FURTHER READING

http://exploit.iemn.univ-lille1.fr/
www.es.osaka-u.ac.jp/en/department/graduate/sys1.html

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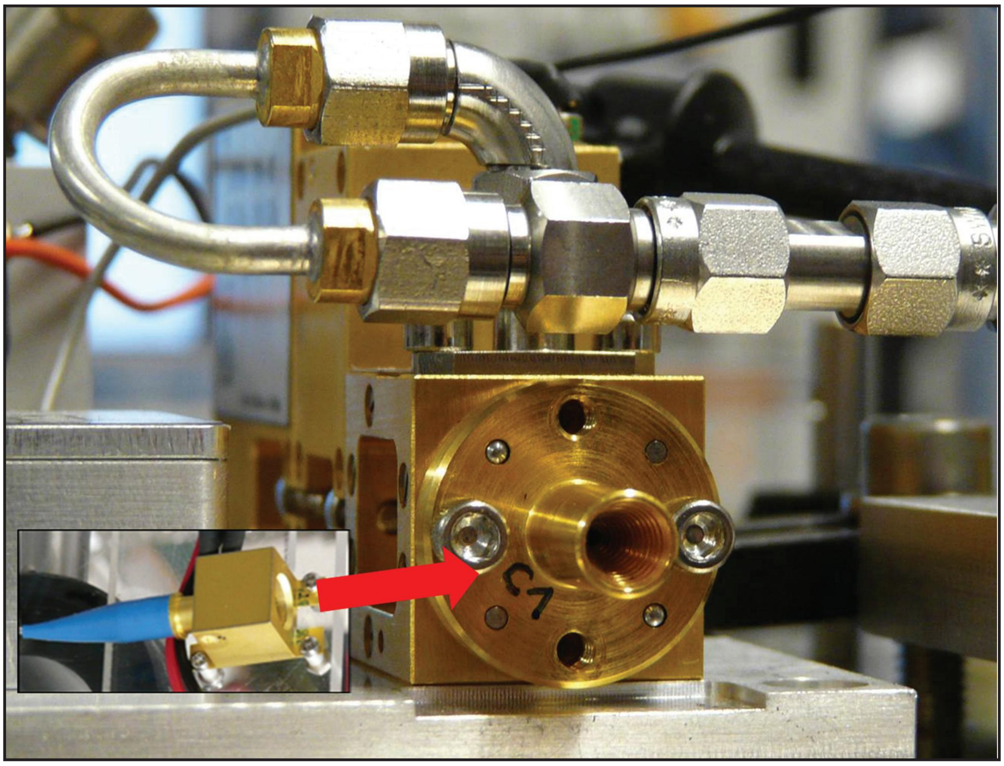
'Coherent THz communication at 200 GHz using a frequency comb, UTC-PD and electronic detection', G. Ducournau, Y. Yoshimizu, S. Hisatake, F. Pavanello, E. Peytavit, M. Zaknoune, T. Nagatsuma and J.-F. Lampin

A real-time photonic-based 10 GBit/s THz link with long term performance and ultra-low power requirement at the receiver using coherent detection

coherent terahertz

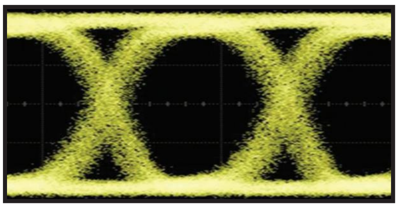


A combined research effort in France and Japan has produced a real-time photonic-based 10 GBit/s terahertz link with shown long term performance and an ultra-low power requirement at the receiver, using a coherent detection scheme.

Laws and limits

It has been observed that the current demand for greater bandwidth to provide new services like video streaming on mobile devices is driving an increase in available data rates in a predictable pattern – Edholm's law of bandwidth. Like Moore's law for transistor counts on integrated circuits, Edholm's law observed that telecommunication data rates have doubled every 18 months, and predicts that they will continue to do so.

The currently used radio bands are heavily allocated, data rate limited and near saturation. One of the avenues of research that is being explored to address this problem is terahertz communication. The challenges of working in the THz regime are balanced by the massive potential to unlock very high data rates for end-users in a large new carrier frequency space for wireless communications.



TOP: The transmitter from the Graduate School of Engineering Science at Osaka University (inset) and the receiver of the system in an IEMN laboratory at Université Lille1/CNRS. The 200 GHz signal emitted at the transmitter can arrive at the receiver with a power of less than 2 μW and still maintain the link
BOTTOM: An eye diagram of a 10 Gbit/s signal sent and received using the system

Fresh pastures

Most THz communication systems use Schottky-based direct detection to produce error-free and effective transmission systems. However, a current limitation with such systems that bars them from everyday application is that the link budgets (the losses between emission and detection) are strongly limited by the currently available emitter and receiver circuit technologies.

Using coherent detection, where the receiver is phase locked to the carrier wave, can drastically reduce the minimum power required to establish and maintain an effective wireless link. This is because it reduces the required number of photons per bit of transmitted data. This, of course, reduces pressure on the link budget requirements and could open up real-world applications of Thz communication. The main challenge with coherent schemes is the need for good synchronisation between the emitter and receiver.

Several research groups around the world have reported impressive results in THz communications but the key issue that remains in achieving robust THz links is obtaining long term error-free performance, which is required for real-time applications like video streaming.

An enduring link

In their Letter, the combined team from Université Lille1/CNRS and Osaka University report the first realisation of a real-time 10 Gbit/s wireless link at 200 GHz using a photonics-based source, with ultra-low required power at reception. They have demonstrated long term performance without the use of signal processing.

"The achievement of a real-time and robust coherent wireless link using a photonics-based optical source above 120 GHz is a key point in demonstrating that photonics-based THz generation is effective for THz links," said team member Dr Guillaume Ducournau. "Our achievement relies on the combination of a very stable photonics frequency comb at emission, an efficient THz emitter (a unitravelling carrier photodiode) and a very high sensitivity coherent receiver."

Pocket terahertz

The authors are now working on increasing the data-rates achievable with their system by using other carrier frequencies. The researchers responsible for the work come from THz Photonics Group of the Institut d'Electronique, de Microélectronique et de Nanotechnologie (IEMN) at Université Lille1/CNRS and the Graduate School of Engineering Science at Osaka University. The Lille group's main interests are in THz sources using photomixing techniques at 1.55 and 0.8 μm and the application of these to wireless data links, THz instrumentation for imaging and THz near-field and nonreciprocity.

Looking to the next decade in this area, Dr Ducournau sees the potential for this kind of technology to move toward ubiquity. "The realisation of THz communications may rely on stable, robust THz emission chips, including power amplifiers at emission and low noise amplifiers at reception. Solid-state electronics are going higher and higher, and in the next decade all the building blocks of traditional communications at Wi-Fi frequencies will be available, leading to ultra-fast connections in the end-user's pocket."