Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Next-generation indoor network enabled by photonics- and electronics-based sub-THz technology

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Source: Seung-Hyun Cho, Sang-RoK Moon, Sooyeon Kim, Wonkyoung Lee, Minkyu Sung, and Joon Ki Lee (ETRI)

218, Gajeong-ro, Yuseong-gu, Daejeon, 34129, Republic of Korea

Telephone: +82-42-860-5721, E-Mail: shc@etri.re.kr

Re: n/a

Abstract: This contribution showcases the implementation of a next-generation indoor wireless network utilizing the sub-THz frequency band. The system adopts a photonics-enabled sub-THz transmission scheme for the downlink and an electronics-based sub-THz transmission scheme for the uplink.

Purpose: Information of SC_THz

Next-generation indoor network enabled by photonics- and elec tronics-based sub-THz technology

July 29. 2025.

09:40~10:00

Seung-Hyun Cho, Sang-Rok Moon, Sooyeon Kim, Wonkyoung Lee, Minkyu Sung, and Joon Ki Lee

Optical Network Research Section, ETRI

ETRI

ETRI 한국전자통신연구원 Electronics and Telecommunications Research Institute

"Next-generation indoor network enabled by photonics- and electronics-based sub-THz technology"

Contents

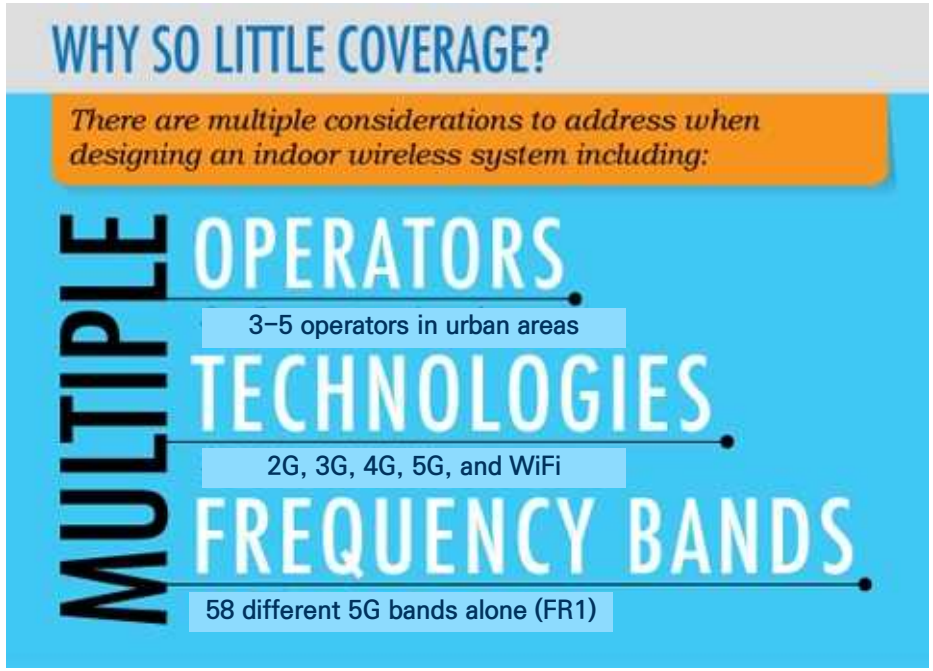
01. Motivations

Mobile data traffic in indoors

- Users generate high-volume traffic such as video streaming, gaming, and video conferencing via Wi-Fi or stable LTE/5G.
- Low mobility and a pattern of staying in a specific location for a certain period of time → traffic is concentrated.

* Reference: A global leader in infrastructure solutions for communications networks, CommScope

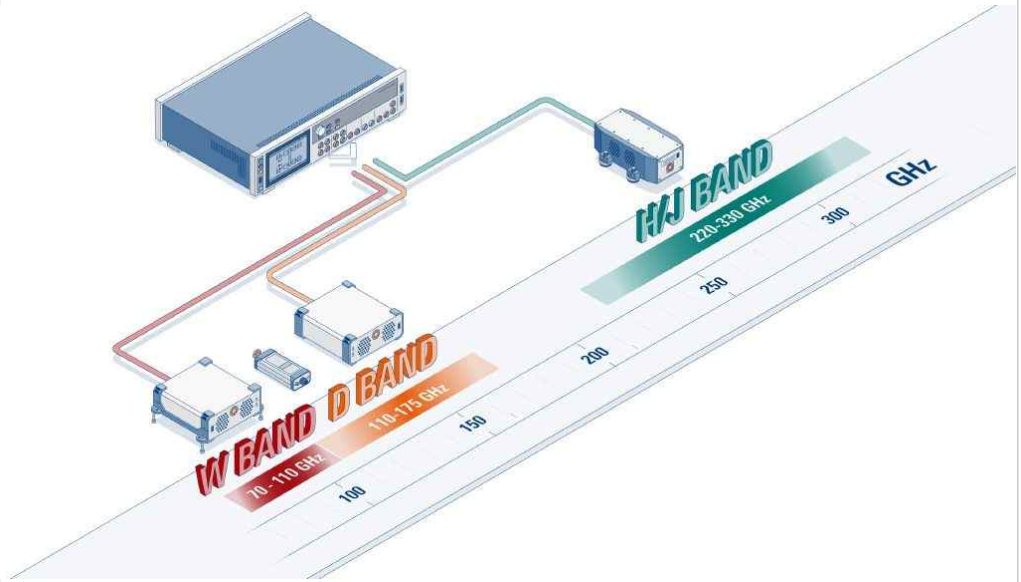
Difficulties for configuring indoor networks



- Only about 2% of all commercial buildings have in-building wireless systems installed. Why?
- In-building systems are very complex and involve a variety of stakeholders.

01. Motivations

Ultra-wide bandwidth of sub-THz regime



- The sub-THz band (0.1 to 1 THz) provides a very wide bandwidth → data transmission from hundreds of Gbps to several Tbps is possible.
- The sub-THz band has relatively little competition for frequency use, so it can secure a wide range of resources.
- It is also advantageous in terms of improving spectral efficiency and frequency reuse.

* Reference: https://www.rohde-schwarz.com/se/products/test-and-measurement/sub-terahertz_256041.html

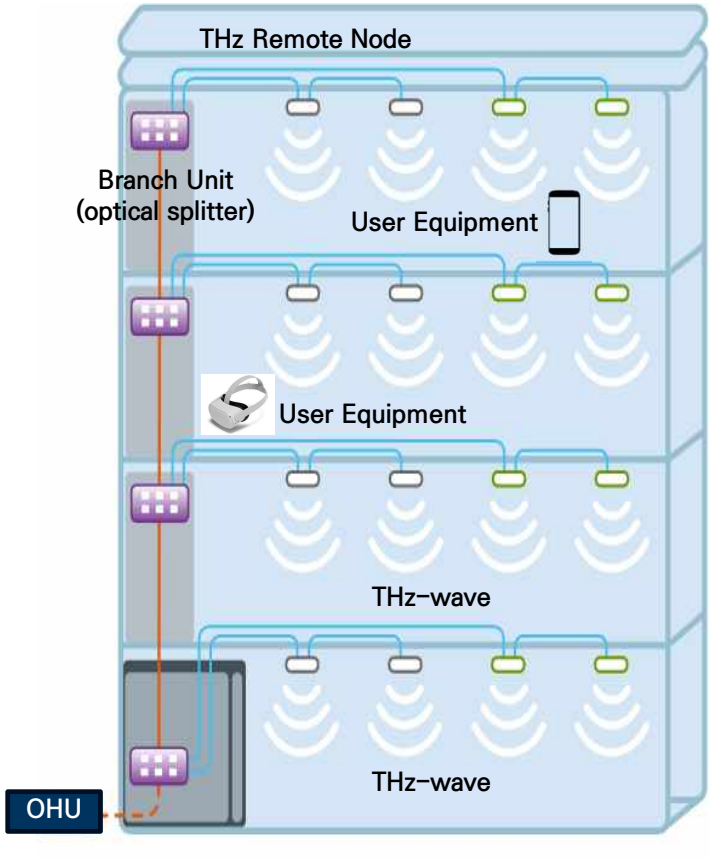
Terahertz Sensing and Communication

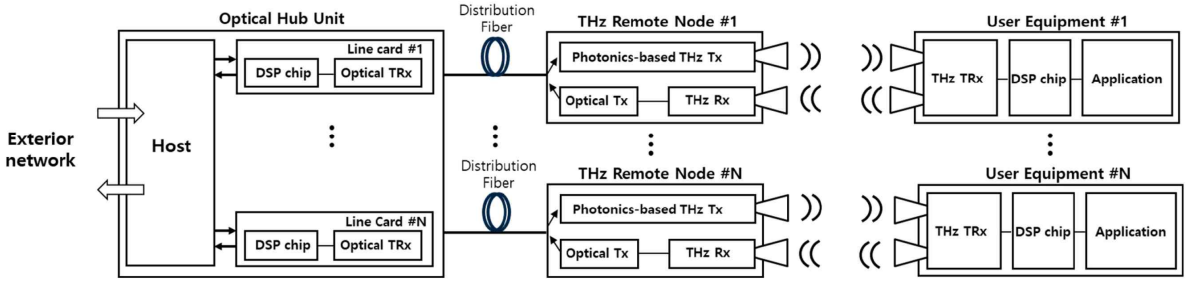
- It is an essential technology for providing services that generate large amounts of traffic, such as immersive XR and 3D holograms in indoor environments, while also enabling accurate location confirmation.
- THz waves have short wavelengths and can be used as sensors.
- Applied to precision location tracking, imaging radar, and indoor environment mapping.

* Image was generated by Bing image creator

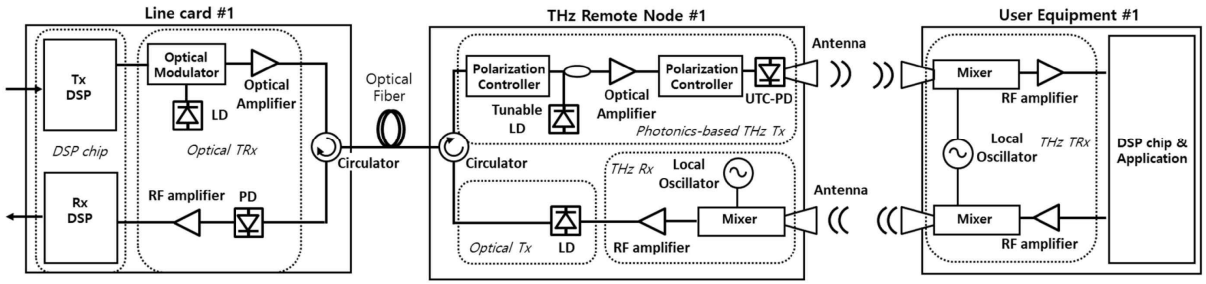
02. Configurations

Architecture of NG-indoor network employing THz-band





Configurations of NG-indoor network with THz-band.

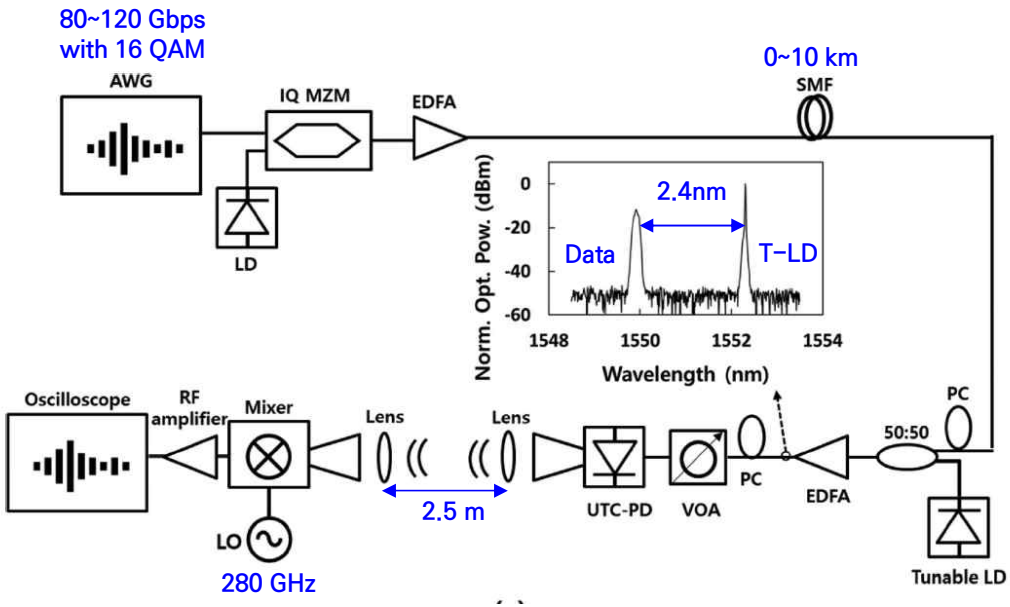


Detail link configurations of NG-indoor network with THz-band.

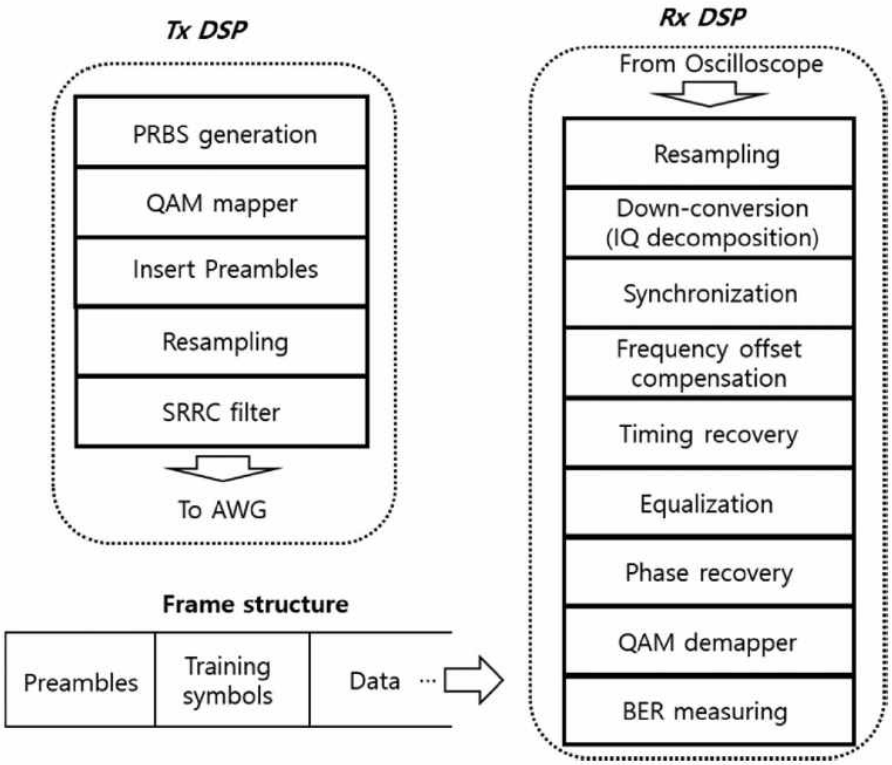
Reference: Sang-Rok Moon et al., "6G Indoor Network Enabled by Photonics- and Electronics-Based sub-THz Technology," J of Light. Tech. vol.40 (2), pp. 499, 2022.

03. Demonstrations of downlink based on photonics

Experimental setup for downlink



Configurations of NG-indoor network with THz-band without THz-band amplifier.

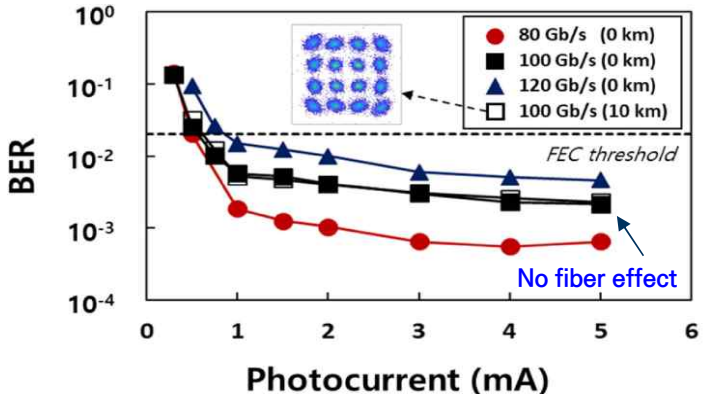


DSP structures for downlink signal transmission

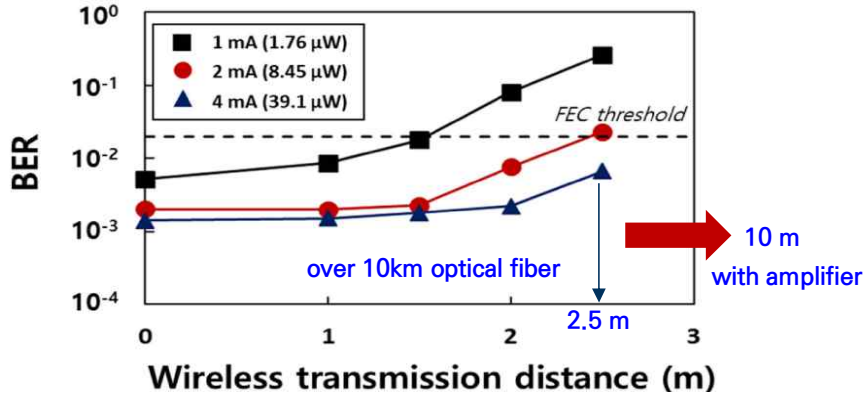
Reference: Sang-Rok Moon et al., "6G Indoor Network Enabled by Photonics- and Electronics-Based sub-THz Technology," J of Light. Tech. vol.40 (2), pp. 499, 2022.

03. Demonstrations of downlink based on photonics

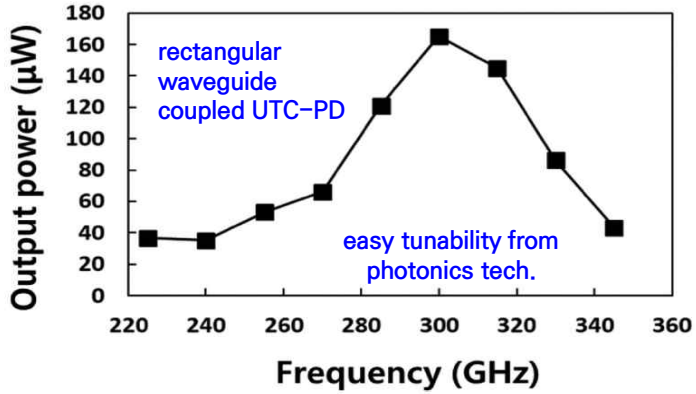
Experimental results for downlink



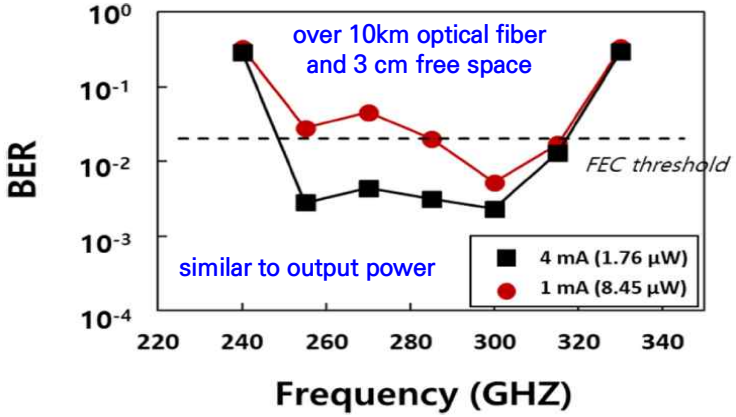
BER curves with a short (~3 cm) wireless distance.



BER curves as a function of wireless transmission distance.



Output power from the UTC-PD at a photocurrent of 7 mA.

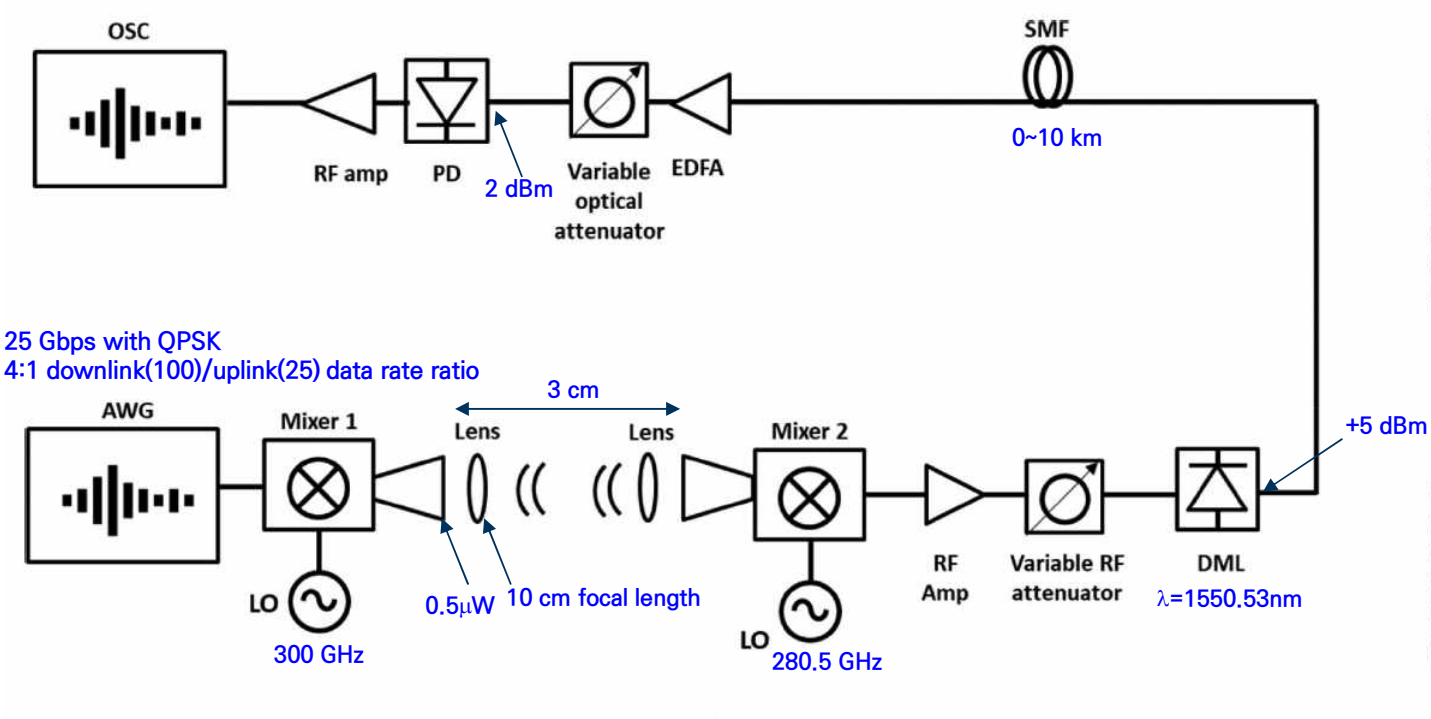


BERs as a function of sub-THz carrier frequency.

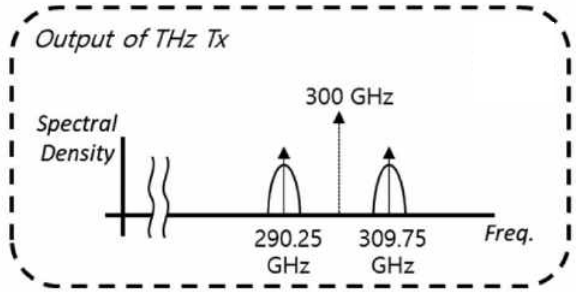
Reference: Sang-Rok Moon et al., "6G Indoor Network Enabled by Photonics- and Electronics-Based sub-THz Technology," J of Light. Tech. vol.40 (2), pp. 499, 2022.

04. Demonstrations of uplink based on electronics

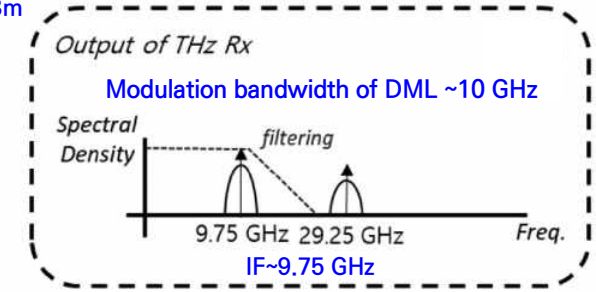
Experimental setup for uplink



Experiment setup for upstream transmission.



Spectrum of THz Tx output from mixer 1.

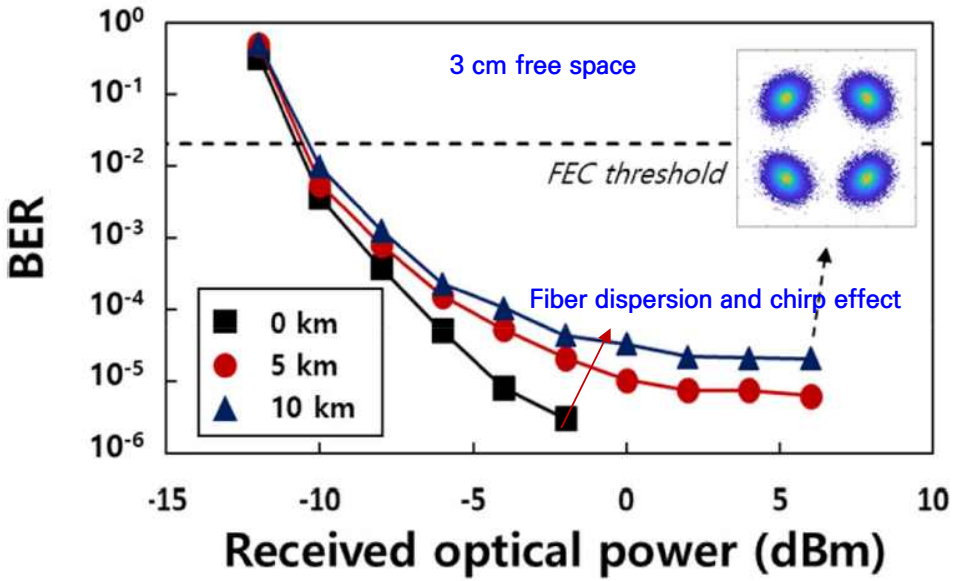


Spectrum of THz Rx output from mixer 2.

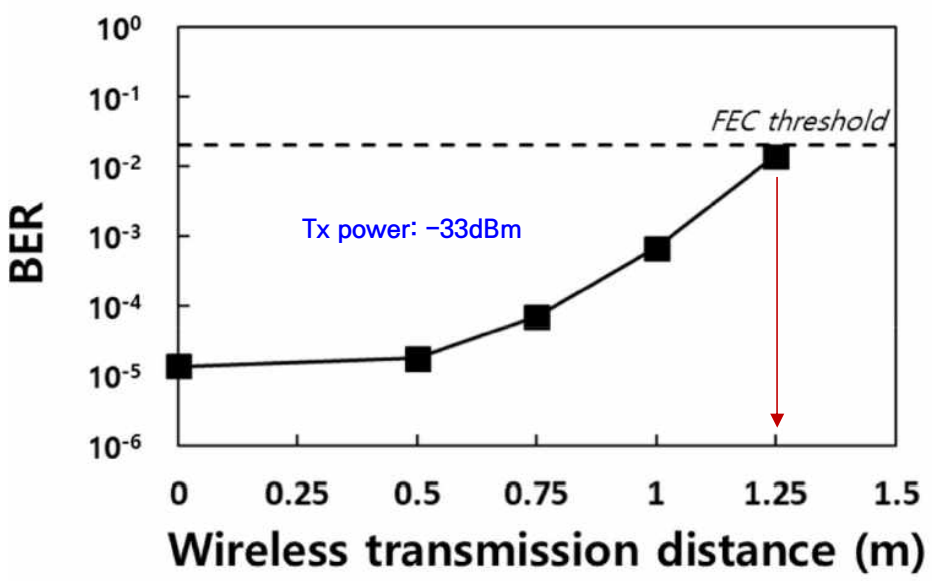
Reference: Sang-Rok Moon et al., "6G Indoor Network Enabled by Photonics- and Electronics-Based sub-THz Technology," J of Light. Tech. vol.40 (2), pp. 499, 2022.

04. Demonstrations of uplink based on electronics

Experimental results for uplink



BER curves as a function of received optical power with various optical transmission distances.



Measured BERs as a function of wireless transmission distance.

Reference: Sang-Rok Moon et al., "6G Indoor Network Enabled by Photonics- and Electronics-Based sub-THz Technology," J of Light. Tech. vol.40 (2), pp. 499, 2022.

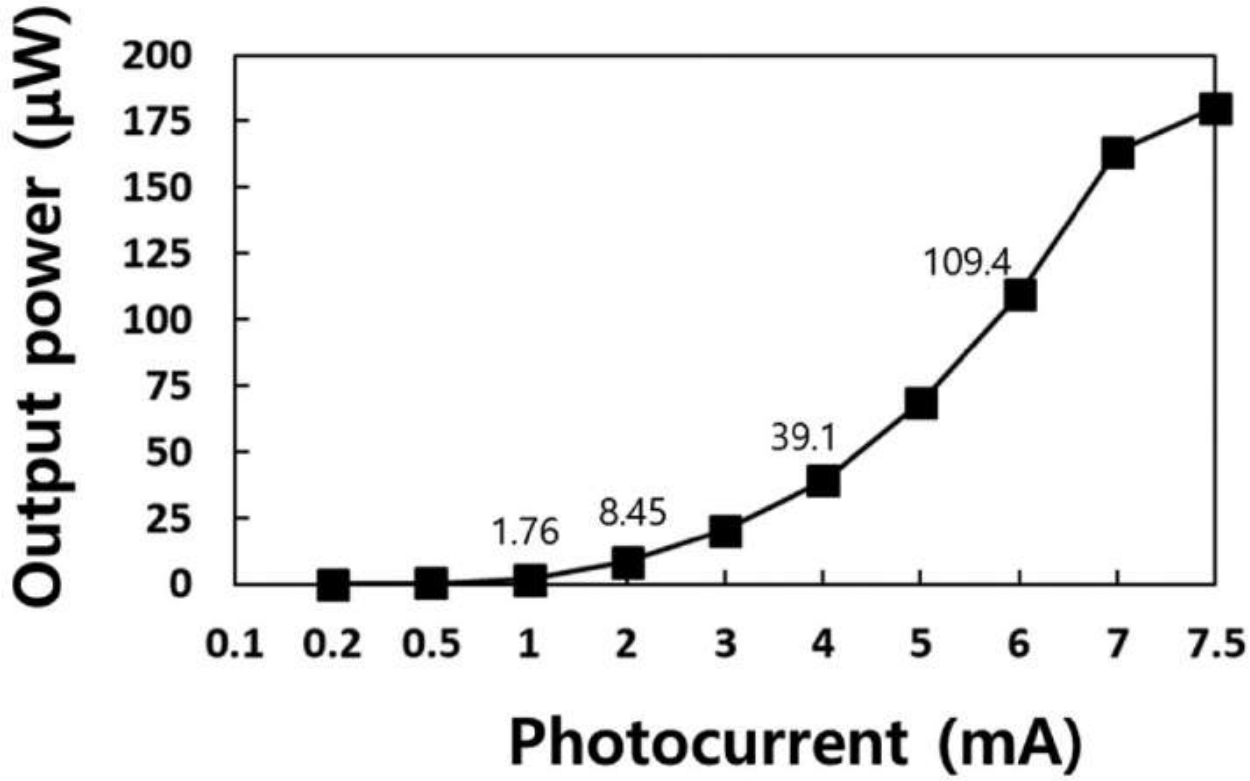
05. Summary

- NG-indoor network employing sub THz-band
- Architectures of NG-indoor network
- Demonstrations of downlink based on photonics
- Demonstrations of uplink based on electronics
- We need more and more data throughput/transmission distance
- Innovative devices required

Thank you

shc@etri.re.kr

Appendix–Output power of photomixer



Output power of the UTC-PD as a function of photocurrent and optical input power at a carrier frequency of 300 GHz

Appendix–Experimental conditions

Name	Manufacturer/Part #/	Specifications	Note
AWG	Keysight M8194A	120 Gsample/s, 45 GHz	Sampling rate and analog bandwidth
IQ MZM	Fujitsu FTM 7977HQA	20 GHz	Bandwidth
UTC-PD	NEL J-band photomixer	100 μW, WR 3.4 waveguide	Output Power
Antenna	VDI DH WR3.4	26 dBi	Horn antenna gain
Lens	Thorlabs TPX100	10 cm	Focal length
Mixer	VDI SAX3.4	40 GHz, 14 dB	Bandwidth and conversion loss
Oscilloscope	Lecroy MCM-Zi-A	80 Gsample/s, 36 GHz	Sampling rate and analog bandwidth
THz PM	VDI PM5	-	-