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Technological Trends for 5G Networks Influence of E-Health and IoT Applications

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ABSTRACT

The fifth generation of mobile communications networks (5G) is currently in the standardization process, which is expected to be completed in 2020. For this new generation, new applications and scenarios are imposing new performance requirements in addition to higher data rates. Specifically, the Internet of Things (IoT) and e-health applications have very important economic roles in 5G networks and define particular performance requirements that must be considered when defining the technologies for 5G networks. In this paper, the author discusses the influence of e-health and IoT applications on the technological trends for 5G networks.

KEYWORDS

5G Networks, E-Health, IoT, Wireless Communications

1. INTRODUCTION

The first generation (1G) of mobile communications networks, implemented in the 1980s, offered only voice communications using analogue technologies. In the 1990s, the second generation (2G), now using digital technologies, provided, in addition to voice, text message applications with data rates ranging from 9.6 kbps to 19.2 kbps. Subsequently, in each new generation, the primary goal was to provide higher data rates. In the 2000s, the third generation (3G) integrated voice and mobile Internet services, offering data rates ranging from 144 kbps to 2 Mbps. Finally, in the 2010s, the fourth generation (4G) supported high-capacity multimedia applications with data rates ranging from 100 Mbps to 1 Gbps (Wei, 2014).

The fifth generation (5G) of mobile communications networks is currently in the standardization process, which began in 2014 and is planned to be completed in 2020 (ITU,2015). Higher data rates are again an important driver behind the definition of the technical solutions for these networks; however, several new applications and scenarios are defining new additional performance requirements for 5G networks. Nominally, the Internet of Things (IoT) and e-health applications, together with the concept of tactile Internet, have new requirements in addition to higher data rates.

The influence of e-health and IoT applications on the technological choices for 5G networks has been summarized in (Brito,2016). In this paper, we extend the analyses presented in (Brito,2016), including some new technological trends for 5G networks, and detail the trends previously presented in (Brito,2016).

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To better understand the evolution process of the mobile communications networks, in the following section, we present technological, social and economic trends that have significantly influenced the emergence of new applications and requirements for these networks. Then, we present the requirements for 5G networks from the perspective of e-health and IoT applications and the four scenarios considered for this new generation. Finally, we present the technological trends for 5G networks, which will enable us to satisfy the presented scenarios and requirements.

2. TECHNOLOGICAL, SOCIAL AND ECONOMIC TRENDS

The evolution of mobile terminals has been significantly influenced by four technological trends: processing capacity, storage capacity, camera resolution and screen resolution.

The processing capacity of generic microprocessors has grown exponentially. For example, in 1995, the Pentium Pro processor had a capacity of 161 MIPS (million(s) of instructions per second). In 2000, the Pentium IV processor had a capacity of 1,342 MIPS; currently, the capacity is approximately 10,000 MIPS (Bit,2013).

The storage capacity of random access memory (RAM) has also grown exponentially, and the cost per stored bit has decreased exponentially. For example, RAM capacity was 256 Mbit in 2000, 4 Gbit in 2006 and is currently 256 Gbit. Furthermore, the cost for 1 Gbit of storage was US$ 500 in 2000, US$ 32 in 2006 and US$ 0.25 in 2015 (Bit, 2013). Similarly, the storage capacity of flash memory is currently doubling every 18 months, resulting in a 10-fold increase in storage capacity every 5 years (Fettweis,2014).

The camera resolution used in mobile terminals has also grown exponentially. For example, the resolution was 0.11 Mpixels in 2000, 2 Mpixels in 2005 and 41 Mpixels in 2012 (Cardinal, 2013).

Additionally, cell phone screen resolution has grown exponentially. For example, the resolution was 19.2 kpixels in 2002, 153 kpixels in 2007 and 3.6 Mpixels in 2015.

As a result of the four technological trends presented above, a user can utilize more powerful applications, take photos and videos with greater resolution, visualize photos, images and videos with better quality, and store more data, including high-resolution photos, images and videos. As a consequence of these possibilities, together with the higher data rates available on mobile networks, new multimedia applications have emerged and the use of mobile networks to access the Internet has become massive. This scenario has led to a new social trend: a normal user, who was previously an information consumer, is now also an information provider, which can be easily confirmed by perusing social networks, such as Facebook, Instagram, YouTube, and Twitter.

This scenario has led to another trend: data traffic in mobile networks has grown exponentially. For example, Cisco forecasts 49 Exabytes per month of mobile data traffic by 2021, a CAGR (compound annual growth rate) of 47% from 2016 (7 Exabytes per month) to 2021 (Barnett, 2015). The exponential growth in data traffic has been the main driver defining the evolution of mobile networks since the second generation. However, as already stated, new 5G network applications, such as IoT and e-health applications, have new requirements in addition to higher data rates; we will address this point in the next section.

In addition to the technological and social trends discussed above, one economic trend is very important to the evolution of mobile networks: the number of mobile network users is close to the saturation point in most countries, even in developing countries. For example, in Brazil, the number of mobile terminals in 2012 was 254 million, and in January 2017, this number was 243 million.

This trend has stabilized the revenue of telecommunications operators. Thus, from the perspective of a telecom operator, it is extremely important that new applications capable of generating new business are developed. Some of these new applications are IoT, M2M (machine-to-machine) communications and applications enabled by the tactile Internet concept. To illustrate this point, forecasts published by Cisco and by BI Intelligence indicate that: the number of M2M connections will grow from 0.5 billion in 2014 to 3.2 billion in 2019, which is a CAGR of 45% (Barnett,2015);