Project II: Cognitive Radio Network Protocols v1.0

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Project II

- Propose, develop and simulate a new idea (or improvement on existing idea) in the field of cognitive radio networks.
- The idea can be related to sensing, spectrum allocation, or combination of both.
- These will be of consideration: Originality and novelty of the idea, implementation details in the simulator, performance results, progress, perseverance and teamwork.

First Presentation

- Papers you have read.
- What are the main references.
- Narrow the topic you want to pursue.
- Develop a good understanding of the topic.
- Improve your presentation skills.

First Slide(s)

- [1] K. J. Prabuchandran, S. K. Meena, and S. Bhatnagar, "Q-learning based energy management policies for a single sensor node with finite buffer," IEEE Wireless Commun. Lett., vol. 2, no. 1, pp. 82–85, Feb. 2013.
- [2] Y. Mao, G. Yu, and C. Zhong, "Energy consumption analysis of energy harvesting systems with power grid," IEEE Wireless Commun. Lett., vol. 2, no. 6, pp. 611–614, Dec. 2013.
- [3] J. Lei, R. Yates, and L. Greenstein, "A generic model for optimizing single-hop transmission policy of replenishable sensors," IEEE Trans. Wireless Commun., vol. 8, no. 2, pp. 547–551, Feb. 2009.
- [4] P. Blasco, D. Gunduz, and M. Dohler, "A learning theoretic approach to energy harvesting communication system optimization," IEEE Trans. Wireless Commun., vol. 12, no. 4, pp. 1872–1882, Apr. 2013.
- [5] S. Mao, M. H. Cheung, and V. W. S. Wong, "An optimal energy allocation algorithm for energy harvesting wireless sensor networks," in Proc. IEEE Int. Conf. Commun., 2012, pp. 265–270.
- [6] M. Kashef and A. Ephremides, "Optimal packet scheduling for energy harvesting sources on time varying wireless channels," J. Commun. Netw., vol. 14, no. 2, pp. 121–129, Apr. 2012.
- [7] Z. Wang, A. Tajer, and X. Wang, "Communication of energy harvesting tags," IEEE Trans. Commun., vol. 60, no. 4, pp. 1159–1166, Apr. 2012.
- [8] H. Li, N. Jaggi, and B. Sikdar, "Cooperative relay scheduling under partial state information in energy harvesting sensor networks," in Proc. IEEE Global Commun. Conf., 2010, pp. 1–5.
- **[9] N. Michelusi, K. Stamatiou, and M. Zorzi, "Transmission policies for energy harvesting sensors with time-correlated energy supply," IEEE Trans. Commun., vol. 61, no. 7, pp. 2988–3001, Jul. 2013.**
- [10] A. Seyedi and B. Sikdar, "Energy efficient transmission strategies for body sensor networks with energy harvesting," IEEE Trans. Commun., vol. 58, no. 7, pp. 2116–2126, Jul. 2010.
- [11] S. Zhang, A. Seyedi, and B. Sikdar, "An analytical approach to the design of energy harvesting wireless sensor nodes," IEEE Trans. Wireless Commun., vol. 12, no. 8, pp. 4010–4024, Aug. 2013.
- [12] N. Michelusi, L. Badia, and M. Zorzi, "Optimal transmission policies for energy harvesting devices with limited state-of-charge knowledge," IEEE Trans. Commun., vol. 62, no. 11, pp. 3969–3982, Nov. 2014.

Second Slide: Journal Paper

5G: Adaptable Networks Enabled by Versatile Radio Access Technologies

Conor Sexton, *Student Member, IEEE*, Nicholas Kaminski, *Member, IEEE*, Johann M. Marquez-Barja, *Senior Member, IEEE*, Nicola Marchetti, *Senior Member, IEEE*, and Luiz A. DaSilva, *Fellow, IEEE*

***Abstract*—The requirements and key areas for 5G are gradually becoming more apparent, and it is becoming clear that 5G will need to be able to deal with increased levels of diversity in both the requirements it must fulfil and the technologies that it uses to fulfil them. The diverse and demanding requirements for 5G necessitate a shift away from the rigid networks of previous generations, towards a more versatile and adaptable network. Essential to enabling this level of adaptability in 5G networks will be the new radio access technologies that are employed. In previous generations, the radio access network (RAN) was comprised of technologies and techniques that were tailored to satisfy the killer application of that era. In contrast, 5G will require versatile solutions that can be adapted to satisfy many different services and applications. The core network will also undergo fundamental changes, with increased levels of abstraction allowing for further reconfiguration of the network. The relationship between the RAN and core network will have a key role to play in managing and enabling adaptable networks. In this paper, we survey the choices and adaptability afforded by some of the radio access technologies being considered for 5G and explore how several system-level techniques, such as software-defined networking and cloud-RAN, can be utilised to enable and manage versatile 5G networks. Specifically, we focus on the relationship between new radio access technologies and emerging system-level techniques, examining how they may assist and complement each other. In this regard, we examine some tools such as virtualization and cognitive networks that can bridge this relationship. This paper is not intended to be a general survey on 5G, but rather a survey on how the requirements of flexibility** characterised by greater versatility and adaptability of radio access technologies (RAT) and system-level architectures that cooperate with one another to cater to diverse service requirements.

In previous generation increments, the primary focus was on increased data rates. Although the need for increased data rates retains its relevance as we progress towards 5G, the requirements for 5G are far more multifaceted than anything before [1]–[3]. New services such as high definition video, traffic safety, e-Health, and automated industry have diverse and often conflicting needs. The myriad of services to be supported can be categorized into three primary areas, which are currently the focus of 3GPP:

1) enhanced Mobile Broadband,
2) massive Machine Type Communications,
3) ultra-reliable low latency communications.

Each area presents different requirements to the network in terms of data-rate, latency, reliability, and energy efficiency. 5G networks may need to be able to handle a 1000x increase in current traffic volumes, provide a 100x increase in the edge data rate, support a latency in the region of 1ms, provide ultra-high reliability and availability, all the while reducing or at least maintaining current energy consumption and costs.

It is difficult to design a network capable of fulfilling all of these service requirements simultaneously. Therefore, unlike previous generations, which were primarily defined by their

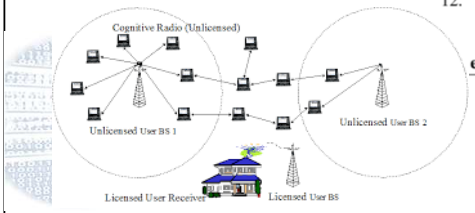
Second Presentation

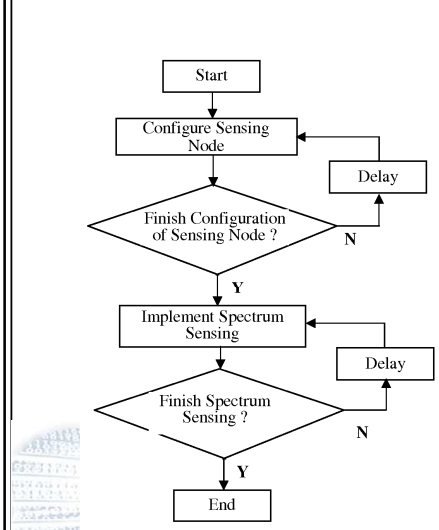
- Your idea
- Illustrations
- Equations
- Flowcharts
- Pseudo-code

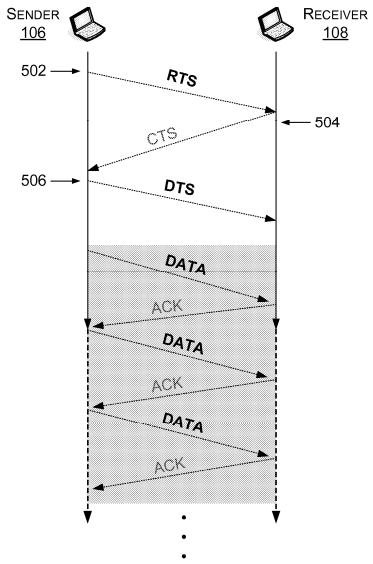
Algorithm: *Leaving band* by BS n at slot $\hat{t}$

1. **Identify** successful bands during slot $\hat{t}$ (set $\mathcal{S}_{\hat{t}}$)
2. **if** $\Lambda_n(\hat{t}) \geq 1$ **then**
3. Do not leave any bands
4. $W_n \leftarrow w \times \tau$
5. **else** /* $\Lambda_n(\hat{t}) < 1$ */
6. **With** probability $L_n(\hat{t}) = \min\left(s_n(\hat{t})/\hat{S}_n, 1\right)$
7. $\nabla_{\hat{t}} \leftarrow \min_{\forall m \in \mathcal{S}_{\hat{t}}} \delta_n^m(\hat{t})$ /* least success */
8. Candidates $\mathcal{B} \leftarrow \{m : m \in \mathcal{S}_{\hat{t}} \wedge \delta_n^m(t) = \nabla_{\hat{t}}\}$
9. **Leave** most recently acquired band B from $\mathcal{B}$
10. $W_n \leftarrow \left\lceil 1 + a_d \times s_n(\hat{t})/\hat{S}_n \right\rceil \times w \times \tau$
11. **else**
12. Do not leave any bands
    $W_n \leftarrow w \times \tau$
    end

end







Presentations

- All team members should attend.
- No discussion inside the class.
- 2 minutes: Announcements (if any)
- Per team (11 minutes):
  - 1 minute setup ppt on laptop
  - 6 minutes presentation (rehearse; 6-7 slides)
  - 4 minutes Q & A
- Any one can participate.

Notes

- Each week one team member presents (rotation).
- Do not exceed your allocated time to allow other teams their chance.
- Will use a timer!
- More discussion can be had in office hours.
- Meet with your team mates regularly (not on presentation day).

PPT Cover Letter

- Title: The best project EVER!
- Team #: 7
- Team Members:
- Mohammed Ali 0153412
- **Abed Alrahaman Ahmad 0142265**
- Othman Sedo 2146452

