SCHEDULING, ROUTING AND QOS IN 5G CELLULAR SYSTEMS

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Motivation

5G cellular networks are expected to provide unprecedented resources to enhance mobile data rates and reduce latency.

On the one hand, communications in the millimeter-wave (mmWave) frequencies (28, 38, 72 GHz) offer vast new bandwidths.

However, the blockage problem of mmWave propagation requires a highly dense deployment of mmWave Base Stations (BSs) for coverage guarantees. This results in a likely multi-hop architecture, which is novel in cellular systems.

On the other hand, current cellular spectrum in below 6 GHz offers wider coverages and is more amenable for in-door located users (UEs).

Therefore, mmWave cellular systems with microWave support may enhance reliability, latency and pave the way to more heterogeneous cellular networks.

Thesis Objectives

The main objective of this thesis is to propose link-scheduling and routing mechanisms for mmWave cellular systems with a multi-hop architecture, including the following aspects:

- ✓ Throughput-Optimality
- ✓ Utility-Maximization
- ✓ Interference
- ✓ Quality-of-Service (QoS)

In addition, coexistence of mmWave and microWave resources in heterogeneous cellular networks must be studied.

Research Plan

1st Year: Throughput and interference management algorithms for mmWave cellular networks.

2nd Year: QoS traffic differentiation algorithms for mmWave cellular networks.

3rd Year: MmWave/microwave coexistence in HetNets

Next Year Planning

- Finalizing current workflow.
- Writing thesis.

Results & Discussions

Journal I (*Published*). We propose a ***fast*** and Throughput-Optimal link scheduling and routing algorithm to ***exploit*** the multi-hop mmWave cellular ***capacity region***. Utility-Optimality is also included via a Dual Congestion Controller at sources. Several ***interference models*** (IF, AI and WI) are proposed for mmWave networks.

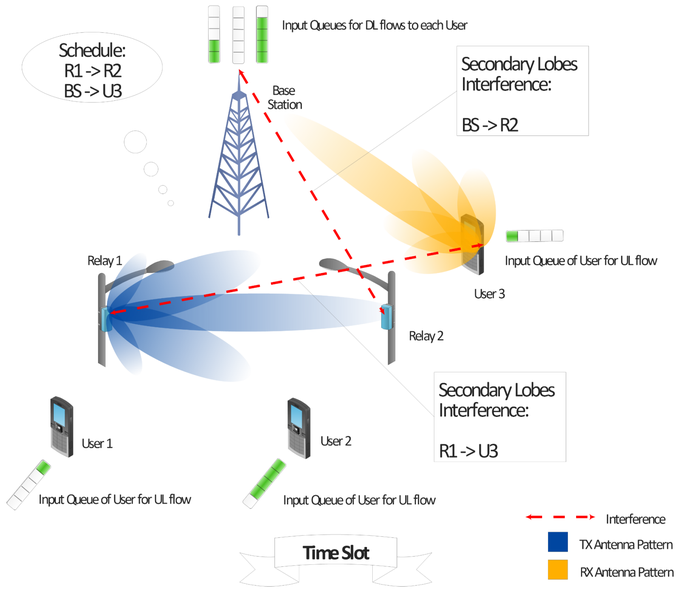
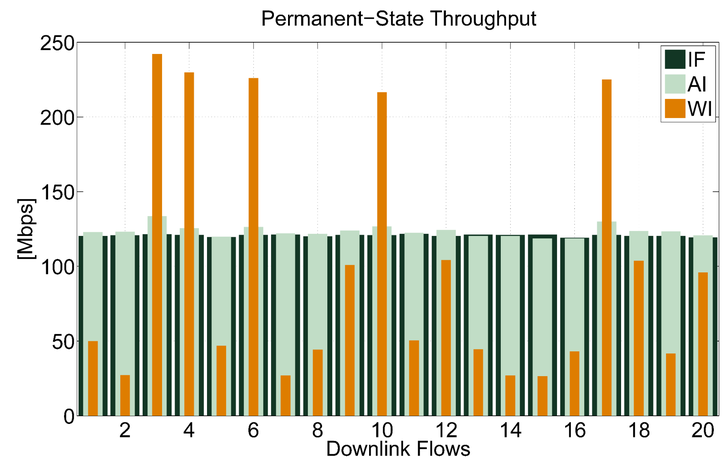
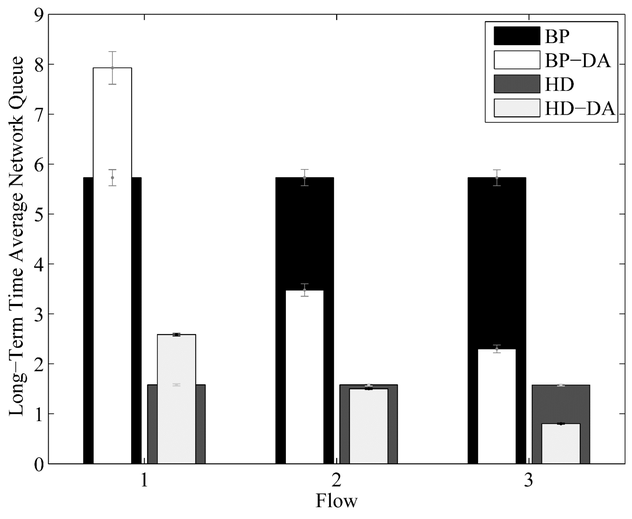


Illustration of a directional multi-hop mmWave celular network

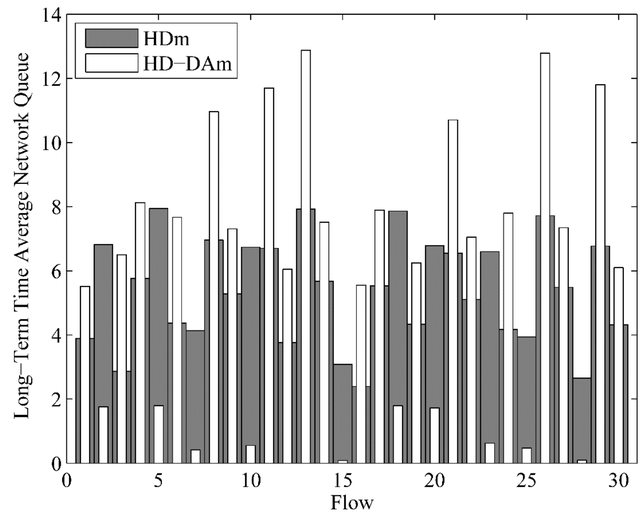


Throughput performance results with three interference models proposed: Actual Interference (AI), Interference-Free (IF) and Worst-Interference (WI)

Journal II (*Submitted*). In this work we define a class of Delay-Aware link scheduling and routing policies, named as DA. We propose an optimization framework for proportional ***flow delay differentiation*** in multi-hop networks. We define BP-DA, BPE-DA and HD-DA algorithms, which are Throughput-Optimal. In addition, HD-DA minimizes Average Network Delay among DA class of policies. Resultant policies are suitable for mmWave networks.



Delay flow differentiation with the proposed DA policies in a line topology



Delay flow differentiation with the proposed HD-DAm policy in a rectangular-grid topology

Conference I (*Accepted*). In this paper we propose an heterogeneous architecture for 5G systems, where ***mmWave*** and ***microWave*** network-slices ***coexist*** and mutually backup each other to enhance network capacity, delay, inter-arrival times and reliability. In addition, traffic splitting is done to efficiently balancing the load among mmWave and microWave interfaces.

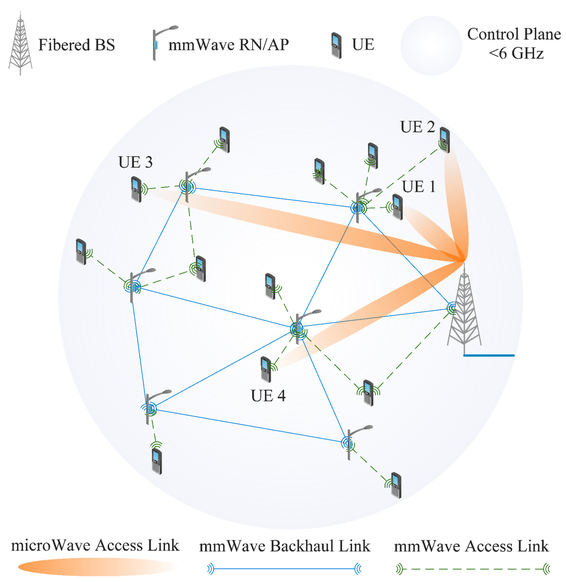
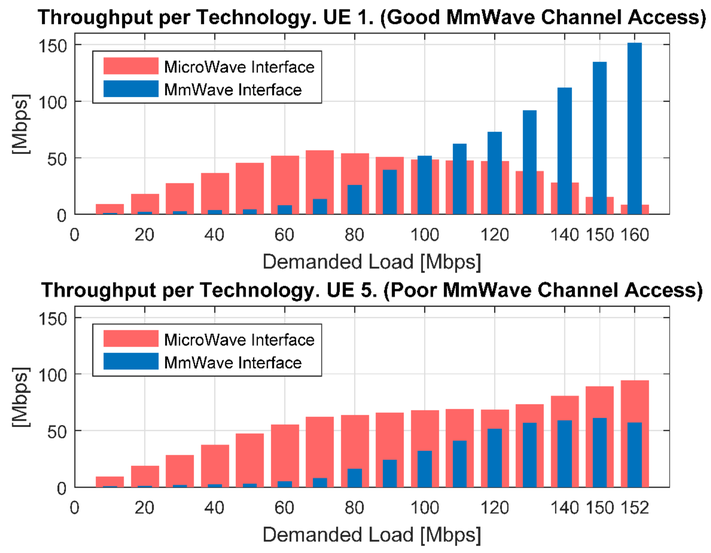


Illustration of the proposed Heterogeneous Cellular Network



Load balancing among mmWave and microWave network slices. The comparison is made between a UE with good mmWave channel and a UE with poor mmWave channel

References

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