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Challenges and Opportunities with mm-wave Communications in 5G

Abstract

Mobile communication systems should evolve to satisfy the tremendous increase in capacity demand by 2020 and beyond.
The requirements for the fifth generation of mobile communications (5G) are multi-fold, and future extreme Mobile Broadband (xMBB) systems should not only meet the significant requirements for capacity increase, but also address the needs for higher user data rates — up to 10 Gbps for services such as 3D immersive user experience and telepresence on mobile devices.
Another key requirement for 5G is reduced latencies. Some services, such as interactive applications and ultra-responsive mobile cloud services, will demand end-to-end latencies as low as 1 ms, and users should experience improved and consistent Quality of Experience (QoE) in all situations.
We introduce some of the challenges and opportunities with mm-wave frequencies for access, backhaul and fronthaul and highlight a few identified key technical enablers to support targeted 5G use cases, with a special focus on multi-antenna and multi-node transceiver architectures, as seen in the mmMAGIC project. We also introduce the research plans in the ChaseOn antenna systems research center at Chalmers University of Technology.

UHD TV/streaming

Immersive and interactive 3D services

Ultra-responsive mobile cloud

Ultra-dense deployment

Multicast support

Self-backhaul/front-haul support

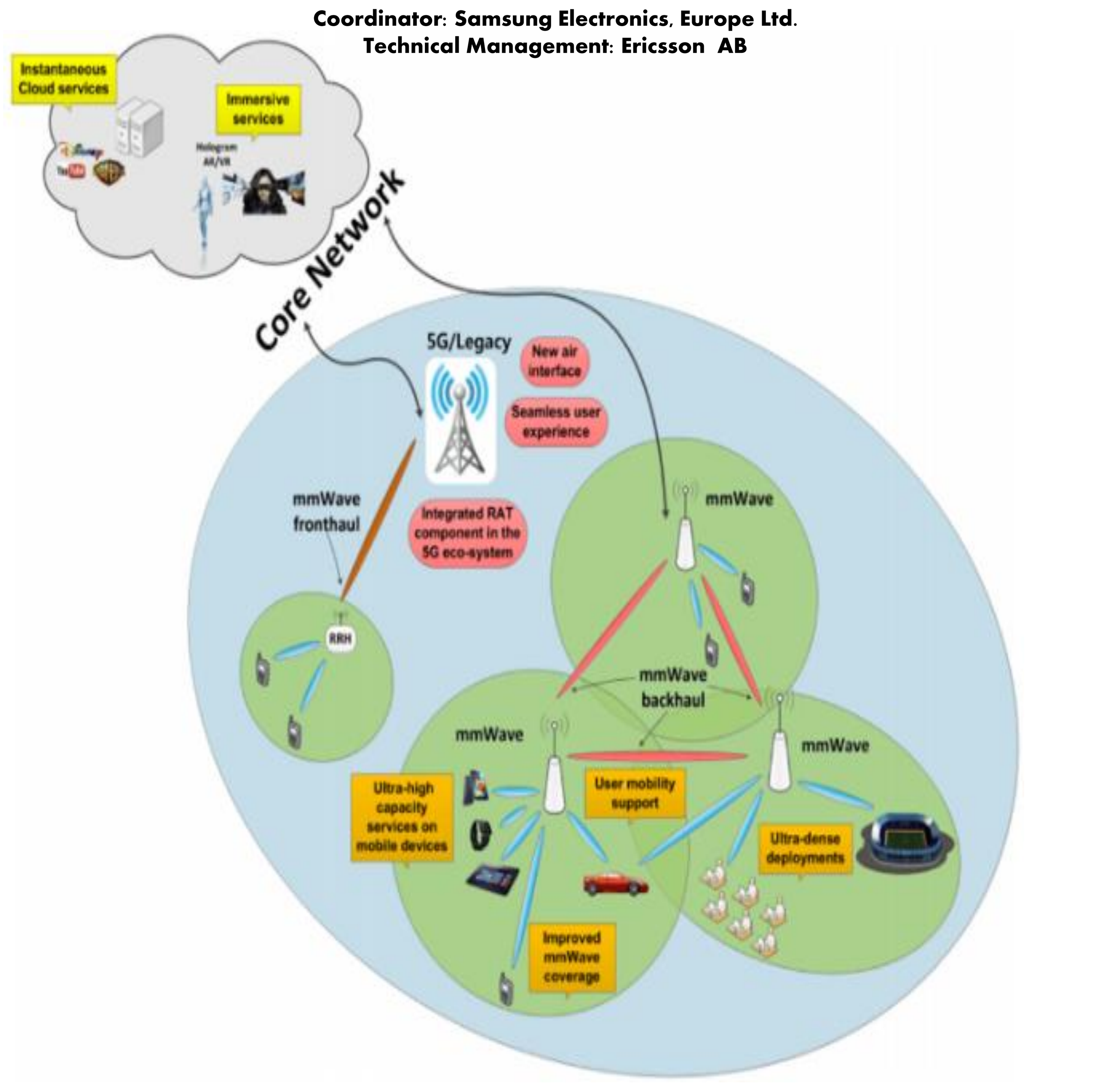
WRC'19 & 3GPP Head-start

mmMAGIC

mm-wave Based **M**obile Radio **A**ccess Network for Fifth **G**eneration (**5G**) **I**ntegrated **C**ommunications

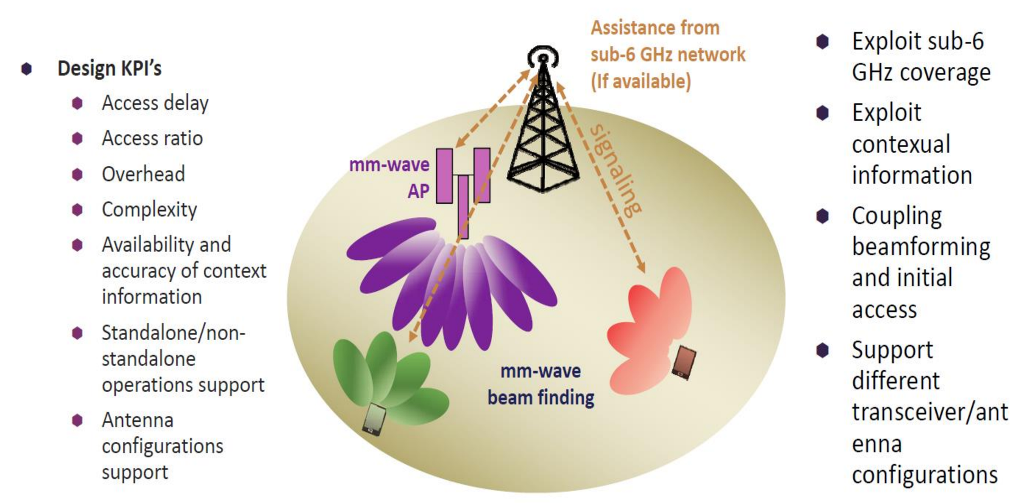
Horizon 2020 Public Private Partnership Consortium

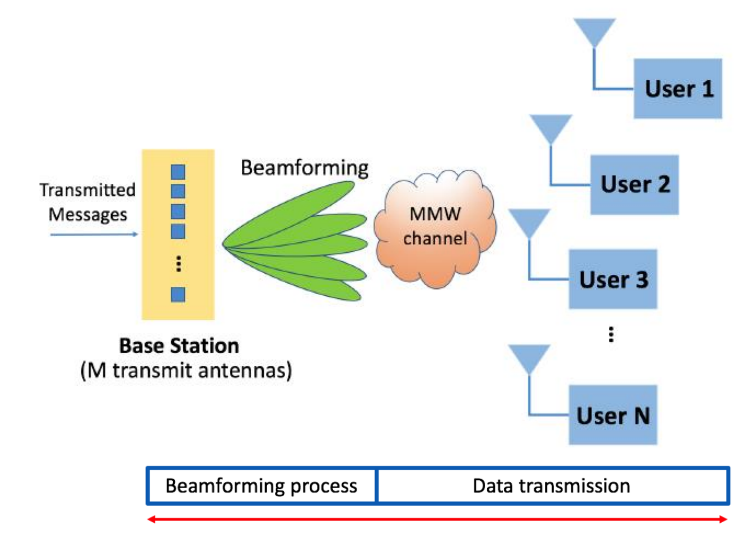
Coordinator: Samsung Electronics, Europe Ltd.
Technical Management: Ericsson AB

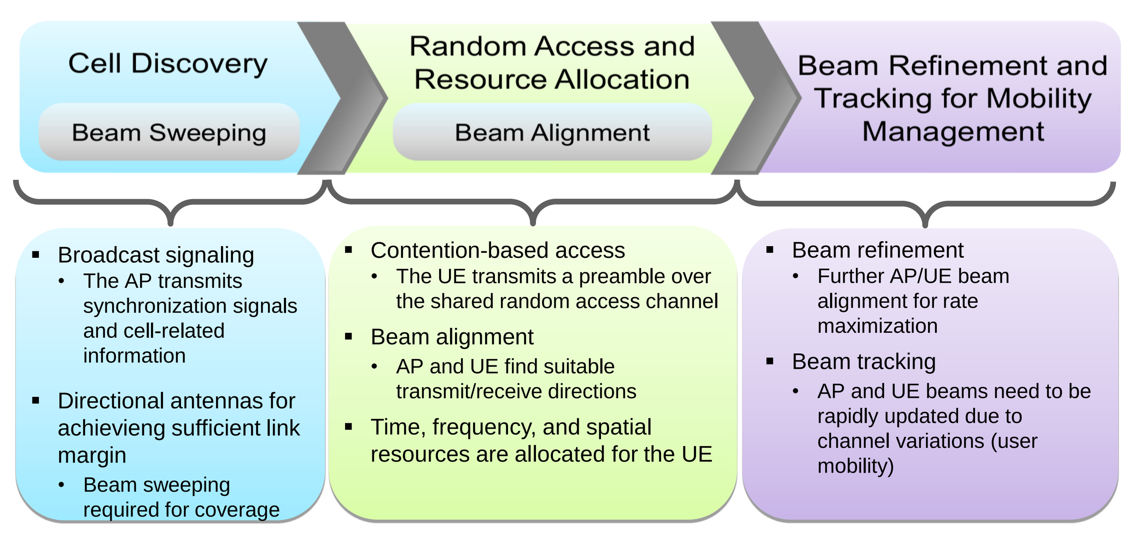


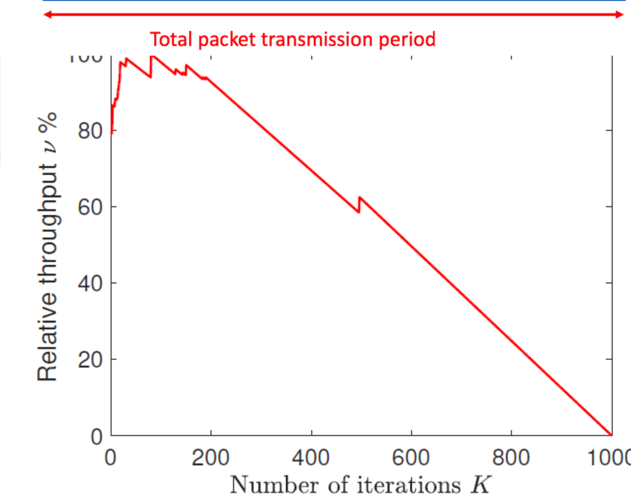
Advisory Board

Selected research results



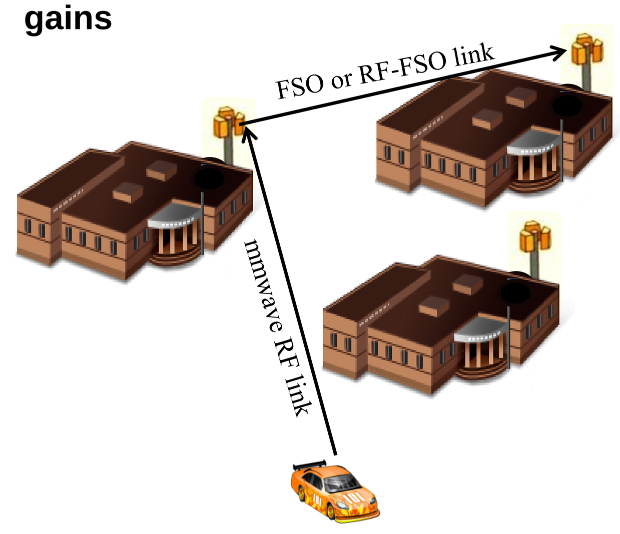


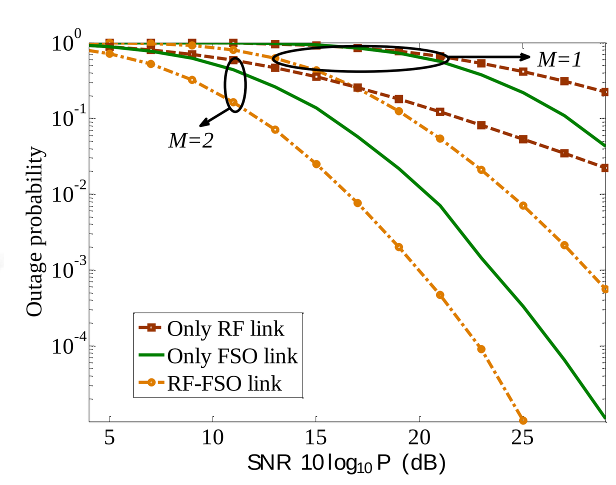




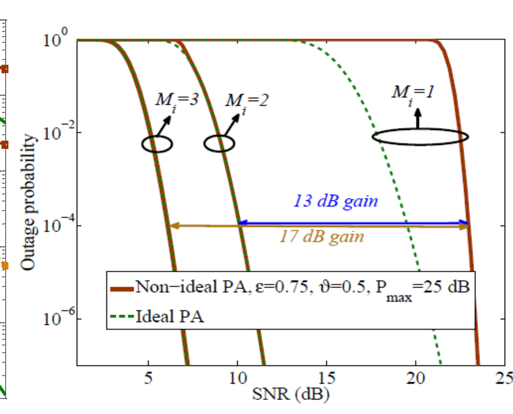
System performance with delay ($\alpha = 0.001$)

Joint RF-FSO with HARQ provides substantial throughput and outage gains



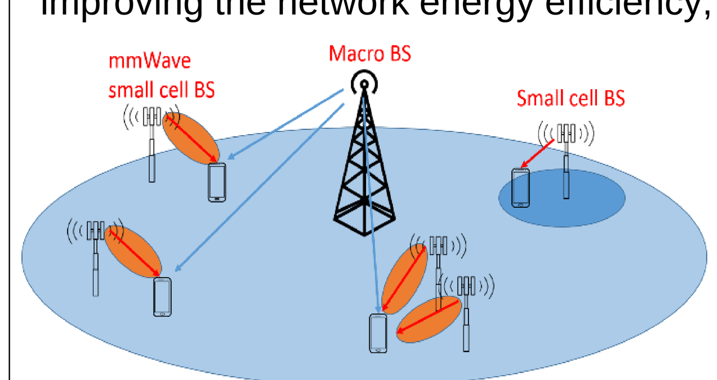


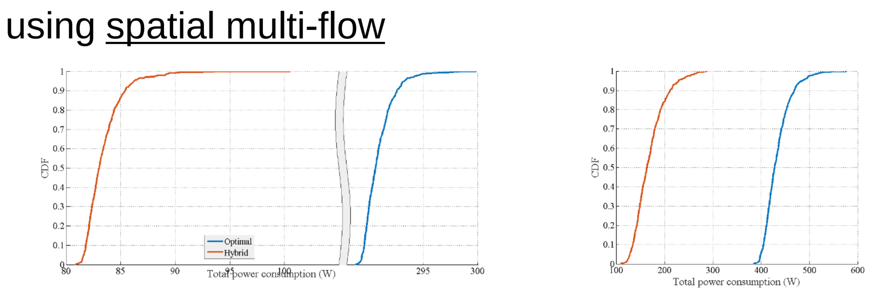
Comparison between the performance of RF, FSO, and RF-FSO based systems. The RF and the FSO links are supposed to follow Rayleigh fading conditions where the path loss exponents follow normalized log-normal distributions. Code rate is 7 bits/s/Hz.



Outage probability for different PA models and number of HARQ-based retransmissions.

Jointly optimization of the multi-node hybrid precoding, load balancing and BS operation modes for improving the network energy efficiency, using spatial multi-flow





CDF of the total power consumption for 3 (left) and two (right) coordinated BSs including the hardware power consumption. The target spectral efficiency is 4 bit/s/Hz.

Multi-node cooperation and coordination is very useful for mm-wave networks, from both beam sweeping, throughput, outage, energy efficiency, load balancing and peak power reduction point of view (EIRP).

Multi-antenna wireless architectures for next-generation wireless systems — MANTUA (2017-2022)

Advanced antenna systems for 5G and beyond mm-wave wireless communication networks

Objectives

- Determine the functionalities of each node in heterogeneous wireless networks towards capacity, coverage, latency, energy efficiency, and reliability
- Develop centralised/decentralised cooperative MIMO techniques.
- Demonstrate the identified solutions on a hardware testbed.

Conclusions

Key technical building blocks have been identified for a mm-wave flexible multi-antenna and multi-node 5G system: Channel models; Hardware impairment models; Waveforms and frame structure; Initial access procedure; Multi-antenna and multi-node techniques

Some observations related to multi-node techniques:

- Advanced initial access techniques are crucial.
- Multi-node cooperation and coordination is very useful for mm-wave networks.
- Hybrid RF-FSO links have a large potential.
- Decode-and-forward relaying can improve the cell edge without sacrificing the spectral efficiency.

Key mmMAGIC final deliverables

- D1.1 Use case characterization, KPIs and preferred suitable frequency ranges for future 5G systems between 6 GHz and 100 GHz, 2015-11-30
- D2.2 Measurement Results and Final mmMAGIC Channel Models, 2017-05-12
- D3.2 Evaluations of the concepts for the 5G architecture and integration 2017-06-30
- D4.2 Final radio interface concepts and evaluations for mm-wave mobile communications 2017-06-30
- D5.2 Final multi-node and multi-antenna transmitter and receiver architectures and schemes 2017-06-30
- D6.6 Final mmMAGIC system concept 2017-07-14

https://5g-mmmagic.eu