INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**Arijit Bhattacharjee**
Roll Number	:	**156102012**
Programme of Study	:	**Ph.D.**

Thesis Title: **INVESTIGATION ON CERTAIN ISSUES RELATED TO DEVELOPMENT OF NEXT-GENERATION BROADBAND WIRELESS NETWORKS**

Name of Thesis Supervisor(s)	:	**Prof. Sanjay Kumar Bose & Prof. Ratnajit Bhattacharjee**
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SHORT ABSTRACT

The day-by-day increasing popularity of mobile phones, wearable devices, and other such personal wireless devices has resulted in a huge surge in user-generated data. This trend has been augmented further by the inclusion of new technologies, services, and applications centered on wireless systems. As a result, the expectations from the mobile networks to cater to the new services and traffic conditions are also rising at an equally concerning rate. To tackle this crisis, researchers from academia and industry are looking for ways to improve the existing network capacities by enhancing the current technologies. The challenge is not just limited to upgrading the existing network capabilities but also to ramp up their link-level capacity and augmenting them in providing reliable last-mile connectivity. For this reason, the need for high-capacity wireless links has become particularly significant owing to the prominence of high data-rate enhanced multimedia broadband (eMBB) applications like HD videos, gaming, and Internet-of-Things (IoT) in the overall share of network usage. However, supporting these applications using the existing commercial communication spectrum seems unlikely, as these bands are already congested, and there is hardly any scope for capacity improvement. Therefore, the prospect of communication using the millimeter-wave (mmWave) bands ranging from 30 GHz to 300 GHz frequencies has been explored thoroughly. Due to their large bandwidths and cheap spectrum costs, these frequencies are considered ideal for supporting the eMBB services and other high data-rate applications.

Unfortunately, the adverse wave-propagation characteristics in these bands and the related medium-access-control (MAC)-layer problems of beam-blockage and poor mobility support render these systems unreliable and untenable for commercial usage. These problems also lead to several incompatibility issues with respect to the existing MAC-layer standards. Since reliable mmWave access networks are also a prerequisite for the successful roll-out of the next generation (5G) networks, this becomes a technological bottleneck. Hence, in consideration of all these factors, this thesis identifies various issues which lead to unreliable and inefficient operation of mmWave systems and aims to provide robust solutions. To this end, the thesis focuses on three types of challenges: The first limitation concerns

the issue of beam blockage that causes unreliable connectivity. For this, the thesis presents various low-cost (low CAPEX, OPEX) solutions based on the MAC layer. These solutions leverage the technique of control delegation to dynamically operate an access point from different vantage points and alleviate the blockage scenario of the network. By using this, two types of delegation approaches have been presented. The first one uses a fixed set of rules to take the delegation decisions, whereas the second approach uses a discrete-time Markov-decision-process (DT-MDP) model to dynamically determine the delegation policy.

In the second area of focus, the thesis discusses the issue of high infrastructure requirements for mmWave systems that operate using the multi-link-connectivity (MLC) architecture. To alleviate this problem, various device-centric dynamic-link-level-redundancy (DC-DLLR) approaches (and their supportive network architecture) are presented to reduce their CAPEX and OPEX requirements.

Finally, in the third area of focus, the issue of blockage-induced anomalous resource allocation is discussed for a class of mmWave networks that operate under the simultaneously-operating-piconet (SOP) configuration (a form of MLC architecture). To address this, the thesis presents a feedback-driven (reactive) approach and a portfolio-theory-based risk-sensitive approach for resource allocation that would enable network operators to allocate resources more efficiently and robustly.