5G and IoT

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Almost everyone has a smartphone today. We take for granted the ability to call friends, send text messages, browse the Internet, and use a variety of apps to stream video, play games, etc. via our smartphones from anywhere and at any time. This is thanks to the smartphone being able to connect to a wireless cellular network. This network is comprised of the towers with the radio equipment that transmit the wireless signal, the fibers and cables that bring the signal to the towers, and the large number of data centers and central offices (i.e., the "cloud") that the fibers and cables originate from. The state-of-the-art technology in current cellular networks is typically the fourth generation (4G), also known as LTE. However, as the demands of our society and industries evolve, there is a need for improving the technology even further, for instance, to provide higher speeds (e.g., faster downloads) and increased reliability (e.g., avoid dropped calls).

The fifth generation (5G) is designed to provide many such advancements. First, 5G provides speeds that are about an order of magnitude higher than 4G. Second, we are already seeing many "things" or devices, such as watches, speakers and refrigerators, that connect to the network - generally known as the Internet-of-Things (IoT). 5G allows the IoT trend to become ubiquitous enabling a massive number of devices to connect to the network simultaneously, which is not possible with 4G. This can be useful in applications which require a massive deployment of sensors and actuators, such as in precision agriculture and smart cities. Third, in some cases, the devices can involve mission-critical or heavy machinery in industrial applications such as automotive, manufacturing, public safety, medical etc. For such applications, 5G provides a highly reliable and extremely responsive (i.e., low delay) connection to communicate with the industrial devices.

As a result, the applications supported by 5G can have a diverse combination of requirements ranging from high speeds to low delays. Moreover, all these applications co-exist on the same network allowing for economies of scale and increased sustainability. Thus, 5G solves an extremely challenging problem of simultaneously satisfying a diverse set of requirements. This is accomplished by conceptually "slicing" the network and automatically allocating network resources depending on the IoT application requirements. Artificial Intelligence (AI) technologies such as machine learning, reasoning and planning play a central role in such automation.

The specifications for 5G are defined by a standardization body called 3GPP. The first release of the 5G standard, known as NR, was completed during 2018. The main design principles of NR are that it should be lean, future proof, and flexible. Therefore, 5G is highly energy-efficient, new features can be added as the standard continues to develop, and the network can be tuned according to the application requirements.

Some of the key topics in 5G are as follows. The support for massive deployment of sensors and actuators is covered by the low-power wide-area network standards, known as NB-IoT and LTE-M. Such devices have a long battery life (at least 10 years), have better coverage than standard smartphones, and are less costly. The support for critical machine-type communications is known as ultra-reliable low latency communication (URLLC). This feature ensures faster and even more reliable transmissions. The topic of positioning or localization involves precisely finding the current location of a device (e.g., a person, a sensor, a machine, etc.). Such positioning could be accomplished just by measuring the radio signals or by, in addition, combining with built-in sensors.

This session features four exciting speakers, who come from both academia and industry. The talks provide an understanding of the underlying technology and an outlook for what to

expect in the future of wireless networks. They illustrate how 5G is being used in different practical IoT applications and the benefits, challenges, and solutions as applicable to the specific use case. Specifically, we discuss the use of 5G for vehicular communication in the automotive and transportation sector. We dive into how 5G networks can be used in factory floors for manufacturing and production. Finally, we look towards a future where 5G supports 4K video, augmented reality (AR) and the Internet-of-Everything (IoE).