POSTER: SpaceSpider: A Hyper Large Scientific Infrastructure For The Space Internet

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***Abstract*—The development of space Internet is in full swing. However, the spatial specificity of this network that exists across multiple layers such as land, sea, and air leads to security threats from different levels. To this end, we propose to design a framework for a large-scale simulation and experiment platform for space Internet called SpaceSpider to realize the ground simulation of all elements of space Internet and establish an attack and defense environment for space Internet to support core technology verification.**

keywords: Hyper Large Scientific Infrastructure; Space Internet; Cyber Range

I. Introduction

In order to fully realize the performance of 5G networks with instant communication and global connectivity to a large number of devices, relying on terrestrial networks alone, evidently, is not enough [2]. Therefore, space Internet will play a key role in the future development of 5G. However, the development of space Internet has also faced severe risks. In 2016, the APT group "Turla group" misused space Internet signals to anonymously leak data from compromised computer systems [3], and in 2018, Raspberry Pi devices were not properly authorized to access the JPL network, resulting in an attack on them. The attackers stole 500 Mbs of information about the Mars mission [1].

SpaceX Starlink, Amazon Kuiper and other companies are deploying hundreds and thousands of satellites [4]. For the problem of high cost and long period of construction of the overall test environment of space Internet, this paper proposes a "security first" strategy, establish a large-scale simulation environment based on physical simulation on the ground side, realize the ground reproduction of all elements of the space Internet, and establish an experimental verification environment. To carry out principle and effect verification for new technologies related to space Internet.

II. Hyper Large Scientific Infrastructure

We believe that this space Internet attack and defense simulation verification platform should be designed as Hyper Large Scientific Infrastructure. We have done a unified scientific research analysis of typical large scientific infrastructures and extracted four essential attributes and ten core features of the attribution of large scientific infrastructures.

The four essential attributes of large scientific infrastructures are summarized as SCDE, which are ordered according to the consideration of construction principles, namely scientific paradigm S (scientification), C (connotation), D (design), and E (evaluative). 'Scientification' refers to **'Scientificity'** and **'Determinism'**. 'Connotation' refers to **'Complexity'**, **'Proprietary'** and **'Fundamental'**. 'Design' refers to **'Systematicity'**, **'Compatibility'**, and **'Timeliness'**. 'Evaluative' refers to **'Leadership'** and **'Economics'**.

In addition to the above ten core characteristics, hyper large scientific infrastructure also have two subjective characteristics of Spatio-temporal transcendence and continuous evolution(Figure 1).

Spatio-temporal transcendence: The Spatio-temporal transcendence lies in their ability to solve deep-sea problems, industry-driven attributes, and technology evolution characteristics(Figure 2).

Continuous evolution: It has to meet the needs of the present generation and develop continuously according to the socio-economic evolution of the times and the changing needs of human beings.

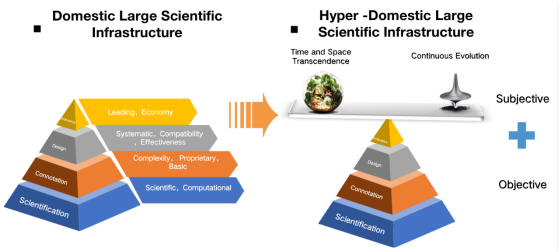

Fig. 1. Characteristics of Hyper Large Scientific Infrastructure

III. SpaceSpider

Up till now, there is no new technology validation environment for space Internet. Based on the three critical technologies of software-defined network, artificial intelligence, and digital twin, we propose a simulation and verification system architecture for space Internet, named "SpaceSpider". The technical system consists of a simulation, link, and security service layer(Figure 3). Finally, it forms a highly integrated space Internet offense and defense simulation and verification platform, which provides sturdy support for the continuous development of heaven and integrational earth networks.

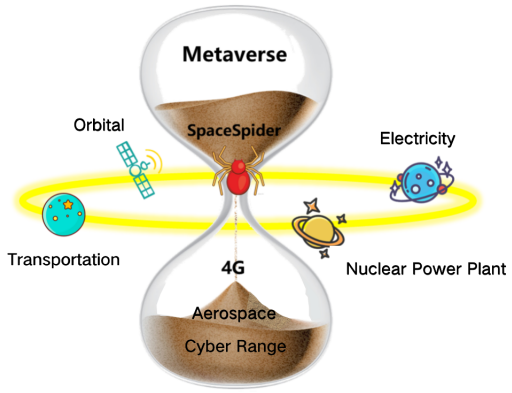

Fig. 2. Hyper Large Scientific Infrastructure: Spatio-temporal transcendence

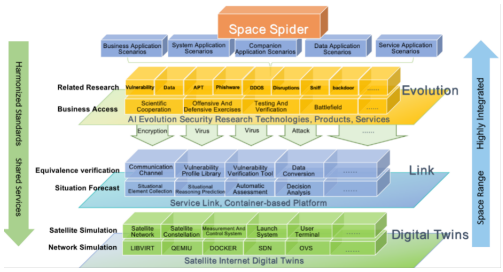

Fig. 3. Technical Architecture of the ”SpaceSpider”

The simulation layer provides infrastructure support for the safety and security services of the entire space Internet hyper large scientific infrastructure ”SpaceSpider”, including the digital space [5], the overall network environment, and the cyber shield.

The link layer is the interface between the security services of the ”SpaceSpider” and the overall infrastructure of the space Internet, including security situational awareness and equivalence verification. At present, the global space Internet has not yet completed, and the integrated planning and construction steps also need to be studied in further depth. Therefore, we need to verify the equivalence of space Internet from the current terrestrial Internet system. The preliminary validation aspects are as follows: (1)Whether the communication protocols, standards, topologies of the traditional Internet apply to the space Internet. (2)Whether the attack methods and means of the traditional Internet apply to the space Internet. (3)Whether the security protection measures of traditional Internet apply to space Internet.

The security service layer is suitable for offensive and defensive scientific research, competition exercises, real-world confrontation, and emergency drills.

In terms of security design, we adopt the security concept of built-in active defense, use shocktrap as a security product, and deploy trap vulnerabilities in the system. When an attack is detected, it will be rejected.

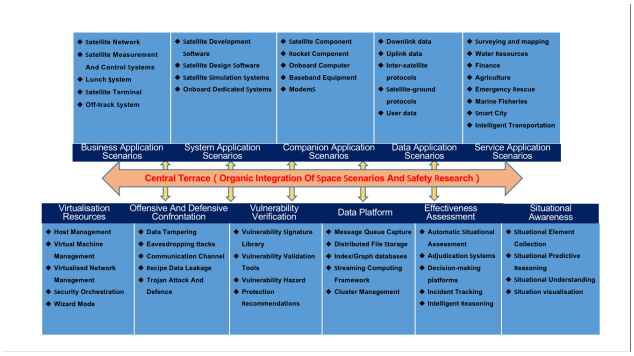

Fig. 4. Business architecture of the ”SpaceSpider”

IV. Implementation Path

The overall construction of the ”SpaceSpider” is divided into four stages. The first stage is to build a ”test bed”, and the ”test bed” is built according to the following four steps.

Step 1: Ground-based simulation of the full range of space Internet elements using digital twin technology to support core technology validation.

Step 2: Build a vulnerability integration platform for rapid and automated deployment of simple or complex vulnerable infrastructure targets.

Step 3: Deploy a lab environment to reproduce various well-known techniques used in real attack scenarios to test and validate the effectiveness of relevant network protection detection tools.

Step 4: Join the space Internet scenario and establish a space Internet offensive and defensive environment to validate the effectiveness and economics of operating space Internet-based services.

V. Conclusion

This paper defines ten objective characteristics and two subjective characteristics of the hyper large scientific infrastructure. And based on Software Defined Network, Artificial Intelligence, and Digital Twin, we propose a space Internet offensive and defensive simulation and verification hyper large scientific infrastructure called ”SpaceSpider” to realize the ground simulation of all elements of space Internet, establish a space Internet-oriented offensive and defensive environment, and support core technology verification.

References

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Abstract

The development of space Internet is in full swing. However, the spatial specificity of this network that exists across multiple layers such as land, sea, and air leads to security threats from different levels. To this end, we propose to design a framework for a large-scale simulation and experiment platform for space Internet called SpaceSpider to realize the ground simulation of all elements of space Internet and establish an attack and defense environment for space Internet to supportcore technology verification.

Introduction

In order to fully realize the performance of 5G networks with instant communication and global connectivity to a large number of devices, relying on terrestrial networks alone, evidently, is not enough. Therefore, space Internet will play a key role in the future development of 5G. However, the development of space Internet has also faced severe risks.

For the problem of high cost and long period of construction of the overall test environment of space Internet, this paper proposes a "security-first" space Internet solution, establish a large-scale simulation environment based on physical simulation on the ground side, realize the ground reproduction of all elements of the space Internet, and establish an experimental verification environment.To carry out principle and effect verification for new technologies related to space Internet.

HYPER LARGE SCIENTIFIC INFRASTRUCTURE

We believe that this space Internet attack and defense simulation verification platform should be designed as Hyper Large Scientific Infrastructure. We have done a unified scientific research analysis of typical large scientific infrastructures and extracted four essential attributes and ten core features of the attribution of large scientific infrastructures. The four essential attributes of large scientific infrastructures are summarized as **SCDE**, which are ordered according to the consideration of construction principles, namely scientific paradigm **S (scientification), C (connotation), D (design), and E (evaluative).**

S: Scientificity , Determinism
C: Complexity, Proprietary, Fundamental
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E: Leadership, Economics

In addition to the above ten core characteristics, hyper large scientific infrastructure also have two subjective characteristics of **Spatio-temporal transcendence** and **Continuous evolution**(Fig.1).

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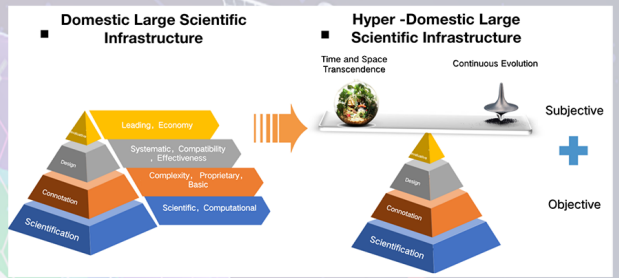

Fig. 1. Characteristics of Hyper Large Scientific Infrastructure

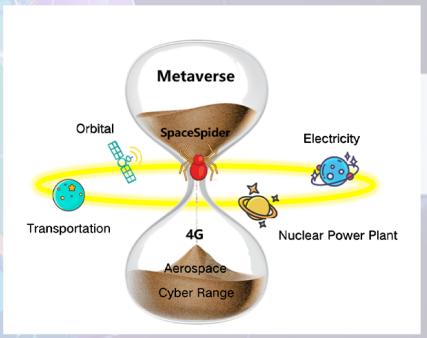

Fig. 2. Spatio-temporal transcendence

SPACESPIDER

Up till now, there is no new technology validation environment for space Internet. Based on the three critical technologies of software-defined network, artificial intelligence,and digital twin, we propose a simulation and verification system architecture for space Internet, named "SpaceSpider", to realize ground simulation, technology verification, attack and defense exercises, service access, standards development and other related work for all elements of space Internet.

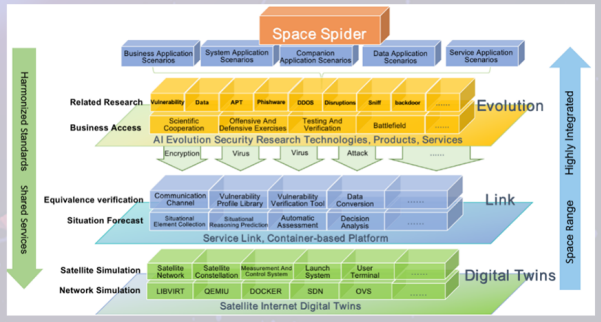

Fig. 3. Technical Architecture of the "SpaceSpider"

The technical system consists of a simulation, link, and security service layer(Fig.3). Finally, it forms a highly integrated space Internet offense and defense simulation and verification platform, which provides sturdy support for the continuous development of heaven and integrational earth networks.

The simulation layer provides infrastructure support for the safety and security services of the entire satellite Internet hyper large scientific infrastructure "SpaceSpider", including the digital space, the overall network environment, and the cyber shield.

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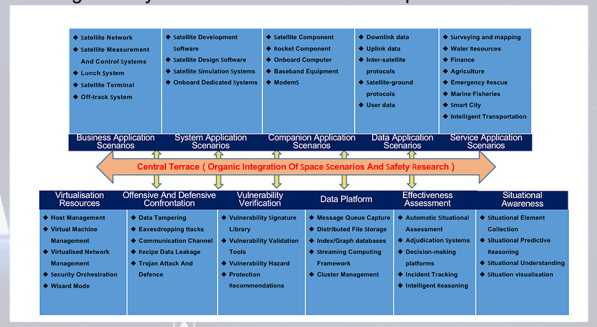

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