Future Wireless Communication Networks: Prospects and Challenges

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The paper deals with the current scenario and future prospects of the 5G system along with the challenges it faces. The fourth-generation wireless communication systems are already implemented or going to be implemented in many countries. However, there are still some challenges facing 4G, such as spectrum problem, power consumption and poor coverages. Mobile phones are moving faster to provide the user the same or even better experience than the personal computer. It is expected that from mobile communication point of view, we should have a higher data transmission rate compared to wire line network. Also, the expectation is for seamless connectivity and access. The wireless designers have started research on fifth-generation wireless systems that are expected to be deployed after 2020. In this paper, various promising technologies for future wireless communication system such as huge multiple input and multiple output system, power efficient communications and cognitive radio network are discussed. Existing and future challenges are also discussed.

Keywords: Wireless communication, MIMO systems, Femto cell, Data rate, Spectrum, Fading

Introduction

5G is the future technology for mobile and wireless communications. The fourth-generation wireless communication systems are already implemented or going to be implemented in many countries, 5G is the successor of 4G and 3G network technologies. However, there are still some challenges facing 4G, such as spectrum problem, power consumption and poor coverage. Video communication is facing many challenges now. 5G wireless networks will provide many features to handle this (Cheng-Xiang *et al*., 2014). It will provide the end users more opportunities and flexibilities in accessing video and multimedia contents (Kwadwo and Mikio, 2014). It is quite interesting to note that the new mobile phones of today, especially the

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smartphones, are not just simple phones but much more than that. They are little mobile PCs and function more or less like that. They provide touch screen, user-friendly graphical user interfaces, Internet services and web browsing, email facility, local wireless fidelity connectivity, built-in camera, high quality music player capability and small media management, besides phone call functionalities. From 2G in 1991 to 3G system first launched in 2001, the wireless mobile network has transformed from a pure voice call to a very rich multimedia system.

Present Scenario of 5G Network

It is too early to define the fifth-generation wireless system that is expected to be deployed after 2020 (Bleicher, 2013; and Patrick and Mikio, 2014). The advantages of 5G over 4G are listed in Table 1.

Table 1: Comparison of 4G and 5G Wireless Systems

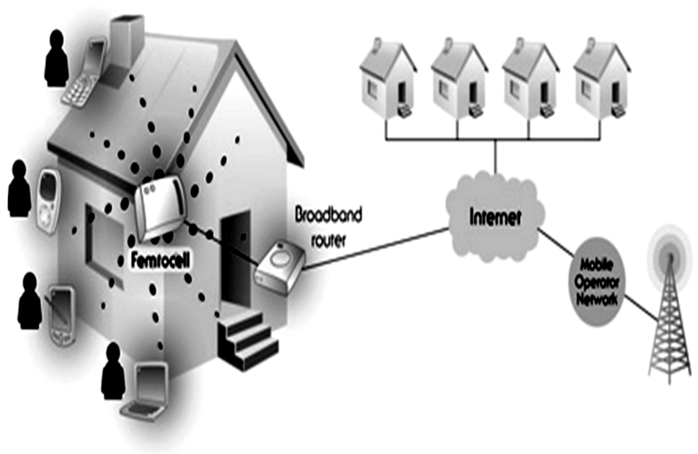
	4G	**5G**
Deployment	2013	2021
Architecture	W-LAN & WAN	4G + WWW
Information Type	Integrated high quality of audio, video and data	Dynamics access information-multimedia services
Data Rate	2 Mbps	1Gbps
Frequency	2 GHz	8 GHz
Class of Switching	Packet	Packet
Multiple Access Technology	CDMA	CDMA
Quality of Service	Less Supported	Supported

Wireless user, especially cell phone and laptop user, stays indoor for more than 70% of time, so significant amount of penetration loss or signal loss will be faced because our conventional cellular architecture normally uses an outdoor base station in the middle of the cell communication.

4G or 5G can mitigate this loss by using separate outdoor and indoor base stations, so penetration loss is somewhat avoided. Nowadays, conventional Multiple-Input Multiple-Output (MIMO) system is being employed, MIMO systems consist of multiple antennas at both the transmitter and receiver (Chandrasekhar *et al.*, 2008; and Patrick and Mikio, 2014). By adding multiple antennas, a greater degree of freedom (in addition to time and frequency dimensions) in wireless channels can be offered to accommodate more information data. Hence a significant performance improvement can be obtained in terms of reliability and spectral efficiency. In massive MIMO systems, the transmitter and/or receiver are equipped with a large number of antenna elements (typically tens or even hundreds). Note that the transmit antennas can be co-located or distributed (i.e., a DAS system) in different applications. Also, enormous number of receive antennae can be possessed by one device or distributed to many devices. Besides inheriting the benefits of conventional MIMO systems, a massive MIMO system can also significantly enhance both spectral efficiency and energy efficiency (Ramya, 2014). Furthermore, in massive MIMO systems, the effects of noise and fast fading vanish.

Another technique proposed at present in 4G and 5G is a femto cell (Figure 1). Femto cell is a new concept that is being used. It combines the mobile relay concept (moving network) (Chandrasekhar *et al.,* 2008; and Bleicher, 2013), with femto cell technology. A Femto cell is a small cell that can move around and dynamically change its connection to an operator's core network. It can be implemented on public transport buses, trains and even private cars to enhance service quality to users within vehicles. Deployment of femto cells can potentially benefit cellular networks. First, femto cells can improve the spectral efficiency of the entire network. Second, it can improve signal quality.

Figure 1: : Femtocell Concept



Femto cells can also be used for small office and underground buildings, as shown in Figure 1, where signal gets attenuated. A cell is divided into smaller cell and femto cell is a subset of small cells. Each class of device connects to a service provider's network through typical broadband, such as DSL or fiber optics cable. They use this connection to broadcast cellular service over a relatively small area, compared with the range of a conventional base station. Nowadays, 4G and 5G wireless communication systems are updating the old systems such as 3G. It requires higher bandwidth in the ranges of GHz and THz could be deployed by utilizing techniques in cognitive radio. This is a highly potential field, and is exploited by wavelength in millimeter range and hence the term millimeter wave is in practice (Cheng-Xiang and Xuemin, 2010; and Rathore *et al.,* 2012). Around 2020, the cellular networks would face a very high data traffic and thereby higher capacity demands for data rate and spectrum. For wireless communication of 5G networks, existing mobile data rate (3G) needs to be increased up to several gigabit per second (Gbps).

Challenges to Forthcoming Wireless Systems

To future wireless systems, there are still many challenges ahead like: how to achieve higher capacity, high data rate, managing massive number of connection, cost and quality of services from a technical point of view (Cheng-Xiang and Xuemin, 2010). This requires a complex signal processing tool for massive MIMO systems. MIMO is an advanced technology that can effectively exploit the spatial domain of mobile fading channels to bring significant performance improvements to wireless communication systems. Past-generation wireless systems used MIMO systems, known as point-to-point MIMO or collocated MIMO, which require both the transmitter and receiver of a communication link to be equipped with multiple antennas. For managing massive number of connections, wireless devices will require multiple antennae, so many wireless devices may not be able to support multiple antennae due to size and hardware limitations. Cross-layer design mechanism plays a critical role in order to supply so many applications and services with quality of service in 5G networks (Wang *et al.,* 2009). In the cross-layer design, the interactions between different network protocol layers can be optimized jointly in end-to-end system. This is done in order to achieve better performance. The content delivery with satisfactory quality of user experience becomes an important issue. The most important issue is to reduce the infrastructure cost and the costs related to their operation, maintenance and management to make connectivity universally available at lower cost (Rathore *et al.,* 2012). The challenge for the design of 5G is that huge improvements are needed, therefore customers are willing to pay proportionally.

Conclusion

The fourth-generation wireless communication systems are already implemented or going to be implemented in many countries. However, 5G wireless communication systems are expected to provide much higher data rates, lower cost per transmitted bit, more flexible mobile terminals and seamless connections to different networks. This paper discussed the features of 5G and also pointed out the shortcomings of the existing technology. 5G seems to be an interesting technology and has many unique features which the world is looking forward to.

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Reference # 70J-2016-05-01-01

Implementation of 2D Discrete Cosine Transform Using Vedic Mathematic Algorithm

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The paper presents the architecture and realization of a cost-effective FPGA realization of a Two-Dimensional Discrete Cosine Transform (2D DCT) for JPEG image compression. The architecture utilizes row-column decomposition of a fast 1D DCT algorithm implemented with distributed arithmetic. The work also used efficient multiplier architecture based on *Urdhva-Tiryagbhyam* sutra of ancient Indian Vedic mathematics. The paper explores the algorithmic evaluations, architectural design and development of Verilog models, verification methods, synthesis operations and timing analysis. This cost-effective design is optimized at different levels of abstraction, i.e., algorithm, architecture and gate levels. The design uses 1952 logic cells of one Vertex IV family FPGA and reaches an operating frequency of 85.12 MHz with the pipeline latency of 96 clock cycles.

Keywords: Two-Dimensional Discrete Cosine Transform (2D DCT), Latency, FPGA

Introduction

Since multimedia applications on portable and low-power devices have become more prominent, the need for efficient, low-power image encoding and decoding techniques increases. The Discrete Cosine Transform (DCT) and the Inverse Discrete Cosine Transform (IDCT) form the transform pair in the JPEG, MPEG, H.261 and H.263 image and video compression standards. Its widespread use can be attributed to the energy compaction quality of the transform. DCT transformation of a natural image from the spatial to the frequency domain results in concentration of energy in low-

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