Selected for MIC's R&D Project on "Research and Development of High-Millimeter-Wave Fixed Wireless Communications to Substitute for Optical Fiber Lines"

【Summary】

Joint R&D proposal by Keycom Corp., Institute of Science Tokyo, and the National Research Institute for Earth Science and Disaster Resilience (NIED) has been selected for the Ministry of Internal Affairs and Communications (MIC) project: "Research and Development of High-Millimeter-Wave Wireless Communications to Substitute for Optical Fiber Lines," a new initiative starting in FY2025 aimed at expanding radio spectrum resources.

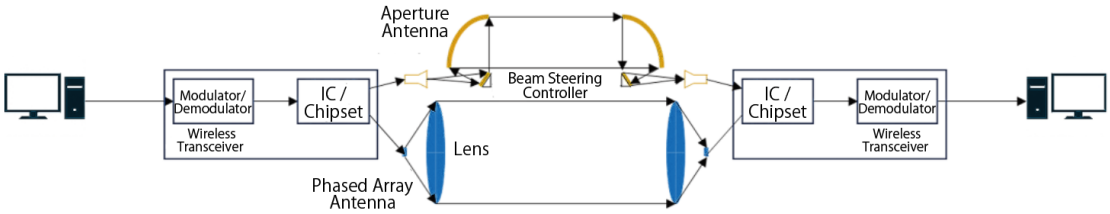
Over the next four years, the project aims to establish high-speed wireless communication technology using the 300 GHz band, achieving transmission speeds of 100 Gbps or higher over a distance of 1 km.

【Key points】

We will develop a communication system that achieves ultra-high-speed wireless transmission (100 Gbps or higher) using the high-millimeter-wave (300 GHz) band. The key features of this project are as follows:

1. Ultra-High-Speed Long-Distance Transmission By utilizing frequency bands of 100, 150, and 300 GHz, we will achieve wireless transmission of 100 Gbps (with a maximum theoretical throughput of 500 Gbps under ideal conditions) over a distance of 1 km.
2. Exceptional Reliability Under Weather Fluctuations The system will ensure an annual unavailability rate of 0.01% or less, maintaining stable operation despite weather conditions such as rain, snow, fog, and humidity changes.
3. Adaptive Mesh Network Architecture We will develop a traffic and weather-adaptive mesh network that seamlessly integrates optical fiber with broadband wireless communication.
4. High-Efficiency Semiconductor Chipsets Using SiGe BiCMOS technology, we will develop semiconductor chipsets that offer high integration, high efficiency, and the commercial viability typically associated with compound semiconductors.
5. Advanced Antenna Systems We will conduct R&D on both phased array antennas and aperture antennas:

- Phased Array Antennas: By employing large-aperture lenses, we will simultaneously achieve enhanced antenna gain and high-resolution beam scanning.
- Aperture Antennas: We will implement high-speed, high-precision directivity control through advanced beam-steering mechanisms.



Block Diagram of the Experimental System

【Project Structure】

Lead Research Institute:

- Keycom Corp. (Representative Director: Hirosuke Suzuki; Toshima-ku, Tokyo)

Joint Research Institutes:

- Institute of Science Tokyo (President: Naoto Ohtake; Meguro-ku, Tokyo)
- National Research Institute for Earth Science and Disaster Resilience (NIED) (President: Kaoru Takara; Tsukuba, Ibaraki)

【Scope of Research and Development】

This research and development project consists of two main technical challenges: Technical Challenge A: Wireless Link Stabilization Technology and Technical Challenge B: High-Efficiency Parallel Wireless Communication Technology.

Technical Challenge A: Wireless Link Stabilization Technology

This challenge focuses on the R&D of semiconductor chipsets and antennas. We will develop two types of antennas:

- Phased Array Antennas
- Aperture Antennas

Technical Challenge B: High-Efficiency Parallel Wireless Communication Technology

This challenge involves the R&D of radio wave attenuation prediction technology, wireless transmission technology, and integrated wireless/optical fiber communication technology. The developed equipment and technologies will be verified through:

- Computer simulations
- Wireless transmission experiments
- Integrated wireless/optical fiber communication experiments

Semiconductor Chipsets

- Lead: Assoc. Prof. Shirane (Institute of Science Tokyo)
  - Develop high-integration, high-efficiency, and mass-producible semiconductor chipsets using SiGe BiCMOS technology, achieving performance comparable to compound

semiconductors.

- Implement an active-mixer-first/last architecture to minimize circuits operating in high-millimeter-wave bands while achieving low noise and high-power output.

Phased Array Antennas

- Lead: Assoc. Prof. Tomura (Institute of Science Tokyo)
- Develop lens-integrated phased array antennas. The "lens + defocused beam-feed" method simultaneously achieves high antenna gain and high-resolution beam scanning.
- Achieve high-speed (control cycle $¥le$ 0.1 ms) and high-precision (accuracy $¥le$ 0.1°) directivity control via electronic beam steering.

Aperture Antennas

- Lead: Keycom Corp.
- Develop aperture antennas for the 100, 150, and 300 GHz bands with an antenna gain of 55 dBi or higher.
- Implement directivity control equivalent to phased array antennas using an advanced directivity control unit (beam-steering mechanism).

Radio Wave Attenuation Prediction Technology

- Lead: Principal Researcher Maesaka (NIED)
- Develop Radio Wave Attenuation Nowcasting technology. This system predicts area-wide attenuation for each frequency up to one hour in advance by utilizing JMA Precipitation Nowcasts, numerical weather models, objective analysis data, MP radar, AMeDAS, and particle size distribution (PSD) data.

Wireless Transmission Technology

- Lead: Prof. Fukawa (Institute of Science Tokyo)
- Develop adaptive wireless transmission technology that optimally controls transmission methods (frequency bands, stream configuration, channel bonding, adaptive modulation, packet transmission, precoding, scheduling, etc.) based on signal quality and weather data.
- Perform PAPR reduction for OFDM in multi-bonding transmission and frequency domain equalization (FDE) for wideband single-carrier transmission.

Integrated Wireless and Optical Fiber Communication Technology

- Lead: Keycom Corp.
- Research and develop optimal route design for wireless mesh networks and integrated wireless/optical fiber communication technologies.
- Develop Full-Coherent Integrated Wireless/Optical Transmission, where wireless IF (Intermediate Frequency) signals are directly converted into optical signals for analog-over-fiber transmission.

Verification Experiments

- Lead: Keycom Corp.
  - To verify the above technologies, we will construct a testbed and conduct wireless transmission experiments and integrated wireless/optical fiber communication trials.

【Contact Information】

For inquiries regarding this project, please contact:
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