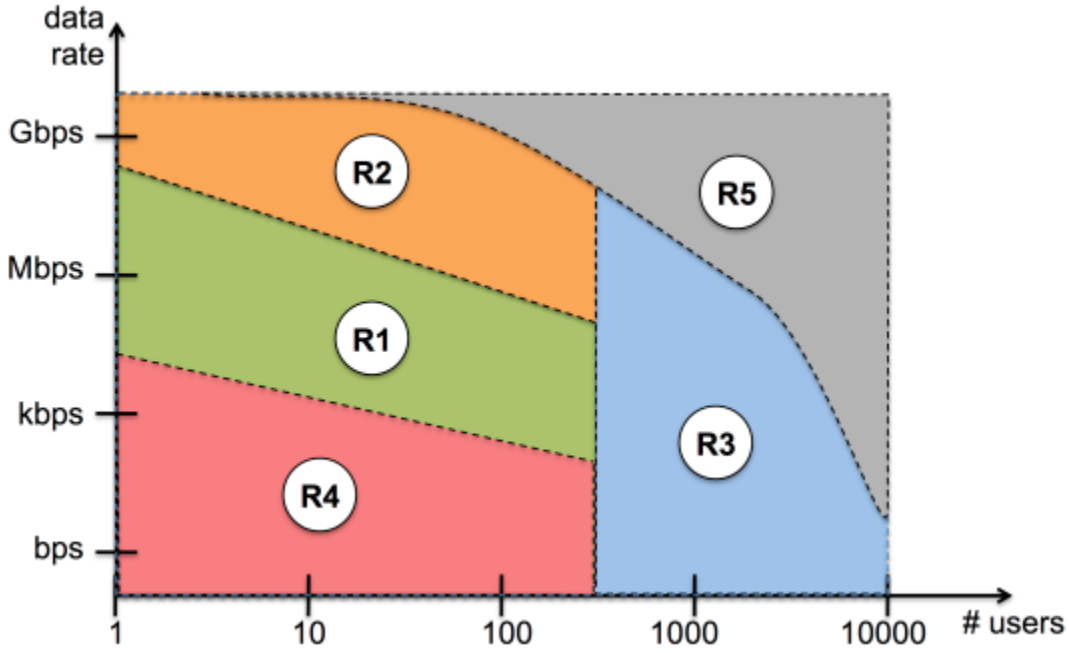
5G WIRELESS WILL BE BROADBAND PLUS LOWBAND COMMUNICATION

Although the figure is conceptual and with no ambition to provide precise numbers, it is interesting to see the reasoning behind the regions. The x-axis is represents the number of users in a cell and the y-axis represents the data rate per device.



- **R1** – Describes the operating region of today's wireless wide-area cellular systems. As the number of users increases in the system, the data rate per user decreases.
- **R2** – It is the region targeted by the wireless research efforts that aim to increase the data rates, such as mmWave, network densification, massive MIMO, etc. Note that the upper part of this region decreases as the number of users increases, but slower compared to R1. This aims to highlight that many of the new broadband

high-spectral efficiency techniques are inherently designed to serve efficiently multiple users, such as: interference alignment, wireless network coding, improved spatial reuse in mmWave wireless, etc.

- **R3** – It is the region of massive M2M communication with relatively low data rate and therefore termed **lowband** communication. The required data rate is able to continuously decrease with the the increase of the number of connected devices, but not go abruptly to zero as the system becomes more congested. It is assumed that each device transmits sporadically and the y-axis represents the average data rate of the device. The declining becomes progressively faster due to the fact that short packets, sent by many devices, are affected by the signaling overhead. To see why this region represents a research challenge, we can think of this as follows: it is relatively easy to send 10 Mbps from each of the 10 devices, but it is much more difficult to send 10 kbps from each of the 10000 devices. The problem is that in the latter case the overhead of the protocols, collision waste, etc. start to dominate the performance.
- **R4** – It is the region of lowband communication, but very low latency or ultra-high reliability. These features are not plotted on the figure. This region represents the connectivity required in e. g. car-to-car communication (low latency, high reliability), public safety, critical control of small-scale M2M installations, etc. To see why this region represents a research challenge, we can think of this as follows: it is relatively easy to send support 10 Mbps to a device during 95% of the time, but it is very difficult to guarantee 10 kbps during e. g . 99.999% of the time. If the 5G wireless connections are able to deliver such a reliability of a stringent latency requirement, then the number of new services will proliferate, as

people and industries will start to trust the wireless connection as being a “true” cable replacement.

- **R5** – region that cannot be reached due to fundamental limits of physics, information theory and networking theory.

We believe that a concise description of what 5G will be is given by the following:

5G=R1+R2+R3+R4

Instead of being only a broadband “4G, but much faster” system, 5G will also include **lowband** communications, represented by the regions R3 and R4.

Source : http://massm2m.wordpress.com/2013/12/14/5g-wireless-will-be-broadband-plus-lowband-communication/