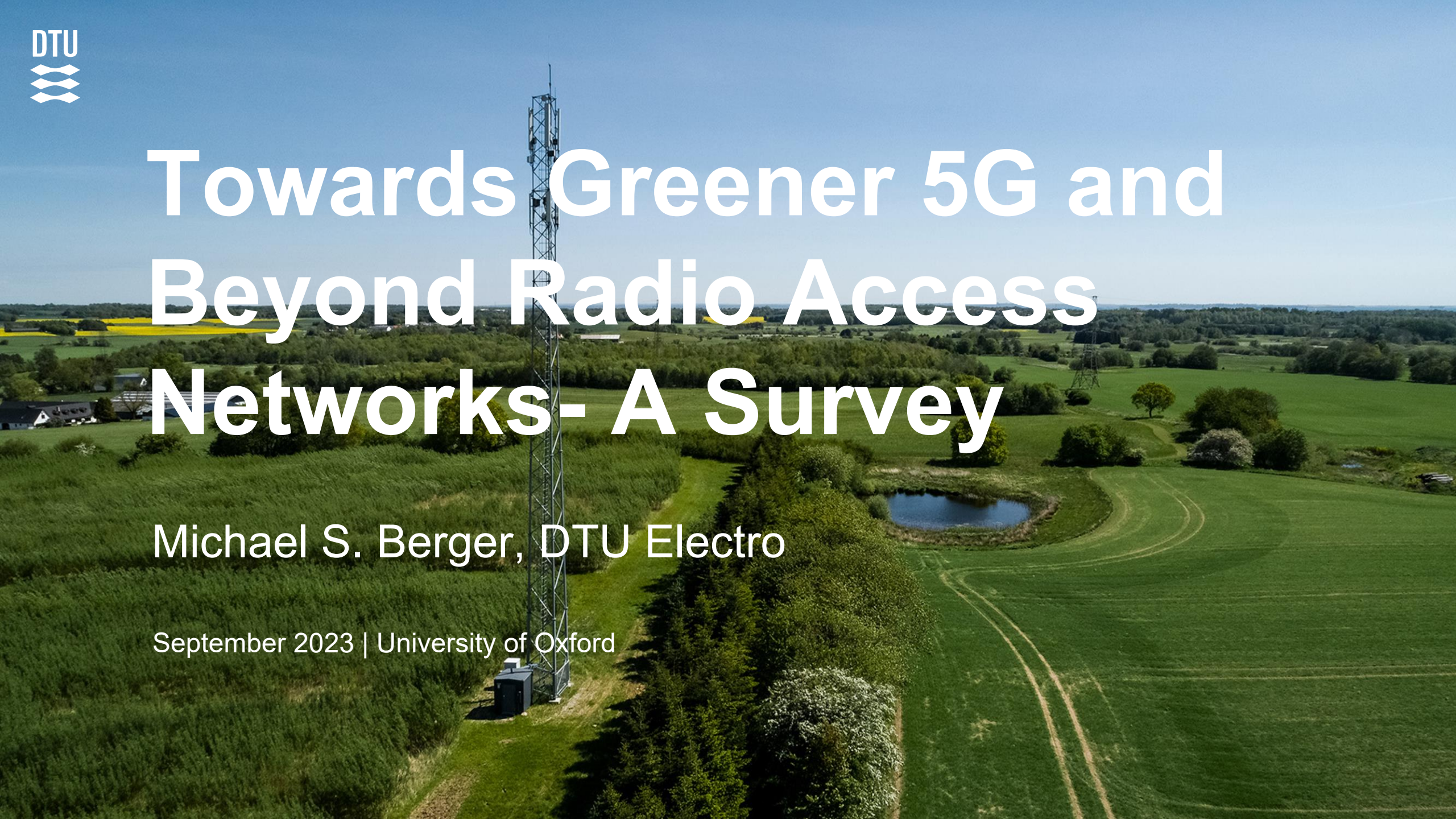

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Toward Greener 5G and Beyond Radio Access Networks—A Survey

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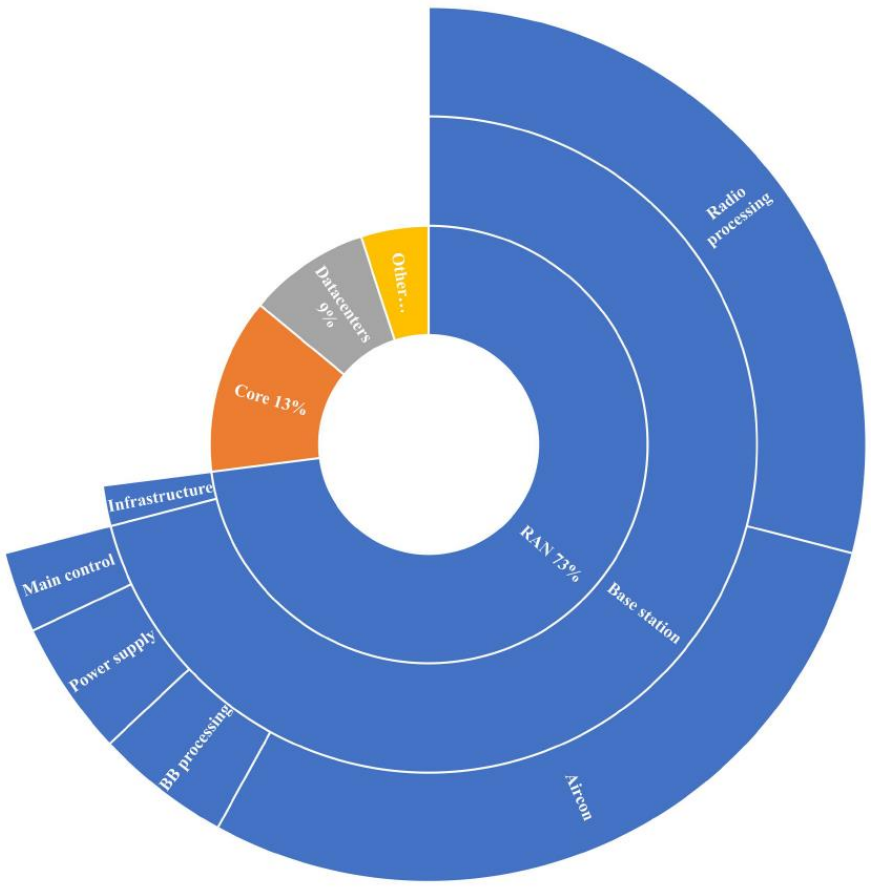
Energy consumption in Mobile Networks



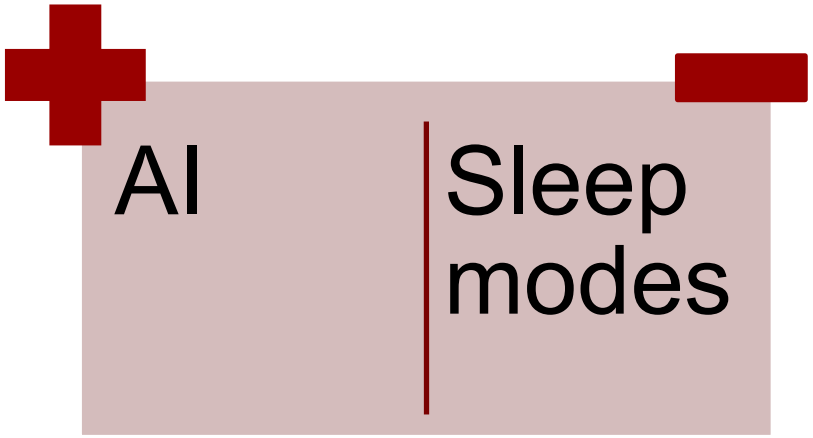
Numbers from NGMN whitepaper:

”Green future networks: Network energy efficiency”

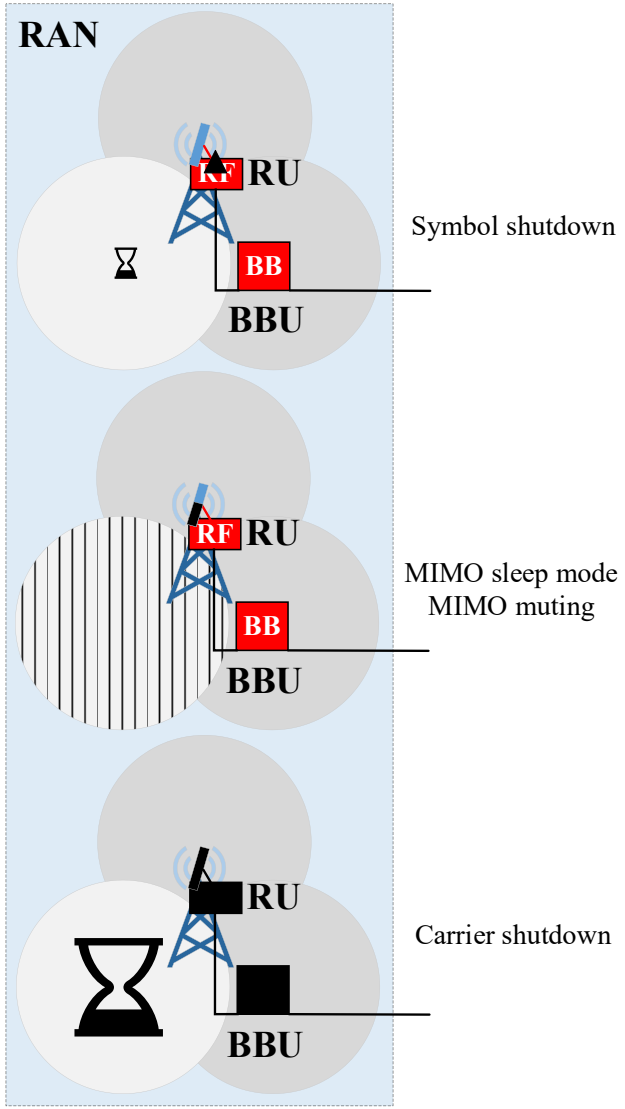
- Published in The Open Journal of the Communications Society (OJCOMS)
- Motivation: To illustrate the overall impact of energy reductions in different parts of the network.
  - Example: How much will 10% decrease in BB processing reduce the energy consumption of mobile networks
- Main areas covered
  - Architectures (vRAN, C-RAN, O-RAN)
  - Technologies (improvements in 4G/5G, opportunities in 6G)
  - Sharing the network (roaming, MOCN, MORAN, slicing)
- MNO perspective
  - Customer Experience (CEX)
  - CEX compared to energy savings

Technology evolution and improvements

- Power amplifier improvements
- Increased spectral efficiency
- Reduced signalling
- Sleep Modes
- Network virtualisation
- AI



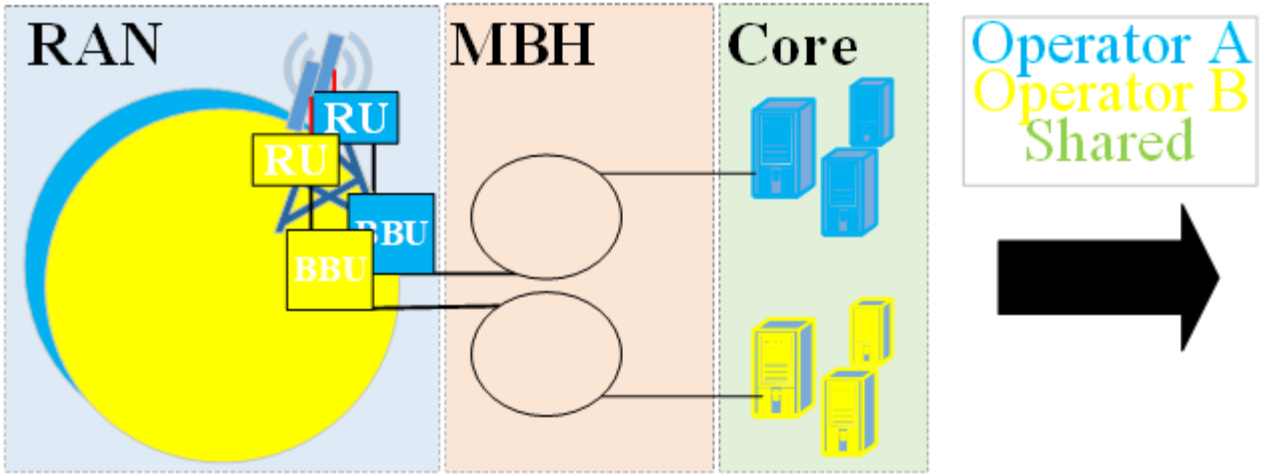
- Impact on CEX

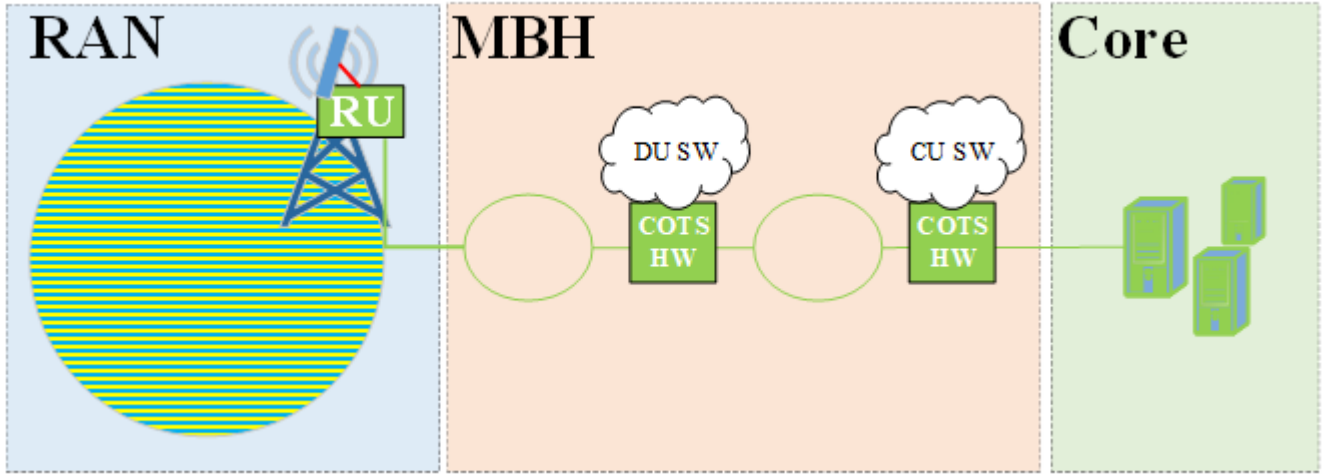


Network architecture optimization – sharing the resources

- Network Architecture
  - C-RAN
  - vRAN
  - O-RAN

- Network Sharing
  - Multi-Operator Core Network (MOCN),
  - Multi-Operator RAN (MORAN)
  - Network Slicing

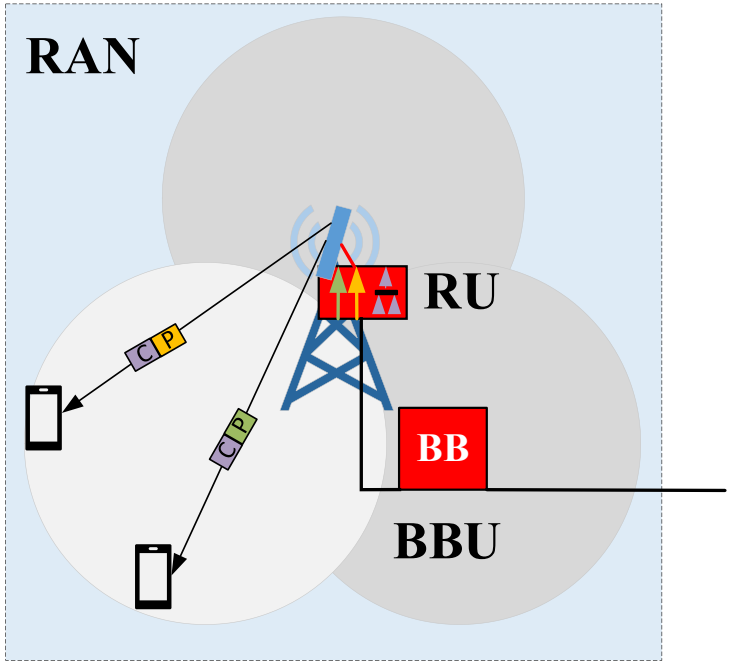


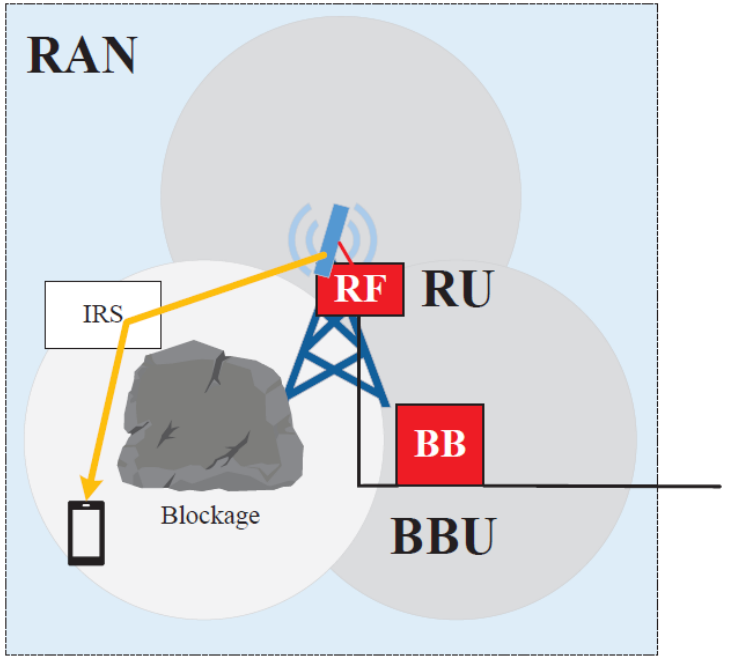


Research directions towards green 6G

Examples of directions for 6G energy reductions

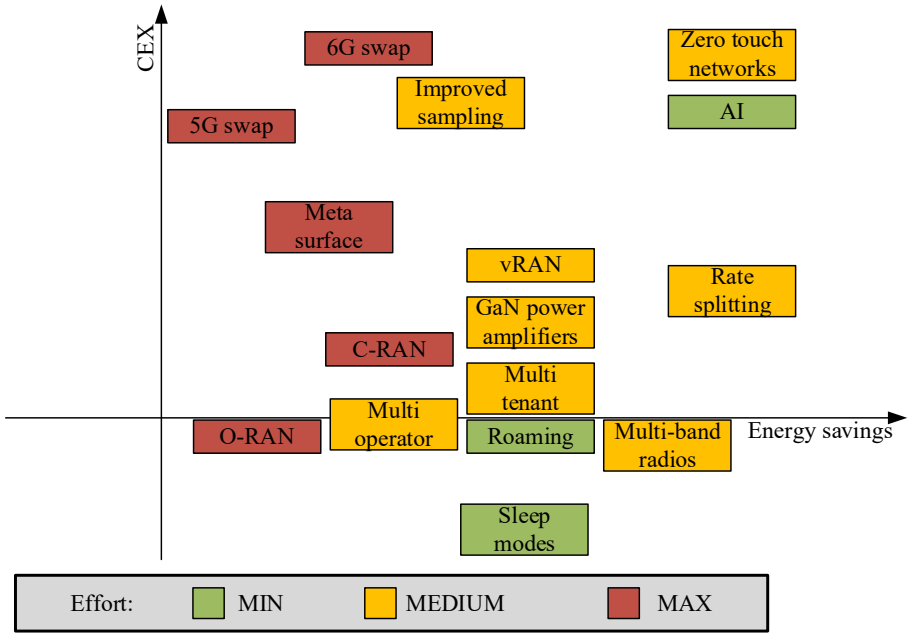
- Zero touch networks
  - Taking AI to the extreme
- Rate Splitting
  - Multiple acces with minimised interference
- Intelligent reflecting surfaces
  - Passive beamsteering
- Sampling
  - Compressive sensing





Survey summary

RAN component	Architecture	Technology	Total	Share of Mobile Network Energy Consumption Saving
Main control	20%	2%	22%	1%
Baseband processing	40%	2%	42%	2%
Power supply	10%	2%	12%	0.5%
Air condition	50%	2%	52%	15%
Radio processing	25%	32%	57%	16.5%



Short term improvements

- Sleep modes
- AI predictions to optimise sleep mode
- Periodical roaming

When equipment is exchanged or new deployed

- Multi-band RUs
- GaN amplifiers

Future possibilities

- Cloud-RAN
- Open RAN/vRAN
- Network sharing

Potential 30% savings

Green energy sources, waste heat and ?

Thank you for your attention

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