THz communications for next generation HD rate wireless links

**Outline**

- THz communications: general issues
- THz devices for coms (Tx and Rx)
- Some reported com links
- Some conclusions

**THz communications: general issues (1/3): why?**

- Context: how to place THz coms on the telecom map?
- Line of Sight - Point to point (actual)
- Single/multi carrier?

**THz communications: general issues (2/3): why?**

- Changing activities…
- How to handle this « big » wireless data???
- Increase backhaul network capability

**THz communications: general issues (3/3): THz windows**

- « 400 GHz » window
- « 200/300 GHz » window
- « 600 GHz » window
- THz coms may index that range

**Applications… indoor? (LiFi like?)**

- Indoor? (LiFi like?)
- Has to be direct line
- Wall/objects reflections?
- Advantage of Photonics: multi-user service

**Concept for optical-to-THz radio links… outdoor?**

- Future fixed 'pencil links'
- Future mobile accesses

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**THz devices for communications**

- **Antennas (Rx)**: Tunable to E-plane. Commercially available.

  ![Antenna Diagram](image1)

- **Arrays**: Tunable to E-plane. Commercially available.

  ![Array Diagram](image2)

- **Data Link**: Under development.

  ![Data Link Diagram](image3)

**Inside the Rx... the LNA!**

- **蚕食性**: Integrated Electronic Design. Power efficient and fully realized modular blocks.

  ![LNA Diagram](image4)

- **Key Technologies**: Can be integrated in specific design (enabling the Rx)

  ![Technology Block](image5)

**Other Rx/circuits or specific devices**

- **Receiver (Rx)**: Fully integrated Rx (SiP).

  ![Receiver Diagram](image6)

- **Linear Amplifier**: Commercially available.

  ![Amplifier Diagram](image7)

- **Tunable**: Tunable to E-plane. Commercially available.

  ![Tunable Diagram](image8)
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**Some THz links reported**

- Reported working data links and mostly THz electronic and/or photonic devices.

**Some THz links reported**

- First links: 120 GHz at NTU; the "Frankfurt pioneers".

**Some THz links reported**

- Frequency conversion system.

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**Some THz links reported**

- Photonics is pushing up the first tests at highest data rates.
- Photonics in data rate @ 237.5 GHz (Same tests IR vs THz).

**Some THz links reported**

- Photonics is pushing up the first tests at highest data rates.
- THz and RF signaling through fiber networks.

**Data formats**

- THz window for first applications (data com) seems to be 300–350 GHz (THz com).
- Single-amplitude coding easy but not sufficient (52 % of optical data direct).
- Bandwidth in THz is huge but other techniques are possible.

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Some conclusions

- Multi-carrier BW
- Transmit
- Wavelength availability
- Coexistence of the THz com with other frequencies...
Fiber-to-THz bridge using Photomixing

Key advantages of the photomixing devices:
- Single fiber THz bridge
- Only one photomixing with an optical signal

THz link budget

- Link budget:
  \[ P_{IN} = P_{OUT} + P_{ANT} = 92.4 + G_e - 20 \log(l) + 20 \log(R) + 4.8 \]
  (antenna gain expressed in dBi, l in km, f in Hz, and power in dBm)

Why not free-space optics??

- Free-space optics has been developed in the past,
  - Devices with polarization / Commonly available for Link backhaul
  - Gain available in the air
  - Solutions with environmental effects compensating (e.g., wavelength effects)

Fiber Optics & THz

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Conclude with open questions?

- What's your vision of the field in ~20 year time?

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THz coms at IEMN, Lille

- THz coms are still in their infancy
- Photonics based devices are very attractive for THz
- Right compatibility and low losses

UTC-PD for THz UWB @ 400 GHz

THz coherent coms
THz QPSK
High distance P2P links
Channel effects

2010 2011 2012 2013 2014 2015

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Thank you!