

CS 6480: Paper reading summary

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1 FlexRAN: A Flexible and Programmable platform for Software-Defined Radio Access Networks

Paper discussed in this summary is “FlexRAN: A Flexible and Programmable platform for Software-Defined Radio Access Networks” [2].

1.1 First pass information

1. *Category:*

This paper is a description of a research prototype. The research prototype being discussed is FlexRAN. FlexRAN is the worlds first open-source SD-RAN platform. And in this paper we dive into the implementation and mechanics of FlexRAN.

2. *Context:*

The technical area of this paper relates to Radio Access Networks (RAN). In fact we also touch onto elements of NFV [4] and 5G [3].

3. *Assumptions:*

They assume that they are the first Open source RAN platform. I’m actually not familiar with RAN. so I can’t say for sure if FlexRAN is the first. Furthermore, they assume that SDN is

highly needed to manage a lot of time requirements for 5G. I think the assumption is true as far as saying that SDN can add more to RAN but it is still up to the user to define how SDN can be used to improve RAN.

4. *Contributions:*

The authors of this paper have a bulleted list of contributions. First, they contribute by creating FlexRAN which incorporates an API for clean separation of control and data planes. They also contribute by implementing FlexRAN over the OpenAirInterface LTE platform. And lastly, they show results from using FlexRAN in a diverse set of use cases relevant to current and future mobile networks.

5. *Clarity:*

From what I have read this paper is written well and appears to be professional.

1.2 Second pass information

• *Summary:*

FlexRAN at the time of its creation was the world’s first open-source SD-RAN. FlexRAN incorporates an API to separate the control and data planes. It offers programmability at two levels, one in the form of RAN control and management applications that can be built over the FlexRAN controller and the other within the

controller to be able to upgrade the implementation of any control function in real time. Furthermore, FlexRAN is transparent to UEs. For FlexRAN, eNodeBs only handle the data plane to perform all the action-related functions. The northbound API, allows RAN control and management applications to modify the state of the network infrastructure. While the southbound API is the primary enabler for SDN control of the RAN. To allow flexible and programmable control of the RAN, the FlexRAN agent provides multiple eNodeB control modules. Each module controls subsystems targeting a specific area of control. Without going to much into detail FlexRAN uses more CPU utilization and memory than that compared to OAI. However, both FlexRAN and OAI experienced the same service quality. Lastly, FlexRAN proves to a useful tool for the SD-RAN platform.

1.3 Third pass information

- *Strengths:*

I liked the abstract and introduction because they do good job of explaining RAN and why most SD-RAN platforms out there do not really help or are physically built to make RAN better. The overall format of this paper was well done. I especially enjoyed the little overview section at the beginning that prepped me for the in-depth FlexRAN. Another strength was the system evaluation section, I thought it was very thoughtful they they included the specs of machines used for their evaluation. FlexRAN use cases bring up an interesting and applicable solutions for SD-RAN. I think it's a great idea for them to take into account what SD-RAN could do, however, this might not be the right paper for this.

- *Weaknesses:*

Although the introduction was a nicely written section, I felt that their contributions at the end of the section were weak. They didn't really feel like contributions, in fact it felt like they were simply describing the future sections of the paper. I think it's a bit of a stretch to envision an

online VSF store similar to mobile app stores, given that VSF are an inherently important aspect of the FlexRAN system. Another thing I didn't like in this paper was the Extending OpenAirInterface with FlexRAN section, it didn't really contribute to the paper, but rather felt like a self-praise by the authors who had to write 10,000 lines of code to integrate FlexRAN into OAI. I do have to say that their evaluation section was a bit weak, and short compared to the build up of introducing FlexRAN and the design behind FlexRAN.

- *Questions:*

I'm not sure what pub/sub communication is. I also have questions as to what the RRC, MAC/RLS, and PDCP protocols are in LTE. I'm also not familiar with heterogenous networks.

- *Interesting citations:*

The 5G white paper in class was good, but relied heavily on previous 4G technologies to explain 5G components and differences. Because of this I feel that I do not have a good foundation or even good knowledge of 5G, that is why I am picking the NGMN [1] white paper on 5G.

- *Possible improvements:*

A few statements were constantly repeated throughout the paper. I believe removing these repeated statements will improve the paper. I wish they cut down their introduction sections and went more in depth for the evaluation section.

- *Future work:*

I think this can definitely extend to 5G NSA or standalone infrastructures. I would also like to expand the master control to work on non-linux systems. Furthermore, FlexRAN is not tied down to specific RAN so the possibilities are endless. Lastly, because this is new technologies there are a variety of places or things this technology could apply to and improve.

References

- [1] ALLIANCE, N. 5g white paper.
- [2] FOUKAS, X., NIKAEIN, N., KASSEM, M., MARINA, M., AND KONTOVASILIS, K. Flexran: A flexible and programmable platform for software-defined radio access networks. *CoNEXT '16: Proceedings of the 12th International on Conference on emerging Networking EXperiments and Technologies* (Dec. 2016).
- [3] GROUP COMPANIES, N. Making 5g a reality. *NEC White Paper* (Feb. 2018).
- [4] HAN, B., GOPALAKRISHNAN, V., JI, L., AND LEE, S. Network function virtualization: Challenges and opportunities for innovations. *IEEE Communications Magazine* (Feb. 2015), 90–97.