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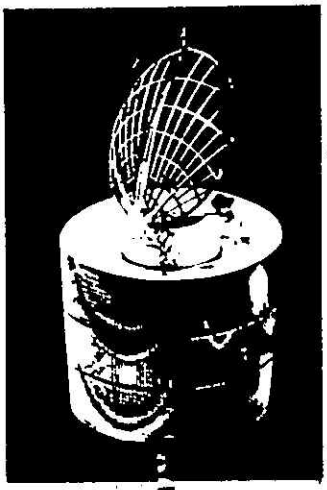
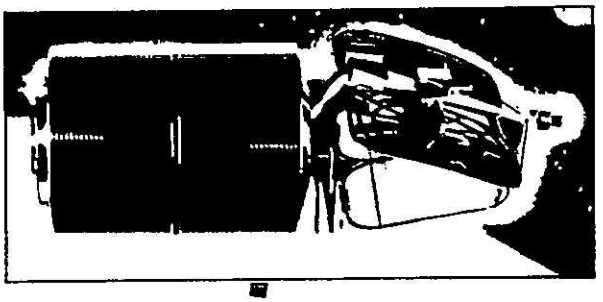
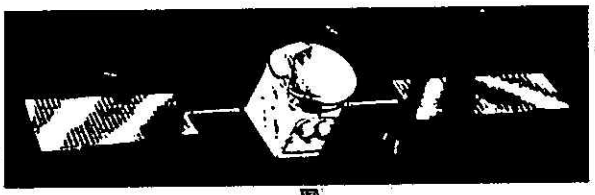
BROADCAST MANAGEMENT/ENGINEERING



SPECIAL REPORT: SATELLITES

- How broadcasters use the birds
- New equipment review
- Planning for an earth station





EDITORIAL

Hard Decisions Re Satellites

SATELLITES REPRESENT AN OPPORTUNITY for broadcasters. But like most opportunities, satellite use presents problems both technically and financially. The "invasion from outer space" will go on and broadcasters will have to face the tough decisions regarding satellites.

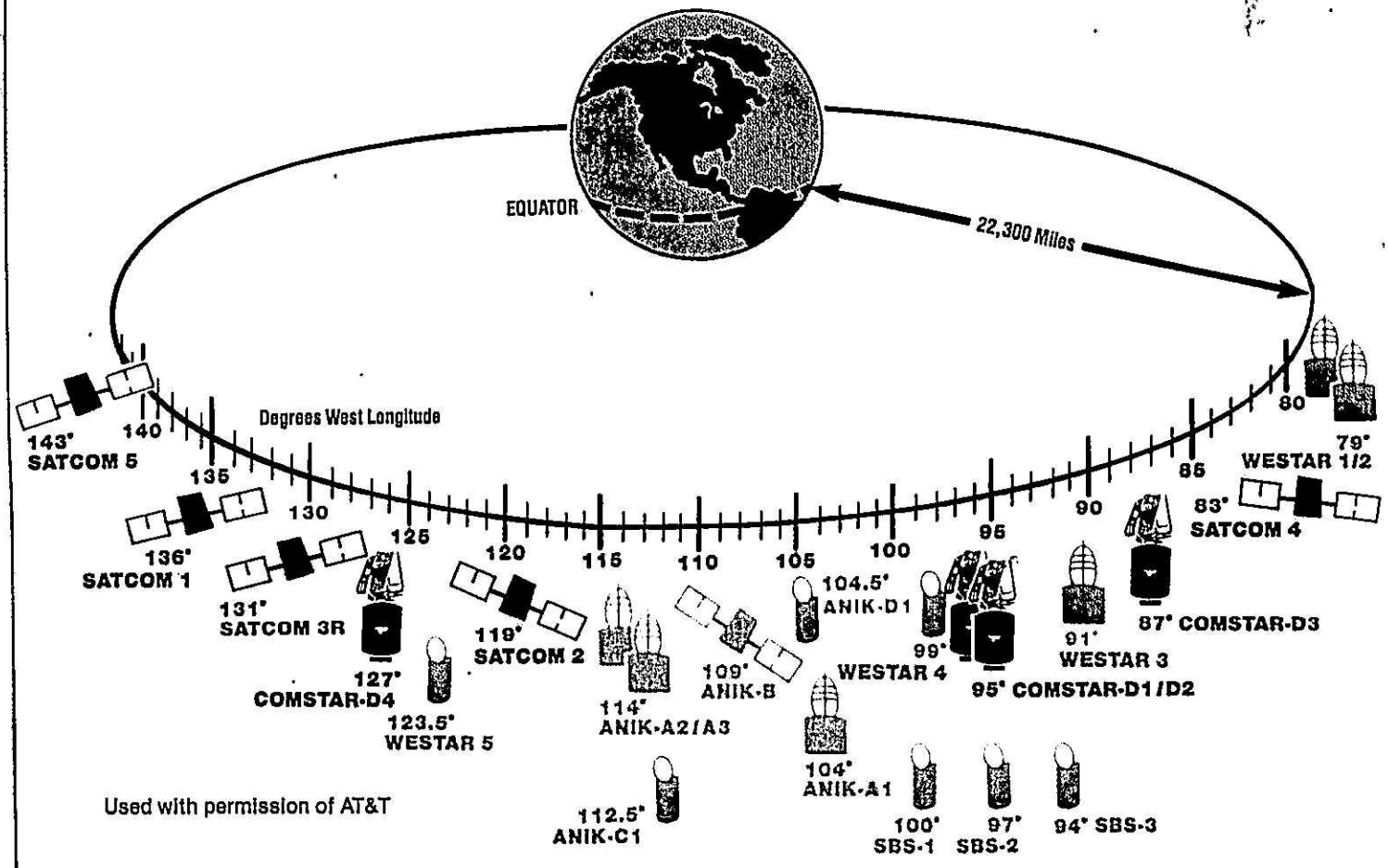
While network and affiliate relations are ordinarily considered family affairs, the stalemate over buying earth station equipment deserves comment. The reluctance of affiliates to purchase the systems approved by the networks is holding up progress in satellite use; therefore, we think that the "big guns in New York" should reconsider their policies in order to break any potential deadlock.

It appears that offers of free earth stations from RKO and a commitment of just $7000 to procure the Mutual dish have justifiably caused most affiliates to hold off the decision to buy the more expensive network-approved equipment. As a result, the heavy investment in satellite transmission by the networks will not mean much if there is no one on the affiliate receiving end.

Meanwhile, at the ultimate receiving end, consumers are being lured into buying their own dishes for DBS pickup. DBS offers new opportunities for broadcasters, but there is a problem to be resolved among the half-dozen or so DBS suppliers over a common transmission standard. The FCC no doubt will stick to its marketplace policy on this issue; however, there is danger that consumers will balk at the idea of having to acquire a different descrambler/converter for each satellite service. Clearly a single unit capable of handling all DBS services would be in order. If the FCC does not take a stand, then it may be up to an industry group like the EIA to work out a standard.

At the heart of the satellite situation is the need for station management to appreciate the many ramifications of dealing with the birds. The options are many and the stakes are high. This is the time that engineering and station management must work together.

For example, both need to analyze the options and develop a long-range plan. Getting the lowest-price receiving system that works today may not work in the future when the number of satellites grows and the possibility for interference increases. Another key issue is the need for reliability and redundancy. Moving into TV transmission, the three major networks have put reliability and backup high on their priority lists, and so should the broadcast stations. Finally, there is indeed a need to plan for very heavy use of satellite signals in the future. With this heavy use comes the need for keeping the plant simple in order to ease maintenance. A patchwork, quick and dirty approach will not do.



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Coming soon to a market near you . . .

INVASION OF THE SATELLITES

They came from outer space and spread across the country into the smallest communities. Soon no broadcaster could deny their overwhelming power.

By James A. Lippke, Editor Emeritus and Robert Rivlin, Editor

Time was, not all that long ago, when communications satellites were thought of as belonging only to other services besides broadcasting. Telephone and data transmission were their primary uses, together with cable TV program distribution. And if a broadcaster used information from a weather satellite, or participated in an occasional ad hoc network to distribute local sports nationally, it was considered a major innovation.

Now, suddenly, satellite programming is everywhere—over 160 programs on 113 transponders of 14 satellites. Much of it, of course, is still cable-oriented—all the various CNNS, ESPNS, HBOS, and Showtimes, to say nothing of the new trend towards cable audio (see news feature in this issue).

More and more of it, however, *is* intended for the commercial broadcaster. On the radio side, there are the syndication services offered by Bonneville, RKO, ABC; services such as WGN, which offer their standard broadcasts as material for syndication; and so forth. Mutual, NPR, AP and UPI, of course, have been on satellites for years. And on the TV side, local or regional networks are being joined more and more frequently by full-scale network distribution systems.

Just as an example of how busy broadcasters are with satellites, consider the case of Don Larsen, director of engineering at Rapid City, SD's KOTA—an NBC TV affiliate and a CBS radio affiliate. Using an Antenna Technology Corp. Simulsat 5 sys-

tem which looks at two satellite feeds at once, Larsen regularly receives programming from six different satellites. Radio comes in from Mutual on Westar IV, NBC and RKO on Westar III (received on Harris and a Microdyne 1100 receivers, with a Scientific-Atlanta DAS system on the way for the CBS digital signal); plus TV programming on Westar V and Satcom 3 and 4 and a prime feed from NBC on Comstar 3 (received with three S-A 7500s). All this in addition to the UPI news feed.

As Bruce Hough, VP and GM of Bonneville Satellite, puts it, "I think the fact that over 150 markets can now be reached with programming delivered by satellite demonstrates a strong endorsement by broadcasters of the flexibility and benefits which satellite transmission provides. We are about to the point where the universe of earth stations, originally installed experimentally, has become indispensable."

And, within the next few months, the birds will become even more crowded, as the major networks switch from landlines to the new digital audio service on Satcom IR. CBS Radio is making a total switch to satellites for program distribution. According to a letter distributed to its affiliates in May, landline delivery or programming to the northern tier of the United States "will be cancelled as of 11:52 (ET) Friday, Sept. 30. Effective Saturday, October 1, the CBS Radio Networks will be fed only by satellite to that part of the country." Affiliates are advised to move immediately to purchase the $10,000 Scientific-Atlanta digital audio earth station systems. ABC began the digital audio service in December last year and over 40 stations have made the conversion to date.

Rumblings are reported, however, among all three network affiliate groups, which are balking at having to spend their own money to install the S-A systems. A report is that only one in five affiliates has ordered, and that interest has slowed to a trickle. Perhaps offers of free earth stations from RKO or the commitment of only $7000 to purchase the Mutual dish system have convinced some affiliates that it might be more worthwhile to switch than fight. It is also possible affiliates are waiting for another manufacturer besides S-A to begin manufacturing digital audio receivers, hoping for a lower cost.

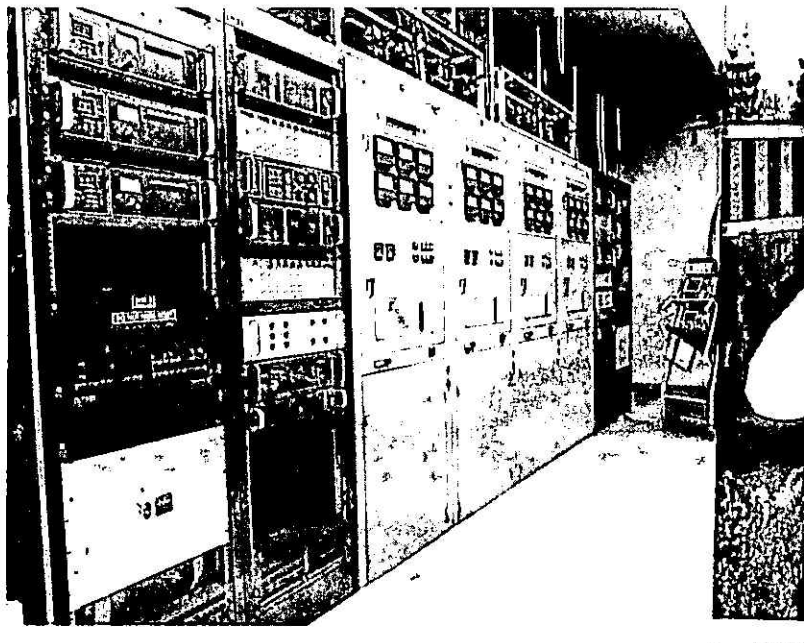
Not only are the radio networks about to convert over, but all three television networks can be expected shortly to begin program distribution to their affiliates via satellite—after both ABC and CBS begin 24-hour-a-day satellite feeds of news, sports, and other programming from Europe to the U.S. through Comsat's Intelsat.

According to Dave White at CBS, VP Administration, Production Facilities and Engineering, the network will begin Phase 1 of its satellite conversion program by sending signals to nine southwestern affiliates stretching from Wichita Falls to Los Angeles. "Phone companies just can't keep up with broadcast demands these days," observes White. "What with independent stations doing their own programming and local and regional sports and increased news operations, they're already overbooked. So we have to expand someplace."

Although the satellite system supplier had not been picked as of this report, White wrote the specs to which the system must adhere. The main downlink antennas will be seven meters, but an auxiliary dish—five to six meters—will be required in case of solar transients or a malfunction; the cost to the affiliate will be $100,000 to $150,000. Nine-meter uplinks will be located at all O&Os except St. Louis and Philadelphia.

Julie Barnathan at ABC also plans to have satellite distribution to affiliates in the Western time zone by the second quarter of 1984. A supplier was to have been picked by now (rumors have pointed to Andrew Corp.), but again the decision had not been announced at press time. Specs for the ABC system are for a 9 m steerable antenna as the main dish, plus a 4.5 m antenna as a backup.

It will be NBC, however, that will get the jump on the other two by beginning satellite distribution to 24 affiliates on January 2, 1984, with expansion to a full satellite



Hollywood, CA harbors the west coast satellite facilities of Metromedia Inc. As part of the extensive array of equipment, three Harris earth stations are located just outside the main building. The two 9 m dishes in the foreground are uplink units with responsibilities for cable news and syndicated programming distribution, while the 6.1 m dish in the rear is a receive-only.

Master control for all satellite functions is executed from the Harris computer. All three steerable dishes and the entire earth station shelter are controlled from the keyboard. Maintenance and power functions can also be attended to from this operator position.

The earth station shelter contains four 3 kW Klystron HPAs (high power amps from Varian) with receivers and exciters to the left. An intricate RF switching network is located atop the Klystrons. The system was designed and installed by Harris Corp.

system by the following September. Although NBC hasn't yet officially announced whose hardware it will use, the distribution plan will be handled by Comsat under a 10-year contract (worth several hundred million dollars). Until 1985, the service will operate over the Ku-band Satellite Business Systems bird, and will then convert over to Americom satellites.

Perhaps more importantly, NBC has apparently decided that its two-year testing program of the Ku band for satellite transmission is acceptable (both ABC and CBS have apparently locked in on the C band). Ku offers the advantages of requiring less power, although critics point to potential interference problems that can be caused by rain, even though solar transients can be expected to interfere with satellite transmissions at least twice a year even on the C band. As NBC's Mike Sherlock pointed out in an exclusive interview last January, however, the occasional interference that might be caused in a heavy rainfall area (the problem arises at the downlink, not the uplink) is certainly no worse than the occasional outages found with current landline use, and the advantages—among them the ability to locate the dish almost anywhere, without fear of terrestrial spectrum interference—far outweigh the disadvantages.

Ku band advantages

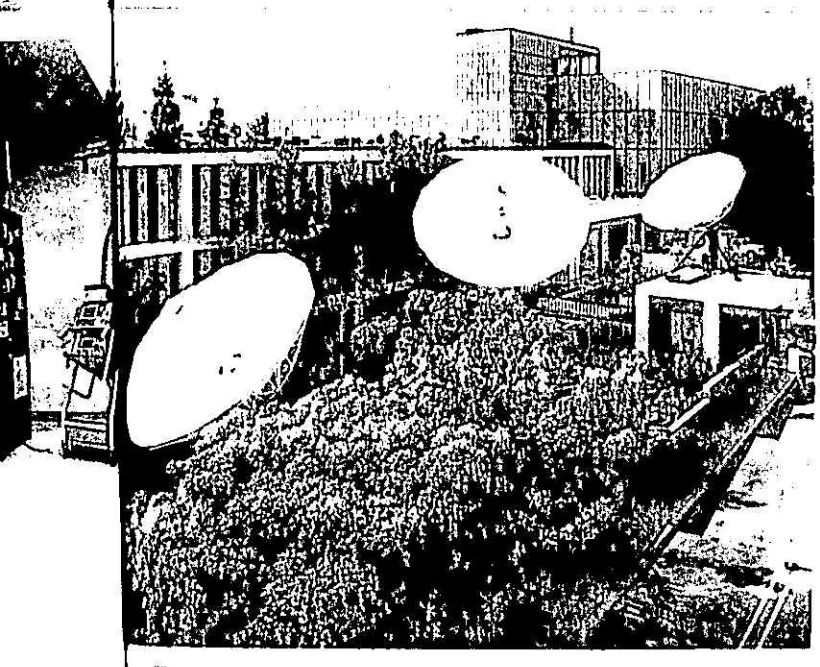
The 12 GHz Ku band has become the broadcast satellite of choice for the '80s, especially since every C band slot at four-degree spacing is filled for the next 10 years. Virtually every major satellite system now being planned is either entirely Ku band or incorporates both Ku- and C-band capabilities. Microdyne, for instance, has just received a $300,000 contract from VideoStar to install 50 earth stations for Hewlett-Packard that will accommodate H-P's teleconferencing needs on the Ku band. Ford Aerospace Satellite Services Corp. plans a 1987 launch of a three-satellite system, each containing 54 transponders, with 23 on the C band and 30 on the Ku band. These are medium-power Ku signals. RCA has filed to launch a high-powered Ku satellite in 1985.

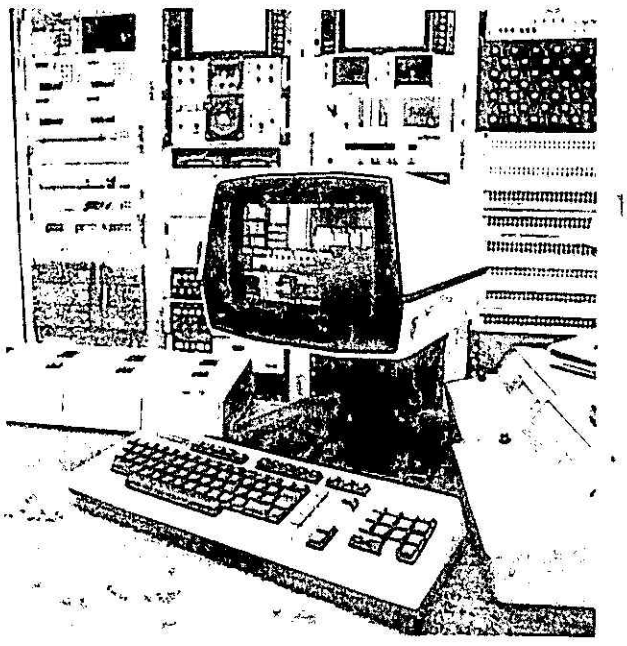
And the field may become even more crowded if SMATV operators heed the advice of Americom's former president Andrew Inglis and switch over to 40 W Ku band transponders as being the most economical and logical way to go (see discussion on SMATV later in this special report).

The 12 GHz Ku band was established by the 1979 WARC conference in Geneva, which allocated the 11.2 to 12.7 GHz C band for fixed satellite services demanded by telephone, cable, data transmission, teleconferencing, and similar operations, and the 12.2 to 12.7 GHz Ku band for broadcast satellite services such as DBS. The distinction may be moot, since the FCC has indicated it may allow the two bands to be combined and used for either service. And the FCC must still resolve where to reallocate current microwave users of the Ku band, which include public safety radio operators. But in the meantime, broadcast use of Ku continues to grow.

C band is still very much alive. One of its chief proponents is AT&T, whose Satellite Television Service, operating out of a central receive/transmit site in Hawley, PA over the Telestar 3 satellite, boasts impressive signal characteristics. Video S/N in clear air is better than 56 dB (54 dB in rain); audio S/N is 63 dB with 0.2 percent harmonic distortion at 18 dBm. Assuming that the FCC permits C-band operation for the networks in the future, this will almost certainly be the way ABC and CBS will go.

NBC, of course, is following the RCA corporate line on Ku band, since RCA Astro itself has been committed to the Ku band since the 1978 launch of the Canadian Anik-B communications satellite. Anik currently offers coverage in the 6/4 GHz band shaped to match the outline of Canada as seen from geosynchronous orbit, and four 14/12 GHz spot beams. It would not be unreasonable to suppose that the future of NBC's plans might revolve around the same concept.





DBS opportunities

NBC's interest in Ku for its network transmissions may be tied into an even larger use of satellites—direct-to-home DBS service. It is in this area that broadcasters can expect immediate expansion, because enormous revenue potentials exist. For as many broadcasters as are now involved with various aspects of cable distribution—contributing to cable news services, distributing their programming for cable service syndication, and so forth, even more may find themselves with new opportunities through DBS.

Much of the recent flurry of excitement over DBS has been caused by a provision in the FCC approval of some nine DBS plans last year which mandated that construction orders be placed by the end of this year. To date, only the Comsat project described below has complied, but the rest are expected shortly. Still to be resolved is whether it is possible to get all the DBS applicants together so that transmissions will be on a common standard, offering the viewer a choice of 20 to 30 channels of service with two or three from each DBS service. This is an area in which the FCC is being urged to take a stand, but in which the com-

A trial of the Alcoa-NEC DBS system.

Applicants for DBS Satellite Service

Name	Parent Company	# Satellites	# Channels	Primary Business	Remarks
CBS	CBS, Inc.	4 (2 Spare)	3	Broadcast Network	HDTV/ Programmer
DBSC	Satellite Systems Engineering, Inc.	3 (1 Spare)	6	Consultant	Common Carrier
Focus	Focus Broadcasting Company	1 (Western Union)	1	Subscription TV	Lease Channel
Graphic Scanning	Graphic Scanning Corp.	2 (1 Spare)	4	Radio Common Carrier	Programmer
Satellite Television Corp.	Comsat	4 (2 Spare)	3	Satellite Service	Programmer
RCA American	RCA	4 (2 Spare)	6	Electronics, Broadcasting (NBC)	Common Carrier
United States Satellite Broadcasting	Hubbard Broadcasting	2 (1 Spare)	3	Broadcasting Stations	Programmer
Western Union	Western Union	4 (2 Spare)	4	Common Carrier	Common Carrier
Video Satellite System	Video Satellite Systems	2 (1 Spare)	2	Newly Formed	Carrier for Dominion Sat. A Related Company

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mission will undoubtedly follow the marketplace policy, as it did with issues like AM stereo and teletext.

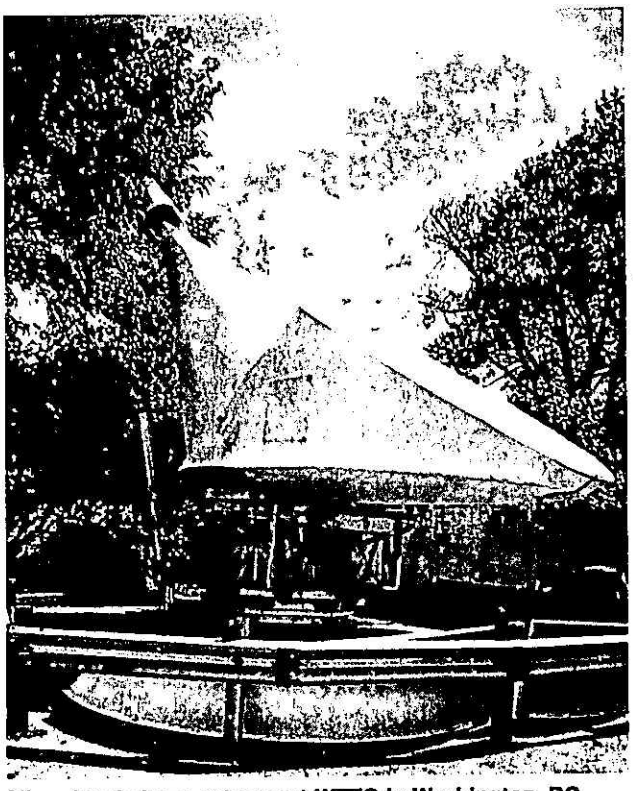
All the plans have in common the use of Ku-band satellites with 200 W transmitters aimed at dishes some 24 to 30 inches in diameter (typical cable service on the C band, for instance, transmits with only 5 W of power and therefore requires much larger receiving antennas). All plan to offer multichannel service, which would presumably include both free channels and premium channels of news, sports, and entertainment—especially movie—programming, together with stereo audio. All will operate off networks of satellites that cover the entire country, with one or more as backups. And all will presumably charge consumers between $500 and $650 for the rooftop antennas, plus additional monthly fees on either a pay-per-view or flat monthly charge basis. It is also possible, given the technology, to transmit data along with the picture and sound, to provide teletext/videotex-like information.

Another possibility is the use of DBS to provide HDTV service directly to the viewer's home, or to regionalized, wide-screen "movie" theaters. Both DBS and HDTV are being actively researched in Europe in experiments which American broadcasters are eyeing with more than casual interest. (The Montreux TV Symposium this year had major demonstrations of both DBS and HDTV, and *BM/E* will carry a full report in the September issue.) From the local broadcaster's point of view, DBS not only offers a viable alternative to the competition which cable provides, but also suggests innumerable programming possibilities in which the station could participate in a direct-to-home satellite network of its own.

The RCA Astro/Comsat plan will launch four satellites in 1986 which will blanket the country with Ku-band coverage, each satellite serving roughly one time zone, though capable of being reoriented toward another. Initially three 200 W DBS channels will be carried on two satellites being built under a $100 million contract for Satellite Television Corp., a wholly owned subsidiary of Comsat, and will carry a diverse selection of popular entertainment, sports, education, culture, and public affairs programming to the eastern and central time zones. The service will operate from a massive $800,000 new facility being built in Las Vegas, equipped with $250,000 in hardware.

Even before service begins on the high-powered (200 W) delivery systems to DBS receivers in 1985-86, however, several short-term projects are likely to introduce American viewers to "medium-power" DBS broadcasting, probably by the end of this year.

One of the most aggressive in this area has been United Satellite Television, which will jump on the bandwagon by using transponders on Telecast Canada's Anik-C2—a satellite which normally covers Canada but which has been approved for use by GTE Satellite Corp. to serve the American market by both the Canadians and the FCC. The service, which had originally been projected to begin this September, has now been postponed to early next year, and will then convert to GTE's own GSTAR bird when it is launched in April 1984. The 15 W USTV signal will be transmitted to earth stations four feet in diameter to achieve theoretically the same TASO grade as the high-power systems coming later. It will be done with the use of the larger antenna and General Instrument's improved downconverter for lower noise and threshold extension techniques. Four channels of service are planned—movies, sports and news and information, plus a pay-per-view premium channel billed through the subscriber's telephone. The antenna and receiver are projected to cost around $550, billed to subscribers at $15/month, with an additional $15/month paid for the programming.



Microdyne's horn antenna at WTTG in Washington, DC.

Interest in Ku-band DBS service has also come recently from publisher Rupert Murdoch. A company which he is financing, Inter-American Satellite Television, has agreed to lease five Ku-band transponders on the Satellite Business Systems SBS-3 bird. Some idea of the worth of this market might be indicated from the more than $75 million expected to be spent in the long-term lease (six years), and the $23 million Murdoch is reported to have invested in setting up the IAST operation. Also involved in this project will probably be Alcoa/NEC, which manufactures the rooftop DBS receivers in the 1.2 to 1.8 meter (24- to 30-inch diameter) size range, possibly marketed nationwide by an organization such as Sears. Tests with 20 W signals using a 1.2 m experimental dish were said to yield good-quality results. At the International Association of Satellite Users Conference in Orlando in April, Sony demonstrated DBS with stereo sound.

SMATV developments

Satellites are, of course, primarily a means of distribution, and the chief advantages of DBS will be to deliver high-quality signals into areas of the country where it is not economically feasible to lay down a cable TV system. Subscribers in these areas will still not have access to the multiple channels of a typical cable system, and thus DBS becomes more like a nationwide LPTV distribution system than it does a full-fledged broadcast service. Many in rural areas have already bought larger earth station systems—

costing from $1200 to $2000—in order to grab whatever is available on the satellites, including pay-TV services such as HBO. Home Box has recently decided to scramble its satellite signals to avoid piracy, now that some 10,000 consumers are said to own their own TVROs.

The legal way to do it is for the individual TVRO operator to become part of the 12,000-unit TVRO industry connected with CATV service. This is the idea behind Omega Satellite's plan to rent eight-foot TVROs in Indiana for $39.95 a month, plus a $200 installation charge. The eight-foot dishes would enable the reception of 24 channels. Ten thousand units have been ordered and Omega was to have commenced installation May 2.

This type of service for rural areas is the equivalent of one of the hottest new areas of satellite development for broadcasters—SMATV (satellite master antenna service)—which is coming to cities across the country. By placing a single TVRO on a rooftop, subscribers in a large apartment building or condo can all enjoy the benefits of satellite-delivered programming without each having to install an antenna and receiver. SMATV adds up to smart practices for the broadcasters, for whom it can be a way of participating directly in the home delivery market without necessarily buying a cable system or even competing with cable franchises already awarded.

One such operation recently initiated by Early Bird Satellite Services allows residents of condos in the Fairfax County, VA area to receive a 10-channel service including both HBO and Cinemax, plus CNN, ESPN, C-Span, MTV, Nickleodeon, the Health Network, and the Weather Channel for $23.95 a month. A basic five-channel service is available for $11.95. The installation fee is $19.95.

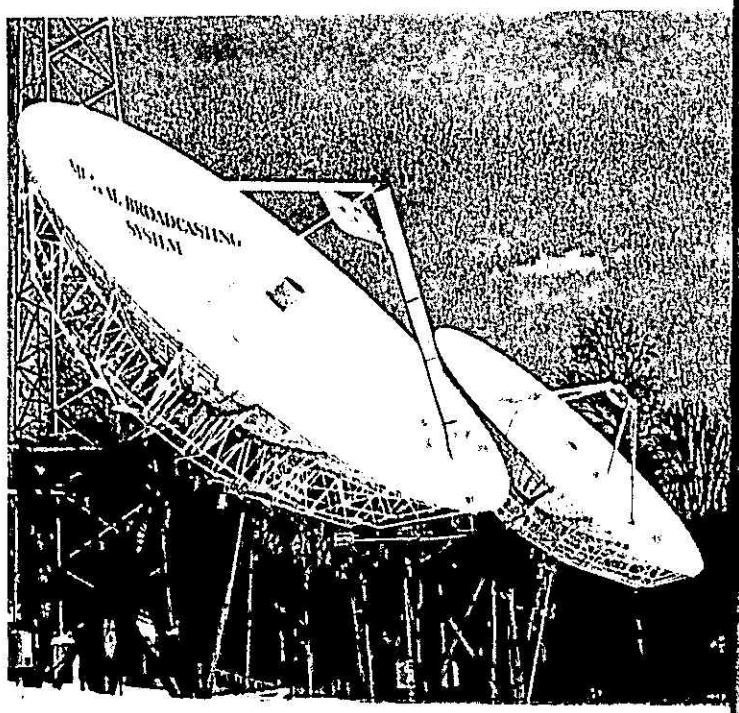
According to a report on SMATV market opportunities recently prepared by International Resource Development, Inc. of Norwalk, CT, the principal problem with SMATV today is that both HBO and Showtime are reluctant to deal with SMATV systems even in areas where cable has little chance to penetrate. This means that even though a SMATV operator may have an apartment building receiving services such as ESPN, Nickelodeon, USA, CNN, and so on, its subscribers still can't get a premium movie service because the premium services do not like working with such small numbers.

To counteract this, the National Satellite Cable Association was recently formed to represent the collective voice of the SMATV operators, perhaps in an attempt to negotiate a group contract with HBO and/or Showtime. Another activity will be to defend the rights to SMATV against the intrusion of cable and the laying of cable in areas already served by SMATV. An example of what cooperation can achieve is that the group has already leased one transponder and is distributing the ESPN signal plus other programming designed for SMATV to its participating members.

Radio Involvement

Not to be forgotten in a discussion of satellites in broadcasting is the increasing role which they are playing in the radio market.

Satellite distribution of radio programs is certainly not a new technology and major distribution systems are familiar to all. National Public Radio's satellite distribution network was established over five years ago. Mutual's



Part of the Mutual Radio satellite complex. More than half its 650 terminal system has full-time stereo multicasting.

service was launched in early 1980. AP and UPI distribution via satellite has been around nearly as long. Last year, the three major networks, ABC, CBS, and NBC, decided to switch to satellite distribution and all three selected the new digital audio service developed by RCA Americom. RKO picked this system too. Programmers ready to capitalize on satellite distribution have sprung up all over. Satellite Music Network made a name for itself almost instantly and within one year had over 100 stations carrying its music syndication program. This last year, regional state networks using lower-cost narrowband channels have popped up in several states.

Despite this impressive growth, many radio broadcasters believe satellite distribution is in its infancy. Certainly not many radio broadcasters are able to uplink today—one capability that is certainly coming. In the future, radio broadcasters will be able to exchange programs with almost anyone—other broadcasters in the state, or anywhere in the nation for that matter. The challenge is to take advantage of satellite distribution as a practical, viable way of expanding business. A broadcaster should not need to invest in three or four different earth receiving stations, as now seems the case, to receive and uplink the programs that are in orbit.

Perhaps some day distribution will gain some semblance of order, with specific satellites and their transponders being known as radio satellites, others as TV satellites, and still others as cable satellites, thus minimizing the problem of multiple reception and transmission. Until that happens, four or five satellites will be used, and therein is the dilemma. If a radio broadcaster makes a big investment in a satellite earth receive sta-

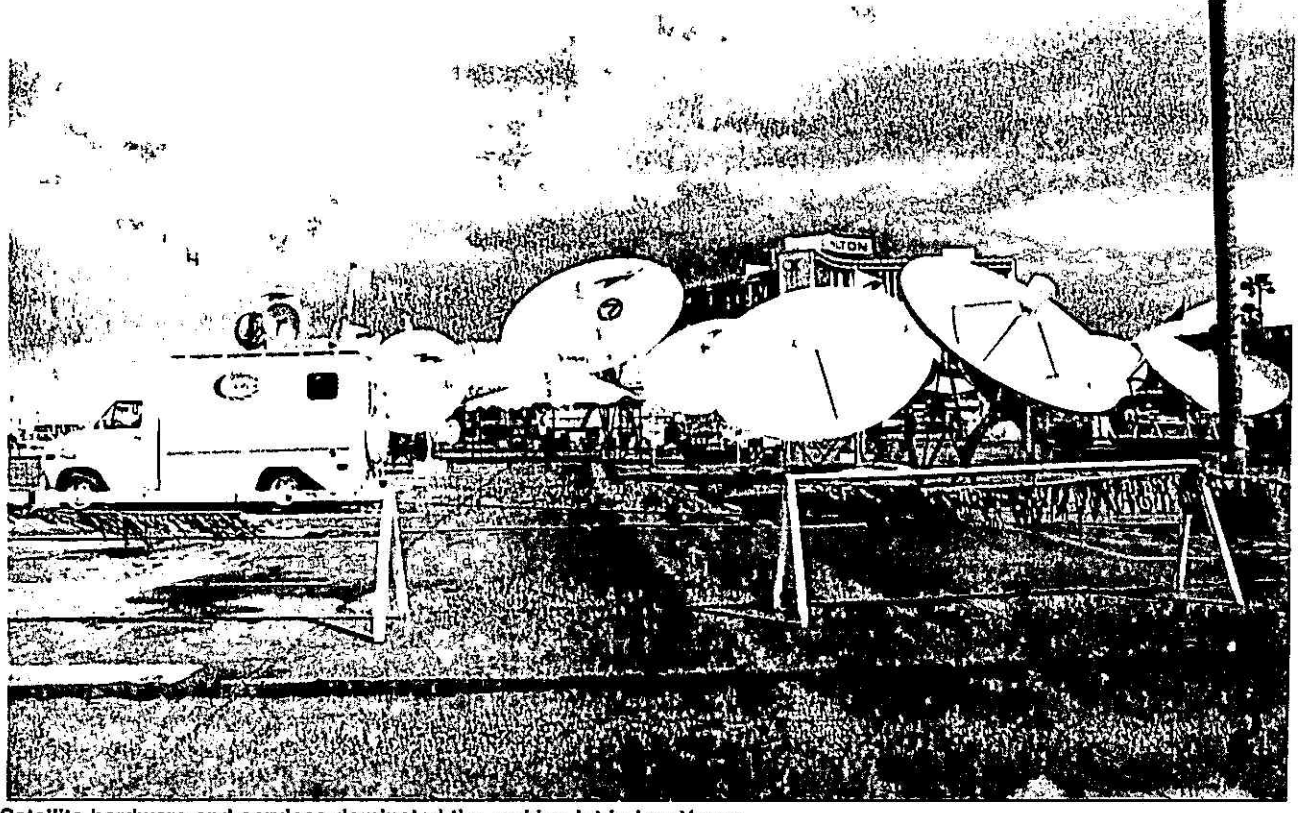
tion, how does he know the system will be adequate for tomorrow's service?

Going to satellites wasn't a hard decision to make until recently. Mutual gave away earth station receiving equipment initially (it now claims 650 earth stations in its system, with 200 more planned), and AP and UPI offered terms cheaper than leasing landlines. But last year when ABC, CBS, and NBC told their affiliates that they would have to lay out $15,000 to $20,000 to get their network program in the future, quite a few broadcasters began to think about what they should do. First and foremost was the question, "Do I need the network?" "Will I make more money with it, or without it?" "Should I switch affiliation to use the less expensive analog service?"

One station that has been thinking about alternatives and the future is WRJN (AM), Racine, WI, owned by Sentry Broadcasting. WRJN is fortunate that its CE Rees Roberts has looked at the future and is not backing away from it. WRJN has been a UPI satellite subscriber for some time and it is also an ABC affiliate and thus began taking the digital satellite feed from ABC last December. Rather than installing two separate systems, Roberts turned to the ATC Simulsat which had been originally developed for television. ATC responded to Roberts' inquiries and came out with a three-meter version. WRJN got the first production model in May. Equipped with two LNAs, one for the UPI feed and another for the ABC feed, separate cables run to two receivers, the Model 7300, which Roberts bought from s-A, and the Harris receiver purchased for the UPI feed. (With a crystal change, Roberts could alternately pick up some other ABC program or the CBS, NBC, or RKO feed.)

One rather than two antennas is a plus in Roberts' mind, but he's not satisfied and he views a generic receiver as another need—a receiver that could pull in any signal, analog or digital, wideband or narrowband, and process it accordingly. Some of the features of a generic receiver would be automatic volume compensation, automatic dynamic range control, various decompanders to bring different standards, and noise reduction circuits. Since there is now a variety of ways being used to send audio—SCPC and Wold's SSTC for instance—the generic receiver should not be limited in this regard. Roberts says several manufacturers are thinking in this direction, and he mentions Arunta Engineering of Phoenix and Automated Techniques of Tulsa as having possible solutions. Of course Roberts wants to be able to uplink too. ATC reports they expect to be able to offer uplink capabilities on their Simulsat antennas (both radio and TV) before year's end.

One thing is clear from all the recent interest and activity in the satellite field: The birds are not just for cable TV and the telephone companies any more. For the broadcaster today, satellites are a viable alternative as a means of signal distribution. For the broadcaster three years from now, satellites may well be the only reasonable choice. **BM/E**



Satellite hardware and services dominated the parking lot in Las Vegas.

Diversity of Satellite Hardware and Services at 1983 NAB

Staff Report

Over two dozen exhibits, either on the exhibit floor or in the parking lot outside, were at this year's NAB Convention—advising broadcasters on how to take advantage of programs now, or soon to be, in the equatorial orbit. There was something for both radio and TV broadcasters. Among the highlights were new network control systems (all designed to win the favor of national network programmers such as ABC, CBS, and NBC), several new antennas, and new radio receivers capable of narrowband reception.

Controllers

The Earth Station Controller, S-A **7600,** designed to monitor and control video earth stations on a single CRT screen from afar, was a key element in **Scientific-Atlanta**'s setup for broadcasters. With a pair of voice-grade phone lines, and a remote option, the controller can be almost anywhere in relation to the earth stations. Designed to be compatible with the 8840 Series of antenna controllers, operation is controlled by following menu-driven displays. The S-A 7600 can be programmed in the field for almost any station configuration, including a wide variety of combinations of antennas, receivers, and uplink equipment. A single 7600 can control stations with up to eight antennas. The processor is a DEC LSI-11 minicomputer. A floppy disk holds the software.

Although the highlight of the **Harris** exhibit was its new 6.1 m delta gain antenna, to be described later, Harris, too, had a flexible satellite earth station controller, the **9125/9165.** The 9165 goes further than any other controller, says Harris. It will automatically monitor everything it has been instructed to watch.

The 9125/9165 can handle day-to-day dish movements and TVRO or uplink control functions automatically. The system simply alerts operators at the studio that an event has occurred and been taken care of; if not, it sets off an alarm. The 9165 remote-control unit allows the control and tuning of up to eight receivers, four exciters, and four HPAS. Twenty-five entries for azimuth, elevation, polarization, and so on can be preset and activated automatically.

Andrew Corp. used the 1983 NAB to unveil its new earth station system controller, the **ESC-200.** It offers the control features of the S-A unit, the control and automatics of the Harris system, and even more in terms of capacity. The ESC-200 can be programmed for fully automatic

operation of 40 antenna positions and 200 events. Individual station addressability and computer interface capability allows remote control operation and multiple-station networking. The unit also features "fail-safe" design, says Andrew, controlling antenna azimuth, elevation, polarization, ground communications equipment, on-line system status, and alarm panel status.

Although S-A, Harris, and Andrew were the big three at NAB in terms of systems, there were other controllers shown. **Pinzone Communications** had a line of **receivers** that were adapted for a special network computer interface. This system can be programmed to do much of the control needed in network control.

And **CAT Systems** showed its remote-control system configured to handle earth receive station switching matters. The **5250** in use at WCCO-TV controls two HPAs, three LNAs, two exciters, two receivers, four switchers, and more.

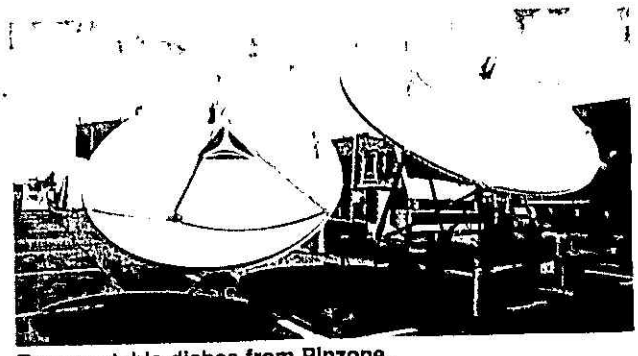
Grumman unveiled what it calls a fault-tolerant **earth station controller** for an entire network. Using "triple redundant" hardware and software reliability features developed for NASA and the military, the system detects transmission error to the bit level, notifies the operator, corrects itself, and makes the appropriate switch connections. Network routing is possible, as is continuous status monitoring and control of the network.

Antennas and other video developments

The big news in antennas was the **Harris 6.1 m delta gain unit,** which it calls a breakthrough. Although smaller in size, its performance is equal to or better than that of 7 m dishes. Its special shape and unique subreflector improves both efficiency and overall sidelobe performance. Essentially, the delta gain has taken some of the advantages of the horn, the prime focus antenna, the Cassegrainian, the Gregorian, and the dual offset-fed antennas, eliminated their disadvantages, and melded their advantages into one. The improved sidelobe performance makes it possible to meet two- and three-degree satellite orbital spacings recently affirmed by the FCC as the U.S. proposal at this year's Region II Administrative Regional Council meeting to increase the number of satellites available in the Western hemisphere.

Andrew's new **9.3 m dish** stresses high gain and high efficiency, especially for broadcasters. Through computer optimization of the Gregorian dual-reflector design, gain at 4 GHz is rated at 50.7 dBi and it has closely controlled patterns. Efficiency is rated at 77.2 percent (at 4 GHz measured at the orthocoupler output flange). Patterns comply with two-degree satellite spacing. The all-aluminum stressed skin reflector and back structure ensures consistent performance over the full temperature range of -40 to 125 degrees F. It has an elevation-over-azimuth mount that can be coupled to Andrew's new ESC-200 controller for rapid repositioning. Yet another new antenna from Andrew was a 3 m receive-only unit described as "offering superb high performance at an affordable price."

Comtech Data Corp. showed a new **7.3 m antenna** as a high-performance type. Featuring a dual-axis mount, the full satellite arc can be covered from any location in the U.S. The antenna can be aimed at different satellites rapidly, using optional high-speed drive systems (1.5 degrees per second). Also optional is a new EC7 microprocessor control system that is capable of storing up to 40 satellite positions.



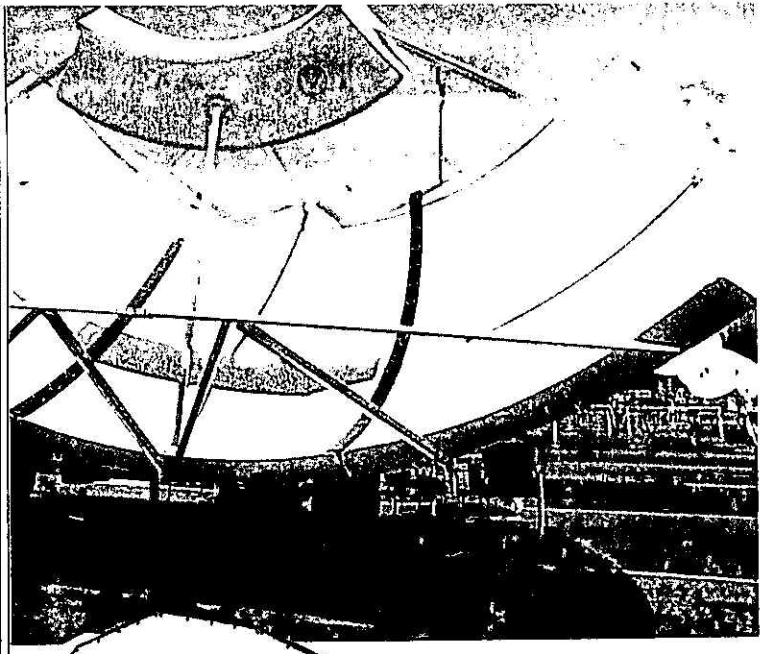
Transportable dishes from Pinzone.

Scientific-Atlanta's featured antenna was the **Model 8010C,** a 7 m dish described as a second-generation antenna offering elevation-over-azimuth geometry. Using either a manual or a high-speed (120 degree/minute) motorized actuator, a 110-degree arc can be scanned quickly. Coverage of 180 degrees is possible by repositioning the azimuth lever arm. This control permits steering with a minimum of space, allowing the antenna to be mounted near existing structures. Midband gain of this dual reflector Cassegrain type is given as 47.7 dBi (receive).

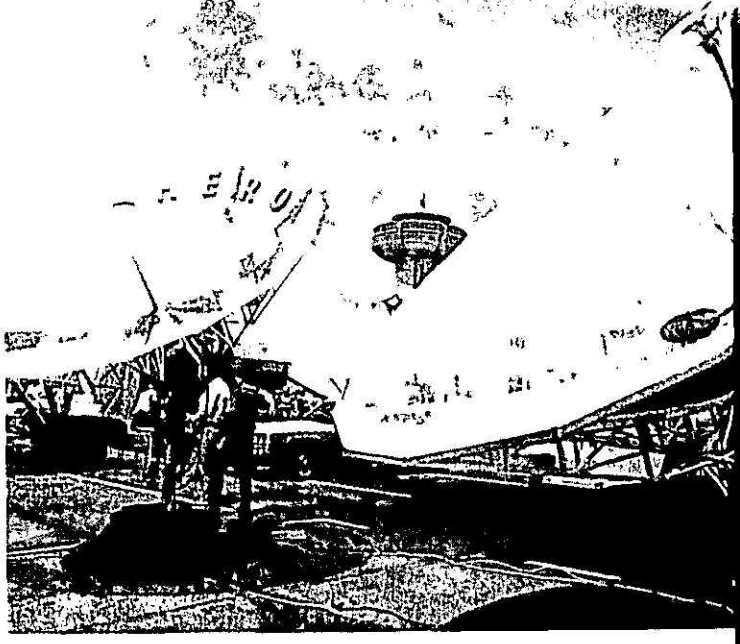
The **Series 7500** video receiver, designed to exceed the performance specs of RS-250B/NTC-7, is easy to control. The frequency (using a phase-locked frequency synthesizer) can be entered via a keyboard, as can the transponder number. Any one of six channel settings can be preprogrammed. Threshold extension demodulation cuts in when the input C/N falls below 11-12 dB. There is provision for three audio subcarriers.

One of the more unusual antennas set up in the parking lot was the **Antenna Technology Corp. Simulsat** multibeam antenna. Although introduced last year, and an instant hit with cable operators wishing to tune in more than one satellite without repositioning (you can see all domestic satellites simultaneously from 75 degrees west to 135 degrees west), this unit is now getting serious attention from broadcasters. New Simulsats include a 7 m unit for TV broadcasters and a 3 m Simulsat for radio. Can you get away with an antenna that does not need to be steered, especially if you are not uplinking? ATC says you can, since Simulsat is able to accommodate up to 20 feeds and has a capture angle of 60 degrees, with uniform gain across the band.

The antenna can handle two-degree satellite separations. Although 7x12 m in size, Simulsat 7 can survive 125 mph winds. The design is something of a cross between a parabolic antenna and a spheroid. With the price of the Simulsat 7 being only $45,000, the advantages of a fixed satellite are obvious. The Simulsat 3 for radio is priced at $8,500, and the Simulsat 5 for cable is listed at $19,500.



Antenna Technology's Simulsat antenna offers the ability to tune into more than one satellite without repositioning.

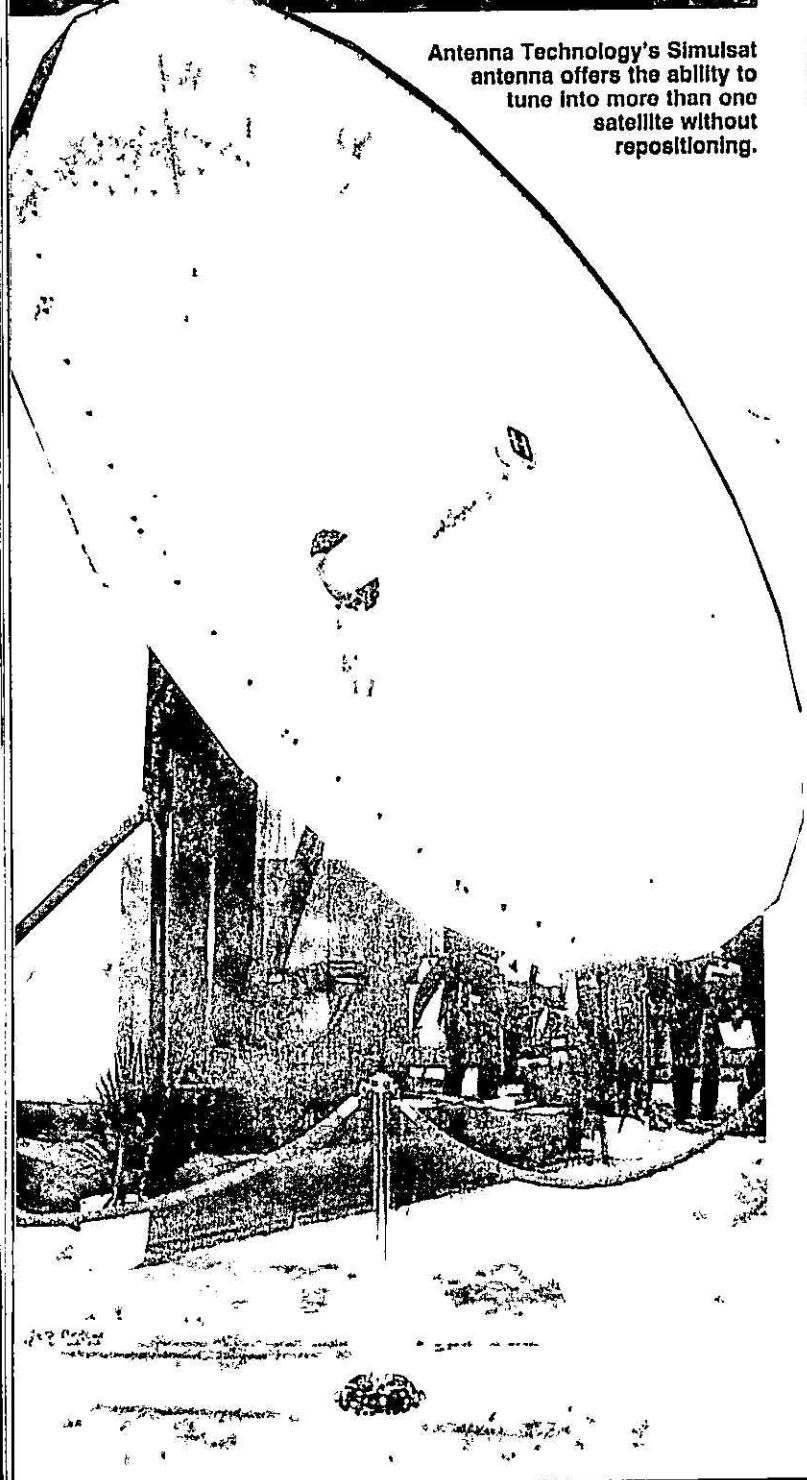


Hero Communications' Super Tennas are aluminum mesh transportables which come in five sizes, from three to 7.56 meters.

The equipment setup at ATC included Modulation Associates receivers and satellite subcarrier transmission systems. The SSTS-S-AT is a solid-state video receiver with a front panel switch that brings in either a fixed designated satellite or any transponder through tuning. This is the system used by Wold for audio. Another product was the R-Sat single-channel-per-carrier (SCPC) satellite receiver optimized for state and regional radio networks. Other MA products included downconverters and a new economy S-AT receiver.

Microdyne is a source of antennas in the 10-foot, 12-foot, five-meter, and seven-meter sizes. Although it was not exhibited, certainly another unique antenna is the conical horn manufactured by its subsidiary, Antennas for Communications. Since horns are highly selective, they can be used in areas saturated with terrestrial microwave signals. Such a horn is used by at least one TV station in the Washington, DC environs. New at the NAB Show was a **5 m fiberglass-type antenna** produced in eight pieces which can be shipped by common carrier. Also by Microdyne was its new **multiple feed satellite system,** which enables simultaneous reception of up to five satellites on the same antenna. The company made news at NAB by announcing a contract with VideoStar to produce two mobile Ku-band uplinks and 30 fully redundant Ku downlinks.

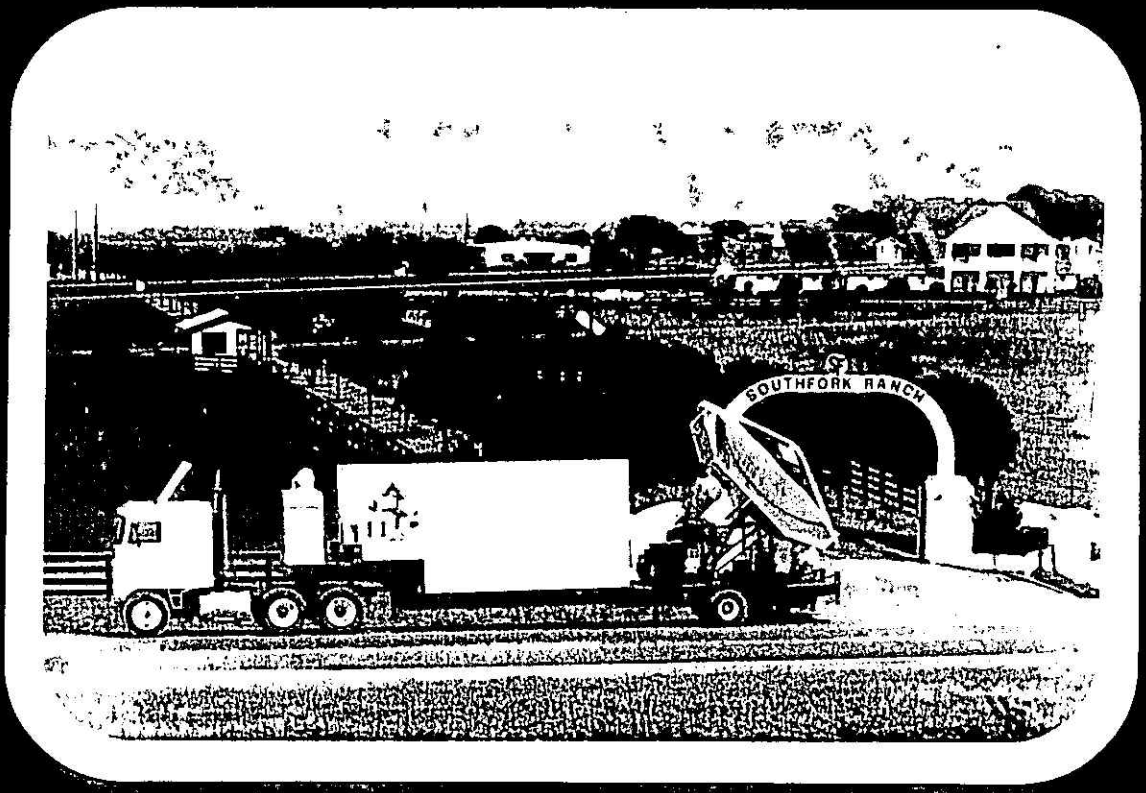
Although not unique, since similar antennas are available in small sizes, but nonetheless different, were the aluminum mesh antennas exhibited by **Hero Communications Inc.** which are lightweight and transportable. The **Super Tennas** are available in 3 m, 3.8 m, 5 m, 6 m, and 7.56 m sizes. Aluminum prefabricated trussed ribs give the antenna stability and the units are designed for wind load up to 125 mph. The 7.56 m unit has a gain of 48.4 dB, beamwidth of 0.07 degrees, and the first side lobe exceeds FCC requirements at 32-25 log 0. The company also manufactures video receivers, the HC/COM line, available in a low-cost version, a professional version, and another



The Harris 6.1-meter delta gain antenna, with its new shape, offers improved sidelobe performance for use in two- or three-degree satellite spacing.

TRANSMIT FROM ANYWHERE

(even Dallas)



D-42

The Dalsat D-42 is the ultimate transportable earth station for remote pickup.

Fully self-contained and capable of transmitting and receiving in C-band (Ku-band option), the D-42 achieves full "network" television performance from anywhere you take it.

The D-42 can be set up and operating within 30 minutes of arrival on site, without a single tool.

Call us today for a free brochure on the Dalsat D-42 transportable earth station.

Contact Dennis Dunbar, (214) 578-7561.

Dalsat

SATELLITE COMMUNICATIONS

1205 Summit / P.O. Box 1960 / Plano, Texas 75074 / (214) 578-7561

Circle 133 on Reader Service Card

for multiple receiver applications. A new SCPC receiver for radio was also shown.

Among the other TV antennas on display was a **5 m hydraulically steerable system from Anixter Communications.** Using a zero-offset polar mount, a hydraulically actuated single-action control positions the dish with no changes to mount members. Manipulation of latitude angle, declination and true north is very simple. Made of 24 stamped petals, two men can contruct the system.

Pinzone showed some fiberglass **3.7 m antennas** mounted on small trailer beds made by **Miralite.** However, a wide range of other TVRO equipment was also shown by Pinzone. Among the gear was Pinzone's own **8250 satellite receiver,** designed to pull in any transponder format automatically. This receiver has a dual LNA input and threshold extension to 7 dB under full video modulation conditions. Audio subcarrier selection is automatic. Dexcell LNAs were featured.

A **receiver-retransmitter** or "broadcasting earth station" was shown by LGT in the **Thomson-CSF booth.** The receiver includes an LNA (rated at 100 degrees K) and a broad frequency range of 2 to 12 GHz. The transmitter was a multichannel unit (up to six channels) with power outputs of from 1 W to 1 kW VHF or UHF. Anticipating such usage in various parts of the globe, Thomson-CSF showed typical G/T system ratings ranging from 20 to 30.5 dB using antennas ranging in size from 3.5 to 11 meters.

Radio systems

As the sole source of digital audio earth station receiving systems specified as the standard by four radio networks, ABC, CBS, NBC, and RKO, **S-A's DAT-32** digital audio terminal got a lot of attention, especially from those affiliates who haven't yet placed their order. The DAT-32, of course, offers more than audio (either 15 kHz or 7.5 kHz channels); it has a voice cue channel at 32 kbit/second and data channels at 32 kbit/second. Receiving a single biphase shift keying (BPSK) carrier modulated by time division multiplex (TDM) digital data, the unit demodulates and demultiplexes the data into audio or data. Actually the system digitally compands the 15-bit word to 11 to reduce transponder bandwidth but as a result of a parity bit (making the total word length 12) and error concealment encoding, the bit error rate could degrade to 10^{-5} before any errors could be perceptible.

The DAT-32 system includes a Series 9000 2.8 m parabolic antenna, a 120-degree LNA, cable and the BPSK receiver (Model 7300) and a Model 7325 digital processing unit. This will bring in any combination of up to seven program, voice cue and data channels.

While all other earth station receiving equipment must be classified as analog, there was a lot. **Microdyne** announced that it has contracted with the Georgia Radio News Service to deliver 103 10-foot SCPC terminals to various Georgia stations. Part of this package includes a new SCPC receiver, the **1100PCDR(3),** described as a flexible, technically advanced demodulator. A front panel switch permits the reception of three carrier formats: NPR, Mutual, and narrowband news/sports programs such as those to be provided by the News Service. Step tuning permits fast precise selection of SCPC radio channels.

Comtech Data announced that it has signed to construct 84 stations for the Arkansas Radio Network, including an uplink at the flagship station—KARN in Little Rock. This system uses Comtech's latest proprietary audio processing system and narrowband SCPC technology which permits more efficient use of the spectrum. Comtech's basic approach is to use different plug-in modules in its RCV 360 receiver (which handles SCPC, MCPC, and data). A recent improvement permits the antenna-mounted downconverter to be remotely controlled for selection of any one of six crystal-controlled satellite channels (previously only three could be controlled). At the NAB Show, Comtech showed its Series 300 satellite earth terminal complete and discussed its Series 900 narrowband uplink terminal which uses a 5 m dish.

Scientific-Atlanta demonstrated the capabilities of its earth station monitor and controller, with remote option.

At least two exhibitors at NAB promoted TVRO terminals for consumers of the forthcoming DBS services: NEC and Oki. Both showed 12 GHz systems that could be used for direct home reception, cable reception, or rebroadcast. Both use outdoor and indoor units. The outdoor portion is a small dish, one meter in diameter, and a low-noise converter. The indoor unit consists of a receiver that sits next to, or on top of, a TV set.

Oki listed specs for its Series 810 system. Antenna gain 40.5 dBi; LNA noise figure of 3.5 dB and a high image rejection ratio of 45 dB; receiver noise figure of 15 dB maximum; and a threshold level of 7 dB C/N. Such specs equal or exceed those set by Comsat's Satellite Television Corp.

Common carriers

AT&T had a large exhibit devoted to satellite transmission techniques now and in the future, such as a sidelobe cancellation system, digital transmission via lightwaves (fiber optics), and satellite audio services. The virtues of AT&T's new Telstar 3 C-band satellite, which will replace

Comstar service beginning in 1983, were touted. The satellite service meets RS-250B performance objectives, AT&T says. AT&T also promoted its transportable TV earth station for hire.

In addition, AT&T also showed its digital audio service, which while not compatible with the RCA DAS, can find use by broadcasters for back-haul service or other private transmissions. It is available on a 24-hour basis. Two channel segments can be transmitted simultaneously, such as two separate audio signals or stereo. Both channels are 15 kHz in bandwidth. Specs issued by AT&T show the service to use a sampling frequency of 32 kHz, 15 bits/sample.

RCA Americom, whose Digital Audio Transmission Service, using PCM time division multiplexing, is in operation now, and was busy playing tapes of various musical selections to show how great digitally transmitted audio can sound. As described earlier, there is a choice of 15 kHz or 7.5 kHz bands plus a 32 kbits/second channel for hard copy or voice cueing. For the RCA system, one satellite transponder can carry 20 15 kHz channels.

During NAB week RCA Americom launched Satcom IR, which became operational just last month. The satellite will have two transponders dedicated to the digital audio service used by the four networks, and a number of video transponders available on a preemptable basis at a low tariff. Ku-band satellites that RCA Americom will launch in the future were also exhibited. At 40 watts per transponder, these should offer adequate margin for rain, says RCA.

Service companies

Largest of the service companies at NAB was Wold Communications/Entertainment, subsidiary of Robert Wold Inc. Wold refers to itself as an "electronic expediter" in distributing TV and radio programs. It currently has 10 transponders on three satellites—Westar IV, Westar V, and Comstar D-3—and holds an option for two more on Westar V. It also leases capacity for radio transmission on Westar III and is part of the AP transponder earth station network.

Most NAB emphasis was on its newest service, the Satellite Subcarrier Transmission System (SSTS), which marries two technologies: SCPC for uplinks, and subcarrier diplexing for downlinks. Wold reports 39 major cities could be linked by the SSTS network.

Making a big impression at NAB was VideoStar, particularly because of its commitment to use the Ku band. As mentioned, VideoStar announced at NAB the purchase of two mobile Ku uplinks and more than 10 downlinks this summer from Microdyne. At the same time, VideoStar announced that it has contracted with Satellite Business Systems (SBS) for the lease of Ku transponder time for its new "VideoStar Express" service.

Systems for hire in the NAB parking lot included those by Intervideo Network Inc. and Tele-Link Communications. Actually, Intervideo was so proud of its video earth station package that it decided to offer them for sale—either as a trailorized mobile unit or as a permanent installation. The whole system, including a 4 m or 5 m dish, fits on a 19-foot trailer bed. With the antenna collapsed, the travel height is 10.5 feet. Weight is 3740 pounds. Set up, the dish will operate in winds of 60 mph. Sale price, including the trailer, is below $16,000.

Tele-Link was showing the Dalsat-42 transportable earth station for TV, which draws its name from the length of the trailer, 42 feet. Included, in addition to the 4.5 m dish, is a 20-foot enclosed shelter. As an uplink, the units included HPAs and a transmitter modulator. The antenna is a proprietary unit built by Dalsat.

USE CARD ON P. 91 FOR MORE INFORMATION ON THESE COMPANIES

Services

UPI used the NAB Show to promote its latest service, CustomCast. A microprocessor at the customer's station can be programmed to receive only those elements of the UPI program that a broadcaster wants. The copy selected is printed out on a high-speed (1200 words/minute) silent printer made by Siemens.

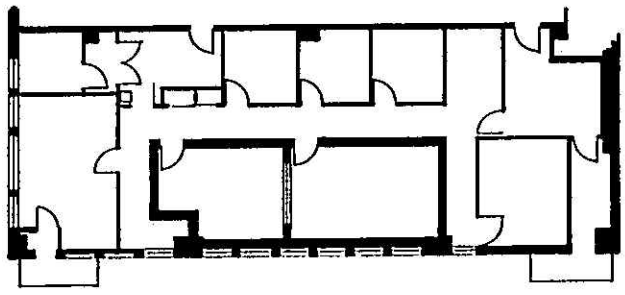
AP announced a new satellite-delivered show at NAB, the four-hour weekend Ed Busch talk show, which commenced the end of April. Carried on a separate channel from AP network news, it can be received simultaneously with the news. Broadcasters do not need to buy an earth station, since the program comes into the broadcaster's community on AP-owned receive stations.

Comsearch Inc. used the NAB Show to announce a new frequency protection service which provides a constant surveillance of all microwave activity on behalf of users in the area of C-band and Ku-band common carriers, STL/TSL microwave links, and cable television head ends.

Spectrum Planning Inc. stressed its competence in making coordination studies for earth receiving stations, as did also Compucon. BM/E

FACILITIES DESIGN AND ENGINEERING

PART 9



THE SATELLITE CONNECTION: BUILDING A RECEIVE-ONLY EARTH TERMINAL

BY WAYNE L. HETRICH

The satellite earth terminal is on the way to becoming a nearly universal adjunct of broadcasting. Most common will be the receive-only terminal, a comparatively inexpensive entry to the era of program distribution by satellite.

Although simple in main function, the receive-only terminal has many basic characteristics and requirements that are well outside the presatellite experience of the broadcast engineer. In this ninth part of *BM/E*'s series on facilities design and engineering, one of the main architects of satellite net technology tells what is required in equipment and design to bring in, with top quality, the signals from those relay stations 22,000 miles in space. — *Ed.*

THE RECOMMENDATIONS IN THIS ARTICLE are intended as guidelines for the broadcast engineering executive who must plan a receive-only radio or television earth terminal. Whether he will design the terminal himself or turn the design in whole or in part over to a "turn-key" supplier or an engineering consultant, he must have a good understanding of the requirements for each main part of the system. He must know why the system is designed the way it is, and what he should expect from each part of it.

No two satellite earth terminals are exactly the same. Although common equipment is used, different antenna pointing angles, different locations with respect to the satellite, different radio frequency interference conditions and different relations between the antenna site and the studio make each earth station unique.

The recommendations divide into three main sections: getting an approved and frequency-coordinated site; choosing and installing equipment for each part of the system; applying for the FCC license. The three parts of the job may in practice be chronologically intermingled, but they are logically separate.

Wayne L. Hetrich is senior engineer, research and development, National Public Radio, Washington, DC. He has been the principal technical architect of the NPR radio satellite net. In 1980 he was given a Major Armstrong Award for technical excellence in FM broadcasting, in recognition of his work on the NPR satellite system.

FINDING A GOOD SITE

Start with a list of "best site" criteria. Here are the most important:

- The most convenient site should be "colocated," that is, the cable run to the studio will be 600 meters (1968 feet) or less. Allow for cable footage in manholes, up walls, and for potential control room moves.
- The cable run should be confined to the station's own contiguous property.
- The site should be reachable by trucks bringing concrete for the foundation, and for delivery of the antenna itself.
- There should be negligible interference from the terrestrial facilities of common carriers operating in the 4 GHz band. This part of the evaluation is covered in detail in the next section.
- The ground terminal antenna should have an unrestricted view of the satellite orbital arc the station wants to reach now, or may want in the future.
- The site should be secured from vandalism and tampering, and protected from falling ice from nearby towers or buildings.
- The ground terminal installation should conform to local zoning and environmental ordinances and the site should be free of restrictions which would prohibit construction of a terminal.
- The use of the site should be within control of the station for at least five years (10 is preferable), and allow construction to proceed without an inordinate amount of site preparation.
- Future building or other construction plans should not create an obstruction to the satellite "look-angle" within the foreseeable future.

If the earth terminal cannot be located within 600 meters of the studio, the terminal is said to be "noncollocated." Except for the first two points above, a noncollocated site must meet the criteria already listed, plus these:

- You should be able to get suitable cable path rights for the entrance cable link. An alternative to the long cable run is the use of a telco interconnect, but it should be

used only in extremely difficult situations.

- There should be access to the proposed site, or it can be provided by the station.
- There should be power at the proposed site, or it can be provided by the station.

CAN INTERFERENCE BE MANAGED?

If the legal and access aspects of the site look favorable, your first big hurdle in rating the performance of the site is the "frequency coordination," the detailed examination of potential radio-frequency interference to the 4 GHz downlink signal from the satellite. As explained in more detail below, the frequency coordination check can also be expanded to give you a useful preliminary rating of the overall system sensitivity you will need.

The process begins with your choosing a site and one or two alternates. Then buy a U.S. Geological Survey (USGS) 7½ minute quadrangle map of the area in which the proposed sites, and your studio, are located. On the map, mark all the locations clearly—the proposed sites and the studio. This map will be the main location instrument of the frequency coordination company you engage to supply you with a detailed report on interference conditions. It will be a good idea to have two copies of the map, so you can keep one for the information you'll need later in your license application.

ROOFTOP ANTENNAS

You may be thinking of putting the earth station antenna on the roof of a building. This will involve additional steps: determining if the building is strong enough to hold the antenna, even under strong wind load conditions; reinforcing the building if necessary; designing and building an interface structure between the frame of the building and the antenna base; hoisting the antenna base and the antenna itself; and installing both on the roof.

Rooftop antennas are not generally recommended. The additional cost averages $10,000, but can run as high as $30,000. Moreover, being up on a roof tends to expose the antenna to more radio frequency interference (RFI) than is normally experienced on the ground. On the ground, trees, land contours, and buildings provide RFI shielding. Sometimes, if a ground site is susceptible to RFI, just moving the antenna a short distance will correct the problem; this is rarely possible on a rooftop.

If you choose a rooftop as your prime site, choose at least two alternate on-the-ground sites in case the RFI level at the rooftop makes that location unuseable. Leases for sites have terms of at least 10 years are recommended, with options for renewal. There is a risk in a shorter lease of a costly move and future unavailability of an RFI-free site.

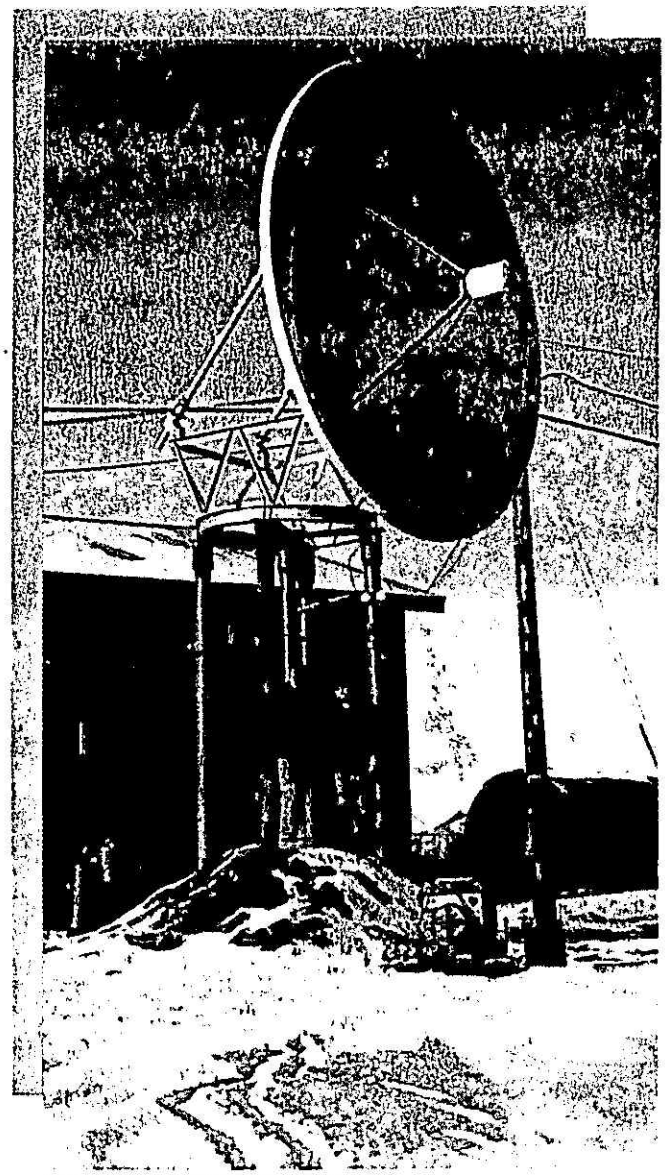
FREQUENCY COORDINATION

The professional frequency coordination firm, if competent and experienced, can get you through this difficult part of the process in an authoritative way. The firm is likely to have a computerized database covering all sources in the area of microwave interference, and computer programs for using this information.

Send them your marked-up USGS 7½ minute quadrangle. They will do a computer cull for your location, which will identify all potential interfering stations within a radius of several hundred kilometers. Examination of the cull by experts will give you your first indication of how your site looks in terms of radio frequency interference. Some stations get a clean bill of health right away; they can then go immediately into frequency coordination.

This means that the coordinator will address all microwave users in the area telling them that your station is seeking coordination, and asking for any objections. If there are none within 35 days, the firm prepares a full report on the interference situation, a copy of which must be forwarded to the FCC along with your application for a license (this is covered in detail below).

If the cull reveals high RFI, an RFI density plot of the area may show close-by locations that are better off than the chosen one. A number of satellite equipment makers



NPR dish at KOTZ in Kotzebue, AK has nearly zero elevation angle to point to satellite, far south.

have transportable earth stations that can be brought in to test conditions at various sites. This can be expensive, so be sure to check costs before you order it.

For more precision, actual measurement of RFI levels can be made with van-carried RF measuring equipment. This can confirm what the computer cull only predicts. It can also evaluate alternate sites exactly for comparative interference levels.

When the source of interference is precisely known, the site may be moved to get a building, a fence, a clump of trees, a wall, or a hill as a barrier to the RF. Or the antenna can be put in an excavation (see photo). Another recourse is a horn antenna (see photo), which has much better sidelobe performance than a parabolic dish.

Before actually starting work (see below) you should be sure that all legal and zoning regulations will be satisfied, and all local permits obtained. You should also have all rights of way you may need for the cable run. Photographs of the site will be useful, one with a person pointing north, and others showing the view to south, east and west. Another should point toward the satellite arc, and one toward the studio building to show the cable route.

OVERALL SYSTEM REQUIREMENTS

The frequency coordination process, and the test reception at the site, if you use it, are valuable in the determination of overall system requirements, as noted in the foregoing. The main factors will be the angle of elevation of the antenna necessary to reach the wanted satellite, the strength of the satellite signal at the site, and the RFI found to be present.

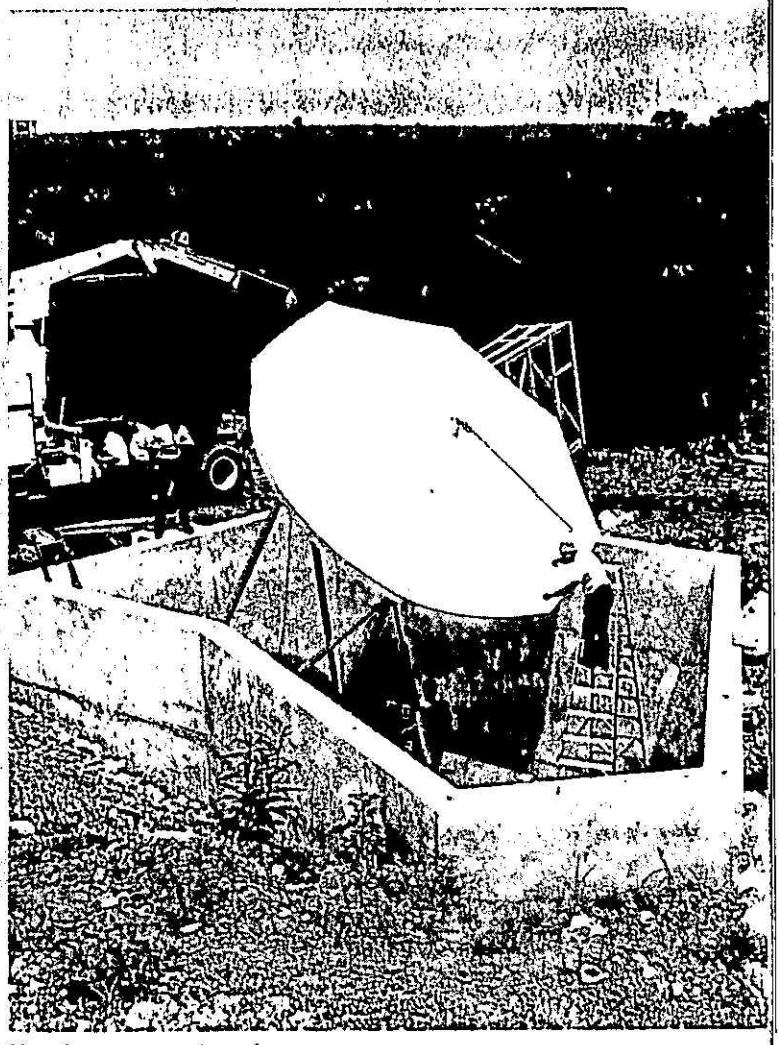
The report should make it clear whether you need a very high performance dish, or can use something of lesser quality. A very low antenna elevation angle, below 30 degrees, which means that the satellite is far around the arc from the station's location, will generally belong to the most difficult site, needing the highest system performance. In the following sections each of the main functional units in the system will be discussed, and then the characteristics will be put together into a system "figure of merit" which indicates in a practical way how to get what you need.

ANTENNAS

There are two main characteristics: the gain and the noise figure. Both are primarily functions of antenna diameter and the first amplifier in the system, called the "LNA." Gain figures for the most used receive antennas are as follows:

3.00 meter diameter—39.5 dB
3.66 meter diameter—41 dB
5.00 meter diameter—44 dB
7.00 meter diameter—46.7 dB
10.00 meter diameter—50 dB

The antenna noise temperature, which will be supplied by the antenna maker, tells you how much sky noise the antenna will pick up, in relation to signal, at various angles of elevation. The larger antennas have lower noise figures at any given elevation angle than smaller antennas. The net effect is that if your angle of elevation is very low, you are likely to need a large antenna to reach the system performance level you need.



Showing one way to reduce interference from terrestrial signals, antenna at WEKU, Richmond, KY was installed in pit.

When we turn to the main electronics units, it is important to note that the characteristics listed are not "ideals" but are the real working performance levels that are essential to satisfactory handling of a satellite signal. The main electronics sections of a receive-only terminal are the low-noise amplifier (LNA), the downconverter, and the demodulator/expander for audio services or the video receiver (which may include the downconverter) for television.

LOW-NOISE AMPLIFIER

The LNA, mounted right at the output of the antenna, typically supplies 50 to 52 dB of gain at the carrier in the 4 GHz range. A main characteristic of choice is the noise temperature figure. As the formula at the end of this sec-

tion shows, the LNA noise figure is a main factor in the system performance.

The figure is ordinarily expressed in degrees Kelvin, referred to as the "noise temperature." Typical noise figures for LNAs now available range from about 95 degrees to about 145 degrees. Cost is generally in inverse proportion to the noise figure, everything else being equal.

Other specifications of a satisfactory LNA define a rigorous quality standard, but one that is necessary to proper handling of a satellite signal. The most important are:

Gain variation versus frequency: With reference to the highest gain at any frequency, that at any other frequency to be no more than 1dB lower.

Gain slope: Not to exceed ± 0.1 dB in any 10 MHz segment of the band.

Gain linearity with input: Within ± 0.5 dB for any input signal from −110 dBm to −55 dBm.

Overdrive: The amplifier to withstand, without damage, an input of 0 dBm at any frequency in the 4 GHz band.

Intermodulation: Third-order products at least 50 dB below any two inband equal signals at −5 dBm, spaced 5 MHz apart.

DOWNCONVERTER

This has two functions: using bandpass filters to select the particular 40 MHz signal segment carrying the program wanted; converting the 4 GHz carrier down to an intermediate frequency (IF) around 70 MHz. The downconverter is also mounted on the antenna, no more than a few feet from the LNA. The most important specifications are:

Return loss: At least 23 dB over the band 3.7 to 4.2 GHz.

Nominal gain: 22 dB.

Minimum input: −85 dBm.

Gain versus frequency: ± 12 MHz of center channel, not more than 1 dB peak-to-peak; ± 18 MHz of center, not more than 3 dB peak-to-peak; at ± 58.5 MHz of center, at least 60 dB down.

Gain slope: Not more than 0.1 dB per 500 KHz, over ± 12 MHz of center frequency.

Noise figures: 13 dB typical, 15 dB maximum, 10 dB design goal.

Image attenuation: At least 70 dB.

Frequency stability: Better than five parts in 10^6 in thirty days.

Intermodulation: Third-order distortion at least 50 dB below each of equal carriers at the RF input with a power sum equal to −30 dBm.

DEMODULATOR·EXPANDER

The demodulator recovers the audio baseband signal from the 70 MHz IF, and the expander reverses the compression applied at the transmitter in the noise reduction system. Virtually all satellite systems for audio transmission will use some form of noise reduction, so an expander will be a usual part of the downlink electronics.

Important characteristics are:

C/KT ratio: 67 dB nominal.

Deviation: Up to 75 KHz peak.

Modulation bandwidth: 50 Hz to 15 KHz for audio; DC to 10 MHz for video.

Energy dispersal: Up to 40 KHz peak energy dispersal modulation on the carriers, with a sinusoidal waveform at 3.75 Hz, ±0.075 Hz.

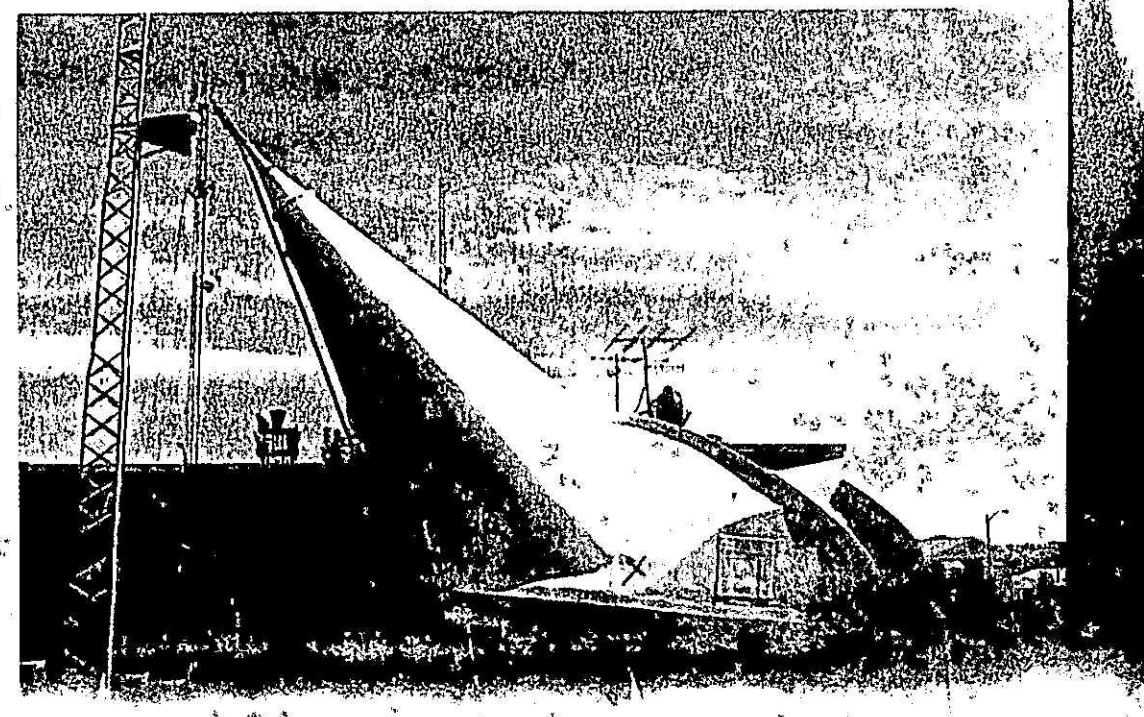
Audio response: +0.5 to −1.0 dB, 50 Hz to 15 KHz.

Insertion gain: Adjustable 0 to ±0.25 dB.

Noise with compandor improvement: With carrier at −65 dBm and C/KT at least 67 dB, ratio of peak test tone plus noise to noise at the expander output is at least 70 dB.

Cross talk: Cross talk in output of "quiet" demodulator is at least 85 dB below the peak modulation tone in an adjacent channel.

The demodulator needs special protection against microwave interference on 60 and 80 MHz, where signals may be far stronger than the design signal input to the unit. These interfering signals are picked up by the feed cable



Some locations need a horn antenna like this at KCND, Bismark, ND, far superior to an open dish in interference rejection.

or input wiring. The frequency assignment plan for the system assures that no satellite IF carrier will be closer than 2 MHz to the main interfering frequencies. The filtering in the demodulator unit must be adequate to keep the interfering signals below a troublesome level.

An important adjunct of the demodulator-expander or video receiver is a circuit allowing the incoming carrier level to be read on a remote meter. The meter circuit should be adjustable so that a one-volt reading can cover any 20 dB of the input signal range. Such a meter can be used at the antenna-pointing controls to optimize the antenna pointing direction.

THE DIGITAL DIFFERENCE

The foregoing applies in an overall sense to receive systems for either analog or digital transmission. The same equipment can be used for both, at least through the antenna and LNA. Theoretically, the downconverter too could handle either analog or digital signals, but the equipment makers for digital receive equipment have so far chosen to sell only complete downconverter-demodulator subsystems, designed to work together.

Obviously the major differences will come in the demodulator (receiver) section. For digital transmission this unit must include a demodulator specially designed for digital signals and a digital-to-analog converter.

However, as a unit in the system, the digital downconverter/receiver must produce results parallel to those of the analog units. In either case the performance level can be summed up in the most used figure of merit, G/T, arrived at in the following equation:

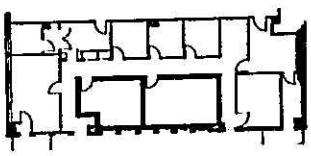
$$\frac{G}{T} = G_A - 10 \log (T_C + T_{LNA} + T_{Sky})$$

where:

G_A = antenna gain
T_C = 14K
T_{LNA} = LNA noise temperature
T_{Sky} = Sky noise temperature

Representative figures of merit or G/T with the best equipment available today range from about 13 dB to about 30 dB. For a rough idea of how this applies in practical cases, consider a broadcaster in the eastern part of Maine who wants to reach a satellite in the western part of the orbital arc. He will almost surely need the top part of the G/T range, especially if he wants high-grade service. Or he may not be able to get good service from a westend satellite at all.

The broadcaster in Utah, say, is far better off. He may be nearly under the satellite he wants, and will not need a low antenna angle in any case. Good service will be far less expensive for him than for the broadcaster in the northeast corner of the U.S.



FACILITIES DESIGN AND ENGINEERING

CONSTRUCTION

With your system completely planned, with frequency coordination complete and access to the site assured, you can build the station—FCC approval is not needed to start construction.

Upon receipt of your order for an antenna, the manufacturer will send you a drawing of the antenna footing and a set of bolts. With these you can build, or have built, the foundation for the antenna. Construction is simple and the orientation of the foundation is usually not critical. When the footing is built and the concrete has had time to cure, notify the manufacturer that you are ready for delivery of the antenna.

If you are planning on using an underground cable from the antenna to the studio, it's a good idea to have the trench dug at the same time that the excavation is made for the antenna foundation. Lay the conduit (PVC pipe) in the trench before the concrete is poured for the foundation.

A nylon rope or pull wire should be placed in the conduit when the conduit is laid. Then put the signal and control cables into the conduit after the concrete has been poured for the antenna foundation.

Three drawings helpful at this point are:

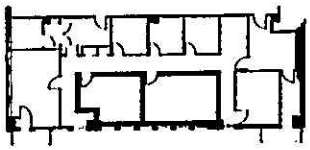
- A plot plan for the earth station itself showing the antenna base, AC outlet, cable runs, fence, equipment shelter if used, and nearby roads, walkways, buildings, and trees.
- A cable route diagram accurately showing where the cable from the antenna to the studio will go, including enough detail so that there will be no question in the builder's mind as to what is wanted.
- One or more drawings of the building and studio, again showing precisely where the cable is routed. If the antenna elevation angle is less than 30 degrees for the desired satellite, the surface of your antenna footing should be a minimum of 12 inches above grade.

In designing the antenna site, it's a good idea to include an ac outlet with a 20-amp circuit breaker. The coax cable which will go from the site to the studio will be 50 or 75 ohm impedance. Any good-quality low-loss cable is suitable. PVC conduit is recommended with an inside diameter of three or four inches. Use large radius elbows for ease of pulling the cable. A two- or three-pair cable is also desirable for receiver AGC monitor, audio monitor, and intercom uses.

For lightning protection, we strongly recommend that you get an eight-foot commercial TV ground rod, drive it into the ground close to the footing, and connect it by heavy copper cable to any good contact point on the mount.

LICENSING

With your final frequency coordination report in hand, with the terminal design made and construction under way, it is time to get your license application in to the FCC.



FACILITIES DESIGN AND ENGINEERING

In 1979 the FCC dropped the requirement that a receive-only satellite earth terminal be licensed, making it optional with the station. Nevertheless, we urge you to license your earth terminal because that's the best way to assure yourself continuing interference-free use of the downlink.

Look at it this way. Suppose you decide to save some money by not licensing your earth terminal. Having built your terminal and having made proper legal arrangements with program vendors you start receiving some great programming. A month later an independent communications company puts up a microwave transmitter a few blocks from your earth station and swamps you with radio frequency intereference. And there's nothing you can do about it. The cost to move your earth station to a new location could exceed the cost of licensing many times over, not to mention the loss of programming in the interim.

The frequency interference protection, which is assured by your license, is important not only for your own use of the earth station, but also for any secondary uses to which you may put your facility.

Moreover, since some forms of tampering, vandalism, and theft to a licensed facility are federal offenses, you can call in the FBI if any of these things happen to your earth station.

Licensing your earth station involves some expense and the effort of preparing and submitting your license application. Much of the expense involves the frequency clearance required by the FCC; but you have to do that anyway.

The FCC recently eased the rules for new receive-only earth terminals. Under the new regulations you do *not* have to:

- have a construction permit approved by the FCC before you build your terminal;
- prove to the FCC that you have the right to the site for an earth station;
- submit an environmental impact statement; and
- submit a financial showing, a balance sheet, or FCC Form 430 with your license application.

On the other hand, you *must:*

- comply with state and local building codes;
- go through the licensing procedure to obtain frequency protection;
- obtain rights to any program prior to using it; and
- notify the FAA if your antenna is more than 20 feet high and is close to an airport.

Unless you have an engineering consultant or contractor thoroughly familiar with the FCC procedures, you may want to get from the FCC the "Receive-Only Licensing Information Package," sent you free if you call 202-632-5930. This tells exactly how to do it. Ordinarily it takes from 60 to 90 days for the FCC to act on the application. When you get your license, and have completed a terminal carefully planned along the lines suggested here, you will know that you will have high quality access to satellite programming for a long time to come. **BM/E**