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Cloud Networking in 5G

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**Abstract**

The following survey aims to cover the importance of developing a faster and more efficient communication technology than 4G which is 5G in order to adapt to the user needs of services delivered over cloud computing. Nowadays the data is increasing in size, there are more and more people that use their smartphones rather than their computers since it is the device carried all around. The development of such technology will not only provide the user with more complex services available on the smartphone or tablet but will give more possibilities to the companies to have more clients on their platform for a wider coverage. The paper will cover the challenges in terms of network design, the research made on the 5G technology, the solutions and future implementation of it, but also how these applications and services will improve and give more when 5G will be the standard.

**Introduction**

The society that we are living in has a need that cannot be stopped which is linked to our natural human behaviour, the need for information. The more information a person has access to, the more it will help that person to have better standards and knowledge about the world he/she is living in. Cellular networks have played a major role into providing information (Pirinen, 2014), from the simple voice call that would make it possible for someone to talk to a person located further away to the Internet’s services and applications made available through the smartphones which gave us access to even more than just call talk. The goal of the cellular network technology is to provide each person with access to information in all the possible locations with any device, from a simple and cheap phone that has access to the Internet to the smartphones that would give people more complex services and applications to fulfil their needs (Shah, 2018). The information access has to have low latency and very high bandwidth so that all these services to be accessed instantly. The following paper is covering the evolution of the cellular networks and how it got to this point, the architecture that would make 5G available to the wide population, the technologies that are emerging for this network, applications and services using 5G and then concluding with the future predictions alongside the overall picture of how cloud computing will have more capabilities in a 5G world.

**Wireless Technology Evolution**

Wireless technology has evolved in many ways since 1980 when the first generation of mobile technology has been released in Japan, also called 1G. The main aspect of the first generation is the fact that it was analogue with a speed of 2.4Kb/s. More countries like Denmark, Sweden, Norway launched it and by 1983 the United States as well (Anon 1G, 2018). It was replaced by the second generation, 2G which would be digital instead of analogue in 1991. The difference between 1G and 2G was the fact that phone conversations would be digitally encrypted, wireless penetration level would be bigger which would provide a signal on longer distances, and also the feature of sending SMS messages compared to 1G. 2G has two categories: GPRS, which has a transfer speed of 40Kb/s and EDGE which can lead up to 1Mb/s speed. One of the features of 2G is that the phone battery would last longer because of the radio signal which is on low power (Anon 2G, 2018).

Continue with 3G development (Anon 3G, 2018) To be continued…

Continue with 4G development (Anon 4G, 2018) To be continued…

Continue with 5G development (Anon 5G, 2018) To be continued…

Anon. 2018. 1G. (October 2018). Retrieved from <https://en.wikipedia.org/wiki/1G>

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**5G Network Architecture**

Overview of the architecture for 5G (HUAWEI, 2016) To be continued…

H.UA WE I. Technologies ed.2016. 5G Network Architecture. (2016).

Different Layers of the Network for 5G (Anon 5G, 2014) To be continued…

Anon. 2014. 5G: Challenges, Research Priorities, and Recommendations. *European Technology Platform for Communications Networks and Services*(September 2014), 1–45.

CRAN and HCRAN challenges and solutions for the 5G implementation (Peng et al., 2015) To be continued…

Mugen Peng, Yong Li, Zhongyuan Zhao, and Chonggang Wang. 2015. System Architecture and Key Technologies for 5G Heterogeneous Cloud Radio Access Networks. *IEEE Network*(2015), 6–14.

Features provided by the architecture (Anon 5GPPP, 2017) To be continued…

Anon. 2017. View on 5G Architecture. *5GPPP Architecture Working Group*(December 2017).

Network coding and communication (Zheng et al., 2015) To be continued…

M.A. Zheng, Z.HA NG ZhengQuan, D.IN G. ZhiGuo, F.AN PingZhi, and L.I. HengChao. 2015. Key techniques for 5G wireless communications: network architecture, physical layer, and MAC layer perspectives. *Science China Press and Springer-Verlag Berlin Heidelberg*58 (April 2015). DOI:http://dx.doi.org/10.1007/s11432-015-5293-y

Mobiel devices access to the network (Rost et al, 2014) To be continued…

In order to fully understand why the research on 5G is following the stages and topics covered in this report, it is also important to understand how and why 5G will “face an exponential increase in data traffic” (Rost et al., 2014, p.69). Firstly, every day there are more devices that search connection to a network, with 5G facing the larger number of devices ever seen. Secondly, all these devices are not only higher in numbers, but they are also more powerful and capable of accessing data and resources of upper quality. As an example, if the beginning of last decade can be simply understood in terms of technology as devices capable of manipulating 2D videos and web-search, the emerging of the next decade will be almost solely towards 3D and real-time interactions, all embedded in a more diverse way. Moreover, all these devices and applications will be used in more in the day-to-day life and industries, such as healthcare, transport, security, but also in the daily shopping, movie time or bed-time story. Finally, a trend already visible nowadays but which is expected to skyrocket in the next few years is the dependency on the smartphone or tablet for doing more complex tasks that necessitated a desk or portable computer in the past. In Rost’s et al. (2014) words, “this implies that per-user storage and processing requirements will further increase, while per-device capabilities will not increase at the same pace” (p. 69).

Similar to Chen (2018) and Dehe…., Rost et al. (2014) is also discussing about the “multi-cell interface”. This is all a result of a centralized process that allows denser networks to work properly, regardless of their complexity. It also makes space for the usage of RRM, or radio resource management algorithms, to be implemented across more than one cell. Furthermore, it “allows optimization of the radio access performance at the signal level, for example, through joint multi-cell processing and intercell interference coordination (ICIC)” (p. 69). The two, RRM and ICIC, will lead to a better RAN implementation as it can avoid cancelling between two neighbouring cells. In the recent past C-RAN has brought the attention of extensive research as a possible method for optimally centralizing the available and needed resources. However, its requirement for optical fibre makes it hard to use as it lacks to support the speed, and its described in the present as having little flexibility as the fibre is not omnipresent in the world and this why it is believed to be an element that will create the future.

On the same topic, Rost et al. (2014) is discussing about the “ultra-dense deployments” that are key enablers for the 5G technology. These are supposed to “use […] very dense, low power, small-cell networks” (p. 69). He mentions two main such effects. The first one is solely referring to the distance between the radio access point and the user. This needs to be as small as possible in order to concrete in very high information rates. The second one, refers to the “recycling” of technology, where some resources are re-used across multiple cells. From the traditional small cell deployment these would use less power and supplies, which is of course implying a better usage of these while shortening the transmission time.

A different opinion is raised by Rost et al. (2014) who considers that Radio Access Network used as a Service is a better solution for 5G instead of the conventional cloud-computing and gives a number of benefits. Although he acknowledges similarities between the two, he is insisting on the ability to enable isolation of the RANaaS platform which can offer a better security for the 5G mobile users. This argument is of high importance in respect to the increasing number of hackings and the importance of data confidentiality and personal safety. Moreover, he is also discussing the possibility to sell an item as both RAN services and their usage as two different products. While understandable from a business and seller perspective, the ethical behind it and the fairness towards the user should be questionable. On a further note, he is discussing about the RAN-Backhaul Operation as a vital part of the 5G survival. This is because the 5G will be dependent on “very dense cell layer that needs to be connected to the RABaaS platform” (p. 71).

In terms of architecture of the future 5G, Rost et al. (2014) are supportive of the adaptable and scalable network as the connection will need to work concomitant with its older relatives. All concepts need to be as transparent as possible in order for this to be satisfied, as previously mentioned, this technology is believed to occupy the market only after a while. He mentions three important elements that need to be satisfied of its architecture:

1. Be completely compatible capable of supporting the process centralization of RAN;
2. Take into consideration the increased traffic and number of devices connected, as well as the backhaul, when considering the “optimal functional split” (p. 71);
3. Be able to submit a function capable of supervising the “interaction of functions distributed on different network entities” (p. 71);

Peter Rost et al.2014. Cloud Technologies for Flexible 5G Radio Access Networks. *IEEE Communications Magazine*(May 2014), 68–76.

**Emerging Technologies**

Overview of the emerging technologies (Demestichas, 2013) To be continued…

Panagiotis Demestichas et al.2013. 5G on the Horizon. *IEEE vehicular technology magazIne*(July 2013), 47–53. DOI:http://dx.doi.org/10.1109/MVT.2013.2269187

Technology for having energy efficient network (Rizvi et al., 2017) To be continued…

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Features and Technologies used to implement wireless 5G network (Chen et al., 2015) To be continued…

Min Chen, Yin Zhang, Long Hu, Tarik Taleb, and Zhengguo Sheng. 2015. Cloud-based Wireless Network: Virtualized, Reconfigurable, Smart Wireless Network to Enable 5G Technologies. *Mobile Netw Appl*(February 2015), 704–712. DOI:http://dx.doi.org/10.1007/s11036-015-0590-7

**Cloud Computing With 5G**

Technologies that enable the storage and transmission of 5G over network (Hansen et al., 2015) To be continued…

Jonas Hansen, Daniel E. Lucani, Jeppe Krigslund, Muriel Médard, and Frank H.P. Fitzek. 2015. Network Coded Software Defined Networking: Enabling 5G Transmission and Storage Networks. *SOFTWARE DEFINED 5G NETWORKS FOR ANYTHING AS A SERVICE*(September 2015), 100–107.

A new smart world in 5G (Han et al., 2015) To be continued…

Qilong Han, Shuang Liang, and Hongli Zhang. 2015. Mobile Cloud Sensing, Big Data, and 5G Networks Make an Intelligent and Smart World. *IEEE Network*(2015), 40–45.

Applications and services in cloud computing using 5G (Shorgin et al., 2014) To be continued…

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Requirements for services to use 5G (Barbarossa et al., 2014) To be continued…

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**Opportunities**

**Conclusion**

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Pekka Pirinen. 2014. A Brief Overview of 5G Research Activities. *International Conference on 5G for Ubiquitous Connectivity (5GU)*(2014), 17–21. DOI:http://dx.doi.org/10.4108/icst.5gu.2014.258061