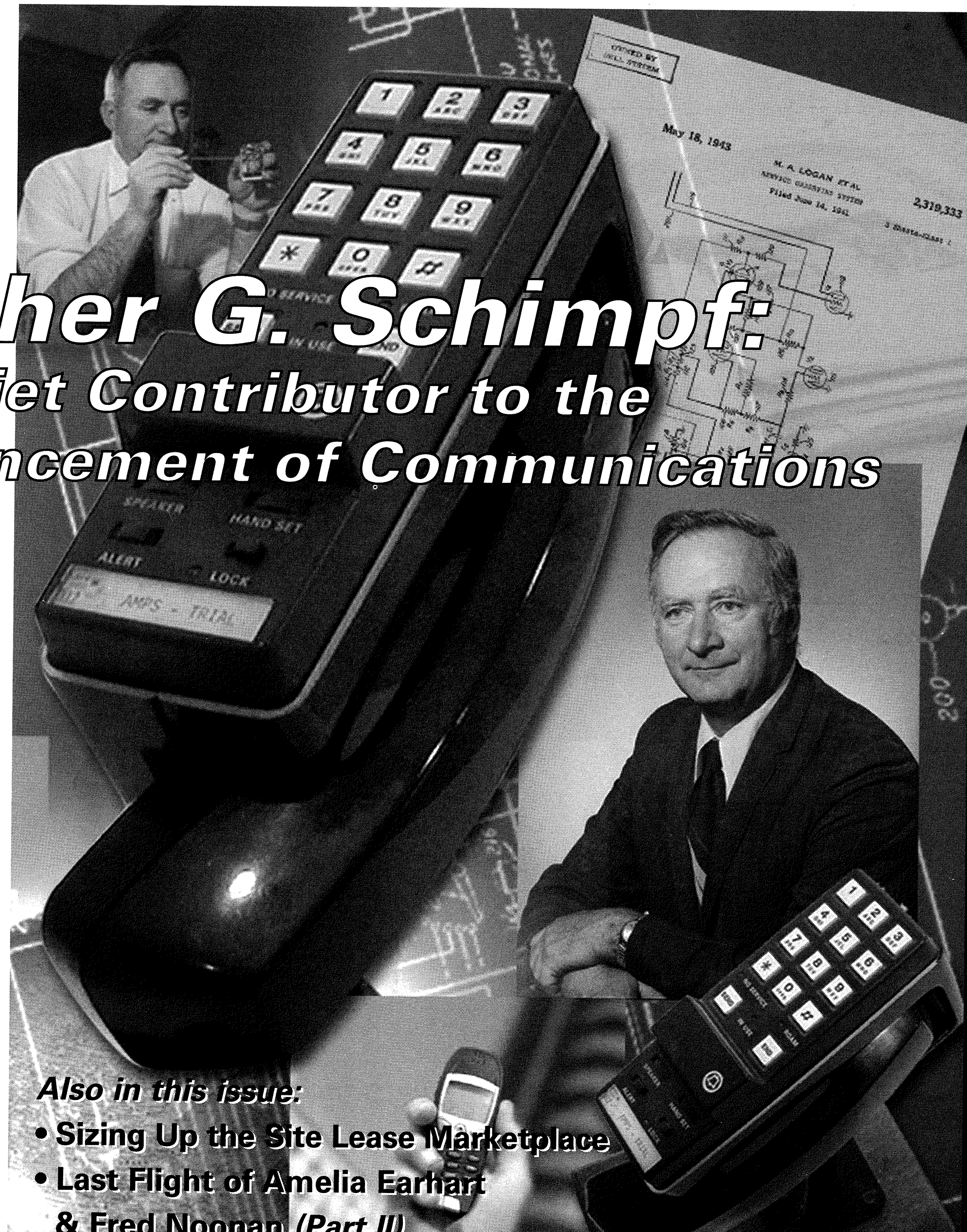
PROCEEDINGS of

THE RADIO CLUB OF AMERICA, INC.

Founded 1909, New York, U.S.A.

FALL 2001



Luther G. Schimpf:
A Quiet Contributor to the Advancement of Communications

Also in this issue:

- Sizing Up the Site Lease Marketplace
- Last Flight of Amelia Earhart & Fred Noonan *(Part II)*
- Member Profile - George Jacobs

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THE RADIO CLUB OF AMERICA, INC.

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By David Hanson

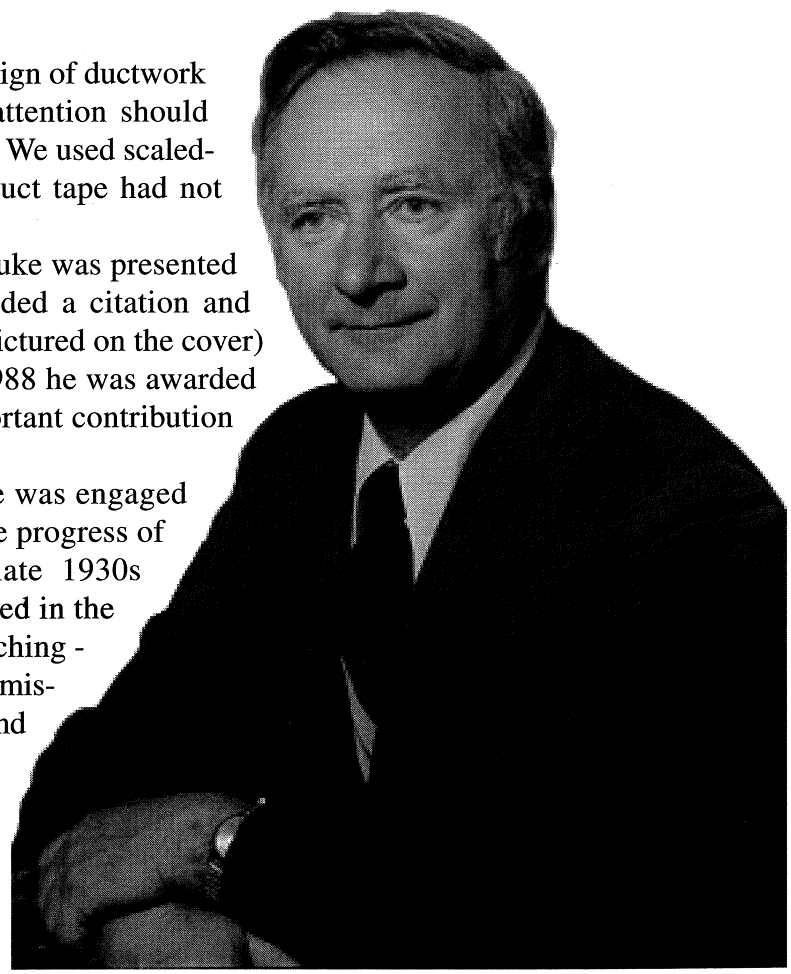
Luther G. Schimpf, 1914-1992:

A quiet contributor to the advance of communications

Inventor, writer, imaginative researcher, and veteran of 47 highly productive years with Bell Telephone Laboratories in Holmdel, N. J.— these are among the attributes of Luther (Luke) Schimpf, whose death deprived us of a highly regarded talent. Luke was quiet, shy and unassuming. He also was one of the original thinkers who helped wage a war, and to propel America into the age of digital technology.

A 1937 graduate of Ohio State University, Luke took pride in being part of a team that designed the first digitized-encrypted speech transmission system used during World War II. He served as technical consultant when the system was installed at Allied Headquarters in Algiers. Unfortunately, he recalled, the system required air conditioning, so its new home was an old hotel's wine cellar with arched ceilings and walls three feet thick.

No Duct Tape



Luke recalled that "considerable redesign of ductwork was required, and realized that more attention should have been given to descriptive geometry. We used scaled-down, trial-and-error paper patterns. Duct tape had not been invented."

In recognition of his contributions, Luke was presented with a number of awards. These included a citation and replica of the first Bell cellular phone (pictured on the cover) and the IEEE's Centennial Medal. In 1988 he was awarded the RCA Armstrong Medal for his important contribution to radio art and science.

A survey of the research in which he was engaged over the years comprises a history of the progress of modern communications. From the late 1930s through the war years, Luke was involved in the application of electronic devices to switching - military communication systems for transmission of speech over HF radio - transmission and acoustics applied to local subscriber stations. During the 1950s Luke was focused on high frequency application of transistors. From the late 1950s through the late 1960s, his work delved into high

capacity mobile telephone receivers, video telephone systems and subscriber loop systems.

A Foundation Block

One industry source close to Luke says his invention and application of PCM, spread spectrum and frequency band compression in the early 1940s "must now be recognized for what it is: a major foundation block in our modern digital processing technology." The same observer notes that Luke's work had a decided impact on today's cellular speech communications systems.

Luke shared his insights and results in numerous published papers on high frequency, wideband transistorized circuits. The 13 patents issued to him serve as evidence of his originality.

His relentless curiosity spurred the man even after his retirement in 1984, and he remained a communication systems engineering consultant at Bell, a member of the technical staff, and a notable contributor to the development of electronic switching, digitized secure speech systems, transistor circuits, and mobile radio and paging systems.

Enduring Contributions

Luke, his wife Mary and their two sons lived in Holmdel, not far from Bell Labs. His leisure pursuits included amateur radio, fishing and gardening. His contributions to the community included long-time membership on the township board of health. But the most lasting contributions of this self-effacing and prolific man are the ease and efficiency of today's communications systems that we take for granted.

By Joseph A. Huie, K2PEY

The Last Flight of Amelia Earhart and Fred Noonan - Part II

Part one *(Spring 2001, The Proceedings)* of this article addressed the background, technology and events leading up to one of the great mysteries in aviation history, the disappearance of Amelia Earhart and Fred Noonan. On June 1, 1937, the two began their attempt to fly around the world, departing Miami after a nine day stop for maintenance.

Earhart and Noonan (the navigator) flew in a Lockheed Electra 10E, which had been built especially for Earhart. The aircraft carried the latest in avionics, including three radio sets that were doubtless the best available at the time. The radio sets included a Western Electric Model 13C transmitter with AM voice and CW capability and a carrier power output of 50 watts. There were three crystal-controlled channels tuned for 6,210 kHz (day frequency), 3,105 kHz (night frequency), and 500 kHz (emergency).

Earhart and Noonan covered 18,500 miles, arriving in Lae, New Guineaon June 29th. From there they were to head to Howland Island, a U.S. possession - a distance of 2,563 statute miles. At 00:00 hours GMT (10:00 local time) on July 2nd, Earhart's Electra lifted off for Howland Island. Twenty hours and 14 minutes later, the U.S. Coast Guard cutter Itasca, stationed just west of Howland, heard Earhart say: "KHAQ to Itasca. We are on the line 157, 337. Will repeat this on 6210 kcs. We are running on line. Listening on 6210 kcs."

This was the last transmission they heard. At 22:10 GMT Itasca was underway headed north (337 degrees) in search of a downed aircraft. No trace was ever found by Itasca or any of the many other searches that followed.

Official Opinion and Other Theories

The official U.S. Navy report filed by the Commandant, Fourteenth Naval District, Pearl Harbor, T.H., dated July 31, 1937 stated in bureaucratic language: "It is regrettably unreasonable to conclude other than that the unfortunate flyers were not above water upon conclusion of the search." Most researchers believe that Earhart and Noonan ran out of fuel and crashed in the ocean not far from Howland Island.

There are basically two other schools of thought: (a) they actually crashed on one of the Marshall Islands about 850 miles to the northwest of Howland, were captured by the Japanese and died in captivity or (b) they crashed on Gardner Island (now called Nikumaroro Island) 405 miles to the southeast of Howland and died there. These theories, although held by a minority, are deeply believed by the proponents.

In assessing the possibilities of what actually happened, the Itasca radio and ship's logs give very important information, especially concerning the radio signals received from Earhart. Most significant, the last four transmissions beginning at 19:12 GMT and ending at 20:14 were all received with "very good" or "good" quality. We have related this to a received signal level of 50 microvolts (-73 dBm), S-5 on the military scale of 1 to 5 (an amateur radio signal level of S-9).

Considering the estimated radiated power from the aircraft (5 watts total and 2.5 watts vertically polarized) and the time of transmissions, the propagation mode that was received must have been ground wave (surface wave) rather than sky wave. Also, the propagation analysis suggests that the aircraft was certainly within 265 miles of Howland during all four transmissions. See graph on page 28 showing calculated ground wave and sky wave signal levels as a function of aircraft distance from Howland.

Note that we assumed a perfectly matched, lossless, vertical antenna for reception. As a practical matter, the actual signal received was most likely less than the level theoretically predicted. The point is that Earhart was probably much closer than 265 miles, which should be considered an outer limit.

Earhart at 19:12 GMT said: "gas is running low..." How much time could she possibly have had before dry tanks? It is extremely unlikely that she and Noonan could have reached either the Marshall Islands or Gardner Island; assuming, of course, that the U.S. Government logs are a reasonably accurate reflection of what happened.

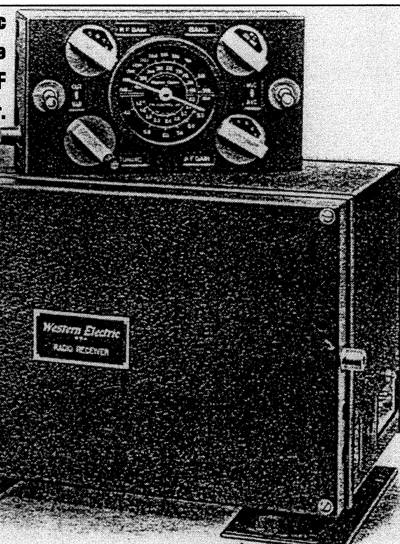
A Possible Scenario

Earhart and Noonan encountered much stronger than expected head winds putting their ETA approximately 72 minutes later than the expected 18:00 GMT arrival and significantly reducing the fuel reserve. Cloud cover made it difficult for Noonan to obtain good celestial fixes in the early morning hours. After sunrise, by measuring the sun's altitude, Noonan was able to determine a line of position; however, their location on the line of position had to be estimated based on dead reckoning from the last celestial fix and had significant error.

As they neared Howland, a fateful decision was made on the method of approach. Because of the low fuel reserve and because they believed the RDF could bring them in, they decided to head straight for the island rather than taking the more conservative alternative of coming in deliberately to the north or south and then running down the sun line to the island.

When they reached the estimated position, the

Photo Source: ATT Archives



Western Electric Model 20B remote controlled MF/HF receiver.

The Electra 10E being serviced during the world flight in 1937

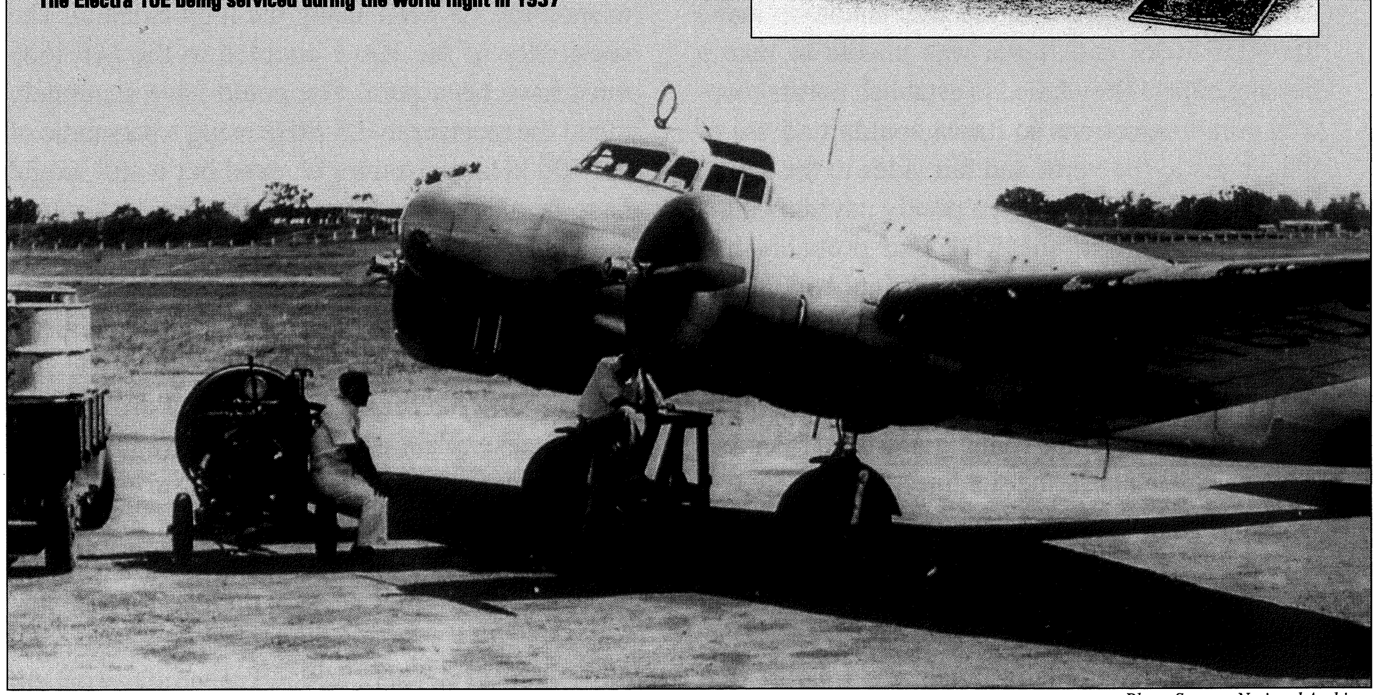
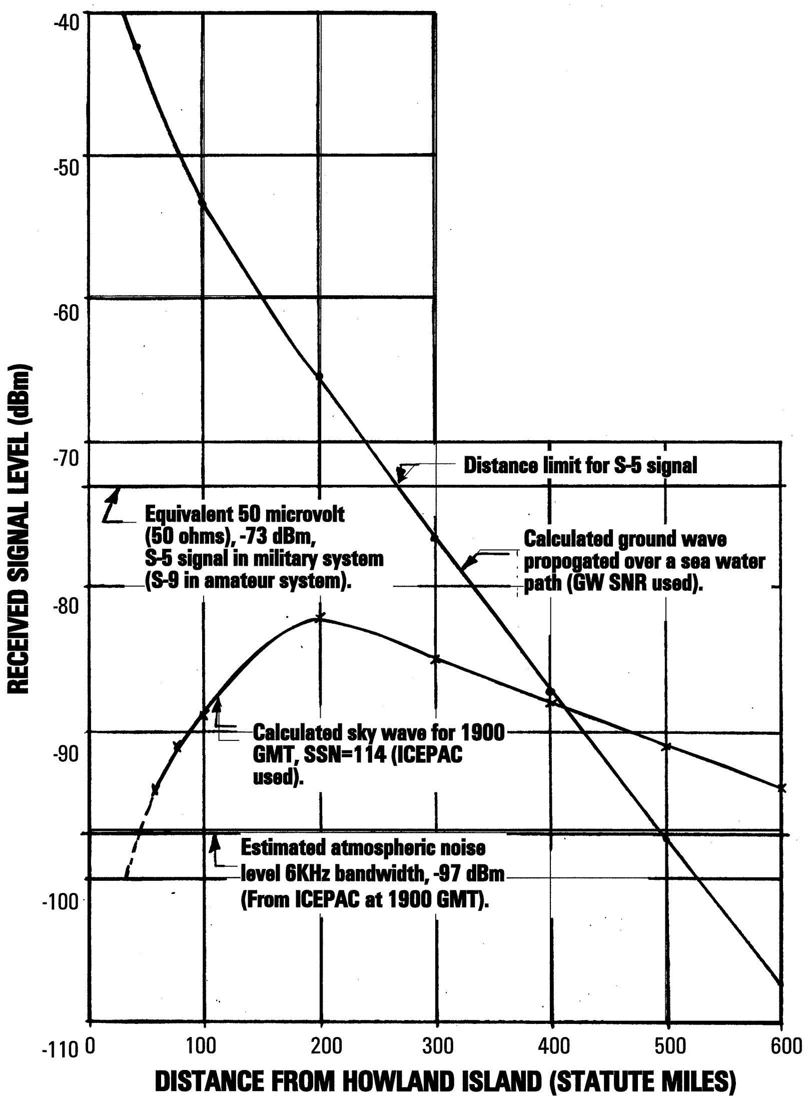


Photo Source: National Archives



Calculated received signal level from aircraft vs distance from Howland Island at 1900 GMT on July 2, 1937 Frequency=3105 KHz

Assumptions:

1. 5 watts total radiated power.
2. Ground wave: only the vertically polarized component propagates and is received (-3 dB).
3. Sky wave: only the vertical component is received by the vertical shipboard antenna system (-3 dB).
4. Receive antenna assumed to be a lossless, perfectly matched, short vertical whip.

island was not there. Earhart was unable to make the RDF work and Itasca was unable to take a bearing either. They failed to establish normal two-way communications so Itasca couldn't advise of the clouds to the north and fair skies to the south. Very likely Earhart had been poorly advised on the frequency range of the RDF and probably had never actually used it under real flight conditions. Whether she had discussed the 7.5 MHz frequency selection with Noonan is unknown.

After circling without sighting the island, they turned to fly on the line running 337 to 157 degrees relative to true north (the sun line). There were two choices, heading 337 or heading 157 degrees. They chose poorly, flying away from Howland. By the time they realized the error, fuel was too low to complete the flight.

Why didn't Earhart hear Itasca's signals until after 19:28 GMT? Likely she set the Bendix RA-1 to monitor 7.5 MHz using the loop antenna. The sensitivity of the RA-1 coupled to the MF loop must have been poor. She could have accurately tuned the receiver to 7.5 MHz using a harmonic of the 500 kHz transmitter channel but it still would have been necessary to rock the tuning knob in order to catch the CW transmission from Itasca. We don't know her normal practice, but she may have turned off the receiver for periods of time in order to save on tube and dynamotor life, increasing the likelihood of frequency drift. These factors can explain why she might have missed the 7.5 MHz transmissions until a very strong ground wave signal broke through at 19:29.

Note that 1937 was at the peak of the 17th solar cycle and the average sunspot number for that year was SSN=114. ICEPAC propagation analysis predicts good 7.5 MHz sky wave propagation all through the night for the estimated distances from

Itasca to the aircraft.

She could have accurately set the Western Electric 20B receiver to 3.105 MHz using her transmitter as a calibration source. By our count through 19:28 GMT, Itasca had called Earhart on 3.105 MHz, CW, 31 times. They called using voice 13 times and using MCW once. (They had also called on 7.5 MHz CW 20 times and 500 kHz CW once.)

Given the high acoustic noise level in the cockpit, she might have never heard the CW transmissions because the 20B had no BFO. The 14 voice/MCW transmissions may have been missed simply because the transmissions were brief and she spent most of her time listening on 7.5 MHz.

What Now?

The final chapter on Earhart and Noonan will never be written until some hard physical evidence is found. We continue searching for more information to help sort out the questions and ambiguities that still exist. One area where we need more information relates to the Bendix RA-1, associated remote control and the RDF loop antenna. Elgen and Marie Long in their recent, informative book have described the Bendix receiver as having five bands and covering 0.2 to 10 MHz, different than the information on the RA-1 we have. We also are searching for manuals covering the radio equipment and antennas carried on board the Itasca. Until evidence is found, the mystery of what happened to Earhart and Noonan will remain.

Errata

*In the **Spring 2001 Proceedings,** the image below was incorrectly identified as the Western Electric Model 20 Remote Controlled MF/HF Receiver. It is actually the Western Electric Model 13C AM/CW 50 watt MF/HF transmitter.*

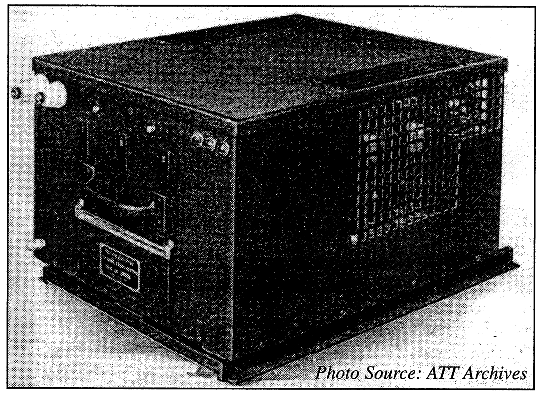


Photo Source: ATT Archives

REFERENCES: -

1. Riley, Jr., John P. (W6GPQ), private correspondence, Feb. 2000

2. Western Electric, "Instruction Bulletin No. 650, Radio Transmitter No. 13A and No. 100 Type Radio Transmitter Mounting"

3. Lovell, Mary, "The Sound of Wings - The Life of Amelia Earhart", St. Martin's Press, 1989 *(pg. 261)*

4. Long, Elgen M. and Marie K., "Amelia Earhart, the Mystery Solved", Simon and Schuster, 1999 *(pg. 112)*

5. CCIR Report 322-3, "Characteristics and Applications of Atmospheric Radio Noise Data" published by the ITU, Geneva, 1988

6. Western Electric, "Instruction Bulletin No. 830, Radio Receiver No. 20 Type"

7. Rafford Jr., Paul (NY4L), private correspondence, December 1998

8. Gray, Captain (USNR) Almon A., "Amelia Didn't Know Radio", United States Naval Institute-Naval History, Nov./Dec. 1993

9. Microfilm Reel NRS-246-C from Naval Historical Center containing U.S. Coast Guard records, Record Group 26, National Archives. "Includes correspondence and messages; Pan American Airways report; Earhart plane flight; and the transcript of USCGC Itasca log for July 1937. These documents cover the period 2 July 1937 to May 1938."

10. Goerner, Fred, "The Search for Amelia Earhart", Doubleday & Company, 1966

11. Richard Gillespie, "The Mystery of Amelia Earhart", Life Magazine, Volume 15, issue 4, April 1992, *pgs. 68-74*

12. War Department, "War Department Field Manual FM 24-6, Radio Operator's Manual, Army Ground Forces", June 1945, *pgs.17-19*

13. Berry, L.A., "User's Guide to Low-Frequency Radio Coverage Programs, Office of Telecommunications Technical Memorandum 78-247, U.S. Dept. of Commerce", January 1978. Includes programs: GW SNR, IT SNR and LF SNR.

Web Sites:

1. <http://www.astro.oma.be/SIDC/index.html>, (Solar Influences Data Center at the Belgium Royal Observatory, access to historical sun spot data.)

2. <http://elbert.its.bldrdoc.gov/hf.html>, (U.S. Dept. of Commerce NTIA/ITS, Institute for Telecommunications, High Frequency Propagation Models including HFWIN32-[99.1110W] Windows-NT and 95/98 32 bit versions of ICEPAC/VOCAP/REC533.)

3. <http://www.emsci.com/mininec.html> (Information on the EM Scientific, Inc. version of MININEC wire antenna analysis software.)

By Richard J. Reichler

Sizing Up the Site Lease Marketplace

Our 'mystery shopper' explores the current leasing environment at antenna sites and presents some observations concerning competitive barriers for 'small' radio systems.

During the past few years the antenna site (a.k.a. tower) industry in the United States has been changing rapidly, as has the wireless industry. This change has been largely due to the public's desire for wireless services and to the Federal Communications Commission's (FCC) licensing of personal communications services (PCS) frequencies. The change in the tower-site environment has affected long-time site users as well as new users providing traditional wireless services. Many of these users involve what I call "small" systems. These smaller players typically require only one cabinet or rack of radio equipment, mount only one or two antennas and operate at relatively low power.

Modus Operandi (Past & Present)

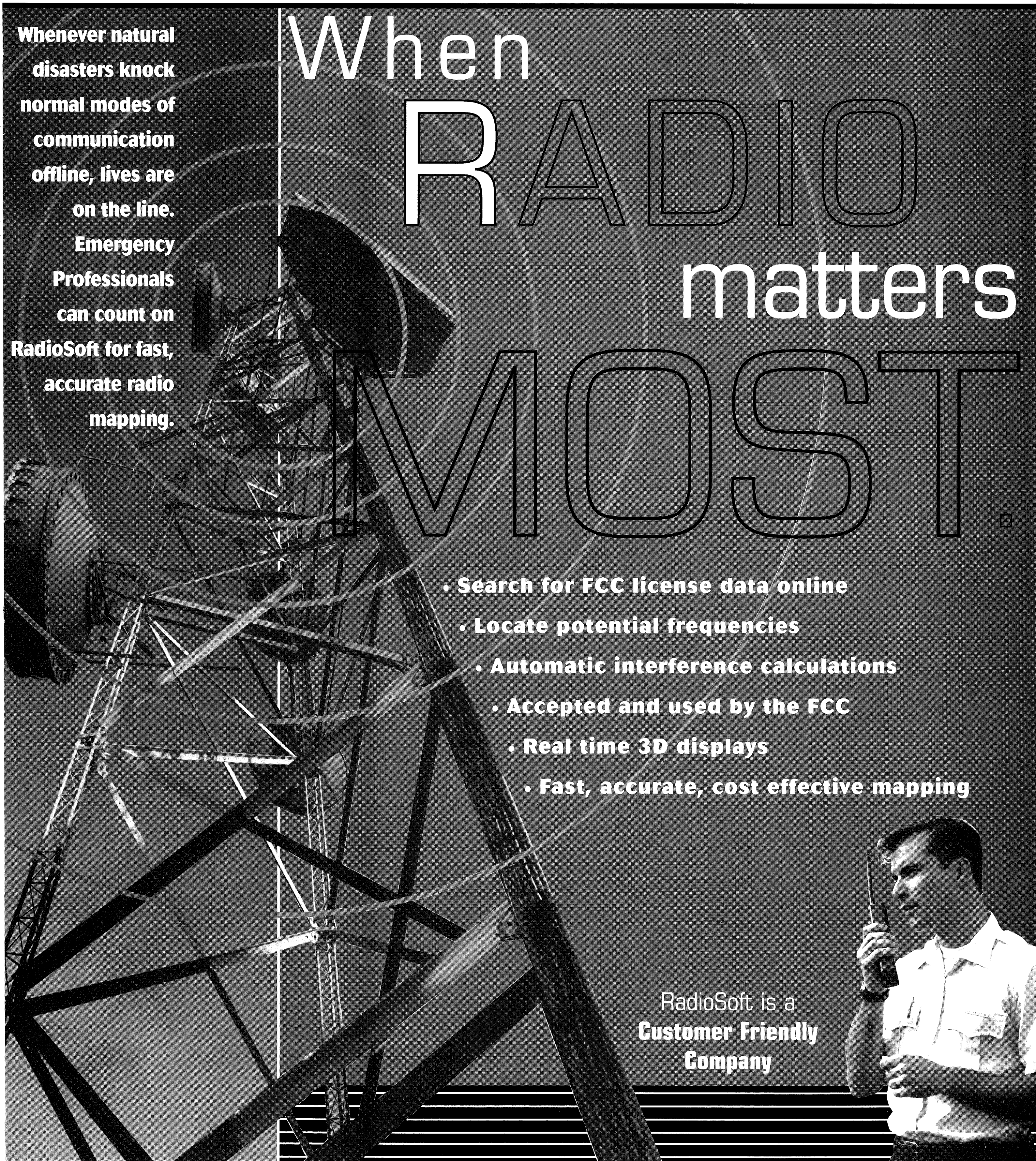
Antenna sites have been critical since wireless communications began nearly 100 years ago. Sites are frequently scarce or unique resources, such as those at strategic high-elevation (mountaintop) locations. Because of the high costs of development and operation, plus the need to reduce visual impact, community (multi-user, shared) telecommunications antenna site facilities came into being. These have been developed and managed by a variety of entities. Space on an antenna-support structure (tower) is the most important feature of such a shared facility. These facilities also typically provide space in a purpose-built shelter to house the radio equipment, primary and standby electric power, security and safety systems and many other features. The site selection checklist *(see sidebar on page 14)* contains a list of factors that should be considered in the selection of an antenna site facility.

Recognizing that consumption of space, power and other resources at sites is costly, designers and manufacturers have increasingly developed radio hardware that consumes less. Smaller RF equipment takes up less space, thus helping to reduce related costs.

There also is a growing trend of enclosing transmitting and receiving equipment in weatherproof cabinets so that shelters are not necessary. These cabinets can be placed on ground-based concrete pads, on building rooftops, on towers and on other components of antenna-site facilities.

RF devices are being made more electrically efficient to help reduce the cost of power as well. Radomes on antennas continue to help reduce wind loading and therefore reduce the stress on costly towers.

Systems of all types with various service offerings and needs share antenna sites. Systems provide data and voice traffic, and they serve public safety, government, amateur (ham), business and other user groups. Small, single-channel systems typically need only a few square feet of floor space, one or two antenna positions and low electric power. These systems include private base stations, community repeaters, some specialized mobile radio (SMR) systems, some electronic newsgathering systems and some fixed wireless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SITE SELECTION CHECKLIST

Some important things to consider in the selection of an antenna site facility.

- RF coverage area; RF interference protection and control.
- Quality of facility and maintenance (tower, building, security, cleanliness, pest control, neatness, weather proofing, fire suppression, lighting, electrical outlets and cable trays).
- Quality of electrical distribution and grounding system, lightning protection and stand-by power (quantity and reliability).
- Quality and reliability of air conditioning (filtering, cooling, heating and humidity control).
- Governmental compliance at facility, e.g. with use permits, FAA rules (esp. tower marking and lighting) and FCC rules.
- Technical and safety standards, and their enforcement by the site manager.
- Responsiveness, experience and qualifications of the site manager; quality of information and services available from the site manager, e.g. permit and license assistance, coverage maps, access instructions, technical support and charts showing location and technical data (frequencies) of equipment (especially antennas) at the facility.
- Continuity and history of management by the site manager.
- Quality of remote site monitoring (power, temperature, intrusion and tower lighting).
- Expectation that the facility will be continually upgraded and expanded, and be available for future needs.
- Site access in all weather conditions; hours of site access.
- Terms and cost of lease/license for use of space.
- Availability of utility services, e.g. electricity and telephone.
- Any special requirements, e.g. permits.
- Future construction in an area that may affect coverage.
- Availability of antenna systems to share.
- Insurance coverage provided and required.
- Availability of space to park a service vehicle near the facility.
- Availability of restroom facilities.

List of Major Antenna Site Suppliers in the United States.

*(*Stk 5 stock symbol, Pvt 5 privately held)*

Business Name	Stk*	Telephone Numer	Internet Address (URL)
AAT Communications	Pvt	800-551-7483	www.AATCommunications.com
American Tower	AMT	877-282-7483	www. AmericanTower.com
Crown Castle International	CCI	724-416-2000	www.CrownCastle.com
Message Center Management	Pvt	888-973-7483	www.MCMgmt.com
Mountain Union Telecom	Pvt	888-748-3647	www.MountainUnionTelecom.com
Pinnacle Towers	BIGT	888-748-3482	www.PinnacleTowers.com
SBA	SBAC	800-487-7483	www.SBASite.com
SpectraSite	SITE	888-468-0112	www.SpectraSite.com
Subcarrier Communications	Pvt	732-607-2828	www.Subcarrier.com

systems. Some paging systems have a small footprint, but they may use a bit more power. High-power broadcast (radio and television) stations may be considered single-channel systems, but they consume more floor space, tower space, electricity and other site resources. Multichannel systems, including SMR, enhanced-SMR (ESMR), cellular and PCS systems, consume a large amount of space.

Site elevation plays a key role because systems require varying amounts of coverage area. High-elevation sites typically serve broadcast, mobile and point-to-point uses where the communication content is the same for the wide area served by each channel.

Low-elevation site facilities (monopoles, commercial building rooftops, water tanks, billboards and utility poles) are increasingly becoming necessary, especially for providing wide-area personal mobile services. Low-elevation sites allow more simultaneous users by allowing the reuse of RF channels in smaller coverage areas. They also allow reliable reception of low-power signals from small personal RF devices. Because many costs (lease or purchase, maintenance, repair, insurance and antenna site space) are associated with each radio transmitter and receiver, network system designers try to minimize the amount of overhead required to serve an area. Their solution is to use an efficient balance of high-elevation and low-elevation sites.

Twenty years ago, low-elevation sites were sparse because there was little use for them and the costs were high. Although mobile telephony was not new, the mid-1980s saw the implementation of the improved and desirable cellular service. Low-elevation sites were suddenly in high demand to serve this new technology. A typical cellular system installation at an antenna site facility (which put the word "cell site" in our lexicon) requires many antennas as well as many radio transmitters and receivers. The amount of consumption at sites is high, but they are also cost-effective because end-user demand is high.

Cellular came to be considered the first-generation of personal communications service. The second-generation, launched in the mid-1990s, was actually called "personal communications service." Unlike the deployment of cellular, the FCC granted (via high-priced auctions) nationwide and regional licenses. Ease of nationwide roaming, improved quality and other features have been instrumental in the demand for and the success of PCS.

FCC deadlines, high auction costs and other factors have motivated PCS operators to quickly construct their systems, and therefore to rapidly acquire antenna sites. New PCS operators are continuing to pressure the antenna site industry to supply needed locations. A typical PCS installation is somewhat like a cellular system, but it more often uses outdoor cabinets. With third-generation service deployment forecast for the middle of this decade, the need for more low-elevation sites is expected.

Consolidation of Antenna Site Suppliers

With the anticipation of PCS and nationwide licenses, major consolidation of the antenna site industry began. The demonstrated success of cellular and the high expectations for PCS drew the financial community's eager support. With capital more easily available, and with PCS operators as prospective tenants, many tower companies began acquiring other tower companies or their tower assets. Some of these entities envisioned forming nationwide (and international) tower companies-and some have succeeded. Today in the United States, there are many nationwide, regional and local antenna site suppliers including five national landlords that are publicly owned. *(See the list of major U.S. antenna site suppliers on page 14)* When they function well, the large site providers can help large wireless system operators quickly construct their networks by providing large blocks of sites, developing many new sites, negotiating volume leases and billing in bulk. If they function poorly, these companies may become bureaucracies and may mismanage many functions such as tower development, installation coordination, billing, customer relations and regulatory compliance.

In less than five years, many PCS systems have been deployed, and a large number of new sites have been developed, thanks to the efforts of the consolidated companies. It appears that the PCS operators, along with their investors and customers, have been getting a lot of support from these large tower site providers. Considering the public demand for PCS, this use of financial and human resources seems appropriate.

The challenges have been understandable, and not everyone is pleased with all the effects of consolidation. All site customers have been inconvenienced by the newly consolidated entities as they have struggled to organize these new, unwieldy, large organizations. Even the PCS community would acknowledge that the past few years have had some challenges, but at least they are getting many new sites that they need. Many small system operators are upset because they are harmed by the inconveniences, as well as by the higher prices and more challenging lease terms and conditions. These system owners believe they are not gaining as much from the consolidations as the nationwide carriers-or in some cases, anything.

Many small operators are established businesses with a smaller scale of annual growth, so they do not get much benefit from most of the new sites becoming available. Most of the large site providers gladly serve the smaller operators, and they are able to do so, to varying degrees. Most have the appropriate sites to serve this user community, but some have few high-elevation and other applicable sites.

Competition has affected site users in various ways. The public is continuously hearing about the competition among ESMR service (principally, Nextel Communications) and the cellular and PCS operators. Their use of antenna sites is comparably larger, although the underlying site costs are about the same. Smaller carriers are trying to compete with their community repeaters, SMR systems and other systems. Their resource requirements at any given site are smaller, but they use fewer sites. On a per-channel basis on any given site, the cost for space for a larger system is typically less than for a small system. If channels have little customer traffic, then the site space may be considered costly on a per-customer basis. A system operator will want to keep the total costs per customer/user to a minimum.

Site space costs have increased for a variety of reasons, many due to industry growth driven by the increased demand for wireless services. Increased awareness of wireless systems and antenna sites has brought additional regulations, and it has increased the costs of site development and site operation. Some of these costs relate to special care given for development in historic districts, scenic trails and migratory bird paths. An accelerated effort has been driven by regulators, to ensure air-traffic safety, RF emission exposure safety and environmental stewardship.

Financing to acquire and construct antenna sites adds to the underlying costs, as do the costs of training new workers involved in site acquisition and development. Some of the large companies are successfully using economies of scale to keep costs down. The efforts of the Site Owners and Managers Alliance (SOMA), a part of the Personal Communications Industry Association (www.PCIA.com), are helping tower companies to reduce their costs with respect to regulatory and training issues. Costs and profit goals help drive what a company may want to charge for site space, but competition and what the market will bear balance those price pressures.

Adequate competition is important in our economy. A consolidator commonly acquires several previously competitive sites at locations such as mountaintop tower farms, thereby reducing competition. This might cause price increases and other changes unfavorable to users. The nationwide carriers and other large wireless service providers have several large site suppliers competing (with favorable terms) for their business, and their need for a vast number of sites reduces the financial significance of a small minority of high cost sites. A small system operator may find that competition has been reduced at an important location so that prices increase and the operator and its users are materially harmed.

Follow the Pricing Mystery Tour

Pricing is one of the main forms of competition among site suppliers. Although the monthly basic use fee (or rent) is usually the first cost considered, competition exists in one-time, up-front fees and other periodic fees. Each site supplier sets up a mix of these fees that it believes will be most acceptable to its customers-and the most profitable.

In mid-July, I spoke with representatives of the major nationwide site providers about the current state of antenna site pricing. I discussed small systems and specified an 800 MHz, single-channel SMR (CMRS) system, using a short cabinet of equipment and a single whip antenna, and operating at low power (60W TPO, 300W ERP) in the Los Angeles/Southern California market. I obtained price ranges because prices vary by location in a market due to coverage, competition and other factors.

Discussions began with up-front fees. The charging of an application fee is a sensitive competitive issue. Some companies wish to be compensated for the up-front efforts of lease and price negotiation, document preparation and other administrative functions. Users may find this acceptable if other fees such as the rent are adequately lower. The Pinnacle Internet home page states "Never a Site Application Fee!" Some companies will waive their application fee under certain situations. Application fees might range up to $1,500 for a system and are frequently, but not always, waived for small systems. Occasionally a structural analysis fee is charged (but almost never for a small system). This may cost as much as $2,000.

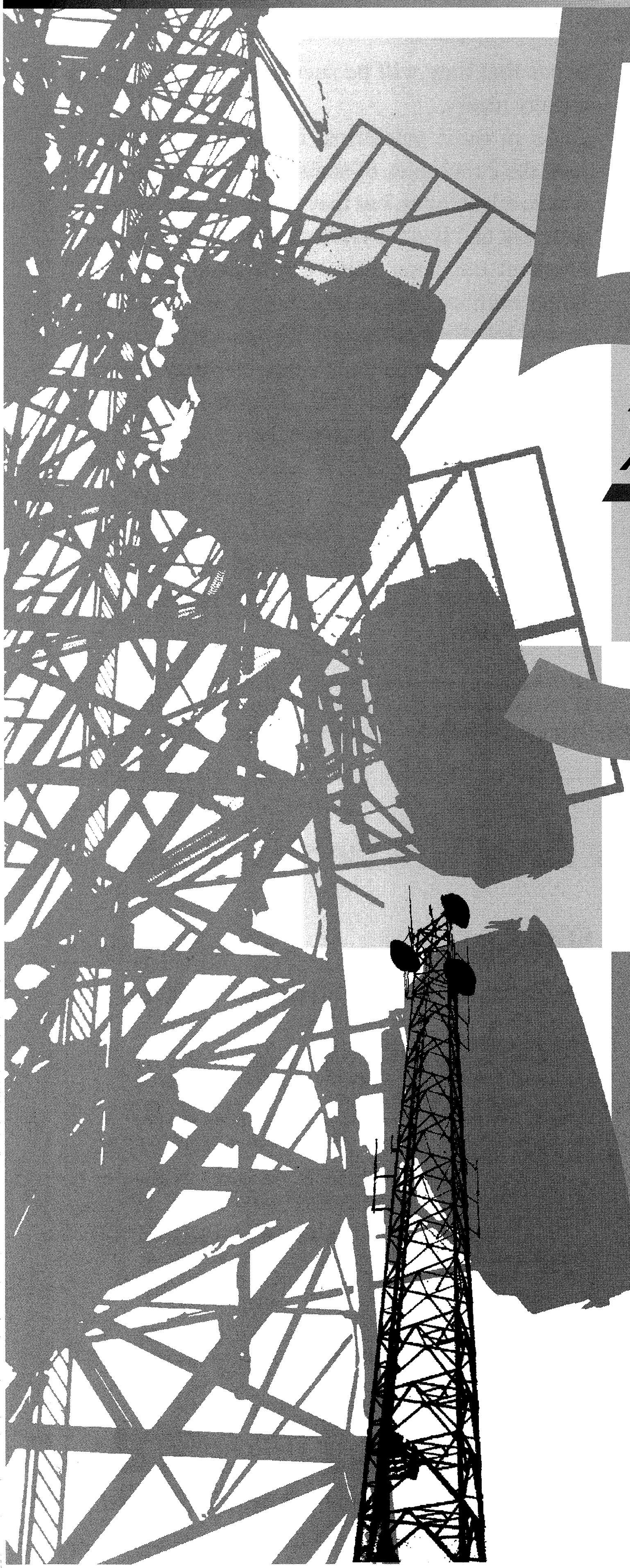
Rent is the most applicable periodic fee and usually is on a monthly basis. A range of $150 to $800 per month was quoted for the above-specified small system. Large systems can go for as much as $2,300 per month-and even higher. Some tower companies will provide discounts if there are multiple systems on a site or when multiple sites are leased. Five-year lease terms are typical, and they usually include annual rent increases. Currently, annual rent increases range from 3 percent to 7 percent, but it is also possible that a CPI will be used. For small (and some larger) systems, the cost of electrical power is usually included in the rent, based on a reasonable estimate of the consumption and the utility rate. There may be provisions for lowering or raising the rent if the utility rate for electricity changes significantly. For large systems, it is common for the site user to obtain its electricity directly from the utility by having its own meter.

Several other periodic fees that might be charged on a monthly, yearly or other basis include charges for road access and governmental land use. Typically, a road owner is the entity requiring payment for road use. The road fee may be linked to ongoing road maintenance, as an incentive to reduce unnecessary traffic, or it may impose a land-use fee directly on a site user. Some, but not all, site providers pass along the land use costs (e.g., rent) that they incur yearly from federal agencies such as the U.S. Forest Service.

USFS Fees

In 1997, the Forest Service began implementing a new system for leasing its land. This system includes a rent structure charged to site providers, which the USFS designates as "facility managers." The rent for each calendar year, charged annually in advance, includes a base amount plus an amount for each tenant that was occupying the facility on Sept. 30 prior to the start of the new year. The tenant-related fee is only applicable to occupants that are communications service providers (e.g., Commercial Mobile Radio Service), and it is a set amount for each type of communications service, regardless of a given provider's size. Thus, the fee related to a small (e.g., single channel) CMRS provider is the same as the fee related to a large (e.g., 20 channel) CMRS provider at the same site.

The tenant-related fee for year 2001 in the Los Angeles market for a CMRS provider is just under $3,400 a year (about $300 a month). Because the tenant-related fee is specific for each tenant in a site provider's facility, some tower companies are passing this fee on to their customers. This is harder on the smaller communications service providers because they bear a higher cost-per-channel than their competitors sharing the facility. Some site providers bill this cost yearly if the tenant was occupying the site on Sept. 30. Others raise the monthly rent proportionately, and others do not charge this fee in any direct form. The Bureau of Land Management operates almost identically to the USFS, and the site providers deal similarly with their customers. Because the BLM and USFS rent structures come up for review in a few years, facility managers and



occupants most likely will participate in the debate to spur changes.

Other Site Issues

Many site suppliers provide other features and services useful to site customers. These are frequently beneficial to the smaller customers that often lack some of these functions and are competing with larger system operators that do have them. Some site features include standby power and specially positioned multi-user antenna systems. Some services include remote site monitoring, coverage prediction, permitting and licensing assistance and technical support.

Accommodating all Comers

All sizes of site providers and system operators have their special place in serving the wireless needs of the public. If the owners and operators of these organizations manage their assets well and price their offerings well, then a good probability exists that they will be successful and serve our society nicely.

As in most industries, the smaller operators lack the economies of scale and some other economic advantages, but they can thrive by offering different and special services along with top management customer care. Considering the ever-larger number of people and organizations being served by efficient and useful wireless devices, it appears that the antenna site industry is performing its function well, despite some of the challenges and disappointments.

Reichler is the owner of RJR Wireless, Calabasas, CA, which provides consulting and special projects for antenna site managers, owners and users. His email address is RJR-Wireles@aol.com.

By Eli Pasternak

SCM

Analog modulation for 21st century digital content

Contrary to popular belief, analog modulation isn't going the way of the dinosaur. Signal code modulation, a hybrid digital/analog scheme, may offer a viable alternative.

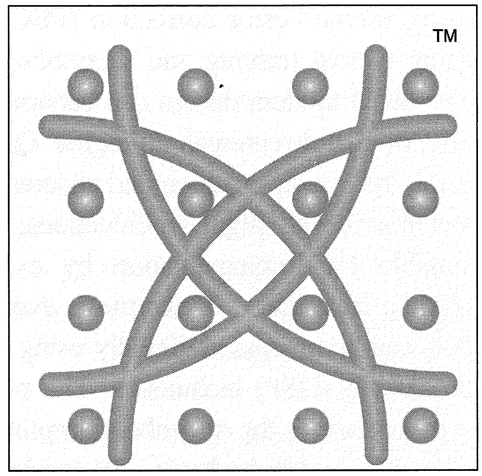
The industry is in the midst of a digital revolution, where virtually every form of information is either digital — or if it is not already digital (e.g. speech, music and video), it is digitized, stored in digital media, or transmitted digitally over communications channels. Is analog modulation a relic of the past, relegated to a time when AM and FM broadcasts were introduced? Should analog modulation ever be considered for state-of-the-art communications? Are there any clear benefits over digital modulation? The answer is yes and signal code modulation (SCM), a hybrid analog/digital scheme with unique advantages, is one strong player.

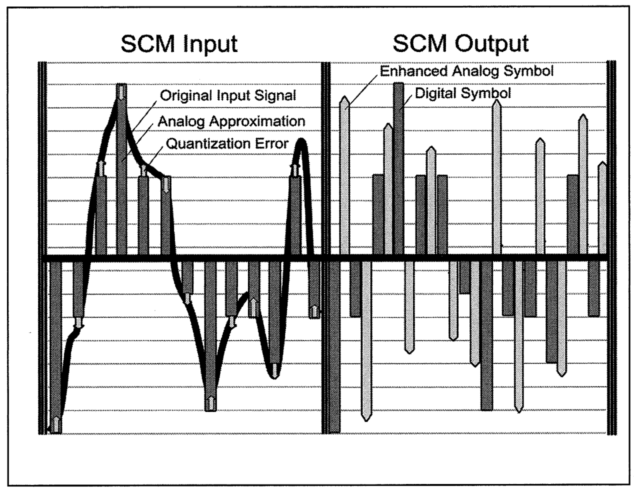
Introduction to signal code modulation

Signal code modulation is a method for transmitting analog information over a noisy channel. SCM provides an analog pipe through which any band-limited waveform can pass, including truly analog information or the output of a digital modem. The operations that SCM performs on the payload signal are simple, as illustrated in Figure 1.

The waveform is sampled and quantized, just like a typical pulse code modulation (PCM) transmission, and the digital signal is then transmitted over the noisy channel using any digital technique, such as quadrature amplitude modulation (QAM). The digital signals are denoted by the symbol D. However, unlike PCM, SCM does not discard the quantization error. This error signal is extracted and transmitted over the noisy channel as an analog symbol, A.

The SCM transmission and reception processes are depicted in Figure 2. The transmission channel is divided into two channels. Channel 1 is analog, and channel 2 is digital. In a process essentially identical to PCM, the original analog signal at the system input is sampled at the appropriate rate, based on the sampling theorem, and converted to digital values. The resulting D symbols are transmitted via channel 2 using a digital transmission technique optimized for the channel. Those D symbols represent N bits per analog input sample. To produce the quantization error





A, the PCM data is converted back to analog and subtracted from the original input. This *A* symbol is amplified by a gain of 2^N or any gain that will optimize the voltage swing of the *A* symbol with that of channel 1.

The SCM receiver performs the opposite operation, combining the *A* and *D* symbols into an analog stream replica of the original analog signal. This replica is not a precise copy of the original signal, because noise in the channels could vary the *A* symbols or cause bit errors in the *D* symbols. However, the 2^N amplitude gain in channel 1 has provided noise power immunity of 2^{2N} to the *A* symbols. This is one of the key benefits of SCM.

Its application

This signal processing method is a straightforward approach in implementing a real wireless application, as shown by the following example. A radio channel of bandwidth *B* is splitting *B* between channel 1 and channel 2 *(see Figure 2.)* The *D* symbols are transmitted as digital QAM symbols, and the *A* symbols are combined in pairs and transmitted as analog QAM. The RF channel bandwidth is divided by time division into the *A* and *D* symbols.

The actual transmission may consist of a stream of ADADAD... symbols. If a *D* symbol contains eight bits and the RF channel is suitable for four bits per symbol, the transmitted signal may be arranged as ADDADDADD..., wherein *D* is a 16-QAM symbol. If, on the other hand, *D* is a two-bit symbol and the channel is suitable for four-bit symbols, the transmission will be AADAADAAD.... Each particular application will determine the optimum SCM mode in terms of choice of number of bits per *D* symbol.

The *D* symbols may be aggregated and encoded

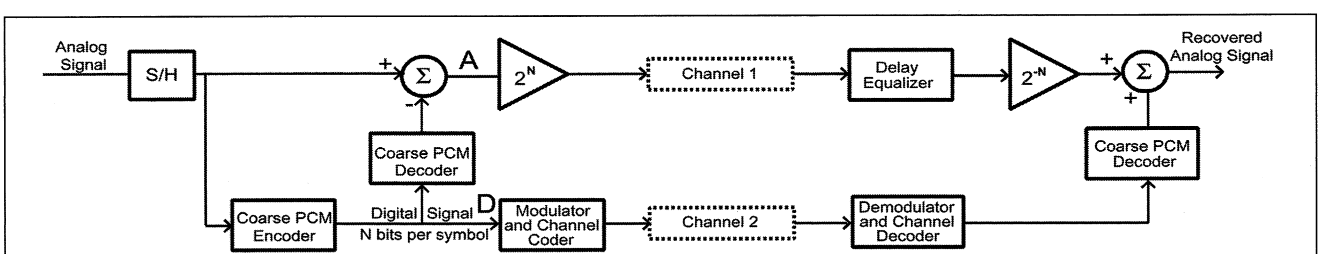


Figure 2: SCM transmission and reception processes.

using forward-error correction (FEC) techniques, using typical framing and scrambling techniques. The SCM modem design can become a modification of a conventional all-digital QAM modem, using the synchronization and channel equalization techniques with slight modifications; thus SCM is suitable for implementation by existing digital modem techniques. Furthermore, even the A symbols can be processed digitally using digital signal processing (DSP) techniques. The presence of D symbols next to the A symbols simplifies the design of such a modem by having the receiver rely on the digital symbols to calibrate the signal gain and perform the adaptive equalization. An example of a transmission constellation in which the original signal is an unmodulated carrier and the D symbols are 16-QAM is shown in Figure 3. *(Note: An explanation of Figure 3 appears in Appendix B.)*

Performance comparison

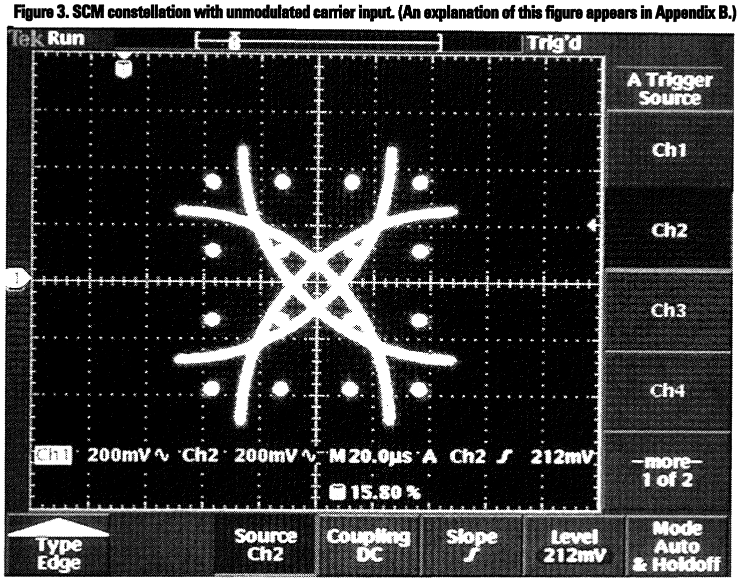
Before explaining why SCM is a nearly ideal analog communications method, it is necessary to define the ideal reference and compare it with existing alternatives. A communications link designer faced with an additive white Gaussian noise channel of bandwidth B and a limited signal-to-noise ratio (SNR) might choose a digital link as a first choice. The analog samples are converted to digital with a resolution of M bits per symbol. It is well-known that, by using an ideal digital error-correction coding technique, the channel can pass the information error-free at a bit rate that is called the channel capacity C, where:

$$C = B \log_2 (1+\text{SNR})$$

If the analog signal-sampling rate is R, the number of bits per symbol cannot exceed $M = C \cdot R$; thus M is limited and quantization noise is unavoidable.

The designer may consider analog modulation, such as frequency modulation FM. Frequency modulation is known to improve the output signal-to-noise ratio, referred to below as the signal-to-noise ratio destination (SNRd), compared with the signal-to-noise ratio channel (SNRc). FM accomplishes this advantage at the expense of bandwidth increase. The designer will soon find that FM is inferior to PCM at the minimum-channel SNR. This is because FM suffers from a threshold phenomenon in which the performance degrades drastically with channel SNR, several decibels (dB) above the PCM[1]. Shannon, who studied this subject, introduced rate distortion theory, from which the performance of an ideal communications system could be derived. Such system performance will depend on the bandwidth expansion factor b, which is the ratio between channel bandwidth and source information bandwidth.

Figure 3. SCM constellation with unmodulated carrier input. (An explanation of this figure appears in Appendix B.)



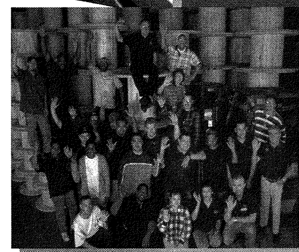
The numbers

Shannon has derived the following equation[2]:

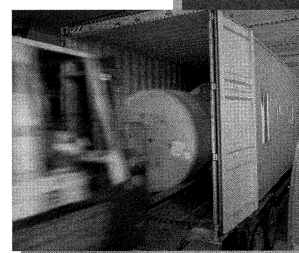
$$SNRd = \left(1 + \frac{SNRc}{b}\right)^b - 1$$

PCM can meet this SNR curve in one point, but the quantization noise remains unchanged as channel SNR exceeds the threshold value. A similar expression can be derived for SCM, as shown in Appendix A. SCM performance is as follows:

Great people...



Great service...



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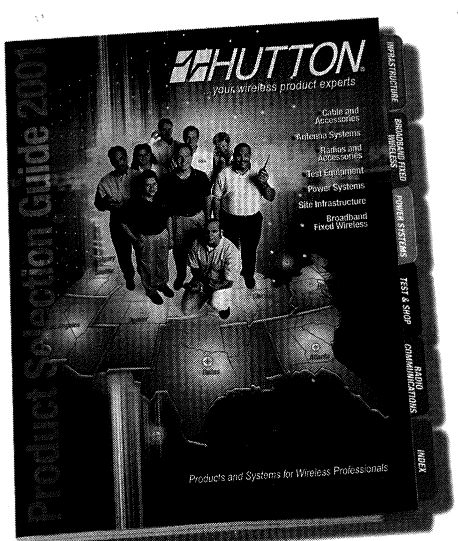

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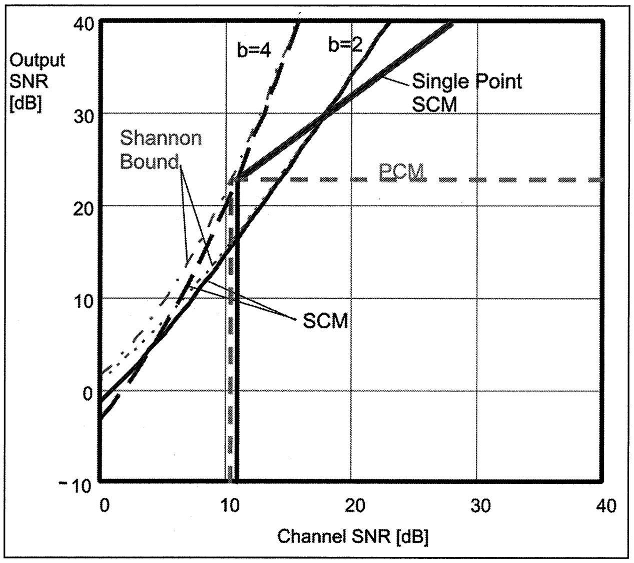


Figure 4: SNR performance of an ideal analog communications PCM and SCM.

$$SNRd = \frac{SNRc}{b}\left(1 + \frac{SNRc}{b}\right)^{b-1}$$

This expression is plotted for *b=2* and *b=4* in Figure 4 for both SCM and the Shannon Bound.

In the threshold corner of SCM, the channel SNR is a fraction of a decibel from the ideal Shannon Bound. If the SCM curve is to follow the Shannon Bound for every channel SNR, SCM must adapt its bit rate and error-coding scheme for each SNR. A practical implementation of SCM is more likely to be optimized for one threshold point only: for example, 23 dB output SNR in Figure 4. The straight line "single point SCM" depicts the resulting performance. The advantage of SCM is now becoming apparent; while optimum PCM performs as well at the threshold channel SNR, SCM continues to improve as channel SNR improves. Any practical communications link operates most of the time at a significant margin above threshold. PCM would remain in threshold performance regardless of SNR, while SCM improves.

Because SCM is essentially an ideal modulation scheme for analog signals, it is difficult to come up with a significantly better scheme. Therefore, SCM is likely to remain useful for the foreseeable future, making it a preferred choice for emerging applications. The obvious question is: Who needs an analog modulation scheme? Surprisingly, most SCM applications are related to digital communications, and this paradox will be resolved in the next section.

Wide range of applications

An SCM-based communications link is basically a transparent, band-limited analog pipe with near-ideal performance in noisy channels. Every analog signal could potentially use SCM because it can outperform other existing modulation schemes. However, SCM has a compelling advantage for digital communications applications as well. For example, SCM can pass digital information by acting as a repeater of a digital channel. This application provides a wireless extension of cable modem digital information.

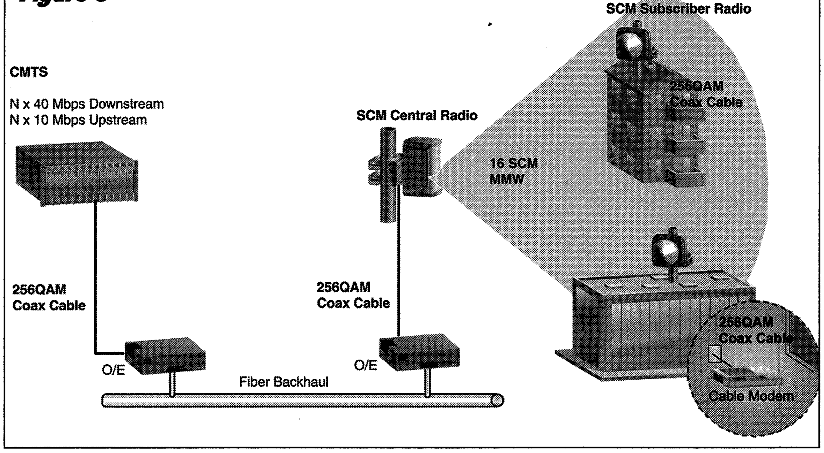
As illustrated in Figure 5, a cable modem termination system (CMTS) transmits a 42 Mb/s 256-QAM signal in a 6 MHz cable channel shared among the cable modems located at the subscribers' premises. The return upstream path from the cable modems is a 10 Mb/s 16-SQAM signal in a 3.2 MHz cable channel. The signals are carried by a combination of fiber and coax referred to as a hybrid fiber/coax (HFC) network. The fiber delivers a large amount of bandwidth over long distances with strong noise immunity. Coax cables distribute the signal between the fiber and each subscriber.

To reach a business park located beyond the reach of the existing HFC network, the cable operator installs an SCM-based point-to-multipoint wireless access system at any point on the HFC network that has line-of-sight to the business park. All customers located at a particular site share the SCM radio located at that site. The subscribers simply use low-cost cable modems that connect to the SCM radio via a shared coax cable. The wireless subscribers can even share the same cable channels with purely wired subscribers because the wireless link is transparent to the cable equipment.

The significance of SCM in this application is its ability to take a 256-QAM signal and transport it over a wireless link suitable only for a lower mod-

ulation scheme, such as 16-QAM. SCM provides significant additional noise immunity, as is depicted in Figure 4 because it uses bandwidth expansion to improve the destination SNR. There is a non-SCM alternative: the 256-QAM signal could first be demodulated back to the original data bits, then modulated as 16-QAM, transmitted over the wireless link, demodulated at the destination, and finally remodulated using 256-QAM. This alternative would be much more costly, given the amount of processing required. It would also add significant latency to the information transported because an efficient channel must perform the error correction of the original signal before transmitting it over the wireless link. Furthermore, because SCM provides a transparent link that is not sensitive to protocol evolution or variations, it is more future-proof and versatile than specific digital standards.

Figure 5



A second example is an application from another discipline: digital audio recording. A new-generation audio CD could include a digital track identical to and compatible with existing CD tracks, and in addition, have an analog track to provide the enhanced quantization error. Such an analog track would provide audio performance that depends on the quality of the recording and of the disc player. The most discriminating audiophile could use the more sophisticated player for true analog reproduction, while the less discriminating users would enjoy the low-cost CD technology in its current format.

The call

SCM is a versatile, hybrid analog-digital modulation scheme for transmitting analog signals to provide a repeater function for digital signals. The transparent nature of SCM allows it to relay signals without depending on transmission protocols and modulation formats. Such transparent links provide significant cost reduction because they use mass-produced end equipment such as cable modems. The near-ideal performance of SCM makes it a good choice for low-cost transparent links.

References

1. B. P. Lathi, *Modern Digital and Analog Communication Systems*, Third Edition, 1998, *page 720.*

2. Ibid., *eqn. 15.70a*, page 718.

About the author

Eli Pasternak is co-founder, senior vice president and chief technology officer of BridgeWave Communications. Prior to BridgeWave, he served as CTO and chief scientist at Netro, which he co-founded in 1994. At Netro, he was responsible for most of the IP related to both AirMAN and AirStar products and wrote four fundamental core technology patents in the area of wireless ATM and its associated MAC layer. He received B.S.E.E. and M.S.E.E. degrees from the Technion in Israel. He can be contacted at: **www.bridgewave.com.** A demonstration of BridgeWave's technology can be viewed at this site .

Appendix A:
SNR performance of an ideal SCM channel

Without loss of generality, it can be assumed that the source signal is sampled at the Nyquist rate and is transmitted as a discrete symbol. If b=1, the modulation is simply pulse amplitude modulation (PAM). It is well-known that this link meets the theoretical limit of performance set by the Shannon capacity theorem[i]:

$$SNRd = \left(1 + \frac{SNRc}{b}\right)^{b} - 1 \qquad \text{(Eqn. 1)}$$

SNRd is the output (destination) SNR, and *SNRc* is the channel SNR. Clearly, for *b=1*, there is no gain, and thus PAM meets the ideal performance. For *b>1* there is a significant performance gain, but how can it be achieved?

Suppose that a band-limited Gaussian channel is used for binary transmission and that by channel coding, the channel capacity is achieved digitally. Such coding is not practical, but today's codes closely approach the theoretical limit. The capacity of a Gaussian channel is:

$$C = B\log_2(1+\text{SNRc}) \qquad \text{(Eqn. 2)}$$

C is the capacity in bits per second of error-free transmission over a channel of width *B*.

Next, consider the following mixed link:

Total bandwidth is *bB*.

It has an analog portion of bandwidth *B*.

It has a digital portion of bandwidth *(b-1)B*.

It maintains the same peak power as the original PAM signal. Thus, with the bandwidth increase, the channel SNR is decreased by the factor *b* (i.e., noise power increases by the factor *b*). The available capacity of the digital channel is

$$C = (b-1)B\log_2\left(1 + \frac{SNRc}{b}\right) \qquad \text{(Eqn. 3)}$$

These bits are used for qualifying the analog symbols in the analog portion. As there are *2B* symbols/sec and *C* bits/sec, there are $M = C/2B$ bits per analog symbol. Now the analog signal in the range [-a, a] is not transmitted in full. Instead, it is divided into 2^M equal segments. We assume that M is an integer; however, we treat M as a continuous variable in the following analysis. For each symbol, only one of the segments contains the analog information. This segment is magnified to the range [-a,a]; i.e., it is amplified by a factor of 2^M and transmitted with PAM modulation. The M bits associated with it are transmitted in the coded digital channel and recovered. The receiver will then take the analog signal, shrink it back by 2^M and translate it to the original level. The signal-to-noise increase is the square of the magnification, thus it equals $2^{2M} = 2^{C/B}$. Therefore:

$$SNRd = \left(\frac{SNRc}{b}\right)2^{\frac{C}{B}} \qquad \text{(Eqn.4)}$$

Substituting Eqn. 3 for C in Eqn. 4:

$$SNRd = \left(\frac{SNRc}{b}\right)2^{(b-1)B\log_2\left(1+\frac{SNRc}{b}\right)}$$

And simplifying:

$$SNRd = \frac{SNRc}{b}\left(1 + \frac{SNRc}{b}\right)^{b-1}$$

Reference

1. B. P. Lathi, *page 711.*

Appendix B:
SCM constellation explanation

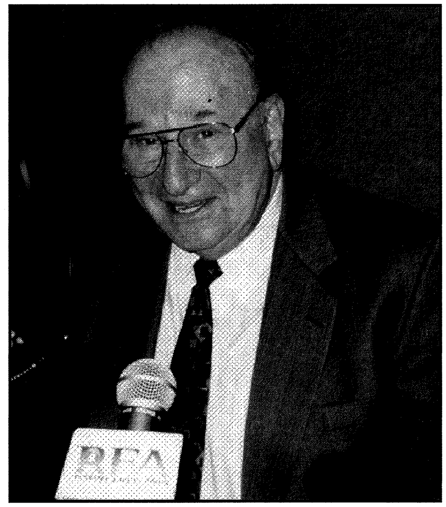
How does SCM cause this unusual constellation diagram on page 16?

This diagram represents a specific SCM mode, AAD, wherein the bandwidth expansion is *b*=1.5, and the input is an unmodulated carrier within the system pass band, although not necessarily at center frequency. I is a 16-QAM symbol carrying four bits, and the SCM conversion uses only a single bit per A dimension. The image is a superposition of many sampling points, each representing a single *A* or *D* point. The collection of all *D* points creates the familiar 16-QAM constellation. When depicted as *I* vs. *Q*, the original analog carrier would produce a circle, a familiar Lissageau waveform. However, SCM, in this example of *N=1* bits per dimension, divides such a circle into four quadrants. The analog difference signal is a quarter of a circle. The four quarters are superimposed in the image, thus forming the symmetrical waveform. By changing the amplitude of the carrier, the quarter circles change their radii, creating different images. ■

This issue of the Proceedings marks the beginning of a new series of member profiles. We begin with George Jacobs. George is the propagation editor for CQ (a position he has held for 50 years!). He has written a number of columns and articles dealing with broadcasting, radio propagation and technical and scientific history. He is also the author of The New Shortwave Propagation Handbook.

George has received a number of awards, including The Marconi Gold Medal Engineering Achievement Award, Lifetime Radio Engineering award (NAB) and Outstanding Achievement and Superior Honor Awards (U.S. Government). He was elevated to the grade of fellow of RCA in 1977, and was presented the Jack Poppele Broadcast Award for 1992 for his important and long-term contributions to the improvement of radio broadcasting. He was recently honored as Dayton Hamvention's 2001 Amateur of the Year.

George is a Life Fellow of the IEEE and was the leader of the IEEE-Popov Society scientific USA-Soviet Exchange in 1978. His bios have appeared in Who's Who in America; Who's Who in the World; Who's Who in Technology *and* Who's Who in Media and Communication.



The following was written by George and appeared in the March 2001 issue of CQ.

The Science of Predicting Radio Conditions

On New Year's Eve, as this is being written, the famous ball in Times Square is slowly dropping to welcome in a new year: four, three, two, one . . . welcome 2001! This will be a very special year for me, since it will mark three anniversaries in my professional career. The new year will be my 60th year in the field of Broadcast Engineering, my 60th year as a licensed radio amateur, and my 50th year as Propagation Editor of *CQ* magazine.

Reminiscing

The masthead from the March 1951 issue of CQ introduced me as the new Propagation Editor, and my first column appeared in that issue. Fifty years have passed since my first article—a total of 600 months—with never a deadline missed! It takes me an average of three days a month to prepare and write this column; it has been the equivalent of five years of my life.

I usually write the column in Silver Fall, Maryland, but my professional broadcast engineering consultancy often takes me to distant lands. To meet deadlines I have written columns in more than two dozen countries, and on at least two occasions within the sounds of war, in Viet Nam and in Israel.

I was first licensed as W2PAJ in December 1941 and was on the air for only two days when the shut down of ham radio came after the Pearl Harbor attack. This was long enough, though, to spark my interest in radio propagation. This interest grew with my WW II service in radar navigation and communications. My interest in wave propagation intensified during my post-war university studies.

I have been an avid reader of *CQ* since 1946, when I found of particular interest the monthly "Propagation Predictions" column and articles written by the late Perry Ferrell. CQ was the first journal to recognize the importance of HF predictions and forecasts for radio amateurs. Perry took the mystery out of HF propagation by converting scientific data into easy to understand and use graphs and charts. His column was an immediate success.

Due to the pressures of conducting a radio amateur sporadic-*E* propagation research project for *CQ,* Perry stopped writing his monthly columns in 1950. His column was sorely missed, since HF propagation data was not then readily available in any other form for radio amateurs.

In 1949, after receiving my Electrical Engineering degree from Pratt Institute, I joined the engineering staff of the Voice of America, specializing in HF propagation. Aside from my engineering responsibilities, I wrote a weekly propagation report for the very popular VOA *Amateur Radio Program.* The program was written and edited by Gene Black, then W2ESO, now W2LL, who was also Editor of *CQ*. It was voiced by the late Bill Leonard, W2SKE, who later became the president of CBS News.

In early 1951 Gene invited me to resume writing Perry Ferrell's *CQ* "Propagation" column. I jumped at the opportunity and had the initial March column ready in a few days. It was my goal to provide *CQ* readers with the very latest state-of-the-art worldwide band-opening predictions, day-to-day propagation forecasts, and down-to-earth explanations of HF propagation phenomena. The rest is history!

Engineers and scientists in the field of shortwave or HF propagation often measure elapsed time not in months or years, but in solar cycles. A solar or sunspot cycle has an average life of approximately eleven years. In March 1951, when I wrote my first *CQ* column, Cycle 18 had passed its peak. I have continued through the entire lifespan of Cycles 19, 20, 21, and 22, and the peak of the present Cycle 23. What cycles these have been!

LAST-MINUTE FORECAST

Day-to-Day Conditions Expected for March 2001

	Expected Signal Quality			
Propagation Index..............	**(4)**	**(3)**	**(2)**	**(1)**
Above Normal: 5-6, 12-13, 18, 22, 23	A	A	B	C
High Normal: 3-4, 7, 10-11, 17 19-20, 23-24, 28-30	A	B	C	C-D
Low Normal: 1-2, 9, 16, 21 26-28	B	C-B	C-D	D-E
Below Normal: 8, 14	C	C-D	D-E	E
Disturbed: 15, 25	C-D	D	E	E

Where expected signal quality is:

A—Excellent opening, exceptionally strong, steady signals greater than S9.

B—Good opening, moderately strong signals varying between S6 and S9+, with little fading or noise.

C—Fair opening, signals between moderately strong and weak, varying between S3 and S9, with some fading and noise.

D—Poor opening, with weak signals varying between S1 and S6, with considerable fading and noise.

E—No opening expected.

HOW TO USE THIS FORECAST

1. Find the *propagation index* associated with the particular path opening from the Propagation Charts appearing on the following pages.

2. With the *propagation index,* use the above table to find the expected signal quality associated with the path opening for any given day of the month. For example, an opening shown in the Propagation Charts with a *propagation index* of 3 will be fair to good (C-B) on March 1st and 2nd, good (B) on the 3rd and 4th, excellent (A) on the 5th and 6th, etc.

Included in this period was the mother of all solar cycles, Cycle 19, which reached the record-breaking smoothed sunspot peak of 201 in November 1957. This was the most intense cycle recorded in the 200 years that sunspot data had been recorded. It produced "once in a lifetime" propagation conditions on the HF bands. My columns during 1957, and some special articles that I wrote for *CQ* at the time, are among the most exciting writings for me, since I realized that I was writing about a scientific event which very likely

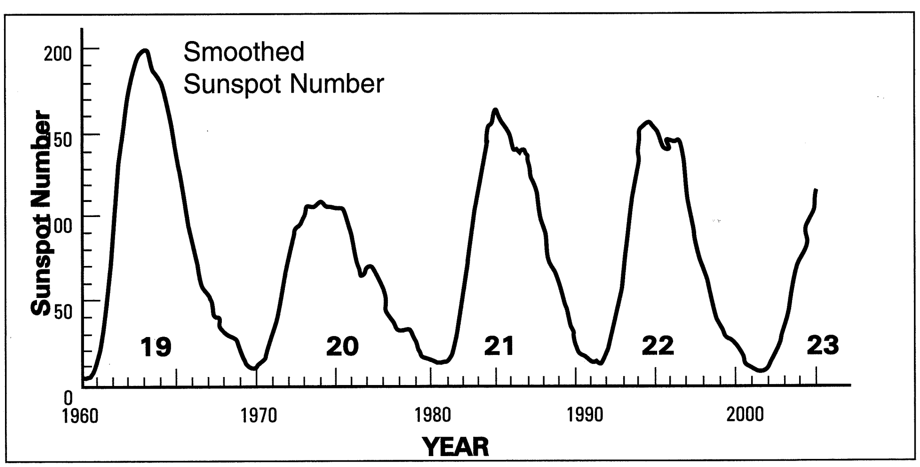


Figure 1. The 50 years that I have been writing this column coincide with sunspot Cycle 19 through the rising portion of Cycle 23. This is the highest level of sustained solar activity since observations began during the mid-18th century.

would not be exceeded in the next century or two. The "twin" cycles of 21 and 22, both of which exceeded a count of 150, also produced years of outstanding HF propagation.

I have paid very special attention to the columns I write each October and November for the CQ World-Wide DX Contests because of the very heavy use amateurs worldwide make of the HF bands during such contests. The contests also serve as excellent checks on the accuracy of band-opening predictions and day-to-day propagation conditions. To date, the accuracy for these contest columns exceeds 90%.

As I have mentioned many times in the past, my greatest reward for writing this column is the comments I receive from readers who have found the propagation prediction and forecast material useful and informative.

Knowing that my writing may help take the mystery out of HF propagation and contribute much to making amateur radio more enjoyable and a more effective communication medium is the fuel that has energized me to write the column month after month.

Fifty years, a total of 600 columns—that's a lot of writing over a very long period of time, but I have enjoyed every minute of it!

Solar Cycle Progress

The Royal Observatory of Belgium reports a monthly mean sunspot level of 106.5 for November 2000. This results in a 12-month running smoothed sunspot number of 119 centered on May 2000. This is a decline of two points from last month's level of 121. During November daily levels of solar activity varied between a high of 147 on November 2nd and a low of 59 recorded on the 26th.

According to daily observations made at Penticton, British Columbia by the Dominion Radio Astrophysical Observatory of Canada, the adjusted mean level of 10.7 cm solar flux for November 2000 was 176. This results in a 12-month running number of 180 centered on May 2000. This is a drop of one point from last month's level.

George's first professional position in broadcasting as an engineer at WKNT in 1941 in Kingston, New York.

A smoothed sunspot number on the order of 115 and a 10.7 cm solar flux level of approximately 180 are forecast for March 2001 as Cycle 23 appears to be declining slowly from its peak level of 121 believed to have been reached during April 2000.

March Conditions

While sunspot Cycle 23 appears to be slowly declining, solar activity during March is expected to remain at near peak levels.

As discussed in last month's column, equinoctial propagation conditions are expected to continue through the month of March and into early April. The experts generally agree that overall DX conditions are usually optimum during the equinoctial periods. Improved DX conditions expected during March should be most noticeable on long circuits between the United States and the southern hemisphere—for example, to Australia, South America, southern Africa, southern Asia, Antarctica, etc. Gray-line DX propagation conditions, both at dawn and at sunset, should peak during March because of the similar conditions that are expected to exist at these times in both hemispheres. Conditions should be optimum for long-path openings as well. Improvement due to equinoctial propagation conditions should be observable on all HF bands.

While considerably fewer east-west openings are likely during March on the 10 and 12 meter bands, fine inter-hemisphere openings should be possible from an hour or two after sunrise, through the daylight hours, and into the sunset period.

Good worldwide DX conditions, including fine

HOW TO USE THE SHORT-SKIP CHARTS

1. In the Short-Skip Chart, the predicted times of openings can be found under the appropriate distance column of a particular meter band (10 through 160 meters) as shown in the left-hand column of the chart. For the Alaska and Hawaii Charts the predicted times of openings are found under the appropriate meter band column (15 through 80 meters) for a particular geographical region of the continental USA as shown in the left-hand column of the charts. An * indicates the best time to listen for 80 meter openings.

2. The propagation index is the number that appears in ( ) after the time of each predicted opening. On the Short-Skip Chart, where two numerals are shown within a single set of parentheses, the first applies to the shorter distance for which the forecast is made, and the second to the greater distance. The index indicates the number of days during the month on which the opening is expected to take place, as follows:

(4) Opening should occur on more than 22 days
(3) Opening should occur between 14 and 22 days
(2) Opening should occur between 7 and 13 days
(1) Opening should occur on less than 7 days

Refer to the "Last Minute Forecast" at the beginning of this column for the actual dates on which an opening with a specific propagation index is likely to occur, and the signal quality that can be expected.

3. Times shown in the charts are in the 24-hour system, where 00 is midnight; 12 is noon; 01 is 1 AM; 13 is 1 PM, etc. In the Short-Skip Chart appropriate *standard* time is used at the path midpoint. For example on a circuit between Maine and Florida, the time shown would be EST, on a circuit between New York and Texas, the time at the midpoint would be CST, etc. Times shown in the Hawaii Chart are in HST. To convert to standard time in other USA time zones add 2 hours in the PST zone; 3 hours in the MST zone; 4 hours in the CST zone; and 5 hours in the EST zone. Add 10 hours to convert from HST to GMT. For example, when it is 12 noon in Honolulu, it is 14 or 2 PM in Los Angeles; 17 or 5 PM in Washington, D.C.; and 22 GMT. Time shown in the Alaska Chart is given in GMT. To convert to *standard* time in other areas of the USA subtract 8 hours in the PST zone; 7 hours in the MST zone; 6 hours in the CST zone; and 5 hours in the EST zone. For example, at 20 GMT it is 15 or 3 PM in New York City.

4. The Short-Skip Chart is based upon a transmitted power of 75 watts CW or 300 watts PEP on sideband; the Alaska and Hawaii Charts are based upon a transmitter power of 250 watts CW or 1 KW PEP on sideband. A dipole antenna a quarter-wavelength above ground is assumed for 160 and 80 meters, a half-wave above ground on 40 and 20 meters, and a wavelength above ground on 15 and 10 meters. For each 10 dB gain above these reference levels, the *propagation index* will increase by one level; for each 10 dB loss, it will lower by one level.

5. Propagation data contained in the charts has been prepared from basic data published by the Institute for Telecommunication Sciences of the U.S. Dept. of Commerce, Boulder, Colorado 80302.

CQ Short-Skip Propagation Chart
March & April 2001
Band Openings Given in Local Standard Time At Path Mid-Point (24-Hour Time System)

Band (meters) *Distance From Transmitter (Miles)*

2300	*50-250 miles*	*250-750 miles*	*750-1300 miles*	*1300- miles*
10	Nil	09-13 (0-1)	07-09 (1) 09-12 (1-2)	07-08 (1) 08-09 (1-
2)			12-13 (1-3)	09-12 (2-
4)			13-16 (0-3)	12-16 (3-
4)			16-18 (0-2)	16-18 (2-
3)			18-20 (0-1)	18-20 (1-
2)				20-21 (0-
1)				
15	Nil	07-09 (0-1) 09-15 (0-2)	07-08 (1) 08-09 (1-2)	07-08 (1) 08-09 (1-
3)		15-19 (0-1)	09-15 (2-4) 15-18 (1-3)	09-15 (4) 15-18 (3-
4)			18-19 (1-2)	18-19 (2-
3)			19-23 (0-1)	19-21 (1-
3)				21-23 (1-
2)				23-01 (0-
1)				
20	11-13 (0-1) 13-16 (0-2) 16-19 (0-1)	08-09 (0-3) 09-11 (0-4) 11-13 (1-4) 13-16 (2-4)	06-07 (1-2) 07-08 (3) 08-09 (3-4) 09-18 (4)	06-07 (2) 07-08 (3) 08-10 (4) 10-15 (4-
3)		16-18 (1-4) 18-19 (1-3)	18-19 (3-4) 19-22 (2-4)	15-22 (4) 22-23 (3-
4)		19-22 (0-2) 22-08 (0-1)	22-00 (1-3) 00-02 (1-2) 02-06 (1)	23-00 (3) 00-02 (2) 02-04 (1-
2)				04-06 (1)
40	06-07 (1-2)	06-07 (2-3)	06-07 (3-2)	06-08 (2-
1)	07-09 (2-3)	07-09 (3-4)	07-08 (4-2)	08-15 (1-
0)	09-18 (4)	09-11 (4-3)	08-09 (4-1)	15-16 (2-
0)	18-20 (3-4)	11-13 (4-2)	09-13 (2-1)	16-17 (2-
1)	20-22 (2-3)	13-15 (4-3)	13-15 (3-1)	17-19 (3-
2)	22-00 (1-2) 00-06 (1)	15-20 (4) 20-22 (3-4)	15-17 (4-2) 17-19 (4-3)	19-03 (4) 03-04 (3-
4)		22-00 (2-4) 00-03 (1-3) 03-06 (1-2)	19-00 (4) 00-03 (3-4) 03-06 (2-3)	04-06 (3)
80	07-11 (4)	07-08 (4-2)	07-08 (2-1)	07-08 (1-
0)	11-18 (4-3) 18-22 (4)	08-11 (4-1) 11-16 (3-0)	08-11 (1-0) 11-16 (0)	08-16 (0) 16-18 (1-
0)	22-00 (3-4)	16-18 (3-2)	16-18 (2-1)	18-20 (2-
1)	00-07 (2-3)	18-20 (4-3)	18-20 (3-2)	20-22 (4-
2)		20-00 (4)	20-03 (4)	22-03 (4-
3)		00-05 (3-4)	03-05 (4-3)	03-05 (3-
2)		05-07 (3)	05-07 (3-2)	05-07 (2-
1)				
160	05-07 (4-2)	05-06 (2-1)	05-06 (1)	05-06 (1-
0)	07-09 (3-1) 09-17 (2-0)	06-07 (2-0) 07-09 (1-0)	06-19 (0) 19-20 (2-1)	06-19 (0) 19-20 (1-
0)	17-19 (3-1) 19-20 (4-2)	09-17 (0) 17-19 (1-0)	20-22 (3-2) 22-03 (4-3)	20-22 (2) 22-03 (3-
2)	20-05 (4)	19-20 (2)	03-05 (3-2)	03-05 (2-
1)		20-22 (4-3) 22-03 (4) 03-05 (4-3)		

HAWAII
March & April 2001
Openings Given in Hawaiian Standard Time

To:	*10 meters*	*15 meters*	*20 meters*	*40/80 meters*
Eastern (1)	08-09 (1)	06-07 (1)	12-14 (1)	18-20
USA (2)	09-14 (2)	07-08 (2)	14-16 (2)	20-22
(3)	14-16 (3)	08-11 (1)	16-18 (3)	22-01
(2)	16-17 (2)	11-13 (2)	18-21 (4)	01-02
(1)	17-18 (1)	13-15 (3)	21-00 (3)	02-03
(1)*		15-17 (4)	00-04 (2)	21-22
(2)*		17-18 (3)	04-06 (3)	22-01
(1)*		18-19 (2)	06-07 (2)	01-02
		19-20 (1)	07-08 (1)	
Central (1)	08-09 (1)	06-07 (1)	09-14 (1)	19-20
USA (2)	09-11 (2)	07-08 (2)	14-16 (2)	20-22
(3)	11-15 (3)	08-09 (3)	16-19 (3)	20-02
	15-17 (4)	09-14 (2)	19-23 (4)	02-04
(4)	17-19 (2)	14-16 (3)	23-03 (3)	04-05
(2)	19-20 (1)	16-18 (4)	03-06 (2)	05-06
(1)		18-19 (3)	06-08 (3)	22-23
(1)*		19-20 (2)	08-09 (2)	23-02
(2)*		20-21 (1)		02-03
(3)*				03-04
(2)*				04-05
(1)*				
Western (1)	08-09 (1)	06-07 (1)	15-17 (3)	18-19
USA (2)	09-11 (2)	07-09 (2)	17-21 (4)	19-21
(3)	11-12 (3)	09-11 (4)	21-00 (3)	21-22
(4)	12-16 (4)	11-15 (3)	00-02 (2)	22-04
(3)	16-17 (3)	15-18 (4)	02-04 (1)	04-05
(1)	17-19 (2)	18-20 (3)	04-06 (2)	05-06
(1)*	19-20 (1)	20-21 (2)	06-08 (4)	21-22
(2)*		21-23 (1)	08-10 (3)	22-23
(3)*			10-15 (2)	23-04
(2)*				04-05
(1)*				05-06

ALASKA
March & April 2001
Openings Given in GMT

To:	*10 meters*	*15 meters*	*20 meters*	*40/80 meters*
Eastern (1)	20-22 (1)	18-20 (1)	13-15 (1)	06-13
USA (1)*	22-00 (2)	20-22 (2)	20-22 (1)	07-12
	00-01 (1)	22-00 (3) 00-01 (2) 01-02 (1)	22-01 (2) 01-03 (3) 03-05 (2) 05-06 (1)	
Central (1)	20-23 (1)	18-20 (1)	14-16 (1)	07-14
USA (1)*	23-01 (2)	20-23 (2)	20-23 (1)	08-12
	01-02 (1)	23-01 (3) 01-02 (2) 02-03 (1)	23-02 (2) 02-04 (3) 04-05 (2) 05-07 (1)	
Western (1)	20-23 (1)	18-20 (1)	16-18 (1)	07-09
USA (2)	23-00 (2)	20-22 (2)	18-20 (3)	09-12
(1)	00-02 (3)	22-00 (3)	20-00 (2)	12-14
(1)*	02-03 (2)	00-02 (4)	00-02 (3)	09-10
(2)*	03-04 (1)	02-04 (3)	02-04 (4)	10-12
(1)*		04-05 (2)	04-05 (3)	12-13
		05-06 (1)	05-06 (2) 08-10 (1)	

#See explanation in "How To Use Short-Skip Charts" in box at the beginning of this column.
*Indicates best time for 80 meter openings. Openings on 160 meters are also likely to occur during those times when 80 meter openings are shown with a propagation index of (2) or higher.
Note: The Alaska and Hawaii Propagation charts are intended for distances *greater* than 1300 miles. For shorter distances use the preceding Short-Skip Propagation Chart.
For 12 meter openings interpolate between 10 and 15 meter openings.
For 17 meter openings interpolate between 15 and 20 meter openings.
For 30 meter openings interpolate between 40 and 20 meter openings.

inter-hemisphere openings, are expected on 15, 17, and 20 meters during most of the daylight hours. Daytime openings on 10, 12, 15, 17, and 20 meters should follow the sun, first opening toward the east and south after sunrise, peaking toward the south and north during the afternoon hours, and toward the west and south during the late afternoon and sunset period. As you go lower in frequency, the bands stay open longer, so plan to work from 10 and 12 through 15, 17, and 20 meters.

Between sunset and midnight expect DX openings on all bands between 15 and 160 meters, with some also possible on 10 and 12 meters when conditions are High or Above Normal. The 15, 17, and 20 meter bands should be open toward the south and west during this time period. Conditions on 30, 40, 80, and 160 meters should favor openings toward the east and south. These bands should peak for openings to Europe and Africa near midnight. Occasional 10 and 12 meter openings toward the south and west should also be possible during this period.

From midnight to sunrise expect optimum DX conditions on 30, 40, and 80 meters, with openings also possible on 160 meters. Conditions should favor openings toward the west and south. Remember, signals peak on 30, 40, 80, and 160 meters when it is *sunrise* on the *easterly* leg of a path. Some fairly good 20 meter DX openings may also be possible toward the south and west during this time period.

All in all, this March should be a very good month for worldwide DX propagation conditions on all of the HF bands. For more detailed information, refer to the DX Propagation Charts which appeared here last month. This month's column contains Short-Skip Propagation Charts which are valid through March and April, as well as Propagation Charts centered on Alaska and Hawaii. The Short-Skip Charts contain band-opening predictions for predominantly one-hop paths, ranging in distance between approximately 50 and 2300 miles.

For day-to-day changes in shortwave propagation conditions expected during March, see the Last-Minute Forecast at the beginning of this column.

For optimum short-skip openings between approximately 50 and 250 miles, try 80, 40, or 30 meters during the day and 80 or 160 meters at night. Between 250 and 750 miles, 30 and 40 meters should be best during the day and 80 or 160 meters at night. Try 20 meters for optimum conditions during the day between 750 and 1300 miles, and 30, 40, or 80 meters at night. For openings between 1300 and 2300 miles, 20, 17, or 15 meters should be best during the daylight hours, with 40 or 30 meters the band to use at night.

VHF Ionospheric Openings

March can be an unusually good month for VHF ionospheric propagation openings. Some 6 meter *F*-layer propagation is expected, along with increased chances for trans-equatorial, sporadic-*E,* and auroral-type openings.

Although solar activity is slowly declining, it is expected to be high enough in March to permit *F*-layer propagation between North America and the deep southern hemisphere, including southern Africa, the south Pacific areas, and South America. The band won't open every day, but look for openings when conditions are expected to be High or Above Normal. If the band is to open at all, it will open toward the southeast by mid-morning. Noontime should be best for openings toward South America. During the afternoon hours skip should extend farther into South America and also shift toward the west and southwest.

Trans-equatorial (TE) propagation conditions usually peak during equinoctial periods. Improved openings should be possible during March from the southern tier states to countries located in the southern half of South America. Most TE openings occur on 6 meters, but some may also be possible on 2 meters. TE openings must cross the magnetic equator at or near a right angle, and signals are at best very weak and often with heavy flutter fading. The best time to check for TE openings should be between 8 and 11 PM local time. TE openings do not occur very often, and when they do, you may have to really dig for them.

Auroras

Auroral activity generally occurs more often during equinoctial periods than in other seasons. Intense ionization associated with auroral displays can be responsible for auroral-scatter openings on the VHF bands and for short-skip openings up to approximately 1200 miles. While ionospheric openings resulting from auroral ionization usually are marked with a distinctive flutter-fading pattern, they at times can be clear and exceptionally strong. Look for auroral activity on days during March expected to be below normal or disturbed.

Frequent daily updates of aurora information, as well as geomagnetic, solar, and ionospheric data, can be found on the web at: http://dx.qsl.net/propagation and http://hfradio.org/propagation.html.

For a more complete review of VHF propagation, see N6CL's informative "VHF Plus" column here in *CQ*.

Meteors

Very little, if any, meteor activity is expected during March. The *delta-Leonids* shower, which reached its peak during late February, should continue through March 10th. This is a weak shower, with only a slight possibility of producing sufficient ionization for meteor-type communications.

73, George, W3ASK

A late-1950 photo showing (left to right) George, W2PAJ (now W3ASK); Gene Black, W2ESO (now W2LL), then Editor of CQ; the late Bill Leonard, W2SKE; and Bill Scherer on a Voice of America radio program. This was the day on which it was agreed to bring back CQ's "Propagation" column in March 1951 under the editorship of W3ASK.

Congratulations to George Jacobs, W3ASK, as he celebrates his 50th anniversary as CQ Propagation Editor, the longest-serving Contributing Editor this magazine—and possibly any magazine—has ever had. George receives information on propagation conditions from the ionosphere on his state-of-the-art crystal ball, or transmits instructions to the ionosphere! George's 90+% accuracy rate in predicting propagation conditions over the past 50 years is most impressive. We hope that George's unbroken string of monthly propagation columns extending back to March 1951 has been helpful to you in your on-air activities.

In addition to writing CQ's propagation column for the past half century, George has been a consultant to the broadcast industry for even longer, starting out as an engineer with the Voice of America just after World War II. His specialty, of course, is propagation. George often communes with the ionosphere from his home in Silver Spring, Maryland. ■

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ELECTRONICS MANUFACTURERS' REPRESENTATIVES

The Radio Club of America, Inc.

Founded 1909

WORLD'S FIRST RADIO COMMUNICATION SOCIETY

APPLICATION FOR MEMBERSHIP

Date: ______________________

TO: **THE EXECUTIVE COMMITTEE**
I hereby apply for ☐ Regular ☐ Retired ☐ Student (please check one) membership in THE RADIO CLUB OF AMERICA, INC. and certify that I meet the requirement for the grade selected. I further agree that, if elected, I will be governed by the Club's Constitution and By-Laws as long as I continue to be a Member.

____
Signature

Full Name: ____
(LAST) (FIRST) (INITIAL) (CURRENT AMATEUR CALL)

Home: ____
(STREET) (The above information is used for mailings and your membership directory listing)

____
(CITY) (STATE) (ZIP CODE)

____
(PHONE) (FAX) (EMAIL)

Business: ____
(ORGANIZATION) (DIVISION)

____
(STREET) (CITY) (STATE) (ZIP CODE)

____
(PHONE) (EXT.) (FAX) (EMAIL)

Birthplace: ______________________ Date of Birth: ______________________

Education and memberships in other clubs and societies: ______________________

____

Present occupation ____

Previous experience, indicate approximate dates (a current resume may be attached to the application):

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In what particular branch of the communications art are you most interested? ______________________

In what year did you become interested in electronic communications? ______________________

Please list the name of a member to whom you are personally known and who will sponsor you.

Sponsor (optional): ______________________

Mail this application with the applicable TOTAL DUE AT INITIATION as indicated on the reverse of this form to:

The Radio Club of America, Inc., 244 Broad Street, Red Bank, NJ 07701
732-842-5070▪Fax 732-219-1938▪Emails: exsec@radio-club-of-america.org [or] info@radio-club-of-america.org▪Website: www.radio-club-of-america.org

The Radio Club of America was founded in 1909 by a group of the industry's pioneers, and is the first active electronics organization in the world. Its roster of members is a worldwide Who's Who that includes many who founded and built the radio industry.

The Club's objectives include promoting cooperation among individuals interested in electronic communications and in preserving its history. The Club administers its own Grants-In-Aid fund to provide educational scholarships from tax-deductible contributions of the Club's members and business organizations.

The Club publishes and distributes its *PROCEEDINGS* twice a year.

ENTRANCE FEE AND DUES

Membership Category	Annual Dues Rate	3-Year Dues Rate	Initiation Fee	***Total Due At Initiation**
Regular	$40	$110	$40	**$150 (Includes 3-yr's dues)**
Retired	$25	$ 60	$25	**$ 85 (Includes 3-yr's dues)**
Student	$15	n/a	$ 7	**$ 22 (Includes 1-yr's dues)**

REGULAR member is a member not qualified for **RETIRED** or **STUDENT** status

RETIRED member is at least 65 years of age and fully retired.

STUDENT member is a full-time student at an accredited academic institution.

*For Non-U.S. Mailing Address please add $45 surcharge ($15 per year of dues) to Total Due At Initiation

☐ Check enclosed ☐ International Money Order enclosed ☐ Traveler's Check enclosed ☐ Credit Card

Visa M/C Amex Card number ______________________ Exp. date ____________ Amt. $__________

Signature ______________________ Billing address for credit card ______________________

____

(The charge will appear on your statement as Meredith & Hopkins.)

All monies to be issued in U.S. funds, drawn on an U.S. bank. International money orders and traveler's checks are accepted in U.S. funds, payable in the U.S. Checks should be made payable to **The Radio Club of America, Inc**

Recommendation of sponsor: (optional)

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Sponsor Signature: ______________________

Date: ______________________

FOR OFFICIAL USE **REV-100100**

Date Application received: ______________________

Date and Amount of Dues Received: ______________________

Admitted to Membership: ______________________

Membership Certificate and Pin issued on: ______________________

The Radio Club of America, Inc.

Founded 1909

WORLD'S FIRST RADIO COMMUNICATION SOCIETY

APPLICATION FOR SENIOR GRADE MEMBERSHIP

Date: ____________________

TO: **THE EXECUTIVE COMMITTEE**
I hereby apply for the Grade of Senior Member of THE RADIO CLUB OF AMERICA, INC. and agree, if advanced to this level, that I will be governed by the Club's Constitution and By-Laws.

____
Full Signature

Full Name: ____________________
(LAST) (FIRST) (INITIAL)

Home Address: ____________________
(STREET)

____
(CITY) (STATE) (ZIP CODE)

____
(PHONE) (FAX) (EMAIL)

PRESENT OCCUPATION

____
(COMPANY OR ORGANIZATION NAME) (TITLE OR POSITION)

____
(STREET) (CITY) (STATE) (ZIP CODE)

____
(PHONE) (EXT.) (FAX) (EMAIL)

SPONSORS

Letters of recommendation are required from two or more members (any grade) for sponsorship of Grade of Senior Member. Letters must be sent by each sponsor directly to The Radio Club of America, Inc., 244 Broad Street, Red Bank, NJ 07701. List Sponsors below:

1. ____________________
2. ____________________
3. ____________________

3. ____________________
4. ____________________
5. ____________________

Mail this application with twenty-five ($25) dollar fee to cover the cost of the Senior Grade Certificate and Pin to the address indicated below.

☐ Check enclosed ☐ International Money Order enclosed ☐ Traveler's Check enclosed ☐ Credit Card

Visa M/C Amex Card number ____________________ Exp. date __________ Amt. $__________

Signature ____________________ Billing address for credit card ____________________

____

(The charge will appear on your statement as Meredith & Hopkins.)

All monies to be issued in U.S. funds, drawn on a U.S. bank. International money orders and traveler's checks are accepted in U.S. funds, payable in the U.S. Checks should be made payable to **The Radio Club of America, Inc.**

(more) ➔

The Radio Club of America, 244 Broad Street, Red Bank, NJ 07701
732-842-5070▪Fax 732-219-1938▪Emails: exsec@radio-club-of-america.org [or] info@radio-club-of-america.org▪Website: www.radio-club-of-america.org

EDUCATION

Institution | Level Achieved | Date | Field

____

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MANAGERIAL, PROFESSIONAL AND TECHNICAL EXPERIENCE RELATING TO ELECTRONIC COMMUNICATIONS

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PUBLICATIONS OF SCIENTIFIC OR PROFESSIONAL PAPERS, BOOKS OR ARTICLES RELATING TO ELECTRONIC COMMUNICATIONS

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OTHER BACKGROUND RELATING TO ELECTRONIC COMMUNICATIONS

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Professional Awards ____

Professional Engineer's License(s) ____

Other Professional Society Affiliations & Grade of Membership ____

____

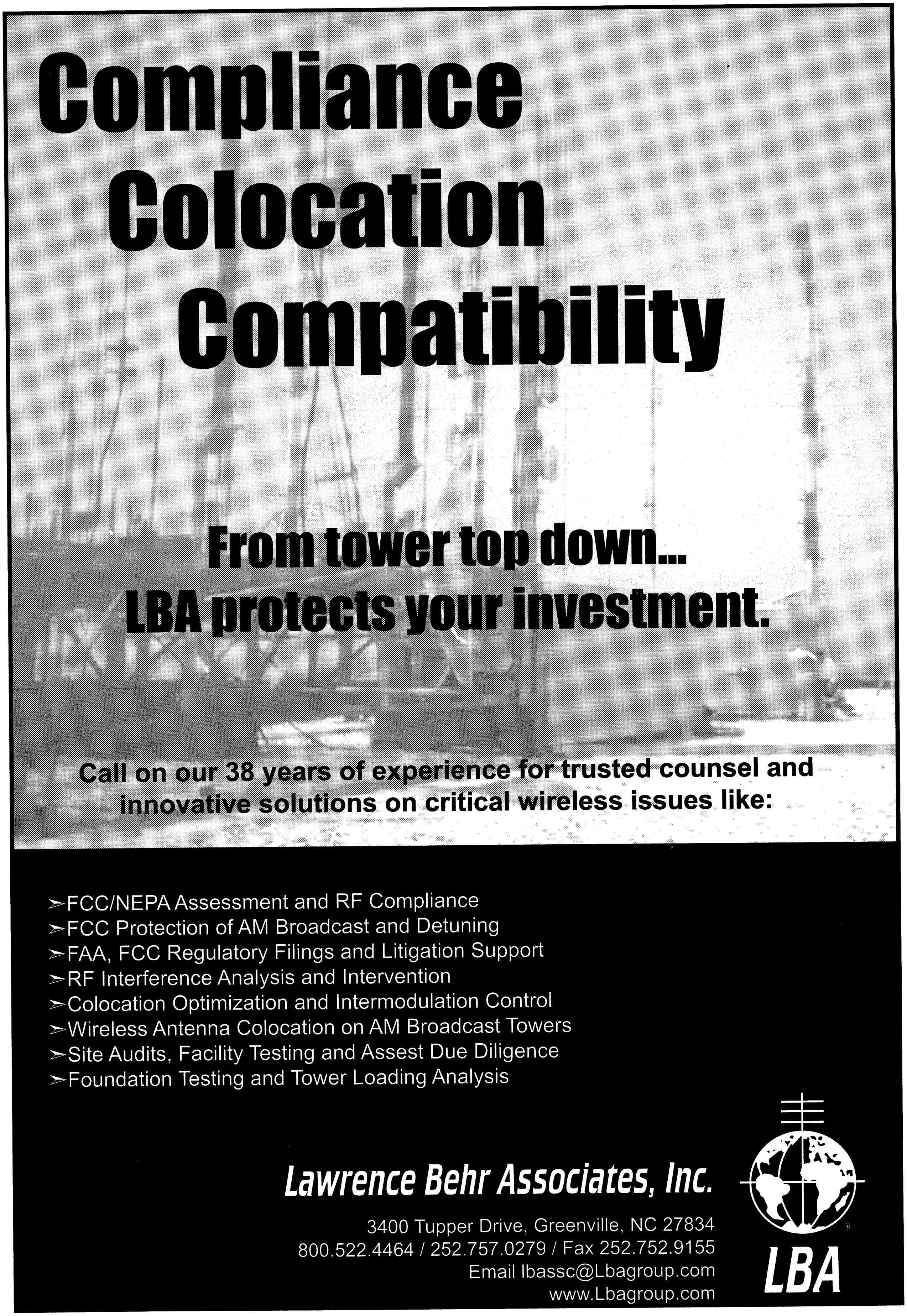
Current Amateur Radio Call Sign ____

Other FCC Licenses Now or Previously Held ____

FOR OFFICIAL USE **REV-071000**

Date Application received: ____________________ Amount of Fee Received: ____________________

Date Approved by Board: ____________________ Certificate & Pin issued on: ____________________


Compliance
Colocation
Compatibility
From tower top down...
LBA protects your investment.
Call on our 38 years of experience for trusted counsel and innovative solutions on critical wireless issues like:
➢FCC/NEPA Assessment and RF Compliance
➢FCC Protection of AM Broadcast and Detuning
➢FAA, FCC Regulatory Filings and Litigation Support
➢RF Interference Analysis and Intervention
➢Colocation Optimization and Intermodulation Control
➢Wireless Antenna Colocation on AM Broadcast Towers
➢Site Audits, Facility Testing and Assest Due Diligence
➢Foundation Testing and Tower Loading Analysis
Lawrence Behr Associates, Inc.
3400 Tupper Drive, Greenville, NC 27834
800.522.4464 / 252.757.0279 / Fax 252.752.9155
Email lbassc@Lbagroup.com
www.Lbagroup.com
LBA