テラヘルツ無線の新しい技術動向と課題
Terahertz wireless communications: Recent progress and future perspective

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Abstract
To date, the demand for ultra-fast wireless communications has been accommodated with advanced modulation schemes and signal-processing technologies at microwave frequencies. However, without increasing the carrier frequencies for more spectral resources, it may be quite difficult to keep up with the needs of users. Though there are several alternative bands, recent advances in terahertz-wave (THz-wave) technologies have attracted attention due to the huge bandwidth of THz waves and its potential for use in wireless communications. The frequency band of 275 ~ 3000 GHz, which has not been allocated for specific uses yet, is especially of interest for future wireless systems with data rates of 100 Gbps or even higher. Though THz communications is still in a very early stage of development, there have been lots of reports that show its potential. In this report, we will review the recent progress of THz wireless communications and discuss some issues that need to be considered for the future research directions and perspective.

1. Introduction

Ever since various multimedia services based on the Internet were introduced in 1990s, traffic related to such services has been steadily increasing worldwide, usually via wired networks. However, with the introduction of new mobile devices and new multimedia services working in wireless environments, we are seeing changes in how people consume multimedia services. Users are consuming many more digital information with handheld mobile devices such as smart phones or tablet PCs. Moreover, the popularity of personal multimedia devices, such as digital cameras and camcorders, and inexpensive large-capacity personal storage media enable every single individual to perform a more active role in the circulation or distribution of multimedia information. Recent users are generating digital contents and distributing them by themselves using their smart phones via the Internet. In these days, each single user is one single source of digital information and those users are demanding new ways to manage and share their data on PCs and mobile devices more easily and quickly.

To satisfy the needs of users, the data capacity of wireless communications has been improved over the last a couple of decades, with progress in speed that has been much faster than for wired systems, and this trend will continue for a while [1]. In order to accommodate the trend and need, it is obvious that more spectral resources are necessary. In the race toward ultra-fast wireless communications systems, in spite of several drawbacks of terahertz (THz) waves such as the poor output power and sensitivity of THz emitters and detectors, respectively, THz wave signal is attracting great interest, especially for short-distance applications [1], because of its inherent large bandwidth. Recently, several attempts of wireless data transmission at above 275 GHz, where is not allocated for specific use yet, have been reported.

In this report, we will present our recent progress for practical THz communications.

2. Recent Progress on Transceiver ICs and Packaging

In the early phase of the research on the terahertz communications, we have conducted the feasibility tests with photonic technologies originally developed for the fiber-optic communications at the 1550-nm wavelength band. Optical heterodyning scheme with an ultra-fast photomixer provides great freedom in generating