Guest Editorial Special Issue on Intent-Based Networking for 5G-Envisioned Internet of Connected Vehicles

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WITH the recent advances in wireless communications, the automotive industry is leading to evolution. To succeed in this emerging era of technology, the Internet of Connected Vehicles (IoCV) has emerged as one of the potential applications of the Internet of Things (IoT). It refers to the dynamic mobile communication systems that communicate between vehicles and public networks to enhance the connectivity between cars via technology. By offering a wide variety of infotainment services, fleet operations, and in-vehicle applications, IoCV has gained the tremendous capacity to provide a safer and sustainable transportation system to the society. According to Gartner Inc., "the connected car is already a reality, and in-vehicle wireless connectivity is expanding rapidly." As a result, the evolution of cars into the IoT will keep on accelerating the global market which is expected to grow by 270% by 2022. Furthermore, the increasing deployment of sensors and ever-evolving cognitive technology opens up new opportunities for IoCV. Due to these significant developments, connected vehicles are receiving widespread attention from the major automotive giants such as Tesla, BMW, Waymo (Google), Uber, Volvo, and so on. Despite all the opportunities offered by the IoCV, their highly dynamic topology and the increasing number of vehicles pose challenges regarding delivering low-latency vehicle-to-everything (V2X) communications.

The fifth-generation (5G) wireless networks emerge as a critical provider to handle the stringent connectivity requirements of IoCV. Moreover, with the development of massive multiple-input-multiple-output (MIMO), non-orthogonal multiple access (NOMA), terahertz (THz) frequencies, millimeter-wave (mmWave), and heterogeneous networks (HetNets), 5G intends to guarantee new capabilities related to connectivity, data rates, transmission delay, throughput and moreover quality of experience (QoE). Thus, integrating 5G cellular systems into IoCV is a promising technology to achieve the goals mentioned above. However, as we are moving towards the 5G communication era, the data generated by connected vehicles are expected to grow exponentially; which in turn brings significant challenges to 5G. Therefore, to promote productivity, improve efficiency, and ensure the efficient handling of continuous growing data, it requires the support of high computing paradigm that can process the data with minimum delays. To accomplish these objectives, a programmable and scalable network paradigm is the need of the hour that can provide a variety of services to 5G-envisioned IoCV in diversified scenarios.

In this direction, software-defined networking (SDN) and network function virtualization (NFV) have gained much attention from the research fraternity. They rely more on network programmability to realize efficient network services. However, this traditional device-to-device management paradigm falls short while dealing with 5G mobile networks as it is characterized by a humongous cycle of connected devices. To overcome these problems, intent-based networking (IBN) has evolved as one of the paradigm shifts which combines automation with intelligence. Typically, IBN is composed of four essential elements, namely, translation and validation, automated implementation, awareness of network state, and assurance and dynamic optimization/remediation, which takes the networking strategy to a higher level. Due to these fundamental elements, IBN holds excellent potential for reliable network support with quick turnaround and scalable services. In addition, it also facilitates simplified network operations with seamless integration of artificial intelligence and machine learning. This, in turn, provides more opportunities to build more robust and efficient network designs for 5G-envisioned IoCV.

Thus, this Special Issue (SI) intends to offer an opportunity for researchers (both from industry and academia) to present the dedicated efforts on the key theories, innovative schemes, and significant applications for realizing QoE in 5G-envisioned IoCV communication. This SI mainly focuses on the original contributions related to IBN–IoCV amalgamation in 5G wireless networks, which aims to provide high-performance scalable computing to connected vehicles while advancing the V2X communication infrastructure. We received around 100 submissions, and each manuscript was assigned to at least three reviewers with relevant subject matter experts. After a thorough evaluation of the articles by reviewers, 37 articles are eventually accepted for inclusion in this SI which have been organized in the following categories:

1) Secure and trustable models for IoCV
2) Unmanned aerial vehicle (UAV)-based solutions
3) Blockchain-powered IoCV applications
4) 5G and beyond applications for connected vehicles
5) Mobility management and network intelligence
6) QoS applications and services for IoCV

We will now briefly introduce the accepted articles and highlight their main contributions.

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I. Secure and Trustable Models for IoCV

Data privacy remains a critical issue in connected vehicles based on the IoT. The vehicle's sensory data contain sensitive information, such as location and speed, which could violate the users' privacy if they are leaked with no perturbation. The article entitled "Preserving privacy in the Internet of Connected Vehicles," by Ghane *et al.*, proposes a differentially private data streaming system that adds a correlated noise in the vehicle's side (IoT layer) rather than the transportation infrastructure. Also, the proposed system can ensure a healthy privacy level over time. The proposed mechanism is data-adaptive and scales the noise concerning the data correlation.

For IoCV, location is more than just query criteria like in location-based services (LBSs) of mobile internet. To solve the location privacy dilemma, the article entitled "LocJury: An IBN-based location privacy preserving scheme for IoCV," by Wang *et al.*, proposes an intent prediction-based approach named LocJury, which benefits from the emerging concept of IBN. LocJury provides location privacy by learning and estimating the intent of location access and penalizes the those malicious location accesses. By simulating the conceptual IBN-based IoCV application scenario, which relies on the location accesses, the performance of LocJury is evaluated under various circumstances.

Controller area network with flexible data-rate (CAN FD) is beneficial for the in-vehicle communication of IoCVs because of its high bandwidth and data field length. However, CAN FD lacks a security authentication mechanism, making it extremely vulnerable to masquerade attacks. The article entitled "Security enhancement for real-time parallel in-vehicle applications by CAN FD message authentication," by Xie *et al.*, proposes the security enhancement for a real-time parallel in-vehicle application adopting a two-stage method. The first stage obtains the lower bound of an in-vehicle application by quickly abandoning most of the sequences, while the second stage enhances security by adding message authentication codes (MACs) to messages taking advantage of the laxity interval from the lower bound to the deadline. Experiments with an example and the adaptive cruise control in-vehicle application show the advantage of the proposed two-stage method in increasing the total byte size of MACs.

It is vital to authenticate data in the Internet of Vehicles (IoV) to make sure that legitimate data is being propagated. The existing literature contains some limitations for robust security in the IoV such as high delay introduced by security algorithms, security without privacy, and reduced overall communication efficiency. To address these issues, the article entitled "On the elliptic curve cryptography for privacy-aware secure ACO-AODV routing in intent-based Internet of Vehicles for smart cities," by Safavat and Rawat, proposes the elliptic curve cryptography (ECC)-based ant colony optimization ad hoc on-demand distance vector (ACO-AODV) routing protocol which avoids suspicious vehicles during message dissemination in the IoV. The experimental results illustrate that the proposed approach provides better results than the existing approaches.

In the article entitled "Privacy-preserving continuous data collection for predictive maintenance in vehicular fog-cloud," Kong *et al.* propose a privacy-preserving and verifiable continuous data collection scheme with the intent of predictive maintenance in vehicular fog, which gathers and organizes the sensor data of each individual vehicle on a sliding window basis. The proposed scheme also aggregates and authenticates the collected sensory data reports on a time-series sliding window basis, which achieves the continuous observation of the recently collected vehicular sensory data.

The article "HDMA: Hybrid D2D message authentication scheme for 5G-enabled VANET," by Wang *et al.*, proposes a hybrid device to device (D2D) message authentication (HDMA) scheme for 5G-enabled VANETs where a novel group signature-based algorithm is used for mutual authentication between vehicle to vehicle (V2V) communication. In addition, a pre-computed lookup table is adopted to reduce the computation overhead of modular exponentiation operation.

Modern cars include a huge number of sensors and actuators, which continuously exchange data and control commands. The most used protocol for communication of different components in an automotive system is the controller area network (CAN). The article entitled "CAN-bus attack detection with deep learning," by Amato *et al.*, uses neural networks and multilayer perceptrons to detect the malicious injected messages toward the CAN-bus. The main innovation introduced in this work is that the approach aims at detecting the malicious injected messages by analyzing human behaviors of attackers.

II. UAV-Based Solutions

UAV-based service providers, i.e., Drones-as-a-Service (DaaS), are increasingly popular in recent years. Due to the heterogeneity of vehicular networks and flying networks, the performance of content distribution between IoCVs and UAVs becomes a new challenge. Moreover, the stringent regulations potentially impede data sharing across independently owned UAVs. The article entitled "UAV enabled content distribution for Internet of Connected Vehicles in 5G heterogeneous networks," by Su *et al.*, presents a novel content distribution mechanism based on IoCVs for UAVs in 5G HetNets. First, a content distribution architecture is developed between IoCV content providers and UAVs. Second, based on the transmission delay of content distribution, an optimization problem is established to determine the strategy of content distribution. Third, a coalition game between IoCVs and UAVs is designed for content distribution, where the utilities of IoCVs and UAVs are formulated to stimulate UAVs to form the optimal partitions. Next, a content distribution algorithm based on a coalition game is presented to derive the optimal strategy.

The article entitled "Energy efficiency and hover time optimization in UAV-based HetNets," by Muntaha *et al.*, proposes an energy-efficient UAV-based heterogeneous network with optimized hover times of UAVs for a longer service duration. The optimization problem is solved by utilizing a two-layer framework which is based on the Lagrange multipliers method

and a sub-gradient approach. The simulation results show a significant enhancement in the quality of service (QoS) of users and better utilization of energy resources in a heterogeneous network (HetNet).

The article entitled "A WPT-enabled UAV-assisted condition monitoring scheme for wireless sensor networks," by Perera *et al.*, investigates a resource allocation and data gathering scenario of a UAV-assisted wireless network, in which the SNs are remotely powered by power beacons (PBs) via radio-frequency wireless power transmission (RF-WPT). A time-block structure with two phases is proposed to accommodate operations in the proposed system. Then, a closed-form expression for the outage probability of the proposed system over Rayleigh and Rician fading channels is derived. Next, the outage probability minimization problem is formulated to obtain optimal time allocation for RF-WPT energy harvesting to improve the system performance. Due to the complexity of the problem, the Lagrangian duality method is used to develop an asymptotic optimal solution with less execution complexity avoiding complex brute force/exhaustive search approach. Furthermore, a heuristic method is presented to further lower the computation complexity.

The article "Learning-based intent-aware task offloading for air-ground integrated vehicular edge computing," by Liao *et al.*, develops a novel task offloading framework for air-ground integrated vehicular edge computing (AGI-VEC), which is called the learning-based Intent-aware upper confidence bound (IUCB) algorithm. IUCB enables a UV to learn the long-term optimal task offloading strategy while satisfying the long-term ultra-reliable low-latency communication (URLLC) constraints in a best-effort way under information uncertainty. IUCB can achieve three-dimension intent awareness including QoE awareness, URLLC awareness, and trajectory similarity awareness.

The article "Towards federated learning in UAV-enabled Internet of Vehicles: A multi-dimensional contract-matching approach," by Lim *et al.*, proposes the adoption of a Federated Learning (FL) based approach to enable privacy-preserving collaborative Machine Learning across a federation of independent DaaS providers for the development of IoV applications, e.g., for traffic prediction and car park occupancy management. Given the information asymmetry and incentive mismatches between the UAVs and model owners, the proposed scheme leverages on the self-revealing properties of a multi-dimensional contract to ensure truthful reporting of the UAV types, while accounting for the multiple sources of heterogeneity. Then, the Gale–Shapley algorithm has been adopted to match the lowest cost UAV to each subregion.

The article "UAV-assisted content delivery in intelligent transportation systems—Joint trajectory planning and cache management," by Al-Hilo *et al.*, presents a UAV platform based on principles of cache design aiming to provide digital content services for vehicles traveling on a highway segment. After dispatching, the UAV attempts to fetch contents from vehicles to fill its cache by adjusting its location to catch up with vehicles' mobility. However, as contents have different popularity profiles and the cache unit is constrained, only vehicles holding popular contents are targeted. Once the UAV cache is filled, the UAV begins to serve vehicles that request available/cached contents by following them. However, as UAV movement incurs power consumption (based on the corresponding velocity), this work accounts for UAV energy efficiency maximization. To do so, the content placement problem is jointly optimized with UAV trajectory. Then, deep reinforcement learning is employed to control the UAV mobility such that it strikes a balance between power consumption and quality of service.

III. Blockchain-Powered IoCV Applications

Today's advances in blockchain have led more IoT applications to adopt such a technology, given its reliability and scalability features. AI-enabled 5G networks are now being supported by blockchain to provide more secure services. In the article entitled "Blockchain-based secure mist computing network architecture for intelligent transportation systems," Sharma and Park propose a secure distributed mist computing network architecture for intelligent transportation systems (ITS) by leveraging the features of blockchain technology. Here, the authors present IoT user/device registration and authentication algorithms and enable the computing resources at the extreme edge of the network by deploying a smart contract. The proposed model uses an aggregate signature scheme to generate a signature for multiple IoT devices.

The article "Blockchain-based cyber-physical security for electrical vehicle aided smart grid ecosystem," by Kaur *et al.*, presents a secure and efficient mutual authentication protocol based on elliptic curve cryptography and blockchain for privacy preservation during smart energy trading. The capabilities of SDN are leveraged to handle the complex interactions between different subsystems of the smart grid whereas blockchain and smart contracts' properties have been exploited to secure energy transactions and underlying data communications.

The article "Enabling intelligent IoCV services at the edge for 5G networks and beyond," by AlRidhawi *et al.*, develops a hybrid service-clustered multi-chord network that is supported by both blockchain and reinforcement learning. The solution adapts an intelligent clustering algorithm that groups similar services, leading to faster composite service retrieval. The proposed decentralized architecture allows for complex composites to be delivered to the requesters in highly dynamic and unstable vehicular networks. Blockchain is used to ensure that nodes interact with each other verifiably and record transactions without the need for trusted intermediaries.

IV. 5G and Beyond Applications for Connected Vehicles

5G and beyond technologies have become the center of attention in managing and monitoring high-speed transportation systems effectively with intelligent and self-adaptive sensing capabilities. The article entitled "Joint computing and caching in 5G-envisioned Internet of Vehicles: A deep reinforcement learning based traffic control system," by Ning *et al.*, develops an intent-based traffic control system by investigating deep reinforcement learning (DRL) for 5G-envisioned

IoCVs, which can dynamically orchestrate edge computing and content caching to improve the profits of mobile network operator (MNO). By jointly analyzing MNO's revenue and users' quality of experience, a profit function is defined to calculate the MNO's profits. After that, a joint optimization problem is formulated to maximize MNO's profits, and an intelligent traffic control scheme is developed by investigating DRL, which can improve system profits of the MNO and allocate network resources effectively.

The complicated edge server locations among macro base stations (MABSs) and roadside units (RSUs) make it difficult to conclude the offloading destinations of the computing tasks in IoCV. Thus, in the article entitled "Adaptive computation offloading with edge for 5G-envisioned Internet of Connected Vehicles," Xu *et al.* devises an adaptive computation offloading method, named ACOM to optimize the task offloading delay and resource utilization of the edge system in 5G-envisioned IoCV. More specifically, the multi-objective evolutionary algorithm based on decomposition (MOEA/D) is fully leveraged to generate the available solutions. Then, the optimal offloading solution is obtained by utility evaluation.

The article entitled "Towards 5G-enabled self adaptive green and reliable communication in intelligent transportation system," by Sodhro *et al.*, proposes a 5G driven energy-efficient and reliable framework for a self-adaptive vehicular network in ITS in order to facilitate the end-users at cost-effective rates. Here, the energy and reliability in terms of received signal strength (RSSI) and packet loss ratio (PLR) optimization is performed under the constraint that all transmitted packets must utilize minimum transmission power with high reliability under a particular active time slot.

The article entitled "Clustering-learning-based long-term predictive localization in 5G-envisioned Internet of Connected Vehicles," by Lin *et al.*, proposes a vehicle clustering method to analyze the behavioral correlation between vehicles and classify them into different clusters. Based on the clustering method coupled with a deep learning model, a clustering-learning-based long-term predictive localization (CLPL) algorithm is further proposed in order to predict vehicles' future location distribution. Here, all the traffic roads are divided into consecutive small segments in order to pinpoint vehicles' precise current locations and to obtain long-term predictions.

The article entitled "An application-driven framework for intelligent transportation systems using 5G network slicing," by doValeSaraiva *et al.*, proposes a new framework for application-driven vehicular networks using 5G network slicing to deal with the heterogeneous requirements of different ITS applications in the complex and dynamic environment of vehicular networks. Each ITS application could have different communication requirements, such as delay, bandwidth, and packet delivery ratio. The framework aims to meet these requirements considering the application's priorities, the vehicles that are subscribers, and the available network resources.

The article entitled "Compiler-based efficient CNN model construction for 5G edge devices," by Wan *et al.*, proposes a search scheme that effectively reduces the sparse kernels (SK) design space based on three aspects: composition, performance, and efficiency. In order to facilitate the direct deployment of deep-learning models on 5G edge devices, it presents a new idea of "information field" to guide how to construct efficient convolution neural networks (CNN) models while maintaining reasonable model accuracy. Then to help ease the difficulty of model transformation a compiler framework is built to realize the automatic model transformation.

The article entitled "6G-enabled network in box for Internet of Connected Vehicles," by Lv *et al.*, analyzes and expounds the 6G technology and its key application fields, and lists several wireless channel measurement methods for 6G which provides an important reference for the development of 6G technology. It is found that the construction of the 3-D information network is one of the important research directions of the current 6G technology development, and there are still many problems in wireless communication channels that need to be solved further. Through the exploration of high-speed railway and train to a vehicle communication channel, it is proved that 6G technology can meet the time and space requirements of vehicle-to-vehicle interconnection.

V. Mobility Management and Network Intelligence

In the IoV, a significant volume of data is exchanged through networks between ITS and clouds or fogs. With the introduction of SDN, the problems mentioned above are resolved by high-speed flow-based processing of data in network systems. To classify flows of packets in the SDN network, high throughput packet classification systems are needed. A key idea to accelerate the software-based classifiers is to parallelize the packet classification algorithms on graphical processing units (GPUs). In the article entitled "Efficient flow processing in 5G-envisioned SDN-based Internet of Vehicles using GPUs," by Abbasi *et al.*, the authors study parallel forms of Tuple Space Search and Pruned Tuple Space Search algorithms for the flow classification suitable for GPUs using CUDA (compute unified device architecture). The key idea behind the offered methodology is to transfer the stream of packets from host memory to the global memory of the CUDA device, then assigning each of them to a classifier thread.

Traditional TCP/IP-based networks for datacenters (DC) inter-connections are facing challenges in managing stringent QoS requirements for different applications in terms of end-users and service providers. The article "EnFlow: An energy-efficient fast flow forwarding scheme for software-defined networks," by Chaudhary and Kumar, formulated the energy-aware routing (EAR) problem of DCs as a mixed integer linear programming (MILP) for which an energy-efficient fast flow forwarding (EnFlow) scheme is designed using SDN. The EnFlow scheme uses the power-saving mode of the network to solve the EAR problem.

The article entitled "Intent-based network for data dissemination in software-defined vehicular edge computing," by Singh *et al.*, proposes an IBN control framework over the SDN architecture for data dissemination in the vehicular edge computing ecosystem. In this framework, a tensor-based mechanism is used to reduce the dimensionality of the incoming elephant-like traffic and then classifying the specific attribute

data traffic according to the defined priority requirement of the underlying applications. Here, the network policies are configured using the intent-based controller according to the application requirement and then forwarded to the SDN controller to enable intelligent data dissemination (through an optimal route) at the data plane. Convolution neural network is used to train the flow table to allocate the route dynamically for the classified traffic queues.

Vehicle-to-vehicle communication assists road-side information exchange granting ease of access and sharing between users. The communication between the vehicles is short-lived due to interference and data congestion in the resource constraint medium. Thus, the article entitled "LACCVoV: Linear adaptive congestion control with optimization of data dissemination model in vehicle-to-vehicle communication," by Sangaiah *et al.*, introduces a linear adaptive congestion control (LACC) augmenting the benefits of greedy routing and data dissemination model (DDM). LACC focuses on selecting a beneficiary vehicle by assessing its end-to-end service capacity and link stability preference. Different from the conventional greedy approach, routing is aided by a linear integer programming module for smart decisions on neighbor selection. The interrupts in data transmission and forwarding due to non-localized vehicles, congested routing paths, and paused transmissions are addressed using LACC as a series of linear optimization.

Vehicular clouds (VCs) use the underutilized resources of vehicles and create an infrastructure for the services offered by the cloud service provider via VMs. Due to its mobility nature, the hosted VMs can be migrated to other potential vehicles to avoid disruption of services. The challenging job here is to map the user requests to the VMs and identify the potential vehicles for migration. Thus, the article entitled "A smart cloud service management for vehicular clouds," by Pande *et al.*, proposes a smart vehicular cloud service with a green migration technique, which provides services with the minimum number of service migrations and the minimum time. For this, the proposed algorithm performs a three-step process, namely the assignment of vehicles to grids, assignment of tasks to grids, and assignment of tasks to vehicles.

The article entitled "Mobility-aware proactive edge caching for connected vehicles using federated learning distributed mobility," by Yu *et al.*, proposes a mobility-aware proactive edge caching scheme based on federated learning (MPCF). This scheme enables multiple vehicles to collaboratively learn a global model for predicting content popularity with the private training data distributed on local vehicles. MPCF also employs a context-aware adversarial autoencoder to predict the highly dynamic content popularity. Besides, MPCF integrates a mobility-aware cache replacement policy, which allows the network edges to add/evict contents in response to the mobility patterns and preferences of vehicles.

VI. QoS Applications and Services for IoCV

Driverless parking, an influential application of mobility as a service (MaaS) model, is one of the clear early benefits for autonomous vehicles, given often narrow spaces and multiple potential hazards (such as pedestrians stepping out from in between other vehicles). Existing studies and investigations of autonomous parking barely investigate and poorly address the privacy issues of vehicles. The article entitled "Privacy-aware autonomous valet parking: Towards experience-driven approach," by Pokhrel *et al.*, develops an experience-driven, secure, and privacy-aware framework of parking reservations for automated cars. The idea of using differential privacy with zero-knowledge proof provides both security and privacy guarantees.

How to arrange waste collection vehicles reasonably and optimize their service routes in real time based on signals sent by intelligent waste bins to meet the daily needs of residents has become an urgent problem. In the article entitled "Optimization of classified municipal waste collection based on Internet of Connected Vehicles," Cao *et al.* propose an improved multiobjective model in order to solve the routing issues of the split-delivery vehicle. The experimental results show that the Pareto-optimal solutions obtained by the algorithm can effectively arrange the vehicle service routes while meeting the needs of classified waste collection in the area.

The article "Performance limits of visible light-based positioning for Internet-of-Vehicles: Time-domain localization cooperation gain," by Zhou *et al.*, focuses on the localization of vehicles using visible light signals. It studies the performance limits of vehicular visible light-based positioning (VLP) for mobile user equipment (UEs). Specifically, a closed-form Cramer–Rao lower bound (CRLB) for the UE location and orientation, respectively, is obtained, which can give insights into the informative contribution of prior knowledge, UE mobility, and observation information to the overall VLP performance. Moreover, the time-domain evolution of the VLP error is studied, which sheds light on the long-term VLP performance and helps understand the essence of time-domain localization cooperation.

The article "A novel emergent intelligence technique for public transport vehicle allocation problem in a dynamic transportation system," by Chavhan *et al.*, presents a novel emergent intelligence (EI)-based dynamic vehicles allocation scheme to perform functions such as group formation, collecting, estimating, sharing, and allocating transport resources and their reliabilities at different clusters in a region of the metropolitan area. The EI technique makes agent estimates (resources and reliabilities) depending upon the commuters' arrival rates, neighborhood depots' reliability, historical database, routes database, surplus and deficit resources, and so on. The mathematical equations are developed for the measurement of transportation reliability, i.e., resource reliability, resource sharing neighbor depots reliability, resource gathering from neighbor depot time delay reliability, travel time reliability, and schedule reliability in a metropolitan area.

The article entitled "Uncertain-driven analytics of sequence data in IoCV environments," by Srivastava *et al.*, presents a novel uncertain-driven high utility-sequence pattern called high-expected utility sequential patterns (HEUSPs) to discover valuable information in IoCV environments. Furthermore, two efficient structures called PUL-chain and EUL-chain with six

pruning methodologies are respectively developed to maintain information that is necessary and reduce the search space for improving mining performance.

The service region of the safety service providers (SSPs) is bounded. Thus, the article "Safe-passe: Dynamic handoff scheme for provisioning safety-as-a-service in 5G-enabled intelligent transportation system," by Roy and Misra, proposes a service handoff scheme among the multiple service providers for provisioning safety-related decisions to the end-users. At the same time, peak/off-peak, local/intercity travel, and one-way/return services are considered when designing end users. It designs the profit calculation method of SSP and adopts the cooperative game of the cooperative alliance to obtain the best switching times. Compared to existing schemes, the proposed approach can provide customized decisions to the end-users on a payper-use basis.

Radio-frequency-energy-powered cognitive radio network (RF-CRN) is being taken seriously in connected vehicles, especially in 5G network, which can better address the challenges of energy limitation and spectrum scarcity. However, the energy efficiency (EE) of the RF-CRN wherein multiple secondary users (SUs) share the same channel is rarely presented. Thus, the article entitled "Energy-efficient resource allocation in radio-frequency-powered cognitive radio network for connected vehicles," by Xiao *et al.*, considers a RF-CRN in which SUs first harvest energy from RF signals originating from a primary network and then utilize the available energy in the battery to transmit data. Specifically, the EE problem is first converted into a convex one by co-frequency interference, and thereafter Frank–Wolfe and 1-D linear programming are utilized to obtain the optimal solution.

The article entitled "Reliability-aware joint optimization for cooperative vehicular communication and computing," by Han *et al.*, comprehensively discusses the cooperative communication and computation of vehicular systems. Based on the cooperative transmission, a stochastic model of V2V communication reliability is established using probability theory. Furthermore, computation reliability is defined as a new metric for computation offloading, and a vehicle computational performance evaluation model is also established. In order to effectively compute the required data, V2V communication and vehicle computing are combined to further characterize the coupling reliability of cooperative communications and computation systems. In addition, a virtual queue model is proposed that combines queue length and vehicle privacy entropy to optimize partitioning. Finally, considering the amount of processing data and cut-off time of vehicle applications, the optimal partition model of vehicle computing is established with the goal of maximizing the coupling reliability, and propose the coupling-oriented reliability calculation for vehicle collaboration using dynamic programming methods.

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