Міністерство освіти і науки України
Сумський державний університет
Шосткинський інститут Сумського державного університету
Фармацевтична компанія «Фармак»
Управління освіти Шосткинської міської ради
Виконавчий комітет Шосткинської міської ради

ОСВІТА, НАУКА ТА ВИРОБНИЦТВО: РОЗВИТОК І ПЕРСПЕКТИВИ

МАТЕРІАЛИ

II Всеукраїнської науково-методичної конференції,

(Шостка, 20 квітня 2017 року)

Суми
Сумський державний університет
2017

УДК 004.733

5G ULTRA DENSE NETWORKS

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The traffic demands predicted by 2030 are up to 10,000 times greater than in 2010 and end-service users will need to support 100 Mbps. One of the key developments that will provide this demand is the deployment of very dense and multi layered networks.

Nowadays, the radio access network (RAN) is composed by macro-cells which are supported by small cells in hot zones such as stadiums, business parks and other areas where the user density is high to provide high-rate wireless transmission. Therefore, the coverage of both, macro-cells and small cells, is overlapped. As the LTE spectrum is saturated, new bands in the 700, 1400 and 2700 MHz is considered, so that the lower bands are suitable for the macro coverage while the higher frequencies are preferred in small cells.

According to Nokia, the key elements that provide more capacity at the same time that minimize costs are:

Update current macro-cells to support multicarrier and carrier aggregation techniques as well as advanced antenna solutions, instead of replacing them by new sites.

Install small cells to provide low cost capacity and coverage at outdoor hot spots. Install small cells to offload macro-cells. DAS solutions will be upgraded to LTE to provide seamless connectivity.

In a case study in Tokyo, Nokia analysed the impact of increasing the traffic up to the levels expected by 2020 (50-700x compared to 2010) where the basic coverage was provided by the existing macro-cells, street level capacity was covered by outdoor small cells and high rise capacity with up-tilted macro cells from existing sites.

The development of massive MIMO and millimeter-wave communication [6] technologies makes the dense deployment of small cells emerge in 5G cellular networks. However, this ultra dense network will produce more frequent user handover, so the small cells won't be a complement for the macro-cells: the small cells will transmit user data while the macro-cells will transmit the management data to control the user handover in small cells.

The deployment of UDNs will create some major challenges that operators will face:

Interference management and mobility concerns: the deployment of UDNs needs to be carefully planned to avoid the interference levels rise dramatically, as well as, the management of the massive number of handovers that could damage the users' throughput.

TCO analysis: the Total Cost of Ownership (TCO) will be multiplied exponentially with the dense deployment of small cells. Several factors, such as construction and acquisition are often the biggest cost components, while the recurring costs are the backhaul transmission, power consumption and support. Therefore, operators will need to study if the option of upgrading existing sites is more suitable than replace them by small cells in the long term perspective.

Site location: optimizing the site placement can significantly reduce the TCO, so operators will need to face with new scenarios that are both, indoor and outdoor.

Backhaul: the different technologies considered for the backhaul are fiber, point to point (LoS and NLoS) and point to multipoint wireless transmission. In addition, the backhaul energy consumption is another constraint that limits the UDN deployment.

Energy consumption: the 15% of the total OPEX is consume by energy. New developments such as shutdown of carriers and switching off MIMO can save a 10% and 5% of energy respectively. In addition, beamforming to reduce interference as well as distributed antenna systems are new solutions.

It is evident that UDN will introduce new challenges in the future 5G. Some of them are already investigated and the solutions are emerging everyday. However, we could summarize by saying that the optimum density of small cells in 5G UDN is still an open problem that once it is determined, it will result in a new telecommunications revolution.

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