Wireless Channel Modeling

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The keyword of wireless technology is 'Wireless', but without a wire how can we get hold of other people? What is the media to connect your mobile phone to other devices? The answer is wireless channels, which are present everywhere, and they are untouchable and invisible to the naked eye. Can the wireless channel be visible and touchable in some situations? Wireless channel measurement answers this question and it also provides a close-to-true measure to it. However, due to the change of the properties of the wireless channels from environment to environment, to perform measurements for all scenarios requires huge data storage and great efforts, which is not practical. Therefore, it is essential to understand the behavior of the wireless channel and capture their characteristics as much as possible, and consequently model them in a realistic way. Then the untouchable and invisible channels can be modeled with certain real world parameters and represented by touchable mathematical models.

Wireless channel models have attracted high attention since they can highly reduce the time of developing wireless devices and systems. As the number of users and service stations has significantly increased in the last decades, systems and wireless channels have become more and more complicated. How to guarantee that the users are satisfied when lots of users are streaming media at the same time? Channel models in such situations give people valuable insights. For example, when planning the wireless system, the channel model can help to predict the communication quality when high data traffic is present. Thus a system margin can be reserved to give users better services. The COST 2100 channel model is one well established wireless channel model that can be integrated with current and next generation wireless systems. It provides statically close-to-true descriptions of wireless channels both for indoor and outdoor scenarios. However, the COST 2100 channel model implementation is still under development and needs more efforts, such as parameterization for some typical scenarios, especially when more wireless terminals are presented.

Can the wireless channels be visualized in some scenarios? The answer is definitely yes. First, efforts have to be made to measure a wireless channel and to analyze the channel data. To be able to visualize the wireless channel, detailed floor plans of the measured scenarios, such as the walls, advertisement board, decorations, etc., have to be well described. Paths from one terminal to another can be visualized in a similar manner as your GPS is determining the driving route from Lund to Stockholm. However, to be able to visualize the channel behavior, further work is needed. First of all, wireless channel measurement campaigns are extremely laborious and expensive; we cannot measure all the possible scenarios. Secondly, to get a detailed floor plan is not a simple task especially when the communication scenario becomes more and more complicated. Thirdly, to find the most likely paths needs large

computational capability.

Position based services, such as navigation, tracking or monitoring, have attracted great attention both in industry and in the academic world. The most frequently used and successful positioning system is the GPS, where satellite signals are used. Have you tried your GPS when you were walking inside a building? Imagine yourself as a patient in a hospital, but you are not familiar with the structure of the hospital, how can you efficiently get to the right building/floor? The GPS system cannot work efficiently due to the significant attenuation the building has on the signal. Therefore, an indoor positioning technology is desirable. There have been extensive discussions on how to achieve indoor positioning with proper accuracy in the past decades. Google maps suggests, for example, its users to report their detailed indoor floor plan. The positioning accuracy is highly dependent on the floor plan, but in the thesis we aim for indoor positioning without floor plan information. It can be noted that the major challenge of indoor positioning is the accuracy, where down to meters or even centimeters is desirable for practical applications. Wireless channels from cellular systems bring new opportunities for indoor high accuracy positioning as the wireless signal can give a distance measure with accuracy down to centimeters.

Overall, in this thesis, the author has studied the COST 2100 channel model thoroughly and provided parameters for some typical scenarios, i.e., sub-urban and urban scenarios, which makes the model suitable for outdoor wireless system planning. This thesis investigates channel characterization when more than one service station is present with wireless channel measurements performed in Kista, Stockholm. To understand the relation between the channel models and physical realities, a measurement based ray launching tool for visualizing the wireless channel on top the floor plan has been developed in this thesis. More specifically, the tool is able to visualize the wireless channels together with the channel measurements for sub-urban and urban scenarios, where valuable insights have been obtained. Last but not least, in this thesis, positioning accuracy down to centimeter is observed from wireless channels, which is a promising result for further position based services.

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