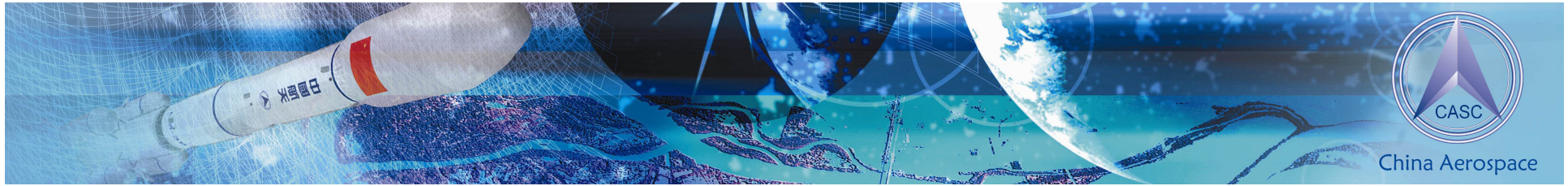


ISU Symposium 2007

The New Generation of Launch Vehicles and Its Applying to China's Lunar Exploration Program

Li Dong, Cheng Tangming

***China Academy of Launch Vehicle Technology
Feb. 2007***

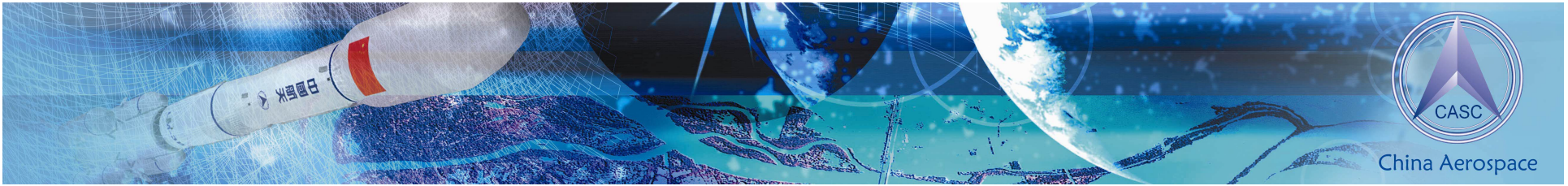


Contents:

Part I: The Long-March family and its history

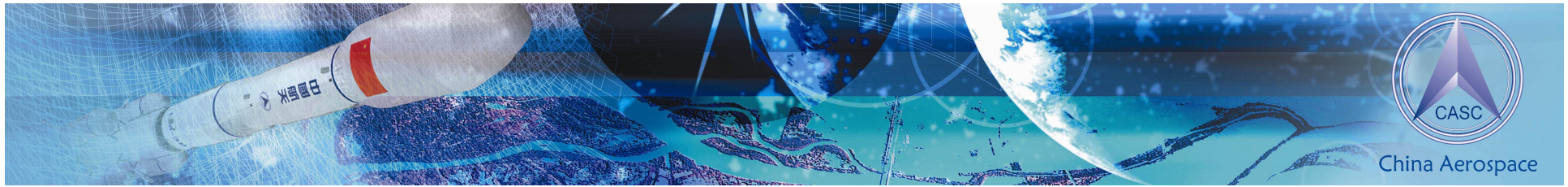
Part II: New generation of LM launch vehicles

Part III: Applying to lunar exploration program



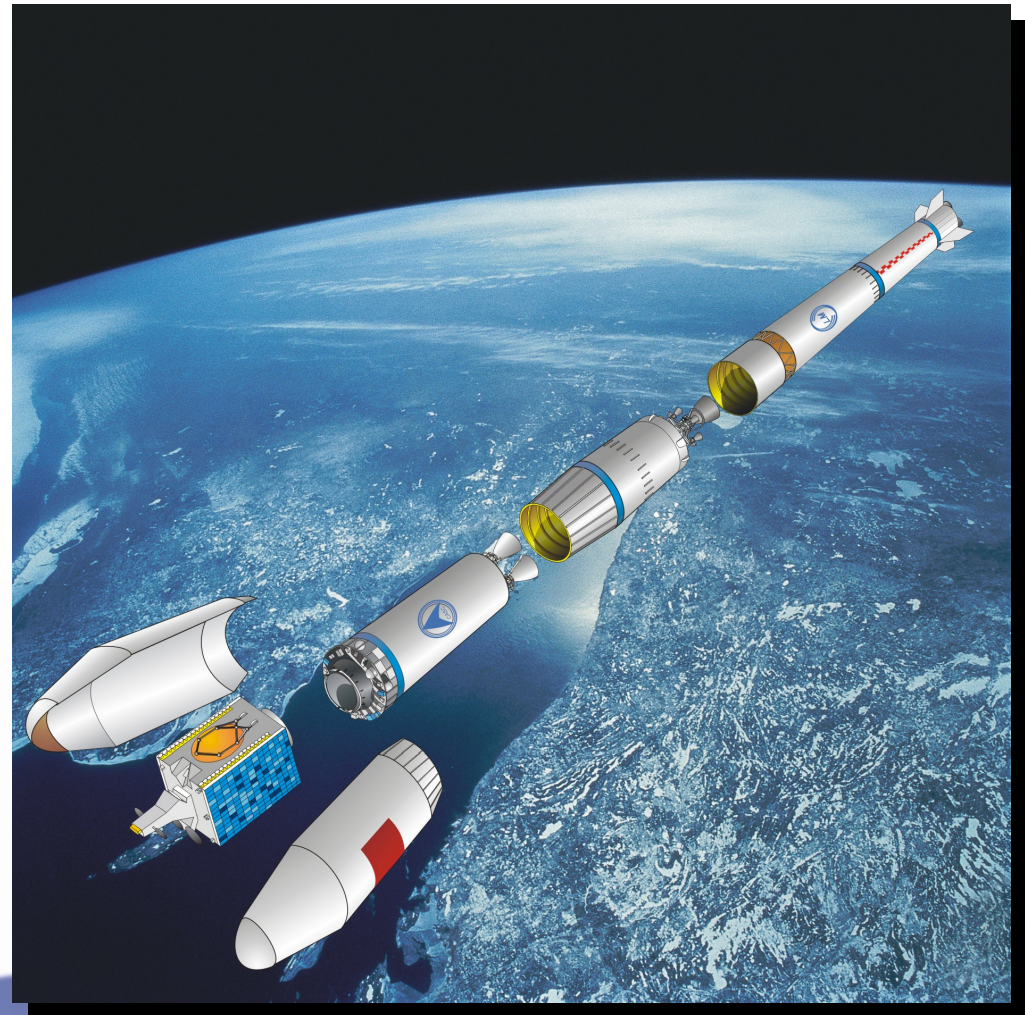
Part I

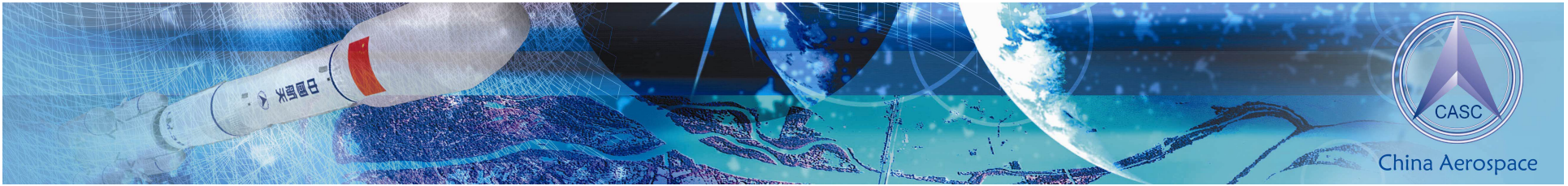
The Long-March family and its history



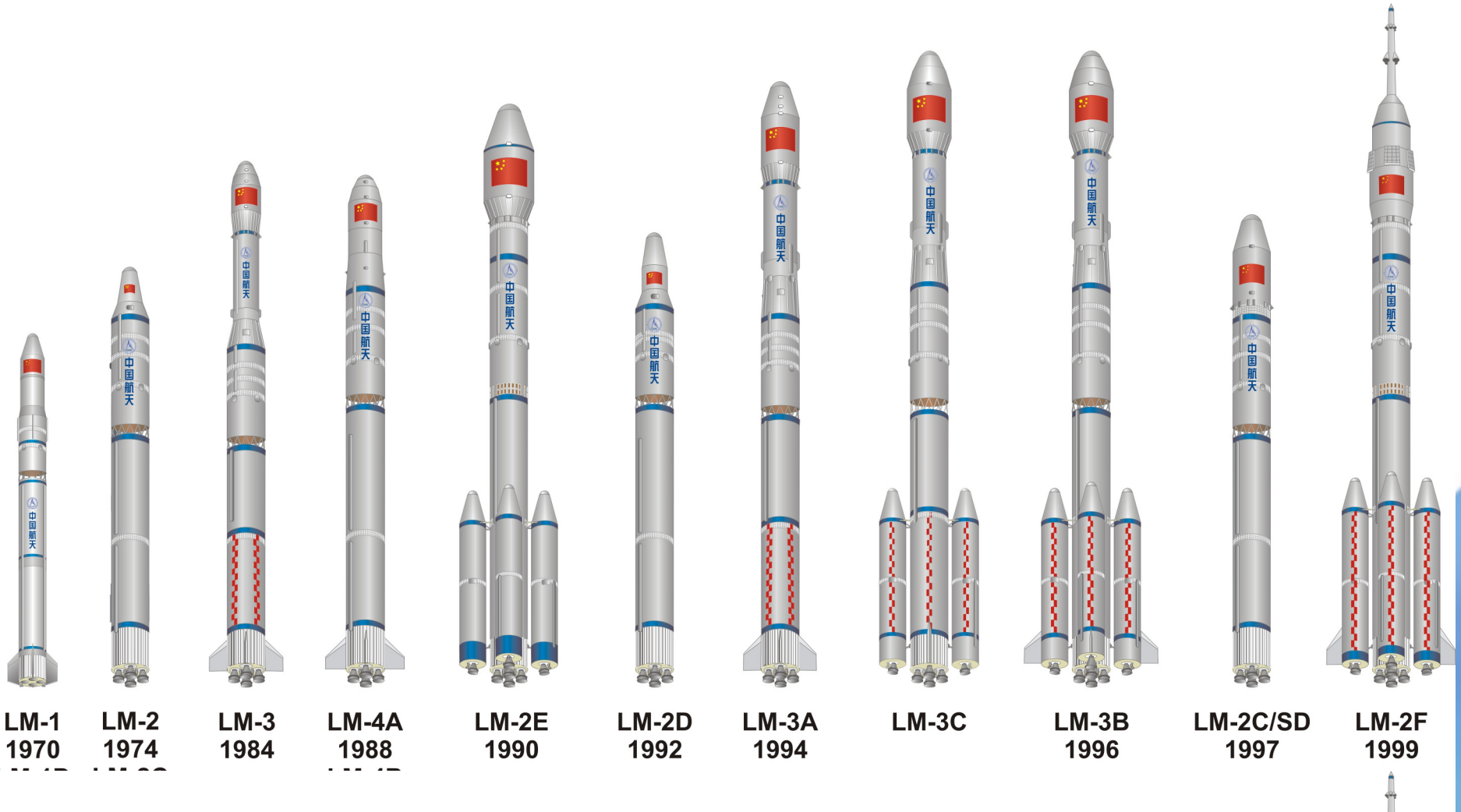
Long-March Launch Vehicles

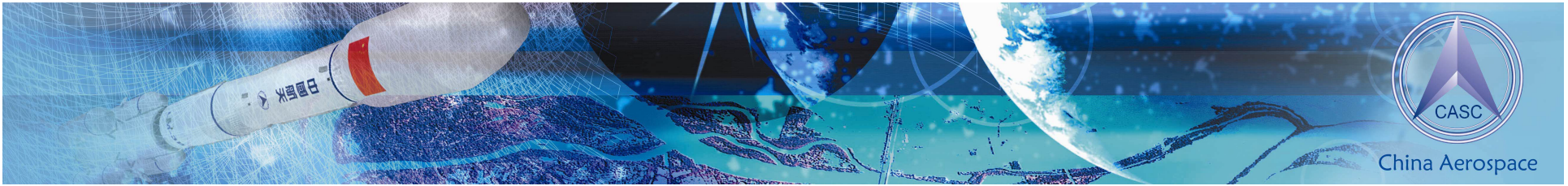
An Essential Force on
World Launch Service
Market





Long-March Family

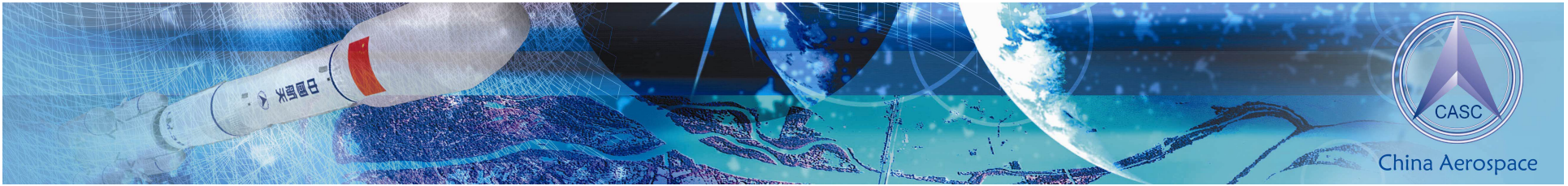




Footprints of LM Launch Vehicle

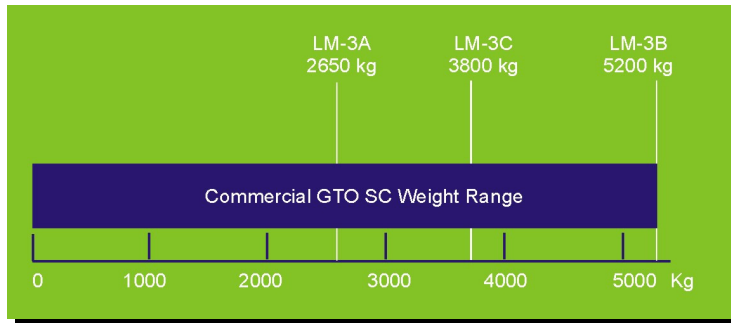
- ❑ *LM-1, the first launch vehicle developed by China, successfully sent the first Chinese satellite into space.*
- ❑ *With successful development of LM-3, China has the ability to launch GTO satellites. Then Long March launch vehicle entered into world launch service market.*
- ❑ *LM-2E was successfully developed in 18 months and conducted several launch service missions.*
- ❑ *LM-3A series launch vehicles (include LM-3B, LM-3C) become Chinese main-force launchers in the world launch service market.*
- ❑ *LM-2F successfully launched China's manned capsules.*





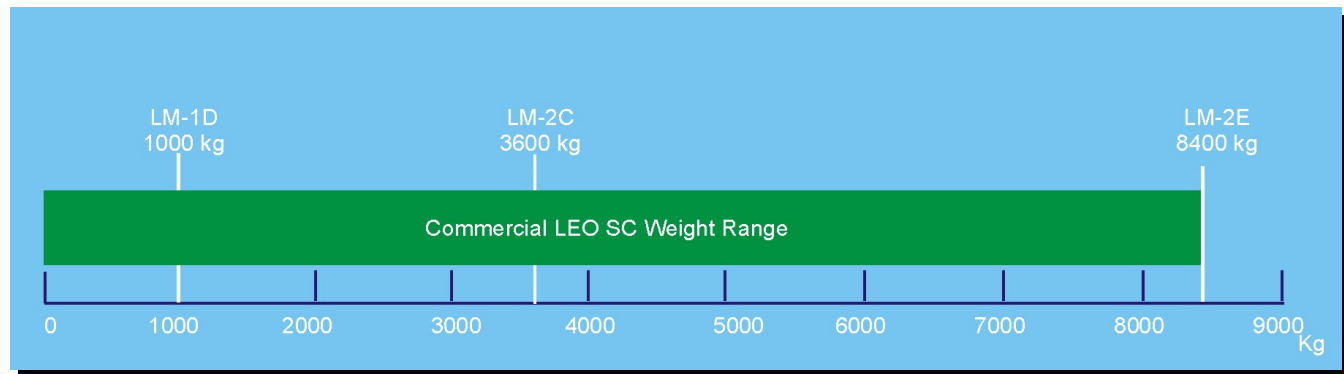
Excellent Performance

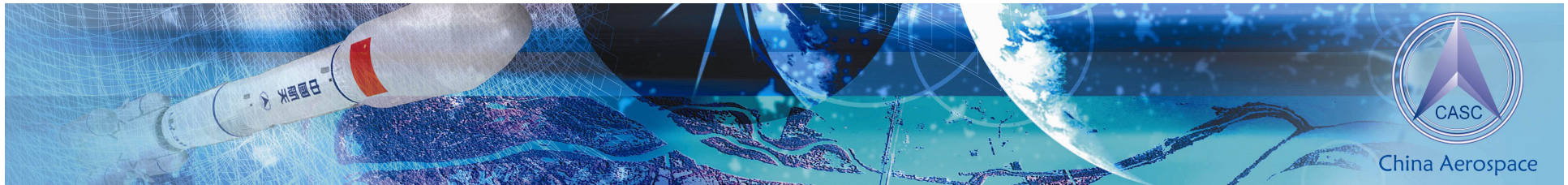
❑ Long-March Launchers are capable of launching most satellites in the world.



❑ GTO Launcher:
LM-3A, LM-3B, LM-3C
Launch Capacity ranging from 2650 to 5400 kg

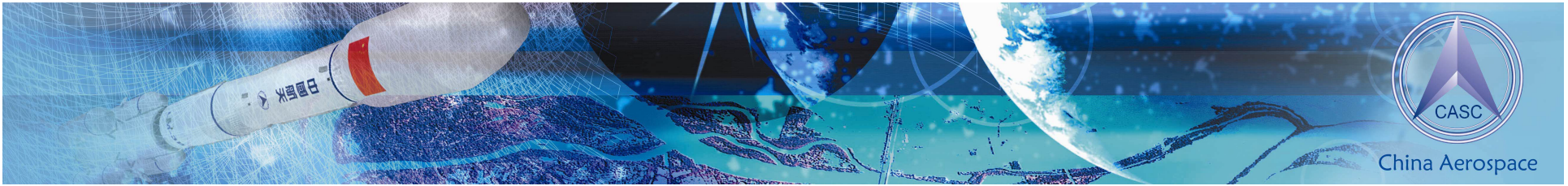
❑ LEO Launcher:
LM-1D, LM-2C, LM-2D, LM-2E, LM-2F
Launch Capacity ranging from 400 to 8500 kg





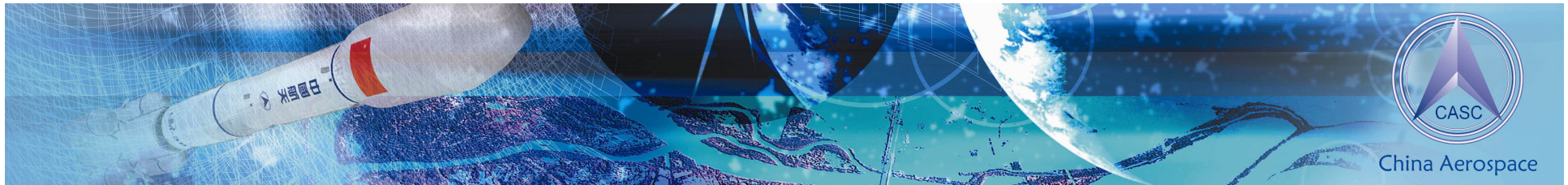
Straight Successes

- ❑ Up to now, Long-March Family have accomplished 95 flights. The success rate has reached 92%.**
- ❑ Since Oct. 1996, Long-March Launch Vehicles have conducted 53 consecutive successful flights.**



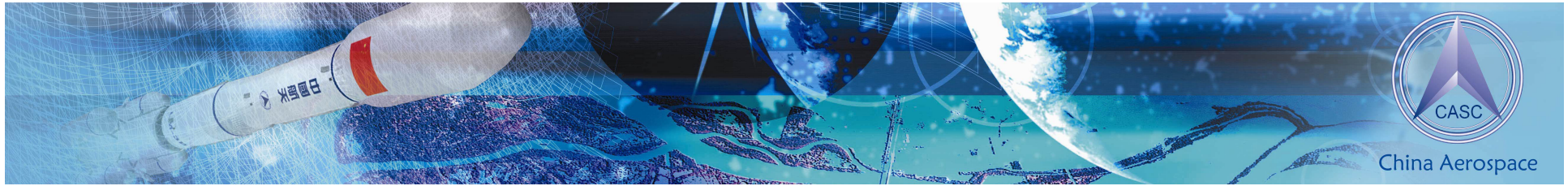
Part II

New generation of LM launch vehicles



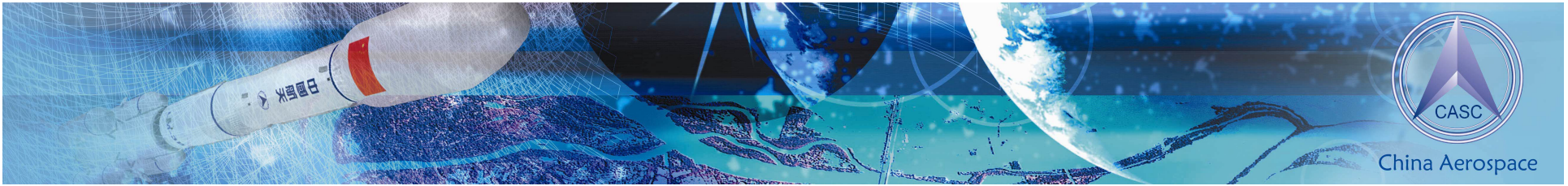
Why New-generation launchers?

- ❑ To meet the needs in the future launch service market
- ❑ To prepare for launching large-scale space station
- ❑ To maintain the development trend of China's launch vehicle technology
- ❑ To drive the development of economy and related high-techs in China



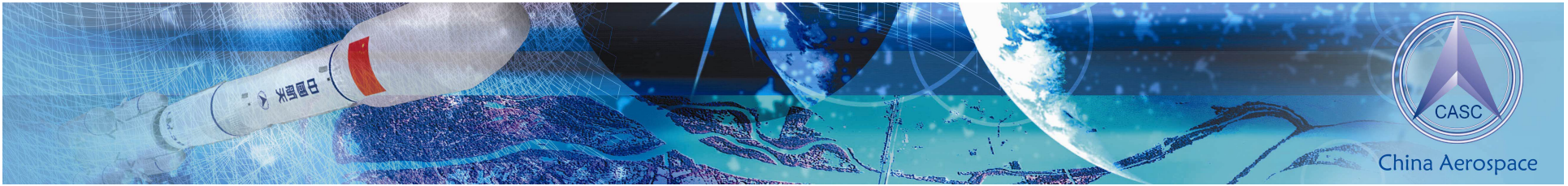
Development Targets

- ❑ To design a series of launch vehicles rather than one launcher made for a specific mission, so that to enhance China's capability of entering the space.
- ❑ To apply the advanced technologies, such as the large diameter core and the powerful thrust engine to increase the launch capacity dramatically, with the goal of launching 25-ton payloads to LEO and 14-ton to GTO.
- ❑ To design a series of launch vehicles based on the principle of generalization, serialization and modularization, with the purpose of meeting the needs of launching different payloads.
- ❑ To use non-toxic and non-polluting propellant.
- ❑ To be low cost, high reliability, and convenient for test and operation.



Systems Concept

- ❑ **Modularized**
- ❑ **Two newly developed engines**
- ❑ **Three standard modules**
- ❑ **One series include three primary classes: the 5-m-dia core variants, 3.35-m-dia core variants and 2.25-m-dia core configuration**

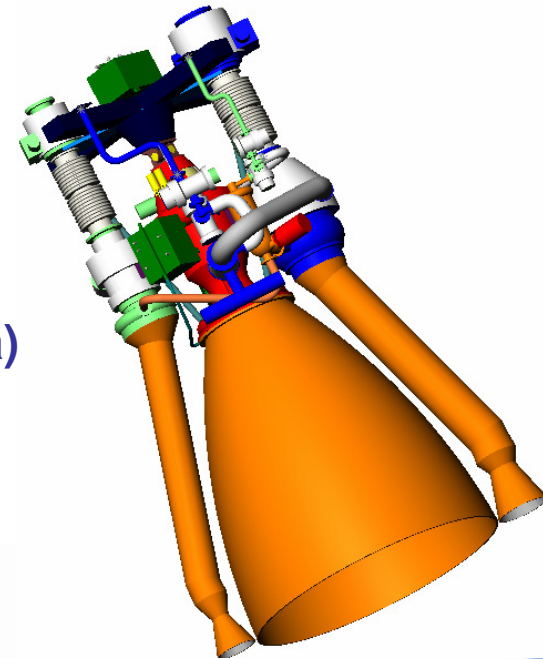
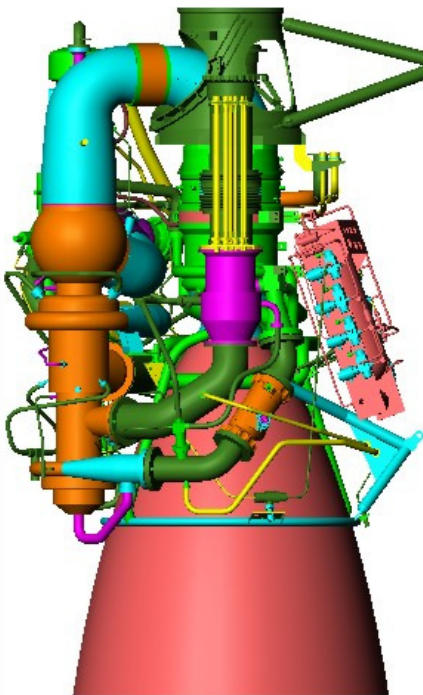


TWO engines

Non-Contamination & High Performance

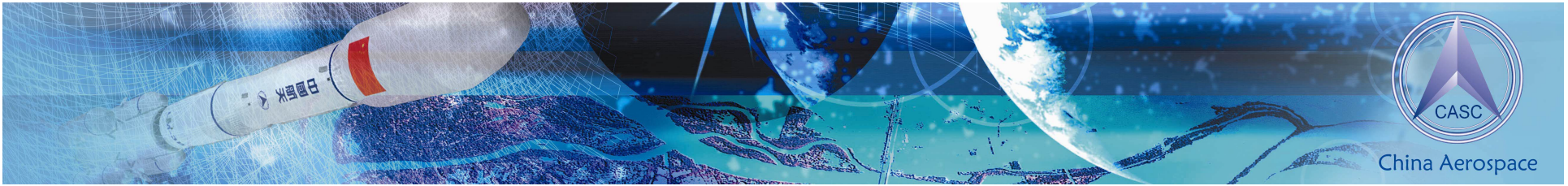
❑ 120t KO/LOX Engine

- ✓ Thrust: 1200 kN (Sea)
- ✓ Specific impulse: 2942 m/s (Sea)
- ✓ One-directional Swinging



❑ 50t LH/LOX Engine

- ✓ Thrust: 700 kN (Vac)
- ✓ Specific impulse: 4198 m/s (Vac)
- ✓ Two-directional Swinging

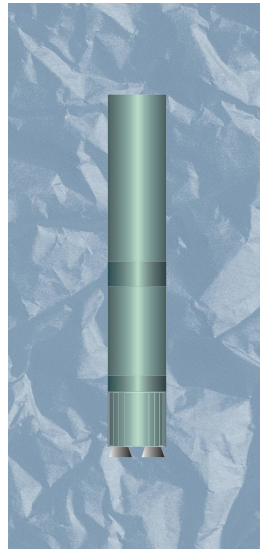


THREE standard modules



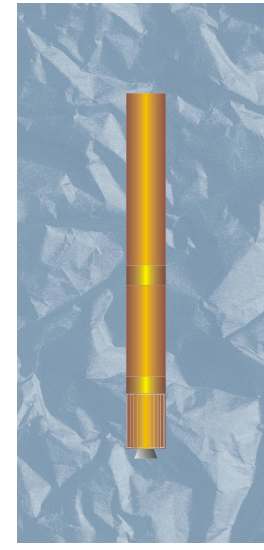
H5-1 Module:

- ✓ Diameter: 5m
- ✓ Length: 31.0m
- ✓ Two 50t LH/LOX Engines
- ✓ Total Mass: 175t



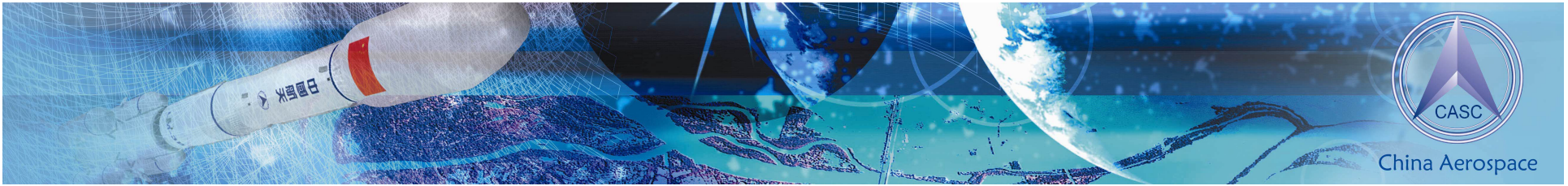
K3-1 Module:

- ✓ Diameter: 3.35m
- ✓ Length: 26.3m
- ✓ Two 120t KO/LOX Engines
- ✓ Total Mass: 147t

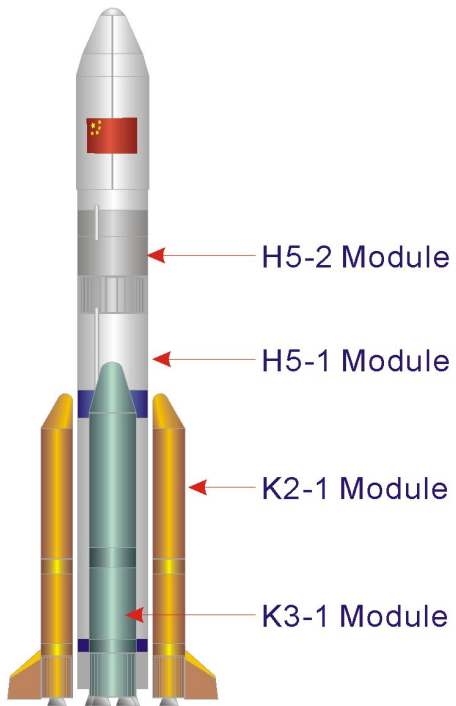


K2-1 Module:

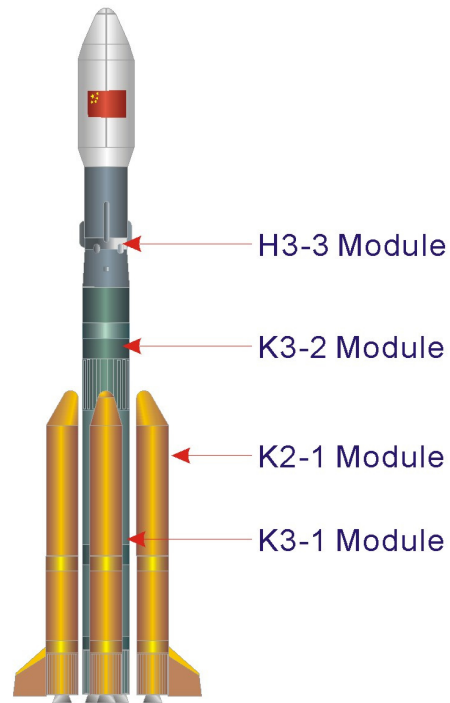
- ✓ Diameter: 2.25m
- ✓ Length: 25.0m
- ✓ One 120t KO/LOX Engine
- ✓ Total Mass: 69t



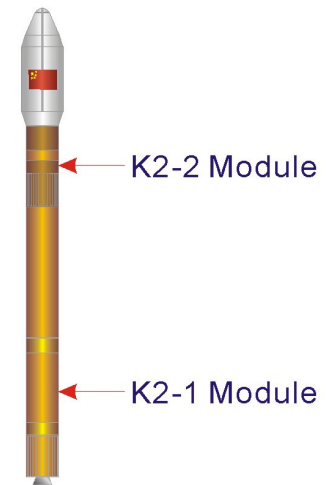
ONE series



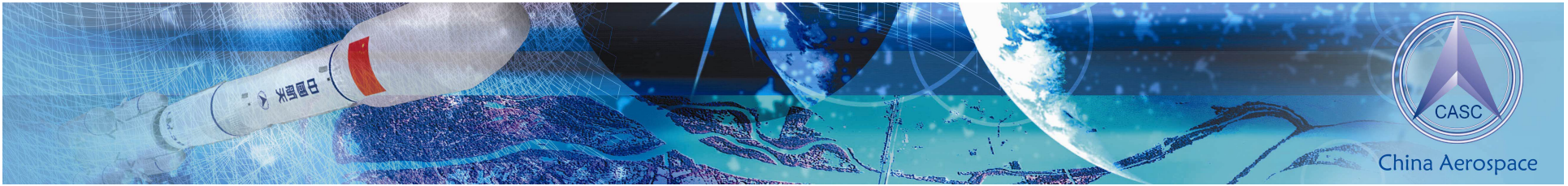
- Base Type 1**
- ✓ 5m Stage-1 & 2
 - ✓ Two 3.35m-boosters
 - ✓ Two 2.25m-boosters



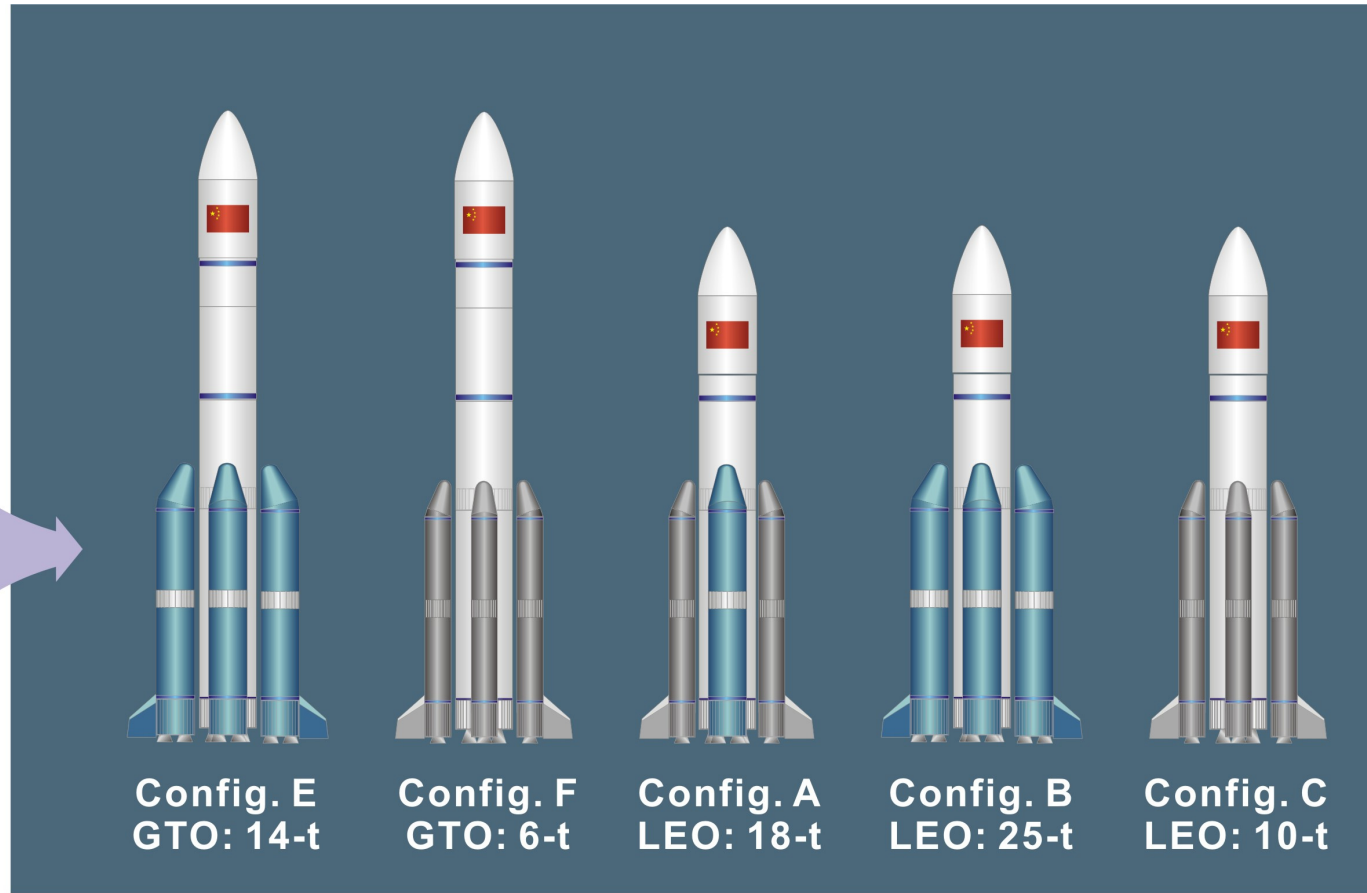
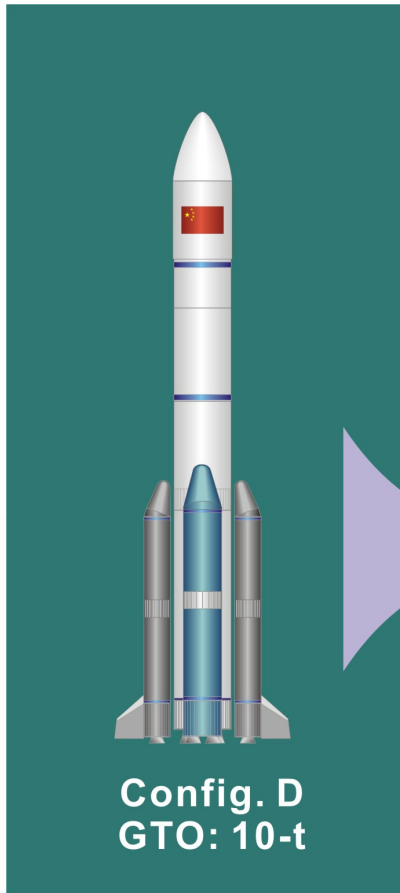
- Base Type 2**
- ✓ 3.35m Stage-1 & 2
 - ✓ 3m Stage-3
 - ✓ Four 2.25m-boosters

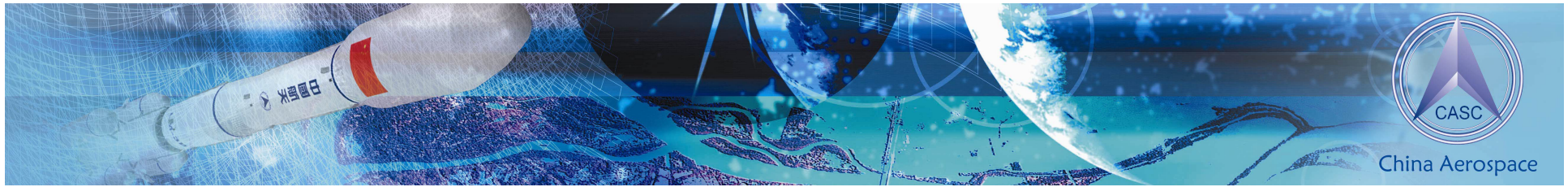


- Small LV**
- ✓ 2.25m Stage-1 & 2



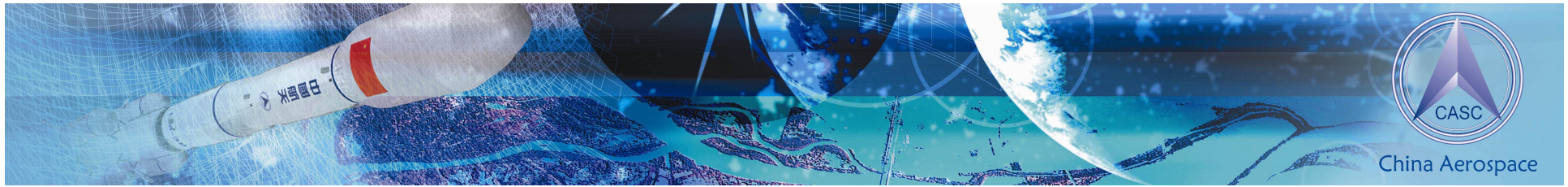
5-m-dia core variants





Launch Capability

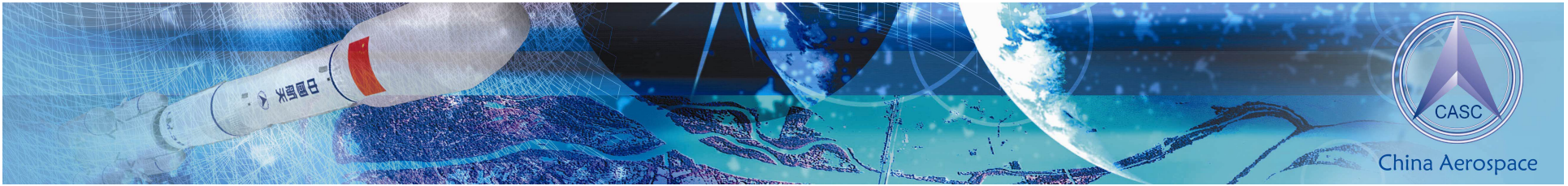
- ❑ GTO: 1.5~14 tons
- ❑ LEO: up to 25 tons



Planning

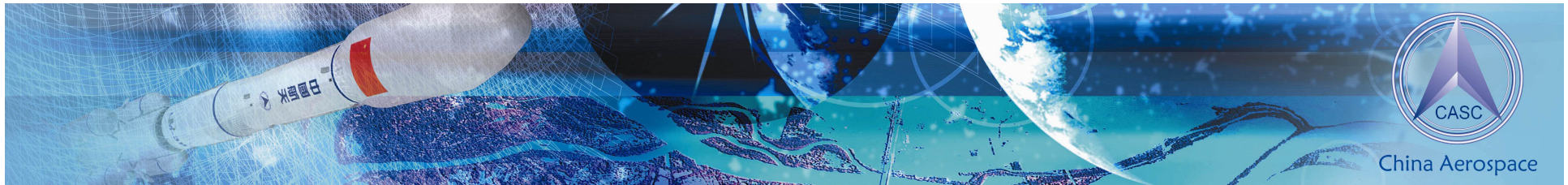
□ Flight in 2013





Part III

Applying to lunar exploration program

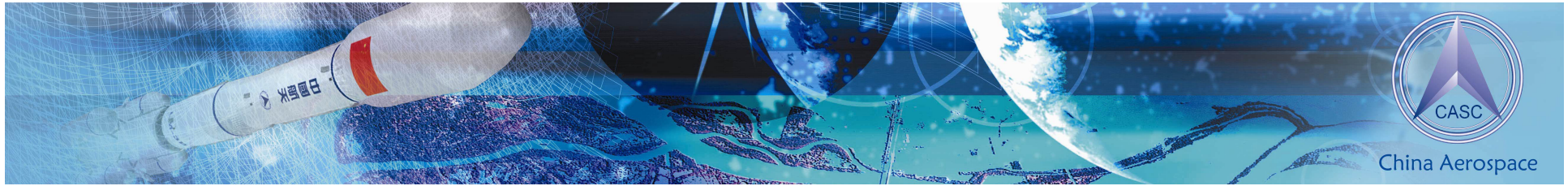


The Aims of China's Lunar Exploration Program (CLEP)

- ❑ To promote the innovation and development of basic science
- ❑ To lay technological foundation for the future deep space exploration
- ❑ To promote the international cooperation in space and improve space technology
- ❑ To make contributions to the exploration of unknown word for human beings

CLEP, named *Chang'e* Program
— Lady *Chang'e* flying to the moon,
an ancient Chinese legend

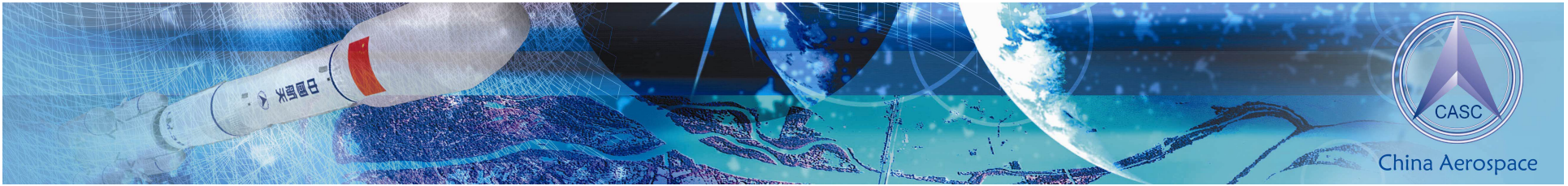




China's Lunar Exploration Program (CLEP)

- ❑ Phase 1: orbiting the moon
- ❑ Phase 2: soft landing on the moon surface and roving
- ❑ Phase 3: sampling and returning to the earth

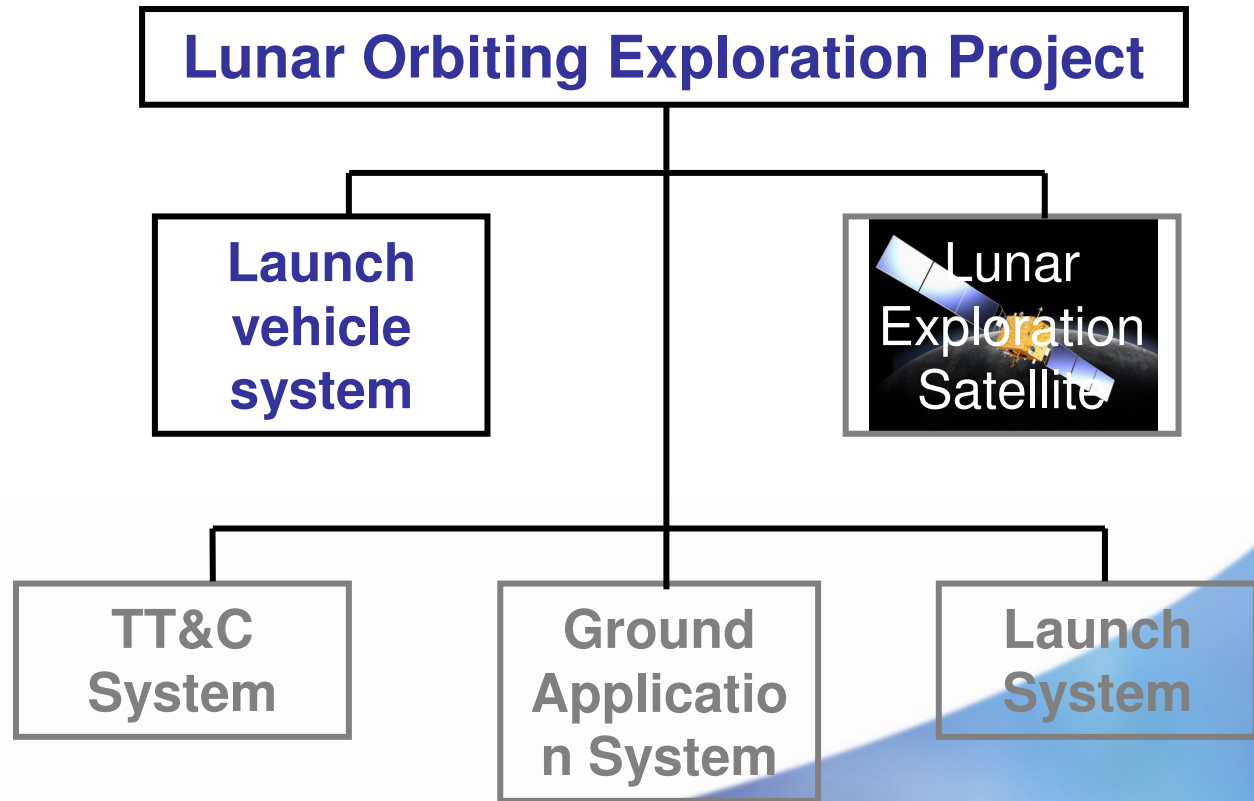


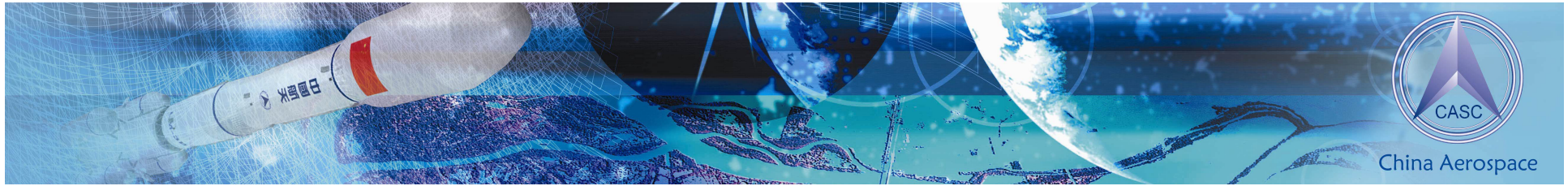


Lunar Orbiting Exploration



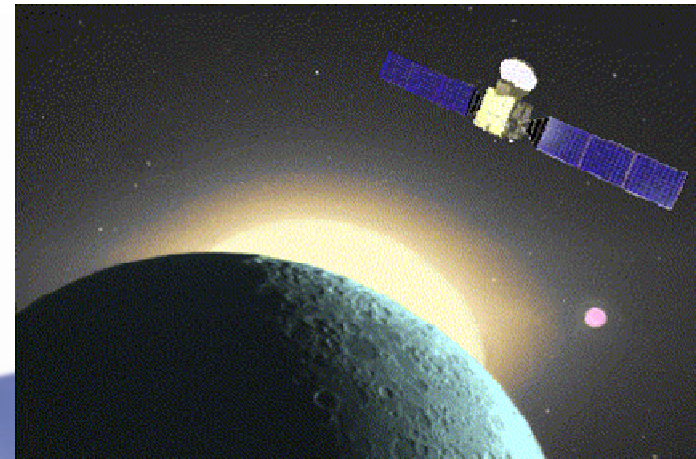
LM-3A

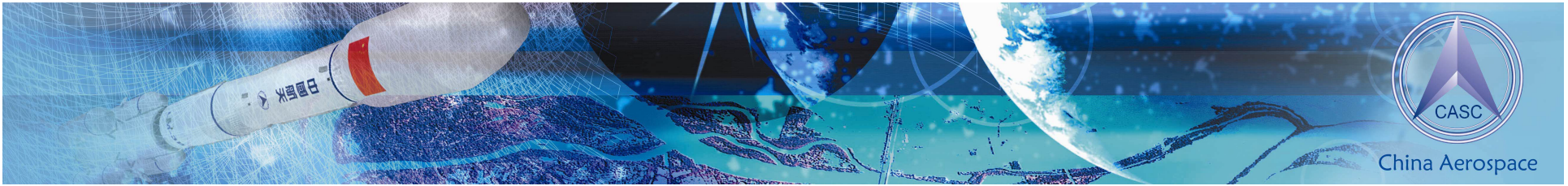




Development Status

- All the work in the Project is going on well as scheduled.
- The prototype of the satellite system is being developed.
- The launch vehicle is under construction as planned.
- TT&C system, launch site system and application system are being developed, rebuilt and constructed as scheduled.
- The whole system will be able to move to the launch site in 2007.



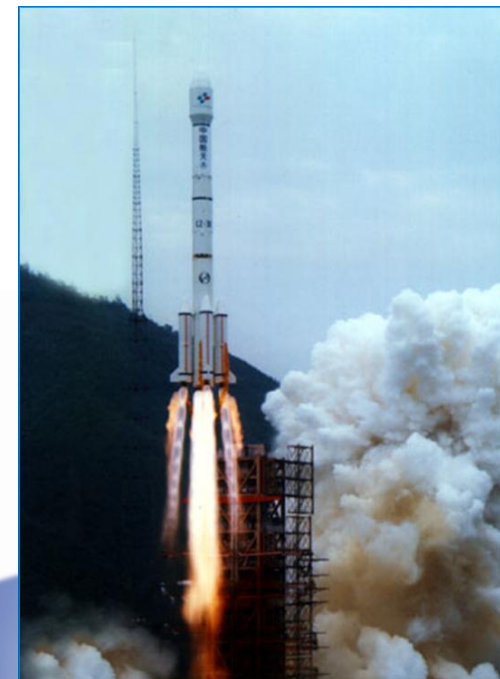


Soft Landing and Roving

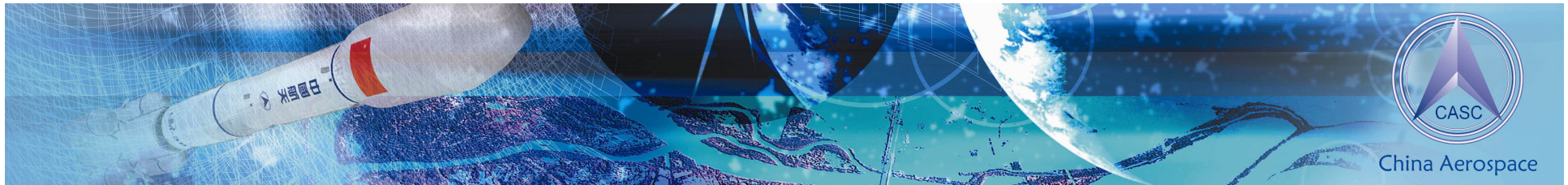
Goals:

- ❑ To make breakthroughs in soft landing, automatic roving and other related technology, including: earth-moon flight, soft landing, lunar rover's automatic surveying and detecting, remote control, tele-analysis, high data rate TT&C and communications and so on ;
- ❑ To develop and launch soft lander and lunar rover and other related scientific detectors.
- ❑ To establish basic lunar exploration system, including: establishing deep space TT&C network, improving ground system so as to form basic coordinated lunar exploration engineering system.

The launch task will be accomplished by LM-3B which can deliver 3.8-ton lunar probe to lunar transfer orbit (LTO).



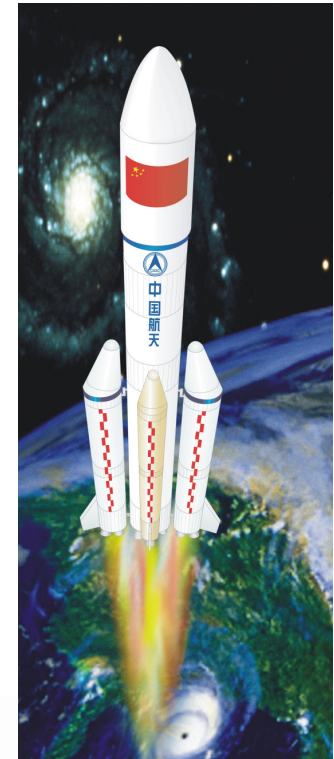
LM-3B



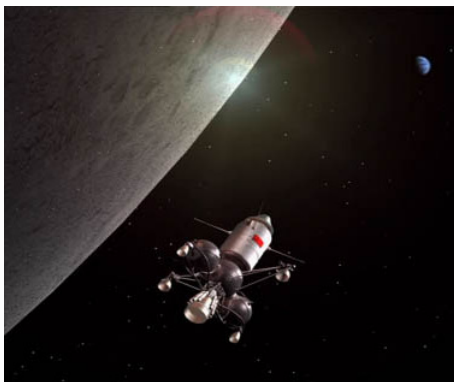
Sampling and Returning

Goals:

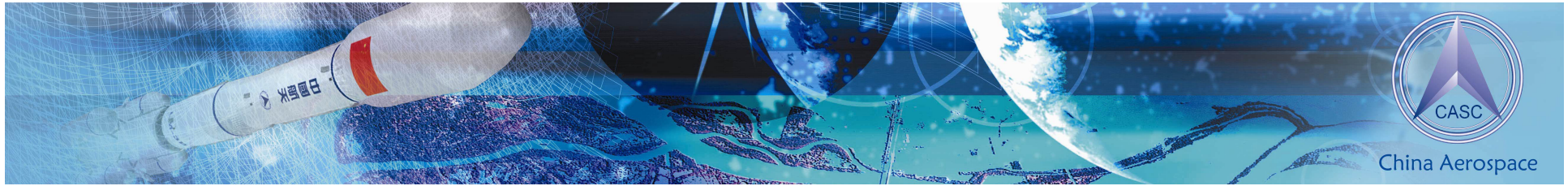
- ❑ To make breakthroughs in automatic sampling and returning flight technology, including lifting off from the moon, the design of returning trajectory, guidance and navigation and control technology, reentry and retrieving technology, the design and control technology of the sampling device, high accurate analysis technology of the lunar sample and so on
- ❑ To develop a small capsule for sampling and returning in order to collect sample and return to the earth
- ❑ To complete lunar exploration engineering system and provide the base for the future deep space exploration activities



LM-5E

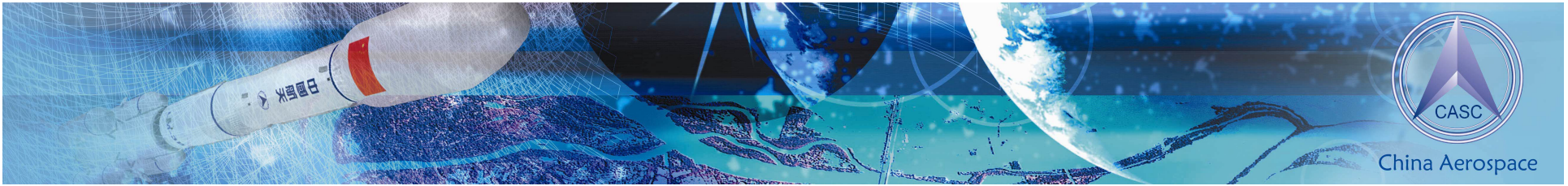


The configuration E with 5-m diameter core will be chosen as the launcher, which can deliver maximum payload of 10.3-ton to LTO directly.

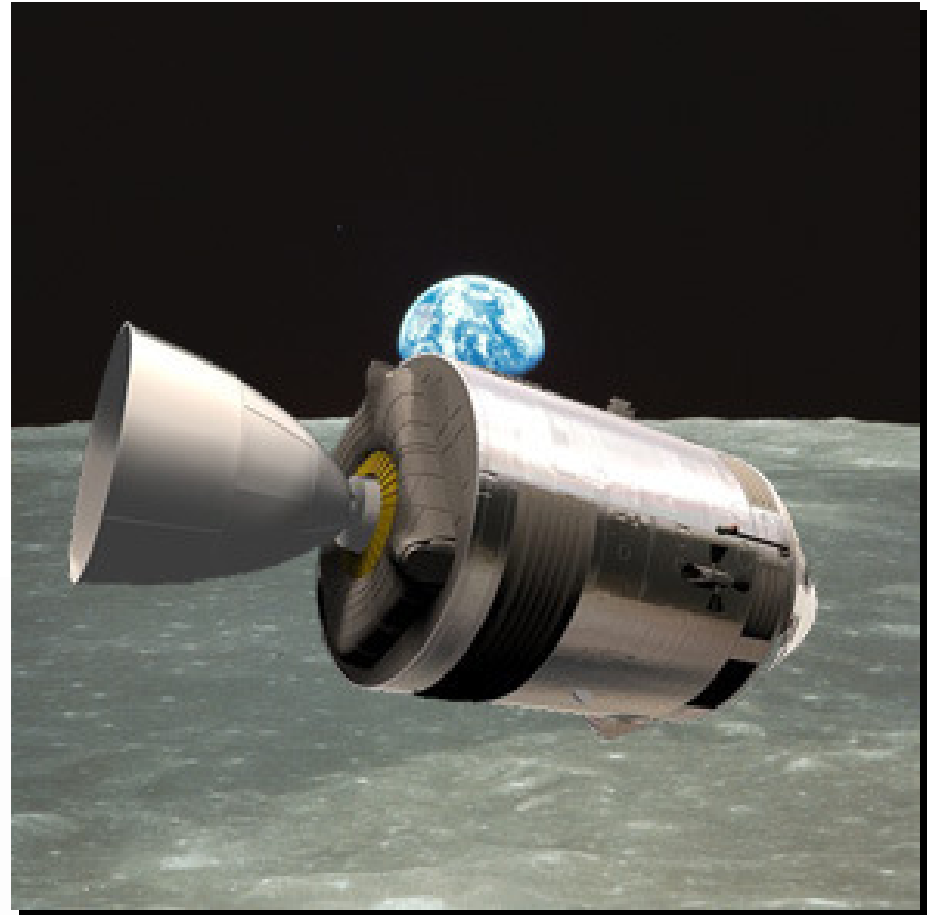
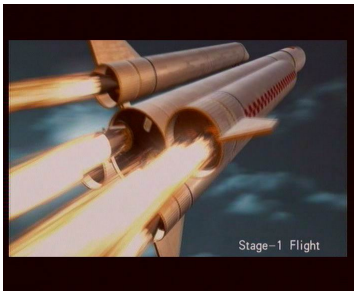


Conclusions

- ❑ China independently conquered many technological difficulties and developed the *LM* launch vehicles in the past 50 years, which is a great achievement.
- ❑ However, with the development of launch vehicle technologies, the *LM* launch vehicles will be upgraded according to the principles of low-cost, high-reliability, and maximum flexibility, while using non-toxic, non-polluting propellant.
- ❑ We should speed up the development of the new generation launch vehicles, taking market demand as the guide and technology progress as the drive, in order to realize the leapfrogging, sustainable development of launch vehicles and the aerospace industry, to meet the needs of China's Lunar Exploration Program and the demands of the other space technology development.



Thank you !



Let's work together for mutual benefits.