Review on the Evolution of 6G and Terahertz Communication for Highspeed Information Processing

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INTRODUCTION

➢ **Significance of the Terahertz** (THz: from 300GHz-3THz) band :

- To meet the demand of high-speed data transfer with least latency.
- To provide the essential higher bandwidth with potential to increase network capacity.
- To develop 6G technology for high-speed information processing.

➢ A communication design would face path loss, fading, poor signal quality due to inevitable molecular absorption, attenuations due to rain, cloud, gaseous molecules. Power optimization and management would be another challenge in

OBJECTIVE

- To review the Opportunities of THz wave.
- To summarize the challenges and some solutions of challenges in THz communication.

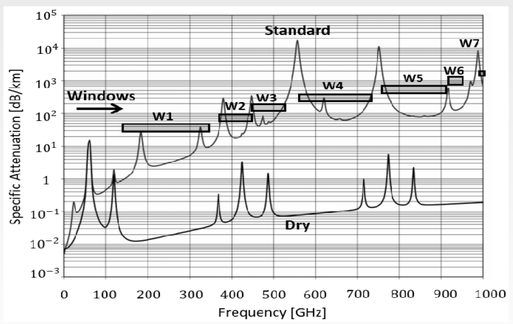

Fig. 1. Atmospheric attenuation vs. carrier frequency. The upper curve presents the attenuation in sea level and the lower curve represents for attenuation in dry air [5,6].

CHALLENGES

➢**Terahertz source and Transceiver design**

- The transceiver bandwidth should be large.
- Generation of THz wave is challenging as conventional oscillator cannot produce this high frequency. With respect to optical photon emitters this frequency is much low to generate .

➢**Antenna and amplifier design**

- The aperture of antenna should be small, and antenna should possess high gain and bandwidth.
- The beamforming should be narrow.

➢**Realization of ADC and DAC**

- The design of Analog to Digital converter (ADC) and Digital to Analog converter (DAC) are challenging as sampling rate should be high enough to get data rate in Tbps.
- More power is consumed when number of bits increases for high resolution.

➢**Proper channel modelling**

➢**Suitable modulation technique**

➢**Path loss**

- Path loss varies with transmission distance, frequency and channel. As per Friis law, received power varies inversely with path loss

➢**Atmospheric absorption loss**

- Due to smaller wavelength THz wave cannot pass through oxygen and water vapor molecules.
- Above 200 GHz water vapor causes high attenuation , Rain attenuation increases up to 100 GHz.

$$T(f,d) = \frac{P_{rx}(f)}{P_{tx}(f)} = e^{-k_{ac}(f)d} \quad \text{---(1)}$$

Where, Transmittance $T(f,d)$ of any material is function of optical depth,$P_{rx}(f)$ and $P_{tx}(f)$ are received and transmitted power respectively,$k_{ac}(f)$ is absorption coefficient. All of these values are dependent on frequency.

SOME SOLUTIONS OF CHALLENGES

➢**High gain antenna** :

- Phased antenna array can handle high path loss.
- Graphene-based antennas can be used for low power consumption.
- To overcome the path loss in THz band, horn and parabolic antenna of high gain can be used.
- Massive Multiple Input Multiple Output (MIMO) antennas can improve the gain, beam forming and spectral efficiency.

➢**Beam steering and modulation techniques** :

- Multi element antenna with high gain limit the spreading of beam.
- Orthogonal Frequency Division Multiplexing (OFDM) can mitigate multi path fading and inter-symbol interference.
- Multicarrier modulation can be used in indoor communication.
- Spectral efficiency can be improved implementing single carrier waveform and phase modulation like Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK) .

➢**On-chip integrable microelectronic sensors and sources in THz:**

- The application of THz sensor devices along with THz sources in communication and high-speed information processing opens a new dimension of research.

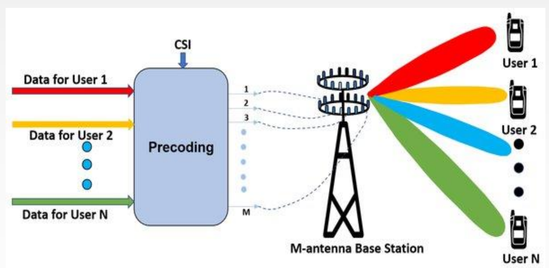

Fig. 2. High gain Massive Multiple Input Multiple Output (MIMO) antenna with beam steering.

CONCLUSIONS

➢Terahertz may be considered as pillar of 6G technology.

➢Terahertz spectrum with higher frequency has the potential to provide Tbps data rate for various application.

➢High Path loss, proper channel modelling, suitable antenna design, non-availability of power efficient transceiver and terahertz generator may draw the attention of researchers in terahertz to develop 6G technology.

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