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Green Communications: An Introduction

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Abstract*— *As the volume of information carried by communication networks grows, the power consumption and environmental impact has been become an issue. Green Communications aims at reducing the energy consumption and environmental impact to a minimum without compromising the quality of service for users. Over the past decade, Green Communications has received much attention from government, academia, and industry.

Keywords—Green Communication, ICT, Power and Energy consumption, Transmission, Bandwidth, Wireless network,

I. INTRODUCTION

Two major factors that impact communications system design and performance are: (1) limited energy resources, and (2) randomly-varying channel conditions. As energy saving environmental protection become global demands, engineers must focus on energy-efficient design, that is, green radio [1]. There has been a growing interest in developing energy-efficient mobile communications systems due to environmental and financial considerations. We need energy-efficient systems to protect our environment, cope with global warming, and facilitate sustainable development. The developed solutions in this regard are known as Green Communications, to reflect the importance of their environmental dimensions [2]. The aim of Green Communications is to create innovative ways of reducing the total power needed to operate the future mobile communications systems.

The Information and Communications Technologies (ICT) industry is responsible for 2% of global Greenhouse Gases (GHG) emissions. The ICT industry has the potential to reduce the current global GHG emissions by 15% by the year 2020 [3]. Besides GHG emissions, telecommunication equipment typically contains a considerable amount of scare materials and treatment of the waste presents an environmental challenge. Green communication promises that emerging wireless network systems will deliver services at the minimum energy cost [4].

The interest in Green Communications has led to the birth of energy-aware consortia such as GreenTouch and Energy Aware Radio and Network Technologies (EARTH). GreenTouch (www.greenhouse.org) is a consortium of international ICT actors and its mission is to deliver architecture and specifications needed to increase network energy efficiency. EARTH's goal is significantly reducing the power consumption of cellular networks [5].

II. FUNDAMENTAL LIMITS

Traditionally, researchers aim to reduce carbon footprint by reducing energy consumption. To develop environmentally friendly ICT systems, we must first determine the fundamental limits of CO_2 emissions for point-point communications. Achieving Green communications requires that all blocks in a communication system (the baseband, the transmitter, the receiver, and the signal modulation) are designed for optimum efficiency. The goal of Green Communication is to ensure that communication systems consume less energy and have a smaller carbon footprint. Strategies for achieving this includes using renewable energy, biodiesel, and solar and fuel-powered cell sites, and installing fuel catalysts and cooling units [6].

Four fundamental trade-offs have been identified [1]: deployment efficiency-energy efficiency to balance the deployment cost and energy consumption in the network, spectrum efficiency-energy efficiency to balance the achievable rate and energy consumption, bandwidth-power to balance the bandwidth utilized and the power needed for transmission, and delay-power to balance the average end-to-end service delay and average power consumed. Figure 1 illustrates these trade-offs.

III. SOLUTIONS

Several solutions have been proposed to reduce power consumption in communication networks. Some have proposed the use of the Openflow protocol as a way of reducing network data center complexity and power consumption. This involves using an external controller to send routing decisions into the network It provides a reliable, scalable, cost-effective computing infrastructure for massive Internet services [3]. Another proposal is the use of time-

reversal (TR) signal transmission as in ideal paradigm for green communication. TR has the potential of reducing power consumption and focusing energy in both spatial and temporal domains allowing for improvement in signal to noise ratio gains. Also, high bandwidth efficiency can be achieved in TR radio communication [5, 7, 8].

An essential part of the solution is to transfer transport services from energy inefficient devices to "greener" ones. Migrating to optical networks is the long-term solution to reduce GHG emissions because optical devices consume less energy than electronic ones.

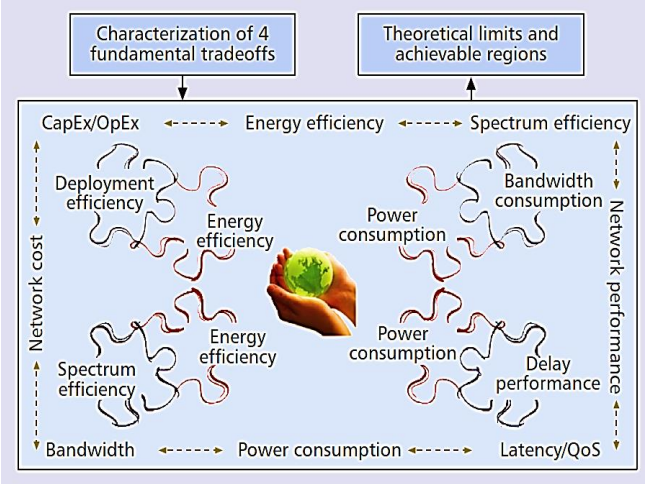

Figure.1 Fundamental trade-offs [1].

IV. CONCLUSIONS

The ability to deliver communication services at minimum energy cost (i.e. Green communication) is a key design issue in the emerging wireless networks. This paper has presented the green aspect of communications by emphasizing the awareness of carbon footprint (green index). The research for Green Communications is an interdisciplinary effort because it depends on various areas from computer architecture to networking. The need of adopting Green Communication has been realized worldwide.

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