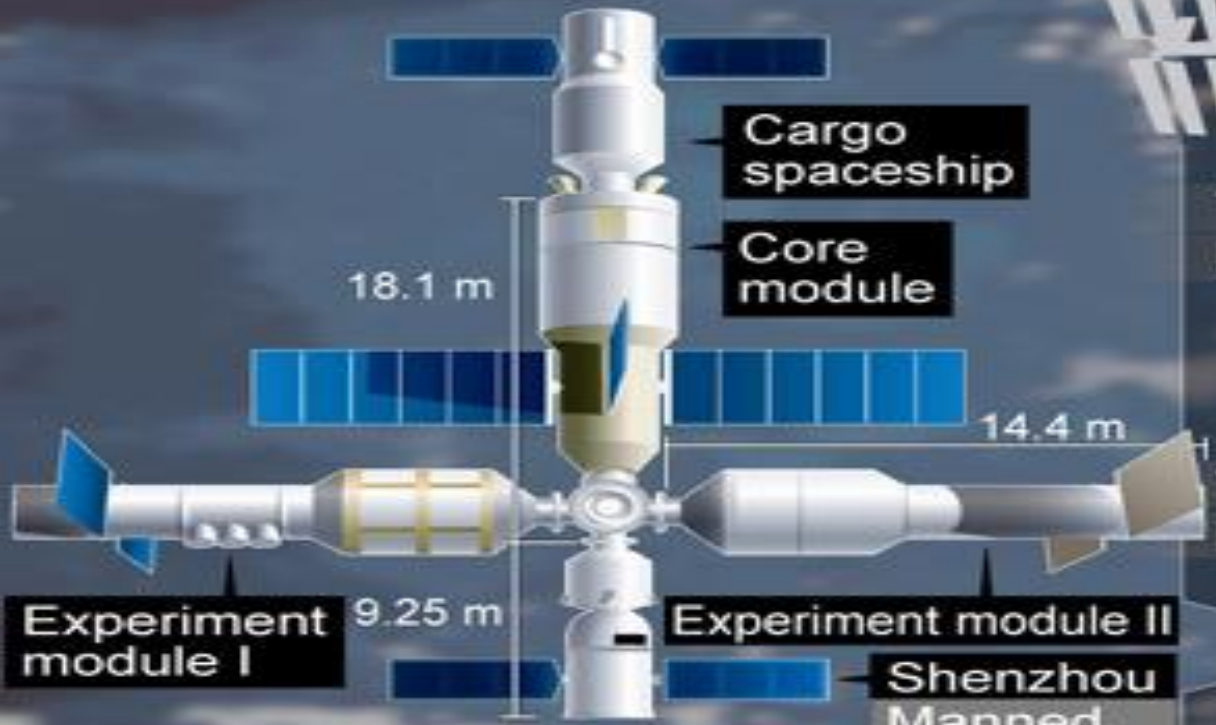
Design and realization of Payload Operation and Application system of China's Space Station

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China's space station to be completed in 2020

The Asahi Shimbun



(Based on China Daily and other sources)



ISS	
Total weight	390 tons
Maximum length	109 meters



Mir [Russia]	
Total weight	130 tons
Maximum length	31 meters



[China]	
Total weight	60 tons
Maximum length	37 meters

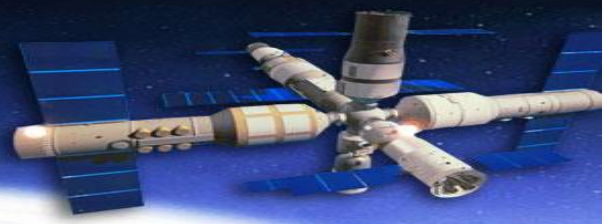
2011年	2011年–2015年	2020年
TianGong-1 Space Lab	ShenZHou8, 9 and 10 SpaceShip	China Space Station



China's first space lab module



docking technology tests



中国空间站计划

搜狐科學制圖

Introduction

Payload Operation and Application system is a very important system of the ground system for the China's Space Station.

- Establishing a communication link with the ground station, spacecraft control center and Science Center
- Receiving telemetry data and various types of application data
- Real-time processing Science and telemetry data
- Monitor the health status of the payload
- Planning and scheduling payload work
- Providing Space Station payload tele-science support
- Providing technical support for science education and international cooperation



System architecture design

The software architecture of the Payload Operation and Application ground system is SOA (Service oriented architecture).

All system functions are designed as service components to achieve software functional reuse in the system. All the service components are designed by the CCSDS SOA Standards.

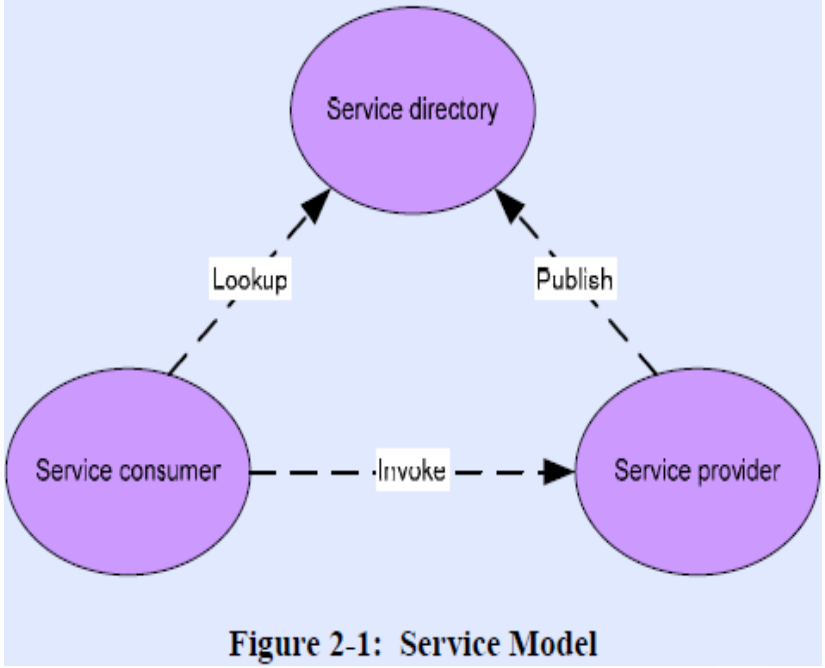
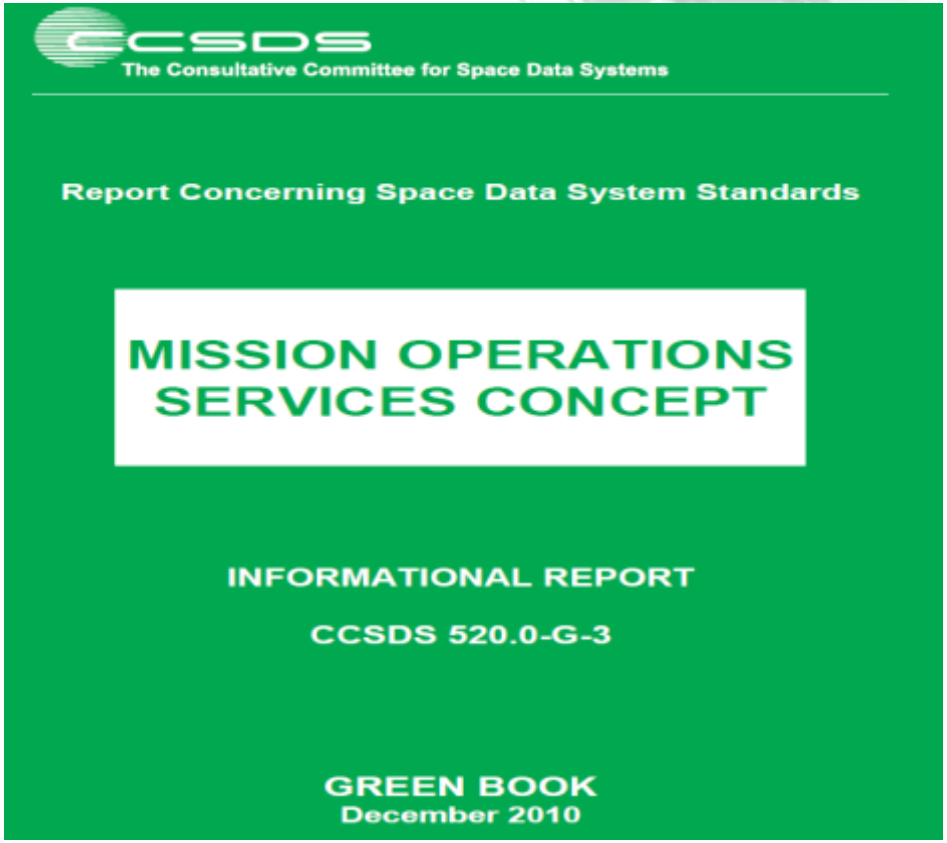


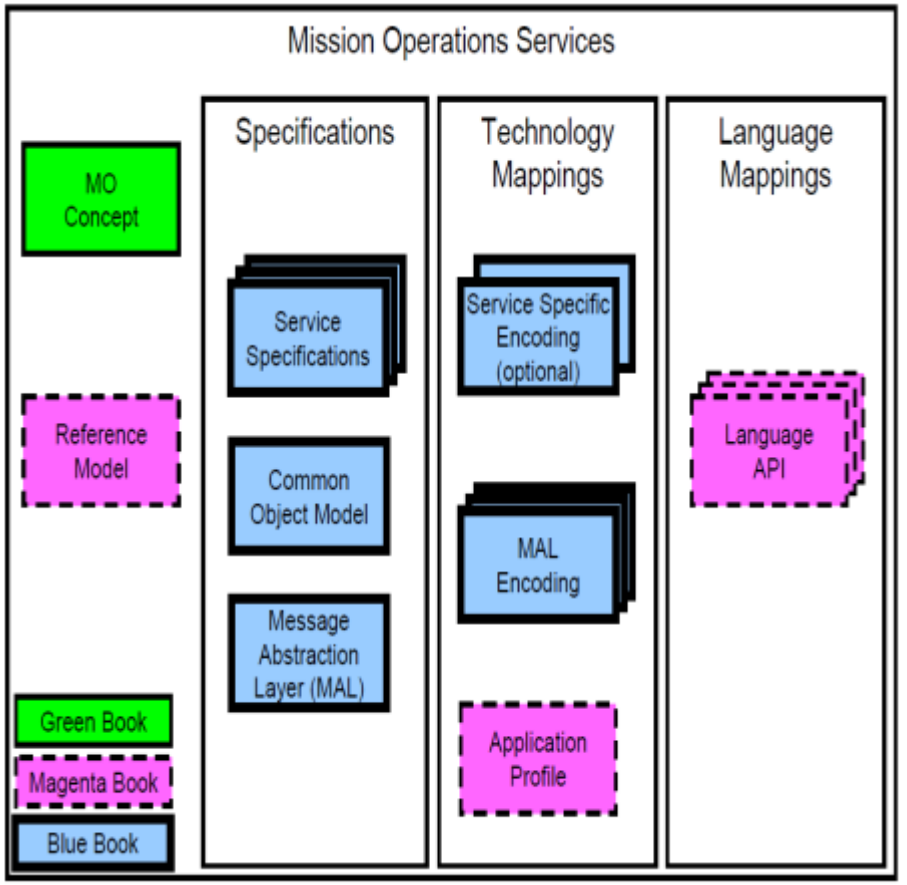
Figure 2-1: Service Model



Problem of Architectural

There is a general trend toward increasing mission complexity at the same time as increasing pressure to reduce the cost of mission operations, both in terms of initial deployment and recurrent expenditure. This lack of architectural openness leads to:

- lack of interoperability between agencies;
- lack of re-use between missions and ground systems;
- increased cost of mission-specific development and deployment;
- inability to replace implementation technology without major system redesign;
- lack of operational commonality between mission systems, and increased training costs.



Mission Operations Service Framework

CCSDS offer a standardisation of a Mission Operations Service Framework, which offers a number of potential benefits for the development, deployment and maintenance of mission operations infrastructure:

- increased interoperability between agencies, at the level of spacecraft, payloads, or ground-segment infrastructure components;
- standardisation of operational interfaces for spacecraft from different manufacturers;
- reduced cost of mission-specific deployment through the integration of re-usable components;
- greater flexibility in deployment boundaries: functions can be migrated more easily between ground-segment sites or even from ground to space;
- improved long-term maintainability, through system evolution over the mission



Overview of the Mission Operations Service Framework

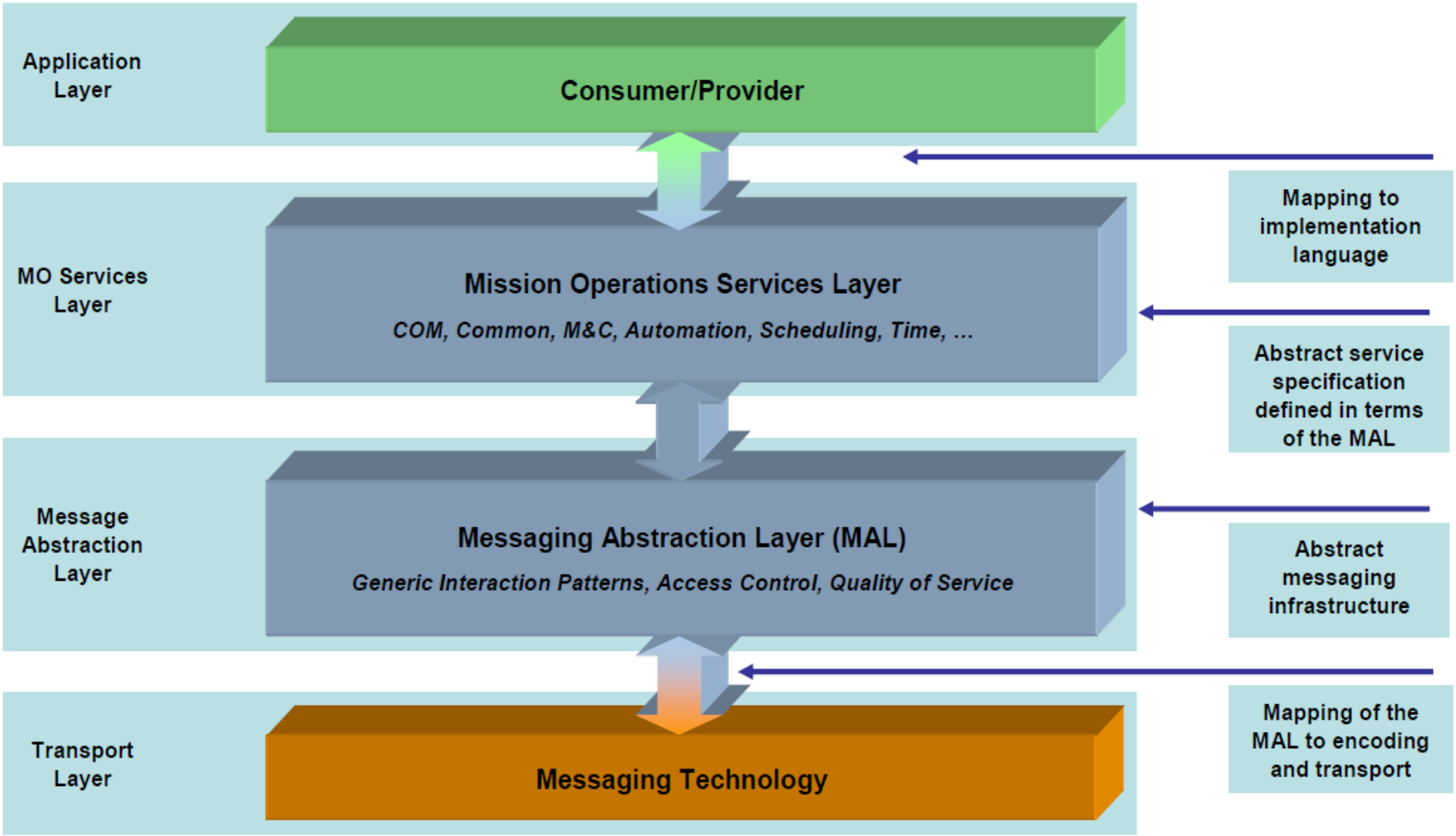


Figure 2-4: Overview of the Mission Operations Service Framework

Overview of the Mission Operations Service Framework

The connecting lines show end-to-end interactions between these functions. As each facility could be operated by a separate agency, where interactions cross distribution boundaries,these could constitute interoperable interfaces. Other distributions may be used

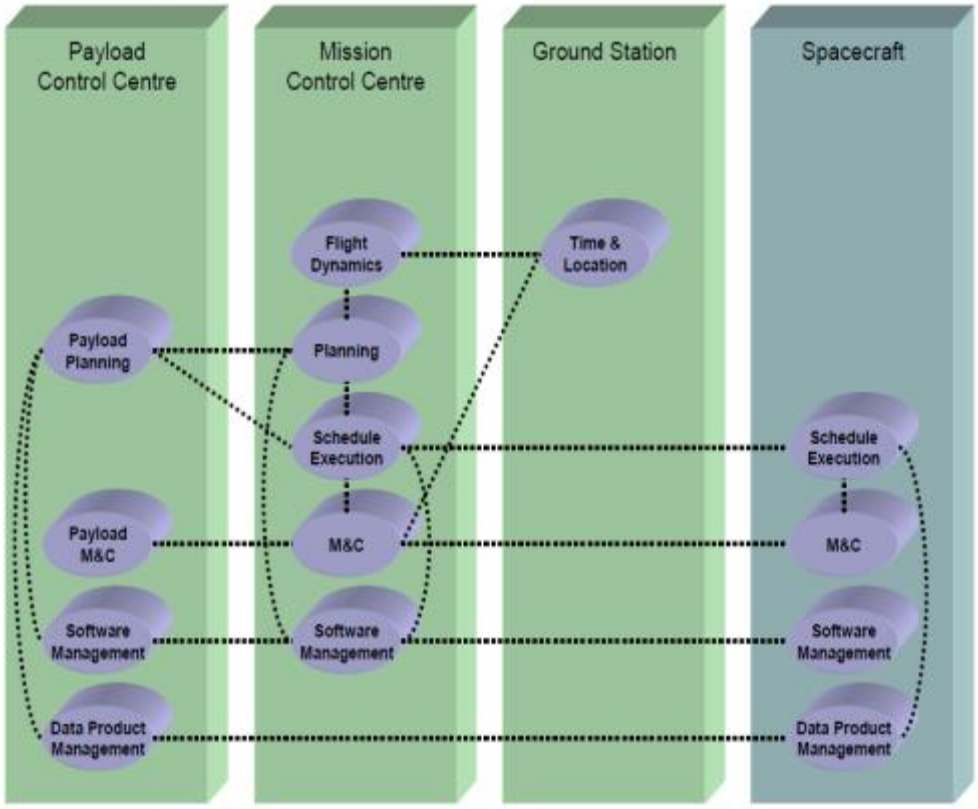
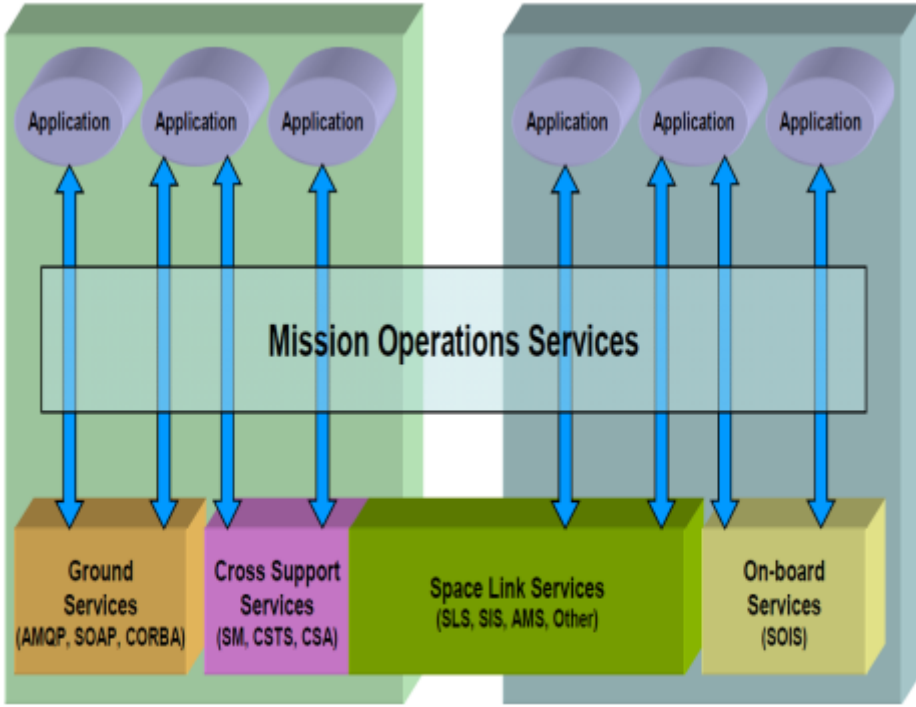


Figure 2-2: Example Distribution of Mission Operations Functions

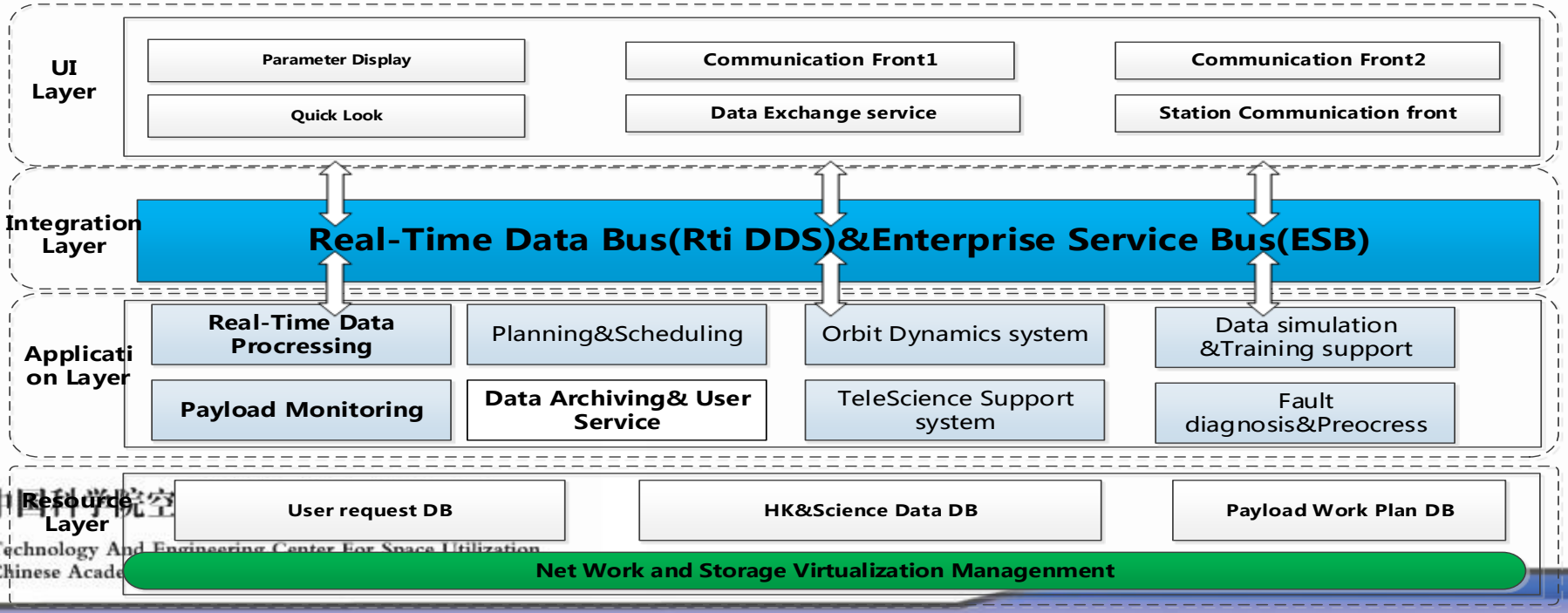
Mission Operations Services are end-to-end application-level services and may be carried over communications protocols appropriate to the environment



gure 2-3: Relationship of Mission Operations Services to Other CCSDS Stand

Software architecture design

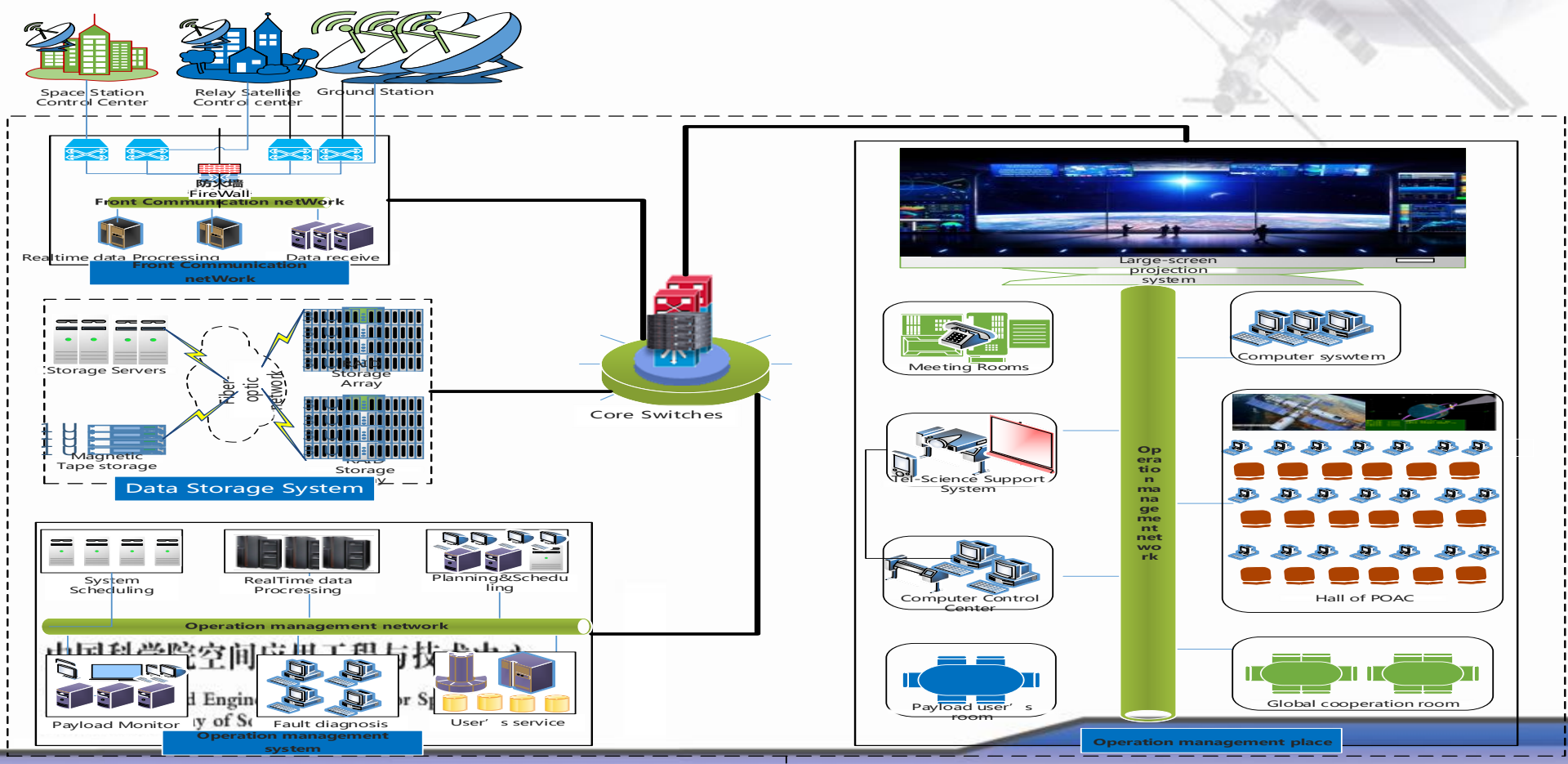
- The software architecture of the Payload Operation and Application ground system is SOA (Service oriented architecture).
- All system functions are designed as service components to achieve software functional reuse in the system.
- All system service components exchange information and data between various functional components through standardized interfaces by Data Distribution Service Bus.
- The feature of this system is reuse, scalability and flexibility.



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Hardware architecture design

Payload Operation and application ground system is a typical information system, composed mainly by the computing systems, network devices, storage system, its high performance computing and mass storage devices are integrated together by virtual software technology for sharing of resources and easy to manage.



Seamless upgrade mechanism



Lego Architecture Design



Construction of the base platform

Expand new task

Good Idea?



Jenga Game



The expanded mission base platform

A plurality of base platform combinations

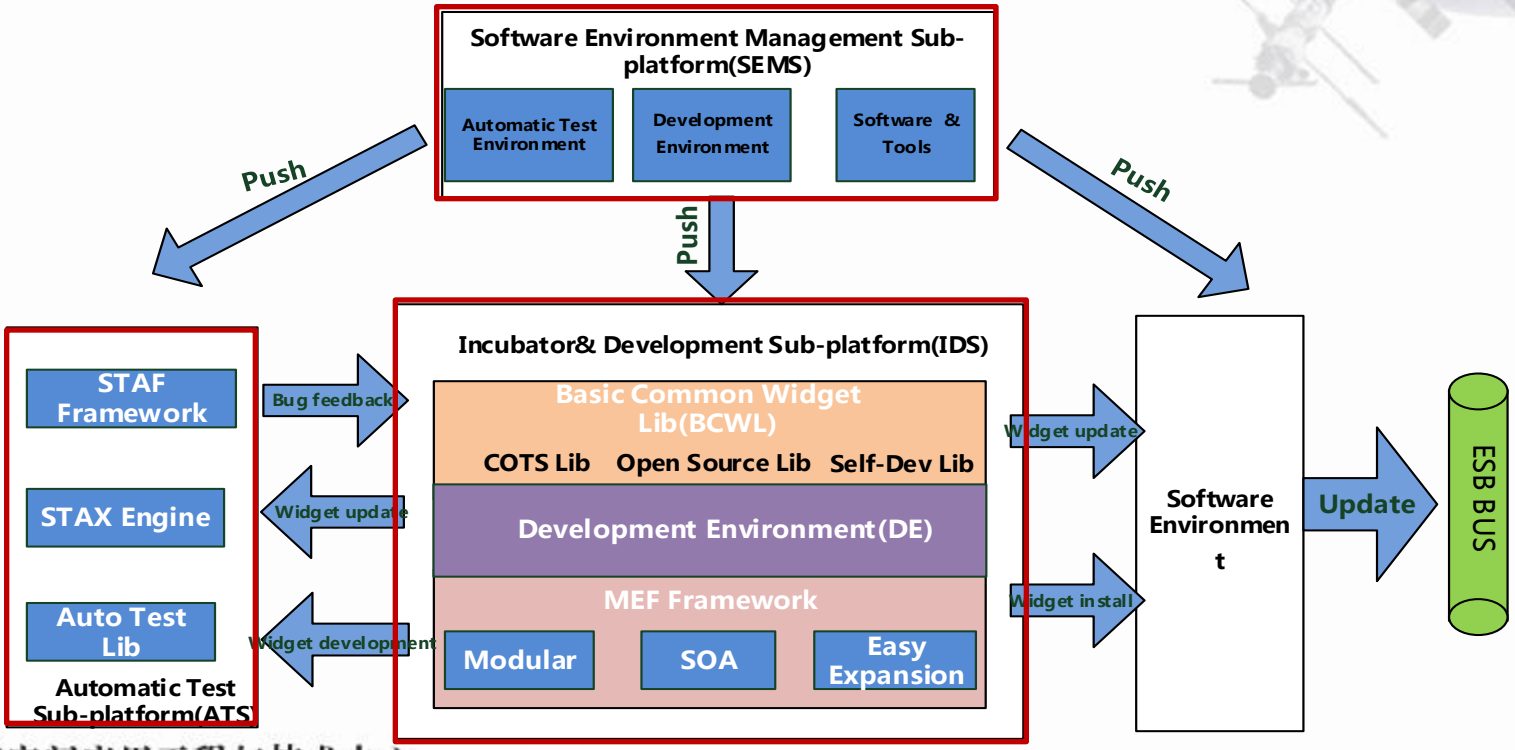


Based on a combination of dynamically scalable mission system

Seamless Upgrade Support Platform

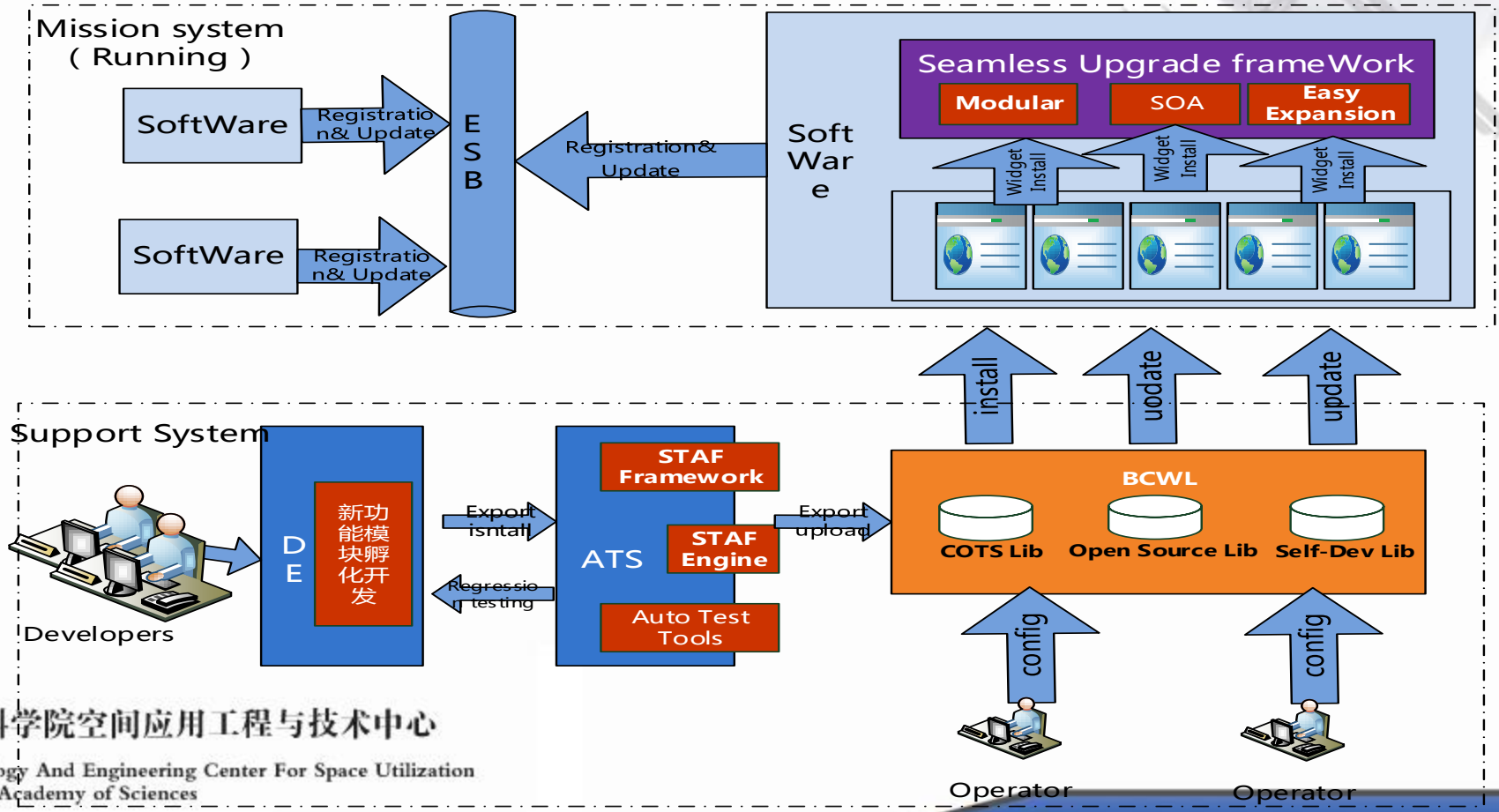
This platform is designed to support the Payload Operation and Application ground system can seamless upgrade easily.

The platform consists of Software Environment Management Sub-platform(SEMS), Automatic Test Sub-platform(ATS) and Incubator& Development Sub-platform(IDS).



Seamless Upgrade Support Platform

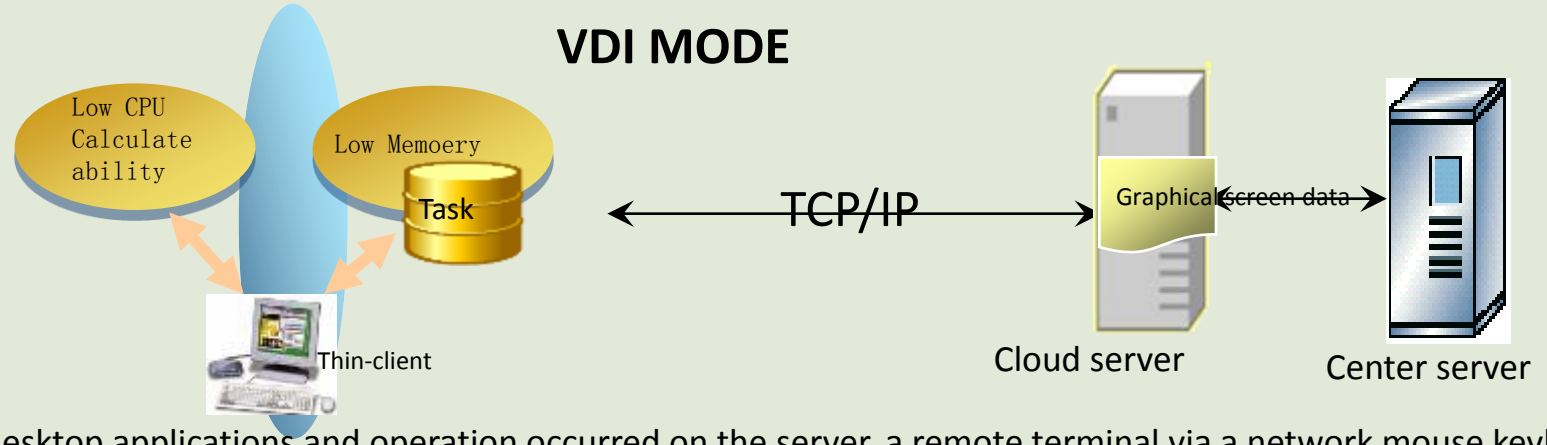
The principles of service-orientation are independent of any vendor, product or technology. SOA makes it easier for software components on computers connected over an ESB to cooperate. Every computer can run any number of services, and each service is built in a way that ensures that the service can exchange information with any other service in the ESB



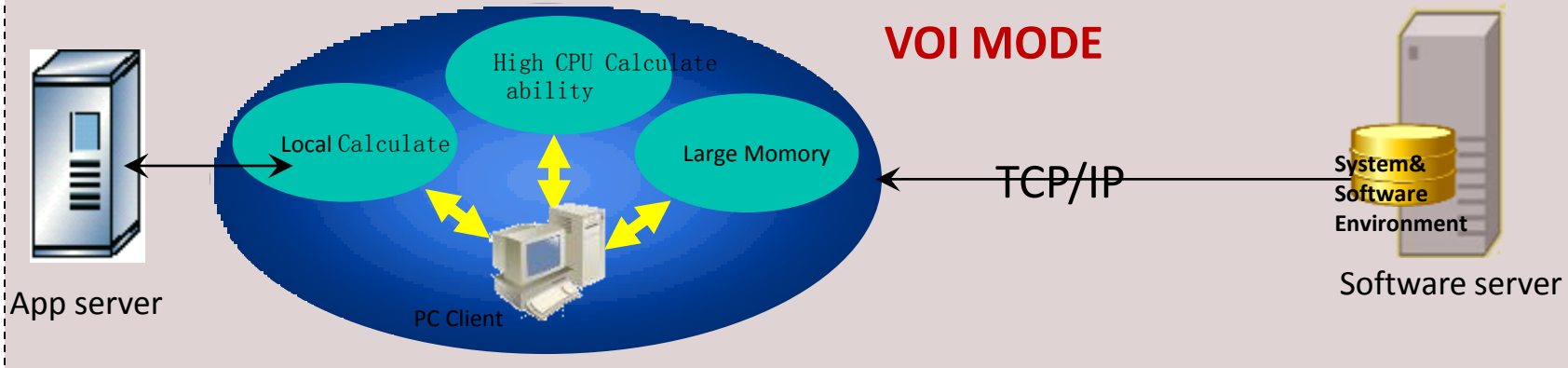
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Software Deployment System(Push)



All desktop applications and operation occurred on the server, a remote terminal via a network mouse keyboard signal transmitted to the server, and the server through the network of information to the output terminal of the output device (usually just the output screen information) for simple applications surroundings.



All software and operating environment in the centralized management server can automatically push software to any client.

Software Deployment Push System





All software and system environment



Development environment



Auto test environment

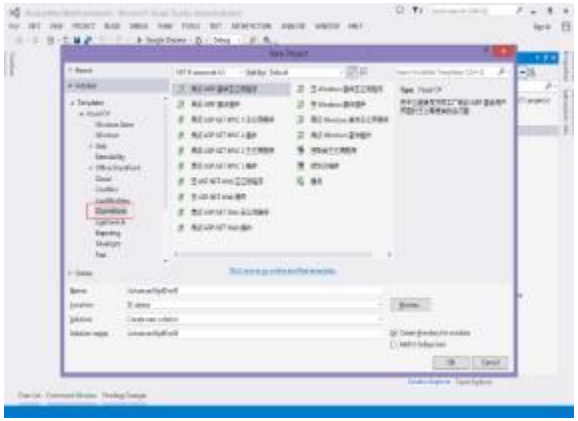


Deployment environment

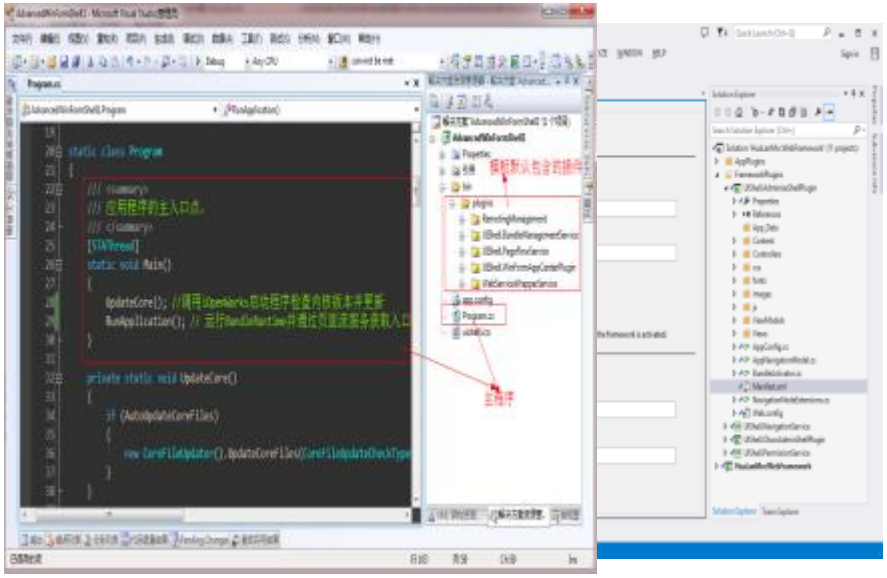


Seamless Upgrade Support Platform--Software Development Tools

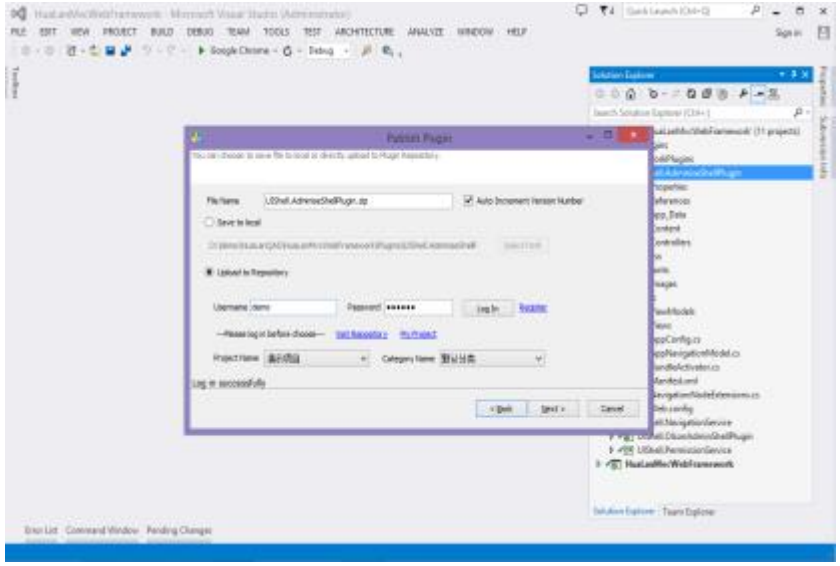
Plug-in Development project template



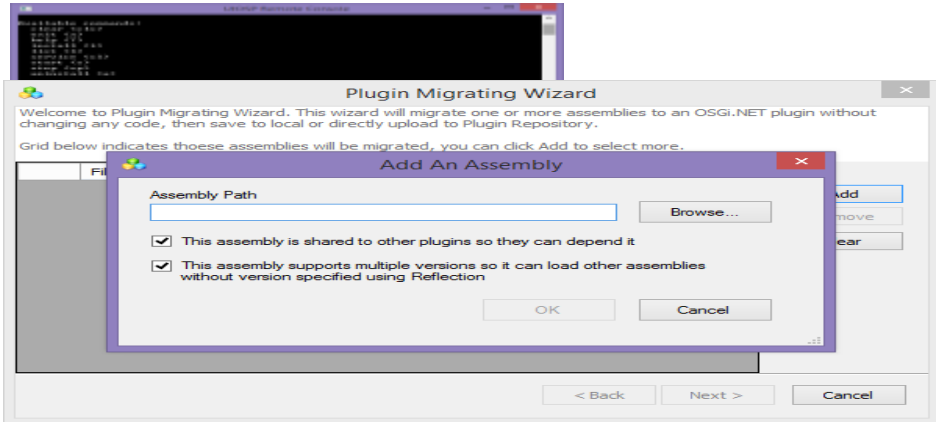
Programming visual editing tools



publishing Packaging tools



Plug-in remote management tools

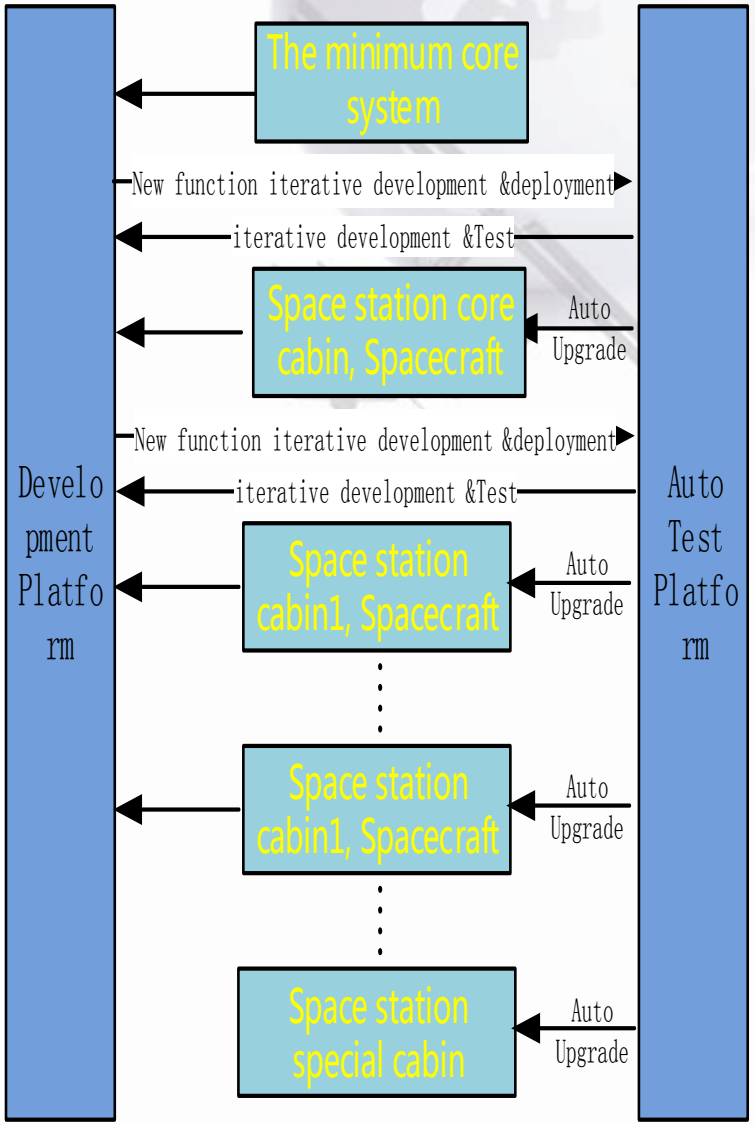


Seamless upgrade mechanism

Payload Operation and application ground system needs to support new scientific experiments tasks by dynamically upgrade while the system working. So this system needs a flexible system architecture to deal with this situation.

With the follows support system:

- **Automatic Test Sub-platform(ATS)**
- **Software Environment Management Sub-platform(SEMS)**
- **Development Environment(DE)**



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System Operating mode

Payload Operation and Application Ground system has three work mode. They are:

◆Normal work mode (NWM) : refers to the payload monitoring and management in accordance with the normal operation control flow and data processing flow to work. It is the most conventional and most comprehensive work mode of our ground system during the Space station on orbit

◆Emergency work mode (EWM):is a special work mode of our system. It will start to work when the payload of the Space station will be broken or has broken. In this mode, we will deal with temporarily interrupted the normal operation control process (Including data processing and task Planning) by fault plan manual requirement to rescue the payload equipment.

◆Minimum system work mode (MSWM) : When the software, computer system or network device of the Payload Operation and Application Ground system are failure, the MSWM mode required to start to make sure continued space science experiments mission not stopped. EWM is a special work mode of our system. It will start to work when the payload of the Space station will be broken or has broken. In this mode, we will deal with temporarily interrupted the normal operation control process (Including data processing and task Planning) by fault plan manual requirement to rescue the payload equipment.

Thanks!!!