WiPLASH

Wireless communications in the terahertz band for massive heterogeneous computer architectures

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3rd Towards THz Communications Workshop

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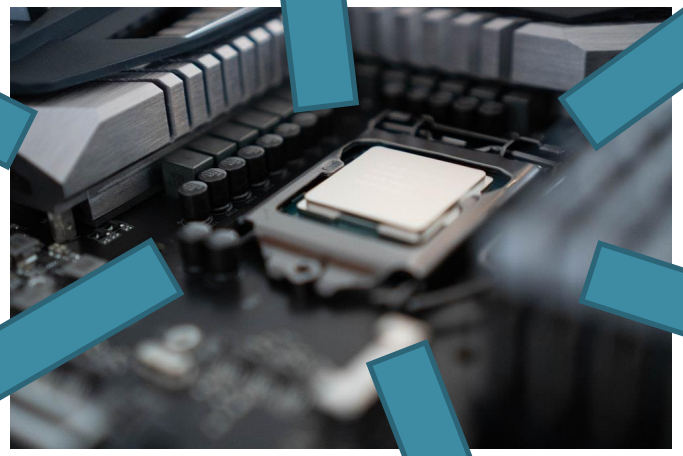
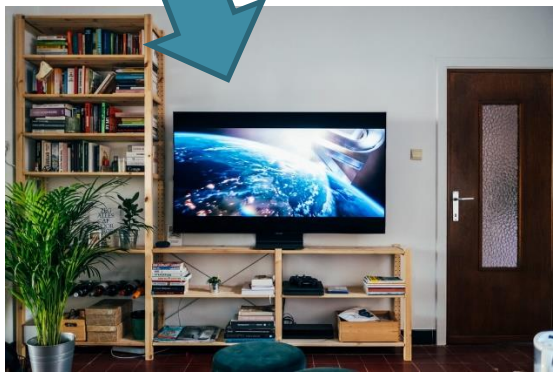
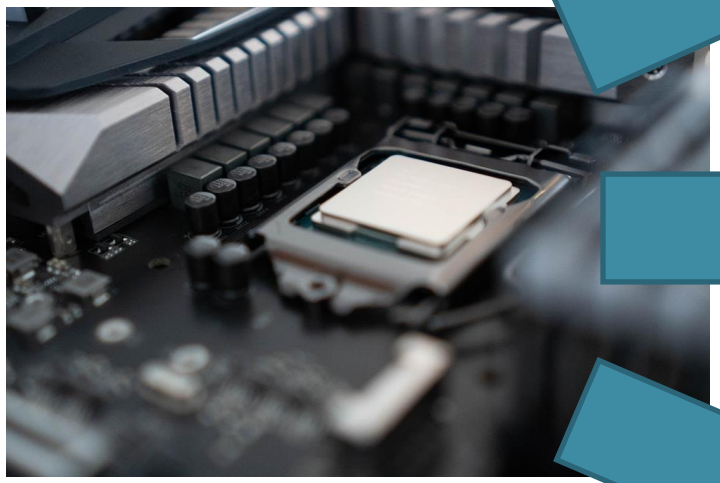




The problem



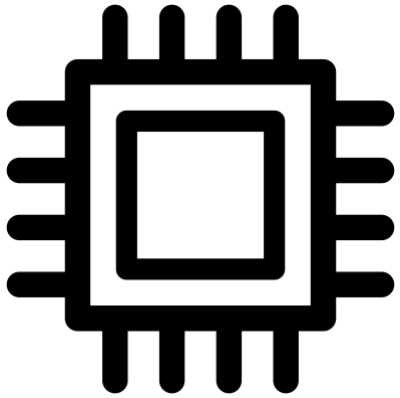
We want them faster

We want them more efficient

Anywhere, always

How are processors designed

General purpose chips



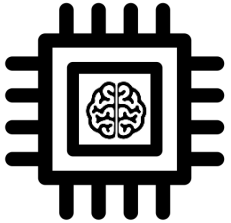
AI 1X

Graphics 1X

Browsing 1X

Regular 1X

Accelerator chips



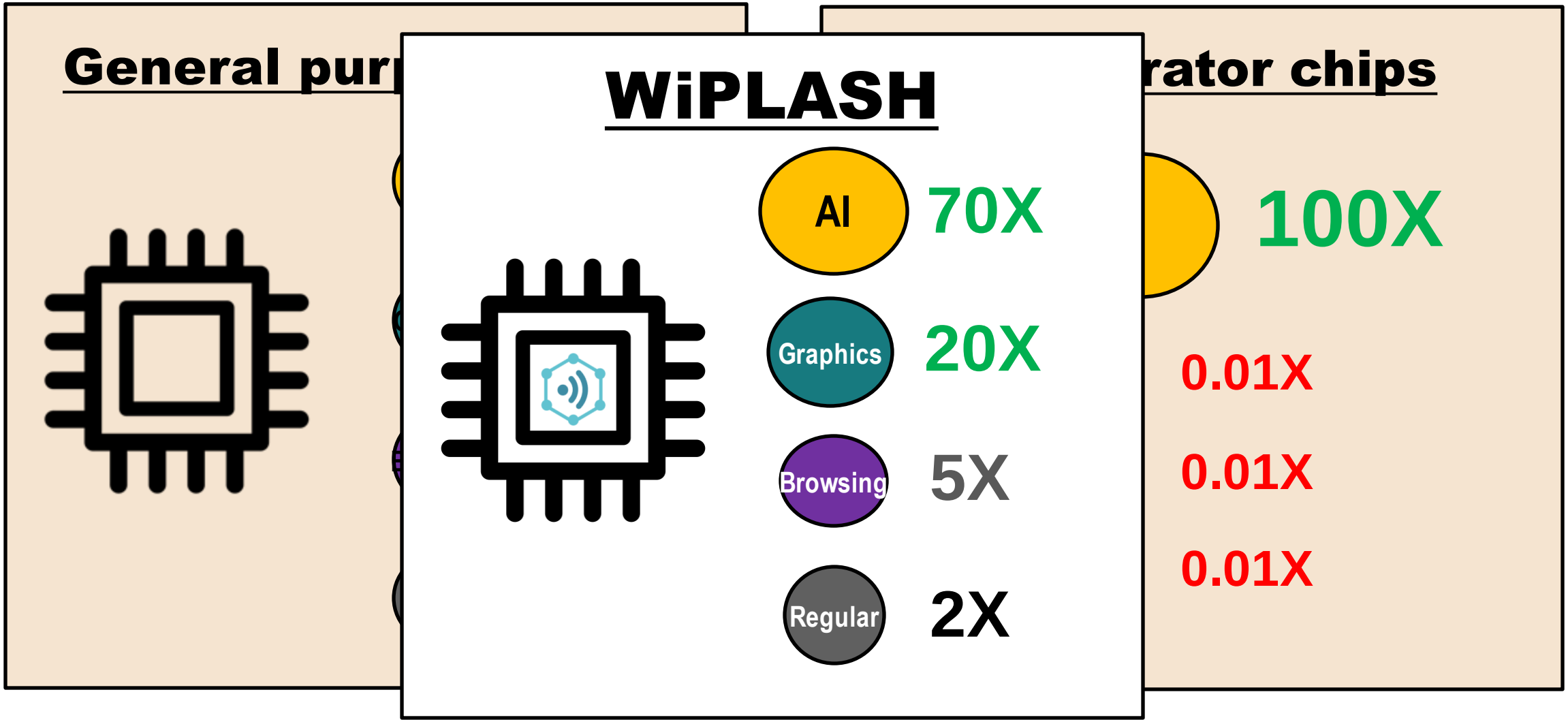
AI 100X

0.01X

0.01X

0.01X

The WiPLASH scenario

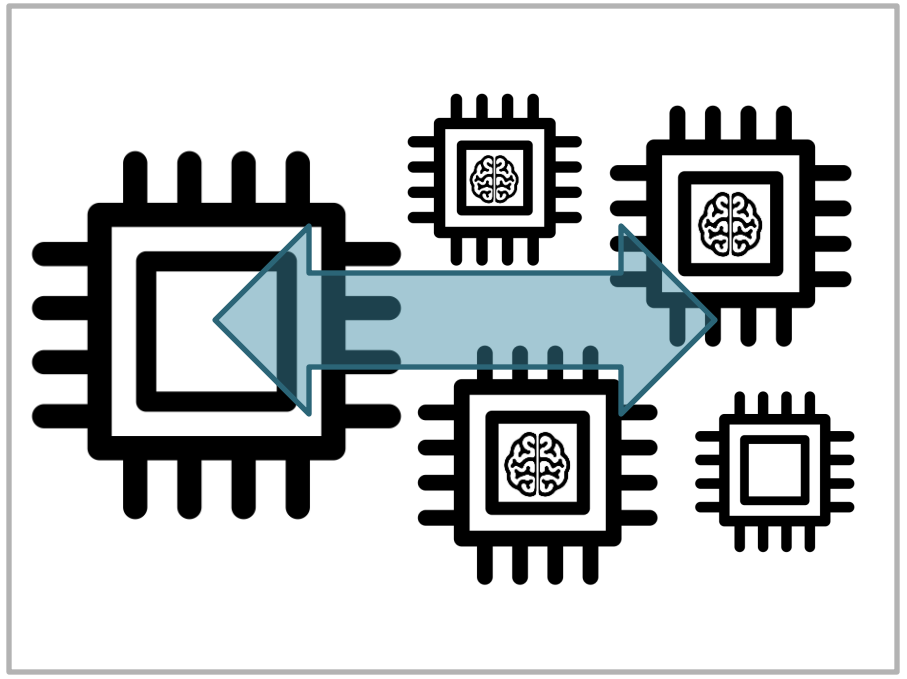


The WiPLASH objective

The vision of WIPLASH is to create new processors that are faster more efficient all the time

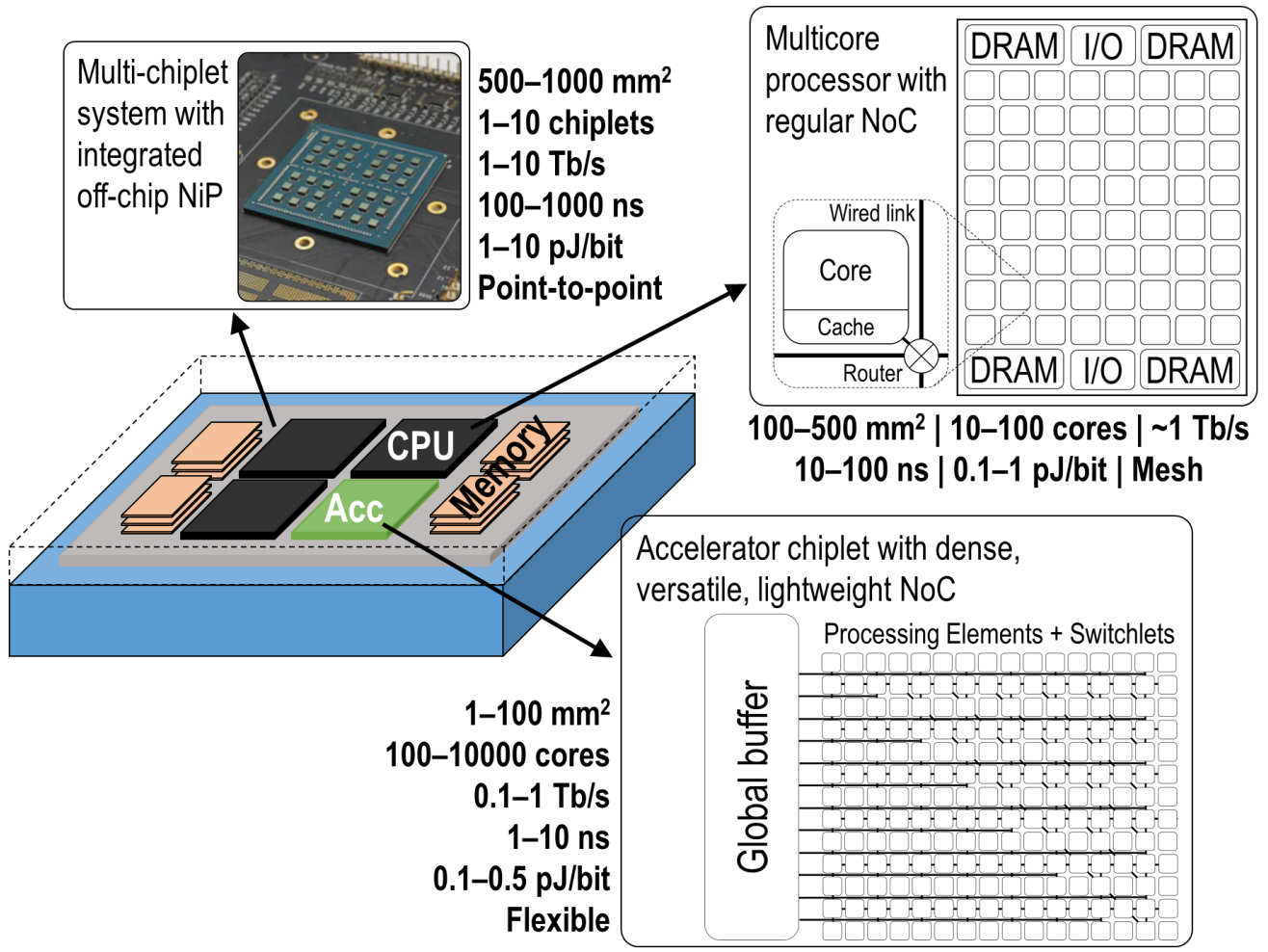
How?

Wireless communication is the key



Why wireless?

- The interconnect is at the center of heterogeneous systems. Communications are challenging:
  - Intense
  - System-dependent
  - Uneven (spatially)
  - Dynamic (temporally)



Why wireless?

- The interconnect is at the cen
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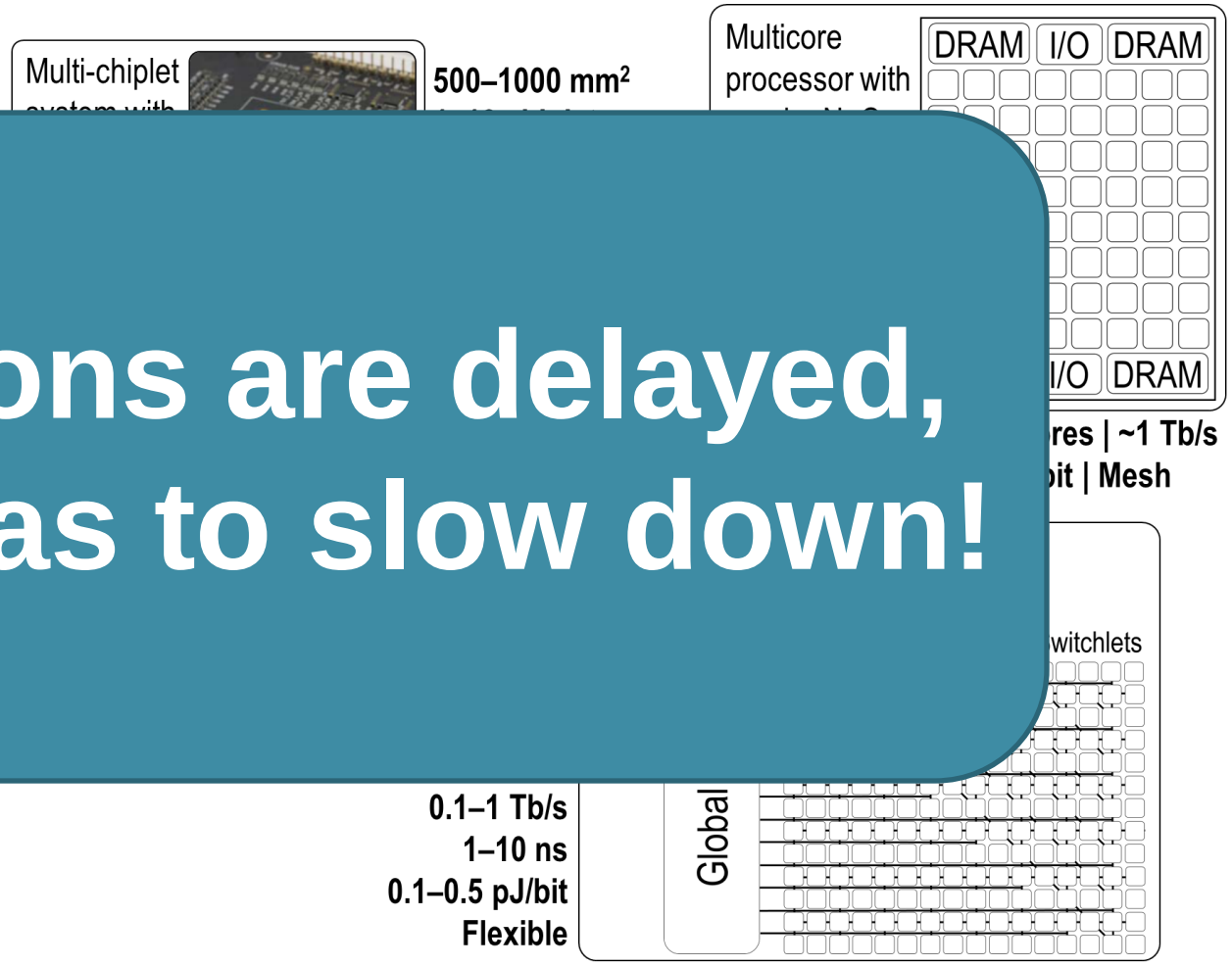
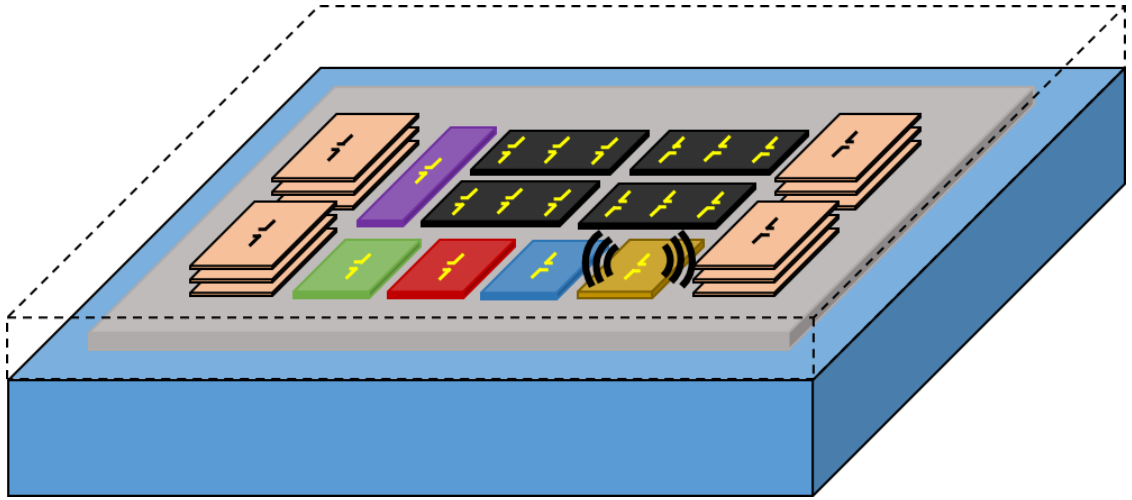
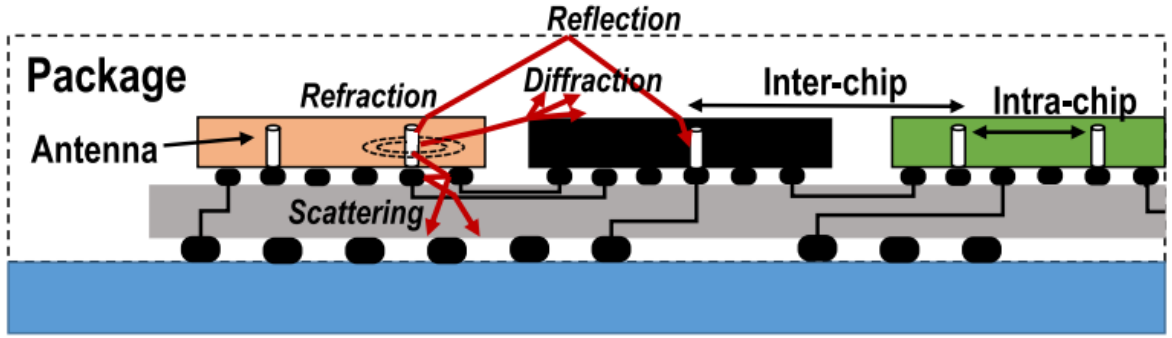
  ar
  -
  -
  -
  - Dynamic (temporally)

If communications are delayed, the processor has to slow down!



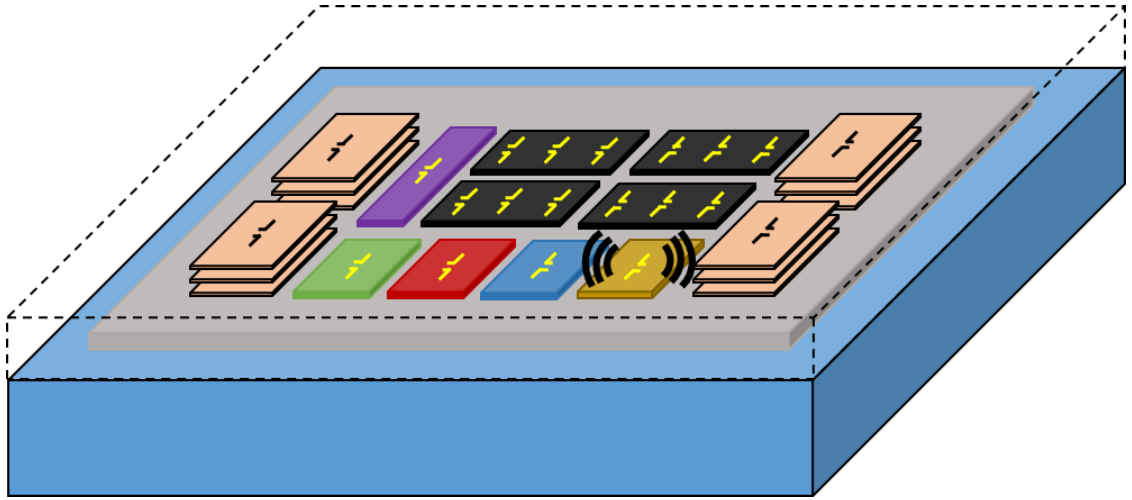
The WiPLASH approach

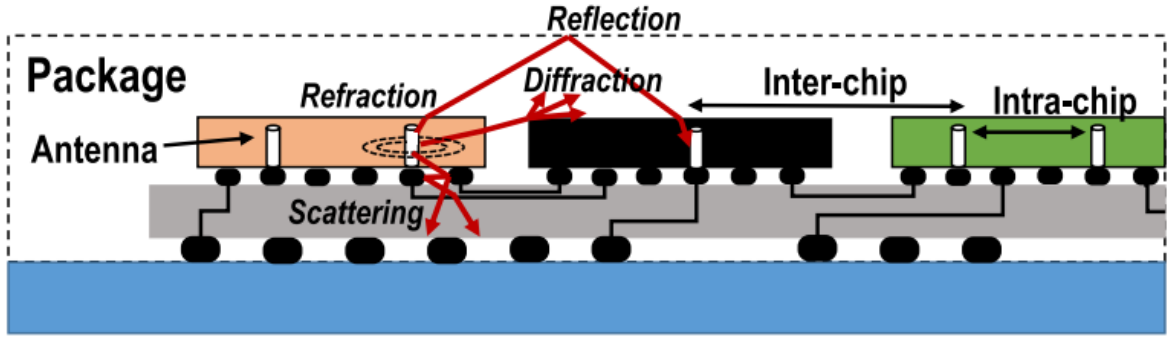




- Integrate on-chip antennas into chiplets.
- Wireless networks through the processor package.
- Complements a wired network.

The WiPLASH approach: Advantages





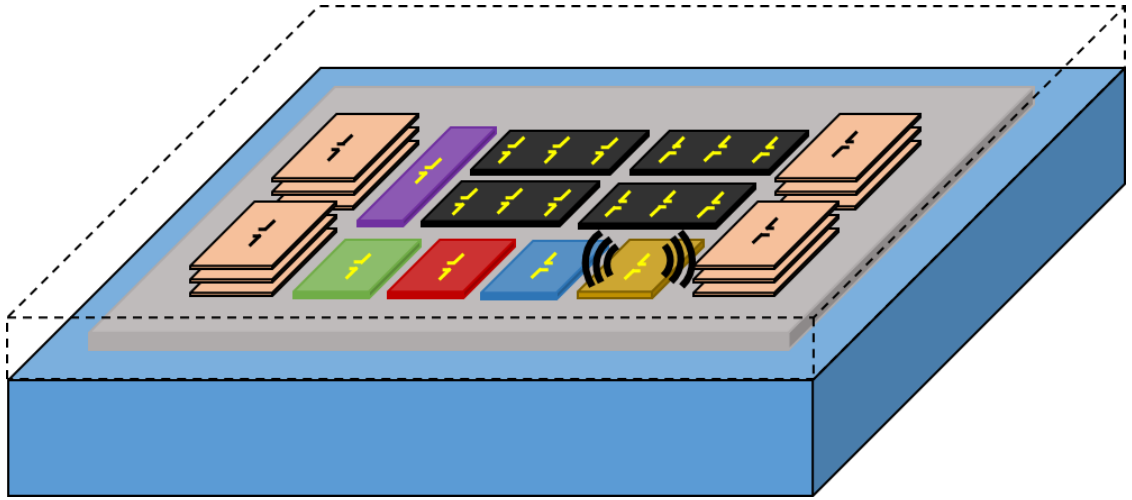
Low Latency (chip-wide, ns)

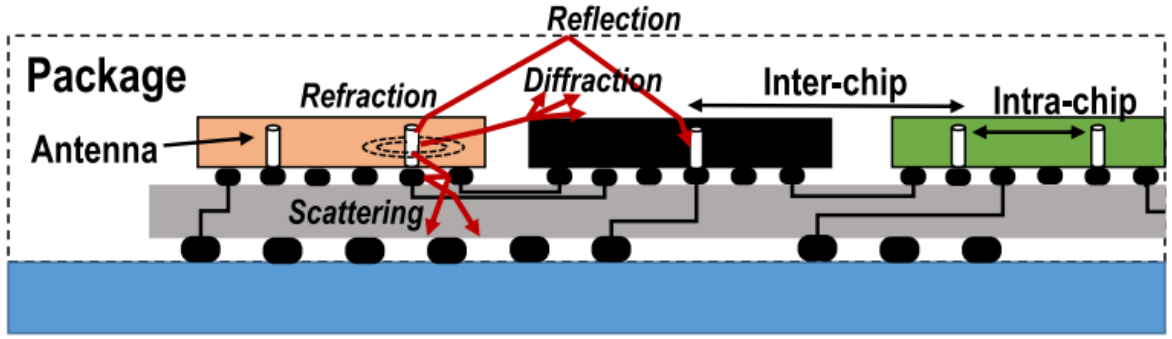
Flexibility

Broadcast and Multicast capabilities at lower costs

Static environment and quasi-deterministic traffic: ~ optimal design

The WiPLASH approach: Challenges





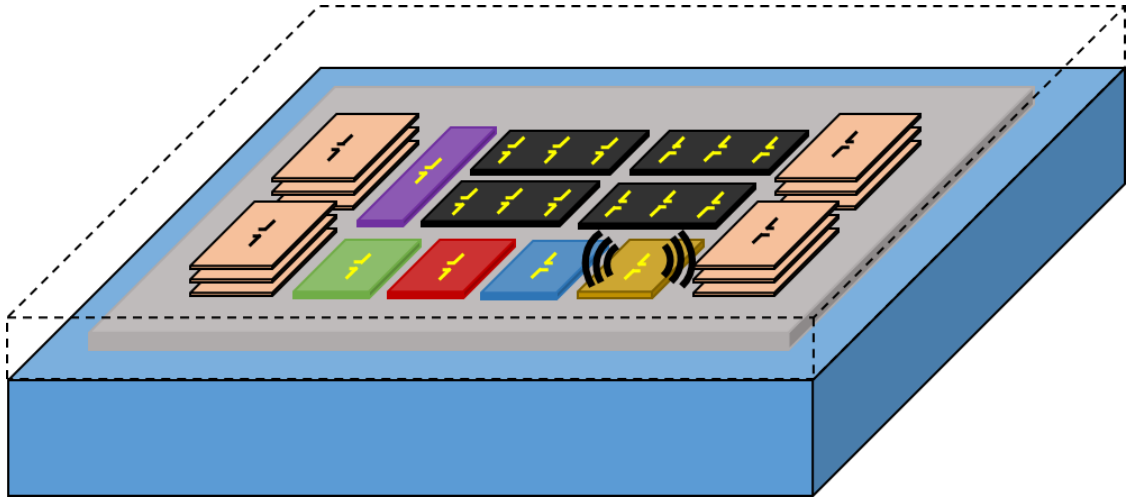
Significant power (~pJ/bit) and area (~mm^2) constraints

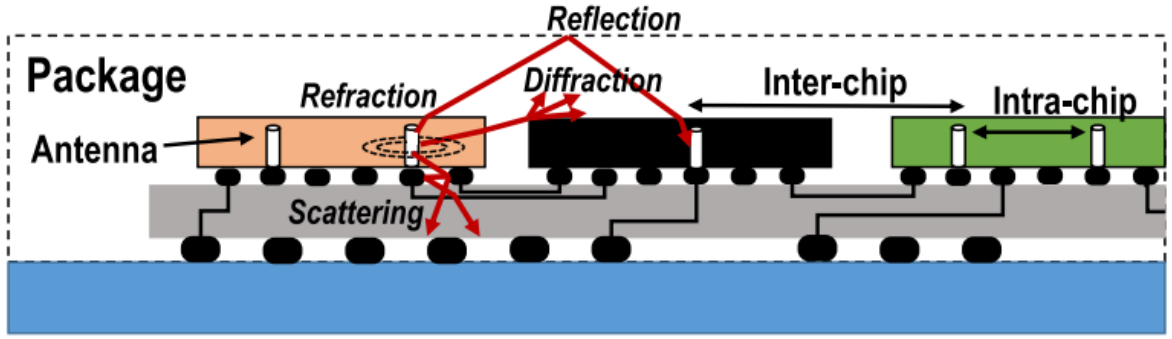
Heterogeneous and hotspot natured traffic characterisitics

Extreme Reliability (BER < 10^{-12})

Low Algorithmic complexity

The WiPLASH approach: How do we do it?





THz wireless: small antennas, high throughput and lower latency

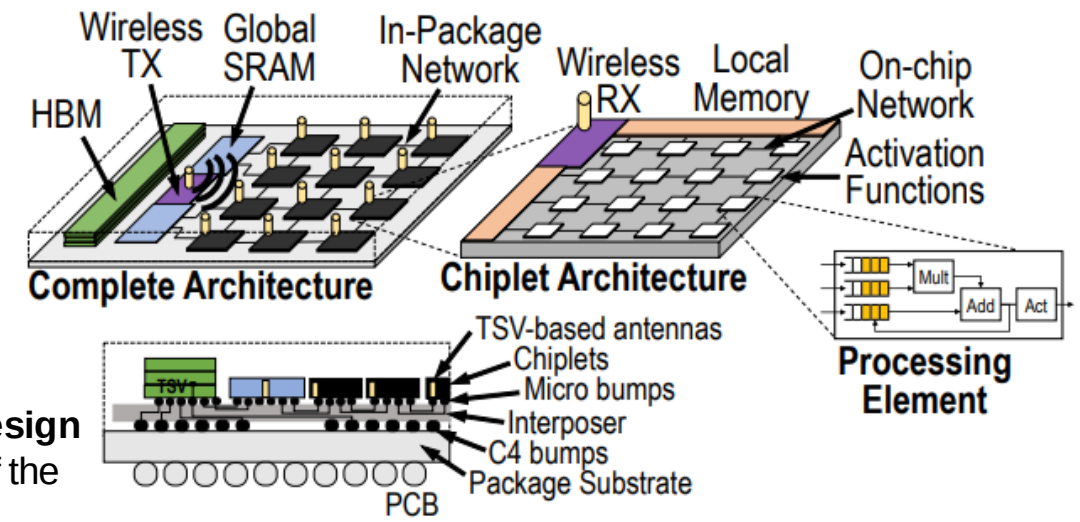
Graphene Antennas: Miniaturization and tunability in the THz band

Smart-MAC: Low complexity medium access methods for extreme reliability and adaptiveness

Arch-NDO: Network design optimization, utilizing the quasi-deterministic nature as well as accounting for architectural limitations

WiPLASH for DNN workloads: WIENNA

- Can we scale-out DNN accelerators thanks to wireless interconnects? WIENNA
  - One TX in memory, one RX in each chiplet
  - Plasticity enables adaptive data flows
  - Wireless bandwidth of 64 Gb/s
  - 2.5X – 4.4X speedups
  - 38% less energy



R. Guirado, H. Kwon, S. Abadal, E. Alarcón, T. Krishna, **"Dataflow-Architecture Co-Design for 2.5D DNN Accelerators using Wireless Network-on-Package,"** in Proceedings of the ASP-DAC '21, Tokyo, Japan, 2021.

Conclusions

- WiPLASH aims to further the push for 5G and beyond networks with the goal of demonstrating the feasibility of "wireless in everything".
- Heterogeneous architectures benefit from wireless, through its low latency, system-level flexibility and inherent broadcast capabilities.
- WiPLASH aims to go one step further thanks to graphene antennas, providing more flexibility and more bandwidth.

Acknowledgments

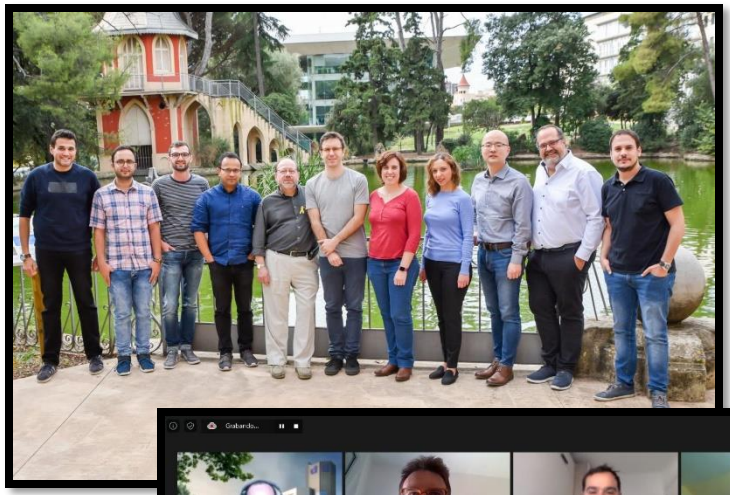
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863337.

Acknowledgments

Find us at

- www.wiplash.eu
- @Wiplash_eu
- linkedin.com/company/wiplash/
- WiPLASH project

WiPLASH Kick-off meeting,
Barcelona, Oct 2019



WiPLASH 2nd plenary meeting,
Virtual, May 2020

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