Considerations about Schemes for Commercial/Defense Joint Operation of LEO Satellite Networks

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***Abstract*—This paper examines how commercial-operated Low-Earth orbit satellite networks can be shared for military purposes. A few schemes are presented and the advantages/disadvantages of each scheme are analyzed.**

Keywords— satellite, LEO, Commercial/Defense Joint Operation

I. Introduction

LEO(Low-Earth Orbit) satellite communication is a next-generation future technology that enables communication with more ground terminals because the distance from Earth is comparatively closer than HEO(High Earth Orbit) satellite communication. In addition, the unit cost of production/deployment is less than that of HEO satellite, and the lower delay time can also be seen as a key strength.[1] Therefore, it is a field that is actively developed and studied in various countries and fields.

On the other hand, many projects are underway on a system that performs multifunctional missions by mounting different payloads on LEO satellite.[2] Among these diverse cases, this paper intends to deal with limited situations aimed at commercial/defense joint operations.

Typically, there is a Blackjack project conducted by DARPA[3], which aims to provide plug-in-type functionality by treating commercial Payload as a kind of block-module like Lego. Through this, commercial communication modules can be mounted on low-orbit satellites that perform military missions to perform both civilian and military missions. In the Blackjack project, civilian equipment is introduced into military LEO satellites under the military leadership, but on the contrary, markets related to LEO satellites are currently being led by private companies such as SpaceX, OneWeb, and Amazon.[4] Commercial low-orbit satellite communication has made a leap forward than military communication through continuous competition with other companies, and is expected to continue to do so. For these reason, it is expected that the dual-operational scheme of payload for military communication in commercial low-orbit satellite systems will be more advanced than in previous research cases.

The simplest scheme is to operate a commercial LEO satellite simultaneously with both commercial and military communication payloads. This scheme seems to have a simple physical configuration, but it is likely to be more difficult than any other method. This is because each communication resource will be consumed to operate the commercial network and the military network at the same time in the scheme. In addition, many additional technologies (avoid interference, frequency division management, respective GSL/ISL management, traffic control) are required to concurrently control two payloads with different characteristics.

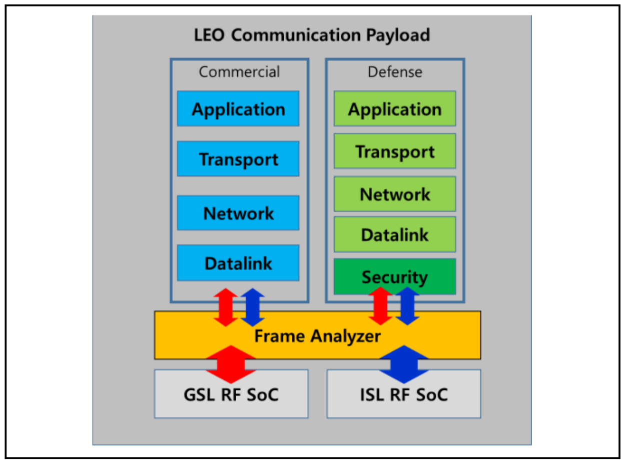

Fig. 1. Scheme 1 Concept Diagram: Dual(Comm/Mil) Network Module

In this paper, we propose two alternative schemes that allow commercial/defense communication systems to coexist and are better than schemes in the form of operating with heterogeneous payloads. We will also consider what advantages and disadvantages each scheme has. The consideration of each of these schemes predicts what concerns will be needed to realize and deploy a particular scheme.

II. Scheme 1: Equipped Commercial Satellites with Defense Network Modules

This scheme shares the RF portion of a commercial LEO satellite. An analysis tool named Frame Analyzer is placed between the network part and the RF part. According to a protocol for distinguishing whether each frame is military or commercial, the Frame Analyzer parses and interprets each frame and forwards it to each independent network module. This scheme is expressed as a concept diagram of Fig. 1. The Frame Analyzer can perform variable encryption in close cooperation with the security part of the military network module. Compared to simplest scheme, this picture has the advantage of requiring relatively few types of resource control techniques for coexistence of commercial and military communications. It is also advantageous in terms of miniaturization/lightness because quite a few modules are used together.

However, it is necessary to develop a communication protocol for the frame analyzer separately. Development of this part requires cooperation with a private company that provides the platform (LEO satellite). Therefore, platform dependent development is inevitable. This quickly leads to major restrictions between developments.

III. Scheme 2: Full utilization of commercial LEO satellite-based network infrastructure

In this scheme, the military does not include anything in the satellite body, but simply piggy-backing commercial satellite networks. It is entirely to use the services provided by commercial LEO satellite networks, and the blueprint will only require a certain fee to be paid to the provider serving the LEO satellite network.

But naturally, it is highly likely that commercially available services do not include features for security. Of course, a separate encryption module between military terminals can be used to establish a minimum end-to-end security measure. However, in order to recognize and transmit messages in commercial satellites, only segments will need to be encrypted/decrypted. Because, encrypted below the network header will not be delivered to the upper layer itself.

IV. Conclusion

In this paper, we propose two schemes to enable the commercial/defense joint operation of the LEO satellite network. In addition, the advantages/disadvantages of each scheme were analyzed. In selecting scheme 1 and 2, it is necessary to decide which should be considered important, economic or security, depending on the nature of the military application that wants to use the LEO satellite network.

In the future, through segmentation of network functions, we will expand the commonly available parts, and analyze the realization methods and considerations of the expanded schemes or methods.

References

[1] Isreal Leyva-Mayorga, "LEO Small-Satellite Constellations for 5G and Beyond-5G Communications", IEEE Access, 2020.

[2] Joseph N. Pelton, "Small Satellites, Hosted Payloads, Dual Use and Strategic Space Services", Handbook of Small Satellites, 2020.

[3] Paul "Rusty" Thomas, Blackjack DARPA program information , 2019, Available: https://www.darpa.mil/program/blackjack.

[4] Pansoo Kim, "Research Trends in Global Wireless Communication Technology Based on the LEO Satellite Communication Network", ETRI, 2020.