Experimental investigation for laser linewidth tolerance on photonic THz wireless systems using PE algorithms

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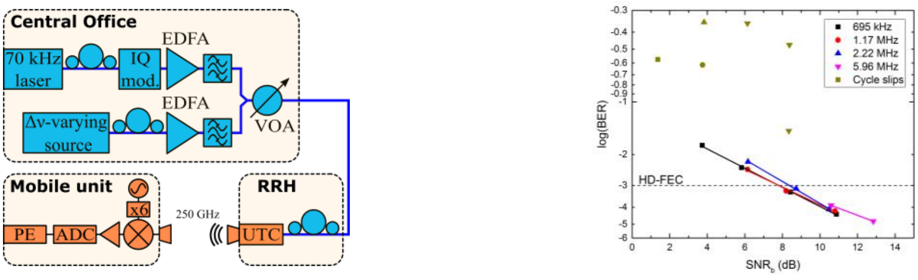
The lower THz band (100 GHz – 1 THz) has several transmission windows with bandwidths of several tens of GHz which can be used to overcome the spectrum congestion at lower frequency bands. The IEEE 802.15 Task Group for 100 Gbit/s Wireless is currently considering the band from 252 GHz to 325 GHz (73 GHz bandwidth) for (a) wireless backhaul and fronthaul systems (b) wireless communication between servers inside data centers and (c) very high-speed wireless LANs and PANs. Due to the extreme high free-space path loss at THz frequencies, the distribution of THz signals from the central office to the remote antenna unit using optical fiber is a very attractive solution. In this scenario, the beating of two optical modes in an ultrafast photodiode (photonic THz generation) may be advantageous over competing technologies as it enables the use of radio-over-fiber (RoF) techniques (see Fig.1 (a)).
On the other hand, this approach has the disadvantage that the electrical signal generated at the photodiode will exhibit phase noise resulting from the linewidth of the two lasers. This may prevent the system from operating at an acceptable BER. Even if two correlated modes are used, phase noise will arise from temperature changes and unmatched transmission paths between the modulated signal and unmodulated carrier. An alternative way to eliminate the phase noise is through the use of phase-estimation (PE) algorithms at the receiver. The function of this algorithms is to remove the phase term coming from both data modulation and additive white Gaussian noise in order to make an estimation of the phase distortion originating from signal linewidth, which is then subtracted from the received signal.
In this work, we show experimentally and through simulations how low-complexity PE algorithms that are already used in coherent optical communications, can enable the use of free-running lasers in photonic THz systems. This is not only an advantage regarding cost, but also in terms of system scalability and flexibility. For the experimental demonstration, we use the setup shown in Fig. 1 (a), which is the typical arrangement expected in future high-speed WLANs based on photonic down-conversion [1]. The PE algorithm implemented at the receiver is a combination of the M^{th}-power operation and a block-averaging filter (M^{th}-power block algorithm [2]). On the optical transmitter, the signal is modulated in a quadrature phase shift keying format at a symbol rate of 10 Gbaud for a total data speed of 20 Gbit/s. As shown in Fig. 1 (b), where the bit error rate is plotted against the signal-to-noise ratio per bit for different combined optical linewidths, this simple algorithm can handle optical linewidths in the range of MHz. This confirms that the spectral purity requirement of future ultra-high speed wireless systems can be met with integrated lasers and without complex stabilization techniques.



(a) (b)

Fig.1: (a) Experimental setup and (b) receiver tolerance to THz signal linewidth. RRH: remote radio head; VOA: variable optical attenuator; UTC: uni-traveling-carrier photodiode; ADC: analog-to-digital converter.

References

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