BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FOR ADVANCED STUDIES & RESEARCH, BUET, DHAKA

(Thesis Proposal)

Date: September 24, 2016

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   Status: Part-time
   Session: October, 2014
2. **Present Address:** Room No. 420, Dept. of CSE, BUET, DHAKA.
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3. **Name of the Department:** Computer Science and Engineering
   Programme: M.Sc. Engineering
4. **Name of the Supervisor:** A. B. M. Alim Al Islam
   Cell No.: +8801817533953
   Designation: Assistant Professor, Dept. of CSE, BUET.
5. **Name of the Co- Supervisor:** Not Applicable
   Designation: Not Applicable
6. **Date of First Enrolment in the Programme:** Novermber 1, 2014
7. **Tentative Title:** OVERCOMING THROUGHPUT DEGRADATION IN MULTI-RADIO COGNITIVE RADIO NETWORKS.
8. **Background and present state of the problem:**
   The famous spectrum scarcity problem along with significant spectrum under-utilization in traditional spectrum management has lead towards the notion of opportunistically dynamic spectrum access [1] through cognitive radios [2]. Cognitive Radio Networks (CRNs) generally exploit the capabilities of cognitive radios in presence of two types of users - Primary Users (PUs), i.e., licensed users, and Secondary Users (SUs), i.e., the unlicensed users employing cognitive radios [3, 4]. On the other hand, classical wireless networks frequently adopt the notion of deploying multiple radios [5, 6] to improve performance of the networks [5, 7, 8, 9]. Consequently, it is intuitive that simultaneous utilization of both these techniques, i.e., multi-radio CRNs, will result in significantly improved network performance. Such multi-radio deployment on CRNs improves end-to-end delay up to a certain point, however, throughput degrades with an increase in the number of radios per secondary user [10]. Therefore, the main motivation behind the study is to investigate how to overcome the already-known phenomena of getting degraded network throughput while equipping secondary users with multiple radios.
9. **Objectives with specific aims and possible outcome:**
   The main objectives of the study are as follows:

   i. The first objective of the study is to propose a new approach for multi-radio CRNs that can improve network throughput through exploitation of the multiple radios.
   ii. The second objective is to evaluate performance of the proposed approach through experimentation.
   iii. The third objective is to compare performance of the proposed approach with that of other contemporary approaches.

   The possible outcomes of the study are as follows:

   i. A feedback-based multi-radio exploitation approach for CRNs where information obtained from lower layers (Physical layer and Data Link layer) will be incorporated in the process of decision making in an upper layer (Application layer).
   ii. An evaluation of the performance of the proposed approach using discrete event simulation through CRE-NS3 [11].
   iii. A comparison of performance of the proposed approach against that of the existing approaches available in the literatures for multi-radio CRNs.

10. Outline of Methodology/ Experimental Design:

Outline of the proposed methodology and experimentation can be summarized in the following steps:

1. First, a feedback-based approach for multi-radio CRNs will be proposed. In the proposed approach, packet delivery ratio for each radio will be measured to evaluate their individual performance, channel utilization ratio for each channel will be calculated, and finally, the data rate for each radio will be set based on these measurements to maximize the throughput.
2. Then, modifications in CRE-NS3 simulator required for implementation of the proposed approach will be performed as current version of the simulator does not support the model.
3. Next, multi-radio CRNs using the developed module will be simulated and the performance of the network will be investigated. Here, operational parameters of the proposed approach will be varied and sensitivity of changing the parameters' values will be evaluated.
4. Then, the following performance metrics obtained through the proposed approach will be compared against that of the existing approaches.
    i. Average network throughput,
    ii. Per node average throughput,
    iii. Average end-to-end delay,
    iv. Average packet loss.
5. Finally, various properties of the proposed approach will be investigated, findings of the study will be discussed, and open issues of the study will be highlighted as future directions.

11. References:

[1] Akyildiz, I. F., Lee, W.-Y., Vuran, M. C., and Mohanty, S., "Next generation/dynamic spectrum access/cognitive radio wireless networks: a survey," *Computer Networks*, vol. 50, no. 13, pp. 2127–2159, 2006.

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[3] Pelechrinis, K., Krishnamurthy, P., Weiss, M., and Znati, T., "Cognitive radio networks: realistic or not?," *ACM SIGCOMM Computer Communication Review*, vol. 43, no. 2, pp. 44–51, 2013.

[4] Zhang, Y., Zheng, J., and Chen, H.-H., *Cognitive radio networks: architectures, protocols, and standards*. CRC press, 2016.

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[6] Adya, A., Bahl, P., Padhye, J., Wolman, A., and Zhou, L., "A multi-radio unification protocol for ieee 802.11 wireless networks," in *Broadband Networks, 2004. BroadNets 2004. Proceedings. First International Conference on*, pp. 344–354, IEEE, 2004.

[7] Draves, R., Padhye, J., and Zill, B., "Routing in multi-radio, multi-hop wireless mesh networks," in *Proceedings of the 10th annual international conference on Mobile computing and networking*, pp. 114–128, ACM, 2004.

[8] Miu, A., Balakrishnan, H., and Koksal, C. E., "Improving loss resilience with multi-radio diversity in wireless networks," in *Proceedings of the 11th annual international conference on Mobile computing and networking*, pp. 16–30, ACM, 2005.

[9] Song, W. and Zhuang, W., "Performance analysis of probabilistic multipath transmission of video streaming traffic over multi-radio wireless devices," *Wireless Communications, IEEE Transactions on*, vol. 11, no. 4, pp. 1554–1564, 2012.

[10] Khan, T. A., Hyder, C. S., and Islam, A., "Towards exploiting a synergy between cognitive and multi-radio networking," in *Wireless and Mobile Computing, Networking and Communications (WiMob), 2015 IEEE 11th International Conference on*, pp. 370–377, IEEE, 2015.

[11] Al-Ali, A. and Chowdhury, K., "Simulating dynamic spectrum access using ns-3 for wireless networks in smart environments," in *Sensing, Communication, and Networking Workshops (SECON Workshops), 2014 Eleventh Annual IEEE International Conference on*, pp. 28–33, IEEE, 2014.

12. List of courses taken:

Course No	Course Name	Credit	Grade	Grade Point	G.P.A
CSE 6806	Wireless and Mobile Communication Networks	3.0	A+	4.0	3.75
CSE 6813	Network Security	3.0	A+	4.0	
CSE 6402	Graph Theory	3.0	B	2.5	
CSE 6602	High Dimensional Data Management	3.0	A+	4.0	
CSE 6506	Data Mining	3.0	A+	4.0	
CSE 6811	Wireless Ad Hoc Networks	3.0	A+	4.0	
CSE 6000	Thesis	18.0	–	–	

Signature of the Tabulator: _____

13. Cost Estimate:

(a) Cost of Materials:

a. Ink Cartridge: Tk.: 4000/=

Total: Tk.: 4000/=

(b) Field works: Not applicable.

(c) Conveyance/Data Collection: Not applicable.

(d) Research finding outreach: Tk.: 50,000/=

(e) Typing, Drafting, Binding, & Paper etc.:

a. Drafting: Tk.: 1250/=

b. Binding: Tk.: 1250/=

c. Paper: Tk.: 1500/=

Total: Tk.: 4000/=

Grand Total: Tk.: 58,000/=

14. Approximate time (in hour) for BUET workshop facilities (if required): Not applicable

15. Justification of having Co-Supervisor: Not applicable

16. Doctoral Committee/BPGS/RAC reference:
Meeting No.: BPGS-2016/10 **Resolution No.:** 4 **Date:** July 26, 2016.

17. Time Extension(if any) up to: Not applicable
Approved by the CASR **Resolution No.:** Not applicable **Date:** Not applicable
Meeting No.: Not applicable

18. Appointment of Supervisor & Co-Supervisor Approved by the CASR Meeting No. (For Ph. D): Not applicable
Resolution No.: Not applicable **Date:** Not applicable

19. Appointment of Doctoral Committee Approved by the CASR Meeting No. (For Ph. D): Not applicable
Resolution No.: Not applicable **Date:** Not applicable

20. Result of the comprehensive examination for Ph. D.: Not applicable

21. Number of Post-Graduate Students working with the Supervisor at Present: M.Sc. (21), Ph.D. (3)

Names and signatures of the members of the Doctoral Committee (if applicable)

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Signature of the Student

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Signature of the Supervisor

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Signature of the Head/Director