Long Term Evolution (LTE) has become the most successful mobile wireless broadband technology, serving over one billion users as of the beginning of 2016. However, looking at the penetration rate, LTE serves only 14.5 percent of the current 7.3 billion mobile subscriptions. Consequently, there is still significant room for LTE to grow as a mobile technology; it will be serving users for a long time to come.

The first version of LTE (Release 8) emerged in 2008, and focused on the mobile broadband use case. Together with the smartphone, LTE has given fourth generation (4G) users unprecedented access to mobile broadband services, facilitating social interactions as well as mobile information sharing. LTE evolved to LTE-Advanced in Release 10, which introduced a set of enhancements in order to fulfill the IMT-Advanced requirements. As we look toward the future, new services such as HD video, virtual reality (VR), and augmented reality (AR) will become pervasive, in addition to the expansion of diverse and plentiful over-the-top (OTT) applications, development of the Internet of Things (IoT), and massive machine-type communications. Aside from the requirement for increased data rates and decreased latency, these applications will require profound changes within the cellular network.

Evolving video services will increase the expected traffic load. Currently the 720p screen has become the basic configuration of smartphones and has already been adopted on a large scale by LTE commercial networks. It is estimated that over 50 percent of YouTube video sources supported 720p HD in 2015. In the near future, mobile 2K video will become mainstream, while mobile 4K video is emerging. AR and VR are being demonstrated on a large scale, for example, at the MWC (Mobile World Congress), and haptic feedback is required for some applications such as remote-controlled machines. Together, the increased use of existing video delivery services as well as new interactive AR/VR services pose significant network challenges in terms of capacity, data rates, and latency. For example, 10-15 Mb/s are needed to support 2K video for smooth experience and 30 Mb/s for 4K video, which implies that about 30 simultaneous video streams will demand a capacity exceeding 1 Gb/s.

At the same time, new vertical markets such as smart metering, vehicle communications, wearable equipment, and other types of automation are beginning to enter our day-to-day environments. The concept of cellular IoT (C-IoT), that is, machine-to-machine (M2M) communication via cellular network technologies, will vastly increase the number of smart devices that require always-on demand and online capability within the network. It is not unreasonable to imagine that smart devices and systems like connected cars, connected wearables, the smart grid, and even smart waste bins will eventually connect directly to the Internet. This interconnectivity with C-IoT can dramatically change the way tasks are accomplished, boost productivity, and improve quality of life.

The industry has already recognized this inflection point in the development of cellular networks. LTE Release 13, also known as LTE-Advanced Pro, marks the start of a wide range of enhancements to better address the challenges posed by existing services in addition to new and emerging use cases. This multipart Feature Topic will investigate some promising technologies, including some included in Release 13 as well as promising technologies for the continued evolution towards 5G.

The first article, “Society in Motion: Challenges for LTE and Beyond Mobile Communications,” discusses the challenges in serving a large number of highly mobile users. It presents a survey of existing technologies, and provides special emphasis on open issues and conflicting priorities.

The second article, “LTE Mobile Network Architecture Evolution toward 5G,” discusses the specific architectural properties that will be needed in the evolution of the LTE network. In particular it will elucidate the evolution toward a “network of functions,” networking slicing, and software-defined mobile network control.
The third article, “Massive Carrier Aggregation in LTE-Advanced Pro: Impact on Uplink Control Information and Corresponding Enhancements,” discusses the massive carrier aggregation work in 3GPP. It presents an overview of the enhancements, their impact on uplink control information (UCI) overhead and transmission, and new control channel formats with link-level analysis using Third Generation Partnership Project (3GPP)-defined simulation assumptions.

The fourth article, “Rate Splitting for MIMO Wireless Networks: A Promising PHY-Layer Strategy for LTE Evolution,” introduces a promising multiple-input multiple-output (MIMO) strategy based on rate-splitting. Rate-splitting relies on the transmission of common and private messages. This strategy was designed to alleviate the need for accurate channel information in current MIMO techniques. Open problems, the standards impact, and operational issues are also elucidated in the article.

This is the first part of this Feature Topic, which emphasizes the characteristics of LTE-Advanced Pro. Subsequent parts of will characterize the evolution needed to address further challenges.

**JOINED BY**

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