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THE ROLE OF BLOCKCHAIN IN 6G: CHALLENGES, OPPORTUNITIES AND RESEARCH DIRECTIONS

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Abstract—The world is going through a fundamental trans- formation with the emergence of the intelligent information era. The key domains linked with human life such as healthcare, transport, entertainment, and smart cities are expected to elevate the quality of service with high-end user experience. Therefore, the telecommunication infrastructure has to meet unprecedented service level requirements such as ultra high data rates and traffic volume for the prominent future applications such as Virtual Reality (VR), holographic communications, and massive Machine Type Communications (mMTC). There are significant challenges identifiable in the communication context to match the envisaged demand surge. The blockchain and distributed ledger technology is one of the most disruptive technology enablers to address most of the current limitations and facilitate the functional standards of 6G. In this work, we explore the role of blockchain to address formidable challenges in 6G, future application opportunities and potential research directions.

Index Terms—6G Networks, Blockchain, Distributed Ledger Technology, massive Machine Type Communications (mMTC), Industrial Internet

I. INTRODUCTION

6G mobile networks are envisioned to nurture the future of ubiquitously connected data-intensive intelligent society [1] powered with complete automation by seamless integration of all sorts of wireless networks spread over ground, underwater, air and space [2]. Moreover, 6G is also envisaged to keep up with the explosive growth in mobile traffic which is estimated to be 607 Exabyte/month by 2025 and 5016 Exabyte/month by 2030 [3] for the emerging applications such as [4]–[7].

By and large, the next generation of mobile networks are expected to be innately softwarized, virtualized and cloudified systems [1], [8] with the motive *to interconnect* seamlessly a staggering number of heterogeneous devices including massive IoT/IoE devices, *to cater* anticipated explosive growth in data traffic at ultra-high data rates along with ultra-low latency [2], *to create* incredible range of new vertical network services [9], [8], and *to support* the development of brand-new set of real-time [2] and data-intensive [7] applications.

Undoubtedly, softwarization, virtualization and cloudifica- tion of next generation mobile networks lead to enormous ad- vantages like micro operator based business models [10], agile and efficient management and network orchestration (MANO), on-the-fly creation of vertical services, differentiated services with network slicing [11], etc. However, they tend to exacer- bate the issues like network reliability, security vulnerability, data privacy and immutability [12], soft spectrum sharing, multiple access control, authentic Virtual Network Functions (VNFs) [13], legitimate resource utilization, and differential security for differentiated services offered by different virtual networks [11].

Lately, blockchain technology and in general distributed ledger technology have gained momentum and have been embraced by the industry and research communities across the globe. Some of the offerings of blockchain technology are: *(i)* decentralization by eliminating the need of central trusted third parties and intermediaries, *(ii)* transparency with anonymity, *(iii)* provenance and non-repudiation of the trans- actions made, *(iv)* immutability and tamper-proofing of the distributed ledger's content, *(v)* elimination of single point- of-failure (improving resiliency and resistance to attacks like DDoS), *(vi)* comparatively less processing delay as well as processing fee. Thus blockchain is regarded as an indispens- able technology to establish trust in future networks.