RADIOWAVE PROPAGATION IN BUILDINGS

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ptt research

MORE AND MORE CORDLESS SYSTEMS FOR INDOOR COMMUNICATION ARE GOING TO BE MARKETED IN THE COMING YEARS. THEY INCLUDE THE DIGITAL EUROPEAN COMMUNICATION SYSTEM (DECT), WHICH WILL OFFER ALL OFFICE STAFF A POCKET PHONE, AND RADIO LOCAL AREA NETWORKS (LANS), WHICH WILL INTERCONNECT COMPUTERS WITHOUT USING WIRES.

Communication by means of such systems takes place through base stations which are usually mounted to walls or ceilings. They maintain a radio link with the device carried by the user and are generally the point of access to the fixed network.

Since the radiowaves are attenuated by walls and floors, the range of a base station is limited. It is therefore nessecary to install a sufficiently large number of base stations in order to cover all desired locations in a building. An excessive number of base stations, however, cause a financial unattractive situation and a risk of mutual interference between devices is increased. This explains why the positioning of base stations plays an important role in the planning of a cordless communication system for use inside buildings. Knowledge of indoor radiowave propagation is obviously essential.

Work at PTT Research

PTT Research is broadening its knowledge in this field through a project called 'Indoor Propagation'. Literature is studied and international conferences are attended. The principal activity, however, is the performance of measurements. Other institutes naturally carry out measurements, but the reports often lack the kind of details needed by PTT Research. Therefore, PTT Research performs its own measurements at familiar test sites where allowance can be made for the inherent inaccuracies of test set-ups and procedures. Another advantage is that remarkable results obtained in certain places can be examined more closely by means of additional or more extensive measurements.

Equipment which determines transmission losses was developed at PTT Research in 1990 and 1991. It includes a fixed transmitter (located somewhere in a building) which produces a radio signal of a known strength. A mobile receiver is pushed along the building's corridors on a trolley and registers the strength of the signal received from the transmitter. The difference between the transmitted and received power is referred to as the transmission loss. With this information it is possible to predict how a communication system will behave between transmitter and receiver locations.

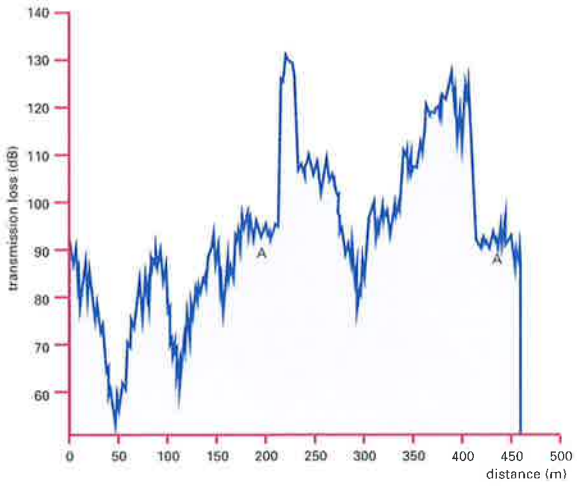

Figure 1: Transmission loss as a function of the travelled distance

Figure 1 contains the results of measurements performed over a route of about 450 metres on the first floor of the Dr Neher Laboratories (DNL) at PTT Research. The vertical axis shows the transmission loss in dB, while the numbers along the horizontal axis correspond with the travelled distance in metres. The route taken is marked on the DNL floor plan in Figure 2, with different colours representing different levels of transmission loss. For these particular measurements, the fixed transmitter was positioned in the middle of the concentric circles.

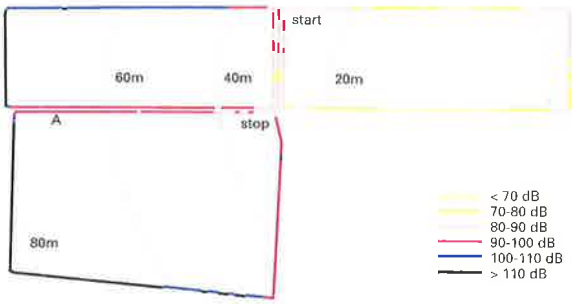

Figure 2:
Route of the mobile receiver

The next step involves identifying radio propagation patterns which might facilitate the planning of indoor radio communication systems. Examine Figure 3 where the test results are presented in a slightly different way. The transmission loss in dB is again plotted along the Y axis, but this time the horizontal axis indicates the distance in metres between the transmitter and receiver. The straight line in the Figure can now be used as a simple model to describe the transmission loss L as a simple function of the distance d between transmitter and receiver: $L = 57*\log(d) + 5.4$.

The constants of this formula naturally depend on the type of building concerned, and the discrepancy between the model values and those actually measured is rather large. This applies especially to the group of results encircled. They were obtained at the locations marked A in Figures 2 and 3. Transmission losses at these positions were relatively small, because the radio signal 'tunnelled' its way through the corridor without undergoing appreciable attenuation.

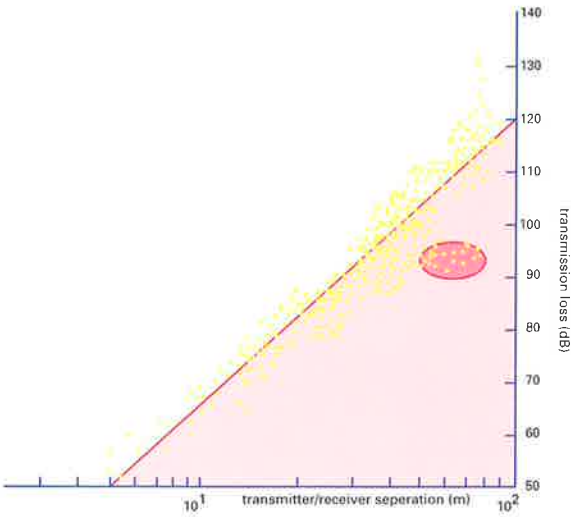

Figure 3:
Transmission loss as a function of the distance between transmitter and receiver

The above points out an important problem which arises during indoor propagation modelling, namely that details like corridors, staircases, lifts, doors and people greatly affect radio propagation. Similarly, it is necessary to take into account the building materials used for walls and floors. Modelling is further complicated by the circumstance that almost every building is unique with respect to these aspects.

Despite these difficulties, the project at PTT Research is attempting to determine and set down rules for indoor propagation. An effort is being made to formulate these rules in a way suitable for incorporation in a planning tool (computer program), which ideally would allow persons without a knowledge of radio propagation to plan a communication system.

Summary

A knowledge of radio propagation in buildings is essential for the planning of cordless communication systems which are to be used inside buildings. An institute like PTT Research must perform its own tests to obtain the depth of knowledge required. For this purpose, PTT Research has developed equipment which measures transmission losses between transmitters and receivers inside a building. With the help of these measurements and desk research, rules are being set down for radio propagation in buildings.

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