The Lenkurt®

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DEMODULATOR

overloaded microwave systems — part 2

Actual capacity often can be extended by several methods short of costly updating

When a microwave system reaches its capacity limitation and additional service is required, there are several practical alternatives which should be explored.

Probably the most fundamental consideration is the nature of the equipment being evaluated; older systems with relatively small channel cross-sections often use older multiplex types such as transmitted carrier or double sideband multiplex – both of which use more bandwidth and load the system more heavily than single-sideband suppressed-carrier (SSBSC) multiplex. In systems using these older multiplex types, the obvious immediate solution is to update with the more efficient SSBSC system.

Other alternatives include sectionalizing the system by using baseband blocking or multiplex interconnects; evaluating the legal and technical possibilities of increasing the number of channels; evaluating the noise performance levels to see if modest relaxing might not permit an increase in capacity; and finally, considering whether it might not be more expedient to simply update the entire system.

In a simple microwave system consisting of only one hop or a few hops in tandem, with most of the required channels going end-to-end over the complete system, the problem is to increase the capacity of the individual hops.

In complex systems, on the other hand, the key to a more efficient use of capacity may lie in sectionalizing the system in such a way as to allow portions of the baseband to be blocked off at intervals and reused in different sections. This principle can be demonstrated by the following hypothetical example.

Example A:

An in-line microwave system (no spurs) connects the imaginary towns of (A), (B), (C), (D); channels are required only between these points, so intermediate repeater stations, if required, will not affect the situation. All microwave hops are designed for 300 channel capacity, and the full baseband is available at all four points. The system is operating at full capacity, with 60 channels in supergroup 1 between (A) and (B), 60 channels in SG 2 between (B) and (C), 60 channels in SG 3 between (C) and (D), and 120 channels in SG 4-5 end-to-end between (A) and (D).

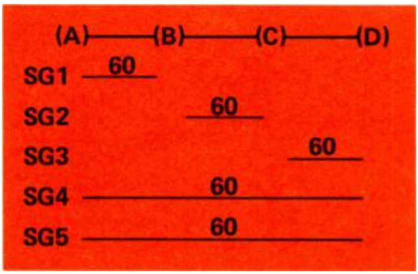

Figure 1.

In this system, a channel or group of channels once used anywhere in the system appear in the baseband throughout the whole system and cannot be used elsewhere. Consequently, this system is at full design capacity.

Sectionalizing With Filters

The system outlined in Figure 1 can be changed as follows: At (B) and at (C) the baseband can be sectionalized by putting in appropriate sets of high-pass/low-pass filters which divide the baseband so that supergroup 1-2 pass through the low-pass side and SG 3-4-5 through the high-pass side. At each of these stations there will be two sets of filters, one looking east and one looking west. The high-pass sides will be cross-connected through the station so that SG 3-4-5 pass through end-to-end. But insofar as SG 1-2 are concerned, the system is now broken into three independent sections, and the full 120 channels of SG 1-2 can be used in each of them creating the following situation:

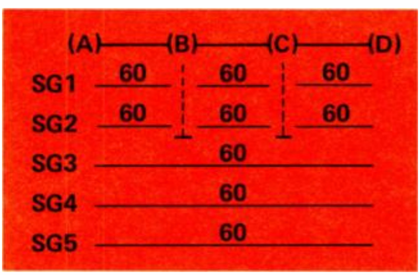

Figure 2.

This relatively simple change produces a microwave system capable of providing 120 channels from (A) to (B), 120 from (B) to (C), 120 from (C) to (D), and 180 from (A) to (D) for a total of 540 channels, yet no portion of the microwave system is carrying more than 300 channels. This has required additional multiplex equipment and some slight rearranging of original equipment. Figure 3 shows the filter arrangement used at the two intermediate stations. The cross-over point for the filters used in this particular application lies in the slot between SG 2 and SG 3, so that SG 1 and 2 pass through the LP side but are blocked from the HP side, while the reverse is true with SG 3 and higher supergroups.

Filters can be arranged either to pass the high groups through the station and drop the low groups, as shown in Figure 3, or the reverse. (The filters shown handle only one direction of transmission. Another identical set is needed for the opposite direction.)

There are many other possible filter arrangements. For example, filters are also available to split the baseband between SG 1 and SG 2, and others to split between SG 3 and 4, SG 3 and 5. Combinations of filters can be used to separate and drop an intermediate supergroup, while passing through the supergroups above and below it. Figure 4 is an example of such a complex filter arrangement. It could be used, for example, to pass SG 3, 4, 5 (and higher if necessary) straight through the station via the HP side of the upper pair of filters; SG 1 passes through via the LP (Low Pass) side of the upper pair and the LP side of the lower pair, while SG 2 is dropped and inserted via the HP (High Pass) side of the lower pair.

Figure 4 also shows another feature which may be needed – a pilot bypass arrangement. This might be required where a pilot must pass through the station which happens to be in the blocked section. The bypass equipment then is used to pick off this pilot and reinsert it on the other side.

Filter arrangements as shown in Figure 4 are relatively inexpensive and simple to apply, but they have some limitations. One is they are somewhat inflexible and difficult to modify or

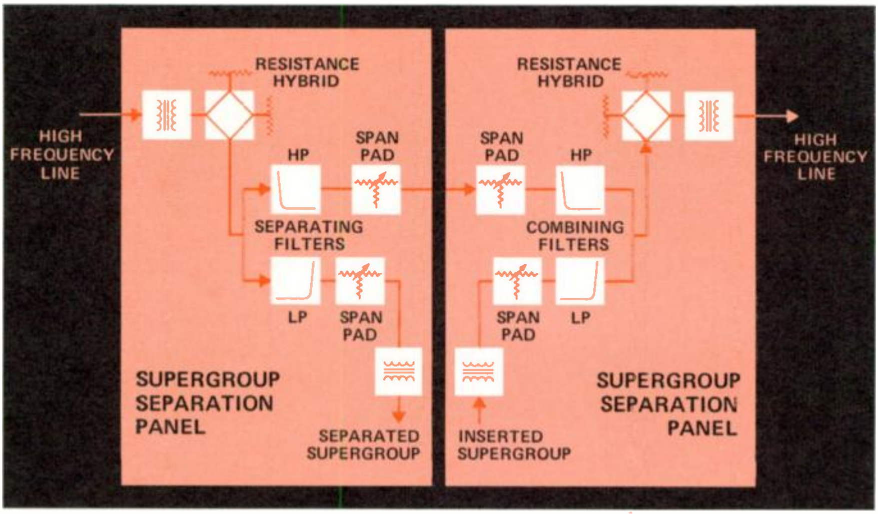

Figure 3. An example of two supergroup separation panels arranged for dropping and inserting a supergroup.

change without taking the system out of service. Another is the fact that separations between the higher supergroups (SG 4 and above) generally involve the loss of a few of the carrier channels in the vicinity of the crossover point. Further, if a number of such filters are used in tandem in a long system, there may be enough degradation in the response of the through paths to affect the end-to-end channels.

Sectionalizing With Carrier Interconnects

The filter type of sectionalizing is done in the microwave baseband. An alternative method of sectionalizing is available which provides maximum flexibility and does not have the limitations of the filter method, though it is somewhat more expensive.

When this alternative method is used, there are no through baseband connections at the sectionalizing station. Instead, each incoming microwave leg is completely terminated in a carrier terminal. Blocks of through channels are passed through the station by means of supergroup interconnects (60 channels) or group interconnects (12 channels) without demodulation. Those groups or supergroups destined for local drop are of course provided with channel modem equipment.

This carrier type of sectionalizing is almost universally used today in the telephone industry. In industrial systems of relatively high density there are often situations in which it is desirable to use carrier interconnect sectionalizing at some of the intermediate points. It is particularly advantageous, for example, at a junction station where several routes converge, with substantial numbers of channels terminating locally, but some blocks of channels needing to pass through the station in various ways. Setting up such a station on a carrier interconnect basis allows efficient use of the capacities of all the microwave branches, and perhaps even more important, allows great flexibility in any rearrangements which may develop as a result of changed requirements. Such rearrangements can be done without affecting service on anything except the particular blocks of channels being rerouted.

Figure 5 shows a simplified example of a three-way junction station arranged with carrier interconnects. Circuits passing through the station as shown are: SG 1 West to SG 2 North; SG 2 West to SG 2 East; SG 1 North to SG 3 East.

Thus this junction station could have 180 circuits to the west, 180 to the north, and 180 to the east, plus three supergroups passing through the station, giving a total of 720 channels.

The great flexibility available for rearrangements or for future additions is quite apparent. Although only supergroup interconnections are shown in Figure 5, it is also possible to make group interconnects in blocks of 12 channels, providing an added degree of flexibility.

Both types of sectionalizing have their advantages and disadvantages. In

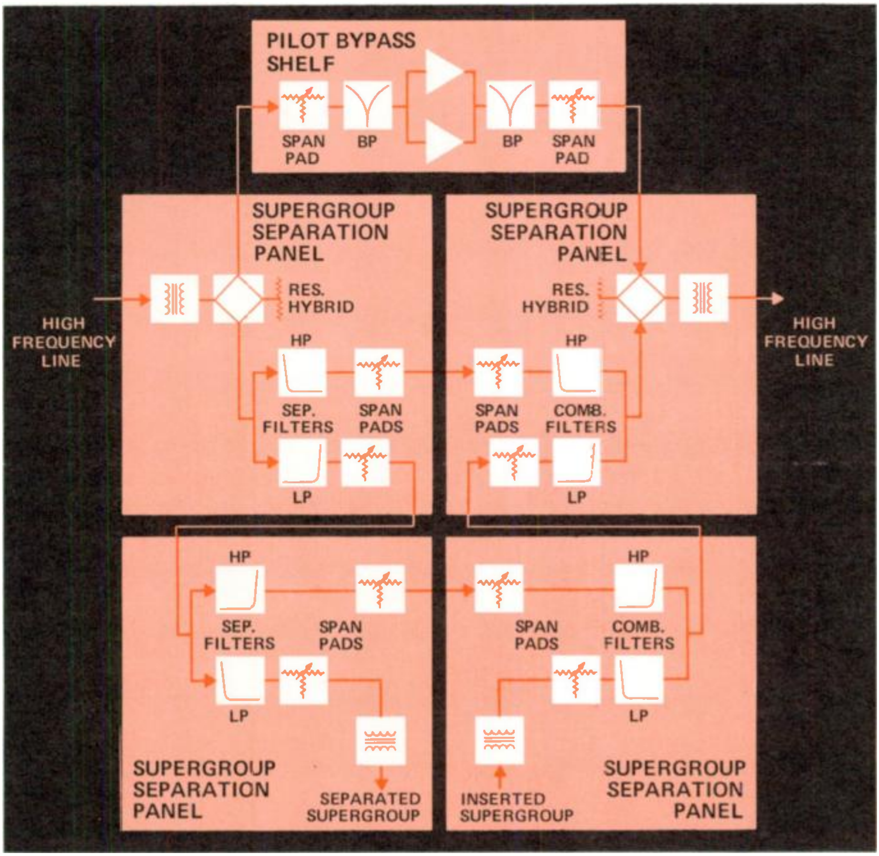

Figure 4. Four supergroup separation panels are shown with pilot bypass shelf arranged for dropping and inserting an intermediate supergroup.

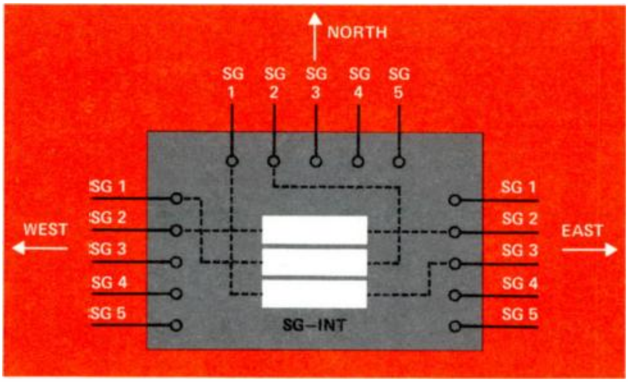

Figure 5. An example of a junction station with supergroup interconnects.

long microwave systems it is often desirable to use carrier interconnections to sectionalize at points of high channel density, and filter interconnects to sectionalize at points of lower channel density. Almost every situation has its own special characteristics, and only by studying the actual situation in light of the overall requirements can a decision be made as to the best method to use in a given station.

Noise Performance Criteria

A relaxation of a few dB in the requirements for channel noise performance can, under certain circumstances, permit a substantial increase in a microwave system's total channel capacity. This same circumstance can often make possible a more efficient use of the existing communications system.

The key lies in properly evaluating the true requirements for noise performance in relation to channel arrangements. Industrial microwave systems tend to perform essentially the same function as the public telephone networks. As a result they are designed to about the same standards of noise performance as long-haul telephone systems. For example, a common objective is 32 dBa0 or better in the worst channel for a system of 1,000 miles. There are very sound reasons for establishing such an objective for the initial system design. But in *using* the system, the user may very well recognize that a noise performance of 35 dBa0 would still provide an extremely good circuit which would be adequate to his needs. It should be remembered that the switching hierarchy in the public telephone network is such that up to eight or more trunks in tandem may occur on a given call, and the intertoll objectives thus must be very stringent indeed. Private microwave systems, even when they are very long, are much less complex and are more easily controlled by the user.

When it is not desirable to relax the end-to-end noise performance requirements in a system, there is still another useful possibility. This is to reserve the lower noise portions of the microwave baseband for the long-haul circuits, and use the higher-noise portions for short-haul circuits. This is in line with practices on the public networks, where considerably lower objectives are applied (on a per mile basis) for short-haul, toll-connecting and direct trunks than are applied to the intertoll trunks.

In an imaginary example, expansion of a 300 channel system to 420 channels could be accomplished by

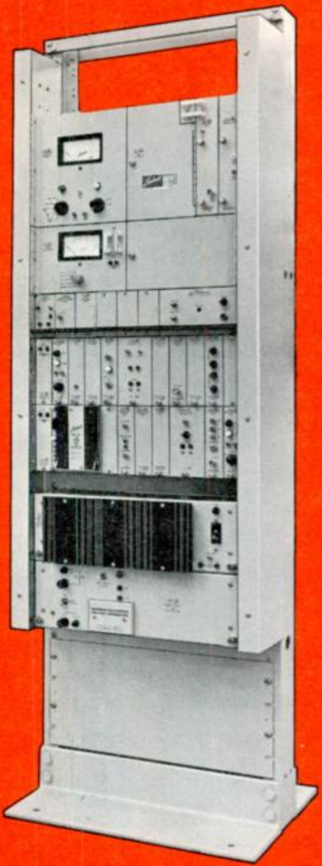

Figure 6. Lenkurt's 78 Microwave Radio System has been specifically designed with the wide flexibility needed to meet the rapid growth rates of modern message and data communications.

adding SG 6 and 7. If deviation were left unchanged the noise in the original 300 channels could be expected to increase by about 1.5 to 2 dB, but the noise in the top channel of SG 7 would be perhaps 5 dB poorer than the worst original channel. If the original system were a 1,000 mile system with end-to-end performance of 32 dBa0, and if the new SG 6 and 7 channels were used on relatively short sections of the system (up to 250 miles), the new channels would be around 31 dBa0 (6 dB improvement because they would traverse only 1/4 of the total system length, 5 dB degradation as indicated above) while the end-to-end channels would be no worse than about 34 dBa0. These values might well be thoroughly acceptable to the user.

Obviously this approach would require careful evaluation and good judgment. It must be recognized that it would not be satisfactory if the noise performance on the original system were marginal. But when properly used in combination with the other methods of system expansion, it can provide very worthwhile results.

Update the System

If other measures prove inadequate the possibility of upgrading the microwave system itself should be considered at least in the most heavily loaded portions by such means as increasing antenna sizes or changing out i-f filters to provide wider bandwidth. In many situations these changes may be relatively simple and inexpensive when compared to the increased capacity obtained.

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