Papers on the Next Step of UNIVERGE : Toward the Future

RADIOSCAPE — A Radio Propagation Analyzing Service for Effective Coverage Area Design —

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ABSTRACT The basic concept of the radio propagation simulator "RADIOSCAPE" is reported. The simulator is helpful for wireless LAN area design. RADIOSCAPE is provided to users as an ASP simulation service through the Internet, and it reduces the initial cost of system installation. RADIOSCAPE applies the latest propagation analysis engine and is useful for system design of various wireless systems, such as wireless LANs, cellular phones, Bluetooth, UWB, and RFID.

KEYWORDS **Radio propagation, Simulator, Area design, Ray tracing, Ray launching**

1. INTRODUCTION

The use of wireless systems in an office, such as a wireless LAN and mobile access to groupware systems, creates a novel business style. A precise estimation of radio propagation and interference from other systems is required to design wireless systems efficiently with high performance.

However, a design technique with statistical propagation analysis widely used for allocating outdoor base stations cannot be applied to indoor design in which various objects are placed, and the channel model is very specific in the room. In addition, a commercially available simulator is expensive and shows a mismatch against a lower cost of wireless LAN consumer equipment.

To solve the problems, we have developed a propagation simulator for supporting an area design of wireless LAN systems (IEEE802.11a/b/g). This simulator is called an "RS simulator" or "RADIOSCAPE" in Japan[1]. RADIOSCAPE provides us with propagation estimation with a low estimation error of less than 5dB. The high accuracy is achieved by using a ray-launching method in which transmission and reflection characteristics of objects are taken into account for an indoor environment.

This paper describes the basic concept with operation examples of RADIOSCAPE and the future evolution in other wireless systems.

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2. BASIC CONCEPT

RADIOSCAPE features server-client configuration and is provided as an application service provider (ASP) through the Internet. By sharing high performance server resources with many users, the initial cost of system installation is reduced. The process of coverage area design by using RADIOSCAPE is shown in **Fig. 1**.

First of all, a user initiates the layout editor by a RADIOSCAPE client and inputs a target environment, such as room and furniture layouts, size, material, and the type of each wireless system, as shown in Fig. 1(a). By inputting the layouts up to five-stories, interference from the upper floor and the lower floor can be estimated.

After the editing process, the user sends the layout data file to the RADIOSCAPE server. The server analyzes the radio condition using a paralleled ray-launching method. In the method, a number of rays are launched to the discrete directions around the transmitter, as shown in Fig. 1(b). The server traces all paths of direct, transmitted, and reflected rays and estimates received power and delay spread at each observation point. The user downloads the calculated data file from the server to view the results.

The radio viewer in the RADIOSCAPE client visualizes the estimated received power and delay spread by tone and color, as shown in Fig. 1(c). Deciding the total performance in considering the receiver characteristics, the coverage area is expressed in either white, gray, or black. When other transmitters are operated in the same frequency, a hatched area can

indicate the performance degradation due to interference, as shown in Fig. 1(d).

In the optimum area design for multi access points of a wireless LAN, interference estimation is essential because a re-allocation of limited frequencies is required. In addition, the interference between different systems, such as IEEE802.11b/g, Bluetooth, and microwave ovens, will occur for co-existence in the Industry, Science and Medical (ISM) band within 2.4GHz. RADIOSCAPE provides us with a superior design environment.

3. PERFORMANCE EVALUATION

3.1 Estimation Accuracy

To evaluate the estimation accuracy of RADIOSCAPE, we compared the measured and estimated received-power levels in a two-story wooden house with a floor area of 150m^2. **Figure 2** shows the compared results for IEEE802.11b signals from two access points. The average error between measurements and estimations was 4.5dB. We confirmed high accuracy in radio propagation estimation using RADIOSCAPE.

3.2 Computation Time

Figure 3 shows an example of computation time per access point for a shopping mall with a floor area of 20,000m^2. We used a cluster server composed of twenty PCs with 2.53GHz Pentium4 processor. The total computation time was reduced by less than 1/20 by developing a high-speed algorithm using hierarchical determination of ray reception[2]. It depends on the simulation condition. The high-speed performance enables us to achieve an automatic area design with iteration processes for wide-area wireless LAN systems[3].

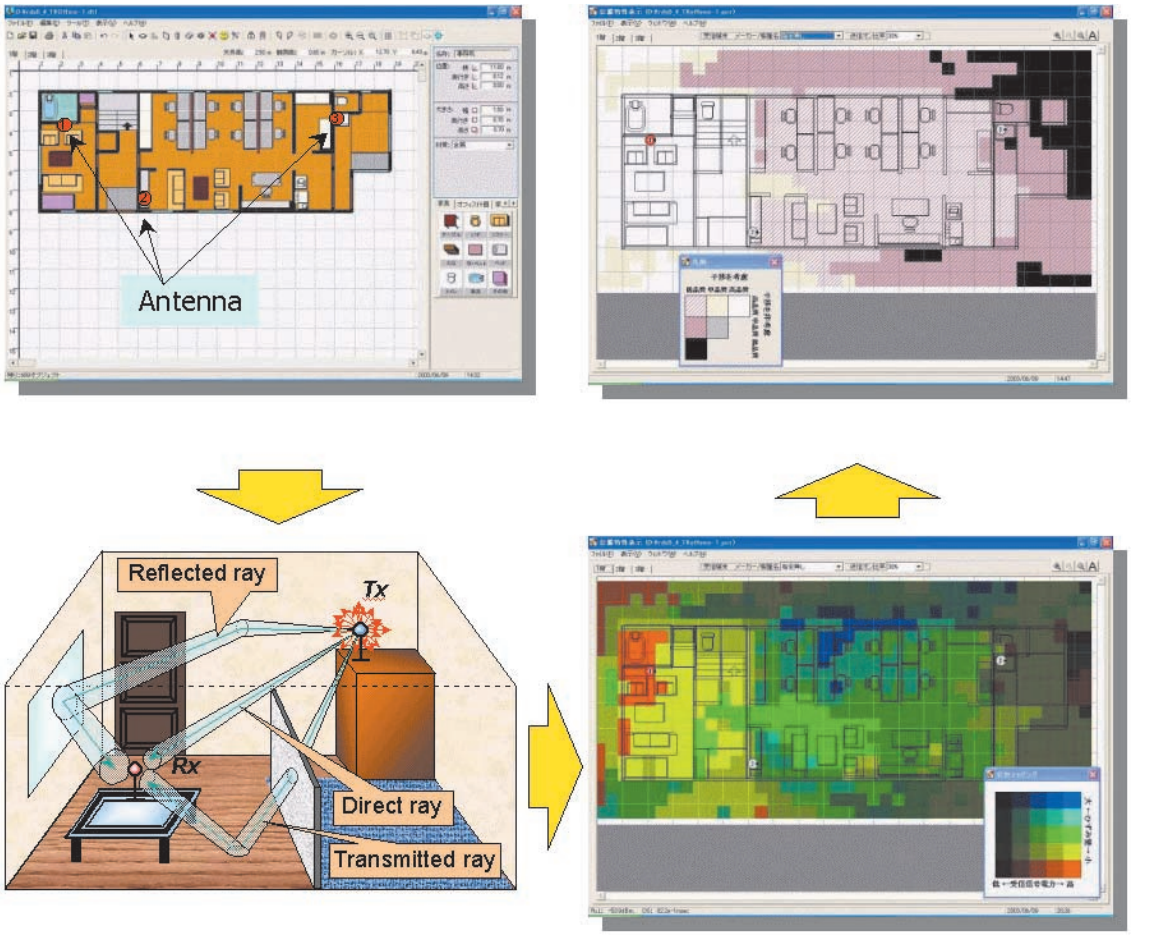

Fig. 1 Process of coverage area design by using RADIOSCAPE.

4. FUTURE EVOLUTION IN OTHER WIRELESS SYSTEMS

Many wireless devices, such as cellular phones, wireless LANs, Bluetooth, and radio frequency identification (RFID) tags, are used in our office and living spaces. The need for progress requires us to upgrade RADIOSCAPE.

Ultra wideband (UWB) technology should be a high-speed and short-range wireless interface in the near future. Because the spectrum of UWB covers from 3.1 to 10.6GHz, UWB systems may cause interference in other wireless systems. However, a conventional ray tracing method is applicable to propagation estimation only around the analysis frequency. To achieve highly accurate broadband channel estimation, we developed a band-divided ray tracing method[4]. By applying this method, a high-accuracy propagation estimation of UWB signals has been achieved that is comparable to the estimation error for a wireless LAN with narrow bandwidth.

RADIOSCAPE is also applicable to the design of RFID reader allocation. When a frequency band of less than 1GHz is used for RFID systems, a diffraction effect should be taken into account for the radio propagation estimation. RADIOSCAPE supports diffraction analysis and expands the applicable frequency band.

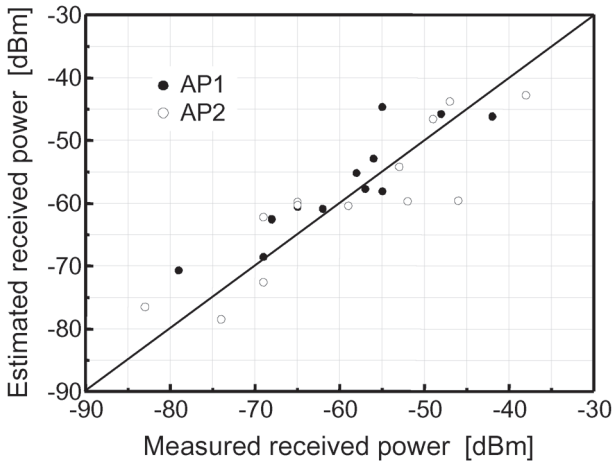

Fig. 2 Measured and estimated received-power levels of IEEE802.11b signals in a two-story wooden house with a floor area of 150m^2.

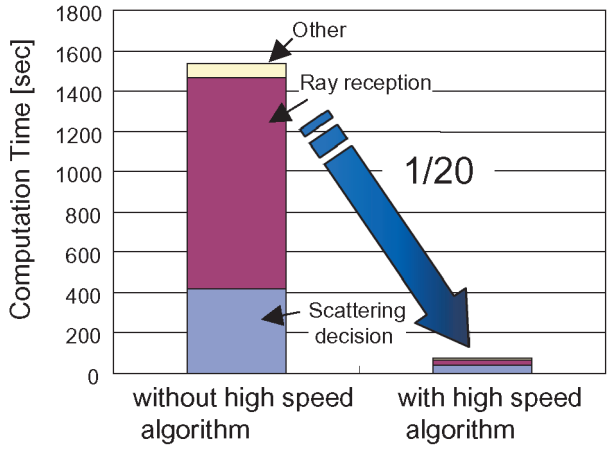

Fig. 3 Example of computation time per access point for a shopping mall with a floor area of 20,000m^2.

5. CONCLUSION

To achieve an effective area design with high system performance, a high speed and accurate radio propagation simulator is indispensable. The basic concept and characteristics of RADIOSCAPE were presented. RADIOSCAPE is applicable to an outdoor radio propagation analysis by using a 3D digital map with building height and altitude data. RADIOSCAPE will provide users with a useful design environment based on a spread of various wireless systems.

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