Are we damaging the environment by using our phone?

Of course, mobile phones on their own don't produce any pollution to damage the environment. However, there is a network, formed by macro base stations, that provides the consistently ever more demanding services and applications that everyone wants to use. The base stations however burn a considerable amount of energy. This amount of energy implies a proportional amount of CO_2 emissions. We are demanding video (including real-time video), Virtual Reality, D2D and even sensor applications which provide information in real time, that need an ever-increasing data volume, which is proportional to the amount of energy consumed. Let's see some numbers:
In LTE, an increase data rate from 3 to 60 Mbps in only one base station, requires an increment of 10% in the power per km^2 consumed (i.e., from 2.4 mW/m^2 to 27.8 mW/m^2). Now, think about the number of base stations that form the network. The telecoms industry is responsible for 2% of the CO_2 emissions, and 60%-90% of this percentage is produced by base stations.

Back in 2009, base stations consumed up to 2.7kW per hour which lead to an energy consumption of more than 20 MW per annum and considering that the volume of transmitted data increases approximately by a factor of 10 every five years, the energy will be doubled by 2020. This is the year when we finally see 5G working.

It is expected that the target peak data rate for 5G networks will reach 10 Gbps. This predicted exponential growth of data volume for the 5^{th} Generation (5G) of Mobile Communications, will dramatically impact on the Radio Access Networks (RAN) energy consumption and related costs. **The higher requirements of throughput expected for 5G, would be proportional to the energy demand which is prejudicial for the environment in terms of CO_2 emissions.**

If we think about it, for the previous generations to 5G, such as HPSA+ and LTE, the RAN design focused on providing high user data rates and QoS. However, because of the impact in the required power and related operational costs, energy efficiency is becoming one of the most important goals in the 5G development.

Therefore, new algorithms to increase data rates are being developed in parallel with energy efficiency schemes. As we have mentioned above, the total energy consumption in the RAN is mainly dominated by the base stations, therefore new approaches need to be developed at the base stations to reduce the increasing expenses due to the system requirements.

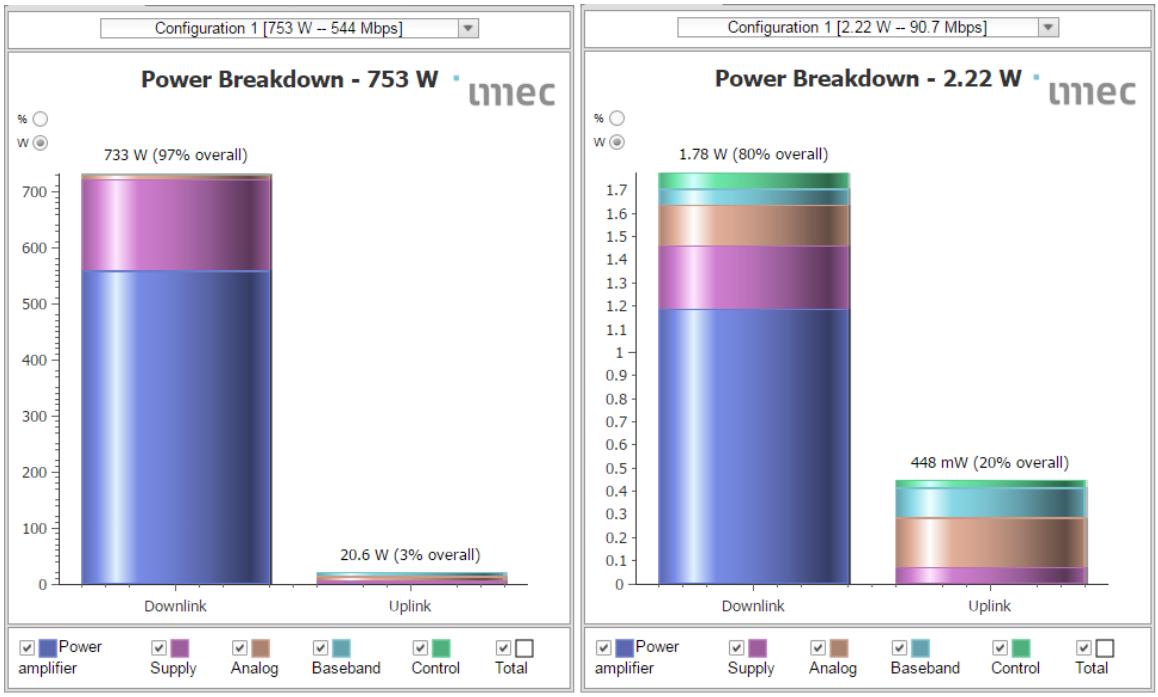

Figure 1. Power models for 2020 macro and small-base stations according to: http://www2.imec.be/be_en/research/wireless-communication/power-model-html.html

How 5G will deal with this problem? Is it possible to provide a constantly increasing data rate and reduce the energy at the same time? Is there any trade-off? Answering to these questions is very challenging but we can trust in the potential of the new developments that will address this issue in 2020. These are some of these solutions:

- The implementation of ultra-dense networks (UDNs) deployed as a combination of small cells and macro-cells, the so called Heterogeneous Networks (HetNet), where

one macro station is replaced by several small or pico-cells which overall consume less energy.

- Base stations can be switch off when they don't need to transmit any data: this is called "sleep" mode, and it's achieved thanks to traffic prediction models where it's possible to know the peak hours and the time where most of users are disconnected.
- Base on the previous principle, adaptive sectorisation (modifying the number of active sectors in a base station according to the traffic demands) improves the RAN energy efficiency compared to fixed sectorisation up to a 25%.
- New protocols that efficiently use the spectrum by reducing the number of energy consuming resources when it's not needed (scheduling and Radio Resource Management techniques).

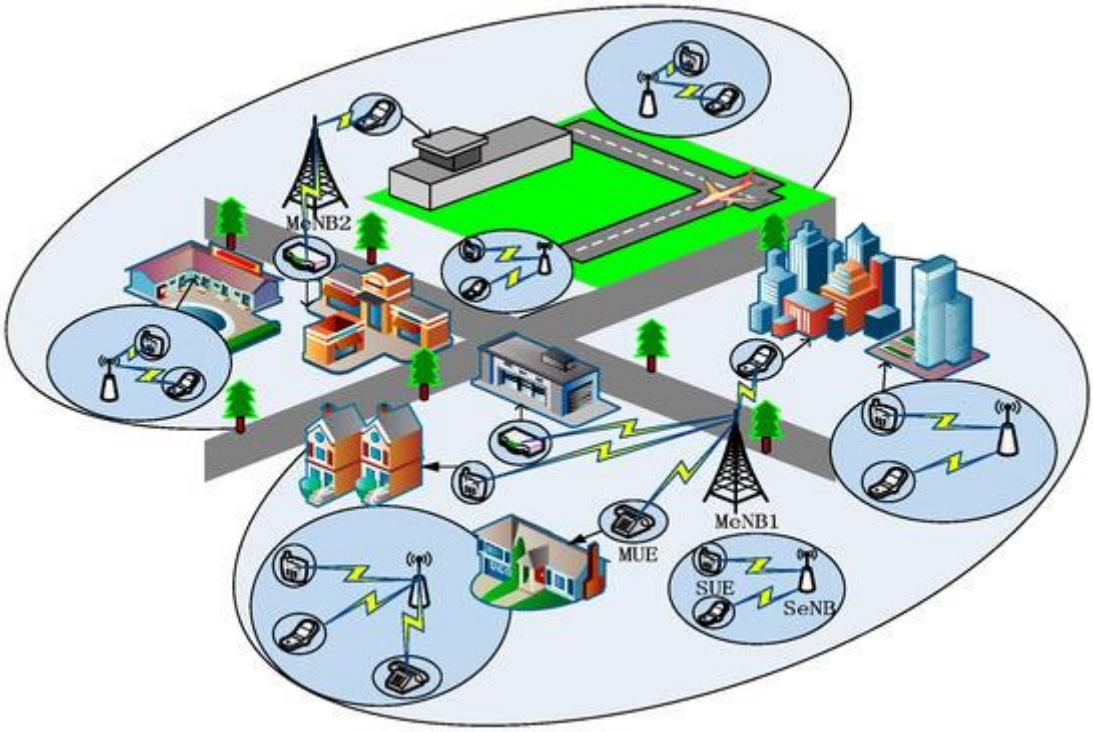

Figure 2. HetNet: small cells offloading traffic. Source: M. Li, P. Chen, and S. Gao, "Cooperative Game-Based Energy Efficiency Management over Ultra-Dense Wireless Cellular Networks," Sensors, vol. 16, 2016.

In conclusion, the new trends in technology are focused on a green communication network rather than just providing higher and higher data rates. Will this environmental requirements limit the achievable data rate or will the service operators accept the energy

costs and CO_2 emissions just to be able to provide better services? Although it seems to be the first option, we will have the answer in 4 years time.

Sources:

[1] Nokia Siemens, White Paper "Beyond 4G", 2011

[2] IMEC, "Power Model for Wireless Base Stations". http://www2.imec.be/be_en/research/wireless-communication/power-model-html.html

[3] DOCOMO, 5G White Paper "5G Radio Access; Requirements, Concepts and Technologies", July 2014.

Natalia graduated in Telecommunication Engineering from Spain. She came to the UK two years ago to study an MSc in Wireless Communications System and upon completion was offered a job as a Research Associate on a 5G project. She is also currently doing a PhD on the same subject and runs the telecoms sections in behindthesciences.com blog.