**Millimeter Wave MAC Layer Design**

**PIs**: Profs. Rangan, Panwar, Erkip

**Students:** Amir Hosseini (PhD, Panwar), Marco Mezzavilla (Post-doc)

**Introduction of Team:** Marco is a recent PhD from Michele Zorzi’s group at the University of Padova, one of the top researchers in wireless networking. Marco did his PhD in various 3GPP networking issues including detailed simulations in ns3. He has worked with Aleks Damnajovic, Qualcom’s MAC-layer lead. Amir is a third-year PhD student and one of the top students in his year.

**Affiliate Sponsors with direct interest**: All of them (per board meeting). This area was identified by the board as an important target area.

**Overview Research Statement**: The project will study various MAC and network-layer design aspects of 5G mmW systems. Particular focus will be on channelization, HARQ and control structure.

**Research Thrusts and Improvements for NYU WIRELESS:** Key research thrusts will include:

* Frame structure, TTIs and sub-channelization. This is particularly key since it ties into how smaller packets can be supported, whether the system can support multiple access, lower bandwidth mobiles (for reduced power consumption) and HARQ buffers. The use of HARQ and its association with computational cost will also be considered.
* Assignment and control channels: This issue is relatively understudied, but especially challenging in the mmW range since it requires transmissions of large number of small control messages to large numbers of users. This sort of broadcast transmission is difficult since it requires that the base station transmit in multiple directions, which is impossible in conventional analog beamforming. Hybrid analog-digital and low-rate fully digital transmission schemes will be considered.
* Support for relaying and multi-hop: We will consider a largely symmetric link structure so that relays, base stations and mobiles can all dynamically access sub-frames / TTIs using a harmonized frame structure.

The goal of the research is initially explore potential designs via simple MATLAB simulations. Then, we will develop a complete ns3 model where we can validate the design with real traffic patterns which will be particularly important to test such effects as packet size and multi-access latency. We will leverage Marco’s ns3 experience for this.

**Existing support and additional justification for the Project**: Amir is currently funded through NSF. Marco is being funded partially via CATT funds.

**Justification for this project :** There are several key motivations for this project:

* Preliminary literature survey by Marco suggested that there is still available publicly on the subject – most work has still focused on channel modeling and PHY-layer aspects. Thus, there is a potential to write significant papers in the subject.
* The themes in the proposal – such as how channels are designed – generally become the essential IP for standards, so there is enormous potential for patents. In contrasts, algorithmic and architectural patents that generally go in the PHY-layer are much less valuable.
* We expect that the MAC-layer design can guide the prototype development. In fact, we are already in collaboration with NI to implement a potential design.