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Blockchain and Double Auction-Based Trustful EVs Energy Trading Scheme for Optimum Pricing

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Abstract: Electric vehicles (EVs) have gained prominence in smart transportation due to their unparalleled benefits of reduced carbon footprints, improved performance, and intelligent energy trading mechanisms. These potential benefits have increased EV adoption at massive scales, but energy management in EVs is a critical study problem. The problem is further intensified due to the scarcity of charging stations (CSs) in near EV proximity. Moreover, as energy transactions occur over open channels, it presents critical security, privacy, and trust issues among decentralized channels. To address the open limitations of trusted energy management and optimize the pricing control among EV entities (i.e., prosumers and consumers), the paper proposes a scheme that integrates blockchain and a truthful double auction strategy for trustful EV trading. To address the transaction scalability, we integrate an Interplanetary File System (IPFS) with a double auction mechanism handled through the Remix Smart Contract environment. The double auction leverages an optimal payoff condition between peer EVs. To address the communication latency, we present the scheme at the backdrop of Fifth Generation (5G) networks that minimizes the optimal payoff response time. The scheme is simulated against parameters such as convergence, profit for consumers, computation time, and blockchain analysis regarding node commit latency, collusion attacks, and EV energy consumption. The results indicate the scheme's viability against traditional (non-blockchain) approaches with high reliability, scalability, and improved cost-efficiency.

Keywords: blockchain; electric vehicles; IPFS; truthful double auction

MSC: 68M25

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1. Introduction

The enormous growth of intelligent transportation systems (ITS) is adversely affecting the green environment of smart cities due to the persistent depletion of non-renewable resources such as fossil fuels, coal, and natural gas. Over the last few years, industries and government institutions have tried to control the emission of harmful greenhouse gases in the urban areas [1,2]. As a result, automotive industries have transitioned from petrol or fossil fuel vehicles to electric vehicles (EVs) so that drivers can also be satisfied with ITS for affordable traveling [3]. EVs utilize renewable resources such as solar energy, nuclear power plant, wind power plant, etc., proving to be a plausible solution for a green and safe environment [4]. Many authors have considered electric mobility in their research work to