Response Letter

Journal Name: IEEE Transactions on Vehicular Technology
Manuscript ID: VT-2022-04874
Title of Paper: Service-Oriented Network Resource Orchestration in Space- Air-Ground Integrated Network
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Dear Editors and Reviewers,

We would like to thank for the time and effort spent on reviewing our manuscript and for the positive feedback and helpful comments, which have helped us to improve the technical contents and presentation quality of this paper significantly. We revised the manuscript to address all of the reviewers' comments. In this response letter, we provide a detailed response to all of the reviewers' comments, including the changes that we made in the manuscript. The reviewers' comments are presented in italic font and are followed by our corresponding responses.

· For the reviewers' convenience, all revised texts and changes in this response letter are highlighted in blue text.

· All reference numbers in this response letter follow the section References at the end of this response letter.

Sincerely yours,
The authors.

Response to the reviewers

Reviewer 1

This paper investigates a service-oriented network resource scheduling problem in space-air-ground integrated networks. An SDN/NFV-based reconfigurable SAGIN network architecture is proposed to manage the large-scale and dynamic network. To improve resource utilization and fulfill the multi-dimensional user requirements, the rate-adaption is introduced into SFC orchestration. Considering the limited network resources and user requirements, an MINLP problem is formulated to maximize the total network profit, where SFC orchestration, wireless network resources, and the transmission rate are optimized jointly. Then, the formulated problem is transformed by successive convex approximation and an iterative alteration algorithm is proposed to obtain a near-optimal solution. Finally, the algorithm is evaluated in terms of total network revenue, service reception ratio, and resource utilization.

→ We thank the reviewer for the accurate summary.

The detailed comments are as follows.

→ We address all of the comments in the following.

Reviewer Comment 1.1 — The structure of Section-I and Section-VI is not well-organized and needs to adjust

Reply: Thank you for pointing out this problem in manuscript. According to reviewer's comments, we have checked the Section I and Section VI, comprehensively. In Section I, we find that some definitions, such as Virtualized Infrastructure Manager, are redundant, and they are omitted in the revised manuscript. Additionally, we have adjusted the structure of Paragraph II and Paragraph III, and added the definitions of the virtual link and the rate. In Section-VI, we find that the Paragraph III and Paragraph IV are not effectively organized. In the revised manuscript, we have re-organized Paragraph III and Paragraph IV.

[Modified Paragraph][Section VI] The convergence performance of our proposed algorithm is depicted in Fig. 3, where the service number is set to 40. Notably, our algorithm demonstrates rapid convergence within three iterations when l_{G1} is set to 75 Mbps, outperforming the convergence rate observed when doubling l_{G1}. This observation is visually apparent from Fig. 3, underscoring the algorithm's ability to swiftly converge under varying network resource conditions. Furthermore, Table III presents the average computation time per request for different total numbers. It has been demonstrated that all these algorithms have the same order of magnitude.A comparative analysis between EM-WR-TR optimization and DE reveals that our proposed algorithm exhibits faster execution times than DE when the number of service requests is below 20. However, it is worth mentioning that the proposed algorithm, owing to its inclusion of two loop structures within a single iteration, exhibits a slightly longer convergence time compared to EM-WR optimization and EM optimization. In contrast, DE employs a fixed population number and converts all constraints into numerical penalties within the objective function, mitigating the impact of the total request number on the average computation time.

Reviewer Comment 1.2 — Both the Section-I and Section-III introduce the orchestration of SFC, it is necessary to simplify that part.

Reply: We sincerely appreciate your valuable feedback and suggestions. In Section I, we have checked the corresponding paragraph describing the SFC and found some redundant definitions. In the revised manuscript, we have omitted some unnecessary expressions in Section I.

[Modified Paragraph][Section I] Fortunately, software-defined networking (SDN) technology can disassociate the data plane from the control plane and enables a more flexible, dynamic, and programmatically efficient network operation [R1]. By network function virtualization (NFV) technology, resources of underlying heterogeneous physical infrastructures can be abstracted into the virtual resources pool, which provides a more flexible approach in resource management than traditional dedicated hardware. Leveraging the power of SDN and NFV, service function chains (SFCs) can be constructed, comprising a sequential arrangement of virtual network functions (VNFs), enabling customizable solutions to cater to diverse quality-of-service (QoS) requirements of users. To conduct a SFC configuration, the physical resources are first abstracted and incorporated into the virtual resource pool. When service requests arrive, they are described as specific VNF chains with resource requirements and forwarded to the SFC orchestrator. Based on the current network state, the SFC orchestrator evaluates the feasibility of accepting the service. Upon acceptance, the corresponding network resource blocks are allocated, enabling the sequential execution of VNFs from source to destination, ultimately accomplishing the service request [R2].

Reviewer Comment 1.3 — In III-C, the energy consumption model of aerial nodes is expressed by power consumption and computation consumption like Ω, and it seems to edit it in C12.

Reply: Thank you so much for your careful check. We have checked the expression of energy consumption model and found that C12 can be simplified, which is revised as

$$C12 : \left[\max_{\mathrm{n} \in N_A} \{\Omega_n\} - \min_{\mathrm{n} \in N_A} \{\Omega_n\} \right]^2 \leq \varepsilon^2. \tag{1}$$

In addition, we have checked the full text to prevent similar expression errors.

Reviewer Comment 1.4 — Fig. 3 depicts the convergence of proposed algorithm shows the convergence of the proposed algorithm. However, it is confusing that why different transmission capacity is compared.

Reply: We thank the reviewer for the rigorous consideration.In Fig. 3, we present the average revenue as a visual representation to showcase the convergence behavior of the proposed algorithm. To avoid the randomness and validate the reliability of the results, we introduce varying transmission capacities. In Fig. 3, our algorithm exhibits remarkable convergence performance across different network configurations, further bolstering its efficacy and applicability.

Reviewer Comment 1.5 — It is vague that why different transmission capacity is considered. Please explain.

Reply: Thank you so much for your careful check. Our model takes into account both terrestrial and aerial networks, each with its unique characteristics. In terrestrial networks, network nodes are connected via wireline connections such as optical fiber, which provides high and constant bandwidth, and does not interfere with each other [R3]. Contrastively, aerial networks operate in wireless channels, and we follow the path loss model in [R4] and channel capacity from [R5]. Since the distinct characters of channel, we consider different transmission capacity to enhance the plausibility of the proposed model.

Reviewer Comment 1.6 — The description of Fig. 7 is not consistent with the figure: The vertical axis of Fig. 7 is "Average Revenue", but it is described as "successfully serving probability".

Reply: We are very sorry for our incorrect writing, and the caption of Fig. 7 are revised as "The average revenue versus the available spectrum". Additionally, we have checked the full text to prevent similar expression errors.

Reviewer Comment 1.7 — By the way, some grammar errors exist in this paper.

Reply: Considering the Reviewer's suggestion, we have checked the grammar in the full text and corrected the mistakes. For example, we have removed the "on" from "In Section II, a review on of related work is presented".

Reviewer 2

Reviewer Comment 2.1 — The paper's quality is good and would need minor writing improvements such as in the introduction section "Traditional, terrestrial mobile networks ..., which have enabled many a large number of applications..."

Reply: We thank the reviewer for the careful check, and we have revised the writing mistakes totally. Specifically, we have found several grammar errors in Section I, Section II, and Section VI, which are corrected in our revised manuscripts. For example, we have removed "the" and replaced "brought from" with "brought by" in "Based on P3, we optimize the transmission power, channel spectrum, and SFC embedding jointly, which is set as a benchmark to illustrate the advantage brought by virtual link rate adaption".

Reviewer 3

The paper provides an optimization process to allocate resources considering the constraints of the network. The paper aims to minimize resource utilization while maximizing what they called network profit.

→ We thank the reviewer for the concise comments of our work.

The authors show the solution achieves good results, but some definitions used along the manuscript are not well explained, or their definitions appear several pages after the first appearance.

→ We gratefully thanks for the precious time the reviewer spent making constructive remarks. According to the reviewer's comment, we have addressed all comments in the following.

Reviewer Comment 3.1 — Already in the abstract, the authors claim that "the rate adaption is introduced" and in the following sentence "formulate the virtual network function (VNF) embedding, transmission rate adjustment,..." There is no definition of which rate authors want to adjust, is it the rate of VNF embedding? In the problem formulation section, the author called as rate-adaptive SFC, which rate? Furthermore, Section VI brings this term, but it seems to refer to transmission power. Since most of the contribution of the paper relies on this concept, it should be clear even in the abstract.

Reply: We gratefully appreciate for your valuable suggestion. In this paper, the interconnections among VNFs in each SFC are defended as virtual links as [R6][R7]. In this paper, the rate we want to optimize is the data transmission rate of each part of the virtual link between VNFs of SFCs. Consequently, the " rate" in "rate adaption", "transmission rate adjustment", and "rate-adaptive SFC orchestration" refers to the transmission rate of virtual links. On the other hand, in Section IV and VI, we consider the transmission power of each link to ensure that the sum of virtual link rates of all SFCs occupying on the wireless channel cannot exceed the channel capacity determined by

$$\varphi^{(n,m)} = b_{(n,m)} \log \left(1 + \frac{h_{(n,m)}^{-\gamma} p_{(n,m)}}{\sigma^2 b_{(n,m)}} \right). \tag{2}$$

To distinguish with the rate-adaptive scheme in coded modulation [R8][R9], we have replaced the "rate adaption" with "virtual link rate adaption between each VNF", and replaced the "transmission rate" with "virtual link rate" in the revised manuscript. Furthermore, the definition of "rate" is supplemented in the fifth paragraph of Section I.

[Modified Paragraph][Section I] Furthermore, current research on SFC orchestration only considers the SFC mapping without taking the virtual link rate (i.e., the data transmission rates of the interconnections between VNFs of each SFC) into account, which significantly increase the blocking probability of network and result in poor service ability. In order to maximize network performance and improve heterogeneous resource utilization, a joint algorithm for rate-adaptive SFC orchestration (SFC orchestration with virtual link adaption) and network resource allocation is urgently required.

Reviewer Comment 3.2 — Next, authors introduce "network profit" metric, in some part of the manuscript referred as revenue. However, this is only explained in Section IV-D. In Section IV-B, what does mean revenue in the delay? it seems more penalty-based, since the service will be rejected.

Reply: We thank the reviewer for pointing out this problem in manuscript, and we feel sorry for the inconvenience brought to the reviewer in the expressions of "revenue" and "profit". In this paper, we design our model from the perspective of network operators. To clarify, we use the term "revenue" to denote the rewards generated by accepted services, and "profit" refers to the value obtained by subtracting the total cost of utilized resources (e.g., utilized transmission resource and computation resource of all network nodes) from total revenue of received services in current time slot. Consequently, the objective in this paper is to maximize this value, which we refer to as the network profit. Upon reviewing Section IV-B, we found no corresponding subsection, and this issue may occurs in Section III-B. As previously discussed in our paper, the SFC plays a crucial role in meeting the diverse service requirements of users, particularly in applications like self-driving and natural disaster rescue. Among these requirements, ensuring a reliable and low-latency network delay is of utmost importance. This ensures that critical services are delivered promptly and efficiently, enabling timely responses in various scenarios. In previous Section III-B, we discussed the revenue to emphasize the importance of delay in our model. Since it is more relative to the cost, we replace that part with the motivation to model the service delay in the revised version of the manuscript. Actually, our model can be regarded as a penalty-based model, as we aim to maximize the total system profit described before. From a mathematical point of view, when current network resources cannot fulfill all arrived services, the orchestration of all services is infeasible. To obtain a valid solution for that problem, some services must be rejected to ensure the other services are satisfied. If a service is rejected, no revenue is obtained, which can be interpreted as a corresponding penalty for rejection. In the revised manuscript, we have added the definitions of profit, revenue, and cost in Section III-C Paragraph I and Section III-D Paragraph I.

[Modified Paragraph][Section III-B, Paragraph I] As previously discussed, the service function chaining (SFC) plays a crucial role in meeting the diverse service requirements of users, particularly in applications like self-driving and natural disaster rescue. Among these requirements, ensuring a reliable and low-latency network delay is of utmost importance.

[Modified Paragraph][Section III-D, Paragraph I] The network's profit mainly depends on the completion of each service, and the services in this model are delay sensitive. Only when a service is completed within the required delay, the system will earn a certain revenue.

Reviewer Comment 3.3 — The author should let clear to authors what means network profit as the cost considered.

Reply: Thank you for pointing out this problem in manuscript. As has been mentioned before, we design the system model from the perspective of network operators. Forasmuch, our objective is to maximize the network profit, which is determined by subtracting the total variable cost of utilized resources from the total revenue generated by received services within the current time slot. Since the service is considered as delay-sensitive, the revenue is generated only when the service meets its requirements. The cost arises from the energy consumption of network nodes that supported each accepted service, and our energy consumption is obtained from [R10][R11][R12][R13][R14][R2]. The higher the number of services received while maintaining the same level of resource consumption, or the lower the resource consumption for a given number of received services, the greater the resulting profit.

In the revised manuscript, we have defined the profit, revenue, and cost in Section III-C Paragraph I, and simplified the description of profit in Section III-D.

[Modified Paragraph][Section III-C Paragraph I] In this paper, we aim to maximize the network profit obtained by subtracting the total variable cost of utilized resources from total revenue of received services in current time slot. Since the service is considered as delay-sensitive, the revenue is generated only when the service meets its requirements. The cost arises from the energy consumption of network nodes that supported each accepted service. In this subsection, the cost of each network node is characterized by considering both resource utilization and energy consumption factors. The variable computation cost is the ratio of allocated computation resources to computation capacity [R10][R11][R12][R13][R14]. For ground nodes, the communication cost depends on link utilization [R2]. The total cost of ground nodes n is expressed as

$$c_n^{BS} = \alpha_{cm,N_G} \sum_{m \neq n} l_{(n,m)} + \alpha_{cp,N_G} \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} \frac{c_{f,n,q} x_{f,n,q}}{C_n}, \quad \forall n \in N_G, \tag{3}$$

where α_{cm,N_G} and α_{cp,N_G} are the weight of communication cost and computation cost of ground nodes, respectively. $l_{(n,m)} = \sum_{q \in Q} \sum_{\forall (i,j) \in E_q} y_{(i,j),q}^{(n,m)} l_q^{(i,j)}$ is the used channel capacity between network node

n and network node m. As mentioned before, FDMA is employed in aerial nodes. $b_{(n,m)}$ and $p_{(n,m)}$ represent the spectrum and transmission power from aerial node n to network node m, respectively. The solution vector is denoted by $\mathbf{b} = \left\{b_{(n,m)} \mid \forall n, m \in N_A\right\}$ and $\mathbf{p} = \left\{p_{(n,m)} \mid \forall (n,m) \in E_{A1}\right\}$ parallelly. For the cost model of aerial nodes, the transmission power is considered. The cost of aerial nodes is expressed as

$$c_n^{UAV} = \alpha_p \sum_{m \neq n} p_{(n,m)} + \alpha_{cp,n_A} \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} \frac{c_{f,n,q} x_{f,n,q}}{C_n}, \quad \forall n \in N_A, \tag{4}$$

where α_{cm,N_A} and α_{cp,N_A} denote the weight of communication cost and computation cost of aerial nodes. α_p denotes the weight of the cost of transmission power, respectively. Compared with ground nodes, aerial nodes lack a continuous and sufficient source of power even equipped with solar battery. Therefore, the energy consumption of aerial nodes is expressed as

$$\Omega_n = \beta_1 \sum_{m \neq n} p_{(n,m)} + \beta_2 \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} c_{f,n,q} x_{f,n,q}, \quad \forall n \in N_A, \tag{5}$$

where Ω_n represent the energy consumption model of aerial node n, and β_1 and β_2 are the weight of power and computation, respectively.

[Modified Paragraph][Section III-D Paragraph I] The network's profit mainly depends on the completion of each service, and the services in this model are delay sensitive. Only when a service is completed within the required delay, the system will earn a certain revenue. The total revenue is expressed as

$$R = \sum_{q \in Q} r_q z_q, \tag{6}$$

where r_q is the revenue generates from the service q. The cost is incurred by the utilization of node resources, which is expressed as

$$C = \sum_{n \in N_A} c_n^{UAV} + \sum_{n \in N_G} c_n^{BS}. \tag{7}$$

The network profit is denoted by subtracting the total cost of utilized resources from total revenue of received services in current time slot, which is expressed as

$$P = R - C, \tag{8}$$

which is the main goal to achieve in the considered system.

Reviewer Comment 3.4 — It's unclear what mean the results of equations 5 and 6. The computation cost is a fraction between number of services and computation and communication cost, considered the transmission Power (in Watts?). In such a case, how can sum these values?

Reply: Thank for your concise comments. In equations 5 and 6, we utilize a general power consumption model from previous research [R14][R15] to quantify the energy costs in computation, and the power consumption of server in computation is expressed as

$$P_{Server} = P_{idle} + (P_{max} - P_{idle}) \times \frac{(\text{ allocated } vCPUs)}{(\text{ installed } vCPUs)}, \tag{9}$$

where P_{idel} is the idle power consumption and P_{max} is the maximum power consumption (whose units are Watts). In this paper, we utilize a similar expression to 9 to model the energy consumption of ground nodes and aerial nodes, which is expressed as

$$c_n^{BS} = \alpha_{cm,N_G} \sum_{m \neq n} l_{(n,m)} + \alpha_{cp,N_G} \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} \frac{c_{f,n,q} x_{f,n,q}}{C_n}, \quad \forall n \in N_G, \tag{10}$$

$$c_n^{UAV} = \alpha_p \sum_{m \neq n} p_{(n,m)} + \alpha_{cp,N_A} \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} \frac{c_{f,n,q} x_{f,n,q}}{C_n}, \forall n \in N_A, \tag{11}$$

where $\sum_{q \in Q} \sum_{f \in \mathbf{f}_q} c_{f,n,q} x_{f,n,q}$ is the sum of all utilized computation resources of network node n, C_n is the computation capacity of network node n, and α_{cp,N_G} and α_{cp,N_A} are the cost weights of power. As a result, the units of second part of (10) and (11) equal to $price\_unit/Watts \cdot Watts = price\_unit$. Notably, a mistake is made in previous (6) and it has been revised in our manuscript. For aerial nodes, the data is transmitted on wireless channel and the energy consumption is mainly the transmission power, and its unit is also Watts. After the transmission power multiplied by the cost weight α_p and summed with the computation cost, the cost of each aerial node n is obtained. Similarly, we utilize a general model of ground nodes in [R10][R11][R12][R13][R14], where the cost of communication is linearly related to the transmission data, which is expressed as the first part of (10). In (10), $\sum_{m \neq n} l_{(n,m)}$ is the sum of transmission rate and α_{cm,N_G} is the cost weight, whose unit is $price\_unit$. Integrated with the cost model of communication and computation, the cost of BSs and UAVs are derived from (10) and (11). In the revised manuscript, we have supplied the references of our cost model.

Reviewer Comment 3.5 — However, the major drawback regards some assumptions in the System Model. Figure 1 describe the SAGIN architecture formed by ground and aerial networks. However, the authors dismissed the mobility of nodes, as described in the System Model section. In such a case, quasi-stationary nodes represent a classical node routing, however with Wi-Fi links. A question that arise is whether the proposed solution does not fit better for Wi-Fi SDN with constraints than to aerial networks.

Reply: We thank the reviewer for the careful check. Indeed, the paper does make assumptions regarding the mobility of network nodes during the determination process. This assumption is based on the fact that our system is designed to operate in a slotted manner, where all incoming services are orchestrated within each time slot. It is worth noting that this assumption is commonly adopted because the trajectories of LEO or UAV nodes are predefined or predictable, where the virtual network topology mapped on them is ensured as quasi-stationary if the time slot is small [R16][R17][R18][R19].

While the proposed solution is designed for SAGIN, it is possible that it could be applied to other network types with constraints like Wi-Fi SDN. Nonetheless, the performance of proposed solution may not fit better for Wi-Fi SDN, wireless mesh network, or other terrestrial wireless network.

Wi-Fi SDN refers to the implementation of Software-Defined Networking (SDN) concepts and principles in Wi-Fi networks. With Wi-Fi SDN, the control plane is decoupled from the data plane, and network policies and configurations can be centrally managed through a software controller. The controller communicates with the Wi-Fi access points (APs) using protocols such as OpenFlow, allowing for greater flexibility and programmability. While our proposed network architecture and Wi-Fi SDN share logical similarities in terms of SDN technology, there are fundamental differences in terms of channel models and network dynamics that must be considered.

Although we assume a static network topology, it is crucial to design algorithms that avoid excessive complexity or reliance on pre-training, particularly with regards to artificial intelligence (AI)-based approaches. AI-based approaches tend to perform well in static network scenarios with ample training data. However, the dynamic nature of network nodes in SAGINs can lead to degraded or even broken performance of these algorithms. Consequently, our proposed solution may not be as effective in Wi-Fi SDN with specific constraints, and approaches developed for Wi-Fi SDN or other SDN-based terrestrial wireless networks may not be entirely suitable for SAGINs, and vice versa.

In the revised manuscript, we have supplied the mechanism of our model in Section III, Paragraph II.

[Modified Paragraph][Section III, Paragraph II]

The arrival of each service is independent and random, and we accumulate these newly arrived services and execute the determination on the end of each time slot. Without loss of generality, network topology and wireless environment can be assumed to be quasi-stationary during each decision-making interval when the time slot is small. [R16][R17][R18][R19]. Nevertheless, it is worth noting that aerial nodes can be moving, and our proposed model is also applicable in such dynamic network scenarios.

Reviewer Comment 3.6 — Equation 16 consider the computational capacity of a node n C_n. In real world scenario, you cannot know in advance the computational cost of a service, since it may vary due to number of request/response rate. Similar comment to Equation 17.

Reply: We thank the reviewer for the careful check. As previously stated, our algorithm operates at the end of each time slot, allocating resources to all incoming services within that timeframe. Equation 16 (or named C6) is expressed as

$$C6 : \sum_{q \in Q} \sum_{f \in \mathbf{f}_q} x_{f,n,q} c_{f,n,q} \leq C_n, \quad \forall n \in N_G, \tag{12}$$

where C_n is the computation capacity of node n, $x_{f,n,q}$ is a binary variable that indicates whether VNF f of service q is embedded on network node n, and $c_{f,n,q}$ is the allocated computation resources. Equation 17 (or named C7) is expressed as

$$C7 : \sum_{q \in Q} \sum_{(i,j) \in E_q} y_{(i,j),q}^{(n,m)} l_q^{(i,j)} \leq l_{G1}, \forall (n,m) \in E_G, \tag{13}$$

where l_{G1} is the channel capacity from ground node n to m, $y_{(i,j),q}^{(n,m)}$ is a binary variable that indicates whether the link between VNF i and VNF j of service q is mapped on physical link (n,m), and $l_q^{(i,j)}$ is the virtual link rate of service q between VNF i and VNF j. $C6$ and $C7$ constrain the allocated resources are within the resource capacity. Actually, it is a widely accepted assumption in SFC orchestration that the VNF chains are predefined upon the arrival of service requests, as indicated in previous studies [R2][R16][R20][R6]. These studies acknowledge that the properties of VNF chains are often correlated with the traffic volume passing through them or are highly implementation-specific, dependent on various factors. To simplify the mathematical model, an approximate value for these properties is considered. Nonetheless, these assumptions are reasonable and practical. For instance, in an enterprise network, incoming files enter through the edge router from an external network and need to traverse a series of network functions, such as Firewall, load balancer, and deep packet inspection, to ensure network security and performance. The file size can be determined, enabling the estimation of required transmission resources, while the computation cost can also be derived, accordingly.

Reviewer Comment 3.7 — In the results, author must explain better the results shown in Figures 8 and 9. What does mean available spectrum, was it the spectrum used or used the entire spectrum (which is unrealistic)

Reply: We express our gratitude to the reviewer for the thorough examination. As shown in Figure 1, in this model, we assume the total authorized spectrum of our aerial networks is B_0, the spectrum dedicated to control system such as trajectory adjustment (i.e., Channel 3 in Figure 1) is B_c, and other unusable spectrum like guard band (i.e., the guard band and Channel 4 in Figure 1) is denoted by B_u. Therefore, the "available spectrum" B (i.e., Channel 1 and Channel 2 in Figure 1) in Figures 8 and 9 denotes the total spectrum that are permitted to transmit data of each services, i.e., $B = B_0 - B_c - B_u$, and the same spectrum is not allowed to be used by more than one aerial nodes simultaneously. In the

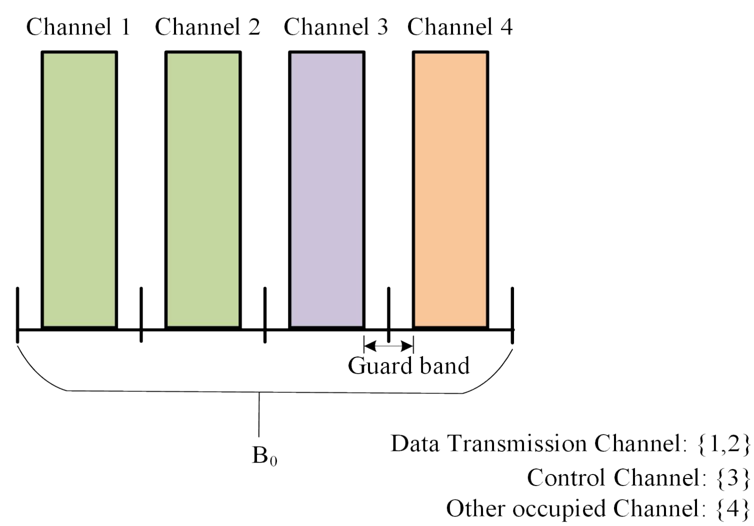

Figure 1: A general spectrum distribution of FDMA system.

revised manuscript, we supplemented the definition of available spectrum in Section III.

[Modified Paragraph][Section III, Paragraph II] Frequency division multiple access (FDMA) is utilized in aerial networks, and the spectrum is allocated to each aerial node orthogonally. The total available spectrum authorized for data transmission of each SFCs are denoted by B, and we assume the radio bands are small enough to be allocated continuously.

Reviewer Comment 3.8 — Editorial aspect: P.3 line 23 a review on of related work → remove the on.

Reply: We are very sorry for our incorrect writing. In the revised manuscript, we have corrected this grammar error. In addition, we have checked the grammar in the full text and corrected all mistakes with our best efforts.

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