Communication Superhighways

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Because of advances in communication, it has been said that more progress has been made in science and general living conditions in the last fifty years than in all the thousands of years preceding. Part of this is due to transportation improvements in all divisions—land, water, and air. Today, auto trips from New York to Chicago in about fifteen hours demonstrate strikingly what a big advance turnpikes make in surface travel. Such thoroughfares are important for the trucking industry, too, and government is pushing superhighway construction all over the country. On these highways traffic has exceeded all estimates, thus proving their value.

The telephone is one of the important parts of the communication art which has contributed so much to our way of living. In its early days, amplification became a necessity for extending the talking distances, and fifty years ago the birth of the electron tube made this practical, as well as ushering in the electronic art which gave us our profession. And this tube, by the process of modulation, led to carrier systems, stacking up many individual channels on single transmission lines that became highways of communication. This was a big advance, greatly reducing the cost and increasing the amount of long distance traffic.

As this process continued to higher frequencies, the increase in losses prompted the use of better transmission lines, one example being the coaxial. Then, as high frequency techniques improved, microwave art produced broader bandwidth systems, wider communication highways which, like the auto highways, are handling more and more traffic.

Other communication requirements have also contributed to this traffic increase. The telephone made possible talking and hearing at a distance. Many years ago, a Bell System research executive said that he was sure people were just as anxious to see at a distance as they were to hear at a distance. The big strides of television in the field have proved the truth of this observation. This has placed large bandwidth requirements on our communication systems, which may well be tremendous, if business and personal television service, even in a small part akin to the telephone service, become a reality. The demand for data transmission is now growing fast too, and other new communication needs are constantly arising.

All of this will require communications superhighways, if it is to be transmitted at a low enough cost for public acceptance. Such superhighways, because of their large bandwidth, must come in the microwave frequency range or higher. So this becomes one of the big challenges and opportunities in microwave theory and techniques.

Radio highways through the air, using the higher frequencies of the spectrum, form an important part of our art and have occupied many pages of the TRANSACTIONS. But radio has definite limitations in available bands, interference, fading, and congestion at large traffic centers. Then too, rain, water vapor, and oxygen place an upper limit on transmission through the air of still higher frequencies which we are learning to generate and use, and which will be necessary for superhighways.

Many of these limitations can be avoided by putting the high frequency waves inside pipes—that is, using waveguides for long distance transmission. This provides a shielded system, avoiding interference and sharing with other services, and permits the use of a nonabsorbing atmosphere. It has been found that one form, using the circular electric mode, has the unique theoretical property of decreasing attenuation with increasing frequency. Experiments have shown its validity, and the conditions for achieving this property. This appears to open vast new frequency areas, perhaps many times larger than the whole radio spectrum now in use, for communication applications. These waveguides have losses that are low enough for economical long distance service in the future. Like most new things, this medium does have difficulties and problems to be overcome, and here is a challenge. Advances in the waveguide art, and in all of the associated microwave technology, are coming rapidly to help us, and more are needed.

Considering the increasing importance of communication in our civilization, it is comforting to know that microwave theory and techniques hold the possibility of supplying communication superhighways when we need them. There is much work to be done, and the opportunities in research, development, installation, and maintenance give great promise for the future of our profession and all those connected with it.