# Microwave Industry Outlook—Wireless Communications in Healthcare

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*Invited Paper*

***Abstract*—Concomitant advances in communications and medical technology have led to increasing deployment of telemedicine systems and services around the world. The goals of these systems are to increase the accessibility of professional caregivers, increase the quality of care to patients, and to increase the focus on preventative medicine through early intervention, all while reducing the overall cost of healthcare. Current pilot programs are beginning to show that these goals are achievable, warranting continued investment in telemedicine technologies.**

***Index Terms*—Healthcare, medical electronics, telehomecare, telemedicine, wireless communications.**

OVER THE last five years, there has been a dramatic increase in the utilization of RF/microwave technologies in medicine as a consequence of the RF/microwave"ubiquitous" communications revolution. This has resulted in the widespread availability of improved components and subsystems of much smaller sizes at much lower prices than was previously possible.

The microwave communications revolution that changed our lives and habits is currently being developed to improve healthcare around the world. Telemedicine, the use of electronic communication for the exchange of images, data, audio, or other information to provide healthcare services between remote locations, is a rapidly growing application of wireless technologies. Telemedicine applications include teledermatology, telepathology, telepsychiatry, teleradiology, telesurgery and telehomecare, and telehealth education. These applications and services are already improving health services and medical education in rural America and between countries (see Fig. 1).

Today, telemedicine systems have been constructed using a combination of off-the-shelf equipment and services plus specialized terminals and software applications. Most rely on the plain old telephone system (POTS) for data communication, but more recent emphasis is on wireless systems that allow both patient–doctor and doctor–doctor interaction without the use of phone lines. As one might expect, available bandwidth imposes practical limitations for applications such as video consultations, real-time data acquisition for patient monitoring, and the transmission of high-resolution diagnostic quality images.

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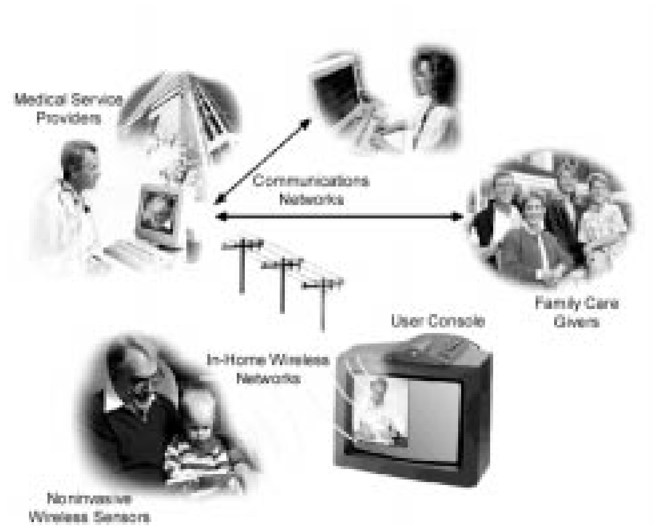


Fig. 1. Components of a future telehomecare system: Small unobtrusive physiological sensors acquire vital signs data and transmit them to an in-home console. The console supports health management and disease-specific applications and uploads data to patient databases. Medical service providers access patient records to assess status and interact with patient via the console application or video conferencing. Back-end systems tie in administrative functions and access by extended caregivers.

Government and military programs continue to be a major force in promoting telemedicine research and development. Remote physiological monitoring of vital signs, originally developed for the National Aeronautics and Space Administration (NASA) astronauts, is now under development for monitoring the health status of soldiers in the field. The ability to access the electronic medical record of military personnel from anywhere in the world and deliver it to the point-of-care is driving the development of worldwide networks combining both military and commercial wireless terrestrial and satellite communications systems.

The ultimate goal of new investments in telemedicine systems is to lower the cost of healthcare. This can be accomplished by providing the means for more efficient utilization of physicians, shortened hospital stays, reducing the skill level and frequency of visits of home-care professionals, reducing hospital readmission rates, and promoting health education. The challenge is to accomplish these goals while increasing the quality of care and respecting the privacy rights of the patient. The business projection for medical communications connectivity around the world—to include home healthcare—is estimated to be in the tens of billions of dollars.

The availability of RF/microwave components has also led to their use in the area of medical therapeutics. In the last five years, many companies have been established around the world to develop diagnostic and therapeutic equipment utilizing RF and microwaves. Among the areas of interest are the detection and treatment of various organ cancers, the treatment of cardiac diseases, etc. (see [1]). The leading companies are estimated to be valued at a total of a few billion U.S. dollars.

Based on the developing market for better health services, the future of the bioengineer with a subspecialty in microwaves and communications is growing. It has always been author Rosen's view that after receiving an undergraduate degree in engineering/bioengineering, graduate level studies in the biomedical field should be carried out in, or with the collaboration of, a medical school. A strong degree of collaboration between biomedical scientists and medical researchers will enhance medical innovation in the future.

## REFERENCES

[1] A. Rosen, M. A. Stuchly, and A. Vander Vorst, "Applications of RF/microwaves in medicine," *IEEE Trans. microwave Theory Tech.*, vol. 50, pp. 963–974, Mar. 2002.

**Jonathan Schepps** (S'80–M'81) received the B.A. degree in biology from Hofstra University, Hempstead, NY, in 1976, and the M.S.E. and Ph.D. degrees in electrical engineering (bioengineering) from the University of Pennsylvania, Philadelphia, in 1978 and 1981, respectively.

He is currently Head of the RF Data Systems Group, Sarnoff Corporation, Princeton, NJ. His group designs and develops RF products for a variety of applications requiring miniature transceivers such as wireless smart cards, identification devices for personal and asset tracking, and remote data acquisition. He is currently involved in biometric identification programs for military and commercial security applications, new concepts for telehomecare systems, and wireless sensors for audio communication devices. He has authored over 23 technical publications and delivered six conference presentations. He holds seven patents for wireless communications techniques.

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Dr. Rosen is an elected member of the National Academy of Engineering. He was an IEEE Distinguished Microwave Lecturer from 1997 to 2000, during which time he has had the opportunity to present his and others' work in the U.S., Japan, Europe, and the Middle East. He has received numerous awards, most recently the IEEE Third Millennium Medal (2000) and an IEEE Microwave Award (2000). He was the recipient of several RCA and Sarnoff Laboratories outstanding achievement and other professional awards, a 1989 IEEE Region One Award, and a 1997 Drexel University College of Engineering, Electrical and Computer Engineering Department Distinguished Alumni Award.