Why Radio Moscow is WINNING the dB WAR

If you are an SWL'er, you may have noticed that Radio Moscow's signal appears much stronger than its competition's. We can't be certain why, but this may be the reason.

*STANLEY LEINWALL

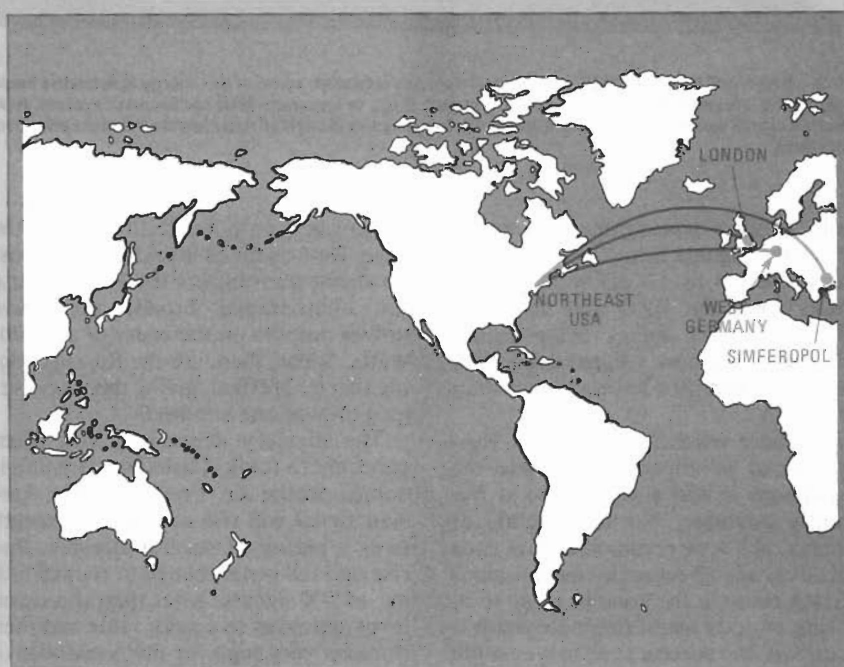

FIG. 1—SIGNALS FROM THE RUSSIAN TRANSMITTERS at Simferopol travel more than 1,000 miles farther than those from the BBC or Deutsche Welle. They also follow a more northerly path, putting them closer to the auroral zone.

RADIO MOSCOW'S ADDITION OF A WORLD Service in English several years ago provided yet another example of the strong emphasis the Russians have placed on shortwave broadcasting as a highly effective and economical medium for the mass dissemination of information. (A "World Service" is a 24-hour-a-day operation that serves all parts of the world; that differs from Moscow's earlier English-language service where broadcasts occurred only at certain times of day and were aimed only at English-speaking regions.) The Russians are by far the world's largest broadcaster. Using approximately 200 shortwave transmitters operating around the clock, they transmit in 65 different languages and dialects to virtually every corner of the globe.

The Soviet effort in broadcasting has not been concentrated solely on quantity. Listeners here in North America have observed that many Soviet shortwave signals are stronger than most competing broadcasts. In some cases, signals coming direct from the USSR are stronger than the relays coming from Cuba, leading you to believe that radiated power levels from the Russian-based transmitters are enormous.

Technically, however, one would not expect that to be the case, and there is, in fact, growing evidence to indicate that the Russians are instead considerably ahead of the West in the application of antenna and propagation theory for long-distance shortwave communication.

As an example, consider one of the principal transmitting sites used by the Soviets for their broadcasts to North America. Located in Simferopol, in the Crimea, it is approximately 5000 miles from the northeastern United States. Yet, signals from that transmitter site are considerably stronger in North America than signals from the BBC and Deutsche Welle, in spite of the fact that the transmitters for the latter two are at least 1000 miles closer to their target areas.

The world map shown in Fig. 1 illustrates the normal paths that those signals travel. Note that not only does the Russian signal need to travel more than 1,000 miles farther than the signals from the BBC and Deutsche Welle, but that the path of the Soviet signals is farther north and closer to the auroral zone. Both factors are quite significant.

In general, the farther radio signals must travel from a transmitting station, the weaker they are. Based on the location of the BBC, Deutsche Welle, and

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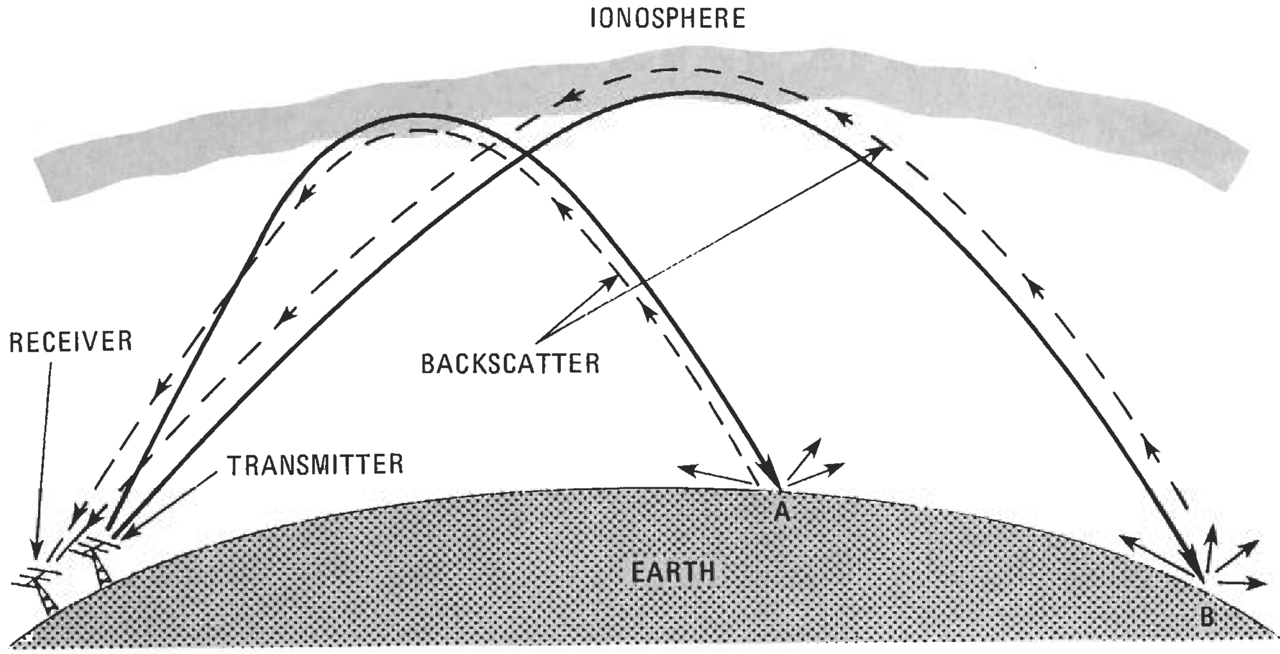

FIG. 2—WHEN SIGNALS STRIKE THE EARTH they are reflected; some of the energy is reflected back towards the transmitter where a receiver can pick it up. In an operational backscatter system, that reflected signal can be used to determine which frequency and angle of radiation are the most effective at the time.

Radio Moscow transmitters, we would expect the signals from the Soviet station to be 10 to 12 dB weaker than signals from the BBC and Deutsche Welle—all other things being equal. Yet, Radio Moscow's signal strength is generally about 10 decibels higher than the BBC's.

The more northern path of the Russian signal is important because the ionosphere in the auroral zone is frequently unstable. Northern lights, or auroras, are very common in that zone and adversely affect radio transmissions passing through the zone or close to it. During periods when the ionosphere is disturbed, the auroral zone moves south and signals that are normally stable are weakened. That is why transmissions from the BBC to North America, for example, "break up" before signals from Rome and Madrid. The paths of the latter signals lie farther to the south and those signals are therefore less prone to auroral effects even during ionospheric disturbances. But despite their more northerly path, Radio Moscow's signals remain strong even under adverse ionospheric conditions.

If SWL's (*S*hort*W*ave *L*isteners) receive Radio Moscow signals about 10 dB more strongly than signals from the BBC, and if we consider that the BBC uses 250-kilowatt transmitters and high-gain curtain antennas that are located more than 1000 miles closer to America than those of Radio Moscow, then a few simple calculations would seem to lead us to the conclusion that the power output of the Radio Moscow transmitters is on the order of 32,000 kilowatts (32 *megawatts*) or more! But that is not the case, for—as far as is known—the most powerful transmitters the Russians use for international broadcasting have power outputs on the order of 500 kilowatts. What, then, are the Russians doing that is, in effect, giving them a power gain of over one hundred?

The mystery deepens if you listen carefully to Radio Moscow when it first comes on the air. Frequently the Russian signal will rise and fall in strength over a period of several minutes; that rise and fall is not related to normal fading of DX signals. After that, the signal level increases to a peak value and then remains very high for the remainder of the broadcast.

Backscatter

Scientists are becoming convinced that they have unraveled the mystery. Since the Soviets are apparently not using super-power transmitters, they must be doing something to their signals. The signal variation may be related to a technique called "backscattering". In addition, the Russians appear to be using antenna systems that are more sophisticated than anything currently available in the West.

The principle of backscatter has been known for a long time. Essentially, on returning to earth after being reflected by the ionosphere, a radio signal is scattered in all directions because of the irregularities in the earth's surface (see Fig. 2). A small fraction of the energy is returned to the transmitter site—having been "scattered" back in the direction from which it came. The strength of the "backscatter" echo depends on the strength of the signal that struck the ground after reflection by the ionosphere.

It follows that if a wide range of frequencies is transmitted, some frequencies will penetrate the ionosphere and go into space, some will be absorbed, and some will be reflected. Backscattered signals will be received only for the frequencies that are reflected. Furthermore, the round-trip time delay of a very short pulse of radio energy is related to how far away from the transmitter the scattering took place; the longer the time delay, the farther away the signal was returned to earth.

A number of very useful facts can be obtained from an operational backscatter-system: We can determine the range of frequencies that the ionosphere is reflecting at any given time. From the strength of the backscatter signal we can learn which frequencies are strongest on reaching the earth from the ionosphere, and that tells us which frequencies the ionosphere is propagating best. From the time delay of the returned pulse and the characteristics of the transmitting-antenna pattern, we can also learn the height of the ionosphere from which the signals are being reflected. Using that information, it is possible to schedule frequencies that will deliver the best signals to a given target area. But, better still, that information makes it possible to determine the optimum radiation angles.

Suppose, for example, that in using conventional radio-forecasting techniques, the Russians have determined that at a particular hour the 7-MHz band should be optimum for transmission to the United States. The best radiation angle for that transmission will depend

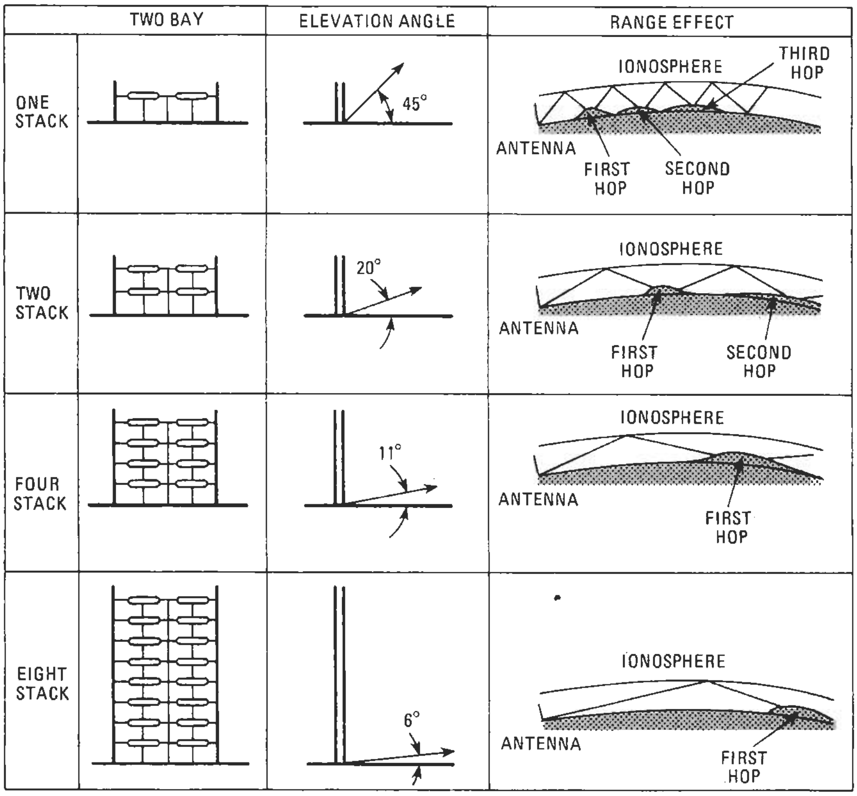

FIG. 3—THE MORE STACKS a curtain antenna has, the lower its angle of radiation will be.

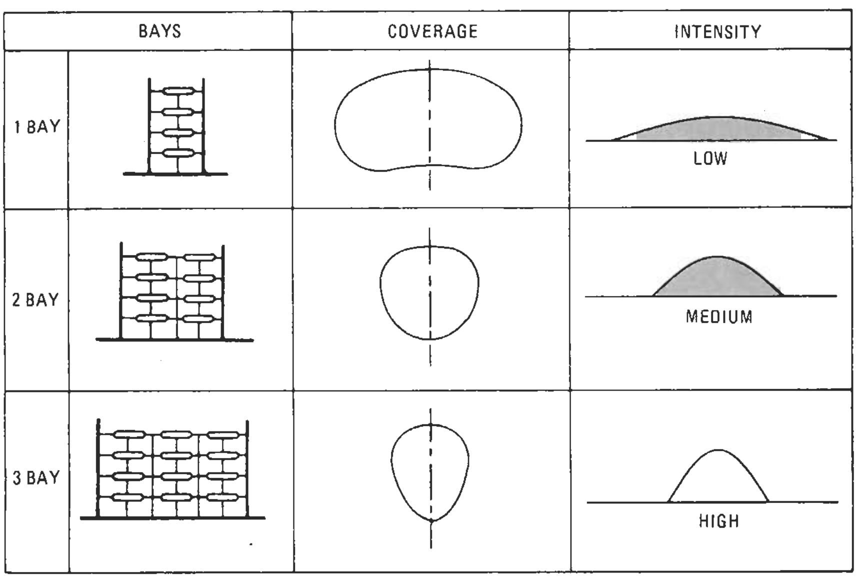

FIG. 4—THE WIDTH OF THE BEAM narrows, and the strength of the signal delivered to the target area increases, as the number of bays of a curtain antenna increases.

upon the height and state of the ionosphere at that time. A backscatter system that transmits very short pulses at various vertical angles could tell the broadcaster which radiation angle was returning the strongest signal, and consequently which angle would *deliver* the strongest signal. Appropriate adjustments in the vertical radiation angle of the antenna could then be made.

Antennas

The most sophisticated shortwave-broadcasting antenna systems are known as *curtains*, consisting of arrays of dipole antennas erected in a plane and fed from a common source. The dipole antennas are arrayed both horizontally and vertically (one above the other). The number of dipoles erected vertically are called *stacks*, and the number horizontally are called *bays*.

As the number of stacks is increased, the vertical firing-angle narrows and becomes lower, concentrating more and more energy into a narrower beam as shown in Fig. 3. As the number of bays is increased, the horizontal radiation pattern narrows, again concentrating the energy into a narrower beam as shown in Fig. 4.

In the West, most curtain-antenna systems consist of four bays and four stacks. Such systems provide an antenna gain on the order of about 20 decibels. There is now considerable evidence to indicate that some Russian transmitting antennas, especially those used for long-distance broadcasting, consist of eight bays and eight stacks, giving an antenna gain of close to 30 decibles. Furthermore, curtain antennas can be slewed—that is, the vertical and horizontal angles at which the antenna radiates can be varied—by adjusting the phasing of the signals being fed to each bay and stack of the antenna.

Experiments have shown that a gain of from 6 to 10 dB is possible if the ionosphere's height is properly used. Slewing is one way that the gain can be achieved. It would appear, therefore, that slewing, combined with a backscatter system, is the method used by the Russians to deliver such strong signals to the United States.

The use of optimum vertical radiation angles would also account for the Russian signals' remaining so strong during ionsopheric disturbances. We have learned that during certain types of disturbances the ionosphere "tilts" and is no longer parallel to the earth's surface. Such tilts could affect optimum radiation angles, and backscattering for optimum angles would be invaluable.

The Russians tell us very little about their technical facilities, and we can only make some guesses from what we observe. But based on the strength of the signals from the BBC and Deutsche Welle using known antenna gains and transmitter powers, we must conclude that the Russians are using facilities and techniques that the United States will not be able to duplicate for at least three to five years. **R-E**