Preface

The increased demand for wireless broadband communication has led to the rapid development of various communication technologies. In recent years, an emerging competitive technology, called High Altitude Platform (HAP), has attracted considerable attention for providing wireless broadband communications and other services. HAP based communication systems have been deployed for testing its delivery capability under various projects, all over the world.

HAP is an aerial platform which can either be an airplane or an airship, operating at an altitude $17 - 22km$. HAPs have been demonstrated to have capability to deliver wireless broadband as well as mobile communication services at competitive investments. HAP has been suggested by International Telecommunication Union (ITU) to provide telecommunication services such as 3G - Worldwide Interoperability Microwave Access (WiMAX), 4G - Long Term Evolution-Advance (LTE - A) etc.. ITU has also considered HAP as the third layer after terrestrial and satellite systems for implementing efficient mobile communication system for its use in 5G networks. Considering the wide area coverage and competitive cost of deployment, HAPs have also been recommended for its use to provide telecommunication services in areas with low population/ mobile user density.

In mobile wireless communication technologies, Quality of Service (QoS) is a measurable quotient of service(s) delivered to its subscribers by the service provider. Delivery of higher QoS can be achieved by using HAPs while providing mobile communication services in an urban or suburban area. HAP can also be integrated to coexist with terrestrial and satellite based communication systems for achieving higher quotients of QoS.

In this thesis, various HAP based techniques and algorithms especially hand-off technique, channel reservation technique and call admission control (CAC) technique have been investigated. The indicator parameters of QoS namely Carrier Interference to Noise Ratio (CINR), Interference to Noise Ratio (INR), Receive Signal Strength (RSS), delay and bandwidth utilization etc. have been considered for improvement by using our proposed algorithms and techniques.

In this thesis, HAP has been considered as a coexisting layer in terrestrial mobile communication system to provide seamless connectivity in shadow zones under terrestrial mobile coverage. Coexistence of HAP and WiMAX has been established in a heterogeneous radio environment by following spectrum etiquettes.

Accordingly, in our first contribution, we have augmented the hand-off procedures between HAP and terrestrial system with superior decision making by using additional control parameters and the Artificial Neural Network (ANN). It has been reported that the proposed ANN based scheme can significantly reduce the rate of call drops during hand-offs.

In our second contribution, call blocking and call dropping have been reduced by using a novel channel reservation technique, both for the new call and the hand-off call requests. Here, exclusive channel reservations have been proposed both for new calls as well as for hand-off calls. It has been reported that our proposed technique can significantly reduce the probability of call blocking Pcb and probability of call dropping Pcd.

Further, for our third contribution, we have considered four types of service classes belonging to two types of user classes i.e. high/ low priority user:

(i) Unsolicited Grant Services (UGS) – as high priority users,

(ii) real time Polling Service (rtPS) – low priority users,

(iii) non-real time Polling Service (nrtPS) - low priority users and

(iv) Best Effort (BE) – low priority

We observed that 'bandwidth reservation' scheme and 'bandwidth degradation scheme' can be augmented through real-time channel state information obtained from the CAC, to manage and regulate incoming and outgoing calls. Here, different bandwidths can be reserved according to the priority for each type of service category. Further, bandwidth degradation scheme can be used to create extra channels for use in a higher priority category by degrading the channel bandwidth of lower priority user category.

Accordingly, in our third contribution, it has been reported that by using our proposed 'Policy integration with CAC' technique, Pcb and Pcd can be enhanced along with significantly improved bandwidth utilization.

Formally, this thesis has been organized in six chapters. The chapter wise highlights have been described as below:

Chapter- I introduces the mobile wireless communication technologies and recent advances. QoS has been discussed for various advance mobile technologies. The possibility of enhancement the performance of advance mobile wireless technologies by using coexistence of various communication systems has also been discussed.

Chapter-II introduces the HAP system, in brief, along with its history of evolution, developments, network architecture, coverage, spectrum allocations and applications. Various aspects have been discussed to establish the benefit of HAP over terrestrial and satellite systems. This is followed by review of relevant research which has been carried out in the recent past. In the concluding part of

this chapter, the objectives of this thesis, our research approach and structure of the write-up has been described.

Chapter-III discusses the hand-off procedure between HAP and terrestrial communication system under coexisting scenario. It is shown that by using HAPs, we can cover the existing shadow zones in a terrestrial mobile communication system and avoid service interruption. We have discussed spectrum etiquettes for harmonious coexistence of HAP in a heterogeneous radio environment and certain additional recommendations have also been reported. These recommendations have also been evaluated under coexistent scenario of HAP and WiMAX to provide wireless broadband and mobile communication services. It also discusses the vertical and horizontal HAP movements and its effects on the coverage area. The effect of HAP's antenna radiation patterns have also been studied.

We have therefore proposed an algorithm for efficient hand-off between HAPs and terrestrial mobile communication systems by using Artificial Neural Networks (ANN). The results show significant reduction in the rate of unnecessary hand-off.

Chapter-IV considers different techniques of channel allocation and channel reservation. The concept of Poisson distribution has been discussed with help of Markov chain to measure the probability of call blocking and call dropping.

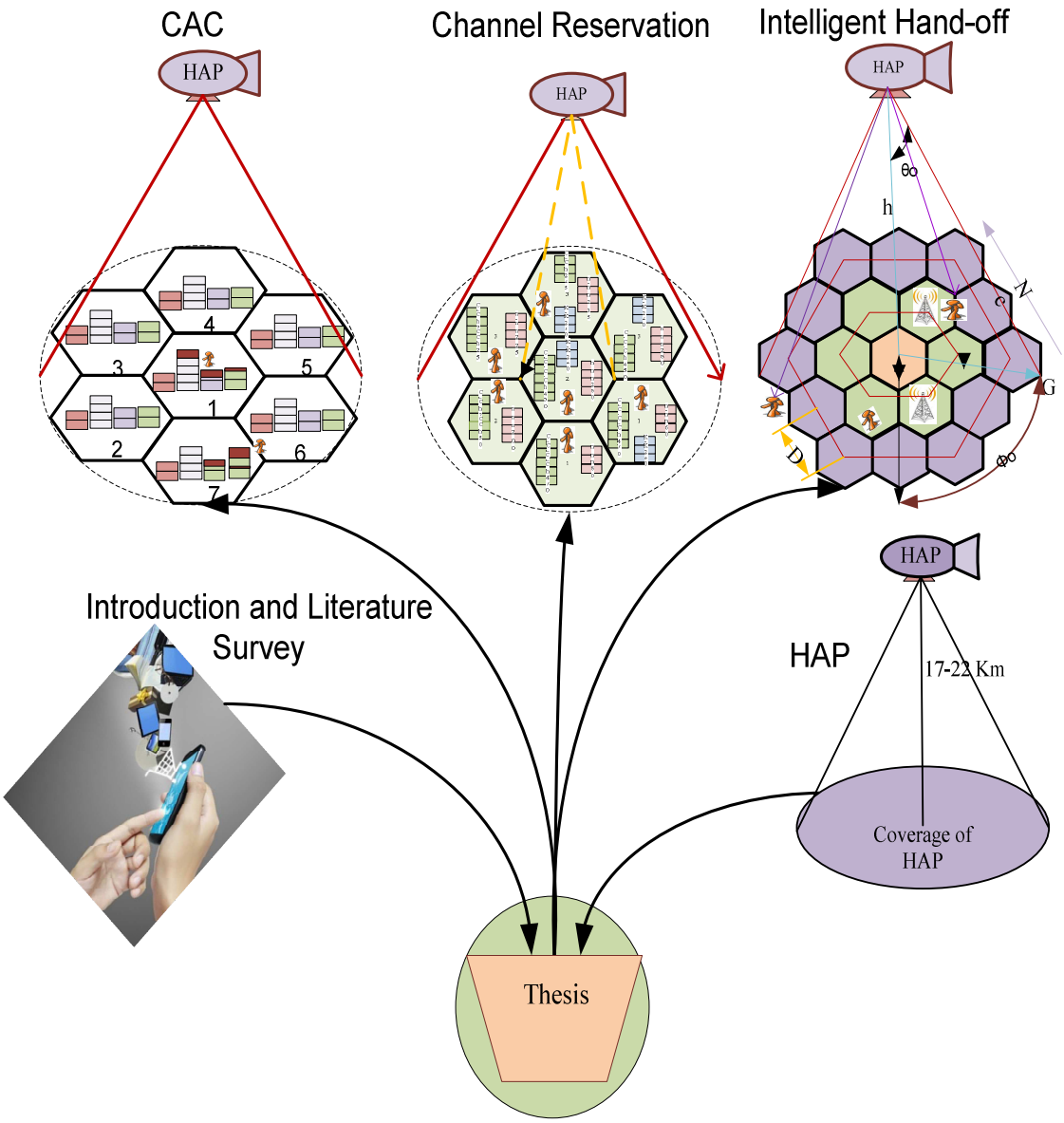
Consequently, a novel algorithm for channel reservation technique, both for new call and hand-off call requests has been proposed.

Chapter-V gives an insight into the CAC technique. It describes how an analytical model can be developed by using Markov chain model for performance evaluation. It also discusses the bandwidth reservation and bandwidth degradation

schemes. It gives the detailed description of the proposed CAC technique, which mainly focuses on achieving high bandwidth utilization with guaranteed QoS.

Consequently, a novel algorithm ‘bandwidth reservation’ scheme and ‘bandwidth degradation scheme’ can be augmented through real-time channel state information obtained from the CAC, has been proposed to manage and regulate incoming and outgoing calls.

Finally, Chapter - VI summarizes the work carried out in this thesis followed by the conclusions which we have drawn from the contributions we have made in this doctoral work. Scope of future work has also been proposed for delivering higher quotient of QoS by using HAP augmented mobile communication services as proposed in this doctoral work.



Thesis Structure

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