part of ISTP program.

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide represents the current state of the geostationary ring at publication deadline. Current launch developments can be followed in ST's Space Launch Report column. Satellite information was supplied to *Satellite Times* by the Goddard Space Flight Center, Phillip Clark and Nichols Johnson, Kaman Sciences Corporation.

Radio Frequency Band Key

P band	230 - 1,000 MHz
L-band	1,000 - 2,000 MHz
S band	2,000 - 4,000 MHz
C band	4,000 - 8,000 MHz
X band	8,000 - 12,500 MHz
Ku band	12.5 - 18 GHz
K band	18 - 26.5 GHz
Ka band	26.5 - 40 GHz
Millimeter	> 40 GHz

Service Key

BSS	Broadcasting satellite service
Dom	Domestic
FSS	Fixed satellite service
Gov	Government
Int	International
Mar	Maritime
Met	Meteorology
Mil	Military
Mob	Mobile
Reg	Regional

'i' indicates an inclined orbit

OBJ NO.	INT-DESIG	COMMOM NAME	LONG (DEG)	TYPE SATELLITE
21140	1991-015B	Meteosat 5 (MOP 2)	0.7E	Met (L)
18952	1988-018B	Telecom 1C (France)	3.2E	Dom/Gov/Mil (C/Ku)
19919	1989-027A	Tele X (Sweden)	5.0E	Reg/BSS (Ku)
20193	1989-067A	Sirius/Marcopolo 1 (BSB R-1)	5.2E	BSS (Ku)
22921	1993-076A	USA 98 (NATO 4B)	6.1E	Mil (C)
22028	1992-041B	Eutelsat II F4	7.7E	Reg (Ku)
22557	1993-013A	Raduga 29	11.1E	Gov/Mil (C)
22269	1992-088A	Cosmos 2224	11.6E	Mil-Early Warning
21056	1991-003B	Eutelsat II F2	11.7E	Reg (Ku)
19596	1988-095A	Raduga 22	11.9E	iGov/Mil (C)
20777	1990-079B	Eutelsat II F1	13.3E	Reg (Ku)
21055	1991-003A	Italsat 1	13.4E	Dom-telephone (S/Ku/Ka)
21803	1991-083A	Eutelsat II F3	16.4E	Reg (Ku)
21139	1991-015A	Astra 1B	19.1E	Reg/BSS (Ku)
19688	1988-109B	Astra 1A	19.2E	Reg/BSS (Ku)
22653	1993-031A	Astra 1C	19.3E	Reg/BSS (Ku)
15383	1984-113B	Arabsat 1D (Anik D2)	20.6E	FSS/BSS (C)
19331	1988-063B	Eutelsat 1 F5	23.5E	Reg (Ku)
22175	1992-066A	DFS 3 (Germany)	23.5E	Dom/BSS (Ku/Ka)
18351	1987-078B	Eutelsat 1 F4 (ECS 4)	26.3E	Reg (Ku)
20706	1990-063B	DFS 2 (Germany)	29.1E	Dom/BSS (Ku/Ka)
21894	1992-010B	Arabsat 1C	32.5E	FSS/BSS (C/Ku)
20041	1989-041B	DFS 1 (Germany)	33.6E	Dom/BSS (Ku/Ka)
21821	1991-087A	Raduga 28	34.8E	Gov/Mil (C)
20953	1990-102A	Gorizont 22	40.1E	iDom/Gov (C/Ku)
23010	1994-012A	Raduga 31	45.2E	iGov/Mil (C)
22981	1994-008A	Raduga 1-3	49.0E	iGov/Mil (C)
21038	1990-116A	Raduga 1-2	49.1E	iGov/Mil (C)
21016	1990-112A	Raduga 26	52.8E	iGov/Mil (C)
22245	1992-082A	Gorizont 27	53.4E	Dom/Gov (C/Ku)
19687	1988-109A	Skynet 4B	53.4E	Mil (P/C/Millimeter)
11622	1979-098B	DSCS II E15	57.0E	Mil-IOR reserve (C)
14421	1983-105A	Intelsat 507	57.9E	Int FSS/Mar (L/C/Ku)
14675	1984-009A	DSCS III A2	60.0E	Mil-IOR primary (P/C)
20667	1990-056A	Intelsat 604	60.1E	Int FSS (C/Ku)
20315	1989-087A	Intelsat 602	62.9E	Int FSS (C/Ku)
20918	1990-093A	Inmarsat 2 F1	64.4E	Mar (L/C)
13636	1982-106A	DSCS II F16	65.0E	Mil-IOR reserve (C)
13595	1982-097A	Intelsat 505	65.9E	Int FSS/Mar (L/C/Ku)
20083	1989-048A	Raduga 1-1	69.7E	iDom (C)
20410	1990-002B	Leasat 5	70.5E	Mil-IOR reserve (P)
20499	1990-016A	Raduga 25	70.5E	iGov/Mil (C)
22787	1993-056A	USA 95 (UFO-2)	71.4E	Mil-IOR primary (P)
22963	1993-002A	Gals 1	71.4E	BSS (Ku)
11621	1979-098A	DSCS II D14	72.0E	Mil-IOR reserve (C)
08882	1976-053A	Marisat 2	72.1E	iMar (P/L)
22027	1992-041A	Insat 2A (India)	73.9E	Dom (S/C)
22931	1993-078B	Thaicom 1	78.5E	Reg (C/Ku)
21759	1991-074A	Gorizont 24	79.9E	Dom/Gov (C/Ku)
20693	1990-061A	Cosmos 2085	80.5E	iData Relay (Ku)
21111	1991-010A	Cosmos 2133	80.7E	Mil-Early Warning
20643	1990-051A	Insat 1D (India)	82.9E	Dom/BSS/Met (S/C)
13969	1983-026B	TDRS 1	84.8E	Gov (C/Ku)
22836	1993-062A	Raduga 30	85.5E	Gov/Mil (C)
18922	1988-014A	PRC 22	87.3E	Dom (C)
22880	1993-069A	Gorizont 28	90.0E	Dom/Gov (C/Ku)
12474	1981-050A	Intelsat 501	91.3E	iInt FSS (C/Ku)
22724	1993-048B	Insat 2B (India)	93.4E	Dom/BSS/Met (S/C)
20263	1989-081A	Gorizont 19	96.6E	iDom (C/Ku)
20473	1990-011A	PRC 26	98.0E	Dom (C)
19683	1988-108A	Ekran 19	99.2E	iBSS (P)
22210	1992-074A	Ekran 20	99.2E	BSS (P)
15629	1985-025A	Intelsat 510	101.7E	Int FSS (C/Ku)
21922	1992-017A	Gorizont 25	103.2E	Dom/Gov (C/Ku)
20558	1990-030A	Asiasat 1	105.1E	Reg (C/Ku)
20570	1990-034A	Palapa B2R	106.9E	Reg (C)
21668	1991-060A	BS-3B (Yuri 3B)	109.3E	BSS (Ku)
20771	1990-077A	BS-3A (Yuri 3A)	109.7E	BSS (Ku)
19710	1988-111A	PRC 25	110.6E	Dom (C)
17706	1987-029A	Palapa B-2P	112.9E	Reg (C)
14985	1984-049A	Chinasat 5 (Spacenet 1)	115.6E	Dom (C/Ku)
21964	1992-027A	Palapa B4	117.8E	Reg (C)
21132	1991-014A	Raduga 27	128.3E	iGov/Mil (C/Ku)
22907	1993-072A	Gorizont 29 (Rimsat 1)	130.0E	iDom/Gov (C/Ku)
18877	1988-012A	CS 3A (Sakura 3A)	131.9E	Dom (C/Ka)
19765	1989-004A	Gorizont 17	133.7E	iReg (C/Ku)
19508	1988-086A	CS 3B (Sakura 3B)	135.8E	Dom (C/Ka)
23118	1993-073E	Meteosat 6	139.4E	Met (L)
20217	1989-070A	GMS 4 (Himawari 4)	139.6E	Met (P/L)
20107	1989-052A	Gorizont 18	140.2E	iDom/Gov (C/Ku)
23108	1994-030A	Gorizont 30 (Rimsat 2)	142.4E	iReg (C/Ku)
20923	1990-094A	Gorizont 21	145.2E	iDom/Gov (C/Ku)
19874	1989-020A	JCSAT 1	149.9E	Dom (Ku)
18316	1987-070A	ETS V	150.3E	iReg (L/C)
20402	1990-001B	JCSAT 2	153.9E	Dom (Ku)
18350	1987-078A	Optus A3 (Aussat K3)	155.9E	Dom (Ku)
22253	1992-084A	Superbird A	157.9E	Dom (Ku/Ka)
22087	1992-054A	Optus B1 (Aussat B1)	159.9E	Dom/Mob (L/Ku)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG	COMMOM NAME	LONG (DEG)	TYPE SATELLITE
21893	1992-010A	Superbird B	162.0E	Dom (Ku/Ka)
16275	1985-109C	Optus A2 (Aussat 2)	163.9E	Dom (Ku)
12046	1980-087A	OPS 6394 (Fltsatcom F4)	171.4E	Mil-POR reserve (P-Bravo)
22871	1993-066A	Intelsat 701	174.1E	Int FSS (C/Ku)
20202	1989-069A	DSCS III B9	175.0E	Mil-WPAC primary (P/C)
15873	1985-055A	Intelsat 511	177.1E	Int FSS (C/Ku)
21814	1991-084B	Inmarsat 2 F3	178.0E	Mob-POR (L/C)
14786	1984-023A	Intelsat 508	179.9E	iInt FSS/Mar (L/C/Ku)
16117	1985-092C	DSCS III B5	180.0E	Mil-WPAC reserve (P/C)
09478	1976-101A	Marisat 3	178.5W	iMar-POR (P/L/C)
15236	1984-093C	Leasat 2	177.5W	Mil-POR primary (P)
12994	1981-119A	Intelsat 503	177.0W	iInt FSS (C/Ku)
21639	1991-054B	TDRS F5	174.4W	Gov (C/Ku)
18631	1987-100A	Raduga 21	170.5W	iGov/Mil (C)
21392	1991-037A	Satcom C5 (Aurora II)	138.9W	Dom (C)
20945	1990-100A	Satcom C1	137.1W	Dom (C)
22096	1992-057A	Satcom C4	135.1W	Dom (C)
22915	1993-074A	DSCS III B14	135.0W	Mil-EPAC primary (P/C)
23016	1994-013A	Galaxy 1R	133.0W	Dom (C)
22117	1992-060B	Satcom C3	131.0W	Dom (C)
13637	1982-106B	DSCS III A1	130.4W	iMil-EPAC reserve (P/C)
15994	1985-076C	ASC 1	128.0W	Dom (C/Ku)
21906	1992-013A	Galaxy 5	125.0W	Dom (C)
16649	1986-026A	Gstar 2	125.0W	Dom (Ku)
15826	1985-048D	Telestar 30	123.0W	Dom (C)
19484	1988-081B	SBS 5	122.9W	Dom (Ku)
16274	1985-109B	Morelos B	116.8W	Dom (C/Ku)
13652	1982-110C	Anik C3	115.0W	iDom (Ku)
17561	1987-022A	GOES 7	112.0W	Met (L)
21726	1991-067A	Anik E1	111.1W	Dom (C/Ku)
22911	1993-073A	Solidaridad 1	109.2W	Dom (C/Ku)
21222	1991-026A	Anik E2	107.1W	Dom (C/Ku)
14234	1983-077A	Telstar 301	107.1W	Dom (L/C/Ku)
08747	1976-023B	LES 9	105.9W	iMil (P/C)
08697	1976-017A	Marisat 1	105.7W	iMar-AOR (P/L)
20946	1990-100B	Gstar 4	105.1W	Dom (Ku)
15643	1985-028C	Leasat 3	104.7W	Mil-CONUS reserve (P)
03029	1967-111A	ATS 3	104.5W	iExp
15677	1985-035A	Gstar 1	103.1W	Dom (Ku)
08746	1976-023A	LES 8	101.4W	iMil (P/C)
22930	1993-078A	DBS 1	101.3W	BSS (Ku)
21227	1991-028A	Spacenet 4	101.1W	Dom (C)
22796	1993-058B	ACTS	100.0W	Exp (Ka)
17181	1986-096A	USA 20 (Fltsatcom F7)	99.4W	Mil-CONUS primary (P/C)
22694	1993-039A	Galaxy 4	99.1W	Dom (C/Ku)
22927	1993-077A	Telstar 401	97.0W	Dom (C/Ku)
20872	1990-091A	SBS 6	95.0W	Dom (Ku)
19548	1988-091B	TDRS F3	93.7W	Gov (C/Ku)
15308	1984-101A	Galaxy 3	93.5W	Dom (C)
19483	1988-081A	Gstar 3	93.0W	iDom (Ku)
22205	1992-072A	Galaxy 7	91.1W	Dom (C/Ku)
23051	1994-022A	GOES 8	90.9W	Met (L)
22988	1994-009A	USA 99 (Milstar 1)	90.0W	Mil (P/K)
18951	1988-018A	Spacenet 3R	87.1W	Dom (L/C/Ku)
15237	1984-093D	Telestar 302	85.1W	Dom (C)
16482	1986-003B	Satcom K-1	85.0W	Dom (Ku)
14365	1983-098A	Galaxy 2	82.4W	Dom (C)
16276	1985-109D	Satcom K-2	81.0W	Dom (Ku)
15235	1984-093B	SBS 4	77.1W	iDom (Ku)
14133	1983-059B	Anik C2 (Argentina)	75.9W	iDom (Ku)
12309	1981-018A	Comstar D4	75.7W	iDom (C)
20873	1990-091B	Galaxy 6	74.1W	Dom (C)
19215	1988-051A	Meteosat P2	74.1W	iMet (L)
13651	1982-110B	SBS 3	74.0W	iDom (Ku)
12855	1981-096A	SBS 2	74.0W	iDom (Ku)
15642	1985-028B	Anik C1 (Argentina)	72.1W	Dom (Ku)
14328	1983-094A	Satcom F2R	72.1W	Dom (C)
16650	1986-026B	SBTS 2 (Brazil)	70.1W`	Dom (C)
15385	1984-114A	Spacenet 2	69.0W	Dom (C/Ku)
15561	1985-015B	SBTS 1 (Brazil)	65.1W	Dom (C)
21940	1992-021B	Inmarsat 2 F4	54.1W	iMob-AOR-W (L/C)
19121	1988-040A	Intelsat 513	53.1W	Int FSS (C/Ku)
20203	1989-069B	DSCS III B10	52.5W	Mil-WLANT primary (P/C)
14077	1983-047A	Intelsat 506	49.3W	iInt FSS (C/Ku)
19217	1988-051C	PanAmSat (PAS 1)	48.5W	Reg (C/Ku)
22314	1993-003B	TDRS F6	46.1W	iGov (C/Ku)
16116	1985-092B	DSCS III B4	42.5W	Mil-ATL reserve (P/C)
19883	1989-021B	TDRS F4	41.2W	Gov (C/Ku)
20523	1990-021A	Intelsat 603	34.7W	Int FSS (C/Ku)
20401	1990-001A	Skynet 4A	34.2W	iMil (P/C)
13083	1982-017A	Intelsat 504	31.3W	iInt FSS (C/Ku)
22723	1993-048A	Hispasat 1B	30.2W	Dom (Ku)
22116	1992-060A	Hispasat 1A	30.2W	Dom (Ku)
21765	1991-075A	Intelsat 601	27.6W	Int FSS (C/Ku)
19928	1989-030A	Raduga 23	25.1W	iGov/Mil (C)
21653	1991-055A	Intelsat 605	24.6W	Int FSS (C/Ku)
22112	1992-059A	Cosmos 2209	24.1W	Mil-Early Warning
20253	1989-077A	USA 46 (Fltsatcom 8)	23.6W	Mil-AOR primary (P-Charlie/K)
21989	1992-032A	Intelsat K	21.6W	Int FSS (Ku)
12089	1980-098A	Intelsat 502	21.3W	iInt FSS (C/Ku)
15391	1984-115A	NATO III D	21.2W	iMil (P/C)
20168	1989-062A	TV Sat 2 (Germany)	19.3W	BSS (Ku)
19621	1988-098A	TDF 1 (France)	19.0W	BSS (Ku)
20705	1990-063A	TDF 2 (France)	18.9W	BSS (Ku)
19772	1989-006A	Intelsat 515	18.1W	Int FSS (C/Ku)
21047	1991-001A	NATO IV A	17.8W	iMil (P/C)
20391	1989-101A	Cosmos 2054	15.8W	iTracking & Relay WSDRN (Ku)
21149	1991-018A	Inmarsat 2 F2	15.7W	iMob-AOR-E (L/C)
15386	1984-114B	Marecs B2	15.3W	iMar (L)
10669	1978-016A	Fltsatcom 1	15.0W	Mil-AOR reserve (P-Alpha)
20659	1990-054A	Gorizont 20	14.5W	iDom/Gov (C/Ku)
18384	1987-084A	Cosmos 1888	13.7W	iData Relay
21789	1991-079A	Cosmos 2172	13.1W	Data Relay
22009	1992-037A	DSCS III B12	12.0W	Mil-ELANT primary (P/C)
22041	1992-043A	Gorizont 26	10.7W	Dom/Gov (C/Ku)
22912	1993-073B	Meteosat 6	9.8W	Met (L)
19876	1989-020B	Meteosat 4 (MOP 1)	8.4W	Met (L)
21813	1991-084A	Telecom 2A	8.1W	Dom/Gov (C/Ku)
21939	1992-021A	Telecom 2B	5.0W	Dom/Gov (C/Ku)
20776	1990-079A	Skynet 4C	1.1W	iMil (P/C)
16101	1985-087A	Intelsat 512	1.1W	Int FSS (C/Ku)
20762	1990-074A	Thor/Marcopolo 2 (BSB R-2)	0.8W	BSS (Ku)

International Shortwave Broadcasters via Satellite

WORLD RADIO NETWORK ONE SCHEDULE

North American Service Schedule
ASC-1, Transponder 23 (SCOLA), 4.160 GHz,
Horizontal Polarization, Audio Subcarrier 6.20 MHz

Galaxy 5, Transponder 6 (WTBS), 3.820 GHz.
Vertical Polarization, Audio Subcarrier 6.80 MHz.

All broadcast are daily unless otherwise indicated.

UTC	SERVICE/PROGRAM	EDT/PDT
0000	Radio Sweden - Stockholm	2000/1700
0030	Kol Israel - The Voice of Israel	2030/1730
0100	YLE Radio Finland - Helsinki	2100/1800
0130	Radio Netherlands - Hilversum	2130/1830
0230	Blue Danube Radio - Vienna	2230/1930
0300	YLE Radio Finland - Helsinki	2300/2000
0330	Vatican Radio	2330/2030
0400	Radio Canada International - Montreal	0000/2100
0430	BBC Europe Today (Mon-Sat)	0030/2130
	BBC International Call (Sun)	0030/2130
0500	Deutsche Welle - Germany	0100/2200
0600	Radio Canada International - Montreal	0200/2300
0630	Swiss Radio International - Berne	0230/2330
0700	Radio Australia - Melbourne	0300/0000
0800	Radio Korea - Seoul	0400/0100
0900	Radio Moscow International (Mon-Fri)	0500/0200
	Topical Tapes-Intl Call (Sat)	0500/0200
	BBC Science Magazine (Sun)	0500/0200
0930	Radio Netherlands - Hilversum	0530/0230
1030	Kol Israel - The Voice of Israel	0630/0330
1100	Radio Australia - Melbourne	0700/0400
1200	Radio Telefis Eireann (RTE) - Dublin	0800/0500
1300	Radio France International - Paris	0900/0600
1400	YLE Radio Finland - Helsinki	1000/0700
1430	Radio Vlaanderen - Brussels Calling	1030/0730
1500	ABC Radio Australia	1100/0800
1600	Blue Danube Radio - Vienna (Mon-Sat)	1200/0900
	United Nations Radio (Sun)	1200/0900
1630	Radio Netherlands until 1655 UTC (Mon-Fri)	1230/0930
	Radio Netherlands until 1730 UTC (Sat & Sun)	1230/0930
1700	Radio France International (French) (Mon-Fri)	1300/1000
	RTE - News at 1730 (Sat & Sun)	1300/1000
1800	Radio Australia - Melbourne	1400/1100
1900	Kol Israel - The Voice of Israel	1500/1200
1930	Radio Vlaanderen - Brussels Calling	1530/1230
2000	Radio Sweden - Stockholm	1600/1300
2030	BBC Europe Today (Mon-Fri)	1630/1330
	Topical Tapes - International Call (Sat)	1630/1330
	BBC Europe Today (Sun)	1630/1330
2100	RTE - Both Sides Now (Mon-Fri)	1700/1400
	Radio Telefis Eireann (RTE) (Sat & Sun)	1700/1400
2300	BBC Newsdesk - London	1900/1600
2330	RTE - News from Dublin (Mon-Fri)	1930/1630
	RTE - News & Sport (Sat)	1930/1630
	RTE - News (Sun)	1930/1630

European Service Schedule
Astra-1B, Transponder 22 (MTV Europe), 11.538 GHz
Vertical Polarization, Audio Subcarrier 7.38 MHz

All broadcast are daily unless otherwise indicated, time zone is British Standard Time.

BST	SERVICE/PROGRAM
0000	National Public Radio (NPR) All Things Considered
0130	NPR Rhythm Review (Mon-Fri & Sun)
	NPR Piano Jazz (Sat)
0230	Radio Netherlands - Hilversum
0330	NPR/BBC Topical Tape Features (Mon-Fri)
	NPR Living on Earth (Sat)
	NPR Horizons (Sun)
0400	YLE Radio Finland - Helsinki
0430	Radio Vatican
0500	Central Europe Today - Budapest (Mon-Fri)
	Radio Canada International (Sat & Sun)
0530	BBC Europe Today (Mon-Sat)
	Topical Tapes - International Call (Sun)
0600	NPR All Things Considered
0800	Radio Australia - Melbourne
0900	Radio Korea - Seoul
1000	Radio Moscow International (Mon-Fri)
	Topical Tapes - International Call (Sat)
	Topical Tapes - Science Magazine (Sun)
1030	Radio Netherlands - Hilversum
1130	Kol Israel - The Voice of Israel
1200	NPR Morning Edition Part 1 (Mon-Fri)
	NPR News Features (Sat & Sun)
1300	NPR Morning Edition Part 2 (Mon-Fri)
	NPR Weekend Edition (Sat & Sun)
1400	Radio France International - from Paris
1500	YLE Radio Finland - Helsinki
1530	Radio Vlaaderen International - Brussels
1600	Radio Australia - Melbourne
1700	Blue Danube Radio - Vienna (Mon-Sat)
	United Nations Radio (Sun)
1730	Radio Netherlands - Hilversum
1830	Radio Telefis Eireann (RTE) - Irish news from Dublin (Mon-Fri)
	Radio Telefis Eireann (RTE) - News & Sport from Dublin (Sat & Sun)
1900	NPR Talk of the Nation Part 1 (Mon-Fri)
	C-SPAN Journal - Washington (Sat)
	NPR Living on Earth & Horizons (Sun)
2000	NPR Talk of the Nation Part 2 (Mon-Fri)
	NPR Afropop Worldwide (Sat)
	NPR Piano Jazz (Sun)
2100	Radio Sweden - Stockholm
2130	BBC Europe Today (Mon-Fri & Sun)
	Topical Tapes - International Call (Sat)
2200	NPR All Things Considered

WRN One schedules are subject to change. European listeners should listen to WRN for details, on Astra 1B or turn to page 222 of MTV text. All programs in English unless otherwise noted.

C-SPAN AUDIO SERVICES

C-SPAN Audio 1
Satcom C3 (F3), Transponder 7 (C-SPAN 1), 3.840 GHz
Vertical Polarization, Audio Subcarrier 5.20 MHz

All broadcast are daily and taped unless otherwise indicated.

UTC	SERVICE/PROGRAM	EDT/PDT
0000	Radio Havana Cuba(Live)	2000/1700
0100	Radio Japan (Live)	2100/1800
0200	Classical Music	2200/1900
0300	Deutsche Welle - Germany (Live)	2300/2000
0400	China Radio International (Live)	0000/2100
0500	Classical Music	0100/2200
0530	Radio Austria International (Live)	0130/2230
0600	Voice of America (Live)	0200/2300

International Shortwave Broadcasters via Satellite

0700	Classical Music and schedule information until 1030 except Thursday and Friday 0800 - 0900 UTC	0300/2400
0800	Paris Rendezvous until 0900 UTC (Thu)	0400/0100
	Israel Magazine until 0900 UTC (Fri)	0400/0100
1030	Radio Korea - Seoul (Live)	0630/0330
1100	Radio Japan - Tokyo (Live)	0700/0400
1200	Open House (Mon) (Live)	0800/0500
	As It Happens - Canadian Broadcasting Corp (Tue-Fri) (Live)	0800/0500
	Classical Music (Sat & Sun)	0800/0500
1300	Classical Music and Schedule Information or Historical Speeches Programs (Mon/Thu/Fri until 1600 UTC, Tue-Wed until 1700 UTC	0900/0600
	Paris Rendezvous, Sweden Today, Israel Magazine (Sat until 1500 UTC)	0900/0600
	Radio Canada International - Sunday Moming (Live) (Sun until 1600 UTC)	0900/0600
1500	Classical Music (Sat until 1700 UTC)	1100/0800
1600	Weekly C-SPAN Radio Journal (Mon until 1700 UTC)	1200/0900
	Paris Rendzevous (Thu until 1700 UTC)	1200/0900
	Israel Magazine (Fri until 1700 UTC)	1200/0900
	Classical Music (Sun until 1700 UTC)	1200/0900
1700	Voice of America Worldwide English Service until 0000 UTC (Live)	1300/1000

C-SPAN Audio 2

Satcom C3 (F3), Transponder 7 (C-SPAN 1), 3.840 GHz
Vertical Polarization, Audio Subcarrier 5.40 MHz

BBC World Service in English is broadcast continuously 24 hours a day on this audio subcarrier.

DEUTSCHE WELLE

Satcom C4 (F4), Transponder 5 (Deutsche Welle TV), 3.800 GHz
Vertical Polarization

The following subcarriers carry Deutsche Welle programming and other foreign language programming:

7.02 7.22 7.42 7.58 7.78 7.95 8.30 MHz

RADIO FRANCE INTERNATIONAL

Spacenet 2, Transponder 2 (GEMS TV), 3.740 GHz
Vertical Polarization, Audio Sub-Carrier 5.80 MHz

ASC-1, Transponder 23 (SCOLA), 4.160 GHz
Horizontal Polarization, Audio Sub-Carrier 5.80 MHz

RFI broadcast can be heard in a variety of languages throughout a 24 hour period.

VOICE OF AMERICA (United States Information Agency)

Voice of America transmits in a variety of languages on the following audio subcarriers and satellites.

NTSC Baseband Subcarrier Frequencies

Primary Television Audio (USIA Worldnet)6.80 MHz

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

PAL Baseband Subcarrier Frequencies

Primary Television Audio (USIA Worldnet)6.60 MHz

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

Satellites

Eutelsat II F1, 13.3 degrees east, Transponder 27, 11.163 GHz, PAL system
Intelsat 510, 66.0 degrees east, Transponder 38, 4.1775 GHz, PAL system
Intelsat 601, 27.5 degrees west, Transponder 14, 3.995 GHz, PAL system
Intelsat 601, 27.5 degrees west, Transponder 21, 3.742 GHz, PAL system
Spacenet 2, 69.0 degrees west, Transponder 2H, 3.760 GHz, NTSC system
Intelsat 508, 180 degrees west, Transponder 14, 3.974 GHz, PAL system

ARMED FORCES RADIO AND TELEVISION SERVICE (AFRTS)

Spacenet 2, Transponder 20 (AFRTS), 4.100 GHz
Vertical Polarization, Audio Sub-carrier 7.41 MHz

AFRTS Radio Service can be heard on this transponder carrying a variety of radio network news and sports programming for servicemen, their families overseas and sailors aboard Navy ships.

WORLD INTERNATIONAL BROADCASTERS, WINB - Red Lion, Pennsylvania

Galaxy 3, Transponder 11 (Keystone Inspirational), 3.920 GHz
Horizontal Polarization, Audio Sub-Carrier 7.38 MHz

Religious shortwave broadcaster WINB can be heard on this audio subcarrier 1600-0330 UTC with religious programming and music.

WORLD HARVEST INTERNATIONAL RADIO, WHRI-South Bend, Indiana

Galaxy 4, Transponder 15 (World Harvest TV Network), 4.000 GHz
Horizontal Polarization

Religious broadcaster WHRI/KHWR uses audio subcarriers to feed three shortwave broadcast transmitters as follows:

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

Satellite Radio Guide

By Robert Smathers

CLASSICAL

Classical Music	E1, 9	6.32 (N)
KUCV-FM, Lincoln, Neb. (Nebraska Public Radio)	S3, 2/4	5.76/5.94 (DS)
Superadio Classical Collections	G5,21	6.30/6.48 (DS)
WFMT-Chicago, Ill.	G5, 7	6.30/6.48 (DS)
WQXR-New York, N.Y.	F4,15	6.30/6.48 (DS)

CONTEMPORARY

CHIN-AM/FM, Toronto, Ontario, Canada (Multilingual)	T301,20	6.83
	E1,13(Ku)	6.83
CKRW-AM, Whitehorse, Yukon, Canada (Adult Contemporary, oldies)	E1,18	5.41, 6.80
In Store Contemporary	S3,18	5.78, 5.96, 6.48
Superadio Light and Lively Rock	G5,21	5.96, 6.12 (DS)
VOCM-AM/FM, St. Johns, Newfoundland, Canada (Adult Contemporary)	E1,12	6.20
WVTY-FM, Pittsburgh, Pa. USA (Adult Contemporary)	F2,16	7.32

COUNTRY

CHON-FM, Whitehorse, Yukon, Canada	E1,12	5.40
CISN-FM, Edmonton, Alberta, Canada (Country 104)	E1,18	7.53/7.62 (DS)
In Store Country	S3,18	6.12
Superadio American Country Favorites	G5,21	5.04/7.74 (DS)
Transtar III Radio Network	S3, 9	5.76/5.94 (DS)
WOKI-FM, Oak Ridge-Knoxville, Tenn.	G3, 5	7.38
WSM-AM, Nashville, Tenn.	G5,18	7.38
WSM-FM, Nashville, Tenn.	F4,24	7.38

EASY LISTENING

CHFI-FM, Toronto, Ontario, Canada (Soft Adult Contemporary)	E1, 8	5.415.58 (DS)
	E1,6/10/12/14)	6.80
Horizon	E1,22	7.62 (N)
In Store Easy Listening	S3,18	6.32, 7.22, 7.40
Superadio Soft Sounds	G5,21	5.58/5.76 (DS)
United Video Easy Listening	F4, 8	5.895 (N)
WZEZ-FM, Nashville, Tenn. (Soft Adult Contemporary, The Light)	G3,13	7.38

FOREIGN LANGUAGE

Antenna FM (Greek)	G3, 9	5.88, 6.20
CBC Radio-French (East)	E1,20	5.38/5.58 (DS)
	E1,20	7.38/7.58 (DS)
	E1,10(Ku)	5.38/5.58 (DS)
CFGL-FM, Laval, Quebec (French)	G4,10	7.62
CITE-FM, Montreal, Quebec Canada (French, Soft Adult Contemporary)	G4,10	5.76
CJMS-AM, Montreal, Quebec Canada (French, Adult Contemporary)	E1, 9	7.58
CJVB-AM, Vancouver, British Columbia, Canada (Ethnic)	E1,15(Ku)	6.12
CKAC-AM, Montreal, Quebec Canada1 (French, Adult Contemporary)	G4,10	6.44
Foreign language/music	S3,15	5.76
French Canadian audio information service	E1,24	6.46 (N)
French language audio service	E1,21(Ku)	6.55
	E1,24(Ku)	6.55
French language rock station	T301,20	7.72/7.83 (DS)
	E1,13(Ku)	7.72/7.83 (DS)
French music	E1,21(Ku)	6.12/6.20 (DS)
	E1,24(Ku)	6.12/6.30 (DS)
Irish Music (Sat 1430-0000 UTC)	S3, 3	6.20
La Nueva Cadena Radio Christiana (Spanish)	F2, 5	5.96
Los Grandes Groupos-Mexico (Spanish)	SD1,5	6.80
RAI Satelradio (Italian)	F1,15	7.38
Radio Sedeye Iran (Farsi)	S3,15	6.20 (N)
Radio Sonora-Mexico (Spanish)	SD1,8	6.80
Radio Tropical (Haitian Creole)	F2,18	7.60
UPS (Spanish news/music)	F1,20	8.30
WCMQ-AM, Miami, Fla. (Hispanic Broadcast Network)	G4, 8	7.75/7.93 (DS)
WIND-AM, Chicago, Ill (Spanish)	F1,13	6.80
WLIR-AM, Spring Valley, N.Y. (Ethnic)	F2,22	7.60
WNTL-AM, Indian Head, Md. USA (Arabic)	F2, 1	6.80, 6.20
WNWK-FM, Newark, N.J. USA (Ethnic)	F2,18	8.30
XEL-AM, Mexico City, Mexico (Spanish)	SD1,5	7.38
XEW-FW, Mexico City, Mexico (W-FM 96.9)	SD1,21	7.38
XEWA-AM, Monterrey, Mexico (Spanish, Super Estelar)	M2, 8	7.38
XEX-AM/FM, Mexico City, Mexico (Spanish, La Super)	M2,14	7.38

JAZZ

KJAZ-FM, Alameda, Calif.	G5, 7	5.58/6.12 (DS)
KLON-FM, Long Beach, Calif.	G5, 2	5.58/5.76 (DS)
Superaudio New Age of Jazz	G5,21	7.38/7.56 (DS)

NEWS AND INFORMATION

Business Radio Network	F4,10	8.06 (N)
C-SPAN ASAP (Program Schedule)	F3, 7	5.58
C-SPAN II ASAP (Program Schedule)	F4,19	5.58
CJAD-AM, Montreal, Quebec, Canada	E1, 2	6.525 (N)
CNN Headline News	G5,22	7.58
CNN Radio News	S3, 9	5.62
	G5, 5	7.58
	GST2-2,6(Ku)	6.30
WCBS-AM, New York, N.Y.	G4,20	7.38
WCCO-AM, Minneapolis, Minn.	ASC1,22	6.20

RELIGIOUS

Ambassasor Inspirational Radio	S3,15	5.96/6.48 (DS)
Brother Staire Radio	F2, 5	5.50
CBN Radio Network	G5,11	6.30/6.48 (DS), 6.12
	C3, 1	6.20
Christian Music Service	F2,23	6.20, 7.60
IBN Radio Network	F1,20	7.38
Praise in the Night (occ audio)	S3, 5	6.48
Religious music (easy listening)	G7,14	7.78
KILA-Las Vegas, Nev. (SOS Radio Network)	F4, 8	7.38/7.56 (DS)
Salem Radio Network	S3,15	5.43, 6.34
	S3,17	5.01
Solid Gospel (gospel music)	G7,14	7.58
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
Trinity Broadcasting radio service (Spanish, SAP)	G5, 3	5.96

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WCRP-FM, Guayama, Puerto Rico	G4, 6	6.53
WROL-AM, Boston, Mass. (occ spanish)	S3, 3	6.20

ROCK

CFMI-FM, New Westminister, British Colombia, Canada (Album Rock, Rock 101)	E1,22	6.80
CFNY-FM, Toronto, Ontario, Canada (FM-102)	E1, 2	6.12/6.30 (DS)
CILQ-FM, Toronto, Ontario, Canada (Q-107)	E1, 2	5.76/5.94 (DS)
CIRK-FM, Edmonton, Alberta, Canada (K-97)	E1,18	7.80 (N)
Rock Radio Network	E1,27(Ku)	6.12/6.30 (DS)
Superadio Prime Demo	G5,21	5.22/5.40 (DS)

SPECIALITY FORMATS

CFRN-AM, Edmonton, Alberta, Canada (Oldies)	E1,18	6.435
Georgia Radio Reading Service	T401,14(Ku)	5.76
In Store Oldies	S3,18	5.20, 5.40, 7.58
In Touch (reading service)	F5,24	6.48
Montreal Expos Baseball	E1, 2	7.45
Nebraska Talking Book Network	S3, 2	6.48
Sports Fan Radio Network	G5,18	7.56
Superaudio Big Bands (Sun 0200-0600 UTC)	G5,21	5.58/5.76 (DS)
Superadio Classic Hits (oldies)	G5,21	8.10/8.30 (DS)
Superadio In Touch (reading service)	F4,10	7.87 (N)
Voice Print (reading service)	E1,13	7.44 (N)
Yesterday USA (nostalgia)	G3,17	6.20
	G7,14	5.76
	S3, 5	6.80

VARIETY

AEN Michael Reagan (0100-0700 UTC)	F3, 1	6.20
American Urban Radio	S3, 9	6.30/6.48 (DS)
Cable Radio Network	F3,23	7.24 (N)
CBC Radio	E1,13	5.40, 5.58
CBC Radio (occasional)	E1,20	5.78
CBC-FM, Atlantic	E1,13	6.12/6.30 (DS)
CBC-FM, Eastem	E1,13	5.76/5.94 (DS)
CBM-AM/FM, Montreal, Quebec, Canada (Fine Arts/Variety)	E1,20	6.12
CBU-FM, Vancouver, British Columbia, Canada (Variety)	E1,22	5.76/5.94 (DS), 7.42
CFWE-FM, Edmonton, Alberta (Variety Music)	E1,18	7.875 (N)
	E1,14(Ku)	6.45
CBKA-FM/MBC Radio, La Ronge, Saskatchewan, Canada (Multilingual)	E1,18	7.71 (N)
CJRT-FM, Toronto, Ontario, Canada (Fine Arts/Jazz-nights)	E1,26(Ku)	5.76/5.94 (DS)
CKER-AM, Edmonton, Alberta, Canada (Adult Standard, Ethnic-night)	E1,18	7.42 (N)
CKNM-FM, Yellowknife, NWT, Canada	E1,14	5.41
(Country/Ethnic)	E1,18	7.92
CKUA-AM/FM, Edmonton, Alberta, Canada (Variety)	E1, 9(Ku)	5.76/5.94 (DS)
Constitutionalist Radio Network	ASC1,11	5.80
For the People Talk Radio	F1, 2	7.50
Interstate Radio Network	E1, 2	5.22
KBVA-FM, Bella Vista, Ark.	G4, 6	5.58/5.76 (DS)
KNOW-St Paul, Minn. (Minnesota Public Radio/BBC overnight)	F4,10	8.26 (N)
KSKA-FM, Anchorage, Alaska (Variety/Fine Arts)	F5,24	7.38/7.56 (DS)
KSL-AM, Salt Lake City, Utah	F1, 6	5.58
KUCV-FM, Lincoln, Neb. (Nebraska Public Radio)	S3, 2	5.76/5.94 (DS)
Lender's Radio Network (Agriculture Information)	ASC1,22	7.70
Media One (Jazz and World Beat)	G3,14	7.38
Network One radio service	F1,11	7.48
Omega Radio Network	G3, 7	5.80
Peach State Public Radio (Georgia)	T401,14(Ku)	5.40/5.58 (DS)
Seltech Radio Syndicated service	E1, 2	5.40/5.58 (DS)
Skylink Discussion channel	G1,15	5.80
Radio syndicated show feeds	E1, 2	7.54
Talk America	S3, 9	6.80
The Weather Channel (occasional audio)	C3,13	6.80
The Weather Channel (background music)	C3,13	7.78
USA Radio Network	S3, 5	5.40, 5.76, 5.94, 6.12
	S3,13	5.01(Ch 1), 5.20(Ch 2)
United Video background music service	F4, 8	5.90

DS—Discrete Stereo N—Narrow bandwidth

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Spacenet 2 Transponder 12 (C-band)

1202.300	USIA Radio Marti, Spanish broadcast service to Cuba

Galaxy 6 Transponder 3 (C-band)

1405.600	KIRO-AM (710), Seattle, WA—news/talk/sports talk radio, Seattle Mariners MLB radio network
1405.400	Sports Byline USA (occasional audio)—sports talk
1404.600	Talk America radio network
1405.400	Sports Byline USA (occasional audio)—sports talk
1404.600	Talk America radio network
1404.400	WLW-AM (700), Cincinnati, OH—talk radio, Cincinnati Reds MLB radio network
1404.000	American Sports radio network
1403.800	WTMJ-AM (620), Milwaukee, WI—talk radio, Milwaukee Brewers MLB radio network
1403.200	Motor Racing Network (occasional audio) plus other Occasional audio
1402.800	Illinois State News Network plus other Occasional audio
1402.600	KFBK-AM (1530), Sacramento, CA—news/talk
1402.200	Data transmission
1400.800	WBAL-AM (1090), Baltimore, MD—news/talk radio, Baltimore Orioles MLB radio network
1400.600	Occasional audio
1398.800	WQAM-AM (560), Miami, FL—news/sports talk, Florida Marlins MLB radio network
1398.300	WGN-AM (720), Chicago, IL—talk radio, Chicago Cubs MLB radio network
1398.000	Occasional audio
1397.800	WDBO-AM (580), Orlando, FL—news/talk
1397.200	WTMJ-AM (620), Milwaukee, WI—talk radio, Milwaukee Brewers MLB radio network
1394.700	Sun Radio Network
1394.500	WSB-AM (750), Atlanta, GA—talk radio
1393.800	WIOD-AM (610), Miami, FL—talk radio (occasional audio)
1393.600	Florida's Radio Network plus other occasional audio
1393.400	WGN-AM (720), Chicago, IL—talk radio, Interstate Radio Network plus other occasional audio
1393.200	Occasional audio
1393.000	Occasional audio
1392.700	WGN-AM (720), Chicago, IL—talk radio, Interstate Radio Network
1392.300	Occasional audio
1391.600	XEPRS-AM (1090), Tijuana, Mexico—spanish language programming, ID-"Radio Express"
1391.200	Occasional audio
1390.900	Occasional audio
1390.600	Los Angeles Dodgers MLB radio network (English)
1390.400	Los Angeles Dodgers radio network (Spanish)
1390.200	Occasional audio
1390.000	Occasional audio
1389.700	Occasional audio, data transmissions (burst)
1389.500	Data transmissions (burst)
1388.900	One on One Sports Radio Network
1388.200	Occasional audio
1388.000	Occasional audio
1387.750	Data transmissions
1387.500	KWKW-AM (1330), Los Angeles, CA—spanish languageprogramming, Spanish Information Service, Los Angeles Dodgers MLB games (Spanish), ID-"Radio Lobo"
1387.100	Sports backhauls plus other occasional audio
1386.700	Michigan News Network
1386.500	WJR-AM (760), Detroit, MI—talk radio, Detroit Tigers MLB radio network
1386.000	Occasional audio
1385.800	WMAQ-AM (670), Chicago, IL—news, Chicago White Sox MLB radio network
1385.500	Occasional audio
1385.100	For the People radio network
1384.800	KFMB-AM (760), San Diego, CA—news/talk radio, San Diego Padres MLB radio network
1384.500	Sports backhauls plus other Occasional audio
1384.400	Occasional audio
1384.200	KMPC-AM (710), Los Angeles, CA—sports talk radio, California Angels MLB radio network
1383.800	KOA-AM (850)/KTLK (760), Denver, CO—news/talk radio, Colorado Rockies MLB radio network
1383.400	KFRC-AM (610), San Francisco, CA—adult standards, Oakland A's MLB radio network
1383.200	KDKA-AM (1020), Pittsburgh, PA—news/talk radio, Pittsburgh Pirates MLB radio network
1383.000	Occasional audio
1382.800	Independent Broadcasters Network
1377.900	Occasional audio
1377.600	KUSC-FM (91.5), Los Angeles, CA—fine arts, National Public Radio (NPR) affiliate
1377.000	KUSC-FM (91.5), Los Angeles, CA—fine arts, National Public Radio (NPR) affiliate
1376.700	Radio Labio Network—spanish language programming
1375.400	USA Radio Network
1374.100	Northwest Direct—news/talk radio

Satcom K1 Transponder 12 (Ku-band)

1313.100	Customized IGA spots

Spacenet 3 Transponder 1 (C-band)

1437.200	Associated Press (AP) 3 radio network
1435.000	Associated Press (AP) 2 radio network
1433.400	Associated Press (AP) 1 radio network

Spacenet 3 Transponder 13 (C-band)

1207.900	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.650	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.450	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1207.200	Good News Radio Network—christian radio
1207.000	Good News Radio Network—christian radio
1206.700	Data Transmission
1206.550	ABC-Satellite Music Network—adult contemporary, Starstation
1206.300	ABC-Satellite Music Network—adult contemporary, Starstation
1206.000	ABC-Satellite Music Network—modem country, Country Coast-to-Coast
1205.850	ABC-Satellite Music Network—modem country, Country Coast-to-Coast
1205.650	ABC-Satellite Music Network—traditional music format, Stardust
1205.400	ABC-Satellite Music Network—traditional music format, Stardust
1204.450	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1204.250	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious
1203.550	Salem Radio Network—religious
1203.350	Salem Radio Network—religious
1203.150	Salem Radio Network—religious
1203.000	ABC-Satellite Music Network—urban contemporary, The Touch
1202.800	ABC-Satellite Music Network—urban contemporary, The Touch
1202.250	ABC-Satellite Music Network—golden oldies format, Pure Gold
1202.100	ABC-Satellite Music Network—golden oldies format, Pure Gold
1201.900	ABC-Satellite Music Network—modem rock, The Heat
1201.700	ABC-Satellite Music Network—modem rock, The Heat
1201.500	ABC-Satellite Music Network—Classic Rock
1201.300	ABC-Satellite Music Network—Classic Rock

Galaxy 4 Transponder 1 (C-band)

1444.450	Data transmissions
1443.800	Voice of Free China (ISWBC)
1443.600	WYFR, Oakland, CA "Family Radio Network" (ISWBC)—religious programming/talk
1443.400	Voice of Free China (ISWBC)
1443.200	WYFR, Oakland, CA "Family Radio Network" (ISWBC)—religious programming/talk
1438.300	WWRV-AM (1330), New York, NY—Spanish religious programming/music, ID-"Radio Vision Christiana de Internacional"
1428.100	National Public Radio (NPR) feeds
1427.800	Occasional audio
1421.700	Data transmissions
1418.250	Data transmissions
1417.800	Data transmissions
1417.500	Data transmissions

Galaxy 4 Transponder 2 (C-band)

1403.400	Data transmissions
1402.600	WVAQ-FM (101.9), Morgantown, WV—West Virginia Metro News
1402.000	WVAQ-FM (101.9), Morgantown, WV—West Virginia Metro News
1399.000	Occasional audio
1398.800	Progressive Farmers Network
1398.400	WBNS-FM (97.1), Columbus, OH—oldies, ID - "B-97"
1398.200	Occasional audio
1398.000	Oklahoma News Network
1397.600	Agri Broadcasting Network (Ohio). WBNS-FM (97.1), Columbus, OH—oldies, ID - "B-97"
1397.400	WKNR-AM (1220), Cleveland, OH—sports talk, Cleveland Indians MLB radio network
1397.200	Occasional audio
1394.400	WWL-AM, New Orleans, LA—talk radio, Louisiana Network

Galaxy 4 Transponder 3 (C-band)

1405.300	WFMT-FM (98.7), Chicago, IL—fine arts, Beethoven RadioNetwork
1405.000	Mutual Broadcasting System—some syndicated talk shows and news cuts
1404.800	KOA-AM (850)/KTLK-AM (760)—news/talk, Colorado Rockies MLB radio network
1404.600	ABC Information network programming, Paul Harvey
1404.400	ABC Information network programming, auto racing news, Tennessee Radio Network farm news
1404.000	ABC Information network programming, auto racing news, Tennessee Radio Network farm news
1403.800	WNTL-AM (1030), Indian Head, MD - multicultural programming
1403.500	International Broadcasting Network—Lutheran religious programming, Home Front program (Sat 10a-2p)
1403.000	Minnesota Public Radio Network
1402.400	WFMT-FM (98.7), Chicago, IL—fine arts, Beethoven Radio Network
1402.100	KNOW-FM (95.3), St. Paul, MN—fine arts, Minnesota Public Radio
1401.800	BBC World Service
1398.300	KRLD-AM (1080), Dallas, TX—talk radio, Texas Radio Network
1398.000	ABC Radio News (Standard) Occasional audio
1397.800	KTRH-AM (740), Houston, TX—news/talk radio, Houston Oilers NFL/Houston Rockets NBA radio networks
1397.500	Minnesota Talking Book Network
1397.300	WFBC-AM/FM (1330/93.7), Greenville, SC—news/talk/oldies, Clemson University sports flagship
1397.100	KPRC-AM (950), Houston, TX—news/talk radio, Houston Astros MLB radio network
1396.900	Spanish Information Service (SIS) radio network (Spanish)
1396.700	ABC Radio News (Standard), Tennessee Radio Network plus other occasional audio
1396.400	Georgia Network News
1396.200	WCNN-AM (680), Atlanta, GA—all sports talk radio
1396.000	WHUR-FM (96.3), Washington, DC—urban contemporary

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1395.800	ABC Radio News (Standard), Occasional audio
1395.500	American Public Radio - Monitor Radio programming
1395.100	National Public Radio (Channel 12)
1394.400	National Public Radio (Channel 11)
1394.000	National Public Radio (Channel 10), American Public Radio carrying Monitor Radio programming
1392.920	Occasional audio
1392.600	National Public Radio (Channel 9), American Public Radio
1392.300	National Public Radio (Channel 8)
1392.000	Cadena Radio Centro (CRC)—Spanish language music/talk
1391.700	National Public Radio (Channel 7)
1391.400	Weak carrier of Cadena Radio Centro (CRC)—probably a backhaul channel for CRC
1391.100	Associated Press (AP) radio network—news
1389.200	Occasional audio
1388.900	Data transmissions (burst)
1388.400	KSJV-FM (91.5), Fresno, CA—spanish programming, ID - Radio Bilingue (network serving stations in several western states)
1388.100	National Public Radio (Channel 6)
1387.800	Data transmissions (constant)
1387.500	National Public Radio (Channel 5)
1387.200	National Public Radio (Channel 4)
1386.200	KSJV-FM (91.5), Fresno, CA—spanish programming, ID - Radio Bilingue (network serving stations in several western states)
1385.800	National Public Radio (Channel 3) and occasional U.S. Naval Observatory Master Clock
1385.400	U.S. Naval Observatory Master Clock and National Public Radio (Channel 2)
1385.000	National Public Radio feeds
1384.700	National Public Radio (Channel 1)
1383.700	Mutual Broadcasting Network/Independent Network News (INN)
1383.400	KRLD-AM (1080), Dallas, TX—talk radio, Texas State News network
1383.100	Mutual Broadcasting System and VSA Radio Network—Ag news
1382.900	Minnesota Radio Network and Minnesota Twins MLB radio network
1382.600	Soldiers Radio Satellite (SRS) network—U.S. Army information and music
1382.300	Motor Racing Network (Occasional audio)
1382.000	WFAE-FM (90.7), Charlotte, NC—fine arts/jazz, NPR affiliate
1381.800	WHO-AM (1040), Des Moines, IA—talk radio
1378.400	Occasional audio
1378.200	WBAP-AM (820), Ft Worth, TX—talk radio/Texas Rangers MLB radio network, ID-"Newstalk 820"
1377.700	Minnesota Public Radio network
1377.400	Data transmission (packet burst/tones)
1377.100	In-Touch—reading service for blind
1376.800	Alabama Information Network (Alanet)
1376.000	Kansas Audio Reader Network
1375.800	Kentucky Network and Kentucky AgNet
1375.300	Occasional audio

Galaxy 4 Transponder 4 (C-band)

1387.500	Dakota Sports network plus other occasional audio
1387.100	Mutual Broadcasting System
1385.600	Louisiana Ag News network
1385.300	WFAN-AM (660), New York, NY— sports talk (Occasional audio) plus other occasional audio
1385.100	Mississippi Radio Network auxiliary channel
1384.800	Mississippi Radio Network
1382.400	Data transmissions
1381.800	Data transmissions
1379.000	Occasional audio
1378.600	Arkansas Radio Network
1378.800	WWL-AM, New Orleans, LA—talk radio, Louisiana Network
1378.100	Data Transmissions
1377.800	Bible Broadcasting Network—religious
1377.500	Bible Broadcasting Network—religious
1377.300	WWL-AM, New Orleans, LA—talk radio, Louisiana Network
1376.000	Data Transmissions
1375.600	KISN-AM (570), Salt Lake City, UT—sports talk, Salt Lake City Buzz AAA minor league baseball

Galaxy 4 Transponder 6 (C-band)

1346.900	WCRP-FM (88.1), Guayama, PR - religious/educational (Spanish)

Galaxy 4 Transponder 1 (Ku-band)

973.200	Data transmissions
971.100	Data transmissions
969.000	Data transmissions
968.400	Data transmissions
966.900	Data transmissions
959.700	Oldies music
959.500	Oldies music
959.200	Satellite Music Network, Real Country—country and western music
959.000	Satellite Music Network, Real Country—country and western music
958.800	Data transmissions
958.000	Data transmissions
957.900	Occasional audio
957.700	Russian-American Radio Network—foreign language audio service
957.500	Russian-American Radio Network—foreign language audio service

Anik E1 Transponder 11 (C-band)

1246.000	Radio Canada International
1245.500	Canadian Broadcasting Company (CBC) Radio - Yukon service
1243.800	Data transmissions

Anik E1 Transponder 13 (C-band)

1206.000	Canadian Broadcasting Company (CBC) Radio - southwestern Northwest Territories service
1205.500	Canadian Broadcasting Company (CBC) Radio - southwestern Northwest Territories service - Occasional carrier

Anik E1 Transponder 14 (C-band)

1166.000	Canadian Broadcasting Company (CBC) Radio - eastern Northwest Territories service

Anik E1 Transponder 17 (C-band)

1126.000	Canadian Broadcasting Company (CBC) Radio - northern Northwest Territories service
1125.500	Canadian Broadcasting Company (CBC) Radio - Newfoundland/Labrador service

Anik E1 Transponder 19 (C-band)

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

Anik E1 Transponder 21 (C-band)

1024.300	Weather Conditions/Warnings
1019.000	CKRW-AM (610), Whitehorse, Yukon Territory—adult contemporary/oldies. Note: This transponder also has 62 other carriers consisting of data transmissions and 6 blank audio carriers.

SBS5 Transponder 2 (Ku-band)

1001.000	Wal-Mart In-store Network
1009.800	Sam's Club Office Supplies In-store Network
1010.200	Sam's Club In-store Network
1010.600	Wal-Mart In-store Network

RCA C5 Transponder 3 (C-band)

1404.800	RFD Radio Service
1404.600	Wyoming News Network
1404.400	KNHN-AM (1340) Kansas City, KS—news/talk radio, ID - "CNN 1340 Voice of the Heartland"
1400.600	Brownfield Network plus other Occasional audio
1400.400	Brownfield Network plus other occasional audio
1400.200	Occasional audio
1400.000	Brownfield Radio Network plus other Occasional audio
1396.600	Kansas Information Network/Kansas Agnet
1396.400	Nebraska Ag Network
1396.200	KMOX-AM (1120), St. Louis, MO—news/talk radio, Missouri Network/St Louis Cardinals MLB radio network
1395.700	WIBW-AM (580), Topeka, KS—news/talk radio, Missouri Net/Kansas City Royals MLB radio network
1390.000	Occasional audio
1387.300	WPTF-AM (680), Raleigh, NC—news/talk radio
1387.100	KMOX-AM (1120), St. Louis, MO—news/talk radio, Missouri Network, St. Louis Cardinals MLB radio network plus other occasional audio
1386.900	Brownfield Network - Farm—Ag news
1386.200	Radio Iowa
1384.600	North Carolina News Network and Capitol Sports Network
1384.400	Occasional audio
1384.200	Occasional audio
1384.000	Occasional audio
1383.400	Occasional audio
1382.900	Missouri Network
1382.600	North Carolina News Network
1382.300	Virginia News Network
1378.700	Radio Pennsylvania Network
1378.500	Occasional audio
1378.300	Philadelphia Phillies MLB radio network, Radio Pennsylvania Network
1374.600	National Association of Broadcasters (NAB)—Occasional audio and various sports radio network broadcasts (Occasional audio)

RCA C5 Transponder 9 (C-band)

1281.000	Armed Forces Radio and Television Service (AFRTS) 2
1280.700	Armed Forces Radio and Television Service (AFRTS) 1

RCA C5 Transponder 21 (C-band)

1045.000	Los Angeles Dodgers MLB radio network (English)
1044.600	Occasional audio
1043.600	Unistar Radio—Today's Hits, Yesterday's Favorites
1043.400	CNN Radio Network
1043.200	Unistar Radio—Today's Hits, Yesterday's Favorites
1042.800	Unistar Radio—Original Hits
1042.600	Unistar Radio—Original Hits
1042.400	Unistar Radio—Good Times and Great Oldies
1042.200	Data Transmissions
1042.000	Unistar Radio—Good Times and Great Oldies
1041.800	CNN Radio Network
1035.200	Business Radio Network
1034.400	Unistar Radio—Hits from 60s, 70s, 80s, and Today
1034.200	Data transmissions
1034.000	Unistar Radio—Hits from 60s, 70s, 80s, and Today
1033.200	Unistar Radio—Country/Western
1032.800	Data Transmissions
1032.400	Unistar Radio—Country/Western
1032.100	Occasional audio
1031.400	Occasional audio
1031.200	Data Transmissions
1030.000	Occasional audio
1029.000	Occasional audio

Satellite Transponder Guide

By Robert Smathers

	Spacenet 2 (S2) 69 degrees	Satcom F2R (F2) 72 degrees	Galaxy 6 (G6) 74 degrees	Telstar 302 (T2) 85 degrees	Spacenet 3 (S3) 87 degrees	Galaxy 7 (G7) 91 degrees	Galaxy 3 (G3) 93 5 degrees	Telstar 401 (T1) 97 degrees	Galaxy 4 (G4) [illegible] degrees	Spacenet 4 (S4) 101 degrees	Telesat D1 (D1) 107.3 degrees
1	Data Transmissions	(none)	o/v	Data Transmissions	SCPC/FM2 (AP) services	BBC Breakfast News/o/v	o/v	Exxxtacy-adult [V2+]/Movie Greats Network/VTC	SCPC services	Data Transmissions	(none)
2	GEMS TV (Spanish) [V2+]	WRAL-CBS Raleigh [V2+]	o/v	o/v	Nebraska Educational TV	CBS-West [VC1]	SSN Empire [V2+]	(none)	SCPC services	Data Transmissions	(none)
3	USIA Worldnet TV	Madison Square Garden 2 [V2+]	SCPC services	o/v	WSBK-Ind Boston [V2+]	o/v	Data Transmissions	Parmount feeds/o/v	SCPC services	Data Transmissions	(none)
4	SUR (Spanish)	WABC-ABC New York [V2+]	o/v	o/v	Nebraska Educational TV	FX-East	Data Transmissions	FOX feeds	SCPC services	o/v	(none)
5	NASA Contract Channel	Main Street TV	NHK New York feeds	HBO2-East [V2+]	KTVT-Ind Dallas [V2+]	FX-West	RTP-Eurovideo [V2+]	o/v	o/v	Data Transmissions	(none)
6	Data Transmissions	Merchandise/ Entertainment TV	Univision feeds	Barry Bargain Home Shopping/o/v	(none)	o/v	Data Transmissions	Buena Vista TV feeds	National Christian Network (Rel)	o/v	Global TV feeds
7	(none)	American Infochannel	o/v	Satellite City Home Shopping/o/v	Data Transmissions	o/v	TV Asia [V2+]	FOX feeds-East	o/v	Data Transmissions	(none)
8	Data Transmissions	WPLG-ABC Miami [V2+]	o/v	o/v	Data Transmissions	Phoenix Grylnd. Pk/o/v [Leitch]	Las Vegas TV Network/o/v [V2+]	PBS-X	Telemundo (Spanish)	o/v	(none)
9	NASA Select TV	o/v	MuchMusic	HBO3-East [V2+]	WPIX-Ind New York [V2+]	o/v	Antenna Satellite TV Network [V2+]	FOX feeds	o/v	3 Angels Broadcasting (Rel)	o/v
10	Data Transmissions	WUSA-CBS Washington [V2+]	Arab Network of America (ANA)	o/v	Data Transmissions	o/v	ESPN Internatioanal [B-MAC]	FOX feeds	CFTM TV (French)	o/v	(none)
11	Canal de Noticias-NBC (Spanish)	Home Shopping Club (HSC)	Data Transmissions	o/v	CNN feeds	Estacion Montellano (Spanish rel)/o/v	Keystone International (Rel)	ABC feeds	o/v	Data Transmissions	o/v
12	Data Transmissions	WXIA-NBC Atlanta [V2+]	o/v	Data Transmissions	Data Transmissions	VSN/o/v [B-MAC]	University Network Dr Gene Scott (Rel)	ABC feeds	o/v	o/v	CTV
13	Data Transmissions	Outdoor Channel	o/v	FLIX [V2+]	SCPC/FM2 services	o/v [B-MAC]	Video Catalog Channel-VCC	FOX feeds-East	o/v	Data Transmissions	(none)
14	Data Transmissions	WBZ-NBC Boston [V2+]	Cornerstone-TV WPCB (Rel)	HBO2-West [V2+]	CNN [Leitch]	Familynet	o/v	FOX feeds-West	Telemundo feeds (Spanish)/o/v	Data Transmissions	(none)
15	Data Transmissions	Natl Program Svc Preview Channel	o/v	Cupid Network TV [V2+]	KTLA-Ind Los Angeles [V2+]	o/v	Video Catalog Channel-VCC	Prostar Sports	World Harvest TV (Rel)	Data Transmissions	o/v
16	Data Transmissions	SSN KBL [V2+]	o/v	o/v	CNN International [Leitch]	o/v [B-MAC]	ESPN International [B-MAC]	Exxxtacy Promo Channel/o/v	CBS-West [VC1]	Data Transmissions	CTV
17	Data Transmissions	Newsport [V2+]	Tokyo BS New York feeds	All News Channel [V2+]	FM2/WEFAX services	Dubai TV	Shop at Home-SAH	o/v	CBS-East [VC1]	Data Transmissions	(none)
18	(none)	SC Philadelphia [V2+]	o/v	TV Erotica/o/v [V2+]	Shop at Home-SAH	CBS feeds/o/v [B-MAC]	ABC feeds [Leitch]/o/v	N.C. Open Net/o/v	CBS feeds [VC1]/o/v	Data Transmissions	o/v
19	Data Transmissions	NHK New York feeds	o/v	o/v	SSN Sportsouth [V2+]	CBS-East [VC1]	Via TV Shopping	o/v	CBS-East [VC1]	Data Transmissions	(none)
20	AFRTS [B-MAC]	NHK Tokyo feeds/o/v	CNN Headline News Clean Feed [V2+]	La Cadena de Milagro (Spanish Rel)	o/v	Natl Empowerment TV	o/v	ABC feeds [Leitch]	CBS-East [VC1]	Data Transmissions	MuchMusic
21	(none)	New England Cable News (NECN)	Penn Natl Rack Track/o/v [Oak]	Cinemax 2-East [V2+]	SSN Pass [V2+]	TV1	America's Collectables Network	ABC-East [Leitch]	Warner Brothers/o/v	Data Transmissions	(none)
22	(none)	SC New York [V2+]	Belmont Park Horse Racing/o/v[B-MAC]	o/v	Data Transmissions	Superior Livestock Auction/o/v	o/v	ABC-West [Leitch]	o/v	Data Transmissions	(none)
23	(none)	SC New England [V2+]	o/v	Showtime 2 [V2+]	SSN HTS [V2+]	o/v	Access America/o/v	ABC feeds [Leitch]	Ostrich-Emu TV/RAI/o/v	Data Transmissions	o/v
24	Oata Transmissions	New York Plus/o/v [V2+]	Pimlico Track Horse Racing/o/v [Leitch]	o/v	(none)	Major League Baseball Intl /o/v [VC1]	o/v	o/v	CBS Newsnet/feeds	Data Transmissiosn	CTV

Satellite Transponder Guide

Solidaridad 1 (SD1) 109.2 degrees	Telesat E1 (A2) 111 degrees	Morelos 2 (M2) 116.8 degrees	Telstar 303 (T3) 123 degrees	Galaxy (G5) 125 degrees	ASC 1 (A1) 128 degrees	Satcom C3 (F3) 131 degrees	Galaxy 1R (G1) 133 degrees	Satcom C4 (F4) 135 degrees	Satcom C1 (F1) 137 degrees
(none)	Data Transmissions	Data Transmissions	TVN Theater 1 [V2+]	Disney-East [V2+]	(none)	Family Channel-West [V2+]	Comedy Central-West [V2+]	American Movie Classics [V2+]	o/v
SCPC services	The Sports Network [Oak]	Data Transmissions	TVN Theater 2 [V2+]	Playboy [V2+]	o/v	The Learning Channel	Galavision (Spanish)	Request TV-PPV [Digicipher]	KUSA-ABC Denver [V2+]
SCPC services	Data SCPC	Data Transmissions	TVN Theater 3 [V2+]	Trinity Broadcasting (Rel)	Data Transmissions	Viewer's Choice-PPV [V2+]	Encore [V2+]	Nickelodeon-East [V2+]	KRMA-PBS Denver [V2+]
(none)	Data SCPC	Data Transmissions	TVN Theater 4 [V2+]	Sci-Fi [V2+]	o/v [B-mac]	Lifetime-West [V2+]	TV Food Network	Lifetime-East [V2+]	SC Pacific [V2+]
XHIMT canal 7	Data SCPC	Data Transmissions	TVN Theater 5 [V2+]	CNN [V2+]	Data Transmissions	VISN/ACTS (Rel)	Classic Arts Showcase	Deutsche Welle TV (German)	KDVR-Fox Denver [V2+]
(none)	WDIV-NBC Detroit [Oak]	Data Transmissions	TVN Theater 6 [V2+]	WTBS-Ind Atlanta [V2+]	Data Transmissions	Court TV	Z-Music	Madison Square Garden 1 [V2+]	KMGH-CBS Denver [V2+]
o/v	Data SCPC	Data Transmissions	TVN Theater 7 [V2+]	WGN-Ind Chicago [V2+]	Christian TV Network (Rel)	C-SPAN 1	Disney-West [V2+]	Bravo [V2+]	SSN Primeticket [V2+]
Telemax	CHCH-Ind Hamilton [Oak]	XHGC canal 5	TVN Theater 8 [V2+]	HBO-West [V2+]	American Independent Network	QVC Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East
o/v	The Weather Network	XHFM Super Canal [B-MAC]	TVN Theater 9/CVS [V2+]	ESPN [V2+]	Data Transmissions	Music Choice	ESPN2 Blackout [V2+]/SAH	QVC Network	o/v
Mexican Parliment	WXYZ-ABC Detroit [Oak]	SEP	Data Transmissions	MOR Music	Data Transmissions	Home Shopping Club 2	America's Talking	Home Shopping Club 1	SSN HSE [V2+]
(none)	CBC North-Pacific feed	CMC [B-MAC]	Data Transmissions	Family Channel-East [V2+]	National Access TV/o/v	Prime Network [V2+]	Eternal Word TV Network (Rel)	The Box	Network One 'N1'
Data Transmissions	WJBK-CBS Detroit [Oak]	Data Transmissions	Data Transmissions	Discovery-East [V2+]	Worship TV (Rel)	Music Choice	Valuevision	Nustar	o/v
Q-CVC	CBC Newsworld [Oak]	XEIPN canal 11	o/v	CNBC [V2+]	Data Transmissions	The Weather Channel [V2+]	Encore [Digicipher]	Travel Channel	SC Chicago [V2+]
Data Transmissions	WTVS-PBS Detroit [Oak]	XEW canal 2	o/v	ESPN2 [V2+]	o/v	New England Sports Network [V2+]	ESPN Blackout [V2+]/SAH	Cable Health Club	KCNC-NBC Denver [V2+]
(none)	CBFT-CBC (French)	Data Transmissions	Data Transmissions	HBO-East [V2+]	Data Transmissions	Showtime-East [V2+]	Shop at Home-SAH	WWOR-Ind New York [V2+]	SC Ohio/Florida/Cincinnati [V2+]
Data Transmissiosn	Global TV [Leitch]	Multivision	(none)	Cinemax-West [V2+]	o/v	MTV-West [V2+]	Turner Classic Movies [V2+]	Request TV 1 [V2+]	Newsport [V2+]
o/v	o/v	o/v	Adam & Eve-adult [V2+]	TNT [V2+]	Data Transmissions	Movie Channel - East [V2+]	The New Inspirational Network (Rel)	MTV-East [V2+]	SSN [V2+]
(none)	CITV-Ind Edmonton [Oak]	(none)	(none)	TNN [V2+]	(none)	Nickelodeon-West [V2+]	HBO Multiplex [Digicipher]	Viewer's Choice [Digicipher]	SSN Sunshine Blackout [V2+]/o/v/STEP
(none)	TV Northern Canada	CNI News	Spice 2-adult [V2+]	USA-East [V2+]	Data Transmissions	Viacom [Digicipher]	Cinemax-East [V2+]	C-SPAN 2	FoxNet
(none)	CBMT-CBC (English)	Data Transmissions	Spice/TVN Theater 10-adult [V2+]	BET	Channel America	Product Information Network	Action-PPV [V2+]	Showtime-West [V2+]	International Channel [V2+]
XEQ canal 9	SCPC services	o/v	(none)	MEU	(none)	Comedy Central-East [V2+]	USA-West [V2+]	Discovery-West [V2+]	Prime Ticket [Digicipher]
Caliente Jai Alai/greyhound racing	BCTV-CTV Vancouver [Oak]	(none)	(none)	CNN/HN [V2+]	Midwest Sports Channel [V2+]	Americana TV [V2+]	Nostalgia Channel	Movie Channel-West [V2+]	SSN PSNW [V2+]/o/v/STEP
o/v	CBC North-Atlantic feed	Tele Hit	o/v	A&E [V2+]	(none)	E! Entertainment TV [V2+]	(none)	VH-1 [V2+]	KWGN-Ind Denver [V2+]
(none)	TV5 (French)	XHDF canal 13	TVN Preview Channel	Viacom [Scientific Atlanta]	Data Transmissions	Digital Music Express Radio	Univision (Spanish)	CMT [V2+]	SSN Sunshine [V2+]

Unscrambled/ non-video

Subscription

Not available in U.S.

o/v = occasional video

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

Satellite	Mode	Frequencies																
OSCAR 13 (AO-13) (Note 1)	B (u/V)	Dn	145.828	838	848	858	868	878	888	898	908	918	928	938	948	958	968	145.978
		Up	435.570	560	550	540	530	520	510	500	490	480	470	460	450	440	430	435.420
	Bcns		145.812															145.985
	S (u/S)	Dn	2400.711	720	730	740	2400.747											
		Up	435.601	610	620	630	435.637											
	Bcn		2400.650															
OSCAR 10 (AO-10) (Note 2)	B (u/V)	Dn	145.825	835	845	855	865	875	885	895	905	915	925	935	945	955	965	145.975
		Up	435.179	169	159	149	139	129	119	109	099	089	079	069	059	049	039	435.029
	Bcn		145.910															

Satellite	Mode								
RS 10/11 (Notes 3, 4 & 5)	A (v/A)	Dn	29.360	370	380	390	29.400	Robot	29.403
		Up	145.860	870	880	890	145.900		145.820
	Bcn		29.357						
RS-12/13 (Notes 3, 6 & 7)	K (h/A)	Dn	29.410	420	430	440	29.450	Robot	29.454
		Up	21.210	220	230	240	21.250		21.129
	Bcn		29.408						

Satellite	Mode					
UoSat 11 (UO-II)	Bcns	Dn	145.826	435.025	2401.500	
		Up	None			
PACSAT (AO-16) (Notes 8, 9 & 12)	[a]	Dn	437.025 (Sec)	437.050		
		Up	145.900	145.920	145.940	145.960
DOVE (DO-17) (Notes 10 & 12)	[b,c]	Dn	145.825	2401.220		
		Up	None			
WEBERSAT (WO-18) (Note 12)	[a]	Dn	437.075	437.100 (Sec)		
		Up	None			
LUSAT (LO-19) (Notes 8 & 12)	[a]	Dn	437.125	437.150 (Sec)		
		Up	145.840	145.860	145.880	145.900

Satellite	Mode												
JAS-Ib (FO-20) (Note 12)	JA Linear	Dn	435.800	810	820	830	840	850	860	870	880	890	435.900
		Up	146.000	990	980	970	960	950	940	930	920	910	145.900
	Bcn		435.795										
	JD [a] Dgtl	Dn											435.910
		Up	145.850	145.890	145.910								

Amateur Satellite Frequency Guide

Satellite	Mode		Frequencies									
OSCAR 21 (RS-14) Trans. #1	B (u/V) Linear	Dn	145.852	860	870	880	890	900	910	920	930	145.932
		Up	435.102	094	084	074	064	054	044	034	024	435.022
(Notes 11 & 12)	Dgtl	Dn								145.983		
		Up	435.016	435.155		435.193		435.041				
	Bcns		145.819						145.952		145.983	
Trans. #2	B (u/V)	Dn	145.866	870	880	890	900	910	920	930	940	145.946
		Up	435.123	119	109	099	089	079	069	059	049	435.043
	Bcns		145.800	145.838	145.948							
OSCAR 22 (UO-22)	[c]	Dn		435.120								
		Up	145.900		145.975							
KITSAT A (UO-23)	[c]	Dn		435.173								
		Up	145.850		145.900							
KITSAT B (KO-25)	[c]	Dn	435.175		436.500							
		Up	145.870	145.980								
IT-AMSAT (IO-26)	[a,c]	Dn		435.820 (Sec.)	435.867							
		Up	145.875	145.900	145.925	145.950						
EYESAT /AMRAD (AO-27)	[b,a]	Dn	436.800									
		Up	145.850									
POSAT (PO-28) (Note 13)	[c]	Dn	435.250	435.280								
		Up	145.925	145.975								
MIR	[b]	Up & Dn & FM voice		145.550								
ARSENE (Note 14)												

NOTES

1. AO-13 carries a 70 cm trammitter for Modes J and L. However, this transmitter failed in mid-1993 and has been inoperative since.
2. The AO-10 beacon is an unmodulated carrier. This satellite has suffered computer damage making it impossible to orient the satellite for optimum service or solar illumination. In order to preserve it as long an possible, do not transmit to it when you hear the beacon FMing.
3. RS-10/11 and RS-12/13 are each mounted on common spaceframes, along with comunication and navagation packages.
4. RS-10 has been in Mods A for some months, but also has capability for Mode T (21.160-21.200 Uplink, 145.860-145.900 Downlink), Mode K (21.160-21.200 Uplink, 29.360-29.400 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.
5. RS-11 is currently tumed off. If activated, it has capability for Mods A (145.910-145.950 Uplink, 29.410-29.450 Downink), Mode T (21.210-21.250 Uplink, 145.910-145.950 Downlink), Mode K (21.210-21.250 Uplink, 29.410-29,450 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.
6. RS-12 has been in Mode K for some months, but also has capability for Mode A (145.910-145.950 Uplink, 29.410-29.450 Downlink), Mode T (21.210-21.250 Uplink, 145.910-145.950 Downlink) an well as combined Modes K/A and K/T using these same frequency combinations.
7. RS-13 is currently tumed off. If activated, it has capability for Mode A (145.960-146.000 Uplink, 29.460-29.500 Downlink), Mode K (21.260-21.300 Uplink, 29.460-29.500 Downlink), Mode T (21.210-21.250 Uplink, 145.960-146.000 Downlink) as well as combined Modes K/A and K/T using these same frequency combinations.

S. Transmitters on both AO-16 & LU-19 are currently using Raised Cosine Mode.

9. AO-16 users are encouraged to select 145.900, 145.920 and 145.940 for uploading and 145.960 for directory and/or file requests.
10. DOVE is designed to transmit digital voice messages, but due to hardware and software difficulties, it has not yet met this objective except for a few short tests. Recently, it has been transmitting telemetry in normal AX-25 AFSK packet.
11. The AO-21 RUDAX supports a number of digital modes. Recently, it has been used in a "bent pipe" DSP experiment which permits conventional FM signals to be processed and retransmitted as conventional FM signals. This provides a single channel "repeater-like" capability. This Mode is periodically interrupted for telemetry and other digital transmissions, somtimes including digitized voice.
12. Letters in [ ] represent digital formats, as follows:
    [a] 1200 bps PSK AX-25
    [b] 1200 bps AFSK AX-25
    [c] 9600 bps FSK
    [d] Digitized voice (Notes 8 & 9)
13. PO-28 is available to amateurs on an intermittent, unscheduled basis.
14. Arsene has experienced failures of both 2 meter and S Band downlinks.

Compiled by

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

Ku-band Satellite Transponder Services Guide

By Robert Smathers

Spacenet 2 (S2) 69 degrees

19	11740	
20	11820	
21	11900	TV ASAHI [Leitch]
22	11980	Occasional video
23	12060	The Kentucky Network (educ)
24	12140	

SBS 2 (SBS2) 71 degrees (Inclined Orbit) (Occasional video on all transponders)

SBS 3 (SBS3) 74 degrees (Inclined Orbit) (Occasional video on all transponders)

SBS 4 (SBS4) 77 degrees (Inclined orbit) (Occasional video on all transponders)

Satcom K2 (K2) 81 degrees

1	11729	NBC-East
2	11758.5	Data Transmissions
3	11788	NBC-Pacific (Spot Beamed to West Coast)
4	11817.5	Cyclesat
5	11847	NBC-Contract Channel
6	11876.5	Occasional video
7	11906	(none)
8	11935.5	North American Chinese TV Network [Oak]
9	11965	NBC-Mountain
10	11994.5	(none)
11	12024	NBC-Contract Channel
12	12053.5	FM2 Services
13	12083	NBC-NBC NewsChannel
14	12112.5	Occasional video
15	12142	NBC-Contract Channel
16	12171.5	(none)

Satcom K1 (K1) 85 degrees

1	11729	(none)
2	11758.5	Primestar DBS [Digicipher]
3	11788	Primestar DBS [B-MAC]
4	11817.5	Primestar DBS [B-MAC]
5	11847	Primestar DBS [Digicipher]
6	11876.5	Primestar DBS [Digicipher]
7	11906	Digital SCPC
8	11935.5	Primestar DBS [B-MAC]
9	11965	Primestar DBS [B-MAC]
10	11994.5	Primestar DBS [Digicipher]
11	12024	Primestar DBS [Digicipher]
12	12053.5	Primestar DBS [B-MAC]
13	12083	Primestar DBS [B-MAC]
14	12112.5	(none)
15	12142	Primestar DBS [B-MAC]
16	12171.5	Primestar DBS [B-MAC]

Spacenet 3R (S3) 87 degrees

19	11740	(none)
20	11820	(none)
21	11900	(none)
22	11980	(none)
23	12060	Oregon Educational Network (West Spot Beam)
24	12140	NYNET (SUNY) Ed Net/NY Lottery feeds (East Spot Beam)

Galaxy 7 (K7) 91 degrees

1	11720	Occasional video
2	11750	(none)
3	11750	Compressed Video
4	11780	Occasional video
5	11810	(none)
6	11810	(none)
7	11840	Occasional video
8	11870	(none)
9	11870	(none)
10	11900	Occasional video
11	11930	Occasional video
12	11930	Asian American TV Network
13	11960	Occasional video
14	11990	Occasional video
15	11990	The Asian Network (TAN)/Occasional video
16	12020	(none)
17	12050	Westcott Communications/FETN [ITC] and ASTN [B-MAC]
18	12050	Occasional video
19	12080	BBC 9pm News (PAL)/Occasional video
20	12110	(none)
21	12110	(none)
22	12140	Occasional video
23	12170	(none)
24	12170	(none)

GSTAR-3 (GST3) 93 degrees (Inclined Orbit)

1	11730	SCPC Transmissions
2	11791	(none)
3	11852	Occasional video
4	11913	Occasional video
5	11974	Data Transmissions
6	12035	(none)
7	12096	ID Channel
8	12157	(none)
9	11744	Data Transmissions
10	11805	(none)
11	11866	(none)
12	11927	(none)
13	11988	Data Transmissions
14	12049	(none)
15	12110	ID Channel
16	12171	(none)

SBS 6 (SBS6) 95 degrees

1	11717	(none)
2	11749.5	SCPC Transmissions
3	11774	Occasional video
4	11798.5	Occasional video
5	11823	Comsat Video Enterprises [B-MAC]
6	11847.5	Comsat Video Enterprises [B-MAC] (half-transponders)
7	11872	CONUS Communications (half-transponders)
8	11896.5	Comsat Video Enterprises [B-MAC] (half-transponders)
9	11921	(none)
10	11945.5	Comsat Video Enterprises [B-MAC] (half-transponders)
11	11963	Occasional video
12	11994.5	CONUS Communications (half-transponders)
13	12019	CONUS Communications (half-transponders)
14	12043.5	CONUS Communications (half-transponders)
15	12075	Occasional video
16	12092.5	Massachusetts Educational Network/Occasional video
17	12110	Comsat Video Enterprises [B-MAC]
18	12141.5	Comsat Video Enterprises [B-MAC] (half-transponders)
19	12174	Data Transmissions

Telstar 401 (T401) 97 degrees

1	11730	SCPC Transmissions
2	11743	National Tech University (Digital Video)
3	11790	South Carolina Educational TV
4	11798	Occasional video (half-transponders common)
5	11845	PBS [Digicipher]
6	11855	SERC/PBS Regionals/Stations (half-transponders)
7	11902	PBS Educational Services (half-transponders)
8	11915	PBS Stations/Regionals and Backhauls
9	11957.5	PBS Digital Video/SCOLA [Digicipher] and VSATs
10	11980.75	Louisiana Public TV feeds [Digicipher]
11	12040	Occasional video (half-transponders common)
12	12046	(none)
13	12095	(none)
14	12108	Georgia Public TV (half-transponders)
15	12147	ABC Affiliate and Network feeds (half-transponders)
16	12167	ABC Affiliate and Network feeds (half-transponders)

Galaxy 4 (K4) 99 degrees

1	11720	SCPC Services
2	11750	Data Transmissions
3	11750	FM2 Services/MUZAK
4	11780	FM2 Services
5	11810	(none)
6	11810	(none)
7	11840	National Weather Networks/Occasional video
8	11870	Occasional video
9	11870	Occasional video
10	11900	Occasional video
11	11930	Occasional video
12	11930	Channel One/Occasional video
13	11960	WMNB (Russian)/Occasional video
14	11990	Occasional video
15	11990	Occasional video
16	12020	FM2 Services
17	12050	CBS Newsnet and Affiliate feeds (half-transponders)
18	12050	Occasional video
19	12080	Legislature of British Columbia/Occasional video
20	12110	(none)
21	12110	Medical News Network/Occasional video
22	12140	Occasional video
23	12170	CBS Newsnet and Affiliate feeds (half-transponders)

Spacenet 4 (S4) 101 degrees

19	11740	(none)
20	11820	Occasional video
21	11900	(none)
22	11980	Occasional video
23	12060	(none)
24	12140	Occasional video

GSTAR-1 (GST1) 103 degrees

1	11730	Data Transmissions
2	11791	(none)
3	11852	Occasional video/BMAC Service
4	11913	(none)
5	11974	Data Transmission
6	12035	(none)
7	12096	Healthcare Satellite [B-MAC]/Video Compression
8	12157	(none)
9	11744	Data Transmissions
10	11805	(none)
11	11866	Occasional video
12	11927	(none)
13	11988	Occasional video
14	12049	(none)
15	12110	(none)
16	12171	(none)

GSTAR-4 (GST4) 105 degrees

1	11730	Data Transmissions
2	11791	Data Transmissions
3	11852	CNN Newsource (Primary) [Leitch]/some feeds ITC
4	11913	Occasional video
5	11974	Occasional video
6	12035	Occasional video
7	12096	CNN feeds/Occasional video
8	12157	Occasional video
9	11744	Data Transmissions
10	11805	(none)
11	11866	Occasional video
12	11927	Occasional video
13	11988	Occasional video
14	12049	(none)
15	12110	CNN Newsource (Secondary)
16	12171	(none)

Solidaridad 1 SD1 109.2 degrees (No video has been seen on any ku transponder)

Anik E1 (EI) 111 degrees

1	11717	Data Transmissions
2	11743	Telesat Services
3	11778	Partial Channel Services
4	11804	Partial Channel Services
5	11839	CBC Newsworld feeds
6	11865	NovaNet FM2 Services
7	11900	Video Compression Services
8	11926	Digital Video Services
9	11961	Alberta Access
10	11987	CBC Parliamentary Channel
11	12022	The Family Channel [Oak]
12	12048	CBC Newsworld
13	12083	MuchMusic
14	12109	SuperChannel [Oak]
15	12144	Knowledge Network
16	12170	Saskatchewan Cable Network
17	11730	(none)
18	11756	(none)
19	11791	(none)
20	11817	(none)
21	11852	Radio Quebec
22	11878	Quatre Saisons
23	11913	Canal Famille (V2+)
24	11939	Musique Plus
25	11974	La Chaine
26	12000	TV Ontario (English)
27	12035	Super Ecran (V2+)
28	12061	Ontario Legislature
29	12096	Reseau des Sports (V2+)
30	12122	The Family Channel (V2+)
31	12157	The Movie Network (V2+)
32	12183	Atlantic Satellite Network

Anik C3 (C3) 114.9 degrees (Inclined Orbit)
This satellite rarely has video transmissions

Morelos 2 (M2) 116.8 degrees (No video has been seen on any ku transponder)

SBS 5 (SBS5) 123 degrees

1	11725	Occasional video
2	11780	SCPC Services
3	11823	(none)
4	11872	(none)
5	11921	(none)
6	11970	Data Transmissions
7	12019	IBM Field TV Network [B-MAC]
8	12068	Occasional video
9	12117	Occasional video
10	12166	ID Channel/MegaBingo/Occasional video
11	11748	Data Transmissions
12	11898	Occasional video
13	11994	Occasional video
14	12141	Cal State Chico/Occasional video

GSTAR-2 (GST2) 125 degrees

1	11730	Data Transmissions
2	11791	Data Tranmissions
3	11852	Data Transmissions
4	11913	Occasional video
5	11974	SCPC Transmission
6	12035	CNN International [Leitch]
7	12096	Occasional video
8	12157	(none)
9	11744	Data Transmissions
10	11805	Occasional video
11	11866	Data Tranmissions
12	11927	Occasional video
13	11988	(none)
14	12049	CNN Airport Channel
15	12110	Occasional video
16	12171	Occasional video/CourtTV backhauls (half-transponders)

ASC-1 (ASC1) 128 degrees

19	11740	Occasional video
20	11820	Occasional video
21	11900	Occasional video
22	11980	Bluffs Run Greyhound/Occasional video
23	12060	Sears Videoconference Network [B-MAC]
24	12140	Occasional video

Feel The Comfort Of Extended Operations With The IC-T21A!

Maximum Comfort

Elastomer Construction – This special material provides a comfortable, positive grip. The compact design fits the natural curve of your fingers and hand – especially welcome during long operating times.

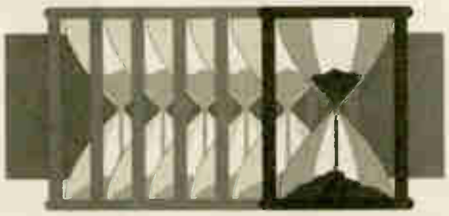
Backlit Keypad – Ample spacing between keys for positive, error free operation.

Large Display – Indicates 17 different functions, battery capacity and subband frequency.

Full Crossband Duplex Operation

Dual Band Receive Capability – Permits reception of another band (i.e.: 440 MHz on the IC-T21A).

Full Crossband Duplex Operation – Possible with the unique "whisper mode" microphone (standard) for telephone type QSO's.



6 Hours Operating Time*

Low Power Consumption – Consumes only 8 mA while standing by.

Auto Power Control – Conserves the battery by monitoring the repeater signal strength and selecting the best matching output power from 5 levels (down to 15 mW).

Auto Low Power Function – Automatically selects 15 mW just before battery exhaustion so you can complete your QSO.

* 5.5 to 6 hours with 1:1:8 duty cycle (Tx high : RX : Standby)

Battery Capacity Indicator – Shows battery capacity.

New Scanning Standards

Ultra High Speed Scan – 3 to 4 times faster than most other handhelds (33 channels/sec., 12.5 memory ch./sec.).

Bonus Band – Can be scanned while the main band is being scanned (e.g.: 70 cm for the IC-T21A).

6 Priority Watch Modes – Check for other signals while operating on a VFO frequency.

Ultra-Convenient Repeater Operations

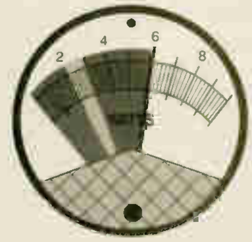
Subaudible Tone Scan – Detects, displays *and programs* the tone frequency into the VFO. Permits access to a repeater when you don't know the tone frequency.

Auto Repeater Function – Automatically activates repeater settings (duplex ON/OFF, duplex direction, tone encoder ON/OFF) when the operating frequency falls in the repeater output range.

Repeater Memory – Quickly recall settings of your last worked repeater (RPT-M key).

5 DTMF Memories – Automatically dial your favorite telephone numbers.

Selectable DTMF Transmission Speed – Adjust the IC-T21A/T41A to the capabilities of the repeater (5 cps, 2.5 cps, 1.6 cps, 1 cps).



Powerful 6 W Output Power*

Our newly designed SC-1257 power module provides all the power necessary to reach fringe areas. Accepts 4-16 V input.

* With a 13.5 V DC power source.

Innovative Memory Functions

114 Memory Channels – Store *all* repeater information.

Memory Select Channels – For quick access, up to 30 can be designated Memory Select Channels.

Memory Transfer – Quickly transfers a memory channel's contents to VFO. Useful for searching for signals near a memory channel.

EEPROM – Memory information is retained virtually forever.

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- Includes Flexible Antenna, Belt Clip, Handstrap, Rechargeable Ni-Cd Battery Pack and Charger
- Built-in Pager, Code Squelch, Pocket Beep & Tone Squelch

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SATELLITE LAUNCH REPORT

By Phillp 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 April, May, and June 1994. The format of the listing is as follows:

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

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

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

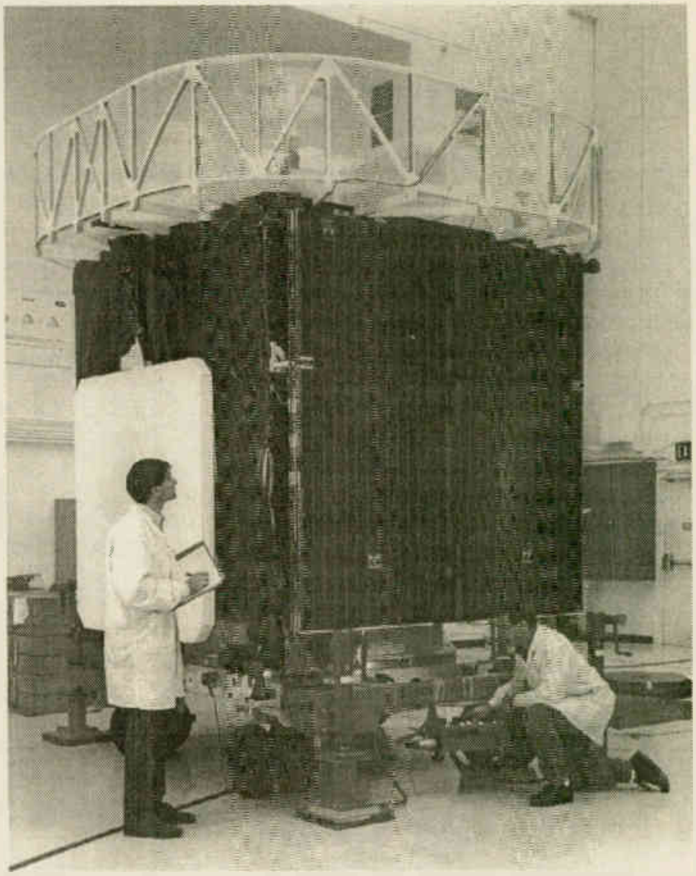
The *Satellite Times* "Satellite Launch Report" is extracted from more detailed monthly listings, "Worldwide Satellite Launches", compiled by Phillip S. Clark and published by Molniya Space Consultancy, 30 Sonia Gardens, Heston Middx TW5 0LZ United Kingdom

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1994 Apr 9/1105		1994-020A	Endeavour/STS-59	100,566 kg
1994 Apr 9.67	57.00 deg	88.88 min	213 km	225 km

Sixth flight of shuttle orbiter Endeavour (62nd shuttle launch), carrying six astronauts: Sydney M Gutierrez (commander), Kevin P Chilton (pilot), Jay Apt (mission specialist, MS-1), Michael R Clifford (MS-2), Linda M Godwin (payload commander and MS-3) and Thomas D Jones (MS-4). Major payload for the flight was SRL-1 ("Space Radar Lab"), mass 9,697 kg plus support equipment, 1,096 kg of which remained in the orbiter's payload bay. Launch from Kennedy Space Center, landed at Edwards Air Force Base Apr 20 at 1655 UTC.

1994 Apr 11/0749		1994-021A	Cosmos 2275	1,300 kg*
1994 Apr 12.27	64.82 deg	675.68 min	19,114 km	19,143 km
1994 Apr 11/0749		1994-021B	Cosmos 2276	1,300 kg*
1994 Apr 28.11	64.81 deg	675.81 min	19,060 km	19,203 km
1994 Apr 11/0749		1994-021C	Cosmos 2277	1,300 kg*
1994 Apr 18.60	64.80 deg	668.52 min	18,780 km	19,117 km

Three "Uragan" navigation satellites in the GLONASS series, each satellite is cylindrical. Operational lifetime of each satellite is expected to be about 5 years. Third stage of Proton-4 launch vehicle left in a 64.85 degrees, 87.65 minutes, 143-173 km orbit, fourth stage (Block DM-2) in an orbit similar to the satellites. Launched from Tyuratam.



A military satellite, UHF Follow-On F-3, undergoes mass property testing at Hughes Space and Communications Company facilities in El Segundo, Calif.

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1994 Apr 13/0604		1994-022A	GOES 8	2,105 kg
1994 Apr 13.55	27.41 deg	769.66 min	164 km	42,720 km
1994 Apr 23.40	0.80 deg	1,466.38 min	30,016 km	42,739 km
1994 May 11.67	0.41 deg	1,435.89 min	35,634 km	35,931 km

Satellite called GOES I ("Geostationary Operational Environmental Satellite") prior to launch, part of US National Oceanic & Atmospheric Administration's (NOAA) program to provide synoptic visible and infra- red imaging and an infra-red/thermal sounding for atmospheric temperature profiles. Prime spacecraft contractor is Space Systems/ Loral. Initial placement during checkout over 270 degress east, to be followed by re-location to its operational longitude of 285 degrees east. Expected operational lifetime is about 5 years. Second stage (Centaur) of Atlas-1 launch vehicle left in the following orbit: 27.41 deg, 758.81 min, 113-42,247 km. Launched from Cape Canaveral.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Mass Perigee	Apogee
1994 Apr 23/0702	1994-023A	Cosmos 2278		9,000 kg*
1994 Apr 24.68	71.01 deg	101.97 min	849 km	855 km

Payload is believed to be an ELINT satellite, built by NPO Yuzhnoye in the Ukraine. Orbital plane of the satellite is 40 degrees to the west of Cosmos 2263 launched in September 1993. Operational lifetime is expected to be about 3 years. Second stage of Zenit-2 launch vehicle is in an orbit similar to that of the payload. Launched from Tyuratam.

1994 Apr 26/0114	1994-024A	Cosmos 2279		825 kg*
1994 Apr 27.46	82.95 deg	104.73 min	957 km	1,007 km

Military "Parus" navigation satellite, co-planar with Cosmos 2180. Operational lifetime is expected to be about 3 years. Second stage of intermediate Cosmos launch vehicle is in an orbit similar to that of the satellite.Launched from Plesetsk.

1994 Apr 28/1614	1994-025A	Cosmos 2280		7,000 kg*
1994 Apr 28.84	70.38 deg	89.26 min	186 km	290 km
1994 Apr 29.46	70.38 deg	89.98 min	241 km	306 km

Fifth generation photoreconnaissance satellite. Expected to remain operating in orbit for about a year. Third stage (Block I) of Soyuz launch vehicle in an orbit similar to the first one listed above. Launched from Tyuratam.

1994 May 3/1555	1994-026A	USA 103		8,000 kg*
No orbital data available				

Classified payload, launched for the US Department of Defense: payload is believed to be a SIGINT satellite, possibly in the Advanced Jumpseat series similar to the shuttle-deployed satellites 1989-061B (USA 40 deployed from STS-28R) and 1992-086B (USA 89 deployed from STS-53). Satellite might bave been placed in a "Molniya-type" orbit, and has been estimated to be 64.4 deg, 718.0 min, 1,325-39,035 km. Third stage (Centaur) of the Titan-4 launch vehicle is probably in a similar orbit. Launched from Cape Canaveral.

1994 May 4/0000	1994-027A	SROSS C2		113 kg
1994 May 4.25	46.03 deg	98.30 min	433 km	922 km

Second successful launch of a SROSS ("Stretched Rohini Satellite Series") in four launches (SROSS 1 was lost on the first ASLV flight on 1987 Mar 24, the second lost on the next flight on 1988 Jul 13 and the third SROSS C reached orbit on 1992 May 20). Satellite carries two payloads: a Gamma Ray Burst experiment for astronomical observations and a Retarding Ray Burst experiment for astronomical observations and a Retarding Potential Analyser to investigate the characteristics of the equatorial and low-latitude ionosphere and thermosphere. Fourth stage of ASLV is in an orbit similar to that of the satellite. Launched from Sriharikota.

1994 May 9/0247	1994-028A	MSTI 2		117 kg
1994 May 10.64	96.94 deg	92.61 min	357 km	448 km

Second launch of a MSTI ("Miniature Seeker Technology Integration") satellite. Carries a platinum-silicide camera and an indium-antimonide instrument with six filters using a gimballed mirror which will allow the tracking of fixed targets and ballistic missiles. Planned lifetime is six months, although this might be extended up to 18 months. Fourth stage of Scout launch vehicle (the last flight of the Scout) is in an orbit similar to the satellite. Launched from Vandenburg.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Mass Perigee	Apogee
1994 May 19/1703	1994-029A	STEP 2 (P91-A)		180 kg
1994 May 19.89	81.96 deg	99.02 min	603 km	821 km

STEP 2 ("Space Test Experiment Platform") carries the SIDEX ("Signal Identification Experiment") and was planned to work with TEX (1990-031B) and REX (1991-045A) satellites. Pegasus launch vehicle deployed from B-52 aircraft after take-off from Edwards Air Force Base: fourth stage is in an orbit similar to that of the satellite.

1994 May 20/0201	1994-030A	Gorizont 30		2,125 kg*
1994 May 21.03	1.37 deg	1,389.78 min	34,731 km	35,019 km
1994 May 29.27	1.33 deg	1,435.76 min	35,773 km	35,787 km

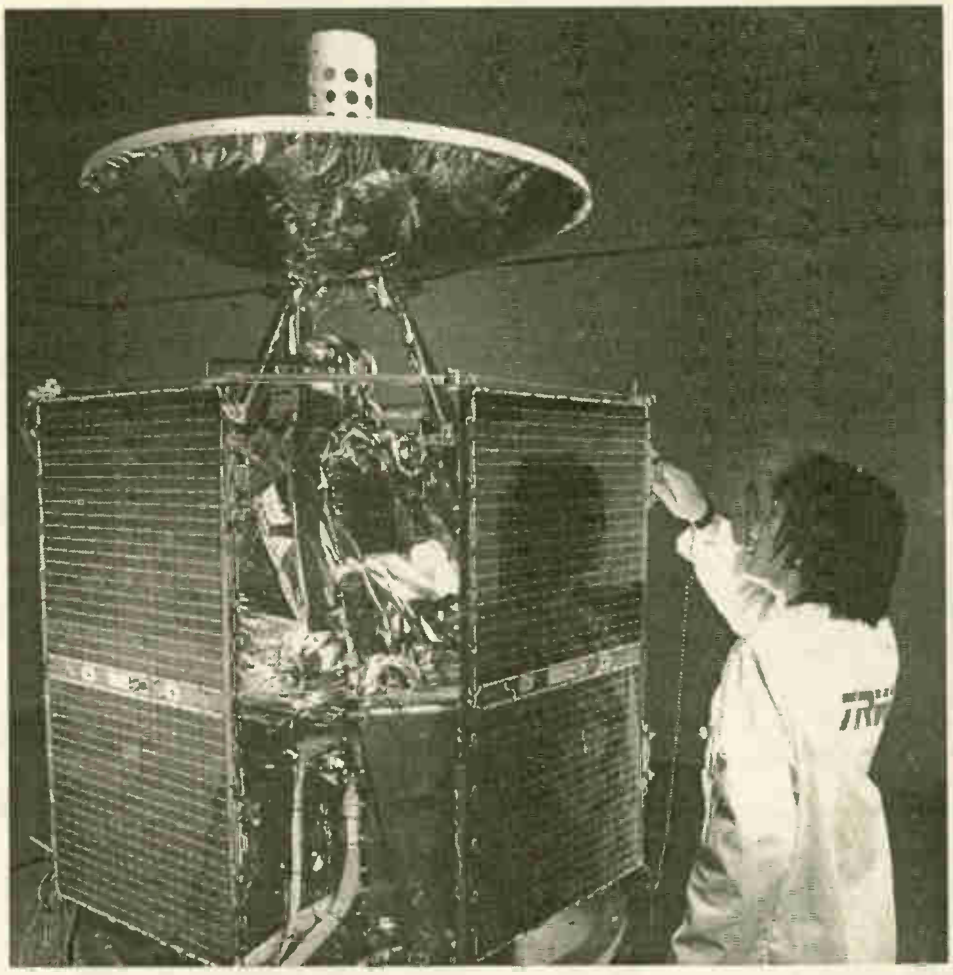
Communications satellite, referred to as "Gorizont 42" in some Russian literature: also known as RIMSAT 2. Like Gorizont 29, the satellite was immediately leased to the RIMSAT Corporation in the USA after launch, with deployment planned over 142.5 degrees east. The stabilized orbit shown above has the satellite over 142 degrees east. This is the final Gorizont to be assigned to RIMSAT. Satellite expected to remain operational for about five years. Third stage of Proton-4 launch vehicle left in the following orbit: 51.66 deg, 88.31 min, 189-193 km. Fourth stage (Block DM-2) is in an orbit similar to the first one listed for the satellite. Launched from Tyuratam.

1994 May 22/0330	1994-031A	Progress-M 23		7,250 kg*
1994 May 22.24	51.62 deg	88.63 mln	185 km	229 km
1994 May 24.37	51.65 deg	92.53 min	398 km	400 km

Unmanned cargo freighter, which docked with the Mir Complex 1994 May 24.25 (0600 UTC). Carrying 2,207 kg of supplies plus a recoverable Raduga capsule. Third stage (Block I) of Soyuz launch vehicle in an orbit similar to the first one quoted above. Launched from Tyuratam.

1994 May 25/0715	None	Cosmos		2,000 kg*
Failed to reach orbit				

On May 25 ITAR-TASS announced that the intended Cosmos 2281 satellite had been launched from Plesetsk that day at 1115 Moscow Time (0715 UTC). The second and third stages of the three-stage Tsyklon launch vehicle had failed to separate since the command for separation had not been received (possibly due to a fault in the satellite's control system), and the assembly comprising the second and third stages and the satellite impacted off the eastern coast of Siberia. No details of the payload have been released, although some western reports have suggested that it was a worldwide ELINT payload, in which case the planned orbit would have been 82.5 deg, 97.7 min, 635-670 km. The launch time suggests that the orbital plane would have been 30 deg to the east of Cosmos 2242 (1993-024A), the previous launch in the series.



TRW engineer performs final checkout of the STEP Mission 2 spacecraft prior to environmental testing.

Launch Date/Time / Epoch	Incl	Int Des / Period	Satellite / Perigee	Mass / Apogee
1994 Jun 7.31		1994-032A	Cosmos 2281	6,300 kg*
1994 Jun 7.61	82.58 deg	88.67 min	180 km	237 km
1994 Jun 8.10	82.58 deg	89.70 min	226 km	293 km
1994 Jun 10.10	82.58 deg	89.84 min	237 km	296 km
1994 Jun 20.20	82.58 deg	90.09 min	235 km	323 km

Third generation, high resolution photoreconnaissance satellite in the Zenit series: spacecraft a modification of the original Vostok design. Flights in this series are now rare, having been replaced by longer-lived satellites. Main re-entry module returned to Earth early on June 29. Second stage of Soyuz launch vehicle in an orbit similar to the first one listed above. Launched from Plesetsk: no launch time was given and thus the figure quoted above (in decimals of a day) is estimated.

1994 Jun 14/1605		1994-033A	Foton 6	6,200 kg*
1994 Jun 14.85	62.81 deg	90.36 min	221 km	364 km

Ninth Foton microgravity research/materials processing satellite to be launched. The first three flights were within the Cosmos program, and the previous named Foton missions have been identified as Fotons 1-5, however, the launch announcement identified the new launch as "Foton 9" rather than the correct sequential "Foton 6" used here. Carried equipment for the production of semi-conductors, glasses and biological active substances in microgravity, in addition to experiments for ESA, France and the German Biopan commercial package. Descent module landed 200 km south east of Kustanay in Kazakhstan at 0533 UTC. Third stage of Soyuz launch vehicle in an orbit similar to the satellite. Launched from Plesetsk.

1994 Jun 17/0707		1994-034A	INTELSAT 702	3,695 kg
1994 Jun 17.97	7.05 deg	632.36 min	276 km	35,777 km
1994 Jun 19.24	3.90 deg	747.00 min	6,018 km	35,768 km
1994 Jun 17.97	7.05 deg	632.36 min	276 km	35,777 km
1994 Jun 19.24	3.90 deg	747.00 min	6,018 km	35,768 km
1994 Jun 21.72	1.00 deg	1,091.16 min	21,712 km	35,750 km

1994 Jun 17/0707		1994-034B	STRV 1A	50 kg
1994 Jun 17.97	7.04 deg	633.57 min	282 km	35,822 km

1994 Jun 17/0707		1994-034C	STRV 1B	53 kg
1994 Jun 17.97	7.04 deg	634.89 min	284 km	35,899 km

Second launch of new-generation INTELSAT-7 series satellite. Mass quoted above is at launch; on station the mass should be 2,250 kg and at the end of the satellite's lifetime it will have dropped to 1,495 kg. Planned for location over 359 degrees east.

STRV 1A and 1B (Space Technology and Research Vehicle) are two small sub- satellites launched for the UK Ministry of Defence for technology demonstrations and various scientific investigations. Ariane third stage (from 44LP variant) remained in an orbit similar to the first one listed for INTELSAT. Launch was from Kourou.

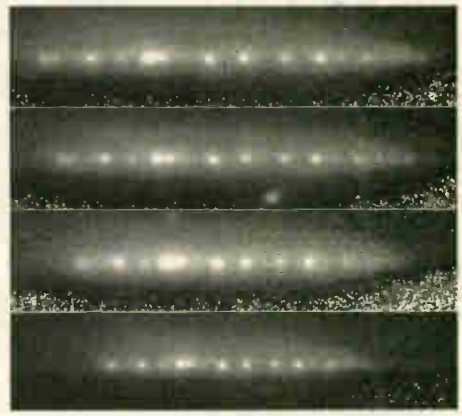
1994 Jun 24/1350	1994-035A	UFO 3 (USA 104)	2,847 kg
No orbital data issued			

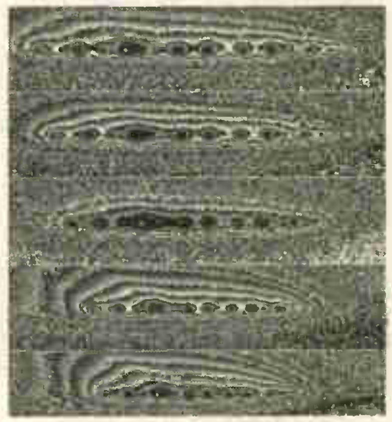
Third UHF Follow-On military communication satellite. Spacecraft design is based upon Hughes HS-601 bus and is part of the program to replace Fltsatcom defence communication payloads. Mass quoted above includes propellant; after reaching geosynchronous orbit the mass was approximately 1,280 kg. Unlike the two previous launches (UFO 1, 1993-015A and UFO 2, 1993-056A) no orbital data was issued for the satellite. The final orbit should be approximately geosynchronous with an inclination of 5 degrees. Second stage of Atlas-1 launch vehicle (Centaur) was tracked in the following orbit: 26.95 deg, 283.30 min, 225-15,596 km. Launched from Cape Canaveral.

Launch Date/Time Epoch	Incl	Int Des	Period	Satellite	Perigee	Mass Apogee
1994 Jun 27/2115 Failed to reach orbit		None		STEP 1		348 kg

STEP 1 (Space test Experiment Program) payload was the third to be launched, following STEP 0 (1994-017A) and STEP 2 (1994-029A): it carried six instruments investigating the ionosphere's effects on radio communications, provide data on the upper atmosphere's composition, temperature, density and drag, and create global maps of electrons present at high altitudes. First use of Orbital Sciences Corp L-1011 Stargazer aircraft to carry Pegasus to altitude and first use of Pegasus XL variant. After departing Vandenberg Air Force Base, the Pegasus was deployed at 2115 UTC. Pegasus was self-destructed 2 minutes 53 seconds after deployment. There were some reports of debris coming from Pegasus about 40 seconds after launch followed later by a loss of telemetry.

NASA SPACE NEWS





Photos above courtesy of Dave Jewitt

Fireworks on Jupiter

For seven days during the third week in July, 21 fragments from the comet Shoemaker-Levy 9 (see June 1994 Monitoring Times, page 10) slammed into the planet Jupiter. This astronomical event has provided astronomers with a wealth of information. Comet co-discoverer David Levy in Tucson, AZ said, "It's almost been a contest as to which is the biggest surprise of this whole magnificent week."

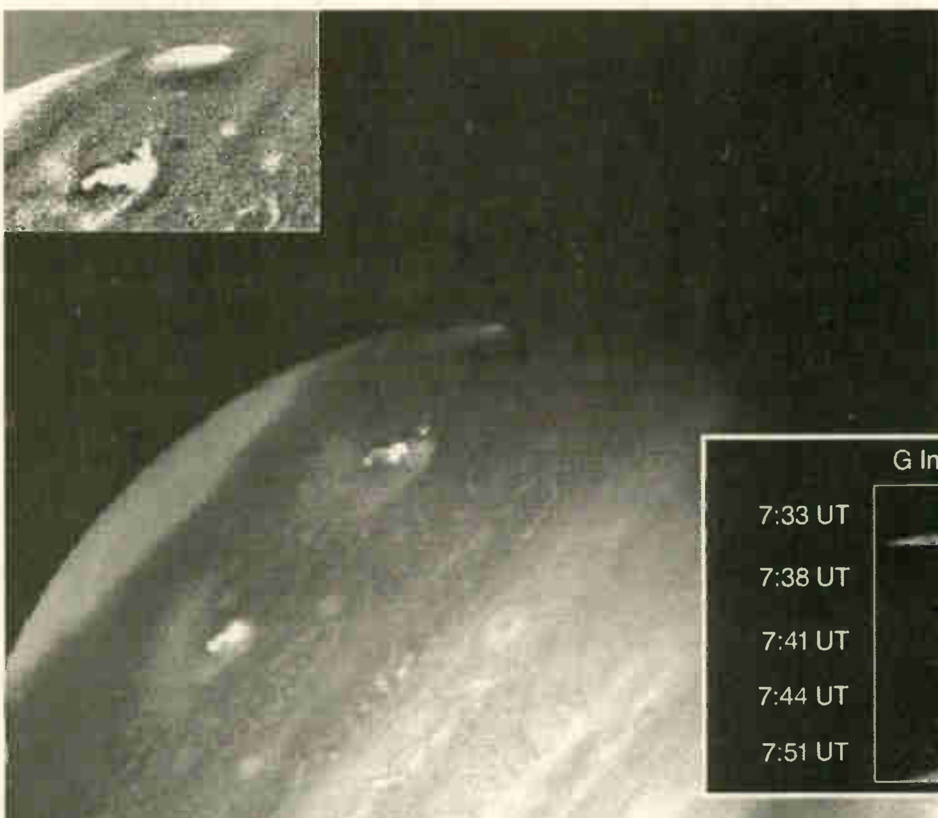
Early reports provided to *ST* by the Society of Amateur Radio Astronomers (SARA) indicate that radio emissions associated with fragment impacts were heard. Professional radio astronomers in Beijing, China and at the Nishi-Harima radio observatory in Japan detected strong decametric (18-30 MHz) bursts believed to be comet fragments as they entered into the Jovian magnetosphere. Another report from a U.S. observer indicated possible comet radio activity at 1.4 GHz. According to SARA Comet Watch spokesman Tom Crowley, amateur radio astronomers from Germany to New Mexico were able to detect an Io related storm at the time of impact for object A.

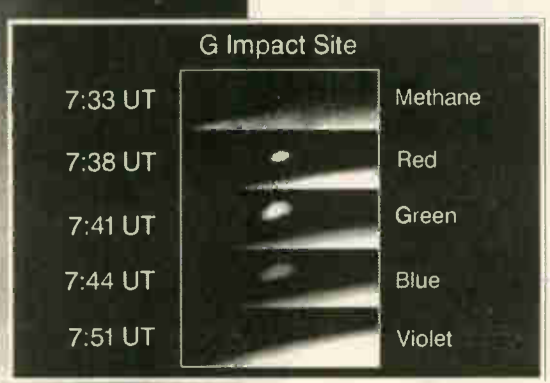
The visual show from Jupiter wasn't a dud either as photographs taken by the Hubble Space Telescope illustrate.

Above: *Sequences of photos of the Shoemaker-Levy 9 fragment train as it moved closer to the planet Jupiter. Smaller photo is a computer-enhanced depiction of the fragments.*

Left: *Photos such as this one of the object G impact site on Jupiter generated tremendous excitement among astronomers and scientists during the third week in July.*

Below: *This sequence of photographs shows the plume of SL9 object G after it's impact on the far side of Jupiter.*



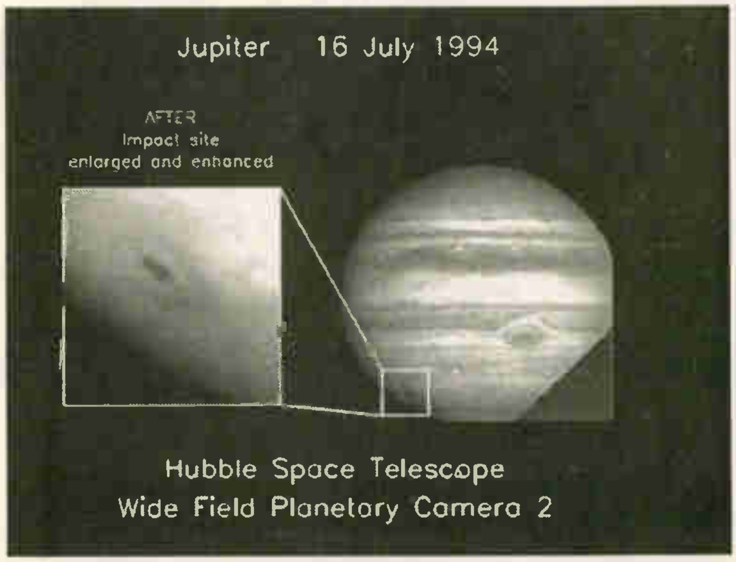


Both photos at left courtesy of the Space Telescope Science Institute

Image of Jupiter's cloudtops after the impact of the first fragment (A) of Comet Shoemaker-Levy 9 on 16 July. A violet (410 nm) filter of the Wide Field Camera 2 of the Hubble Space Telescope was used to make the image, which was taken at 5:32 EDT on 16 July 1994, 1.5 hours after the impact.

The impact site is visible as a dark streak and crescent-shaped feature, several thousand kilometers in size, in the lower left of the image. The comet entered the atmosphere from the south in the direction of the streak at an angle of about 45 degrees from the vertical. The crescent-shaped feature may be the remains of the plume that was ejected back along the entry path of the projectile. The features are probably dark particles from the comet, or possibly condensates dredged up from Jupiter's deep atmosphere.

Photo courtesy of Heidi Hammel, MIT and NASA



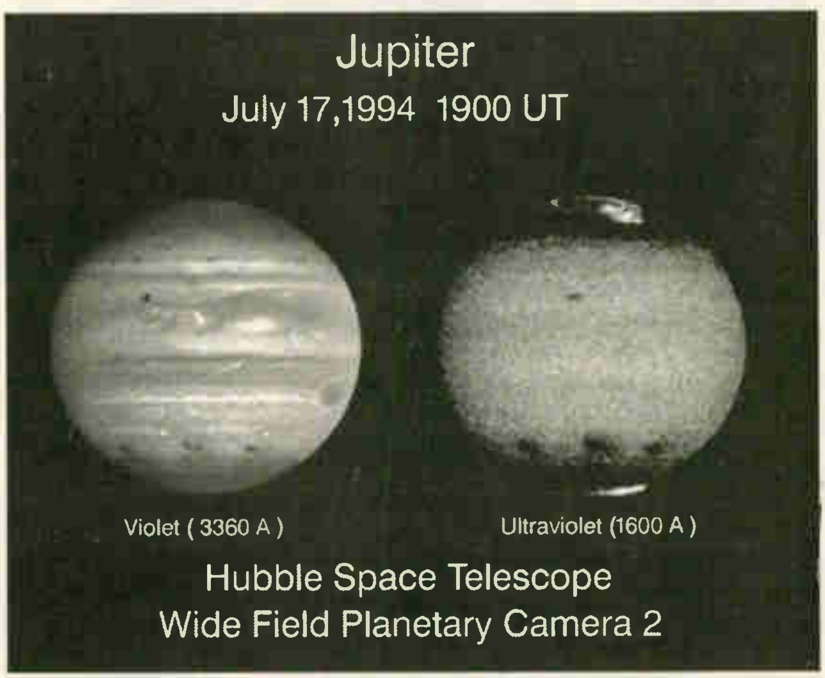
This image of Jupiter was obtained with a filter at 336 nm (near-ultraviolet light) at 18:42 UT on 17 July 1994. Three impact sites (from left to right: C, A, and E) are visible as dark spots across the lower portion of the image. All other features in this picture are characteristic of Jupiter's normal state. The feature created by the impact of A is 23 hours old in this image. The C and E features are 12 and 5 hours old, respectively. Io is seen as a dark spot in the northern hemisphere (on the left) and the red spot is visible on the right limb.

Photo courtesy of the Hubble Space Telescope
Jupiter Imaging Team

Blue and far-ultraviolet (FUV) images of Jupiter taken with the Wide Field Planetary Camera-2 (WFPC-2) on NASA's Hubble Space Telescope show how the appearance of the planet and of comet Shoemaker-Levy-9 impact sites differ at these two wavelengths (1400-2100 and 3100-3600 Angstroms). The images, taken 20 minutes apart on 17 July 1994 (around 19:00 UT), show the impact sites on the south hemisphere, from left to right, of comet fragments C, A and E about 12, 23, and 4 hours after each collision. Jupiter's satellite Io is seen crossing above the center of the disk.

In both colors the planet is seen in sunlight reflected by the atmosphere. The visible light penetrates to the top of the cloud decks, but the FUV light only reaches the stratosphere and higher altitude levels (100's of kilometers above the cloud tops).

Photo courtesy of the Hubble Space Telescope
Jupiter Imaging Team



By John A. Magliacane, KD2BD

A Star is Born

Amateur radio communication via earth satellites is certainly not new. Hams with well-equipped stations have been bouncing their signals off the moon for years in an effort to establish VHF and UHF radio contact with stations far beyond their horizons. Orbiting Satellites Carrying Amateur Radio (OSCARs), and the amateur space program as a whole, however, got their start 33 years ago 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 ham radio operators with 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 vehicle 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 parallel. The beacon sent the letters "HI" in Morse code. "HI", an internationally recognized friendly salutation used by amateurs, 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, an important consideration for a satellite operating under battery power.

The beacon operated on a carrier frequency of 144.983 MHz in the amateur 2-meter band, and the speed of the telegraphy was controlled by an internal temperature sensor on board the spacecraft. This elementary form of telemetry gave OSCAR satellite designers, and those who received the beacon transmissions, their first look at the "living conditions" on a small, low-earth orbiting satellite. OSCAR-1 continued to operate for 21 days until its internal battery power was exhausted. OSCAR-1 decayed in the earth's atmosphere on January 31, 1962, just 1 and 1/2 months.

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 OSCAR-1, gave spacecraft designers all the ambition needed to move onward and upward to larger and more capable amateur communications satellites. OSCAR-2, a slightly more sophisticated version of the first OSCAR satellite was launched on June 2, 1962, but it was not until the launch of OSCAR-3 on March 9, 1965 when an amateur communications transponder was first carried into earth orbit on an OSCAR satellite.

The OSCAR Program Today

Today, the constellation of operational amateur satellites has grown to 17 spacecraft, the majority of which are in nominally circular orbits. There are OSCAR satellites that carry a myriad scientific experiments of interest to amateur radio operators, educators and researchers around the world. Other OSCAR satellites carry analog communications transponders that make reliable long distance communications possible on the VHF and UHF amateur bands. Still other satellites carry digital communications transponders that pass large quantities of data between OSCAR ground stations around the world, and some that carry television cameras that take images of the earth below and make them available to suitably equipped OSCAR ground stations.

There is enough redundancy in the current OSCAR constellation to make amateur satellites a practical medium for reliable communications, and yet there is enough diversity to make for some exciting communications possibilities. OSCAR satellites and the amateur satellite program as a whole also provide adequate resources for the research and development of new and innovative modes of radio transmission and reception using state-of-the-art techniques.

These new modes are not only beneficial to the future of the amateur radio service, but are supported and encouraged by the Federal Communications Commission (FCC). The pioneers who are involved in these activities are indeed charting the course for the future of radio communications, with OSCAR satellites providing the testbed for their research.

Table 1 is a list of currently active amateur satellites. Although the oldest operational satellite, AMSAT-OSCAR-10,

TABLE 1: List of Currently Active Amateur Radio Satellites*

Name	Object Number	International Designation	Launch Date
AMSAT-OSCAR-10	14129	83058B	16-Jun-83
UoSAT-OSCAR-11	14781	84021B	01-Mar-84
RS-10/RS-11	18129	87054A	23-Jun-87
AMSAT-OSCAR-13	19216	88051B	15-Jun-88
PACSAT-OSCAR-16	20439	90005D	22-Jan-90
DOVE-OSCAR-17	20440	90005E	22-Jan-90
WEBERSAT-OSCAR-18	20441	90005F	22-Jan-90
LUSAT-OSCAR-19	20442	90005G	22-Jan-90
FUJI-OSCAR-20	20480	90013C	07-Feb-90
AMSAT-OSCAR-21	21087	91006A	29-Jan-91
RS-12/RS-13	21089	91007A	05-Feb-91
UoSAT-OSCAR-22	21575	91050B	17-Jul-91
KITSAT-OSCAR-23	22077	92052B	10-Aug-92
KITSAT-OSCAR-25	22830	93061H	26-Sep-93
ITAMSAT-OSCAR-26	22826	93061D	26-Sep-93
AMRAD-OSCAR-27	22825	93061C	26-Sep-93
POSAT-OSCAR-28	22829	93061G	26-Sep-93

** These satellites will be covered in greater detail in upcoming issues of Satellite Times.*

***STS-35 Training** — Astronaut Robert A.R. Parker (facing camera, right) briefs payload specialists for the STS-35 flight during a training session at the Johnson Space Center (JSC). Looking on is Ronald A. Parise, WA4SIR, second left. Ronald operated a SAREX station during the flight from Columbia. (Photo Courtesy of NASA)*

is over 11 years old and is showing signs of its age, it still continues to provide long distance communications possibilities using its Mode B (435 MHz up, 145 MHz down) linear communications transponder. Many OSCAR satellites have surpassed their expected lifetimes, and some have proven themselves to be more reliable than their commercial (and much more expensive) counterparts!

While OSCAR satellites were often launched and deployed singly in the past, the recent trend has been to launch groups or clusters of "micro" satellites rather than a single large satellite in order to take better advantage of a launch opportunity. The Russians were first to launch multiple amateur satellites when six Radio Sputnik satellites (RS-3 through RS-8) were deployed from a single launch vehicle on December 17, 1981. This was followed by the multiple MicroSat launch early in 1990 that deployed six amateur satellites, four of which remain active in the amateur service today.

"CQ Space Shuttle"

Amateur space activity is not limited to the platform of an OSCAR spacecraft; ham radio communications experiments have been carried on U.S. Space Shuttle missions as secondary payloads for over 10 years.

The first Shuttle Amateur Radio EXperiment (SAREX) package was carried on shuttle mission STS-9 and operated by mission specialist Dr. Owen Garriot, W5LFL, in 1983 on space shuttle Columbia.

Several SAREX configurations have been approved by NASA for operation on the space shuttles and are frequently carried on STS missions when a licensed operator is among the shuttle crew. 15 SAREX packages have flown so far, with at least one on every shuttle orbiter. NASA thinks very highly of the amateur radio service and encourages SAREX participation, especially among school children around the world. In fact, it has been reported that new astronauts undergo an amateur radio licensing course as part of their regular NASA astronaut training, and there is talk of including a permanent amateur radio station on board the US Space Station Freedom currently under development.

SAREX activities usually involve making 2-way FM voice contacts in combination with either packet radio or slow-scan television transmissions. These operations center on the use of a Motorola 2-meter FM handheld transceiver running only about 2.5 watts of transmitter power, more than adequate for communicating with stations on the earth below. The strip-line antenna used for SAREX communications is a mounted in one of the shuttle's windows.

"CQ MIR"

A VHF amateur radio station was installed on the Russian orbital space station Mir in November, 1988. The station consisted of a Yaesu FT-290R 2-meter FM 2.5 watt transceiver. A ground plane antenna was mounted on the exterior of Mir for this transceiver during an extravehicular activity (space walk) by Musa Manarov. This station allowed FM voice contacts between the crew of Mir and ground stations between 144 to 146 MHz.

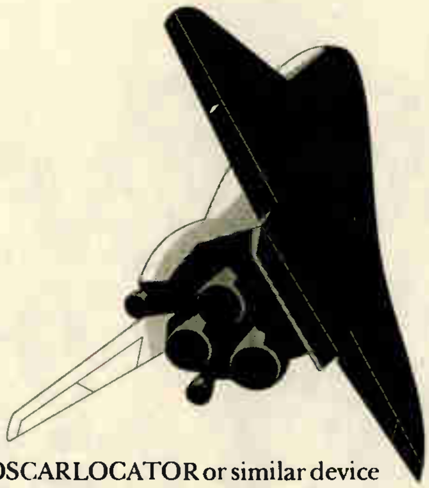
In February 1991, the station was upgraded to an ICOM IC-228A/H 2-meter FM transceiver capable of output power levels of 5 and 25 watts and operation between 144 MHz and 148 MHz. In addition to the new transceiver, a PacComm "Handi Packet" packet radio terminal node controller (TNC) was brought up to Mir along with a PC-AT laptop computer giving Mir full packet radio communications capability.

The packet station on Mir has been in almost continuous use ever since. The TNC features a Personal Message System (PMS) electronic mailbox that makes it possible to exchange e-mail messages with the cosmonauts or other ground stations using Mir as a "flying mailbox". The cosmonauts reply to messages and make live voice contacts with ground stations as their work schedules permit.

Satellite Tracking and Orbital Prediction

Unlike many commercial communications satellites, amateur satellites are not placed in geosynchronous orbits. As a result, their non-geosynchronous motion takes them around the earth between 2 and 15 times a day. It is therefore necessary to predict satellite passes prior to their occurrence in order to plan ahead and aim ground station antennas at the satellite as it moves from horizon to horizon. Most amateur satellite ground stations employ some form of satellite tracking and/or orbital prediction routines to accomplish these tasks.

Early forms of satellite tracking used graphs, tables, and charts to predict satellite passes from "classical orbital elements". This required OSCAR enthusiasts to make basic orbital calculations based on a satellite's nodal period, longitudinal increment and equator crossing times. This information was sometimes used in conjunction with an



OSCARLOCATOR or similar device to plot the position of a satellite orbit on a map of the world. This was a popular satellite tracking method a decade ago and it gave OSCAR enthusiasts a good feel for some basic orbital mechanics, but today the home computer has taken over the chore of crunching numbers and has eliminated many of the difficulties and pitfalls encountered when performing repetitive orbital calculations by hand.

Satellite tracking and orbital prediction software is available for a variety of computers from a number of sources. The best source, however, is the AMSAT Software Library, PO Box 27, Washington, DC., 20044, USA. Shareware and public domain software is widely available through the Internet from a variety of anonymous FTP sites around the world. One such site is pilot.njin.net (128.6.7.38) at Rutgers University that I personally maintain. Satellite tracking and orbital prediction software is located in the pub/SpaceNews/software sub-directory at this site. The satellite orbital prediction program "PREDICT" in this sub-directory is one that I wrote and use for making all my OSCAR orbital predictions.

Ground Station Automation

Many modern OSCAR satellite ground stations have a personal computer at their core. Computers have been used not only to predict satellite passes and steer antennas towards satellites, but also to tune uplink transmitters and downlink receivers in compensation for Doppler shift during a pass. The advent of digital "Pacsat" satellites allows us to go one step further: total automation!

Electronic mail messages can be prepared in advance of their transmission and uploaded to "Pacsat" satellites without operator intervention. Using sophisticated software, the operator needs only to select the next satellite in view and the

TABLE 2: KD2BD's Orbit Calendar For ITAMSAT*

Date	Time	El	Az	Phase	Lat	Long	Range	Orbit
10Aug94	02:42:15	0	157	226	14	63	3213	4539
10Aug94	02:43:52	6	155	230	20	65	2563	4539
10Aug94	02:45:29	16	153	234	26	66	1932	4539
10Aug94	02:47:03	30	147	238	31	68	1363	4539
10Aug94	02:48:28	51	130	241	36	69	962	4539
10Aug94	02:49:30	67	79	244	40	70	842	4539 +
10Aug94	02:50:09	61	34	246	42	71	877	4539 +
10Aug94	02:50:57	46	11	248	45	72	1027	4539 +
10Aug94	02:52:04	30	359	250	49	74	1361	4539 +
10Aug94	02:53:29	17	354	254	54	76	1871	4539 +
10Aug94	02:55:02	8	351	2	59	79	2476	4540 +
10Aug94	02:56:39	1	350	6	65	84	3118	4540 +
10Aug94	02:57:05	0	349	7	66	85	3293	4540 +
10Aug94	04:23:42	0	214	227	16	89	3228	4540
10Aug94	04:25:19	4	224	231	22	90	2756	4540
10Aug94	04:26:56	9	237	235	28	92	2376	4540
10Aug94	04:28:33	12	255	239	33	93	2142	4540
10Aug94	04:30:08	13	275	243	39	95	2099	4540 +
10Aug94	04:31:43	11	293	247	44	97	2254	4540 +
10Aug94	04:33:19	7	308	251	50	99	2572	4540 +
10Aug94	04:34:55	2	320	0	56	102	3002	4541 +
10Aug94	04:35:54	0	325	2	59	104	3296	4541 +

** KD2BD's satellite orbital prediction program "PREDICT" provides all the information needed for successful OSCAR satellite communications.*

computer does the rest. Without intervention the computer adjusts the uplink transmitter and downlink receiver to the proper frequencies for the satellite, steers the antennas, switches in the proper packet radio modems, and negotiates file transfers with the satellite when it comes into view. The latest collection of Keplerian (orbital) data can also be accessed before disconnecting from the satellite so the satellite tracking software is always supplied with latest orbital data. And you thought RTTY autostart was impressive!

One of the important functions an automated "Pacsat" ground station serves is that of a gateway between OSCAR satellites and the terrestrial amateur packet radio network (AMPR). The use of Pacsat gateways has reduced network contention on many of the terrestrial 300 baud packet links on the HF bands and has increased information throughput tremendously as a result. Packet radio users are now able to direct outgoing packet messages through "SatGate" stations if they need a fast turnaround time. Some satellite gateway stations pass hundreds of messages a day through UoSAT-OSCAR-22 alone.

Telemetry

One of the things all OSCAR satellites have in common is that they have beacon transmitters that transmit telemetry information to ground stations. The methods through which this is accomplished vary, but a lot can be learned about a satellite's health and welfare by decoding its telemetry transmissions. In fact, the UoSAT-OSCAR-11 satellite does nothing more than transmit telemetry information on a continuous basis, reporting the results of its many near-earth sensors and scientific experiments it carries in space.

The earliest OSCAR satellites used CW beacons to convey telemetry data to ground stations; later satellites used RTTY. Today, the majority use either straight ASCII or AX.25 packet radio techniques for easy interpretation by telemetry-decoding programs running on PCs. Some satellites, such as UoSAT-OSCAR-11, are able to articulate telemetry information in plain English using digital voice synthesis techniques, something which is ideally suited for classroom activities.

LOS

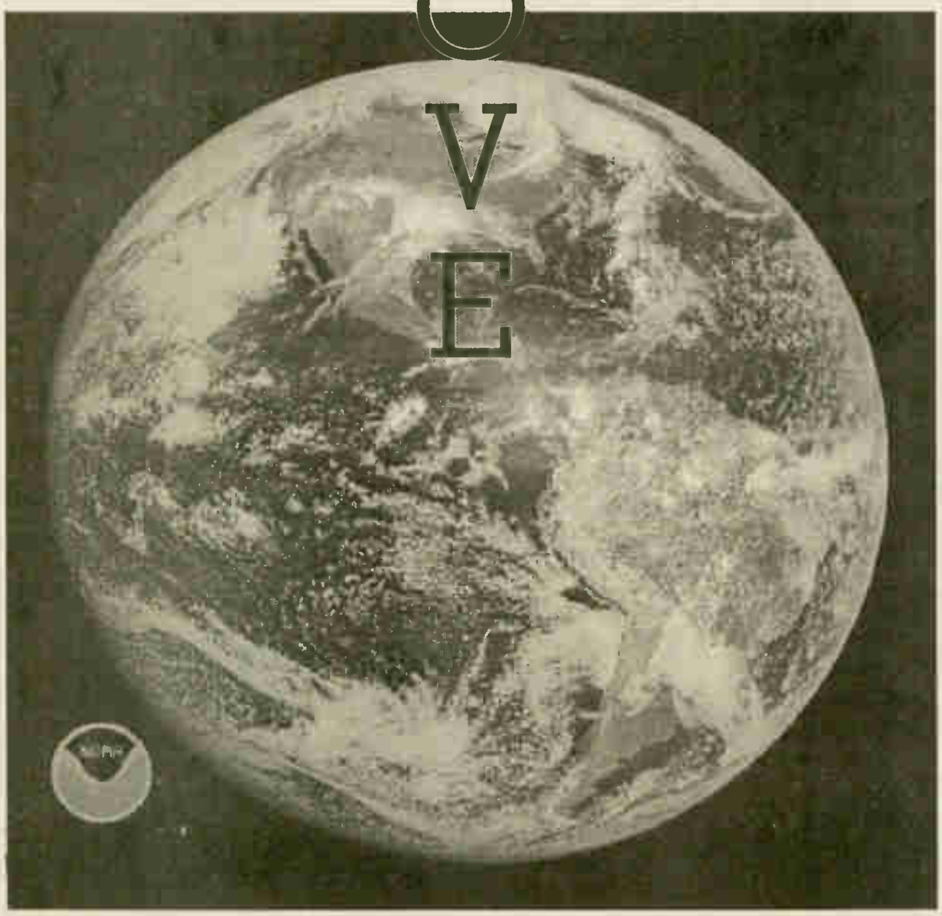
That's all the time we have for this pass, but in the next issue of Satellite Times we will be looking at the current OSCAR satellite constellation in greater detail and reporting on some of the latest happenings in the amateur satellite program. We will also report on the status of some of the latest amateur satellites currently under construction by OSCAR groups around the world. Ham radio is definitely looking up. Stay tuned!

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

The View From ABOVE

Receiving weather satellite pictures and remote imagery from space is one of the most fascinating aspects of monitoring. Our column will be your guide to a variety of high resolution images from satellites orbiting the earth above 400 kilometers. We will discuss a wide breadth of topics, from the basics of tracking weather satellites and their frequencies, to acquiring images on your home personal computer, and on to advanced image processing and building your own weather satellite ground station.

The coming months will bring a 'mini-course' in weather satellite imagery, a series of articles that build upon each other to help both novice monitors and professionals alike to be able to track, receive and view live weather satellite images on their own monitoring stations! We will look not only at U.S. weather satellites, but also those of the Soviet Union (CIS), China and the European Space Agency (ESA).



First GOES 8 image of Mama Earth.

Weather Satellites: An Overview

The National Aeronautics and Space Administration (NASA), together with the National Oceanic and Atmospheric Administration (NOAA), build, launch and operate a constellation of low-and high-earth-orbiting satellites to keep a constant watch on the world's weather systems for the benefit of all mankind. ESA, the CIS, China and several other nations also operate weather satellites, most of which have compatible frequency assignments and image formats so that the civilian population world-wide may share this critical information in a timely manner.

NOAA operates two different weather satellite systems: polar orbiters and geostationary (GOES) platforms. Each system augments the other in a global network of space-borne monitoring of the world's weather. The polar orbiters (low earth orbit) circle the globe in a north-south orbit (inclined 98 degrees to the equator), passing over both the north and south polar regions. One satellite crosses the equator in the morning, and the other in the afternoon. There are four polar orbiters in orbit-NOAA 9, 10, 11, and 12; NOAA 13 is not functioning).

These polar orbiters circle in a 'sun-synchronous' orbit at approximately 870 kilometers, and each observes the entire earth twice a day. Typical orbital periods are 102 minutes per orbit, or 14 orbits per day. Since these satellites are in sun-synchronous orbits, they cross the equator about the same time each day. The morning satellite (NOAA 10) crosses southward over the equator around 7:30 a.m. local time, and the afternoon bird (NOAA 11) crosses northward about 2:30 p.m. local time.

Operating together as a pair, these satellites assure that measurements for any region of the earth are no more than six hours old. They provide visible and infrared radiometer data (images) that are used for imaging purposes, radiation measurements, and temperature profiles, and can help calculate water vapor content of the atmosphere as well.

The geostationary operational environmental satellites (GOES) constellation consists of GOES East and GOES West, which orbit at 75 degrees and 135 degrees west longitude. Each can view almost a third of the earth's surface of North and South America. These two satellites operate together to send a full-face image of the Earth every 30 minutes, day and night, in both visible and infrared imagery. Their difference from the polar orbiters is that the GOES circle the earth in a geostationary orbit. This means they orbit the equatorial plane (about 35,800 kilometers above the earth) at a speed and altitude that allows them to 'hover' continuously over the one same position of the earth, and are high enough to give a full disk, global view (as contrasted with the more limited view of the polar orbiter 870 km. orbit).

At this time the Soviet Union and China only operate polar orbiters; they do not yet have geostationary weather satellites. ESA operates the Meteosat series of geostationary satellites, similar to GOES. But what does all of this mean to the satellite enthusiast? All of the images that are transmitted are unencrypted--the signal can be received and displayed by anyone with modest ground station equipment. The polar orbiters of the U.S., CIS, and China all operate their automatic picture transmission (APT) imagery in the VHF frequency range. Figure 1 shows a list of VHF frequencies that you can easily monitor on your home scanner with a simple omnidirectional antenna.

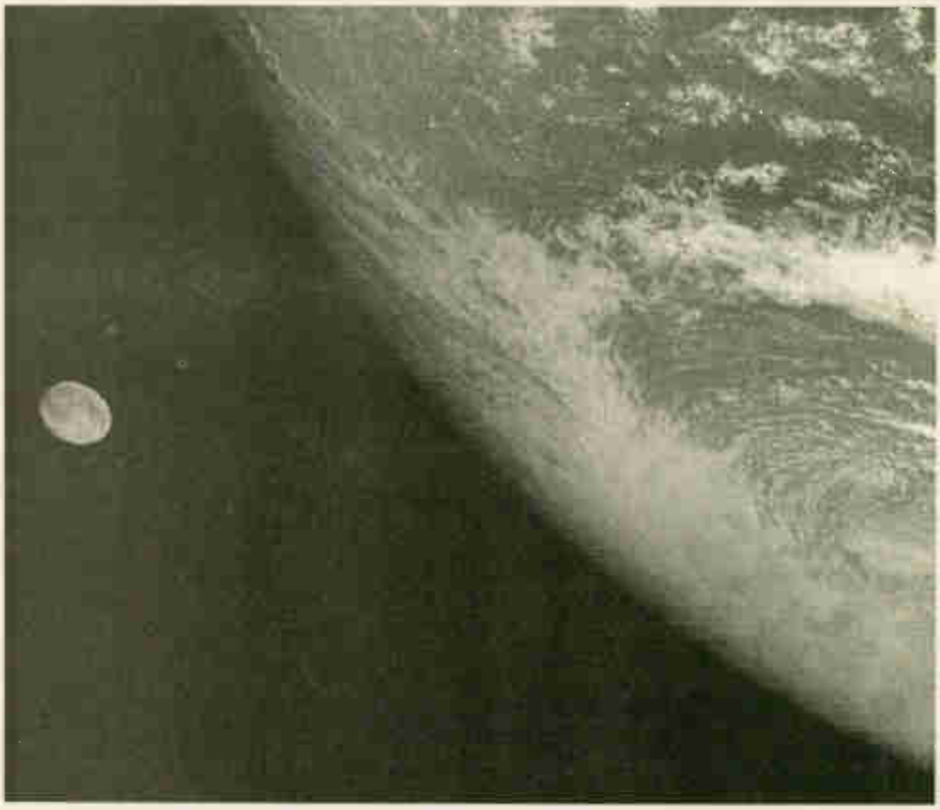
FIGURE 1: VHF Frequencies for Monitoring Weather Satellites

U.S.		CIS	China
NOAA 9	137.620 Mhz (FM)	Meteor Series	Feng-Yun
NOAA 10	137.500 Mhz	137.300 Mhz	137.795 Mhz
NOAA 11	137.620 Mhz	137.400 Mhz	
NOAA 12	137.500 Mhz	137.850 Mhz	

The exact methods for actually demodulating these FM signals (and their 2400 Hz AM subcarriers) will be covered in future articles. For now, try leaving your scanner on 137.500 in the early morning or evening and listening for the U.S. NOAA birds. If you hear a 'tic-tock' chirping, that is the downlink signal. You can actually hear the change in modulation when the satellite switches from visible imagery to infrared when it passes the terminator from daylight to nighttime!

The GOES satellites operate in the 1691.0 MHz range for the GOES and Meteosat platforms. Most ground stations down-convert these frequencies to 137.5 MHz to make it easier to process the RF signal.

At right, GOES 7 image showing the crescent earth and the moon in the same image!



The latest GOES satellite was launched on April 13, 1994 at 0604 UTC into a geostationary orbit. GOES I (GOES 8) is a new series of meteorological satellites with a higher resolution of imagery. The image of the earth on page 60 is one of the first visible engineering images received from this new satellite. At right is an outstanding (and rare!) visible image from GOES 7 that shows the crescent earth and the moon all in the same image! Thanks to Dallas Remote Imaging Group member Roger Beale for this fine image received on his home ground station equipment.

You may receive many images, satellite tracking programs, image processing routines, and updated NASA/NOAA information by dialing the Dallas Remote Imaging Group BBS, at (214) 394-7438. Please set your modem to 8 data bits, N parity, 1 stop bit, and any baud rate from 2400 bps through 28.8 kbps.

Future articles will take you step by step into receiving and displaying your own imagery from the fascinating world of the "View from Above"!

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- Double Cooling Fan
- Selectable Filters
- 10 dB Pre-amp, 20 dB Attenuator
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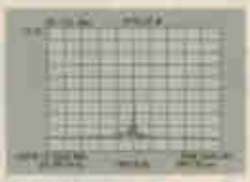
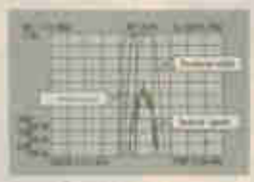
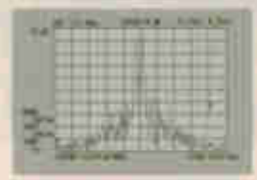
- RIT, ΔTx, ΔRx
- 10 Key Pad
- VOX
- RF Gain
- 101 Memory Channels
- Passband Tuning
- AF-type Speech Compressor
- CW Full Break-In
- Notch Filter
- Noise Blanker
- Large Display



Transmitter C/N Ratio



PBT Characteristics



3rd IMD Characteristics

Now you can work all of the HF bands AND have access to one of the most exciting amateur bands – 6 M! The IC-736 is an all band, all mode transceiver with a general coverage receiver. Only an antenna, coaxial cable and AC outlet are necessary to get up-and-running with this rig. Cutting edge features and "plug 'n play" operation make the IC-736 a "complete station in a box!"

The IC-736's compact and cleverly designed **Automatic Antenna Tuner** has preset memories for each 100 kHz step, thereby providing very high speed tuning. Tunes all ham bands plus 6 M!

Equipped with **2 Antenna Connectors,** the IC-736 includes an **Automatic Antenna Selector.** In each band, the band memory memorizes the selected antenna so you don't need to change an antenna manually each time you change the operating band.

The IC-736 employs power **MOS-FET's** in the driver and final amplifier stages, providing a clean, 100 W of output power over all of the ham bands as well as the 50 MHz band.

An **Aluminum Die-Cast Frame** and **2 Large Cooling Fans** help stabilize the IC-736's PA circuit to obtain 100% full duty cycle operation. Performance you can count on under the most demanding of conditions.

CW fans will love the IC-736. The **Full Break-In Function** (QSK) allows you to receive signals between transmitted keying pulses (semi break-in is also available). **Separately Designed CW Key Jacks** allow you to connect both a memory keyer and a paddle – great for contest operation!

The **Double Band Stacking Register** memorizes 2 frequencies along with modes in each band so it can be used like 2 VFO's in one band.

Up to 10 **Electronic "Memo Pads"** are available. This is especially useful during contests or while DX hunting. When catching a station you would like to temporarily store, simply push the memo pad write button. The frequency and mode is automatically stored in a memo pad so you can continue band searching.

For interference rejection, the IC-736 has **Passband Tuning** and a **Notch Filter.** During crowded band conditions, these two functions can be used in combination, providing an extremely effective method of reducing most types of interference.

The **RIT** and **ΔTX** functions independently change the receive or transmit frequencies, respectively. Great for split frequency operation or for compensating for the frequency drift of another station.

The IC-736's offset frequency for **Quick Split** Function can be pre-programmed. A **Split Lock** function prevents you from mistakenly changing the receive frequency while changing the transmit frequency.

A newly designed **DDS** (Direct Digital Synthesizer) provides frequency resolution to an exacting 1 Hz. Rotate the main dial and experience the comfortable analog feeling of fine tuning. One complete dial rotation is equal to 200 Hz.

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Donald E. Dickerson, N9CUE

Some 'Information Highway' Technology is Here Today

The year 2001 has a mystical quality about it. It's not just the beginning of another decade--or a new century for that matter. If you came of age in the 60's, the year 2001 marked, if only symbolically, the beginning of a "brave new world" of high-tech optimism for the future of mankind. As it turns out, the brave new world is, in fact, the brave New World Order which like the technology that drives it, has already begun in the 90's.

The Information Super Highway promoted by the Clinton administration is well on its way to changing our lives even more rapidly. The government is doing all it can to promote the new age of information access; it has, in fact, done most of the research and development that has brought us to our current high tech status.

Much of America's high tech consumer technology was developed by and for military and intelligence use. This includes such things as spread spectrum techniques, frequency hopping, packet data formats and satellite technology in general. Much of this technology has filtered down to the consumer level.

It is the government's national security concerns that have driven the development of new space technology. In a recent study on National Security Telecommunications, conducted by the Board on Telecommunications and Computer Applications of the National Academy of Sciences, pointed to the need for a mobile satellite system to ensure communications could be maintained during a natural or manmade disaster. Most government communications, including military and intelligence, are conducted through telephone cable systems. which are now being replaced by state-of-the-art fiber optics. It takes fewer cables to handle a much higher volume of calls; the drawback to this is it makes the system more vulnerable to acts of terrorism. It requires fewer system failures to disrupt larger portions of the system. A satellite system--could and should--serve as a back-up to the fiber optic system according to the National Academy.

Strengthening national security is a positive force behind the advancement of technology which ultimately benefits the consumer in two ways: by protecting ourselves and our interests, and by the technology translating into new and innovative consumer products and services. The down side to promotion of the information super highway is the privacy issue. On the one hand, the government wants to prop up the illusion of privacy with laws prohibiting listening, (as with the 1986 Electronic Communications Privacy Act), while on the other they have introduced the Clipper chip designed by the National Security Agency (NSA) to insure

Don't give up on fanciful technology such as Dick Tracy's "wrist radio." Communication satellites and new technology will make it all possible. Illustration of MSAT mobile satellite, to be launched by Canada this year or next, courtesy of TMI Communications.

that the government could easily and inexpensively intercept and decode all voice and data communications. It seems NSA would like easier access to your computer terminals, facsimile and phone answering machines for purely national security reasons, of course!

The FBI has gone a step further, according to the June issue of *Security* magazine. It states that the bureau has introduced a bill to congress that would require all common carriers who supply wire and wireless communications links to include specific information in each transmission it makes. For example, all transmissions would be required to contain the names of the parties involved, locations, addresses, etc. in plain text or easily accessible (with the Clipper chip) so they will not have to go to the trouble to break any codes or use specialized equipment to read your mail. They want it handed to them on a silver platter. The common carrier would be required to provide any hardware needed to make this possible. As taxpayers, should we applaud the cost savings because the government would not have to go to the expense of intercepting and decoding encrypted personal messages or do we bemoan the fact that big brother has finally arrived on the shirt tails of the New World Order-Information Superhighway? The choice is yours.

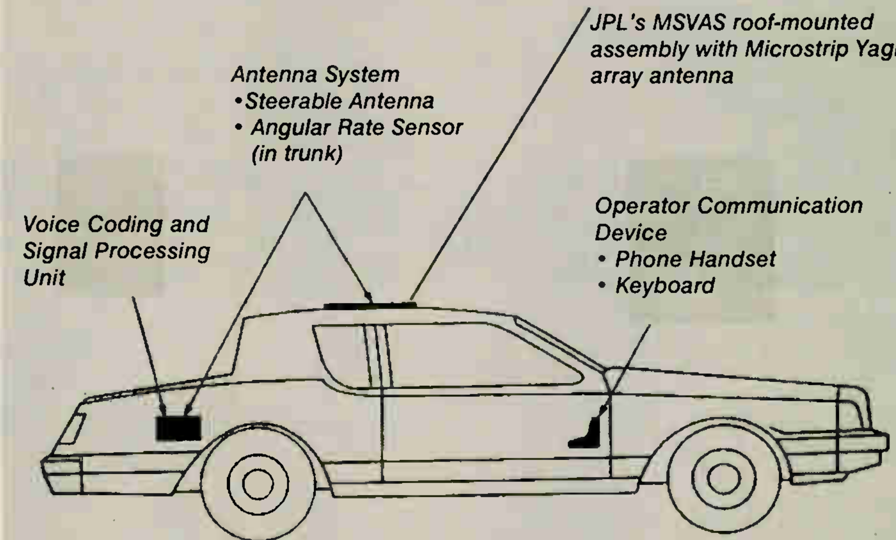
Leaving the entertainment of the privacy issue, just what has the federal government done to pioneer new technologies? Plenty! It was the research of National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) that has been the driving force behind the development of the Mobile Satellite Service (MSS).

In 1987, JPL began working on the proposed system which would offer standard, full duplex voice; data; paging; two-way messaging; one-way broadcast; vehicle and cargo monitoring; and radio determination services. JPL's first task was to develop a new type antenna for vehicular use, one that would track azimuth and elevation on a vehicle that was continuously and rapidly changing angle and direction. Maintaining a lock on a satellite signal under these conditions is no small challenge.

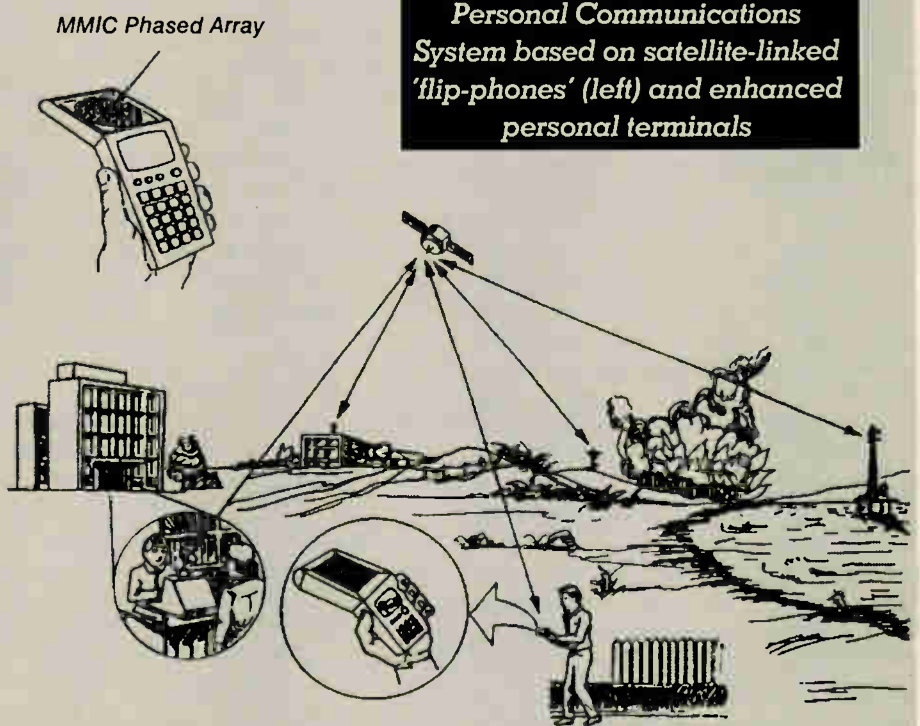
The mobile scanning vehicle antenna system, designed by JPL is roof mounted and automatically scans the horizon for a satellite signal to lock onto. The strip-line

Future of Personal Communications

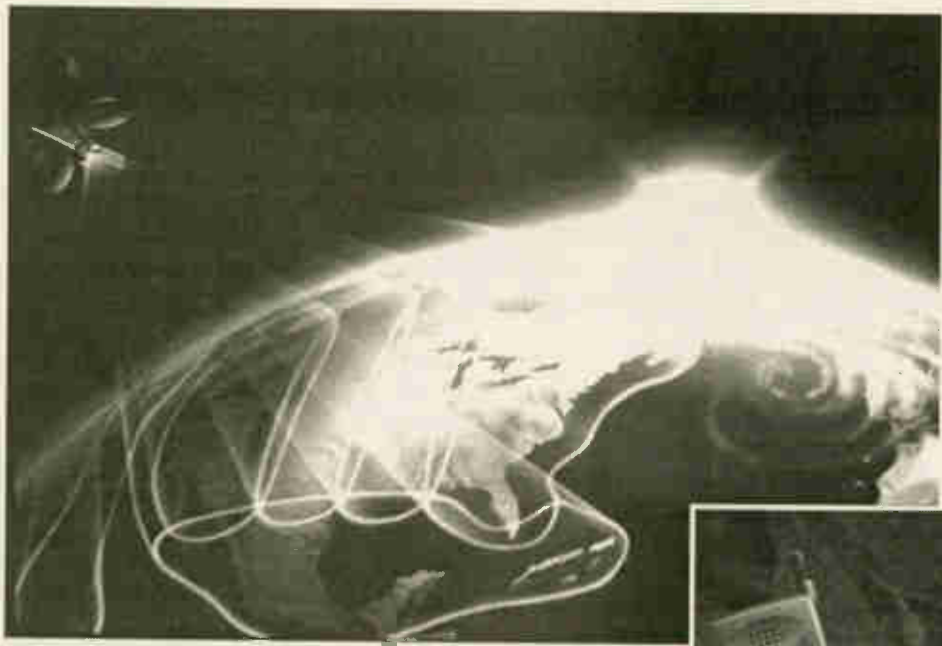
Complete mobile system for ground-based satellite communications



Personal Communications System based on satellite-linked 'flip-phones' (left) and enhanced personal terminals



Illustrations courtesy of JPL



The technology for a continential satellite personal communications system is just around the corner. Already available are mobile telephone units such as the Mitsubishi DiamondTel Series satellite/cellular mobile telephone (right). Photo and illustration courtesy of American Mobile Satellite Corporation.

antenna is 18 inches in diameter and 1 and 1/2 inches tall, consisting of four 4-element yagi antennas. The beamwidth of the array is 30 degrees and tracks between 20 and 60 degrees elevation. As the vehicle moves, azimuth is tracked by sampling the variations in the signal-to-noise ratio. This information is then fed into an inertial stabilized tracking system that incorporates a high performance gyro.

In 1989 JPL tested a two-way digital voice terminal; this narrowband voice format will be used on all versions of the system -- land, sea and air. The equipment was first tested in a Boeing 707 which flew over the east coast while communicating with a ground station in Southbury, Connecticut. Signals were relayed through one of the Inmarsat satellites. Due to the limited frequency space of the MSS allocation in the L-band, narrow band voice and low data rates were used. Each channel occupied only 5 kHz. JPL's digital voice terminal used advanced digital modulation techniques to allow a signal consisting of 4.8 kilobits per second in order to maintain the narrow 5 kHz bandwidth.

The test proved that aeronautical radio communications could be successfully relayed via satellite, now a regular communications link for major airlines today, thanks to JPL's 1989 experiment.

In August of 89' the first full scale field test of the land mobile segment of the mobile satellite service was conducted in Australia with the assistance of AUSSAT Pty Ltd., the Australian National Satellite System who provided the ground stations and personnel. Japan provided space on their Experimental Technology Satellite (ETS-5) for the experiment. A mobile unit mounted in a van drove the 450 miles between Brisbane and Sydney for the test. While the van maintained highway speeds, it made phone calls of up to two hours in duration under a variety of conditions, terrain and natural sources of interference--buildings, trees, telephone and power lines, etc.

It was during this portion of the test that the new digitalencryption techniques for the FBI and Drug Enforcement Administration were conducted. The techniques needed to pass the National Communications Systems (NCS) standards; this may have been the test bed for the Clipper chip.

The mobile satellite service has been allocated frequencies in the L and Ku-bands. The L-band will be used for the communications link with the mobile unit, both uplink and downlink. The Ku-band will be used for communications between the spacecraft and ground stations called "gateways" for interconnection with other communication systems when needed.

One of the first mobile satellite service satellites to be launched is MSAT. The North American mobile satellite system (MSAT) will provide the United States and Canada with an unprecedented range of innovative mobile satellite services. MSAT will be the first dedicated system on this continent for mobile telephone, radio, facsimile, paging, position location and data communications serving land, maritime and aviation users. MSAT will service approximately 80 percent of Canada and the United States that lies outside the range of two-way radio towers used by cellular systems.

American Mobile Satellite Corporation (AMSC) in Washington, D.C., and Canadian-based TMI Communications have signed contracts with Hughes and Spar Aerospace Ltd. of Canada to build their respective satellites for the initial systems. AMSC and TMI are jointly purchasing two of Hughes' newest line of satellites, the three-axis, body-stabilized HS- 601. This high performance spacecraft is designed to handle the high power requirements of the mobile satellite service.

AMSC and TMI will each operate one spacecraft. Both will provide complementary mobile services, and each will provide backup and restoration capacity for the other. Both MSAT spacecraft are schedule for launch in late 1994 and early 1995.

That's all well and good you say, but where and when will you be able to get your own private Star Trek communicator or Dick Tracy wrist watch? It may be sooner than you think because the good people of JPL have been working on two other systems that will change the way we communicate. Satellite-linked "Flipwill be using new high-tech radio receivers in your home, car and office. Your car; digital receiver will receive CD quality radio broadcasts directly from orbiting satellites. You could have up to 500 channels of your favorite news, sports, stock market, religious, shopping, music stations or every international broadcaster to choose from. Shortwave broadcasting as we know it will become a thing of the past in the first quarter of the next century, thanks to satellite technology and mass production of consumer electronics.

Imagine you're sitting at your computer terminal at the office and need to place a call overseas. You could have all the equipment you need already installed into your computer. A small antenna sitting on top of your monitor and a built-in transceiver in the computer would give you access to the same satellite system your flip-phone uses, and with the same ease of operation.

The first successful demonstration of the feasibility of DBS-RS was conducted in 1991. JPL used a Comsat station located in Southbury, Connecticut, and the Inmarsat MARECS-B2 satellite with programming from National Public Radio (NPR) for the experiment. Quality digital signals were successfully transmitted through the satellite and to a van driving in the Washington, D.C., area.

Researchers are hoping to develop CD-quality stereo fidelity. The digital receivers will have a selectable data rate for the different types of transmissions they will receive. For example, voice services can have as low as 2.4 to 4.8 kbps (kilobytes per second). AM-broadcast- band-quality signals require between 16 to 32 kbps, FM requires 48 to 64 kbps, and CD quality requires 192 to 256 kbps. The U.S. Information Agency (USIA) is also cosponsoring research on development of the digital receivers.

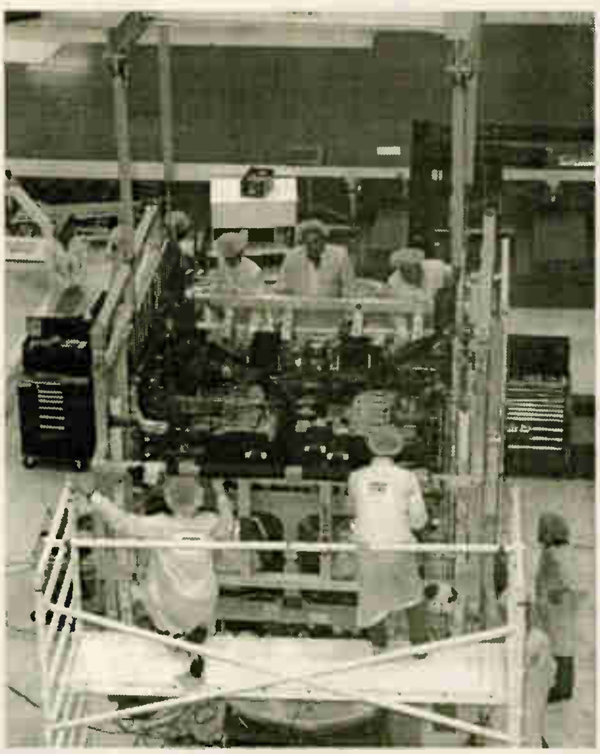
The University of Texas has been working with JPL on propagation studies of the proposed frequency bands that the Personal Communication Satellites would use. The frequencies are in the 20 and 30 GHz bands, (K and Ka bands) which are susceptible to several undesirable propagation effects. The C-band (6/4 GHz) and the Ku-band (14/12 GHz) have been saturated since the 80's. Both bands consist of a 500 MHz chunk of spectrum, but the new 30/20 GHz band is 1,000 MHz wide. Ka-band signals are attenuated by rain and clouds, and are greatly effected by shadowing by anything coming between the receiving antenna and the satellite.

phones", not much bigger than a Star Trek communicator are already here, although we are still waiting for the deployment of satellite systems to make it all work. There are currently plans on the drawing boards for Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and geostationary orbit systems that would support the concept of the World Phone.

The proposed cellular-phone-compatible satellite systems that have been proposed generally fall under the heading of Personal Communications Satellites (PCS), originally called the Personal Access Satellite System (PASS) by JPL.

We are not quite sure what this new class of telephone will consist of. The World Phone, as some call it, may come with a life long telephone number that you never change. It would allow you to make calls to and from anywhere in the world from your flip-phone through a direct access satellite.

Phone calls are just the tip of the technology iceberg that's waiting for us at the turn of the century. A third technology that JPL is working on is called Direct Broadcast Satellite Radio Service (DBS-RS). At the same time you are carrying a flip-phone on your belt or a credit card size phone in your shirt pocket, you



Payload specialists lower payload onto bus during assembly of the MSAT M1. Photo courtesy of the Government of Canada Department of Communications.

Telephone lines can attenuate signals by 20 dB; this results in a high data-error rate. A technique called "interleaving" can spread an error rate out over time, allowing the decoder to recover more of the signal and lessen the effect. There is a limit to interleaving, however. It is generally accepted that providing mobile reception service in urban areas will require a hybrid satellite/terrestrial system with urban boosters. Providing a usable signal in downtown office buildings is also a challenge. Propagation studies have shown that the indoor environment is a complex maze of standing waves and frequency-dependent nulls caused by signal reflections within the building.

Diversity reception techniques, placing multiple antennas about the building at locations where the signal is strong, seems to be the most practical way to correct this effect. The problem of excessive signal loss due to walls will require remote receivers and or antennas to solve.

Satellites will help us find our exact locations while in the car, plan the best route home after work, and keep us informed of accidents and road construction in a real-time, minute-by-minute mode. Of course, satellites will provide us with interesting and entertaining technologies that we have not even thought of.

Now that we know a little about the origins of Personal Communication Satellites we can appreciate the effort that went into their development, and we will be looking closely at several satellite systems that are being readied for deployment in the not-too-distant future. Our first stop on this flight into the future was the past; our next stop--next issue--will be the present as we look at NASA's Advanced Communication Technology Spacecraft (ACTS). It's playing a major role in the development of the DBS-RS and Personal Communication Satellites.

Listening to the COSMOS

By Jeffery M. Lichtman

In the Beginning

While the beginner may think that the first thing we should do when we become interested in a new hobby is to buy and scrounge equipment; that's not the way to start. The correct way is to read all you can in the way of books and articles about that particular subject. Next contact a group or individual with some knowledge of the subject and let them be your mentor(s). It is also important to be able to filter out the good material from the bad; this can only be done by learning all you can by hands-on-experience.

A Look Back in Time

Radio Astronomy started in 1932. A young physicist named Karl Jansky was employed at Bell Labs in New Jersey; his assigned task was to determine the source of static on the trans-atlantic communications frequencies.

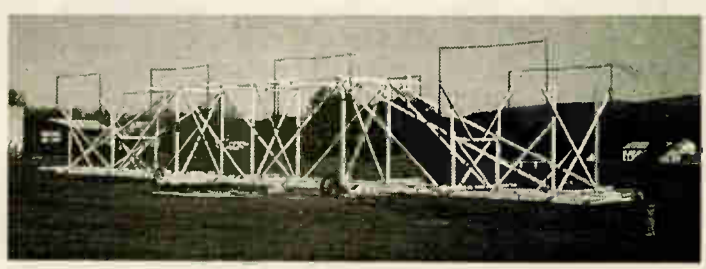
While observing at 15 meters, and with his antenna pointed towards the galactic plane (Milky Way), static increased on his receiver. Further testing concluded tht it was indeed coming from the galactic center. The discovery did not stir up much interest at the time and due to other pressing assignments, Karl Jansky did not investigate any further. This was the beginning of the study of astronomy using non-visible wavelengths..

In 1937, Grote Reber, a ham radio operator (W9GFZ) in Wheaton, Illinois, designed and built a 31 foot parabolic dish antenna in his back yard. His wish was to continue the work of Jansky. Reber first conducted his searches at 137 MHz and discovered discrete radio emissions. Further investigation at higher frequencies yielded a presence of additional radio noise.

Reber plotted the regions of the sky and recording radio intensity and its sources. This was the kick-off point for radio astronomy.

Observation Programs

Most of us work around a budget, the following observational programs require a minimal cash outlay for getting started.



Jansky's antenna (courtesy of NRAO)

Solar Flare Studies; Radio Study of the Planet Jupiter

In addition, some basic knowledge of the subject is required. The solar flare and Jupiter observation programs will allow the individual to become familiar with equipment and the techniques of radio astronomy before embarking to higher frequencies and more exotic equipment.

Radio astronomy may be performed on any clear frequency. There are some frequency blocks in the RF spectrum protected by international agreement from interference. A few of these include:

25.55 KHz	37.50 MHz
73.00 MHz	406.1 - 408 MHz
608 MHz	1420 MHz
1660 MHz	2655 MHz

The observer may choose instead other frequencies, but only after a site investigation for terrestial interference is performed. This may be done with a spectrum analyzer or careful monitoring with a receiver. The signals we will eventually be listening for will be very close to the noise floor of most receivers.

The TVRO industry has many receivers that are suitable for radio astronomy observations. In fact a few of the SARA members have used the 3.7 - 4.2 GHz. frequency range (TV satellite C band) to do observations. Since most satellite receivers operate in the 950 - 1450 MHz range, one of those accompanied with a good low noise GASFET (Gallium Arsenide Field Effect Transistor) or HEMT (High Electron Mobility Transistor) amplifier would make a fairly decent system.

The antennas used in radio astronomy range from a simple dipole to a yagi or parabolic type (which may be used from 400 MHz and up).

The two types of receivers used most widely by amateurs and professionals are the total power and the Dicke switched

Reber's antenna (courtesy of NRAO)

receivers. I prefer the simplest of the two, total power. Figure 1 illustrates a simple block diagrams of the latter receiver.

There are numerous radio sources (100,000); a good receiving system will be able to resolve several dozen of the stronger ones.

Radio Detection of Solar Flares

Our solar cycle has a period of 11 years duration. This cycle is broken down into 2 parts: 5.5 years of increasing solar activity and 5.5 years of decreasing solar activity.

Many amateurs have observed the sun at the VLF (Very Low Frequency) with simple receivers tuned in the 27-40 kHz. range. The antenna system is a simple long wire antenna and the recording devices may be a chart recorder or an A/D (analog to digital) converter and a personal computer.

Solar flares spread charged particles into the D layer of the atmosphere causing it to be reflective. The result is the sudden enhancement of atmospheric (SEA) noise detected by the receiver. A block diagram is shown in Figure 2.

The sun may be observed at all frequencies; therfore, one may use any receiver to do solar work (AM/SSB, not FM).

Radio Jupiter

The planet Jupiter is known for its elusive radio noise storms, first observed in 1955 by radio astronomers Burke and Franklin while working at an observatory in Australia. The frequency they were monitoring was 22.2 MHz, and the noise heard on the receiver speaker was similar to the sound of waves crashing on a shore.

By 1956 noise from Jupiter had been detected all the way up to the microwave frequencies. In 1964 E.K. Brigg determined that Jupiter's moon Io moving through the planet's magnetic field was a great influence in the triggering process of these lightning storms.

Decametric (10-20 meters) observation of Jupiter's synchrotron radiation is easily done at any frequency from 18 - 22.2 MHz. By the use of a simple shortwave receiver, antenna pre-amplifier and long wire antenna, one may be able to experience these radio sounds.

The Society of Amateur Radio Astronomers (SARA) has an active Jupiter observation program which also monitored the collision of comet Shoemaker-Levy 9 in July.

SARA member Tom Crowley heads this special program as well as the normal observations of Jupiter. Tom put together a comprehensive publication on all the facts pertaining to Jupiter and the collision. He may be contacted at 3912 Whittington Dr., Atlanta, GA. 30342 (SASE to Tom for further information). In addition, there are two computer programs available (**not SARA related**): RADIO JUPITER 2.0 ($27.50) and JUPITER SPACE STATION ($12.50), available through Jeff Lichtman, 190 Jade Cove Dr., Roswell, GA 30075. (Partial proceeds for the Jupiter Space Station benefit the SARA/Robert M. Sickels Memorial Student Fund).

If any of this has peaked your interest, its time to get going! SARA is a non-profit educational organization made up of members worldwide. The organization meets in June each year at the National Radio Astronomy Observatory (NRAO) at Green Bank, West Virginia. There our members get together to report on their research programs, get hands-on use of the professional equipment, and participate in workshops. The group is made up of people with a genuine interest in the field of amateur/ professional radio astronomy and I must say they are all very down to earth. No question goes unanswered and all are encouraged. Experience levels range from beginner to professional.

SARA publishes a monthly newsletter; a technical library is also available as is information on regional groups worldwide. Further information may be obtained by writing to SARA Membership Services, 247 N. Linden St., N. Massapequa, N.Y. 11758. Membership is $20.00/yr (U.S) and $28.00 Foreign.

Radio astronomy may be entered into simply and explained in layman's language. In the upcomming months we will discuss a variety of radio astronomy projects, observatories, news and technical data.

FIGURE 1

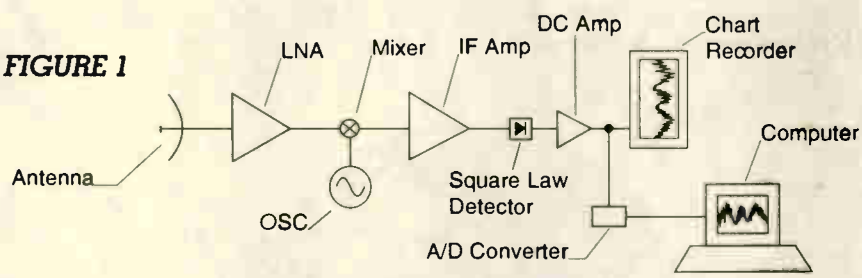
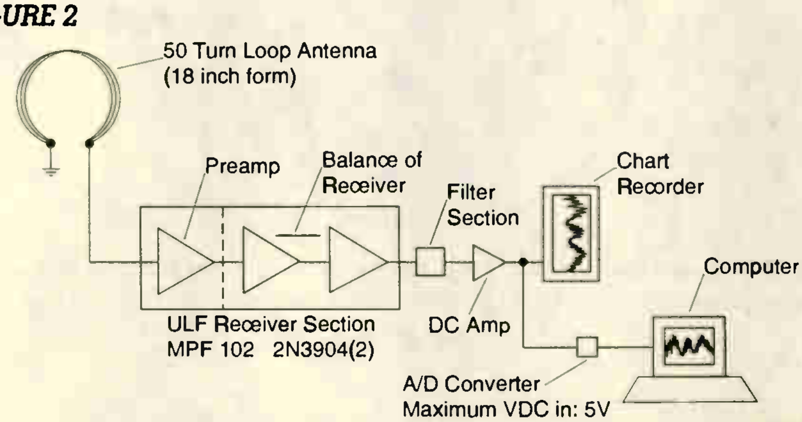


FIGURE 2



By Dr. T.S. Kelso

Orbital Propagation

Part I

We are about to embark on an adventure of discovery—an adventure I have been looking forward to for quite some time. I hope you will enjoy the experience as much as I and will want to follow each new episode.

Along the way, we will learn the subtleties involved in computer tracking of satellites in earth orbit. Were should you point your TVRO antenna to pick up your favorite television shows? Were do you look to see the Mir space station on a twilight pass? When can you DX the Space Shuttle on the next SAREX mission? We'll cover it all.

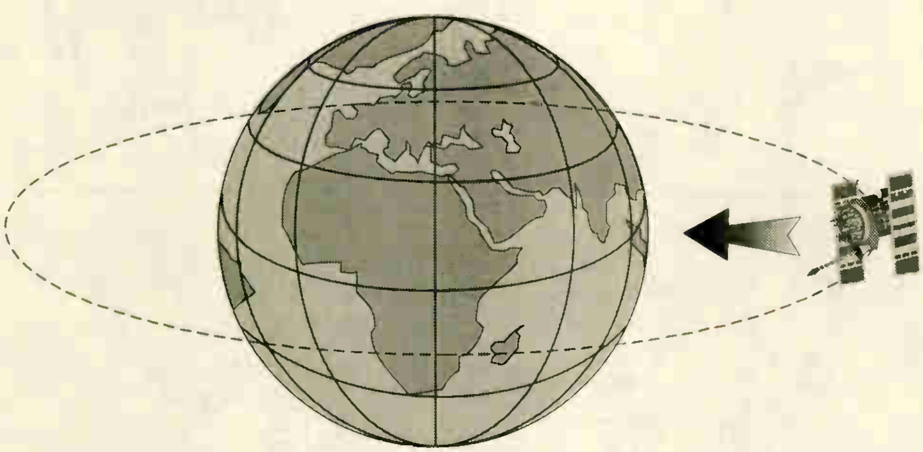
Let's start with some of the basics of orbital propagation (just a fancy way of saying "predicting where a satellite is going to be") to understand why certain orbital models are used and why it is important to apply the proper data with those models.

Next, we'll talk about the various choices amoung coordinate systems and the coordinate transformations needed to move back and forth among these systems. We'll include snippets of computer code to illustrate the process and help you build your own algorithmic tool chest.

From time to time, we'll review available computer software which can make it easier for you accomplish your satellite tracking tasks—from commercial products to the finest in public domain software. We'll share information on good places to find satellite-related information—both on dial-up BBSs and out on the Information Superhighway. And, of course, we'll cover timely sources for orbital element sets, without which none of us would be able to track satellites.

As your tour guide on this adventure, I'll do my best to anticipate some of the more common questions: How are orbital element sets generated? How often should I get new data? Why do the individual modules of the Mir space station have separate element sets when they are physically docked together? Why can't I find a two-line element set for the sun or the moon?

But for you to get the most out of this experience, you must participate, too. I want you to feel free to ask questions as we go along. I'll do my best to answer each and every one of them. I look forward to hearing from you.



The gravitational force attracting objects in space is a product of their individual masses divided by the square of the distance between them, or:

$$F = \frac{G M_1 M_2}{r^2}$$

Orbital Propagation

Although the fundamental concepts of how objects move under gravitational attraction has been understood since the time of Isaac Newton, the practical determination of an object's position in orbit is considerably more difficult. According to Newton's Law of Universal Gravitation, the gravitational attraction between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. Newton's genius allowed him to deduce this law as the common explanation for why an apple drops to the ground and the moon orbits the earth.

Let's develop a mathematical model to demonstrate the properties of the system. Our two objects will orbit about their common center of mass; if one object is considerably more massive than the other, the smaller object will appear to follow an elliptical orbit around the larger object.

Since we are primarily interested in the motion of an artificial satellite around the earth, let's consider that as our system. While the primary force affecting the motion of our satellite is still gravitational attraction, now we must consider many additional conflicting forces, or perturbations, to accurately predict the position of the satellite and the path it will take in orbit.

If the earth were perfectly spherical and had a uniform density, it would be possible to treat it as a point mass, but the earth is not spherical—it bulges at the equator, primarily due to the centrifugal force of its own rotation. Neither does it have uniform density--it is enveloped with oceans which bulge under the tidal forces of the sun and the moon. The lighter material of the continents *floats* on the denser mantle. While Newton's Law still applies, it is now necessary to consider the gravitational effect of each individual *piece* of the earth on our satellite. All of a sudden, our simple model has become a lot more complicated.

There were only two gravitational masses in our original model, but we cannot ignore the gravitational effects of the sun and the moon; and what about the gravitational effects of the planets?

There are non-gravitational forces to consider, as well; the primary one is atmospheric drag. Ignoring this perturbation for a low-earth orbit will result in significant errors. Even tiny forces, such as solar radiation pressure, can have a significant effect on a satellite's orbit under the proper conditions.

But since the subject of this column is *computers* and satellites, we must develop a mathematical model of an artificial satellite's orbital motion which trades off the accuracy of an extremely complex description of our system against the reduced computational burden of a simpler description.

If we know the of a satellite in orbit, position and velocity and the forces acting upon it, we can determine the satellite's state at some future (or past) time. However, if our model is too simple, or if we take too large steps in time, the accuracy of our results will suffer.

If we are given a particular set of starting conditions for our satellite orbit, we must begin at that point and step along in time until we get to the point in which we are interested; this approach can require considerable calculations. We would prefer a model which provides an analytical solution wherein if we know the time of interest we can directly calculate the state of the satellite's orbit at that time without the need to "step" along in time.

Next time, we will examine how the implications of this material has affected the historical development of the orbital propagators in use today, particularly those used by the North American Aerospace Defense Command (NORAD). Armed with this background, we will delve into the relationship between orbital data and orbital models and the importance of using the right data with the right model.

The author is an Assistant Professor of Space Operations at the Air Force Institute of Technology and holds the rank of lieutenant colonel in the United States Air Force. He can be reached on Internet at tkelso@afit.af.mil.

Getting Keplerian Data

If you already have a satellite tracking program and want to start tracking satellites, where do you get the all-important Keplerian data to make that software work? One source of data is from NASA at the Goddard Space Flight Center.

Requests for prediction bulletins should include International Designator and name of the satellite. Send to:

Project Operations Branch (Code 513)
NASA Goddard Space Flight Center
Greenbelt, MD 20771

The user can request either two line orbital elements or three part prediction bulletins for the satellite of interest. You only need the two line sets for your computer work and the they get to you faster than the three part bulletins.

The following are format explanations for the two line orbital element sets.

PART I, LINE ONE FORMAT:

Col	Description
1	Line number (1)
2	(blank)
3-7	Satellite number
8	U-Not applicable
9	(blank)
10-11	International Designator (Last two digits of launch year)
12-14	International Designator (Launch number of the year)
15-17	International Designator (Piece of launch)
18	(blank)
19-20	Epoch Year (Last two digits of year)
21-32	Epoch (Julian day and fractional portion of the day)
33	(blank)
34-43	First time derivative of the mean motion or ballistic coefficient (depending on the ephemeris type)
44	(blank)
45-52	Second time derivative of mean motion (Field will be blank if doesn't apply)
53	(blank)
54-61	BSTAR drag term (Not needed by the common user)
62	(blank)
63	Ephemeris Type (Specifies the ephemeris theory used to produce the elements)
64	(blank)
65-68	Element Number
69	Check Sum

PART I, LINE TWO FORMAT:

Col	Description
1	Line number (2)
2	(blank)
3-7	Satellite Number
8	(blank)
9-16	Inclination
17	(blank)
18-25	Right Ascension of the Ascending Node
26	(blank)
27-33	Eccentricity (decimal point assumed)
34	(blank)
35-42	Argument of Perigee
43	(blank)
44-61	Mean Anomaly
52	(blank)
53-63	Mean Motion
64-68	Revolution Number at Epoch
69	Check Sum

Example:

METEOSAT 3
1 19215U 88 51 A 92 7.84202973 -
.00000258 00000-0 00000+0 0 3408
2 19215 0.1507 303.0917 0003688
2.9527 53.8842 1.00254532 1324

Name of satellite is Meteostat3. On the first line, the satellite number is 19215U. The epoch time is 92 7.84202973 (could be written 9207.84202973. Decay= -.00000258 revs/day/day. That's all the information needed, from the first line.

On the second line: Satellite number is repeated without the "U". Inclination=0.1507 (very small because this is a geosynchronous sat). RAAN=303.0917. eccentricity= "0003688" but is entered as "0.0003688". Argument of perigee=2.9527. Mean Anomaly= 53.8842. Mean Motion=1.00254523(this is a geosynchronous satellite so the mean motion figure is very small). Epoch Rev.=132 (not "1324").

By Todd D. Dokey

How GPS Works

They say that knowledge is power, and that this is the information age. GPS puts important information literally in your hands. This information is power only if you have an understanding of what you can do with it!

In the last few years the accuracy of time measurement has improved dramatically. But to be useful, time must not only be accurate, but traceable to an agreed-upon standard. Time standards cannot be locked up in your filing cabinet until needed like weights and measures.

To be called a "chronometer", a clock originally had to be accurate to within 30 seconds per month. Today, the standard time, Universal Coordinated Time (UTC), is accurate to better than 1 microsecond. The latest implementation of transmitting the time code is the NAVSTAR Global Positioning Satellite (GPS).

In order for time to be useful, we need a "synchronized referent with which to order our sensory inputs" -- a fancy way of saying we all need to agree to some form of standard so we all know when to meet for coffee! It is for this reason that standard time and frequency stations like WWVB, WWV and OMEGA exist.

Of course, GPS gives you the time, but because of the relative measurements taken by the receiver between the satellites in the NAVSTAR "constellation", it can also tell you where you are.

With GPS an old proverb is more true than ever, "The Earth is your home. - You can't be lost in your home, but you can be someplace where nobody knows where you are." GPS gives us much more information than just "where you are."

GPS provides accurate date, time, speed, position and direction information anywhere on earth - and above it! The information the GPS system provides is affordable for many people including hobbyist, yachtsmen, pilots, astronomers and even radio monitors.

Even without the total constellation of twenty-four satellites, a GPS receiver can give you data accurate to within several yards (civilian)or within a few feet (military). With the full constellation in operation, these figures reduce themselves dramatically. By adding a technique known as "differential GPS" (see below) the accuracy is within the centimeter range!

GPS illustrates the notion of relativity by determining where you specifically are on earth by calculating your relative position to the satellite constellation. By measuring your relative location on earth as compared to the relative (but known) positions of four NAVSTAR satellites, you can know in very short order precisely where you are.

The accuracy of the global positioning satellite system is
the sum of a group of errors. The atmosphere (including the ionosphere) causes the radio signals from the NAVSTAR satellite constellation to delay as they pass through the atmospheric interface.

These delayed signals can create position measurement errors because the GPS receiver performs calculations on the arrival time of the signal in order to determine the location of the satellite it is currently measuring. Several errors can be calculated out of the data by built-in mathematical models used in better receivers.

Errors in the atomic clocks on board the satellites and receivers, and in multipath reception, can also cause problems. Sometimes the arrangement of the constellation can magnify the other errors in the system. The contribution of each possible source of error can change based upon atmospheric, local and equipment conditions. Another error is purposeful and under human control.

The Department of Defense can intentionally modify the accuracy of GPS data using a mode called "selective availability", designed to prevent enemy forces from obtaining accurate positioning data from the NAVSTAR constellation during times of conflict. When it is in use, it becomes the biggest error factor in a GPS receiver's calculations.

Most people don't want to see the trigonometry and geometry involved in the calculations of the GPS data. With atomic clocks, microchips and a handheld device that can do it for you, who would? What we want is the result of these calculations. And, of course, this is the beauty of GPS because that is exactly what it gives you!

The DOD Global Positioning Satellites (24 in complete constellation)

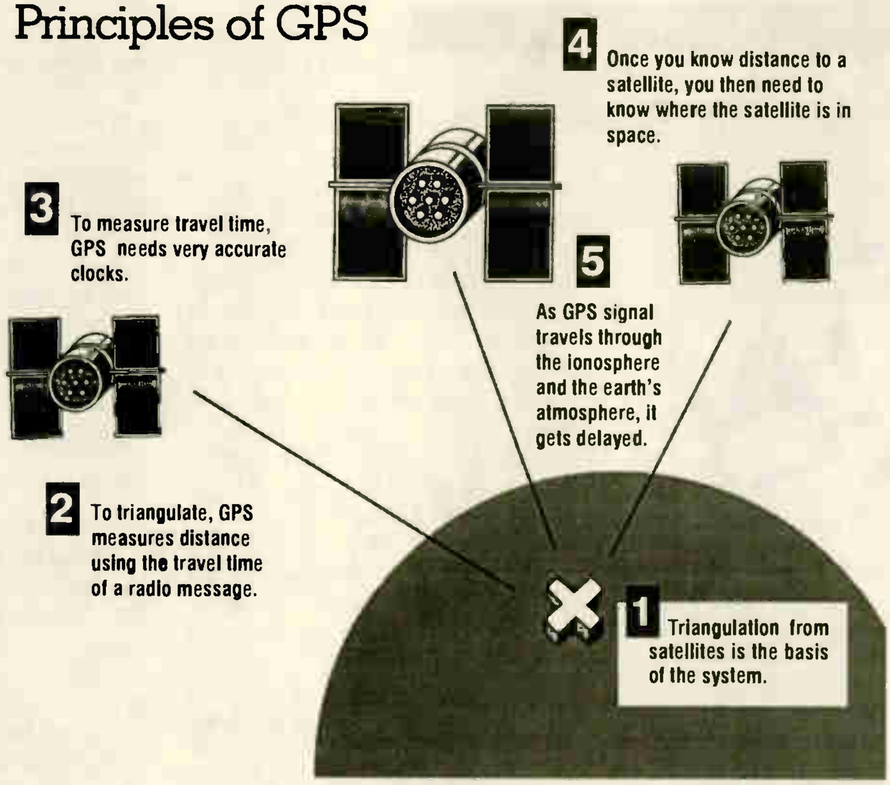
Name :	NAVSTAR
Built By :	Rockwell International
Altitude :	10,900 Nautical Miles
Weight :	1,900 lbs. (in orbit)
Size :	17 ft. (With solar panels extended)
Orbital :	Period: 12 Hours
Plane :	55 degrees to equatorial plane
Lifespan :	7.5 years (planned approximate)
Frequency:	1,227.6 and 1,575.42 MHz.

Each satellite has a group of on-board atomic clocks. The satellites and their clocks are maintained, tracked and synchronized by the US Naval Observatory to stay locked on time. This gives us a traceable standard to United States Naval Observatory (USNO) UTC time.

Many of us have used a map and compass to triangulate our position against natural land marks. This essentially is dead reckoning. In surveying, navigation with a sextant, cartography and route finding, we find similar use of distant or known points to determine our location. With GPS, you have a "smart compass" that will determine your position for you based on an artificial frame of reference.

These calculations are performed based upon the position data of the constellation of NAVSTAR satellites, the arrival time of the data, and the corellation of the data from one satellite as calculated against other satellites.

The combination of data gives you



more than the average compass alone. Because the NAVSTAR satellites have known (albeit changing) locations, the GPS receivers can interpret their data to provide your position in relation to the constellation. This result includes your local time and date, altitude, speed and direction of travel.

In the map and compass system, we take a sighting across the area of land we can see to a landmark that we can hopefully identify on the map that we hopefully have with us.

The GPS receiver listens for several satellites, stores a sample of data, and compares them until it finds a match of the pattern stored within receiver memory. Then the receiver determines the distance to that satellite, and calculates the same for at least two more satellites.

The pattern GPS uses is a long pseudo-random code which reduces errors because there are fewer chances for the receiver to lock up and match a pattern with a large percentage of noise. The receiver has the same pattern information built in which it compares to the pattern received from the NAVSTAR constellation.

The amount of shift needed between the two patterns allows a calculation to be made which determines the delay in time that it took for the satellite signal to reach the receiver.

GPS satellites transmit the pseudo-random code for timing purposes, plus a "data message" which contains information regarding the exact orbital position of the currently-received satellite. The timing accuracy involved in most receivers is in the nanosecond range--that's 0.000000001 second!

The course-acquisition code (C/A code-also known as the "civilian code") is a sequence of binary, biphase, pseudo-random modulations on the GPS carrier which repeats about every 267 days. Each one-week data segment is unique to each satellite and is reset by USNO. A fourth satellite is used to further reduce the errors in calculation and the results are displayed.

While three satellites can be used to get a fix, more satellites are necessary if you wish to track yourself in flight with accurate altitude, speed and direction. Some military GPS receivers use five or six.

Differential GPS

The accuracy of GPS can be improved by using a method known as "differential GPS" which uses several receivers in a group to take data from the constellation as well as information from a fixed point. A receiver in a known location is used to transmit correction data to calibrate and correct errors in the data which is sent to the other receivers in the area.

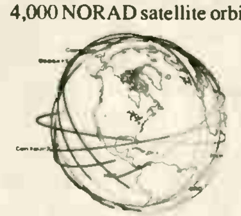
Trimble Navigation (645 N. Mary Ave, P.O. Box 3642, Sunnyvale, CA 94088-3642, 800-TRIMBLE) makes a ground-based differential GPS receiver that can be used for ranging. The data in this signal has the differential corrections that can be used by other GPS receivers to correct for errors down to the centimeter level.

There are pitfalls in certain types of GPS receivers. A quick and dirty test is to see how well the receiver displays position and velocity while standing still--it should not change its reading much at all. But, some manufacturers program their receivers to read zero velocity at speeds below one knot! Yet another problematic error.

Some manufacturers provide GPS computer interfaces to work with PCs, PC networks and VME bus types. These cards are GPS receivers which communicate time and date information to the computer network for synchronization of the clocks. This can be useful in digital signal processing or data acquisition over wide distances.

Trimble Navigation publishes a simple set of pamphlets entitled, "GPS: A Guide to the Next Utility." To better understand navigation, you could review Bowditch's "Practical Navigation". If you want to examine GPS receivers first hand, go to a yachting or boating supply or pilot shop.

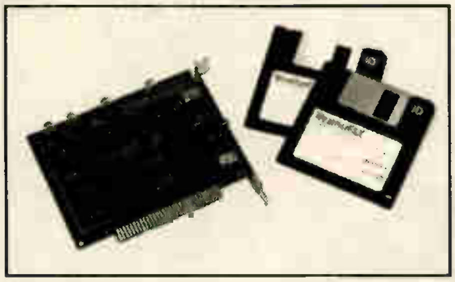
Whether you are a yachtsman, back packer, merchant mariner, pilot, researcher, astronomer or just plain curious, you can use the information provided by GPS anywhere in the world.



WHAT'S NEW

by Wayne Mishler, KG5BI

LOOK MA, NO INTERFACE!



Now there's a way to receive satellite transmissions by simply connecting your short-wave radio or satellite receiver to your computer. The OFS WeatherFAX V5 computer card plugs into any empty expansion slot in your computer. Next, install the accompanying software, connect the card to your receiver, and you're ready to start capturing and displaying high-quality weather satellite images and marine fax--without an outboard interface!

WeatherFAX works with all standard satellite receivers and most short-wave receivers that connect to a computer's RS232 port. Many ICOM, Drake, Kenwood and Yaesu receivers have this feature.

The capture board is a compact, half-size card with AM and FM that fits into any computer slot including portable computers.

A Doppler-shift correction provides straight edges from NOAA polar satellites and maintains frame sync -- even in noise, fading and signal dropouts.

WeatherFAX captures all signal types including GOES and Meteosat Wefax, NOAA and Meteor APT, HF marine fax, and wire photos.

The software and peripherals are controlled from the keyboard; there are no knobs to adjust. A self-test feature enables you to quickly verify correct system operation.

WeatherFAX uses standard two-line satellite tracking (ephemeris) data, a world-wide map database, and a true elliptical orbital model to draw geopolitical maps with labeled latitude and longitude grid lines as well as markers showing your location. Temperature calibration of NOAA infrared images allows you to determine ground and sea surface temperatures.

WeatherFAX includes enhancement and measuring tools. Enhancement filters sharpen images and bring out detail. Three-dimension gives you a layered view of cloud heights and variations in sea surface temperature.
WeatherFAX also includes an integrated satellite tracking program.

The basic package including card and software sells for $445 and is available from the manufacturer: OFS WeatherFAX, 6404 Lakerest Court, Raleigh NC 27612, telephone (919) 847-4545.

WINDOW TO THE WEATHER

At first glance, it's an unobtrusive little box that measures only six inches wide and three inches tall, and sits out of the way on your desk. But it opens a window to real-time weather pictures for anyone with a DOS computer and HF short-wave radio or satellite receiver.

It's called the WSHFAX. It's new. And it's available for $189.95 from A & A Engineering, 2521 W. LaPalma, Unit K, Anaheim CA 92801, telephone (714) 952-2114.

The WSHFAX is an interface that takes audio from your short-wave radio or data from your satellite receiver, translates them into computer lingo, and passes the translation to your computer for display on screen.

The interface comes with software that will run on any 286 or greater computer of 10 MHz or more. Slower computers can't keep up with the satellite data stream.

The interface has an attractive faceplate with LED tuning indicator, gain control and selector switch for choosing between HF and satellite signals. It comes pre-wired and tested, or you can buy it as a kit and assemble and align it's circuitry yourself for $30 less. Software is included with either the assembled version or the kit.

MULTIFAX ANNOUNCES NEW PRODUCTS

The MultiFAX company has announced the release of several new products including an external demodulator, TVRO down-converter and decoding software.

The external demodulator is housed in a vinyl clad aluminum and steel case, and runs on 12 volts DC from the included AC adapter or the cigarette lighter of your car or boat. An internal version is available.

Either version passes data from your HF short-wave or satellite receiver to the parallel (printer) port of an IBM compatible laptop, notebook or desktop computer. These images include HF WEFAX transmissions, NOAA and Meteor polar orbiting satellites, and GOES and Meteosat geostationary satellites. Price of the external demodulator and AC adapter is $389.

The down-converter is housed in a weatherproof metal case and installs outside at the antenna; it passes GOES and Meteosat data to a satellite receiver and is powered by your receiving system. The introductory price is $225.

The software (MFMAP Version 6) controls the demodulator and processes incoming data. It is a comprehensive program with numerous features to enhance images. It requires an IBM compatible computer with parallel port or vacant expansion slot, a VGA monitor, DOS 3.0 or higher, and hard drive with 4 megabytes of space.

Additional product information is available from MultiFAX, 143 Rollin Irish Road, Milton VT 05468, telephone (802) 893-7006.

SWAGURSAT SOLVES BANDWIDTH PROBLEM

For owners of ICOM R7000 and R7100 receivers, the SWAGURSAT, an external video demodulator manufactured by Swagur Enterprises, solves a common problem of receiving WEFAX satellite images on scanner radios. The problem is bandwidth.

While scanner radios operate in FM mode and receive frequencies on which WEFAX images are transmitted, they are designed to receive narrow band transmissions from police, fire and amateur radio stations. Their IF sections pass signals of about 10 to 15 Khz bandwidth and cut off frequencies outside of that window. WEFAX images typically are transmitted to earth with a FM deviation (or bandwidth) of about 40 Khz.

Like an airplane flying through a tunnel, a 40 Khz wide image pulled through a normal narrowband 10.7 MHz scannerIF will be severely clipped in the process. The high and low frequencies--and the image data they carry--will be lost. The center portion of the transmission gives you a picture, but without the highs and lows (whites and blacks) that produce high quality pictures.

The SWAGURSAT, which connects to the 10.7 MHz IF output ports of ICOM R7000 and R7100 receivers, intercepts the satellite signal in the receiver and sends it through its own receiver, which has an IF of 40 kHz, enroute to your computer. The signal arrives at your computer with all of its vital data intact. The computer's decoding software gets everything it needs to produce a quality image with full resolution and definition.

SWAGURSAT is very easy to use. Just plug one end of the patch cord, which comes with the unit, into the marked IF jack on the unit's case, and plug the other end into the IF jack on the ICOM receiver. You don't have to take the cover off your ICOM since no internal connections are required.

Another patch cord plugs into the signal output jack on SWAGURSAT and into the input jack of the decoding card in your computer. Insert the DC plug of the AC adapter into the jack on the back of SWAGURSAT labeled "power", plug the AC adapter into a 120 volt wall outlet, and you're in business.

SWAGURSAT is available from Swagur Enterprises, Box 620035, Middleton WI 53562-0035, telephone/fax (608) 592-7409.

BAYLIN RELEASES NEW BOOKS

Baylin Publications has released the third edition of its *World Satellite TV and Scrambling Methods--The Technician's Handbook.*

This revised and updated handbook includes several additional topics and expanded information on such subjects as LNB design and construction, flat plate antennas, feedhorns, smart cards, and case studies of encryption.

The authors explore components of modern home satellite systems complete with circuit and block diagrams. Nearly a third of the book covers broadcast formats, digital audio techniques, and basic scrambling and encryption methods.

Other topics covered include setting up a test bench, troubleshooting, and understanding special electronic components. Topics are illustrated with detailed graphics. This 388 page book measures just over 8 x 10 inches and contains over 200 photographs, diagrams, tables, and schematics.

The handbook is available from Baylin Publications, 1905 Mariposa, Boulder CO 80302.

TRACK SATELLITES IN WINDOWS

A new satellite computer program for Windows is on the market and combines sophistication with point and click simplicity. WinTrak, designed for satellite watchers, astronomers and amateur radio operators, features real-time tracking of satellites and will even track the moon, sun and stars.

Speed, simple operation and accuracy head a long list of features of WinTrak, which includes a database of more than 700 satellites; other satellites can be added by the user. The database can be expanded to include a nearly-unlimited number of satellites.

A new Auto Tracker interface provides automatic antenna control, with radio tuning for Doppler shift. You can use WinTrak to follow multiple satellites and modes as well as predict upcoming satellite passes and get three-dimension satellite views of the earth, too!

There are provisions for tracking satellites against star backgrounds and printing ground tracks at high printer resolution.

WinTrak runs on IBM and compatible 386, 486 and Pentium computers with Windows in either standard or enhanced modes. The program requires four megabytes of RAM, three megabytes of hard disk space, a 1.44 megabyte floppy disk, DOS version 5.0 or greater, and Windows 3.1 or greater. A math coprocessor is recommended.

WinTrak is available for $49.95 plus shipping and handling from R. Myers Communications, P. O. Box 17108, Fountain Hills AZ 85269-7108. Telephone: (602) 837-6492.

LOCK ONTO FAST-MOVING SATELLITES

Locking your antenna onto fast-moving satellites just got easier.

That's the specialty of a new hardware and software package from Emoto called SAT TRACKER, available from Electronic Distributors Co., (telephone (703) 938-8105), and other distributors.

The system tracks low-orbit satellites such as military LEO or ham Microsats, and tracks other types of satellites and celestial bodies as well. It puts you in control of remote antenna polarity and direction, and is upgradable for such things as optional transmitter Doppler shift frequency control.

SAT TRACKER includes a desktop control box and works with your PC to operate either Emoto or Yaasu satellite antenna rotators. It takes power from the rotator and connects to any existing parallel port on your computer, so there's no need to tie up an expansion slot.

The computer program that comes with SAT TRACKER is compatible with DOS and Windows 3.1, and runs in the background as a TSR (terminate and stay resident) program which lets you do other things with your computer while it controls your satellite antenna.

SATELLITE TIMES TESTS

By Larry Van Horn, N5FPW

The Icom IC-820H All-Mode Dual-Band Transceiver

Superior performance and features in a compact package

The Icom IC-820H is an all-mode, dual-band transceiver that is compact and offers many features that amateur radio satellite operators will appreciate.

The IC-820H covers from 144 to 148 MHz VHF and 430 to 450 MHz UHF, each band has two independent VFO's. The unit is compact and light-weight, measuring 3.7"H x 9.5"W x 9.4"D and weighing 11 pounds.

This rig is perfect for field operations or mobile use, but don't let its small size fool you. There are some high-performance, state-of- the-art features on the 820 that make this radio a good buy for the satellite enthusiast, features that were previously found only on more expensive radios.

Icom America, Inc.
2380 116th Avenue N.E.
Bellevue, WA 98009-9029
Telephone: (206) 454-8155
Fax: (206) 454-1509
Brochure Hotline: (206) 450-6088
Customer Service: (206) 454-7619

Satellite Operators Rejoice!

Tracking and communicating through an orbiting satellite can be a labor-intensive exercise for a ham. You are constantly adjusting antenna elevation/azimuth rotors (unless you have computer-aided tracking); moving your transmit frequency to compensate for Doppler shift; spotting the downlink beacon for signal strength; watching the clock for LoS; and tuning around the downlink looking for stations to work. The 820's built-in satellite functions has been designed to reduce some of the operator's workload during a satellite pass.

One operation that has been simplified is the selection of normal/ reverse tracking for a particular linear satellite transponder. A linear transponder takes a slice of the RF spectrum that is centered on a particular frequency, amplifies the entire slice and retransmits it centered on a different frequency.

There are two basic types of linear transponders used by amateur satellites: the noninverting transponder which retransmits the entire slice as received, and the inverting transponder which "flips" (reverses) the slice. Although frequency inversion may appear to be an unnecessary complication, it does have an important function--it reduces the magnitude of observed Doppler shifts. The 820 handles this function easily with the operator only having to press two buttons to switch between normal and reverse.

Another nice function available on the 820 is independent uplink/downlink control for Doppler shift compensation. Standard satellite operating practice requires operators to adjust their uplink frequency for Doppler shift and not move the receive downlink frequency. This approach is suggested because it generates a minimal amount of QRM to a large number of stations rather than completely disrupting communications in a single downlink frequency.

The 820 also has a separate VFO for satellite communication use and 10 satellite memories that provide quick switching from terrestrial to satellite operation. The 10 satellite memory channels make it easy to recall your favorite satellite uplink and downlink modes/frequencies.

Additional Features

Independent controls and indicators for each band make the 820 easy to operate. To change from the main band to the sub-band, you simply push a button. You can even receive simultaneous signals on each band and monitor the signal strength's of both signals on separate S-meters.

Other features include IF shift that electronically adjusts the center frequency of the receiver pass-band for effective interference reduction and a noise blanker that effectively eliminates "pulse-type" interference.

The 820 also has an AF speech compressor, auto repeater and one-touch repeater functions, built-in high stability (±3 ppm) crystal unit, RIT (Receiver Incremental Tuning), CW semi-break-in, and side tone. A memory allocation function that divides the memories between the bands is standard on the IC-820H. Packet operation (9600 bps) is possible with the built-in modulation limiter circuit.

The 820 can perform several types of scanning functions; these include a programmed scan (search between two frequency limits), memory scan (scanning the frequencies you have programmed into the memory channels), or a mode-select scan (scanning only memory channels programmed with a particular mode). If an optional tone encoder or tone squelch has been installed, the 820 will also perform a selected-tone memory scan.

Totally New Concept!

It's always nice to get "more for less", and in the case of the IC-820H, we get just that. Most PLL circuits in use by amateur transceivers employ a 2-loop circuit with 10 Hz frequency resolution. Icom has taken advantage of some new technology called the 1-loop DDS (digital direct synthesizer) in the transceiver's PLL (phase lock loop) circuitry. This new chip generates a signal with 1 Hz of resolution. Icom's DDS PLL also contains a normal PLL chip as the main loop and a DDS as the sub-loop. The selection of 1 Hz or 10 Hz tuning steps involves holding down the function button for more than one second. Other tuning steps include:

FM: 0.1, 5, 10, 12.5, 20, 25, or 100 kHz
SSB: 1, 10, 50 or 100 kHz

In Operation

The 820 proved to be an excellent performer, on both terrestrial signals as well as the OSCAR (Orbiting Satellite Carrying Amateur Radio) satellites. For this test, I was using two omni-directional antennas--the Scantenna from Antennacraft on two meters and a homebrew 435 MHz ground plane. Receiver sensitivity on the 820 is exceptional. Several repeaters were heard that had not been heard before, and I was able to hear most of the operating amateur satellites beacons with good signal strengths even without preamps.

I was able to hear several stations on OSCAR 13, even at slant ranges in excess of 20,000 km. Full quieting voice and packet signals were also received from the STS-65 SAREX experiment on 145.550 MHz during several passes of Columbia. Thanks to the 820's high transmit power, as N5FPW, I even managed a few voice contacts through RS-10 and AO-21. In each case, operators on the other end gave the 820 good signal reports.

I especially liked the 820's satellite memory channel feature. It really made it easy to check signal strength on downlink beacons or getting tuned in on my favorite operating frequencies when I found myself late for a pass.

A Few Criticisms

Icom's promotional literature advertises this transceiver as a base station. When I think of a base station, I think 'AC power supply". The IC-820H doesn't have one and prospective buyers need purchase an optional DC power supply to use the rig as a base station.

A major disappointment was the lack of a supplied microphone. There is nothing worse for a ham than to open the box of a new rig to find no mike to communicate with. This is also an option that must be purchased even though the operators manual on page one refers to "a supplied microphone". I called a couple of Icom dealers and they were not aware of the lack of microphone situation; they thought a mike was included. I know that desk microphones are always considered options, but a hand microphone would have been better than nothing at all. Given the retail price of the IC-820H, I think Icom should have sprung for at least an HM-12 hand mike.

Finally, the owner's manual is typical Icom. I haven't meet an Icom manual I've liked yet. Even in the section marked 'Basic Operation', the instructions consistently refer the reader to other pages to set up the transceiver for basic operation. For example, to set up the transceiver for basic FM operation (page 17), the manual requires you to read additional instructions on two other pages (pages 21 and 27). At the bottom of page one is a section marked, 'Convenient functions for FM mode'. This section will send you off to seven different pages to learn about six more functions on FM mode operation! 820 owners will spend quite a bit of time prior to getting on the air studying the owner's manual. I suggest you have a good, sharp pencil handy for making lots of notes in your owner's manual.

The Bottom Line

I really had fun using the 820 once I mastered the owner's manual (about two nights of intensive study), and found a compatible microphone and power supply to use with the radio. The relatively high price is fully justified by its outstanding performance and built-in satellite features. This transceiver will probably be a real winner for Icom. The suggested retail price for the IC-820H is $1,999.00.

Manufacturer Specifications

General

Frequency Coverage: 144-148 MHz, 430-450 MHz
Modes: SSB, CW, FM
Number of memory channels: 116 (50 regular, 1 call 2 scan edges for each band and 10 satellite memories)
Antenna Impedance: 50 Ω unbalanced
Frequency stability: ±3 ppm (14 to 140 degrees F)
Power supply requirement: 13.8 VDC ±15%

Current drain:	Transmit	High	16.0 A
		Low	7.0 A
	Receive	Max audio	2.5 A
		Stand-by	2.0 A

Transmitter

Output Power	Band	Mode	High/Low
	144 MHz	FM, CW	45W/6 W
		SSB	35W/6 W
	430 MHz	FM, CW	40W/6 W
		SSB	30W/6 W

Spurious emissions: Less than -60 dB
Carrier suppression: More than 40 dB
Unwanted sideband: More than 40 dB
Microphone impedance: 600 ohms

Receiver

Receive system	Band	Mode	Conversion
	144 MHz	SSB, CW	Single, superperheterodyne
		FM	Double, superheterodyne
	430 MHz	SSB, CW	Double, superheterodyne
		FM	Triple, superheterodyne

Sensitivity (both VHF and UHF bands)

FM	0.18iV for 12 dB SINAD
SSB, CW	0.11iV for 10 dB S/N

Squelch sensitivity (both VHF and UHF bands)

SSB, CW	More than 2.3 kHz/-6 dB Less than 4.2 kHz-60 dB
CW narrow (optional)	More than 0.5 kHz/-6 dB Less than 1.34 kHz/-60 dB
FM	More than 15.0 kHz/-6 dB Less than 30.0 kHz/-60 dB

Spurious and image rejection ratio:	More than 60 dB
Audio output power:	More than 2.0W at 10% distortion with an 8 Ù load
RIT variable range:	SSB, CW ±2 kHz (max) FM ±10 kHz (max)

THE BEGINNER'S COLUMN

By Ken Reitz, KC4GQA

The Mystery of Satellites Revealed

If you're not an industry insider, noted author, or NASA scientist, you're not alone! In fact millions of us have come to the satellite hobby with varying degrees of interest and enthusiasm. But we all have one thing in common: The desire to know more about this fascinating hobby. That's why you're reading this magazine, and that's what this column is all about.

Let's Get Started!

In the issues to come we'll be covering all the basics of satellite communications from DBS to amateur and all the spots in between. We'll review books, products and publications; we'll share tips on how to put together inexpensive receiving systems, how to actually see satellites in the sky, or how to convert your dish into an enormous ear, or how to build fancy installation tools from stuff found in your child's school desk. In addition, you'll get a background on satellite history as well as an exposure to some of the things hobbyists in other regions of the world are seeing and doing with the satellites over their skies.

The important thing to remember from the outset is that, to the millions of us for which this is not our job, it is a hobby; as such we are free to experiment to the point at which our bank accounts, time and spouses object. This is where the ingenuity comes in. If you weren't blessed with a great deal of disposable income, you'll appreciate the ability to do a little more with a lot less.

If you're one of the millions of satellite dish owners who came to the hobby via the entertainment route, you'll be interested to know that there's a lot more to do with your dish than watch infomercials and re-runs. Many other exciting worlds of satellite transmissions await exploration, from low orbiting weather satellites to ham radio operators on the Space Shuttle. So tighten up that chin strap and settle into that recliner for the thrill of getting into one of the most interesting hobbies of our time!

Building Your Satellite Library

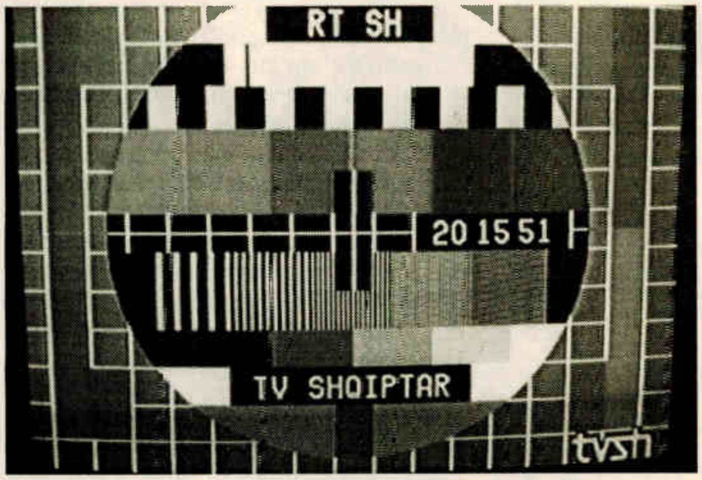
Better look for your reading glasses because our first stop is the library. But if your public library is like mine, the latest book on this technology is likely to be ten years old. The reason for this is simple: The economy for the past several years has not been kind to public libraries; as a result, most have had their budgets cut severely and expensive trade publications on this subject are not high priorities. Don't bother looking at your local franchise bookstore, either, because satellite titles don't move quite as fast as Stephen King's or Danielle Steele's.

Surround yourself with as much information as you can get for the least amount of money. Start with the mail order catalogs. You might be surprised at how much you can learn from a well designed catalog. Best of all, it's free. See the chart chart included with this column for more information.

Not So Free

The next step is to acquire information which is not free, but well worth the price. Refer to the end of this column for the address and phone numbers of publications listed. Foremost is Fortuna Communications' "Satellite TV Buyer's Guide". Sold in most bookstores on the magazine

Your Beginner's Column author drinking some coffee and surveying the dish farm. Would you believe that big dish was once the size of the small one? The trick is plenty of mulch and the right "feedline"! Photo by Jensen Montambault.



You probably missed this test pattern but our man in Merseyside, England didn't. He caught this test from Albania via Eutelsat 2F3 at 16 degrees east. Photo by John Locker.

rack, this guide is the cheapest, most comprehensive look at satellite TV available. Price is usually around $5 for this 90 page magazine format publication. Published once a year, the new edition is usually out in late fall. Among the useful information found here is a glossary of satellite terms, an overview of available reception equipment, and an explanation of audio and data reception.

Amateur Radio Satellites

How To Use the Amateur Radio Satellites (fourth edition) by Keith Baker, KB1SF, is a wonderful place to start in your search for "other satellite worlds". An amazing number and variety of amateur radio satellites have been launched through the years; many of these are still functioning quite well, providing countless hours of fun and amazement for the world's amateur radio community.

The good news is that you don't have to be a ham to "listen in"; if you own a shortwave radio and a scanner you already have the necessary receivers to start tuning in. Even better, with a small amount of study you can earn an amateur radio license and get in on the on-air action. The new edition has been substantially updated with lists of computer BBSs which can be easily accessed to provide tons of current information on AMSATs.

Weather Satellites

Year 'round, the most-talked about topic for most people after government and sports is the weather, and there's only one place to go for the most comprehensive treatment of weather satellites: The Weather Satellite Handbook by Dr. Ralph E. Taggart, WB8DQT. This $20 book is no cheapy, but there's no other single book which covers every aspect of weather satellite reception. You'll learn how to put together an inexpensive receiving system to pull in spectacular weather pictures direct from NOAA weather satellites. This technical book is not for the mathematically fainthearted!

Satellite Info Via Internet

Plugged into the Information Superhighway? You can access conferences, bulletin boards and all manner of interesting information via Internet. If you're on CompuServe, America On-line or a similar computer service with access to Internet, check out FIDO or Usenet for their satellite conferences. You'll meet hundreds of fellow enthusiasts eager to share their information on the subject.

Ho, Wait! Where's The Mystery?

That's just the point. If you were ever befuddled before by industry jargon and baffling scientific concepts, I say to you, "Go forward and befuddle no more!" Satellite Times' Beginners' Column can help. With each issue we'll tackle another tricky problem and together we'll learn more about satellites, the technological wonder of this end of the 20th century. Do you have a question about satellites? Ask it! If I don't know the answer to your question, I'll find an expert who does! Just write care of the address in the front of this magazine. For personal replies please enclose a self-addressed, stamped envelope.

Free Information Table

The following have mail order catalogs which include amateur radio satellite antenna systems in addition to other electronic gear.

Amateur Electronic Supply
5710 W. Good Hope Road
Milwaukee, WI 53223
Phone: 800-558-0411
FAX: 414-358-3337
BBS: 414-358-3472

Ham Radio Outlet
933 North Euclid Street
Anaheim, CA 92801
Phone: 800-854-6046
(Western U.S./Canada)

The following have mail order catalogs primarily involving Satellite TV reception equipment.

DBS Satellite Television
2316 Channel Drive
Ventura, CA 93003
Phone: 800-327-4728
FAX: 805-652-2190

NBO Distributors, Inc.
5631 Palmer Way
Carlsbad, CA 92008
Phone: 800-346-6466

Satman
6310 N. University No. 3798
Peoria, IL 61612
Phone: 800-472-8626

Skyvision, Inc.
1010 N. Frontier Drive
Fergus Falls, MN 56537
Phone: 800-543-3025
FAX: 218-739-4879

The following have mail order catalogs featuring satellite related publications.

Mark Long Enterprises, Inc.
P.O. BOX 159
Winter Beach, FL 32971
Phone: 305-767-4687
FAX: 407-589-9411

Baylin Publications
1905 Mariposa
Boulder, CO 80302
Phone: 303-449-4551
FAX: 303-939-8720

For more information on Satellite TV Buyer's Guide write Fortuna Communications Corp., P.O. Box 308, Fortuna, CA 95540-0308 or call 707-725-6951.

To order Keith Baker's "How To Use The Amateur Radio Satellites" Send a check for $5 to: Radio Amateur Satellite Corp. (AMSAT), 850 Sligo Avenue, Washington, D.C. 20044. Phone: 301-589-6062.

Dr. Ralph Taggart's "Weather Satellite Handbook" is available for $20 from the American Radio Relay League, 225 Main Street, Newington, CT 06111. Phone: 203-666-1541 FAX: 203-665-7531.

An Antenna Primer for Satellite Reception

By W. Clem Small, KR6A, CET

Sorting out the differences among the various types of antenna designs in common use today can be confusing. Let's review some important factors to consider in choosing antennas for receiving satellite signals.

Some Simple, Low- and Moderate-Gain, Linearly-Polarized Antennas

The simple low-and moderate-gain antennas discussed here are often useful for initial detection of satellites which orbit the earth. Sometimes they are adequate for monitoring, or even two-way communication, with the satellite. On the other hand, if the satellite's signals are weak, it will probably be necessary to switch to one of the higher-gain antennas discussed below.

Groundplane Antennas

The quarterwave groundplane is "low-gain"; it is less responsive to received signals than a "high-gain" antenna. Its nondirectional reception pattern, however, allows it to function well for initial detection of earth-circling satellites, except for a null (small zone of no response) directly overhead. This lack of overhead sensitivity can be overcome by tilting the vertical element at about 30 degrees from the vertical. A 5/8 wavelength groundplane antenna will give somewhat better response for satellites at low angles (near the horizon), but less response at higher angles.

The Halfwave Dipole

A horizontal halfwave dipole will receive well from most directions except for a null directly off each end of the antenna. The nulls can be removed by mounting the center of the antenna high and the ends low, making the antenna into an inverted V.

The dipole's coverage of satellites at various vertical angles (i.e., at different heights above the horizon) is not as consistent as is the groundplanes'; at low vertical angles it may miss signals. Changing the dipole's height above ground (or other reflective surface) varies its gain and vertical response patterning; heights of 1/2 wavelength and higher produce many nulls in its vertical pattern.

The Discone

The halfwave dipole and the groundplanes discussed above are relatively limited in bandwidth; they function best over a narrow band of frequencies. The discone antenna has the nondirectional response of the quarterwave groundplane combined with exceptionally wide bandwidth, typically 10-to-1; this means that the highest frequency it covers would be ten times the lowest frequency covered. Therefore this antenna can be useful for initial detection of moving satellites and for reception of strong-signal satellites over a wide frequency range.

Antenna Polarization and Signal Polarization

If an antenna's elements are vertical with respect to the earth, the radiated electrical field is vertically oriented; we call this "vertical polarization". If the antenna's elements and field are horizontally oriented, we say that they are "horizontally polarized". Such vertical, horizontal, or other specifically-oriented antennas are said to be "linearly polarized."

Receiving antennas respond best to signals which share the same polarity When the polarization of the received signal and the receiving antenna are 90 degrees out of alignment with each other (a vertically polarized signal and a horizontal receiving antenna, for instance), we say that they are "cross-polarized." Cross-polarization can cause a very significant (20 to 30 dB) loss in signal strength.

Signals received from spinning satellites periodically produce cross- polarization. Fortunately, circularly-polarized antennas which have relatively little loss (3 dB) when receiving such signals are quite useful in satellite signal reception.

Some Simple, Low- and Moderate-Gain, Circularly-Polarized Antennas

The Eggbeater

This low gain antenna has an nondirectional horizontal-directivity pattern. An interesting feature is that its polarization is linear at low angles, changing to circular at higher angles. As with the dipole, this antenna's height above ground or other reflective surface can add gain and modify its vertical directive pattern.

Quadrifilar Helix

By variations in construction, the vertical-directivity pattern of this moderate-gain antenna can be modified from relatively spherical to somewhat flattened. Its horizontal-directivity pattern is nondirectional.

Crossed Diploes

The crossed-dipole antenna is a circularly-polarized antenna with moderate gain and a nondirectional horizontal-directivity pattern. Its vertical directivity varies with height above ground or other reflective medium.

Circularly Polarized Beam Antennas

Antennas with a high degree of directivity are known as "beam" antennas.

TABLE 1. Gain and Polarization for Common Satellite Antennas

Antenna Type	Gain Level	Polarization
Quarterwave Groundplane	Low	Linear
Discone	Low	Linear
Halfwave Dipole	Low-Moderate	Linear
5/8 Wavelength Gndplane	Low-Moderate	Linear
Eggbeater	Low-Moderate	Circ. & Linear
Crossed Dipoles	Low-Moderate	Circular
Quadrifilar	Moderate	Circular
Crossed Yagi	Mod to High	Circular
Helical	High to Very High	Circular
Horn	High to Very High	Linear
Dish	High to Very High	Set by Feed Ant.

Circularly polarized beam antennas with moderate to very-high gain and directionality include the turnstile with reflector (crossed dipoles over a reflector), crossed Yagis, the helix, and the various dish-reflector antennas with circularly polarized feed antennas.

For satellite listening purposes we can define "noise " as containing terrestrial (originating on earth) signals, received electrical noise, and unwanted satellite signals on the channel of operation. A notable feature of higher-gain, directive beam antennas is that they can reject much of this unwanted noise; this is because their responsiveness is focused primarily into their reception pattern's main "lobe" (zone of concentration). Thus, in the direction to which their main lobe points, a beam antenna has a greater responsiveness than a low gain antenna, and for signals and noise coming from directions other than the direction of its main lobe, it has less responsiveness than lower gain antennas. The resulting signal-to-noise ratio improvement obtained with a beam makes it possible to receive much weaker signals than is the case with lower gain antennas.

Generally speaking, the greater the gain of an antenna, the more narrow its major lobe (i.e., more narrow its beamwidth). A very narrow beamwidth with its very high gain means a high signal-to-noise ratio (that's good); however, narrow beamwidth can make it difficult to aim the antenna and to track a moving satellite. Beams with narrow beamwidths also are more prone to signal loss due to minor slippage of the antenna mount or to satellite drift.

Using an antenna with the least gain that will provide good communications will minimize these problems. Beam antennas with fixed or directable mounting are usually utilized with geosynchronous satellites; for use with moving satellites, a tracking mount and tracking control system may be utilized.

In Conclusion

Low or moderate gain, nondirectional antennas function well for initial detection of satellites which move in relation to the earth, and for receiving stronger signals they may be all the antenna that you need. On the other hand, once the satellite is located a beam antenna with higher gain may be necessary for satisfactory weak-signal reception. When using a beam antenna, a fixed mounting is appropriate for orienting the beam to receive geosynchronous satellites, while a tracking mounting may be required for continuous work with satellites which move in relation to the earth.

In future issues of *Satellite Times* we will provide both informational and construction articles covering many of the antenna types discussed above.

Ask Larry

By Larry Van Horn, N5FPW

Questions or tips sent to "Ask Larry" are printed in this column as space permits. If you desire a prompt, personal reply, mail your questions along with a self-addressed, stamped envelope (no telephone calls, please)

Q. I would like to receive SCPC signals like the ones you mention in your Satellite Services Guide in ST. What equipment do I need? (Mike Townson, Tampa, Fla.)

A. SCPC means Single Channel Per Carrier and is often confused with standard audio subcarriers available on your satellite receiver. SCPC signals cannot be received on a conventional TVRO receiver. You must use a separate SCPC or VHF/UHF communication receiver to hear these audio signals. Your selection of a receiver should include the following considerations:

1. Continuous frequency coverage from 950-1450 MHz.
2. True FM mode in two bandwidths, narrow and wide.
3. Stable frequency selection and high quality.

The ICOM R-100 or R7100 works well as a SCPC receiver. You can also purchase dedicated SCPC receivers (i.e. Universal SCPC-100/300) that deliver excellent performance. You will also need a high frequency splitter (950-1450 MHz), with a power pass port to complete your installation. For more information, get a copy of Tom Harrington's *Satellite Radio on Your Satellite System*, $16.95 plus $4.50 shipping (UPS) or *Hidden Signals on Satellite TV*, $19.95 plus $5.50 shipping (UPS). Both books are available from Grove Enterprises.

Q. What are the basic scrambling methods encountered by satellite dish owners in the North American geostationary arc? (Art Grein, Boston, Mass.)

A. In North America, there are several methods of scrambling TVRO signals and only one that the U.S. consumer will be authorized to decode.

VideoCipher II Plus (VC II+) is used by virtually all C-band subscription programmers serving the home satellite marketplace. VC II+ encrypts the video by stripping away the vertical and horizontal synch pulses prior to uplinking the signal. The VC II+ scrambler also creates a negative image by inverting the video. At the uplink site, the VideoCipher encoder also converts the sound portion of each TV signal from an analog to a digital signal.

Each subscriber's descrambler is assigned a 12-digit unit address number that has been pre-programmed into its electronic circuitry. The subscriber must supply the programmer with the unit address number whenever ordering a scrambled service.

Other scrambling methods used include: VideoCipher 1 (used by the CBS television network), B-MAC (used by Primestar and AFRTS to name a few), and Leitch (ABC television network). Home dish owners are not authorized to purchase any of these descramblers to receive any of these services. Canadian uplinkers use the Orion scrambling system to encrypt their TV signals and these decoders are only available to Canadian viewers.

Q. I just bought and set up an RCA DSS satellite system. I would like to use the system on my 42 foot boat in the Bahama Islands. Will I be able to see a useable signal from the DBS-1 satellite? (Roy P. Finney, Spring Hill, Fla.)

A. Yes. The satellite footprint for DBS-1 published in the 1994 WRTH *Satellite Broadcasters Guide* indicates that its downlink signal would be visible in the Bahama Islands.

Q. Would it be possible to receive INMARSAT signals with a Yagi antenna, and if yes, does such an antenna exist? (Robert S. Elbl, Salina, Kan.)

A. Yes on both questions. While signals from INMARSAT satellites in the 1530-1545 MHz range are right-hand-circularly polarized, with the right combination of antenna gain and low noise pre-amplification, full quieting signals are possible pn a loop yagi. Even though a loop yagi is linearly polarized, the loss due to cross polarization is only about 3 dB. This loss can be made up through the use of a good, low-noise GaAsFET preamplifier. A good source for L band antennas and preamplifiers is Down East Microwave, RR1, Box 2310, Troy, Maine 04987-9721 (207-948-3741). Bill Olson, the owner, wil1 send you his latest free catalog on equipment covering the 1.5 to 1.7 GHz spectrum on request.

Q. I have a Uniden UST-4400 satellite receiver that is stuck in the Ku band mode. I only have C band capability through my Odom 10 foot dish. What can I do to get my C band reception back? (Dick Hoskinson, Murphy, N.C.)

A. According to Ron Johnson at Uniden satellite tech support, you should first try a "hard kill" or clear your receiver's memory. First, unplug your satellite receiver from its power source; then, facing the front of the receiver, remove the top cover. In the center of the receiver, locate the lithium battery and at the six o'clock position on the battery you will find jumper J121. Remove the jumper on J121 and short the pin closest to the front of the receiver to chassis ground. This will reset the receiver to manufacture presets and should restore your receiver to the C band frequency range.

If the above procedure does not work, then you probably have a bad ROM memory chip which will have to be replaced. You can call Uniden at 1-800-261-9498 and they will tell you the procedures on getting a new chip.

Q. There is no nearby outlet for National Public Radio. Is it carried by satellite? (David O. Chastain, San Antonio, Texas)

A. National Public Radio (NPR) uses SCPC signals for program distribution. You will also find several affiliates that can be heard on conventional audio subcarriers in both C and Ku bands. Check this issue's Satellite Services Guide for complete information on audio subcarrier affiliates and SCPC signals from NPR.

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IC-2700H

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The IC-2700H has **Independent Controls and Switches** for each band. Often-used dials and switches for each band are duplicated, providing true dual band operation in V/V, U/U or V/U modes.

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- 14 Autodialing Memories
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- One-push Action Buttons
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- Voice Synthesizer (opt. UT-66)
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- Optional Tone Squelch and Pocket Beep

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IC-2340H with supplied HM-77 DTMF Microphone

IC-2340H

The IC-2340H offers **Independent Controls and Switches** for each band (VFO/MHz, Memory/Call, Volume/Squelch and main tuning dial) for **True Dual Band Operation.** Both frequencies are "stated" for quick visual reference and greater driving safety.

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The IC-2340H also offers both an **Auto Repeater Function** and optional **Tone Scan Function.** Just as with the IC-2700H, the IC-2340H will automatically select the proper duplex and offset direction for repeater operations. It will also scan for and set the subaudible tone frequency being transmitted by other stations.

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ST's Space Interest Groups list those local, national and worldwide groups you can join directly that promote space and space activities. If you belong to a space group and haven't seen it listed in *Satellite Times* write today and ask for a Space Group listing form. Your group will be listed each month, and will be featured in a group profile at least once, as well as receiving a complimentary *ST* subscription for group use. Write to: SIG Editor, c/o Satellite Times, P.O. Box 98, Brasstown, NC 28902-0098.

Space Group Profile: AMSAT

AMSAT is a worldwide group of Amateur Radio Operators who share an active interest in building, launching and then communicating with each other through non-commercial, Amateur Radio satellites.

By any measure, AMSAT's track record has been impressive. Since its founding, nearly 25 years ago, AMSAT has used predominately volunteer labor and donated resources to design, construct and with the added assistance of government and commercial space agencies, successfully launch, some thirty Amateur Radio communications satellites into Earth orbit.

The Radio Amateur Satellite Corporation (as AMSAT is officially known) was formed in 1969 as a not-for-profit, 501(c)(3), educational organization chartered in the District of Columbia. Its aim is to foster Amateur Radio's participation in space research and communication.

AMSAT was founded to continue the efforts, begun in 1961, by Project OSCAR, a West Coast group which built and launched the very first Amateur Radio satellites. OSCAR stands for *O*rbiting *S*atellite *C*arrying *A*mateur *R*adio, a term that is still used to identify most Amateur Radio satellites.

Besides building and launching satellites that allow Amateur Radio operators to experiment with new and more sophisticated ways of communicating, AMSAT has also helped both government and commercial space agencies develop new ways of carrying payloads into orbit.

In addition to its unmanned satellite efforts, AMSAT has also been active in manned space and educational activities. Working together with the American Radio Relay League (ARRL) and the National Aeronautics and Space Administration (NASA), AMSAT volunteers helped develop new space-qualified hardware and have since donated their technical communications "know-who" to a number of flights involving Amateur Radio operation aboard the NASA Space Shuttle. In recent years, these Amateur Radio operations, called SAREX (which is short for *S*huttle *A*mateur *R*adio *E*xperiment), have been used to bring school children in a number of countries into direct radio contact with Shuttle astronauts in Earth orbit.

For the past 25 years AMSAT groups have played a key role in significantly advancing the state of the art in space science, space education and space communications technology. Membership: $30/U.S., $36/Canada, $45 elsewhere a year.

Amateur Satellite Corporation (AMSAT)
P.O. Box 27
Washington, DC 20044
(301)-589-6062

ASERA Ltd
PO Box 184
Ryde, NSW, Australia, 2112
email: lindley@syd.dit.csiro.au
Membership $A100 (dual subscription), Subscriptions $A25 (newsletter only) $A50 (journal only).

British Interplanetary Society
27/29 South Lambeth Road
London SW8 1SZ
ENGLAND
Membership: No dues information available at present.

Canadian Space Society
43 Moregate Crescent
Bramalea, Ontario
CANADA L6S 3K9
Answering Machine: (416)-626-0505
CSS BBS: (905)-458-5907 (8N1, up to 2400 buad)
Membership: Annual dues are $25/year ($15/year for full-time students, $100/year for corporate members).

National Space Society
Membership Department
922 Pennsylvania Avenue, S.E.
Washington, DC 20003-2140
(202)-543-1900
Membership: $20 (youth/senior) $35 (regular).

The Planetary Society
65 North Catalina Avenue
Pasadena, CA 91106
(818)-793-5100
email psociety@delphi.com
Membership: $5/year

Space Access Society
4855 E Warner Rd #24-150
Phoenix, AZ 85044
(602)-431-9283 voice/fax
hvanderbilt@bix.com
Membership: $30/year, $1000/lifetime; includes email updates. $50 for email plus mailed hardcopy ($25 extra outside the US).

Space Studies Institute
258 Rosedale Road
PO Box 82
Princeton, NJ 08540
Membership: $25/year. Senior Associates ($100/year and up) fund most SSI research.

Students for the Exploration and Development of Space
MIT Room W20-445
77 Massachusetts Avenue
Cambridge, MA 02139
(617)-253-8897
email: odyssey@athena.mit.edu
Membership: Dues determined by local chapter.

United States Space Foundation
PO Box 1838
Colorado Springs, CO 80901
(719)-550-1000
Membership: Charter $50 ($100 first year), Individual $35, Teacher $29, College student $20, HS/Jr. High $10, Elementary $5, Founder & Life Member $1000+

World Space Foundation
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South Pasadena, California 91030-1000
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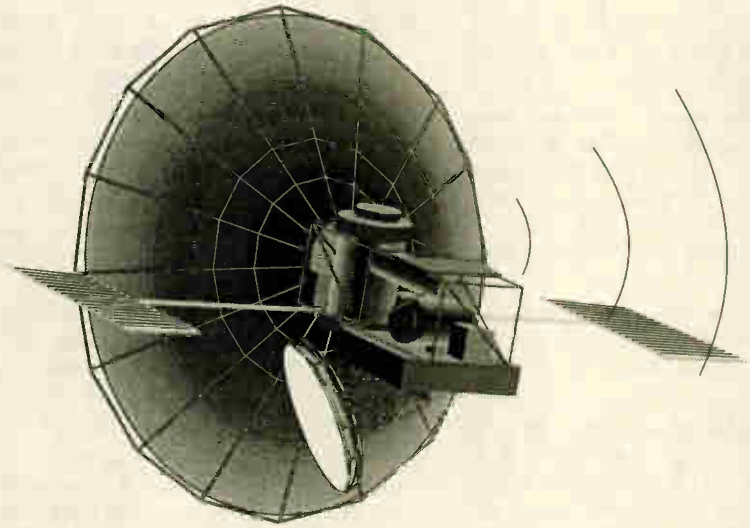

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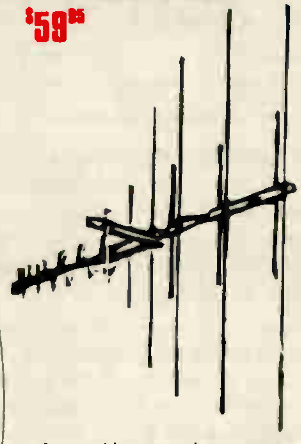

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By Bob Grove, Publisher

Just a few short months ago, several of us were sitting around a table at the *Monitoring Times* editorial offices discussing an idea: With many formerly-earthbound communications services now moving to satellites, might it not be a good idea to publish a magazine directed toward these new services?

The general reaction was not only that it was a good idea, but why hadn't we thought of it before? And why hadn't anyone else done it?

With the new Personal Communications Service (PCS) looking toward Low Earth Orbiting (LEO) satellites for range extension, with broadcasters moving to Ku band for emerging digital technology, and with the government, military and private sectors banking on satellites for the future, it is a technology whose time has come.

Just as *Monitoring Times* was the first wide-spectrum monitoring magazine for terrestrial services, *Satellite Times* is the first wide-spectrum monitoring magazine for space services.

ST is a unique publication which has amassed one of the greatest pools of writing talent in the satellite industry. Our columnists and feature writers have been hand-picked, chosen not only for their knowledge, but for their skills in knowing how to share that knowledge with their readers.

But you will play a vital role as well; as *ST* continues to grow, we invite your comments, your recommendations and your criticisms. We want *ST* to be YOUR magazine, YOUR window on the heavens.

Space communications is the new reality for those of us who grew up in an age of science fiction and emerged into a world of science fact. *Satellite Times* is your guide to that "brave new world." Welcome to the future!

If You Think The Sky's The Limit...Think Again!

Touch the future right now and venture into space through satellite communications. It's a fascinating aspect of Amateur Radio–and more.

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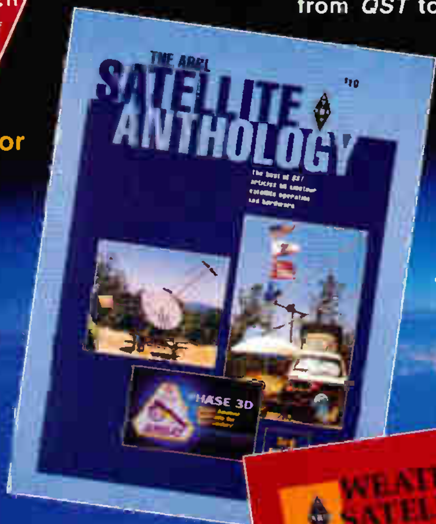

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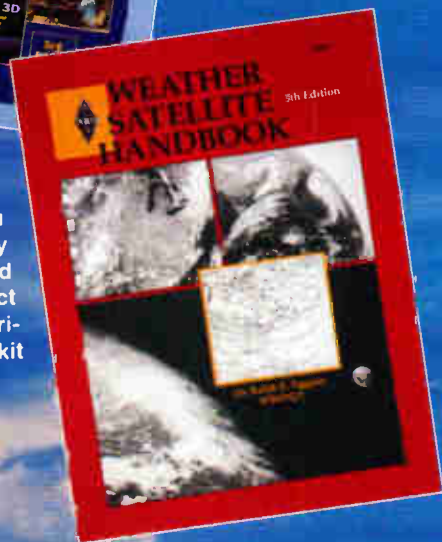

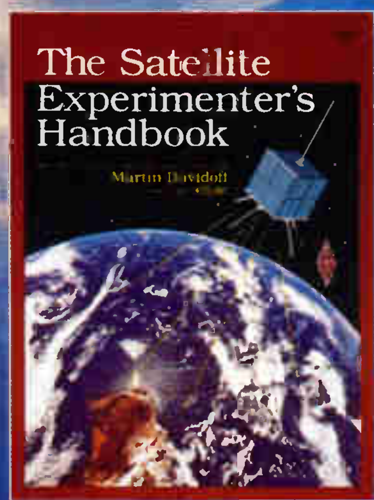

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