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Achieve Sustainable Development in 5G Mobile Technology

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Authors' contributions

This work was carried out in collaboration between both authors. Author TRSAA designed the study, wrote the protocol. Author RMA managed the literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The next step in the evolution of mobile communication is 5G, and it's a key of the component of the future networked society. With capabilities such as massive system capacity, higher data rates, very low latency and ultra-high reliability, 5G will provide significantly enhanced the mobile-broadband experience but also support a wide range of new wireless applications and use cases. Sustainable development will lead to changes in the way mobile and wireless communication systems are used. As well as the rational exploitation of natural resources and the maintenance of ecological balance, taking into account the interests of future generations Essential services such as e-banking, eLearning, and e-health will continue to proliferate and become more mobile. On-demand information and entertainment (e.g., in the form of augmented reality) will progressively be delivered over mobile and wireless Communication systems. These developments will lead to an avalanche of mobile and wireless traffic volume, predicted to increase a thousand-fold over the next decade.

As the deployment and commercial operation of 4g systems are speeding up, technologists worldwide have begun searching for next-generation wireless solutions to meet the anticipated

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demands in the 2020 era given the explosive growth of mobile internet.
this study presents our perspective of the 5G technologies (Fifth generation technologies)
With achieving sustainable development By network capacity be significantly increased while network power consumption is decreased. Sustainable development is achieved investigated through five interconnected areas of research: energy efficiency and spectral efficiency co-design, no more cells, rethinking signalling/control, invisible base stations, and full duplex radio.
In this paper, we describe the scenarios identified for driving the Fifth generation research direction, integration for new radio concepts, such as massive MIMO (Multiple Input-Multiple Output), ultradense networks, moving networks, and device-to-device, ultrareliable, and massive machine communications, will allow Fifth generation technologies to support the expected increase in mobile data volume while broadening the range of application domains that mobile communications can support beyond 2020. Furthermore, we give initial directions for the technology components (e.g., link level components, multimode / multi-antenna, multi-RAT(multiple Radio Access Technologies), and multi-layer networks and spectrum handling) that will allow the fulfilment of the requirements of the identified Fifth generation technologies scenarios.

Keywords: 5G techniques; network capacity; energy efficiency; mmWave and green radio.

1. INTRODUCTION

With the maturing of the fourth generation (4G) standardisation and the ongoing worldwide deployment of 4G cellular networks, research activities on that will allow the fulfilment of the requirements of the identified Fifth generation [1]. Communication technologies have emerged in both the academic and industrial communities [2].

There is a broad consensus that will allow the fulfilment of the requirements of the identified Fifth generation technologies requirements include higher spectral efficiency (SE) , energy efficiency (EE), lower end-to-end latency, and more connection nodes [3,4].

As global carbon emissions increase and sea levels rise, worldwide weather and air pollution in many large cities across the world is becoming more severe. Consequently, energy saving has been recognised as an urgent issue worldwide [5]. Information and Communications Technologies (ICT) take up a considerable proportion of total energy consumption [5,6]. In 2012, the annual average power consumption by Information and Communication Technology (ICT) industries was over 200GW, of which telecoms infrastructure and devices accounted for 25 percent [6].

This paper aims at achieving sustainable development in communications technologies are universally deployed across this network, significant energy savings can be realised, enabling larger infrastructure deployments for fourth and Fifth generation(4G & 5G) capacity upgrades without requiring a significant increase in average revenue per user ARPU (average revenue per user).Dramatic improvements in Energy efficiency (EE) will be needed; consequently, new tools for jointly optimising network SE and EE (Spectral Efficiency and Energy Efficiency) will be essential [3]. Internet traffic growth and a large number of new applications/services demanding much shorter times to market, much faster turnaround of new network capabilities are required. Dynamic RAN reconfiguration can handle both temporal and spatial domain variation of mobile traffic without overprovisioning homogeneously [7,8].

Sustainable development technologies are the key to resolve these issues.

C-RAN implements a soft and virtualised BS with multiple baseband units (BBUs) integrated as virtual machines on the same server, supporting various radio access technologies (RATs) [9]. By separating software and hardware, control plane and data plane, building software over General-Purpose Processors (GPPs) via programming interfaces and virtualisation technology, it is possible to achieve lower cost and higher efficiency using Software Defined Networks (SDNs) and network functions virtualisation (NFV) [10].

This Sustainable study development will elaborate on a green and soft Fifth-generation technology vision. So, the traditional emphasis on maximising SE, EE must be positioned side by side for joint optimisation [4]. We present an EE and SE co-design framework. The concept of no more cells is highlighted later with user-centric design and C-RAN as key elements of a soft cell infrastructure. The rationale for a fundamental rethinking of signalling and control design in Fifth generation technologies is provided [11]. This study further discusses the idea of invisible BSs incorporating line-side answer supervision (LSAS) technology [12]. And the fundamental interference management issues in networks based on full duplex technologies and potential solutions are identified [13]. We try to pinpoint important focus areas and potential solutions when designing an energy efficient 5G mobile network architecture [14].

One of the big challenges is to meet the future requirements and expectations in an affordable and sustainable way. Low energy consumption is the key to achieve this [15]. Already today, the mobile operator's energy bill is an increasing part of their OPEX (operational expenditure), and with the future requirements and expectations, there is a clear risk that this may increase even further if nothing is done [16]. This is also important from a sustainability perspective; even though mobile communications today only contribute to a fraction of a percent of the global CO2 footprint [9] it is essential to maintain or even reduce this in the future. Hence, low energy consumption is an important design target for mobile communication systems in the future [17]. These include system architecture, where a logical separation of data and control planes is seen as a promising solution; network deployment, where (heterogeneous) ultradense layouts will have a positive effect; radio transmission, where the introduction of massive antenna configurations is identified as an important enabler; and, finally, backhauling solutions that need to be more energy efficient than today [18,19]. We try to pinpoint important focus areas when designing an energy efficient 5G mobile network architecture [20]. The outline is as follows: After a more in-depth discussion on significant challenges for mobile networks in the future, the essential focus areas and some potential solutions are outlined. Finally, a summary and concluding remarks are provided [20,21].

2. MATERIALS AND METHODS

There are a number of different challenges and requirements that mobile networks need to be able to handle in the future. Some of the most important ones from sustainable development design perspective will be discussed in the following subsections.

2.1 Data Traffic Volumes

Today, there are over 2 billion mobile broadband subscriptions worldwide, a figure that has grown 40% annually over the last six years, making mobile broadband the most dynamic market in the entire ICT sector [1] furthermore forecasts predict that data traffic volumes will experience an exponential growth in the coming years [22] as illustrated in (Fig.1). for example, it can be seen that the data traffic volumes are expected to increase approximately 10 times between 2012 and 2018. By extrapolation of this, one easily realises that a several hundred-fold, or even a thus and fold, an increase can be expected somewhere beyond 2020. This is well in line with other forecasts [18,22]. For example, predicts that per-user data rates are expected to grow by a factor of up to 50-100; on the other hand the density of mobile Internet users is expected to increase by a factor of up to 10, implying a factor of 1000x capacity demand in the 2020 time frame [23,24].

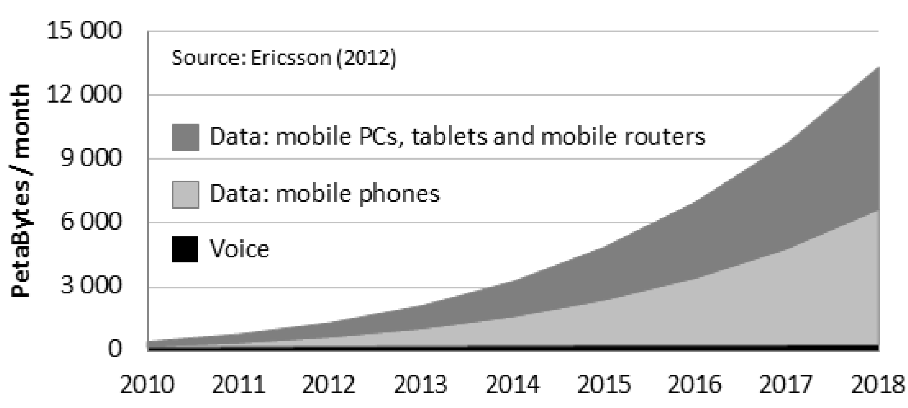


Fig. 1. Evolution of mobile data traffic per month up to 2018

Hence, it is obvious that mobile systems in the future need to be capable of delivering significantly more capacity than today [25,26,27]. This trend is important also from a green design perspective, since the mobile network evolution (additional deployment of legacy 2G,3G and 4G equipment and installation of new and efficient Fifth generation technology) should be performed by avoiding the risk of an unreasonable over-provisioning of the network that in this scenario will become more and more unsustainable in terms of costs [28] In fact, up to now mobile networks were dimensioned by taking into account the peak capacity. With this approach, exponential grow rate will imply a costly network deployment. Instead, evolved mobile networks should satisfy the increasing traffic demand by a flexible availability of capacity (in time and space) in order to sustain the data rate development that has been observed during recent decades [12,29].

2.2 Number of Connected Devices

Today, there are almost 7 billion mobile subscriptions, and thereby wireless connected devices, worldwide. Most of them are devices used by humans such as mobile phones, laptop computers, or tablets. However, in the future this is predicted to change, as different kinds of machines such as smart grid devices, sensors and surveillance cameras will be connected to the networks [30]. This is usually referred to as Internet-of-things or machine-to-machine (M2M) communication, and means that everything that can benefit from a wireless connection will have a wireless connection [31,32] Just by considering the number of devices in a normal home, one realizes that the number of connected devices in the future will be 10-100 times higher than today [33]. This kind of evolution will also introduce new characteristics of the traffic in the networks, e.g. due to the presence of a large number of M2M devices requiring small amount of bits, but requiring a relatively high overhead in terms of signaling. In this sense, the need of an efficient signaling management will be crucial also in terms of offering to the network nodes the possibility to be de-activated during no traffic periods. From this point of view the M2M traffic will introduce additional challenges for a green network design [34].

2.3 Diverse Requirements

In the evolutionary scenario discussed in the present paper, Fifth generation technologies will include a myriad of applications with a wide range of requirements and characteristics, some of them vastly different than what is the case in mobile systems of today. Some applications may require low latency, for example time critical control functions in industrial applications [30,34]. The same type of applications typically. Also require very high reliability, while others such as simple sensors can have lower reliability requirements. Certain applications such as surveillance cameras may have to convey enormous amounts of data while others have very small data amounts to send. This challenge need to be taken care of in the system design, as this sets up new and varying quality-of-service (QoS) requirements [35]. This may have a significant impact on the green design, as the minimization of network power consumption should not have impacts on the correct and efficient management of the Quality of Service (QoS) in the system [36].

2.4. Energy Consumption

Perhaps the most important challenge is to meet the above mentioned challenges and requirements in an affordable and sustainable way. Cost is an important issue to consider, and will be so also in the future. A capital expenditure and an operating expenditure (CAPEX & OPEX) need to be at a level where services can be provided at a reasonable end user price and with attractive business cases for the mobile operators. Already today, the mobile operator's energy bill is a substantial and increasing part of their OPEX, and with the future requirements and expectations there is a clear risk that this may increase even further if nothing is done. Hence, low energy consumption is very important, and we have above discussed the impact of the other challenges on this.

The energy consumption should at least be kept at the same level as today (despite the traffic growth, the massive amount of devices, and new requirements), but we believe that it is possible to go further than that. The EARTH project showed that it is possible to cut the energy consumption of LTE by a factor of 4 with a 2012 baseline [7,37] and recently the Green Touch consortium issued a press release [8] saying that they could cut the energy consumption of current systems by a factor of 10 with a 2010 baseline. Sustainable development will target a factor of 10 lower energy consumption compared to today, while fulfilling the requirements stated in the previous subsections [37,38].

Various organizations from different countries and regions have taken initiatives and launched programs aimed at potential key technologies of 5G: NOW Fifth generation technologies and METIS launched under the European Telecommunications Standards Institute's (ETSI's) Framework 7 study new waveforms and the fundamentals of Fifth generation technologies to meet the requirements in 2020; the Fifth generation Research Center was established in the United Kingdom to develop a world-class testbed of 5G technologies; the Third Generation Partnership Project (3GPP) has drawn up its draft evolution roadmap to 2020; and China has kicked off its Institute of Management Technology 2020 (IMT-2020) Forum to start the study of user demands, spectrum characteristics, and technology trends [35,39].

Several research groups and consortia have been investigating EE of cellular networks, including Mobile VCE, EARTH, and Green-Touch. Mobile VCE has focused on the BS hardware, architecture, and operation, realizing energy saving gains of 75–92 percent in simulations [40]. EARTH has devised an array of new technologies including low-loss antennas, micro direct transmission (DTX), antenna muting, and adaptive sectorization according to traffic fluctuations, resulting in energy savings of 60–70 percent with less than 5 percent throughput degradation [41,22]. Green Touch has set up a much more ambitious goal of improving EE 1000 times by 2020 .Several operators have been actively developing and deploying Sustainable development technologies, including Sustainable development BSs powered solely by renewable energies, and Sustainable development access infrastructure such as cloud / collaborative/clean radio access network (C-RAN). Carrier grade networks are complex and composed of special-purpose nodes and hardware [42]. New standards and features often require a variety of equipment to be developed and integrated, thus leading to very long launch cycles [43]. In order to accommodate the explosive mobile, The study will involve performance analysis and simulation of the proposed techniques applied to Antenna muting is proposed in EARTH to improve EE, while LSAS stipulates EE improvement by increasing the number of antennas. The seemingly contradicting conclusions are actually consistent with the analysis presented, where the difference is that the former operates in a low SE region, whereas the latter operates in a high SE region [44,45]. While some progress has been made in EE and SE co-design investigation, there is still a long way to go to develop a unified framework and comprehensive understanding in this area. We will work Ideally, So that it must achieve the EE-SE curve in future systems the following criteria:

- The EE value should be improved for each SE operation point.
- The EE-SE win-win region should be enlarged and the EE-SE trade-off region should be reduced.
- The slope of the EE-SE curve in the tradeoff region should be reduced.

With such tremendously expanding demand for wireless communications in the future, researchers are currently looking for viable solutions to meet the stringent throughput requirement. In this regard, three paradigms have emerged:

- Reduce the transmitter-receiver (Tx-Rx) distance and improve frequency reuse: ultra-dense networks (UDNs) and device-to-device (D2D) communications;
- Exploit unused and unlicensed spectrum: millimeter wave (mmWave) communications and Long Term Evolution (LTE) in unlicensed spectrum (LTE-U);
- Enhance spectral efficiency (SE) by deploying a massive amount of antennas: massive

2.5 Multiple-Input Multiple-Output (M-MIMO)

The technologies listed above increase the system throughput from three different angles. However, the performance gains introduced by these technologies do not come for free [46]. For example, M-MIMO exploits a large number of antennas for potential multiplexing and diversity gains at the expense of an escalating circuit power consumption in the radio frequency (RF) chains which scales linearly with the number of antennas. In addition, power-hungry transceiver chains and complex signal processing techniques are needed for reliable mmWave communications to operate at extremely high frequencies [22,47]. In light of this, the network energy consumption may no longer be sustainable and designing energy-efficient Fifth generation networks is critical and necessary. In fact, in recent years, energy consumption has become a primary concern in the design and operation of wireless communication systems motivated by the desire to lower the operating cost of the base stations (BSs), prolong the lifetime of the user terminals (UTs), and also protect the environment. As a result, energy efficiency (EE), measured in bits-per-Joule, has emerged as a new prominent figure of merit and has become the most widely adopted green design metric for wireless communication systems [41,48,49].

2.6 Millimeter Wave (mmWave) Communication Technologies

MmWave communications exploit the enormous chunks of spectrum available at mmWave frequencies and are expected to push the mobile data rates to gigabits-per-second for Fifth generation wireless networks [6]. However, the propagation conditions at the extremely high frequencies of the mmWave bands lead to several fundamental issues including high path attenuation, severe blockage effects, and atmospheric and rain absorption, which poses new challenges for providing guaranteed quality-of-service (QoS). Thanks to the small wavelengths of mmWave bands, a large number of antenna elements can be integrated in a compact form at both the BSs and the UTs and leveraged to synthesize highly directional beams leading to large array gains. Energy-efficient mmWave communications comprises the following aspects [22].

2.6.1 Energy-aware hybrid transceiver architecttures

For mmWave frequencies, the conventional fully digital architecture employed for micro-wave frequencies, where each antenna is connected to a dedicated RF chain, is unsustainable. In particular, an excessive power consumption arises from the processing of massive parallel giga samples per second data streams, leading to an energy inefficient and expensive system. Thus, a direct approach to reduce power consumption in practice is to adopt analog beamforming. Specifically, one RF chain is connected to multiple antennas and the signal phase of each antenna is controlled by a network of analog phase shifters (PSs) [13,50]. However, hybrid structures have been developed:

- Fully-connected architecture: each RF chain is connected to all antennas.
- Partially-connected architecture: each RF chain is connected only to a subset of antennas

2.6.2 Low resolution design

Besides hybrid structures, employing low resolution analog-to-digital converters (ADCs) at the receivers is an alternative approach towards energy-efficient designs [50]. The theoretical motivation is that the power dissipation of an ADC scales linearly with the sampling rate and exponentially with the number of bits per sample. Furthermore, the data interface circuits connecting the digital components to the ADCs are usually power hungry and highly depend on the adopted resolution have recently emerged as an attractive solution to meet the exponentially increasing demand on mobile data traffic [51]. Moreover, ultra dense networks (UDNs) combined with mmWave technology are expected to increase both energy efficiency and spectral efficiency. In this paper, user association and power allocation in mmWave based UDNs is considered with attention to load balance constraints, energy harvesting by base stations, user quality of service requirements, energy efficiency, and cross-tier interference limits. The joint user association and power optimization problem is modeled as a mixed-integer programming problem, which is then transformed into a convex optimization problem by relaxing the user association indicator and solved by Lagrangian dual decomposition. The proliferation of network devices and the growing demand for network services are contributing to a dramatic increase in overall network data traffic. This problem is exacerbated in typical macrocell networks because of blind spots and shadowing. A promising solution is the deployment of ultra dense networks comprising flexibly deployed low-power small base stations (BSs), such as microcell BSs, picocell BSs and femtocell BSs [9]. In Fifth generation technologies, ultra dense networks that are deployed with low-cost and low-power small cells are expected to enhance the overall performance of the network in terms of energy efficiency and load balancing. The millimeter wave (mmWave) frequency band is 30 ~ 300 GHz, corresponding to wavelengths from 10 to 1 mm. Due to its physical properties, mmWave can effectively solve many problems of high-speed broadband wireless access, and thus it has a broad application potential in short distance communication, such as in ultra dense small cell networks. The attenuation of mmWave reaches its maximum values in the 60 GHz, 120 GHz and 180 GHz bands [9]. This means that the interference levels for these attenuation bands are much lower compared to the 2-3 GHz bands. Moreover, due to the large 60 GHz bandwidth, mmWave systems can provide a relatively high data rates [9,52]. These characteristics of mmWave can play an indispensable role in enhancing spectral efficiency and energy efficiency of ultra dense networks. Load-balancing is a main factor influencing the performance of BSs in heterogeneous ultra dense networks. Due to the cross-tier interference and the various capabilities of BSs, although users are uniformly associated with BSs, the uneven power allocation leads to differences in user experience [9]. Load awareness based user association was proposed in and Traditionally, the signal-to-interference-plus-noise [31].

2.7 full Duplex Radio

Current cellular systems are either frequency division duplex (FDD) or TDD. To double SE as well as improve EE, full duplex operation should be considered for Fifth generation technologies. A full duplex BS transmits to and receives from different terminals simultaneously using the same frequency resource. Self-interference cancellation is the key to the success of a full duplex system since high DL interference will make the receivers unable to detect the UL signal. Significant research progress has been made recently in self interference cancellation technologies, including antenna placement, orthogonal polarizations, analog cancellation, and digital cancellation [52]. Most of the research, however, has been on either point-to-point relay or a single-cell BS scenario. There is also inter-user UL-to-DL interference in the single-cell full duplex system. To mitigate such interference, the inter-user interference channel must be measured and reported. The full duplex BS can then schedule proper UL and DL user pairs, possibly with joint power control. In the case of a multi-cell full duplex network, interference management becomes significantly more complex. For current TDD or FDD systems, the DL-to-DL interference received at UE and UL-to-UL interference received at BSs have been studied extensively in literature and standardization bodies (e.g., CoMP in 3GPP LTE Advanced and IEEE 802.16m). In a full duplex system, however, there are new interference situations. For example, if there are two BSs, there will be additional interference in the UL and DL between multiple UE mobile devices with the same frequency and time resources. In addition to intracell interference, there are inter-BS DL to UL-interference and intercell inter-user UL to- DL interference. These additional types of interference will adversely impact full duplex system performance. Traditional transmit or receive beamforming schemes can be applied to mitigate inter-BS DL-to-UL interference. The intracell interference mitigation can be extended to handle intercell inter-user UL-to-DL interference [43].

2.8 Rethink Shannon: EE and SE Co-Design

Given limited spectrum and ever-increasing capacity demand, SE has been pursued for decades as the top design priority of all major wireless standards, ranging from cellular networks to local and personal area networks. The cellular data rate has been improved from kilobits per second in 2G to gigabits per second in 4G. SE-oriented designs, however, have overlooked the issues of infrastructure power consumption. Currently, RANs consume 70 percent of the total power. In contrast to the exponential growth of traffic volume on mobile Internet, both the associated revenue growth and the network EE improvement lag by orders of magnitude [16]. A sustainable future wireless network must therefore be not only spectrum-efficient but also energy-efficient. Therefore EE and SE joint optimization is a critical part of Fifth generation research. Looking at traditional cellular systems, there are many opportunities to become greener, from the equipment level, such as more efficient power amplifiers using envelop tracking, to the network level, such as dynamic operation in line with traffic variations both in time and space. For the fundamental principles of EE and SE co-design, one must first revisit the classic Shannon theory and reformulate it in terms of EE and SE. In classic Shannon theory, the channel capacity is a function of the log of the transmit power (P_t) noise power spectral density (N_0), and system bandwidth (W). The total system power consumption is a sum of P_t and the circuit power P_c, that is,

$$P_{tot} = P_t / \rho + P_c$$

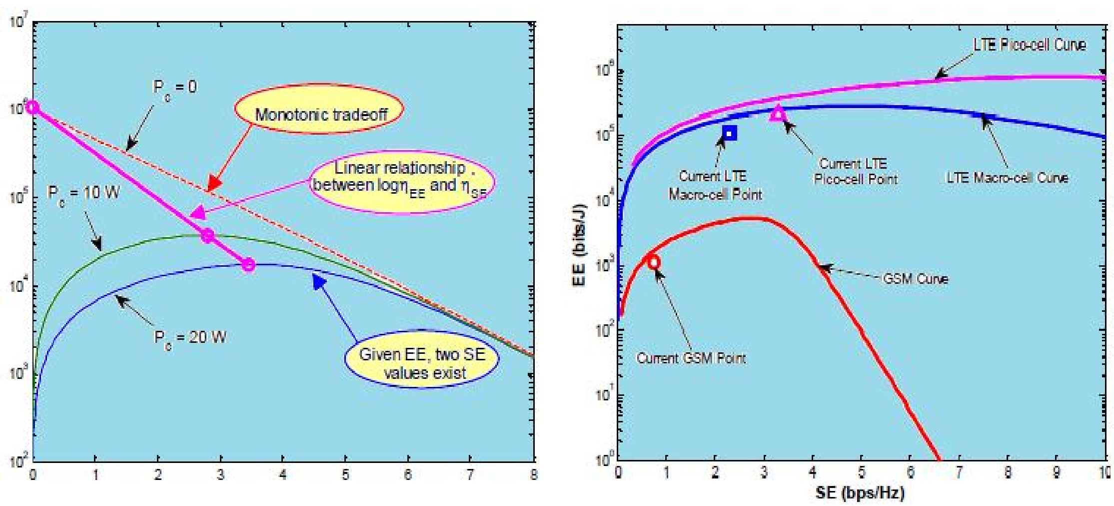
where r is power amplifier (PA) efficiency defined as the ratio of the input of the PA to the output of the PA. From the definition of EE [11,31] EE is equal to the channel capacity normalized by the system power consumption. SE is the channel capacity normalized by system bandwidth. The relationship of EE and SE can be shown as a function of PA efficiency and P_c in Fig. 2a. From Fig. 2a, it can be observed that when P_c is zero, there is a monotonic trade-off between η_{EE} and

η_{SE} as predicted by the classic Shannon theory. For nonzero P_c, however, η_{EE} increases in the low SE region and decreases in the high SE region with η_{SE} (for a given η_{EE}, there are two values of η_{SE}). As P_c increases, the EE-SE curve appears flatter. Furthermore, when taking the derivative of η_{EE} over η_{SE}, the maximum EE (η^*_{EE}) and its corresponding SE (η^*_{SE}) then satisfy the following: $\log 2\ \eta^*_{EE} = \log 2\ \rho /(N_0 \ln 2) - \eta^*_{SE}$. This means there is a linear relationship between $\log 2\ \eta^*_{EE}$ and η^*_{SE}, and the EE-SE relationship at the EE optimal points is independent of P_c. This observation implies that as P_c decreases, an exponential EE gain may be obtained at the cost of linear SE loss (Fig. 2). 2b compares the EE-SE performance of current Global System for Mobile Communications (GSM) and LTE BSs. LTE performs better than GSM in terms of both SE and EE; both, however, are working in a low SE region, indicating room for improvement.

Antenna muting is proposed in EARTH to improve EE, while LSAS stipulates EE improvement by increasing the number of antennas. These seemingly contradicting conclusions are actually consistent with the analysis presented above where the difference is that the former operates in a low SE region, whereas the latter operates in a high SE region. While some progress has been made in EE and SE co-design investigation, there is still a long way to go to develop a unified framework and comprehensive understanding in this area. Especially, new techniques, like spatial modulation [43]. Can utilise the antenna resource more efficiently. Ideally, the EE-SE curve in future systems should achieve the following criteria:

- The EE value should be improved for each SE operation point.
- The EE-SE win-win region should be enlarged and the EE-SE trade-off region should be reduced.
- The slope of the EE-SE curve in the tradeoff region should be reduced.

MIMO systems have been studied under these criteria. As shown in (Fig.3). Besides the linear relationship between $\log 2\eta_{EE*}$ and η_{SE*}, the slopes of the EE-SE curve are also affected by different parameters. We can see that when SE approaches zero, the slope depends only on the bandwidth and circuit power, and is independent of the antenna configuration and the knowledge of CSI at the transmitter. From the solid curves, we can see that reducing the circuit power can improve the EE in the low-SE region significantly. When SE approaches infinity, the slope is only related to the number of data streams, i.e. multiplexing gain, and independent of circuit power. From the dashed curves, it can be observed that when increasing the number of antennas, the EE improvement mainly happens in the high SE region. This observation implies that reducing circuit power has advantage in the low SE region while developing transmission techniques can improve the EE in the high SE region.



(a) (b)

Fig. 2. a) - SE and EE Relationship For Different Circuit Powers. b) - SE and EE Relationship For Current Cellular Networks

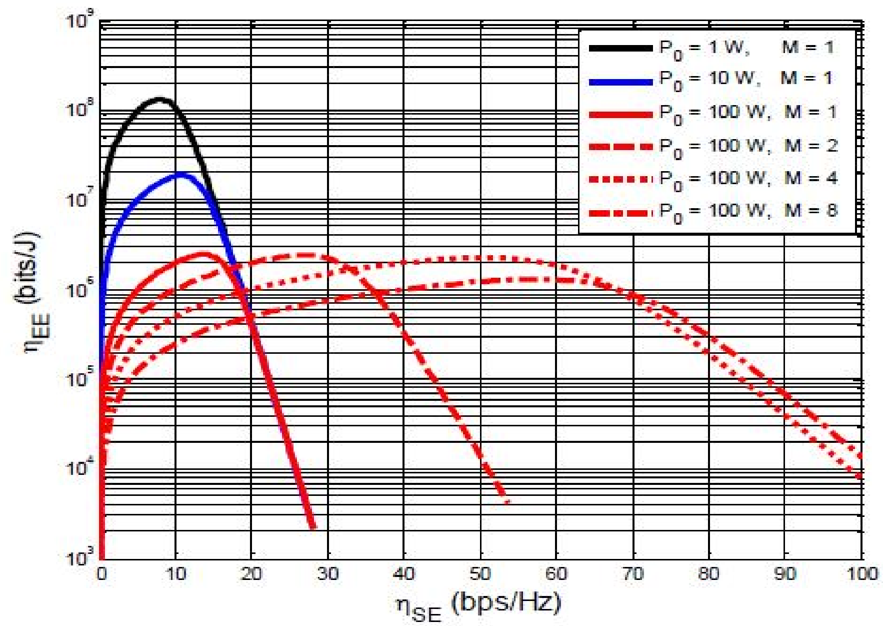


Fig. 3. The impact of the circuit power and the number of antennas on the EE-SE curves

2.8.1 EE-SE analysis of N by M active antenna structure

Although the generic LSAS requires a complete transceiver chain for each antenna element, for practical considerations, a much smaller number of transceivers than that of antenna elements may be adopted. Unlike current BS RF structures, where each transceiver is connected to a column of antenna elements generating a fixed coverage beam, the LSAS system under investigation is an LSAS system of size $L = N \times M$, where N is the number of transceivers and M is the number of active antennas per transceiver. For a given L, it would be desirable to find the optimal N in terms of EE-SE performance. In order to simplify the problem, it is assumed that there is perfect analog beamforming within each set of M active antennas with zero inter beam interference. Zero beam interference is based on the assumption that the number of transmit antennas L is larger than the number of receive antennas M. Assuming normalized channel gain, the sum capacity of this structure can be expressed as the number of transceivers times the log of the transmit power, number of antennas, and PA efficiency (similar to the Shannon channel capacity discussed later). In this model, a simplified power model of the sum of the antenna transmit power and total circuit power is used. The EE-SE relationship can then be written as the system capacity normalized by the number of transceivers' transmit power plus the circuit power. As shown in Fig. 4, when the transceiver power P_0 dominates, smaller N yields better EE performance at lower SE, while the optimal N increases at higher SE (optimal M can then be calculated by the size of L where $M = L/N$).If the P_{common} (common circuit power independent of the number of transceivers) is dominant, with larger N there is better EE performance at almost all values of SE.

2.9 No More Cells

this cell-centric design has been maintained through every new generation of standards including 4G.the nature of a homogeneous cell-centric design is that cell planning and optimization, mobility handling, resource management, signaling and control, coverage, and signal processing are all assumed to be done either for or by each BS uniformly. in practical deployment, it is clear this system does not match with traffic variations and diverse environments. relay, coordinated multipoint (CoMP), distributed antenna systems (DASs), and heterogeneous networks (HetNets) have been implemented as short-term solutions to amend these issues. Recently, beyond cellular green generation (BCG2), liquid cells, soft cells, and phantom cells have surfaced as potential radio access architectures. These paradigms all lead to the principle of no more cells. Fifth generation technologies design should start with such a paradigm shift, departing from cell-based coverage, resource management, and signal processing, and leaning toward user-centric coverage facilitated by a cran architecture [51].

2.9.1 C-RAN

Building on the architecture of distributed BSs where radio units are placed outdoors closer to the antenna and baseband units (BBUs) are placed indoors at cell sites, C-RAN goes one step further by bringing BBUs from multiple BSs to a central pool location (Fig.6). The GPP servers perform baseband processing using virtual machines running on real-time Linux. The centralization of the baseband processing leads to more energy-efficient cooling, making the CRAN network architecture an essential part of the design of energy-efficient networks. Energy savings of 70 percent in the OPEX of the BS infrastructure have been realized in 2G and 3G trials inside China. By virtualizing the baseband processing, new features can be added to the network within months, as opposed to years in the traditional infrastructure. The centralized baseband processing allows for soft technologies such as Co MP processing, multi-RAT virtualization, as well as soft and dynamic cell reconfiguration [18,51]. C-RAN is a revolutionary new type of radio access architecture and another essential element of Fifth generation technologies.

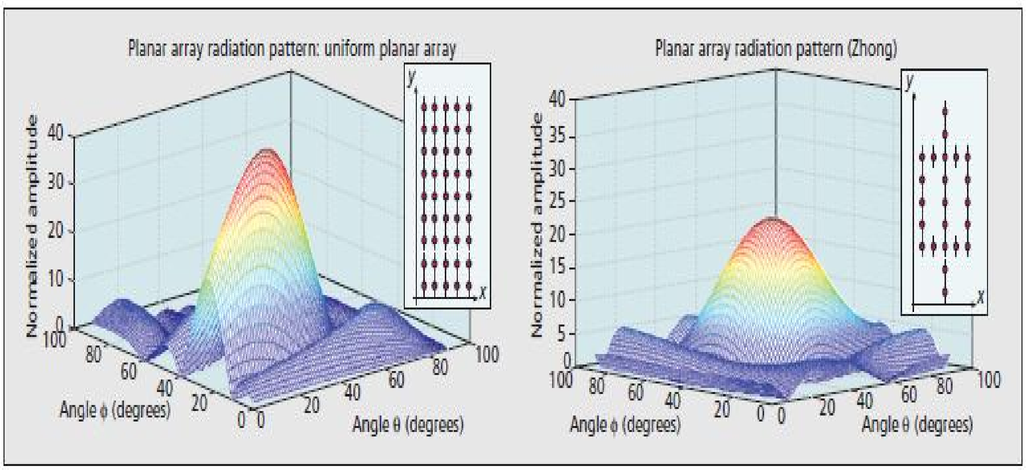


Fig. 4. 3D radiation patterns for uniform and irregular arrays

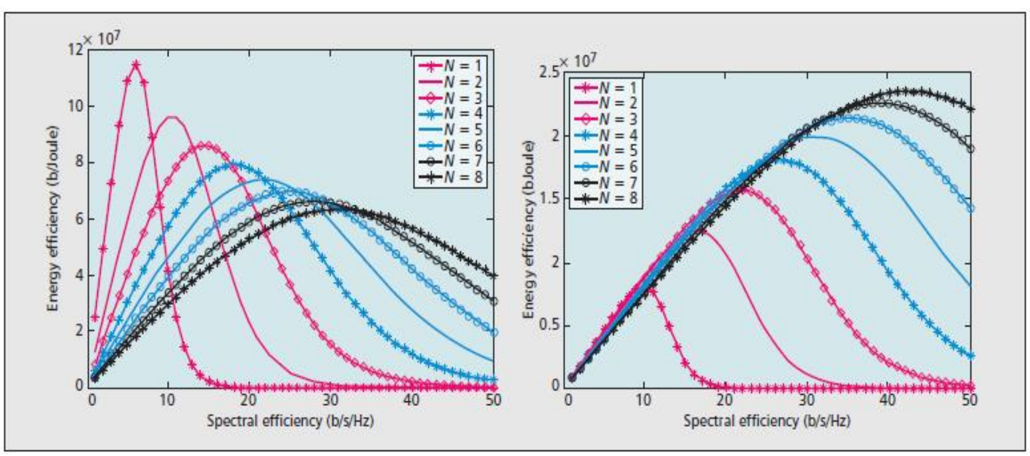


Fig. 5. ***EE-SE curves for* N *transceivers where* P*0 = 4* W *and* Pcommon *= 0* W *for the left and* Pcommon *= 100 W for the right graph***

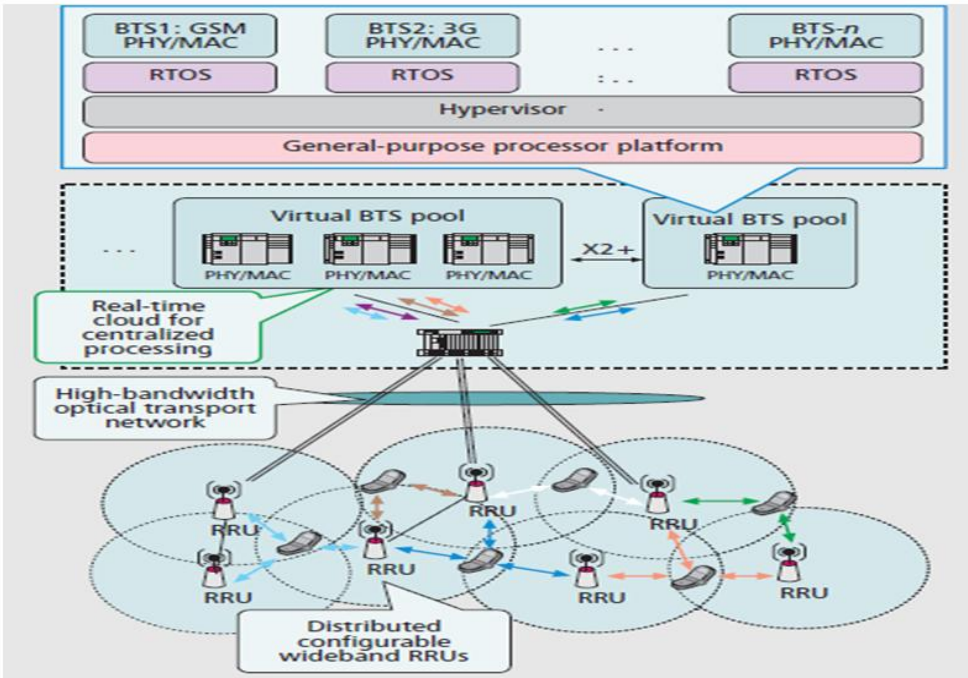


Fig. 6. C-RAN architecture

3. RESULTS AND DISCUSSION

In this paper we proposed targeting a achieve sustainable development in Fifth generation system. The fundamental differences between classic Shannon theory and practical systems are first identified and then harmonized into a framework for EE-SE co-design. The characteristics of no more cells are described from the perspective of infrastructure and architecture variations with particular emphasis on C-RAN as a typical realization in order to enable various soft technologies. Rethinking signaling/control based on diverse traffic profiles and network loading is then explored, and initial redesign mechanisms and results are discussed. Virtually invisible base stations with irregular LSAS array are envisioned to provide much larger capacity at lower power in high-density areas when integrated into building signage. Optimal configuration of transceivers and active antennas is investigated in terms of EE-SE performance.

EE can reduce the negative impacts of energy use on the environment and human well-being .So, EE can increase the availability of primary energy reserves while achieving maximum service benefits from the available energy.

4. CONCLUSION

This paper has provided an outlook on Sustainable development aspects and solutions for Fifth generation mobile network design. New interference scenarios are identified in full-duplex networks, and several candidate solutions are discussed. The feasibility of the combination of Sustainable and development is investigated through five interconnected areas of research: energy efficiency and spectral efficiency co-design, no more cells, rethinking signalling/control, invisible base stations, and full duplex radio. These five areas provide a potential for fundamental breakthroughs, and together with achievements in other research areas, they will lead to a revolutionary new generation of standards suitable for 2020 5G deployment. It has been found that:

- Inefficient use of energy = higher costs
  - To companies and industry
  - To the end-user
  - To the environment
- Energy use is environmentally detrimental
  - Locally (soil degradation, poor air quality)
  - Globally (climate change)

- Conventional energy resources are finite
- More efficient use of energy => greater availability of a scarce resource.

4.1 The Future Scope

The need for Sustainable development communications and networking technologies has been recognized during the last few years by our research communities. However, many challenges still remain to be addressed.

is encourage high-quality research in Sustainable development communications and networking , that will allow for the fulfillment of the requirements of the sustainable development in Fifth generation technologies, and push the theoretical and practical boundaries forward for a deeper understanding in fundamental algorithms, modeling, and analysis techniques from academic and industry viewpoints.

Authors from both academia and industry are invited to submit papers presenting new research related to the theory or practice of Sustainable development communications and networking for that will allow the fulfillment of the requirements of the identified Fifth generation technologies, including algorithms, modeling, technologies and applications. The topics suggested can be discussed in terms of concepts.

Topics of interest include, but are not limited to:

- Sustainable development Multiple access/modulation schemes beyond OFDMA
- Focus on energy efficiency technique and method for re-allocating bandwidth.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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