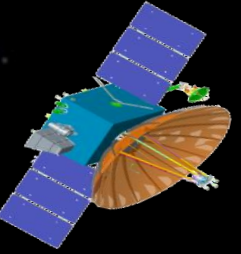




17th Meeting of the International Committee on
Global Navigation Satellite Systems



The Envision of Earth-Moon and Deep Space Communication- Navigation-Remote Sensing Integrated Constellation System



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CONTENTS

01 Current Situation and Envision of
Deep Space Exploration in China

02 Requirement and Analysis of
Current Ability

03 Envision of Prospective Scheme
and Development Method

04 Mode of International
Cooperation





1、 Current Situation and Envision of Deep Space Exploration in China

Current Situation and Envision of Deep Space Exploration in China



- The peaceful exploration, development and use of outer space are equal rights for all countries in the world. China calls on all countries working together to **build a community with a shared future for mankind**, and deepen international exchanges and cooperation in space on the basis of **equality, mutual benefit, peaceful utilization and inclusive development**.

——2021 China Space White Paper



Current Situation and Envision of Deep Space Exploration in China



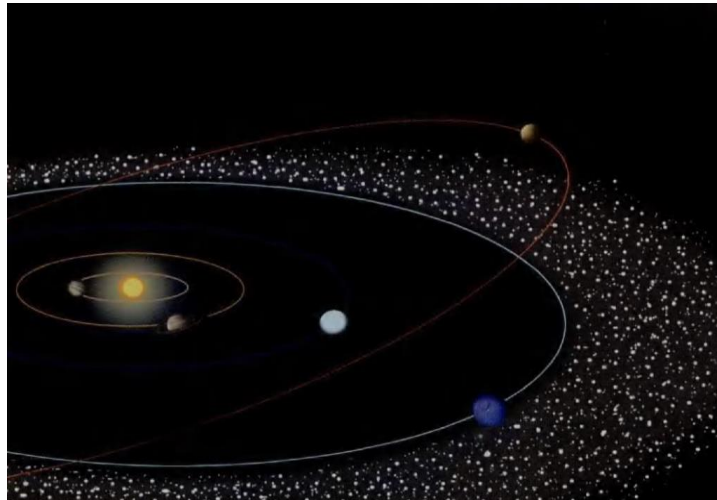
- In deep space exploration, “CE-4” has landed on the far side of the moon, “CE-5” returned to the earth with soil of the moon. **Three steps of China’s Lunar exploration project “surrounding, landing and returning” have been completed successfully.** “TW-1” visited Mars, accomplished “surrounding, landing and touring” with one mission. Space Exploration of China has been accomplished **from Earth-Moon scope to interplanetary scope.**



Current Situation and Envision of Deep Space Exploration in China



- In the coming year, China will continue to carry out **Lunar exploration project**, such as exploring and taking samples from the far side of the moon, high-precision Lunar polar region landing ,and carry out the construction of International Lunar Research Station(ILRS).
- China will continue to carry out **planetary exploration project**, complete missions like sampling and returning from **Mars**, exploring the **Jupiter** scope, sampling from near-Earth asteroids, exploring the comets belt, and demonstrate plans for exploring the margin of solar system.





2、 Requirement and Analysis of Current Ability

2.1 Communication-Navigation-Remote Sensing Requirements for Deep Space Exploration



- **Communication:** to increase the coverage capability of the Moon and other Planets, and support various of frequency bands.
- **Positioning:** to support the activity on the moon and the positioning of astronauts, etc.
- **Remote Sensing :** to support the location selection of ILRS, etc.

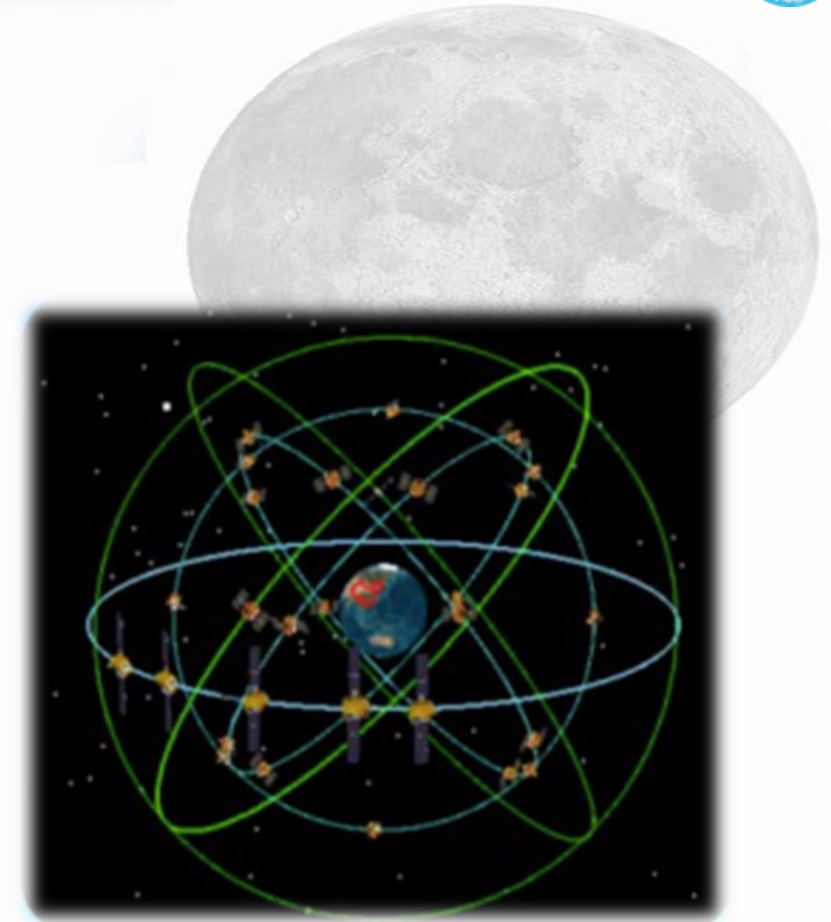


2.2 Analysis of existing GNSS and Lunar Communication capabilities



(1) Support capability of BD for SSV

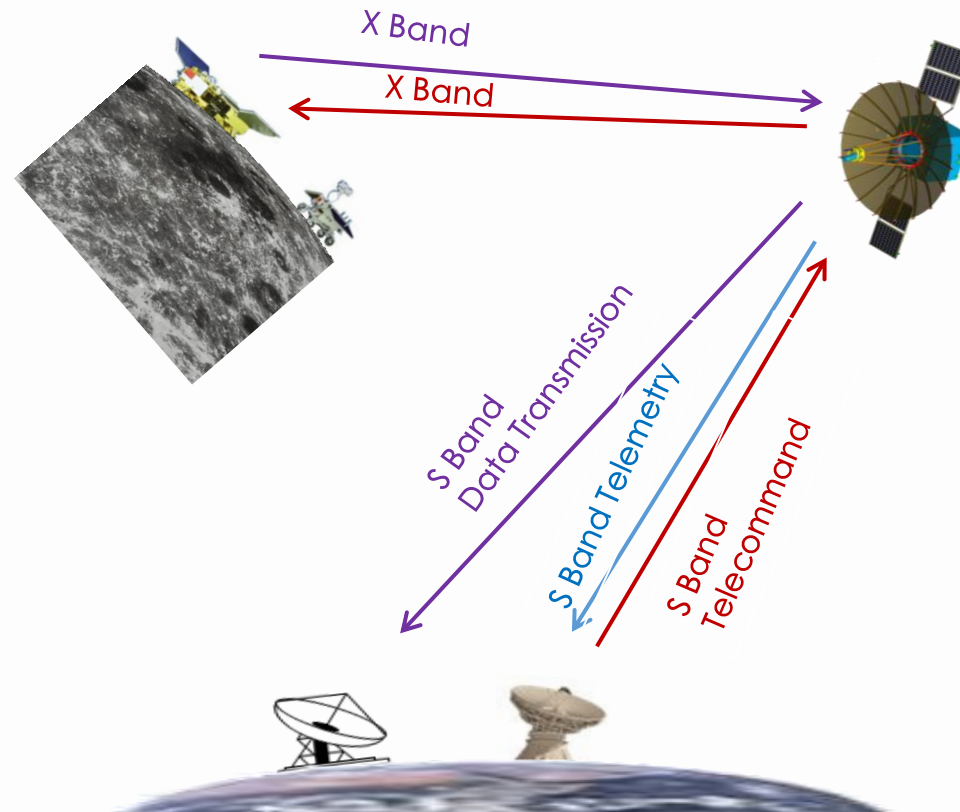
- The advocacy of **interoperation among GNSS** can effectively make up for the shortcomings of single navigation satellite system in space service volume.
- In the process of BD system from regional to global, **the coverage overlap and positioning accuracy** of the signal are significantly improved.
- Navigation signals and message information are **interoperable with other GNSS**.



2.2 Analysis of existing GNSS and Lunar Communication capabilities

(2) Capability of Lunar relay communication

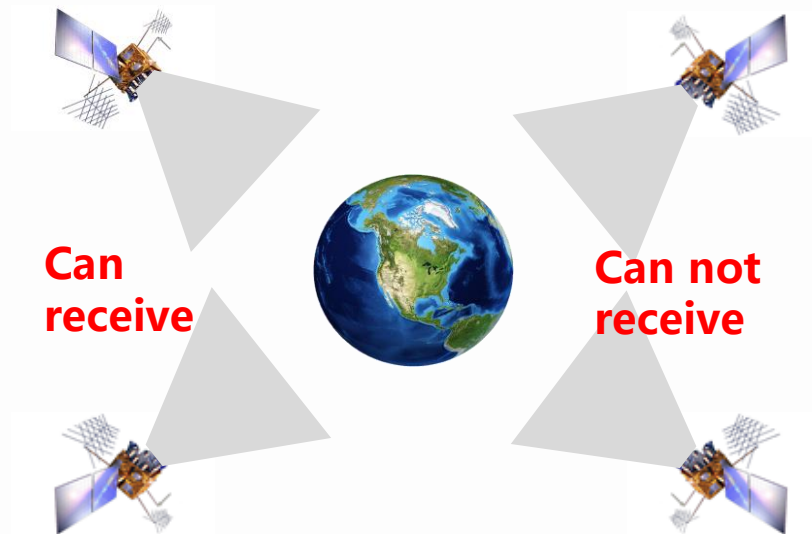
- The QueQiao-1 satellite developed by China was launched into halo orbit at L2 point, which is **the first relay satellite providing communication** on the far side of the Moon.



2.3 Shortage of Earth-Moon scope GNSS and relay communication



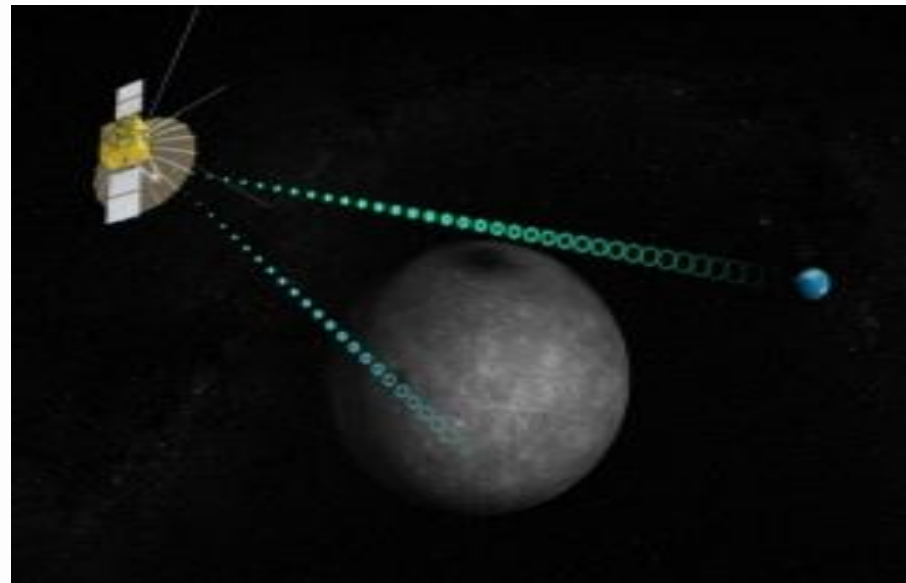
- GNSS satellites mainly serve the ground or near-Earth space, which limits the number of navigation satellite that can be received by the probe in the Earth-Moon space.
- When the probe is on the far side of the moon, all GNSS satellites are not visible.
- The orbit determination accuracy of Earth-Moon space probe using GNSS navigation is limited.



2.3 Shortage of Earth-Moon scope GNSS and relay communication



- The current QueQiao-1 has insufficient support for the lunar south pole, which is difficult to meet the relay communication requirements of the ILRS and other missions at the **lunar south pole**.
- Difficult to support the **cislunar** space mission.
- The communication **rate** does not meet the future demand.
- It can not support **S, Ka** relay links.



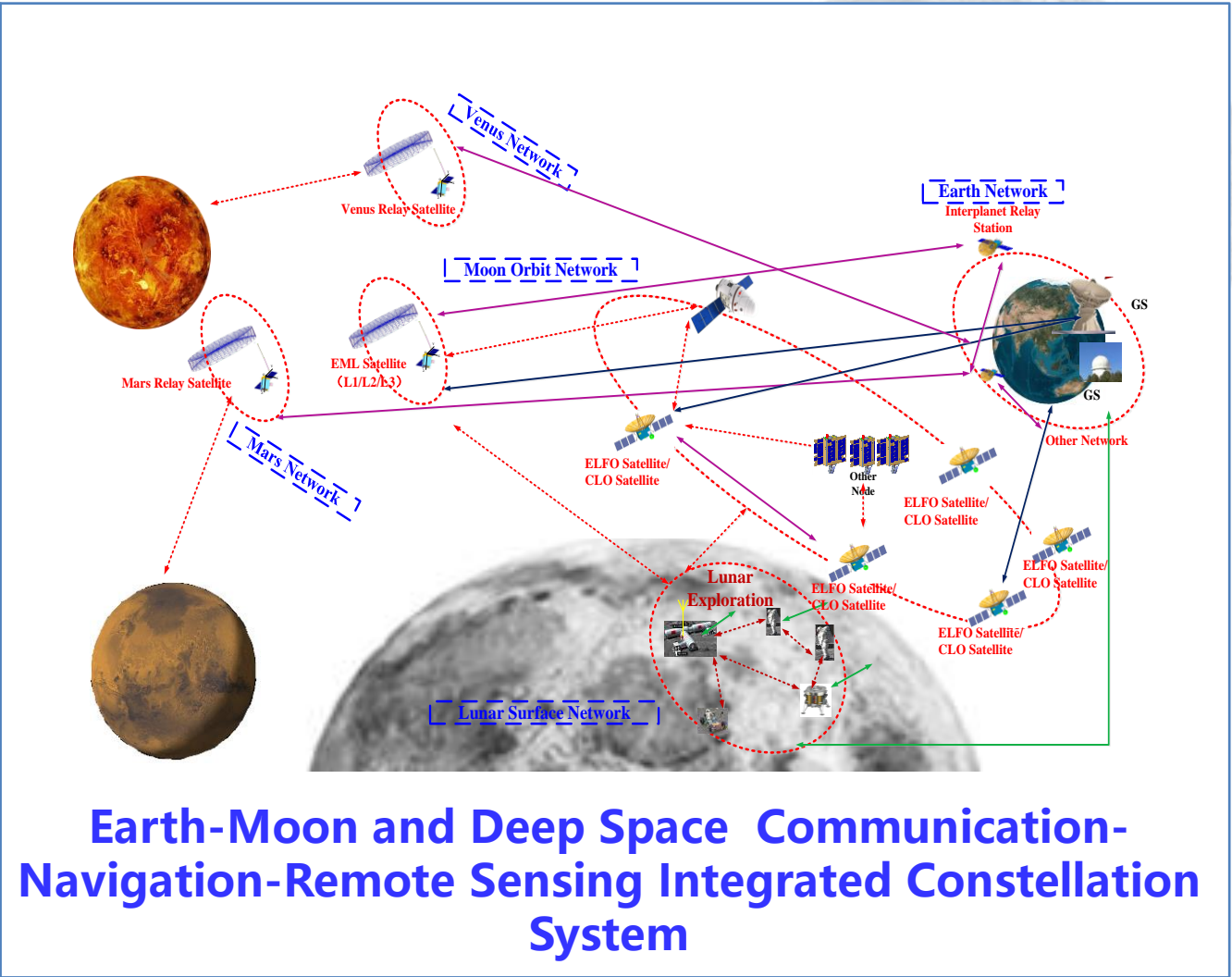


3、Envision of Prospective Scheme and Development Method

3.1 Concept and Intension



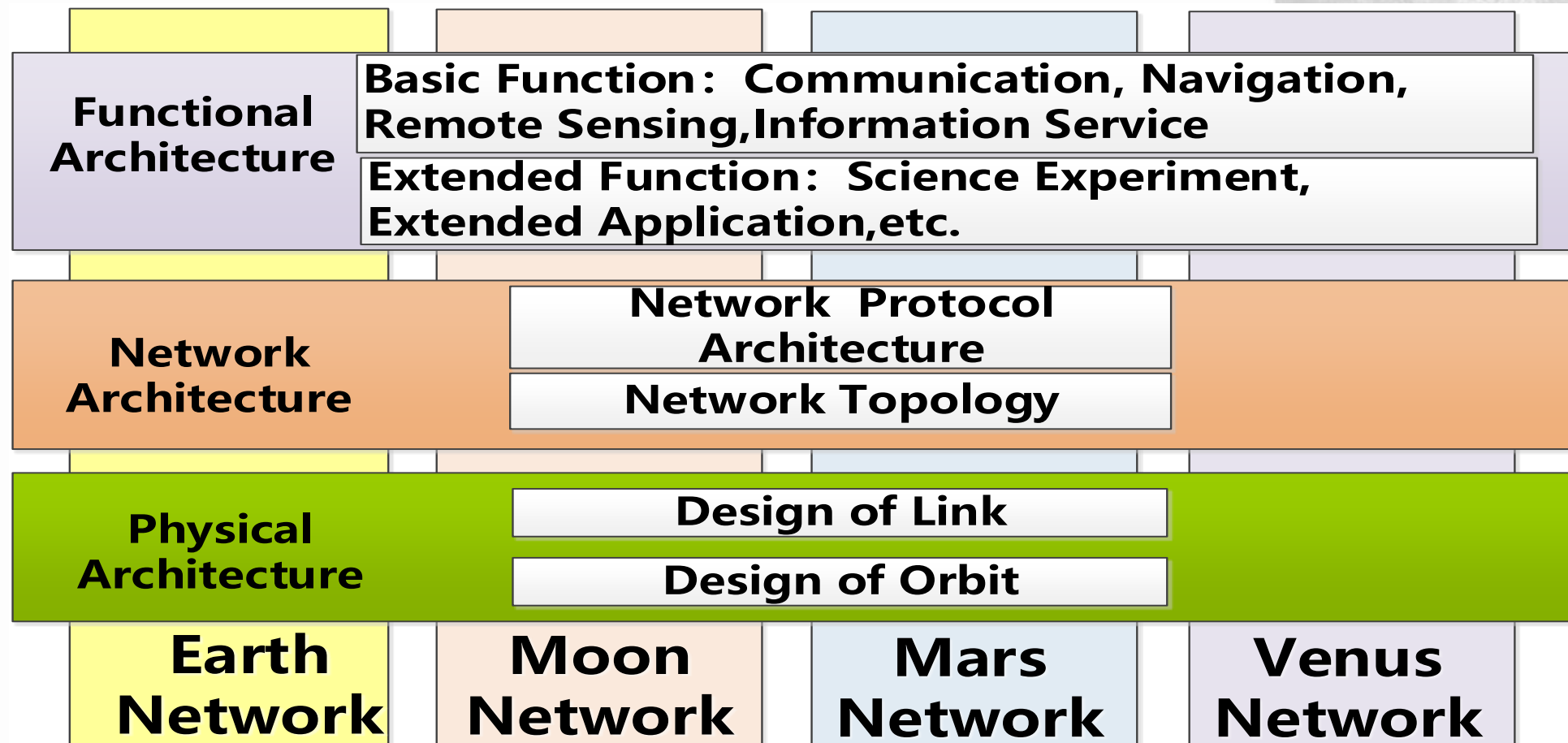
- Role:** Information Facility of Deep Space Communication-Navigation-Remote Sensing
- Function:** Provide High Efficient Network Communication, Precise PNT, High Efficient Remote Sensing, Information service to Deep Space Exploration and Resource Utilization
- Service Scope:** Earth-Moon Space, Interplanetary Space , etc.



3.2 Envision of Prospective Scheme



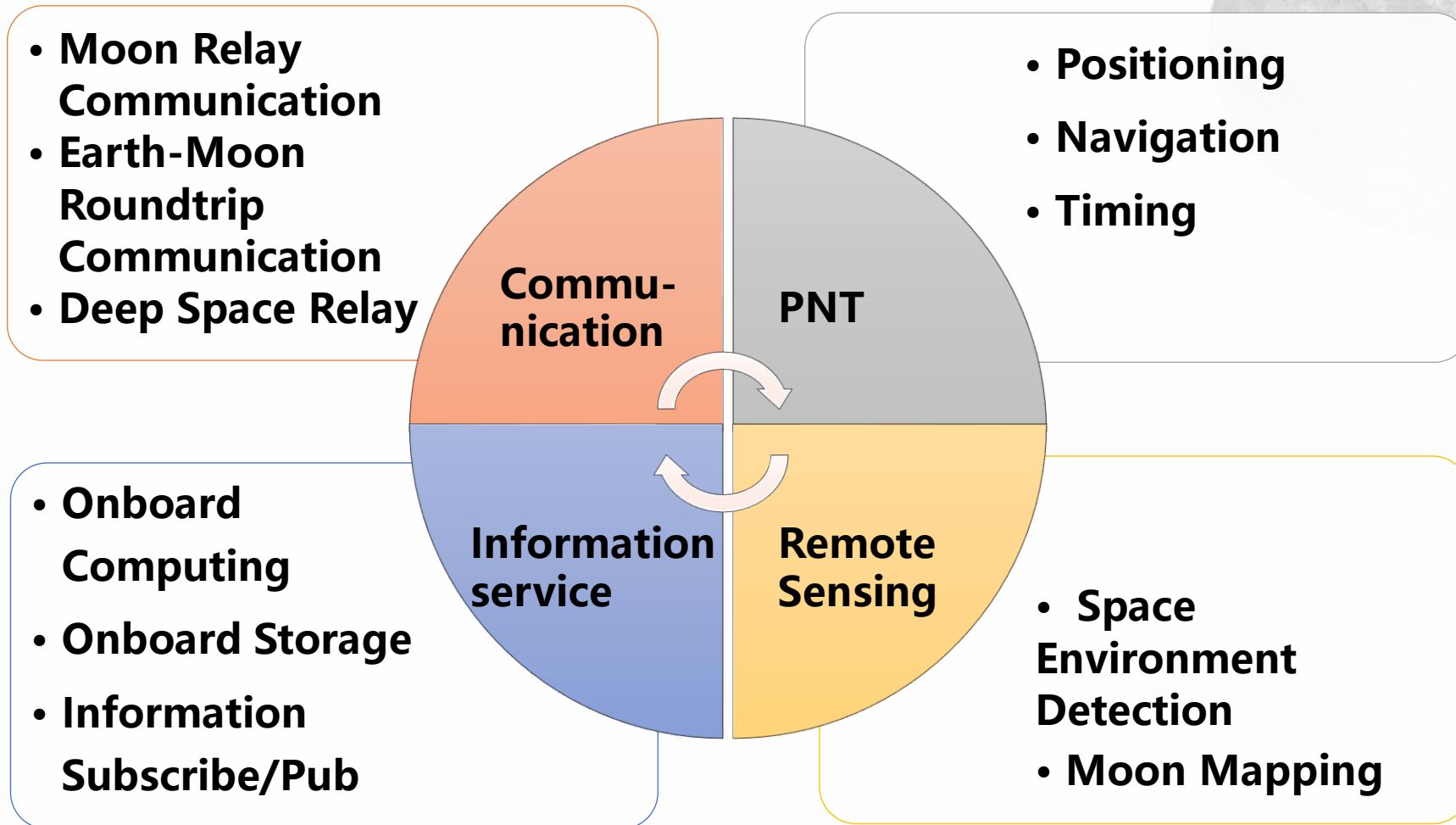
Construct the Earth Network, Moon Network, Mars Network, Venus Network as an Interplanetary Network through the design of Function Architecture, Network Architecture and Physical Architecture.



3.2 Envision of Prospective Scheme



1、Functional Architecture

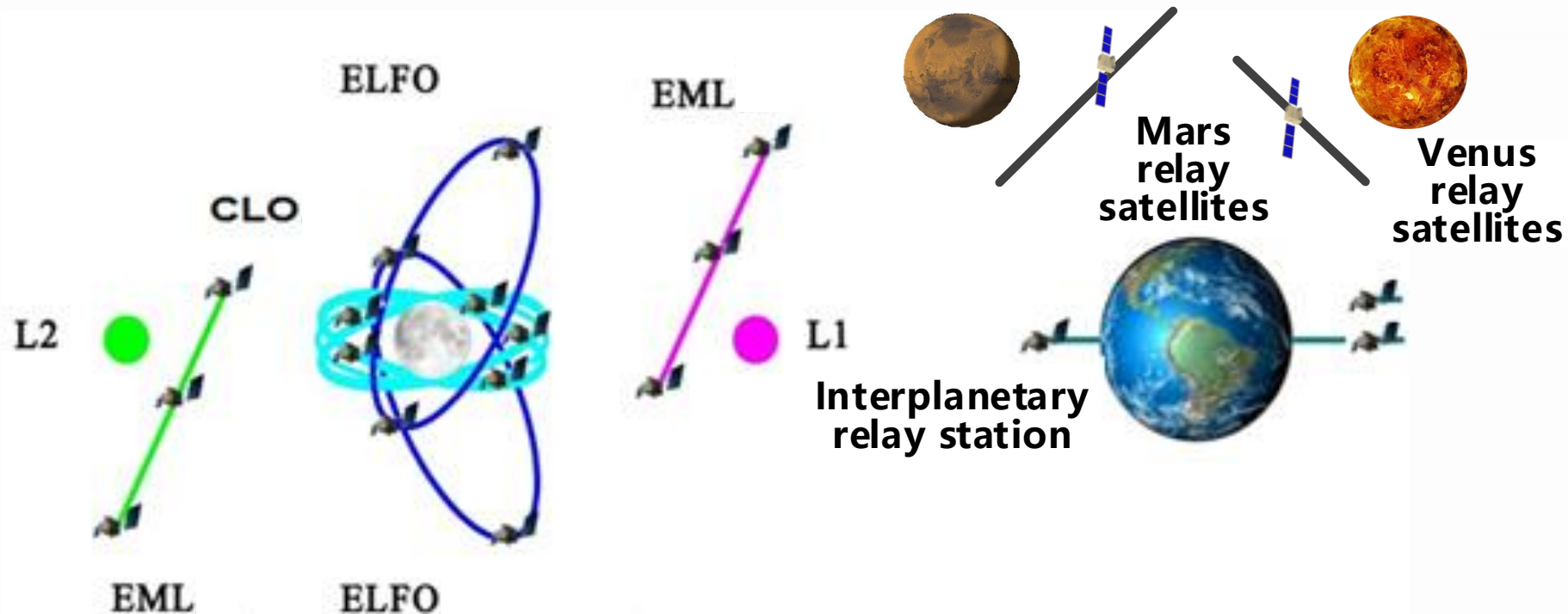


3.2 Envision of Prospective Scheme



2、 Physical Architecture

- Support users on the lunar surface and orbit through **ELFO** and **CLO** satellites.
- Build backbone link between Earth and Moon through **Interplanetary Relay Station** and L1/L2 satellites.
- Build backbone link between Earth and Mars/Venus through **Interplanetary Relay Station** and Mars/Venus relay satellites.

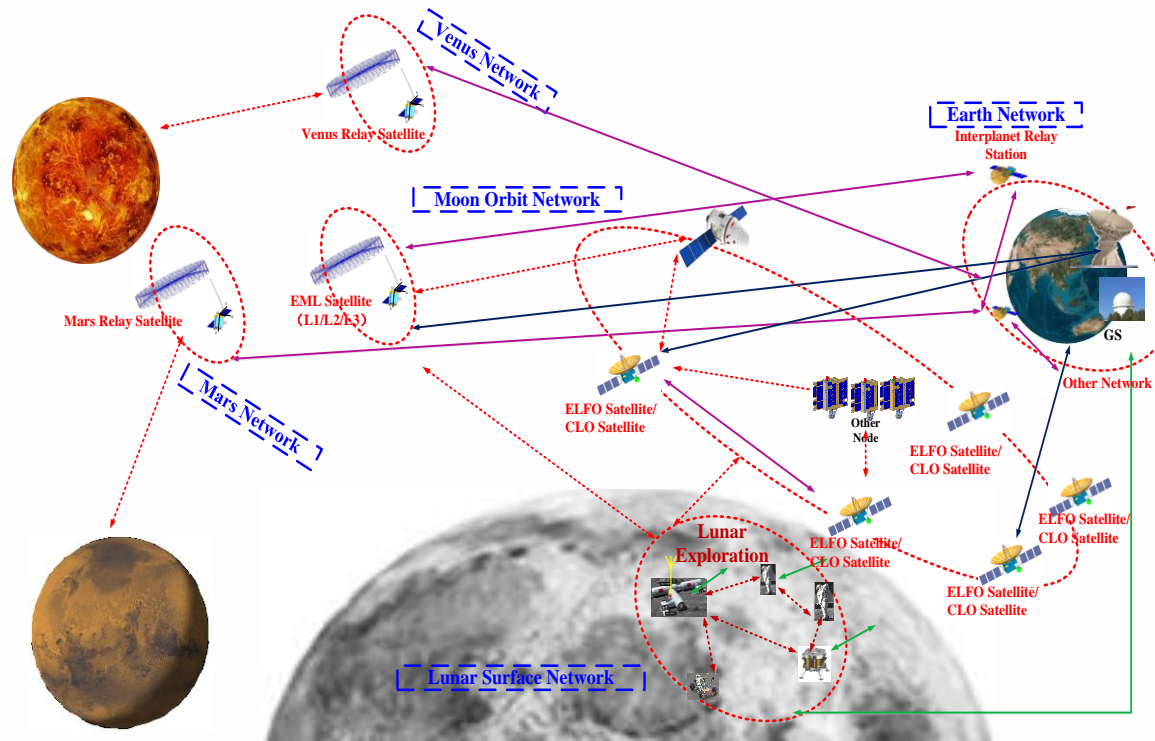


3.2 Envision of Prospective Scheme

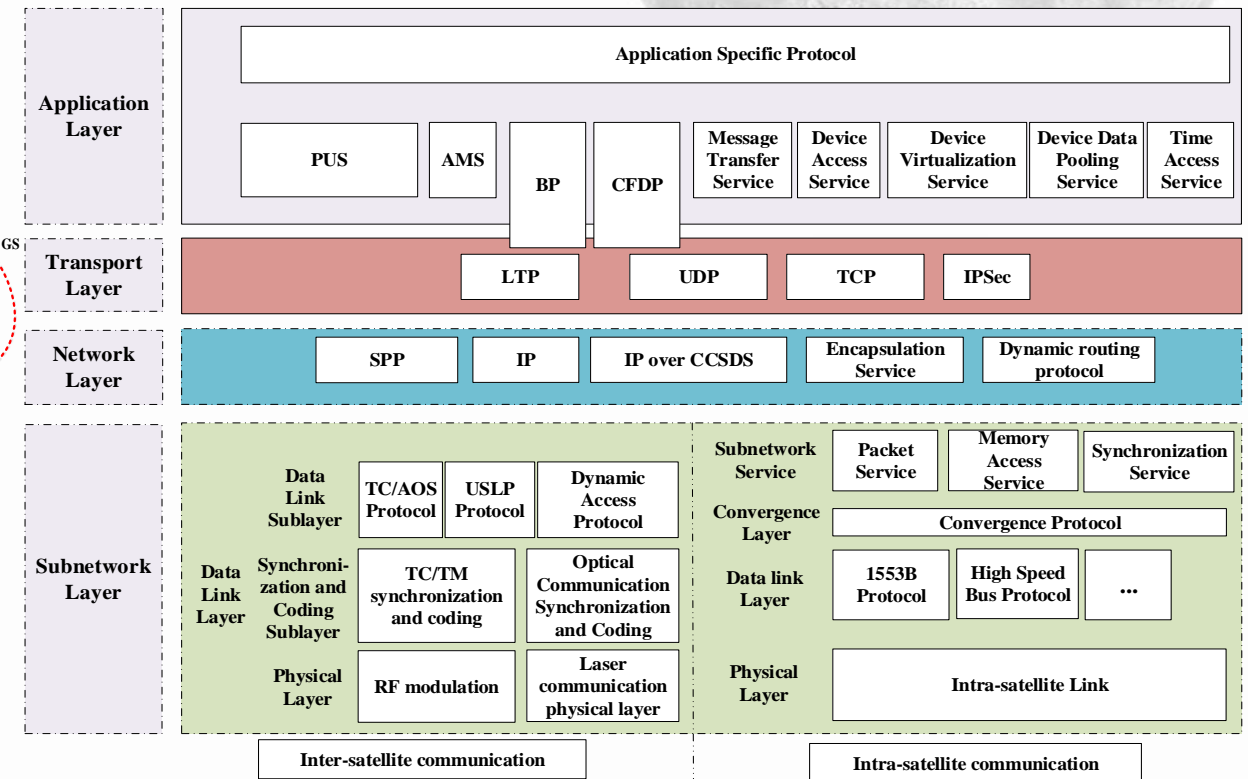


3、Network Architecture

The future system consists of Moon Network, Mars Network and Venus Network , which can be connected to Earth Network through **Interplanetary Relay Station** .



Primary Network Topology



Primary Network Protocol Architecture

3.3 Envision of Development Method



A suggested development method is as follows.

Step 1

Provide primary Earth-Moon communication ability, verify network, navigation, remote-sensing technology.

Support Lunar Exploration Phase IV, ILRS, manned lunar exploration.

Step 2

Provide full Earth-Moon communication , navigation and remote sensing ability.

Support ILRS, lunar scientific exploration and development, international lunar exploration.

Step 3

Provide primary deep space communication , navigation and remote sensing ability.

Support Moon, Mars ,Venus , and Solar System Marginal Exploration.

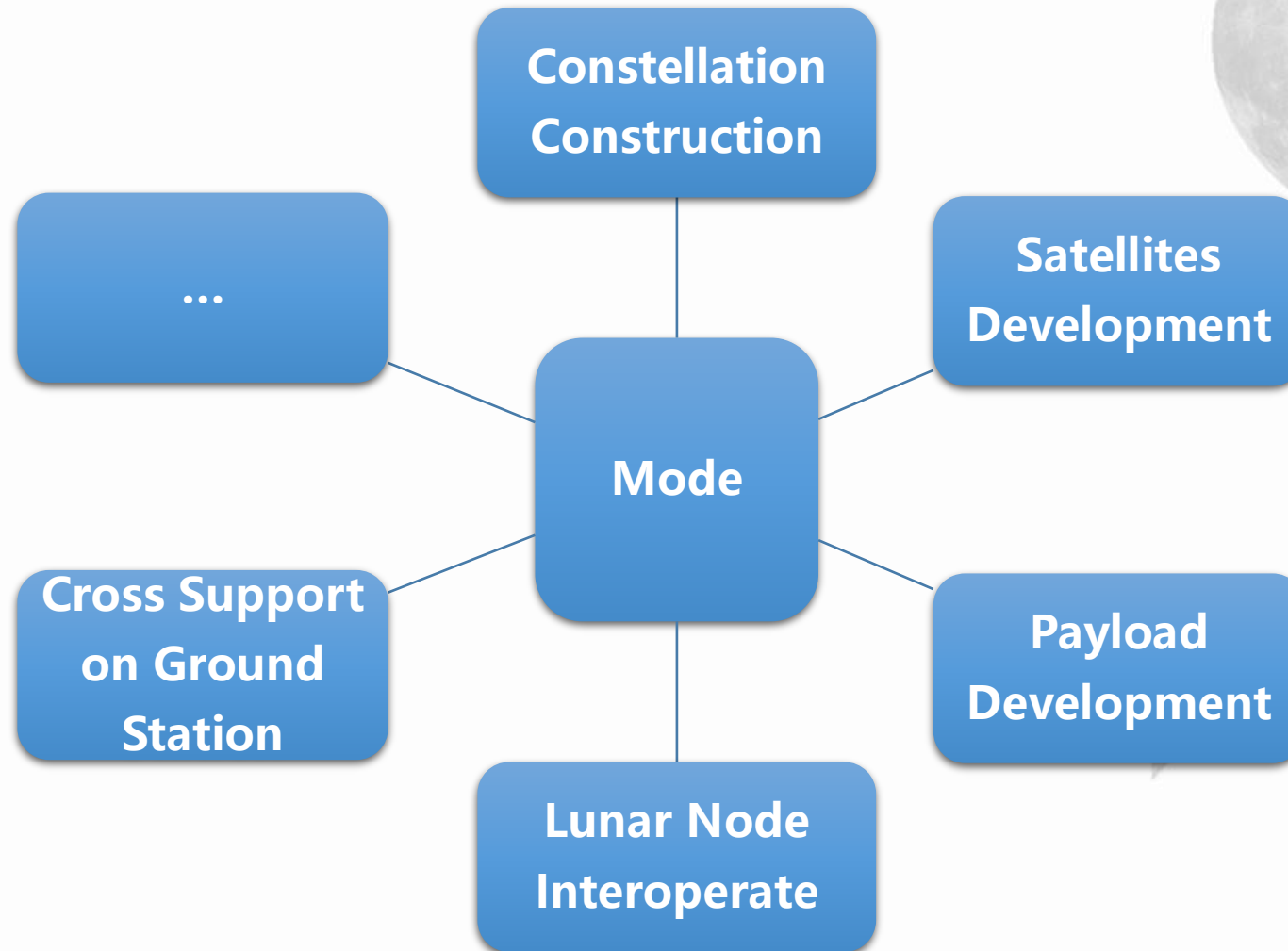


4、 Mode of International Cooperation

4.1 Mode of International Cooperation



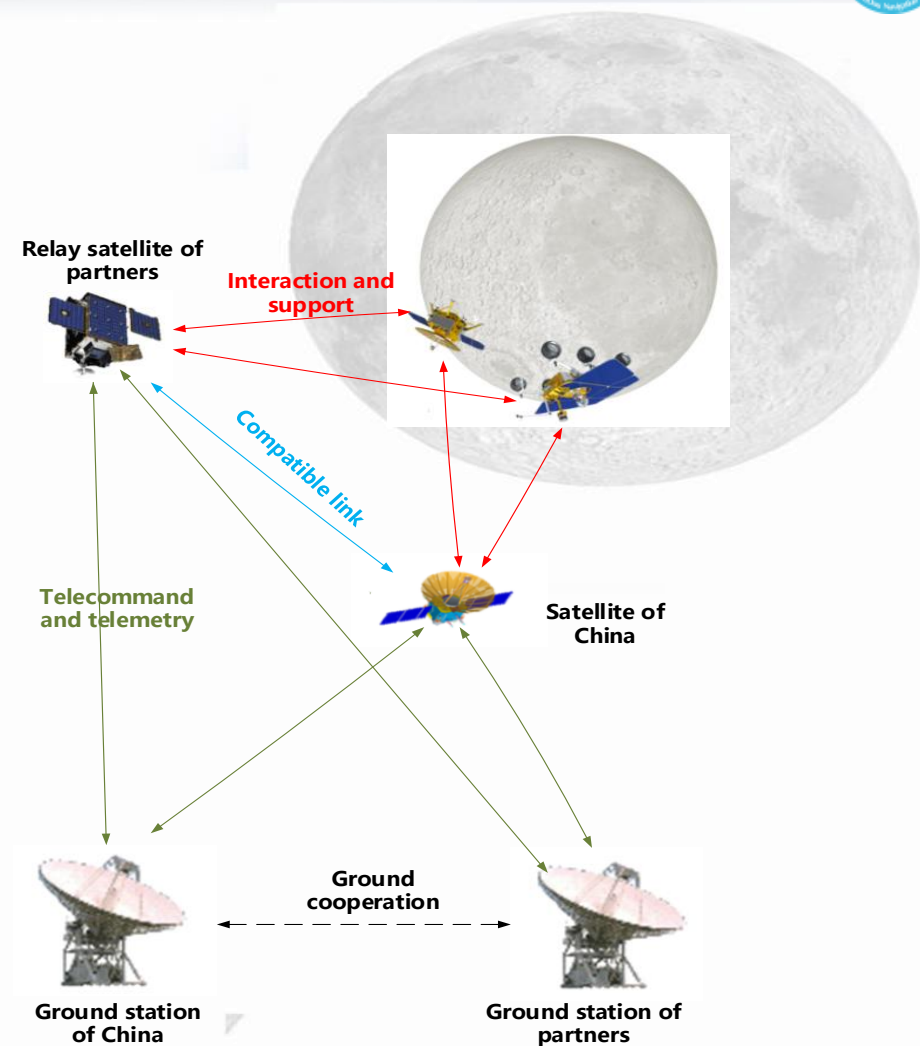
Construct the system through the collaboration of multiple countries, international institutes, colleges, and business organizations.



4.1 Mode of International Cooperation



- **Task Level**
 - Support international lunar exploration.
 - Support international deep space exploration.
- **System Level**
 - Around the moon: design the unified system structure and cooperate to establish earth-moon communication-navigation system.
 - Around the earth: Using ground station of cooperative partner to support the earth-moon communication-navigation system.

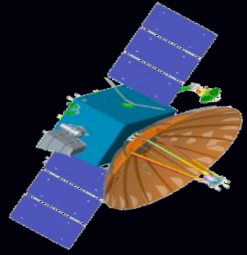


Ways of cooperation

4.2 The Ending



- **The establishment of the Integrated Constellation System, as the Earth-Moon and deep space information infrastructure, provides communication ,navigation and remote sensing services for international lunar exploration, deep space exploration, etc.**
- **It is a powerful guarantee to boost the development of the Earth-Moon space economy and aerospace industry, and an important support for efficient utilization and cognition of space.**
- **We are willing to continue to work collaboratively.**



Thanks!

