Going Toward 6G

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Introduction (1/2)

- The cellular industry has just reached another milestone with the development of 5G wireless communication technology. While research in 5G is a core part of the Signal Processing for Communications and Networking (SP-COM) technical committee
- We will discuss the expected goals that 5G has and has not achieved and what might be coming in 6G cellular networks
- Cellular communication systems are constantly evolving, with new releases every one to two years. Roughly every 10 years, one of the releases is branded as a new *generation*

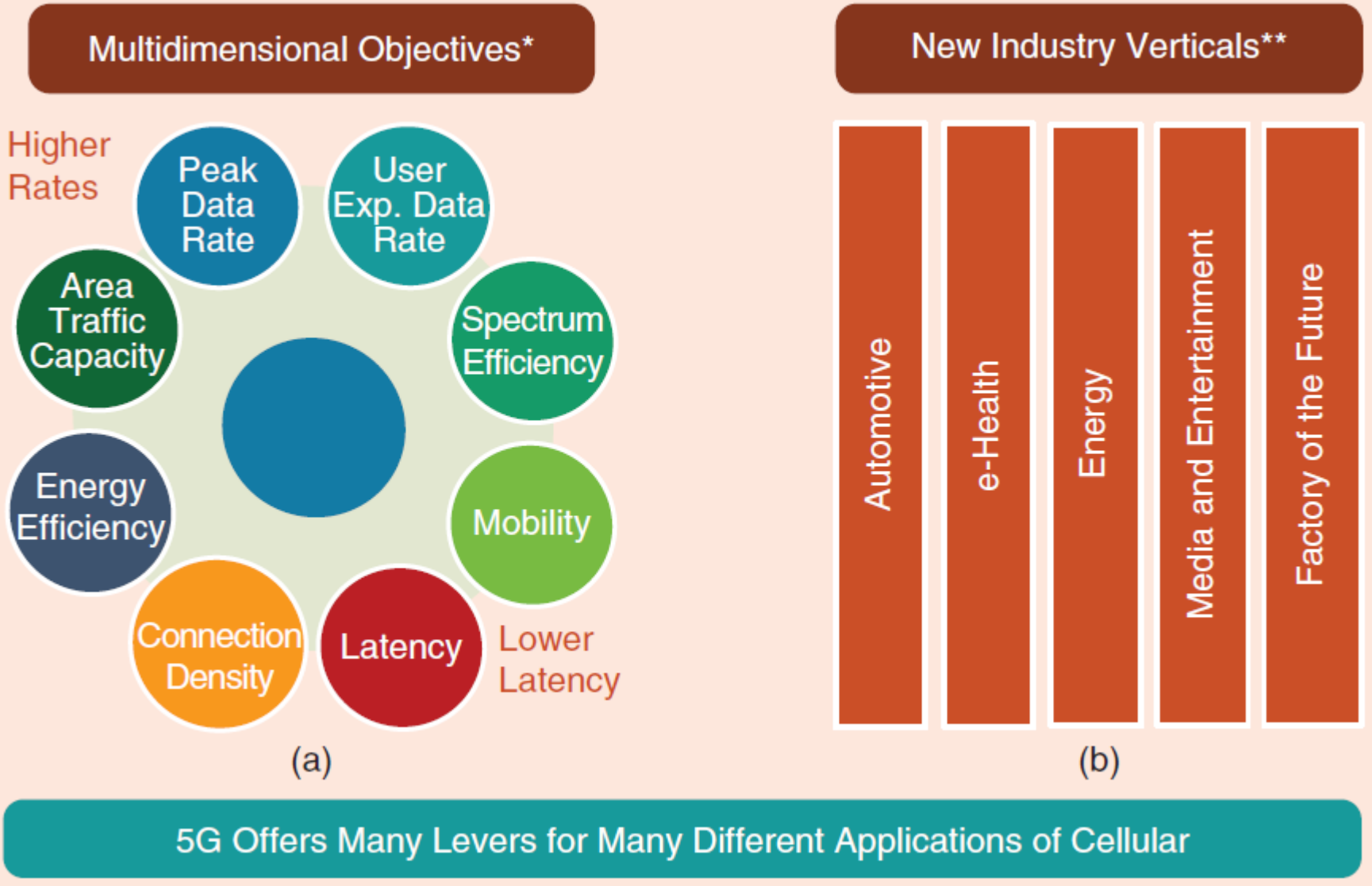
Introduction (2/2)

- Usually, the new generation standard has been designed to achieve some significant performance improvements

Applications of Cellular Provided by 5G (1/2)

- The "5G flower" is shown in Fig. 1(a). It indicates the different performance objectives that might be achieved by a 5G link
- These different performance objectives are conflicting and cannot be optimized simultaneously, *e.g.*, low latency, high mobility, and high data rates may not be possible at the same time
- Fig. 1(b) shows some of the key industry verticals. Many different industries have made use of cellular communication in the past, but 5G also considered the requirements of devices associated to the different verticals

Applications of Cellular Provided by 5G (2/2)



Research Directions (1/1)

- Physical layer needs to support higher bandwidths, higher carriers, yet at lower powers
- The industry verticals from Fig. 1(b) were not completely served and how 6G may be designed around these areas
- Machine learning may play in 6G in a more integrated fashion than done before

Research Direction 1 (1/2)

- At the physical layer, one of the differentiating features of 5G is the use of the millimeter-wave spectrum or even the terahertz bands. The reason to go to carrier frequencies around 28 GHz and above is the potential for higher bandwidth communication channels
- 5G may support 400 MHz of bandwidth at millimeter-wave channels. With larger bandwidths, the data rate are proportionally higher
- The other opportunity is the support of low-resolution multiple antenna architectures. By reducing the resolutions of the analog-to-digital and digital-to-analog converters to as little as 1 bit

Research Direction 1 (2/2)

- The other opportunity is to re-investigate large bandwidths in the context of signal processing models. Most models used in SPCOM research make a narrow-band assumption, which starts to be violated for large bandwidths or large array apertures

Research Direction 2 (1/1)

- There is no reason that the focus should just be placed on ground vehicles. Aerial vehicles are now playing a larger role in society including for monitoring, package delivery, and personal transport
- Robotics is a significant use case of signal processing as found in the factory of the future

Research Direction 3 (1/1)

- The third direction for 6G research is in the applications of the machine-learning toolset
- Transfer learning might be useful to convey models learned in one cell to another cell, while end-to-end learning may be helpful for dealing with physical layer modeling mismatches and nonlinearities
- Signal processing under the guise of machine learning, may play a leading role in 6G – more than all of the previous generations of cellular technology

References

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- [2] Recommendation ITU-R M.2082-0, "IMT vision-framework and overall objectives of the future development of IMT for 2020 and beyond," Sept. 2015.
- [3] "5G empowering vertical industries," 5GPPP White Paper, Feb. 2016.