In 1947, Major Armstrong demonstrated the *"Continental Network"* to the NAB Convention. The network spread from Washington, D.C., up north to the peak of Mount Washington in New Hampshire, and as far west as Niagara Falls, New York. Comprised of 18 FM stations, the network used both land line and off-air relay facility.

Since those early days the use of an FM facility for program forwarding and the forming of regional networks has been steadily on the increase. FM networks range from the large and extensive webs to those linking two or three stations.

Some nets were set up to distribute programs to local and regional AM stations via a powerful FM station in their area. This FM network idea was excellent in concept, and still is, but with the increased interest in FM, many stations would like to program separately and yet still relay programs to their network. Among the large webs, serving FM stations exclusively, in the QXR network.

With the inovation of the multiplex channel, it became possible for a radio station to forward programs to a network on one of its subchannels while maintaining a separate program schedule on the main FM channel--in either stereo or mono. It also made it possible for a station to relay two different programs simultaneously.

A TYPICAL NETWORK

The Knight Quality stations of New England comprise five stations which are located in Manchester (WGIR), Portsmouth (WHEB), Claremont (WTSV) and Hanover (WTSL) all New Hampshire. The fifth outlet (WEIM) is in Fitchburg, Mass.

A few years ago a regional network was set up with WGIR, because of it's central location, as the key station. Network programs came into the Manchester studios via AT&T facilities. Here they were processed and sent to the Knight stations through two separate TELCO lines. One leg went to Fitchburg, the second to Claremont/Hanover.

After construction of WGIR-FM it was planned to use the FM facility to relay programs to the Knight Network on a 67KC subcarrier channel. Furthermore, WGIR, was to obtain its network programs by use of an off-air pickup.

WGIR is affiliated with the Yankee Network and the Boston Sports Network, both of which are regional networks covering all of the New England States. These networks are headquartered in Boston, which is some 55 airline miles south of WGIR's s Manchester studios. WRKO (fm) is the key station for the Yankee network, while the sports network is fed thru WHDH-FM. Both outlets are Class B stations, with maximum power for their antenna heights.

On a number of occasions WGIR relays a Red Sox or Bruins hockey game on the sports network on the main channel, while the 67kc subcarrier is carrying the Yankee schedule, The sub-channel can also be used for pre-feeding news cuts and programs, closed circuit information, and any other material that is not suitable for broadcast on the main channel.

EQUIPMENT

Flexibility and reliability were of prime importance in the planning of the network. In order to attain this goal three FM tuners were acquired for the studios. Two McMartin crystal tuned receivers are used, one for each of the Boston networks and the third is an REL continuously variable tuner used mainly as a back-up. This receiver can be quickly and easily patched in anywhere in the system whenever desired.

On the roof of the studio building are two separate “Yagi” type antennas mounted on a 20 foot pole pointing southward towards Boston. The upper antenna is feeding an FM distribution amplifier located in the FM receiver rack. The other antenna is used solely as a stand-by and can be connected either to the distribution amplifier, or directly into any of the tuners, should the need arise. The output of the distribution amplifier feeds all three receivers. This receiver and antenna arrangement makes it possible to have the two networks in service at all times, and, in addition, offers protection against component failure by switching to a substitute immediately if necessary.

The decision to use a distribution amplifier in the system was made at an early date. The reason for this decision use was that, in addition to requiring only a single antenna for all three receivers, it provides added signal strength at the receiver input. This makes it possible for the receiver IF limiter stages to operate well saturated. This took the operation out of the marginal signal strength area and improved the signal to noise ratio. It also minimizes the flutter and fading that accompanies the flight of an airplane through the signal path. Although this condition can still occur, it is not now noticeable in the audio, because the signal strength never drops below the threshold level required for 20 DB of quieting.

The receivers are mounted in a rack next to the control position in the master control room. This makes it possible for the engineer on duty to monitor the audio as well as the signal strength on the receiver's "S" meters. AC power to the rack remains on 24 hours a day, this provides better receiver tuning stability plus giving longer tube life. The audio output of all the tuners is divided into two lines, one feed goes to the console for local programming, and the other to the subchannel switching box. This box is mounted at the control position, and allows the engineer on duty to select the correct audio source for relaying to the network. The control box has provisions for switching: NBC, Yankee, Sports Network, and the output of the audition channel from the control board. This switching arrangement makes it possible to relay any program material, either local or net, at a moment's notice. The output of the network switch is patched into a Gates “Levil Devil” amplifier, and this in turn is feeding the Mosley SCG-4 subcarrier generator.

OPERATION

After installing the switching system, it was found that not all program sources were at the same level. After a few months of operation, the difference in level was found to be very noticeable at the receiving end, and showed up as varying amounts of crosstalk from the main channel. It was then decided that a level as high as possible should be transmitted and maintained into the SCG-4. This helped to keep the crosstalk level down, because, before installing the "Level Devil” there was as much as 10 DB difference in levels--which meant a 10 DB increase in crosstalk when the level had to be increased at the receiving end. An FM limiting amplifier in the main channel also helps the crosstalk problem.

The WGIR FM transmitter site is 6.5 airline miles west of the studio location, and is programmed and remotely controfled through a Moseley studio-transmitter link. Both the main and the multiplexed subchannel are carried by the STL, in addition to the control tones. Up on the hill the 67KC sub is filtered from the output of the STL receiver through a passive network. The subcarrier is not demodulated at the transmitter site. The output of the filter drives the exciter of the RCA BTF-1D transmitter, and an RCA BFA-6A antenna at 920 feet above average terrain. Feeding the subcarrier into the exciter without demodulation helps to keep the crosstalk level down. It has been proven that there is no noticeable increase in crosstalk when a subchannel is fed directly into another exciter without first demodulating it. Another advantage of this system is having the multiplex generator at the studio site, this enables the engineer to keep an eye on its operation, although this unit is very stable and rarely requires any attention.

The multiple generator is equipped with a muting switch which mutes the output of the generator after approximately a five second pause in programming. This muting system is excellent for background music operations, but when program relaying it was found to be advantageous to disble the muting. Provisions for monitoring both the main and the subchannels is at the studios and also at the transmitter site. This is very helpful in checking out the operation in time of trouble.

After one year of operating this 100% radio network, much improvement over the former land line facilities was found, and the system was rated as over 95% reliable. There were many growing pains, but now these problems have quieted down-although the stations on the receiving end may tend to disagree with that statement on some occasions! Most of these problems have been human errors, such as forgetting to switch the proper program to the subchannel. There has been the usual crop of technical problems. At the receiving stations in the Knight network have a “Yagi” antenna, and are similarly equipped with McMartin crystal tuned receivers for both the main and subchannels.

These “FM networks” allows small networks to be formed, linking stations for entertainment programs and also emergency information in case of a national or regional disaster, and without exhorbetant landlive charges that mount up even during idle periods.

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