A Terrestrial and Satellite Communications Interworking Scenario for UAM Services

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Abstract—This paper presents a terrestrial and satellite communications interworking scenario for urban air mobility (UAM) services which have been considered as one of the most important services for 6G communications. For the UAM services in the 6G communications, gNBs with the up-tilted beamforming antennas have been newly required to provide the high date rate of mobile services[1]. For this reason, there may be coverage holes in the air according to the altitude. In addition, since it can be necessary to additionally deploy the gNBs with the up-tilted beamforming antennas for UAM services, the UAMs can fly in areas where the gNB for UAM services are not deployed. Like the terrestrial communications for UAM services, there may be a consideration in the satellite communications. The data rate can be dramatically decreased at the cell edge due to the strong interference signal of neighbor cells which can be caused by the wireless communication environments between the ground terminal and the satellite[2]. For this reason, it can be considered that a multi-connectivity scheme between terrestrial and satellite communications is needed to complement these problems of the terrestrial and satellite communications.

Recently, a regenerative satellite structure has been being discussed in the 3GPP standardization working groups and thus a satellite can have a role as a gNB[2]. In this case, since Xn interface between the terrestrial gNB and the satellite gNB cannot be applied, the dual connectivity previously specified in the 3GPP standards may be not adequate for the multi-connectivity between the terrestrial and satellite communications. Thus, the dual steer has been being discussed in the 3GPP service and system aspects 1 (SA 1) working group[3]. By the dual steer, the data traffic can be switched, steered, or split at the UE and mobile core networks. By using the dual steer, a multi-connection and a traffic path switching scenario between the terrestrial and satellite communications for the UAMs can be included. For an example, a UAM can be simultaneously connected with the terrestrial and satellite communications in order to increase the date rate, and the traffic path can be switched from the terrestrial communications to the satellite communications for the service continuity when the UAM fly in the coverage holes of the terrestrial communications.

Unfortunately, since the protocol architecture and procedures for the dual steer have not yet been handled in the 3GPP SA 2 working group, there still exist a lot of research and discussion issues. In this paper, we assume that the UAM has dual protocol stacks and modems for the terrestrial and satellite communications, and the UAM and core networks can have several peer-to-peer functions for the dual steer such as traffic separation, traffic aggregation, traffic management based on the channel status, and so on. We have addressed various procedures of the dual steer for data traffic switching and radio link failure scenarios. The proposed procedures include new control messages to overcome the wireless channel degradation. The details of the procedures are omitted due to the lack of paper space.

Keywords— UAM, satellite communications, multi-connectivity

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