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1. System Introduction

Under the unified deployment of Foreign Affairs Ministry of China, and with the support of the China-ASEAN maritime cooperation fund, Lancang-Mekong River Space Information Cooperation Center Project (hereinafter referred to as "MeSIC") constructs information system based on space application technology to ensure basin ecological protection and resources comprehensive utilization of Lancang-Mekong River region.

The main cooperative construction content of MeSIC in Cambodia can be summarized as "2 + 1 + 1", which includes two systems, a set of systematic training and targeted application demonstrations.

Systematic training includes basic courses, specialized courses, software and hardware operation training and in-station training. Besides, a set of application demonstration will be carried out for guiding the actual application in Cambodia.

MeSIC will carry out the systematic construction in Cambodia and deploy related systems in China supporting remote sensing information sharing and system maintenance & assurance. This project provides an indispensable infrastructure of space technology applications for current and future deployment of satellite application in Cambodia.

The system construction of MeSIC includes the following contents:

One (1) Remote sensing application service platform;

One (1) Unmanned Aerial Vehicle Forest Monitoring System.

As well as a data coordinating and sharing system (DCS) built in China. It also carries out application demonstration services with users, focusing on enhancing the application capabilities of the users in the remote sensing data and improving the application value of the remote sensing satellites.

2. Document Descriptions

This document is a detailed design scheme of Lancang- Mekong River Space Information Cooperation Center Project, describing the system requirements, design analysis, technical specifications, design schemes, packing, transportation, Training and after-sales maintenance, etc.

3. Reference Document

《Annex Performance Specification between Ministry of Posts and Telecommunications (MPTC)，Kingdom of Cambodia and China Academy of space technology (CAST), P, R, CHINA on Lancang-Mekong River Space Information Cooperation Center Project (MeSIC)》

CAST/SSTC/ MPTC

《Technical agreement Between Ministry of Posts and Telecommunications (MPTC), Kingdom of Cambodia and China Academy of Space Technology, P. R. CHINA On Lancang-Mekong River Space Information Cooperation Center Project (MeSIC)》

CAST/SSTC/MPTC

4. System Requirements

4.1 Deliverables

The system-level deliverables of the MeSIC are shown in the following figure:

Table 4- 1 Delivery list

NO.	Project Name	Product Name	Quantity	contents
1.	MeSIC	RSASP	1	One Image Processing System(IPS); One Typical application System(TAS) One Data Management System(DMS) One Public Service System(PSS) One Operation Service System(OSS) One Computer Network Security System(CNSS)
2.		UAVFMS	1	One UAV Subsystem(UAV) One Information Processing Subsystem(IPS)

4.2 System External Interface

There are four main types of external interfaces of MeSIC.

4.2.1 Interface for Remote Operation and Maintenance Support System

OSS sends the fault information to the remote operation and maintenance support system (RMS) deployed in China, after OSS obtains logs, orders, notifications information of monitored sub-system. Besides, OSS can obtain feedback information from RMS to solve problem of monitored sub-system.

4.2.2 Shared Star Sources Interface with DCS

Because there is not ground receiving station to obtain remote sensing satellite data, the satellite data of MeSIC is acquired in two ways. One way is that the DCS can support users to coordinate Chinese satellite data (GF-1, GF-2 and CBERS-04) and some commercial satellite data (SPOT-6, Radarsat-2). The other way is that free satellite data (Landsat series, NOAA-18, MODIS) can be download from internet. Users of Cambodia can access, login and use the DCS remotely using the Internet.

4.2.3 Interface with Supporting Data

Users of Cambodia should provide supporting data (DEM, GCPs, etc.) to produce advanced image

data (Level 3 to 4) and thematic products.

In addition, there are vector image, field measurement data, weather data and other supporting data, which need to be input in RSASP platform according to TAS application requirements.

4.2.4 Interface with External Users

External users of RSASP are mainly divided into two categories. One is domestic users in Cambodia. The other categories is all MeSIC users. Domestic users in Cambodia can order and customize products by login in PSS website. Besides, PSS provide the comment and attachment upload/download function to domestic users. The MeSIC users share and apply remote sensing data through the DCS.

4.3 Main Function Demands of the System

4.3.1 Remote Sensing Application Service Platform

a. Product production capability: the Cambodia user forms the capacities of the remote sensing application product production and the data distribution, including the data storage, advanced processing and production of thematic products, of which 35 kinds of thematic products provided by the typical application systems cover seven fields such as agriculture, forestry, water resources, coastal zone, oil spills, floods and droughts.

b. Application demonstrations: The remote sensing application service platform should provide corresponding advanced image product, remote sensing application thematic product and verify services of products precision. The advanced image products are mainly used for producing, fusing and mosaic products for capitals or important cities of Cambodia; The agricultural thematic product mainly contains the crop growth monitoring and crop plant area estimation; The forest remote sensing thematic product mainly contains the multi-source forest classification and changes monitoring.

c. Multi- source data sharing: a data coordinating and sharing system built in China sets up a platform for the inquiry of the satellite remote sensing data products and service transactions in Laos, Thailand, Cambodia, Myanmar and also provides the release, retrieval, browsing and provision of the remote sensing data products channels aiming at multi- source remote

sensing satellite data products and service resource information. The platform can not only be used to meet the application demands of the users of satellite remote sensing applications in different countries but also achieve the sharing and exchange of the remote sensing information through interconnection and interworking. The users from various counties can quickly and accurately obtain the local satellite remote sensing data through the remote sensing information and product sharing mechanism.

4.3.2 Unmanned Aerial Vehicle Forest Monitoring System

The functions of Cambodia Unmanned Aerial Vehicle forest monitoring system can be divided into emergency monitoring functions, aerial shooting and mapping function, data processing functions and transportation guarantee functions.

a. With visible / infrared real-time monitoring functions, being able to mount a small photoelectric pod to Unmanned Aerial Vehicle system for target area real-time observation, and achieve the high-precision imaging of the target area;

b. It can plan monitoring plan of Unmanned Aerial Vehicle system based on monitoring mission requirements, forest environment, weather forecast and other information, to determine the Unmanned Aerial Vehicle route and task load work plan;

c. It is with real-time generation, sending and telemetry information receiving function of Unmanned Aerial Vehicle, task load and other remote control information;

d. The ground station of loaf is deployed fire monitoring software, which can identify fire sources and locate fire point in the forest in real-time, to achieve real-time monitoring of fire.

e. It can use the Unmanned Aerial Vehicle being equipped with visible light camera, to shoot with fixed time and distance in the forest area during the flight process. After processing, generate orthophoto map to complete the general survey and mapping of forest area;

f. It can plan the surveying and mapping scheme of Unmanned Aerial Vehicle system and determine track and work plan such as mission load for Unmanned Aerial Vehicle according to information such as forest region, requirement of surveying and mapping and geographical environment.

g. The load ground station can save and display the visible light/infrared video data received

by airborne mission equipment of Unmanned Aerial Vehicle in real-time;

h. The system has the ability of image data handling capacity for Unmanned Aerial Vehicle to generate orthophoto map and DSM data product in scale of 1:5000, 1:2000 and 1:1000.

i. It has the ability of ground object information extraction and vectorization of forest region in orthophoto map;

j. The fire monitoring software can generate fire report document.

4.4 General Design Requirement Analysis

4.4.1 Security Requirements

In the design and implementation process of internal and external network access of the system, system network security, information security and other aspects are mainly considered, to ensure that the information security can control user access and prevent information theft, and have anti-virus and anti-intrusion functions.

4.4.2 Maintainability Requirements

The system is easy to maintain and the maintenance time is short, it has remote maintenance means and perfect maintenance mechanism to ensure that the system can be quickly restored after failure.

4.4.3 Redundancy Requirements

The system has a backup mechanism of the key node equipment to avoid single point failure. When little damage to the general equipment such as server, hard disk will not affect the normal operation of the system.

4.4.4 Services Provided

a. System design, transportation, testing, integration and installation;

b. Provides one-year warranty service. Free of charge to solve the quality problems during warranty service phase;

c. Provide training services, the number of trainees is 15, the training lasts 7 weeks (3 weeks for domestic training and 4 weeks for training abroad). Training contents include: basic

knowledge training, professional knowledge training, domestic software and hardware operation training & overseas equipment operation and onsite maintenance training.

5. System Design Analysis

5.1 Remote Sensing Application Service Platform

5.1.1 Data Source Requirements Analysis

5.1.1.1 Satellite Source Analysis

The Remote Sensing Application Service Platform (RSASP) involves 11 remote sensing satellites required for 35 remote sensing application thematic products generation, among which 5 China satellites including: CBERS-4, GF-1, GF-2, FY-2G and FY-3B; 6 international satellites including: Landsat-8, Radarsat-2, SPOT-6, Terra/Aqua (MODIS), and NOAA-18 (Advanced Very High Resolution Radiometer, AVHRR).

Data management system (DMS) supports storage and management of the 12 remote sensing satellites data. Image processing system (IPS) conducts processing for 4 specified formatted satellites (GF-1, GF-2, SPOT-6, Landsat-8) data and produces level 2-4 image products. (Accurate ground control points (GCPs) and digital elevation model (DEM) data necessary for data production are provided by the user). Typical application system (TAS) can comprehensively utilize the domestic and international satellite source data to conduct advanced processing and analysis. On such basis, it can also provide remote sensing application product production and thematic mapping function for 7 fields such as agricultural remote sensing monitoring, water resource remote sensing monitoring and evaluation, forestry remote sensing monitoring, marine oil spill monitoring, coastal zone monitoring, river basin flood monitoring, and river basin drought monitoring.

Table 5- 2 Satellite Source Analysis table of RSASP

Satellites		China Satellites Source				International Satellites Source				
		CBERS-4	FY -3B	FY-2G	GF-1/2	Landsat-8	Terra/Aqua (MODIS)	NOAA-18 (AVHRR)	SPOT-6	Radarsat-2
IPS	Data level				L2A	L1G			L1A	
DMS/PSS/ DCS	Unified Storage Management, Distribution, Sharing	●	●		●	●	●	●	●	●
TAS	Agricultural remote sensing monitoring	●	●		●	●	●	●		
	Water resource remote sensing monitoring and evaluation	●		●	●	●	●		●	
	Forestry remote sensing monitoring	●			●	●	●	●		
	Marine oil spill monitoring									●
	Coastal zone monitoring	●			●	●	●		●	
	River basin flood monitoring	●			●	●			●	
	River basin drought monitoring		●				●			

Note:

China satellite source: Shall be coordinated by MPTC with CNSA.

International satellite source: The free satellites data include Landsat-8, Terra/Aqua (MODIS), NOAA-18(AVHRR), which require users to download data from official data service websites by themselves; Commercial satellites include SPOT-6, Radarsat-2 shall be purchased by users themselves.

5.1.1.2 Supporting Data Analysis

a. **Supporting GCPs and DEM for GF-1/GF-2：**

The resolution of high precision GCPs is almost same with the resolution of image to be processed, the relation between the two should not exceed 4 times; Besides, the precision of GCP is superior to 1pixel (1δ); The precision of DEM data is superior to 2pixel (1δ).

b. **Supporting GCPs and DEM for SPOT-6 /Landsat-8：**

Precision requirement for GCPs: The precision of GCPs for SPOT-6 is superior to 2m (1δ). The precision of GCPs for Landsat-8 satellite is superior to 0.5 * ONE Landsat-8 panchromatic pixel (1δ).

DEM Precision requirement: DEM data precision of SPOT-6 is superior to 4m (1δ).

c. **Auxiliary data for thematic product generation：**

Geographic information data: It mainly contains the administrative boundary, basin boundary map, land utilization classification map etc.

Meteorological data: long series of meteorological data, such as daily maximum temperature, daily minimum temperature, daily precipitation, relative humidity, sunshine duration, average wind speed, etc., and latitude and longitude, altitude and so on of the corresponding site. (daily precipitation (mm), temperature (℃), atmospheric pressure (Kpa), relative humidity, wind speed (m/s), average daily water vapor pressure (hPa), actual sunshine duration (h), maximum possible sunshine duration (h), total solar radiation (MJ/m^2), net solar radiation (MJ/ m^2), etc. monitored by the ground meteorological site, finally using the above information to form the 1km spatial resolution distribution map by using Kriging space interpolation)

Crop information data: The main crop types (corn and rice), phonological period and historical grain output etc.

Basic forestry information data: national forest Class II survey data.

Flood disaster damage assessment supporting data: vector map of flooded area.

5.1.2 Data and Thematic Product Analysis

IPS processing product list is shown below:

Table 5- 3 IPS processing product list

Product level	Product definition	Support satellite and load	Description
Level 2 product data	Geometric correction product	GF-1,GF-2,SPOT-6,Landsat-8	Resampling mode: refers to the data after the system geometric correction and after mapping the corrected images on the specified map projection coordinates on the basis of the RPC data. RPC mode: refers to the parameters gained from the DEM model through the corresponding relation between image grid points, ground longitude, latitude and height established with the system geometric correction module.
Level 3 product data	Geometric precise correction product	GF-1,GF-2,SPOT-6,Landsat-8	On the basis of the radiometric correction, using precise satellite orbital data or ground control points, make the image geometric correction, the corrected image is mapped to the product data in a specified map projection coordinates.
Leve4 product data	Orthographic correction product	GF-1,GF-2,SPOT-6,Landsat-8	On the basis of the radiometric correction, using precise satellite orbital data or ground control points, make the image geometric correction, and using DEM to correct the data which has the parallax due to undulating terrain.

The remote sensing application thematic product list is as shown below:

Table 5- 4 Typical application system product list

Satellite Source	Application Industry	Product Name
FY-3B, GF-1, GF-2, Landsat-8, Terra/Aqua(MODIS), NOAA-18(AVHRR)	Agricultural remote sensing monitoring (6)	Crop growth remote sensing monitoring
		Crop planting area remote sensing estimation
		Crop unit yield remote sensing estimation
		Crop yield remote sensing estimation
		Crop plantation structure monitoring
		Multiple cropping index monitoring

Satellite Source	Application Industry	Product Name
FY-2G, GF-1, GF-2, Landsat-8, SPOT-6, Terra/Aqua(MODIS)	Water resource remote sensing monitoring and evaluation (6)	Land surface water area remote sensing monitoring
		Rainfall space-time distribution remote sensing monitoring
		Chlorophyll-α concentration remote sensing monitoring
		Water suspended matter concentration remote sensing monitoring
		Water transparency remote sensing monitoring
		Water eutrophication degree remote sensing monitoring
GF-1, GF-2, Landsat-8, Terra/Aqua(MODIS), NOAA-18(AVHRR)	Forestry remote sensing monitoring (5)	Forest remote sensing classification
		Forest change monitoring
		Fire point monitoring
		Burned area monitoring
		Wetland information monitoring
Radarsat-2	Marine oil spill monitoring (3)	Oil spilling monitoring
		Oil slick characteristic extraction
		Oil slick diffusion predication
GF-1, GF-2, Landsat-8, SPOT-6, Terra/Aqua(MODIS)	Coastal zone monitoring (7)	Sea water extraction
		Reclamation domain monitoring
		Coastal land use monitoring
		Offshore water color abnormal monitoring
		Red tide monitoring
		Enteromorpha monitoring
		Mangrove monitoring
GF-1, GF-2, Landsat-8	River basin flood monitoring (2)	Basin flooding area monitoring
		Flood disaster damage evaluation
FY-3B, Terra/Aqua(MODIS)	River basin draught monitoring (6)	One map of drought monitoring
		Drought monitoring change analysis
		Drought monitoring timing sequence analysis
		Surface evaporation estimation
		Drought index remote sensing monitoring
		Soil moisture remote sensing monitoring

Note: the main crop type is rice.

5.1.3 Data Production Capacity Analysis

According to the processing experience of GF-1/2、SPOT6、Landsat8. IPS supports 24 hours production every day, the Level 2 product processing speed is about 8min/scene, which is no more than 15min/scene. Combined with the actual production demand, IPS will use 4 servers to process at the same time with 8 hours production each day, so it can process 128 scenes of

products each day, the maximum data volume each day of Level 2 product is 2.35GB*128 ≈ 300.8GB. Because Level 3/4 product generation need manual operation, if the generation rate is about 30 minutes/scene and calculated according to 8 hours/day, 2 operators can process 32 scenes of Level 3/4 products each day. The maximum data volume each day of Level 3/4 product is 2.35GB*32 ≈ 75.2GB. (Note: 2.35GB is the volume of one scene of GF-2 panchromatic image)

Above all, the max data volume of IPS each day is 300.8GB.

5.1.4 Data Storage Capability Analysis

According to the architecture design of remote sensing application service platform, the actually capacity of disk array is about 80TB. In addition to the use of DMS, the IPS, TAS, PSS and CNSS take up the storage capacity of the disk array, therefore, it is necessary to calculate the data volume of every subsystem, estimate the size of the storage space of each subsystem, and provide basis for the rational division of disk array storage space.

5.1.4.1 Online Data Storage Capability Analysis

According to the requirements of each subsystem, the disk array is partitioned into interaction area, DMS storage area, IPS production area, TAS storage area, PSS storage area, and CNSS storage area. The specific partition of the disk array storage area is shown in the following table.

Table 5- 5 Estimation of actual occupation capacity of online storage

Disk array area	Sharing interactive area		Archival area	Production area	PSS storage area	TAS storage area	CNSS storage area	Total
	To-be- archived area	To-be-pushed area						
Storage	1TB	1TB	44TB	4TB	15TB	5TB	10TB	80TB
Remarks	Store 3-day data temporarily	Store 3-day data temporarily	Online for 130 days	IPS production area	Store metadata, browse diagrams, and temporarily stored products	Store Tiff images, SHP files, SHP slices, meta-information, thumb images, browse diagrams, and statistical information	Mount in 7 physical servers and store mirror image documents of virtual machines	Net data storage size

a. Partition Basis of To-be-Archived Area

The to-be-archived area stores product data waiting for archiving of DMS after being produced by IPS and TAS. According to the analysis of daily data processing volume, the maximum daily capacity of IPS is 0.294 TB, that of TAS is 0.044 TB, and considering that there might be the case that DMS system breaks down and cannot archive data timely, and therefore, the temporary storage period of the data is set as 3 days based on the space size of the disk array and the time needed for evaluations and solutions to the problem. The size of to-be-archived area is calculated as follows:

The size of to-be-pushed area DMS storage area = (IPS maximum daily capacity (0.294TB) + TAS maximum daily capacity (0.044TB) * temporary stored time (3 days) ≈1TB.

b. Partition Basis of to-be-Pushed Area

The to-be-pushed area stores product data that DMS push to IPS and TAS. According to the analysis of daily data processing volume, the maximum daily capacity of IPS is 0.294 TB, that of TAS is 0.044 TB, and considering that there might be the case that DMS system breaks down and cannot archive data timely, and therefore, the temporary storage period of the data is set as three days based on the space size of the disk array and the time needed for evaluations and solutions to the problem. The size of to-be-pushed area is calculated as follows:

The size of to-be-pushed area DMS storage area = (IPS maximum daily capacity (0.294TB) + TAS maximum daily capacity (0.044TB) * temporary stored time (3 days) ≈1TB.

c. Partition basis of archival area

The archival area stores product data produced by IPS and TAS. According to the analysis of daily data processing capacity, the maximum daily capacity of IPS is 0.294 TB, that of TAS is 0.044 TB, and the online storage duration lasts for 130 days. The size of DMS storage area is calculated as follows:

The archival area = (IPS maximum daily capacity (0.294 TB) + TAS maximum daily capacity (0.044TB) * online duration (130 days) ≈44TB.

According to the calculation, 44 TB should be partitioned from the disk array for the archival area.

d. Partition Basis of Production Area

The online stored data has higher access frequency of IPS, so it requires higher access speed requirement on online stored and IPS production area requires a high-speed disk access speed. To locate a failure and solve it once it occurs, IPS needs to cache the production data and intermediate data for a while, and it is suitable to set the cache period as 3 days based on the actual space size of the disk array and the time needed for solutions to the problem. According to

the analysis on daily maximum processed data volume of the image processing system, the maximum daily capacity of IPS is 0.294TB, and the volume of intermediate data it produces is 0.294*3TB. The size of the production area of IPS is calculated as follows:

IPS production area = IPS maximum daily capacity (0.294TB) * cache period (3 days) + intermediate data volume (0.294TB *3) * cache period (3 days) ≈4TB.

According to the above calculation, 4TB should be partitioned from the disk array for the IPS production area.

e. Partition Basis of PSS Storage Area

PSS storage area mainly stores level 2-4 standard products, thematic products, metadata data and browse diagrams, with the specification of each browse diagram being calculated as per 1024pix*1024pix, that is, about 3MB. The data volume of browse diagrams input by the public service system is as shown in below table. According to the table, PSS needs to archive about 1.09GB of information every day.

Table 5- 6 Data volume of browse diagrams input by the public service system

Product Level	Level 2 products (scene)	Level 3-4 products (scene)	Thematic product(scene)	Total
Number of scenes	128	32	200	**360**
Data volume (GB)	0.4	0.09	0.6	**1.09**

Assumed that the distribution capacity of PSS per year is not lower than 130 thousand scenes, the daily distribution capacity is about 360 scenes (taking one year as 365 days), and assumed that all data is GF-2 panchromatic data which has the largest data volume, the size of data per scene is about 2.35GB, and data to be distributed having been stored for two weeks needs about 12TB storage space.

Above all, the total storage space of PSS is the sum of 1TB for metadata, 1.09TB for browse diagrams, 2.09TB for storage space, and 12TB for two-week data to be distributed, which is 14.09T, and thus, the total storage space is about 15TB.

f. Partition Basis of TAS Storage Area

TAS storage area is mainly used to store thematic application product data, mainly including Tiff images of specific products, SHP files, SHP slices, meta-information, thumb images, browse diagrams, and statistical information.

Tiff images of each piece of specific product are about 500MB, 400MB to SHP files, 1GB to SHP slices, and 100MB to meta-information, thumb images, browse diagrams, and statistical information in total, which means one set of products need about 1GB in total. There are seven main fields of thematic products, with each storing about 300 sets, and therefore, the storage volume per year is about 2.5TB, and that for two years is 5TB.

g. Partition Basis of CNSS Storage Area

The virtualization platform of CNSS server adopts VMware vsphere virtualization software architecture, and in the virtualization design principle of VMware vsphere server, this platform needs a storage space of 10TB for backup of system software VMirror.

5.1.4.2 Design of Read-Write Permission of Areas in the Disk Array

Table 5- 7 Read-write permission of areas in the disk array

Name of disk array area	Sharing interactive are		Archival area	Production area	PSS storage area	TAS storage area	CNSS storage area
	To-be-archived area	To-be-pushed area					
Permission	IPS/TAS (only write), DMS (only read)	DMS (only write), IPS/TAS/PSS (only read)	DMS (read and write)	IPS (read and write)	PSS (read and write)	TAS (read and write)	Disk has the complete control permission (read and write)

a. IPS production area is mainly used to calculate data produced by IPS and store intermediate product data temporarily. The read-write permission is only granted to IPS.

b. The archival area is mainly used by DMS to archive data produced by IPS and TAS. The

read-write permission is only granted to DMS.

c. The interaction area is mainly for the data interaction among three production systems of IPS, DMS and TAS. To avoid data corruption caused by access to the interaction area simultaneously by more than one system, the interaction area may be divided into to-be-archived area and to-be-pushed area. The to-be-archived area is used for temporarily storing the produced IPS and TAS data, and IPS and TAS has write permission. The to-be-pushed area is mainly used for temporarily storing data pushed by DMS to IPS, TAS and PSS. Above all, IPS, TAS and PSS only has read access permission.

d. The PSS storage area is mainly used to store data to be distributed by PSS. The read-write permission is only granted to PSS.

e. The TAS storage area is mainly used to store thematic application production data produced by TAS. The read-write permission is only granted to TAS.

f. All servers in CNSS system are deployed with VMware vsphere virtualization software and require the complete control permission of the disk, namely, including read-write permission.

5.1.4.3 Offline Storage Strategy

According to the actually operation requirement of the business system, we design the data storage strategy, namely, online storage and offline storage. The online storage strategy mainly stores IPS/TAS production data to online storage devices; the offline storage refers moving the data that reaches the online storage period to offline device and carries out long-term storage. Data management system software should record the data of migration in the data migration process and facilitate the user to perform data retrieval.

The system offer 40TB space for offline storage. It is necessary to move out the data having been saved for a long time but seldom used regularly, so as to ensure that there is enough storage space in the disk array for data newly input.

5.1.5 Network Bandwidth Analysis

According to business analysis on business convention quantity flow, peak bandwidth of data domestic bandwidth data of the internal area provided by each subsystem is show as table below:

Data sender	Data receiver	Content	Data bandwidth peak
IPS server	DMS Server	Confirmation of data product customization order	1Mbps
		Domestic/foreign satellite-source data extraction request	1Mbps
		Report for data product customization failure	1Mbps
		Product data and metadata	212Mbps
		Product data and metadata task order	1Mbps
	PSS Server	Confirmation of data product customization order	1Mbps
		Report for data product customization failure	1Mbps
	IPS Client	Product data	400Mbps
	OSS server	Confirmation of custom orders of inner/domestic user data products	1Mbps
		Domestic/foreign satellite-source data extraction request order	1Mbps
		Product data archiving list	1Mbps
		Product customization failure report	1Mbps
		Log information	2Mbps
		Fault information	1Mbps
IPS Client	IPS server	Product data	400Mbps
DMS client side	DMS Server	Server management	6Mbps
DMS Server	IPS server	Confirmation of custom orders of inner/domestic user data products	1 Mbps
		Domestic/foreign satellite-source data extraction request	1 Mbps
		L2-L4 imagery data product/product data	212 Mbps
		Browse diagram/ metadata	7Mbps
		Confirmation of thematic product archiving	1Mbps
	PSS Server	Product data (L2-L4)/thematic product data	424 Mbps
		Browse diagram/ metadata	24Mbps
		Pushing notice and conformation information	1 Mbps
	TAS workstation	Product data (L2-L4)/thematic product data	150Mbps
		Browse diagram/ metadata	24Mbps
		Confirmation of thematic product archiving	1Mbps
	OSS server	Internal user data product order confirmation ordering flow	1Mbps
		Data product query notice	1Mbps
		Thematic Special product query	1Mbps
		Notice on for special data product push completion	1Mbps
		Notice on for thematic special product push completion	1Mbps
		Metadata Data push completion notice	1Mbps
		Internal user data product custom customization	1Mbps

Data sender	Data receiver	Content	Data bandwidth peak
		order	
		Data extract order confirmation	1Mbps
		Confirmation of data product archiving	1Mbps
		Confirmation of thematic product data archiving The filing notice about the metadata of special product	1Mbps
		Completion report of the on-demand data production custom order	1Mbps
		(Data product) delete corresponding record notice	1Mbps
		(Thematic Data product) delete corresponding record notice	1Mbps
		Log information	2Mbps
		Fault information	1Mbps
PSS Client	PSS Server	PSS system management	6Mbps
	OSS server	Fault information	1Mbps
		Log information	2Mbps
		Data product purchase order	1Mbps
		Thematic Data product purchase order	1Mbps
		Data Product purchase order completion report	1Mbps
		Thematic Product purchase order completion report completion report	1Mbps
		Custom order of domestic user data products	1Mbps
		Completion report of custom order of domestic user data products	1Mbps
		Thematic Confirmation of special product customization order	1Mbps
		Completion report of thematic the on-demand production custom order	1Mbps
		(Data product) meta data deletion completion notice	1Mbps
		(Thematic product) meta data deletion completion notice	1Mbps
	TAS workstation	Thematic Confirmation of special product customization order	1Mbps
PSS Server	DMS Server	Interface file such as product purchase ordering sheet etc.	1 Mbps
	IPS server	Custom order of domestic user data products	1 Mbps
TAS workstation	DMS Server	High-level processed products and thematic products	150 Mbps
		Browse diagram and meta file data	24 Mbps
		Thematic product archival order	1 Mbps
	OSS server	Confirmation of thematic product custom order	1Mbps
		Report of thematic product custom failure	1Mbps
		Thematic product archival order	1Mbps
		Log information	2Mbps
	PSS Server	Confirmation of thematic product custom order	1Mbps
		Report of thematic product custom failure	1Mbps
OSS server	OSS workstation	Log, faults, and procedures procedure display	20Mbps
	Remote operation and maintenance	Remote operation and maintenance	6Mbps

Data sender	Data receiver	Content	Data bandwidth peak
	support system (CHINA)		

According to information collected in the above table, traffic passing through the core switch mainly includes traffic among IPS, DMS, and TAS, traffic pushed by DMS to IPS, PSS, and TAS and traffic among servers and client of each system. According to the calculation, the maximum peak width of the core switch in theory must reach 2127Mbps.

Traffic passing through the firewall mainly includes product data downloaded by Internet users from FTP server of PSS, WEB webpage visits, VPN connection with remote operation and maintenance support system (China), which is abbreviated as RMS, to countries of MeSIC, and data interaction between systems and Internet, the calculation formula of which is as follows: 350+120+60+150=680Mbps, through which we can see that theory peak bandwidth of intranet firewall should reach 680Mbps in principle.

It is proposed to use high-width switches in the consideration of the later expansibility, network transmission redundancy, and network width utilization. All core switches are designed to adopt complete ten-gigabit switches, switches on access layer of the server are switches with complete ten-gigabit access and ten-gigabit interface, and firewalls adopt ten-gigabit output devices.

5.2 Unmanned Aerial Vehicle Forest Monitoring system

5.2.1 Analysis of the Product Production Efficiency

Data acquisition capability: Fixed-wing Unmanned Aerial Vehicle, the maximum life time of 5.5 hours, the measurement and control radius of 50km, the load capacity of 20kg, the system deployment time of 30 minutes, single flight effective operating hours of 4 hours, survey able area of 50-70 km^2, 1 -2 flight operations per day according to mission needs;

Data Processing Capability

a. Fire identification, monitoring mode:

1) Fire point display: Real time

2) Fire monitoring report: Real time;

3) Fire Burned area report: Real time;

b. Forest census Map (DOM, DSM) production capacity: 1 km^2 / day (1:1000 scale), up to 10 km^2 / day after upgrading hardware and software configuration.

5.2.2 Analysis of Hardware Equipment Selection

5.2.2.1 Fixed Wing Unmanned Aerial Vehicle Selection

5.2.2.1.1 Sharing Tasks Undertaken

The ZW-5B fixed-wing Unmanned Aerial Vehicle is a core component of the Cambodia Unmanned Aerial Vehicle forest monitoring system, providing a loading platform for all on-board equipment such as data links, task loads (visible light cameras, small dual-light pods). Through the small photoelectric pod (visible light and infrared load) loaded on the ZW-5B Unmanned Aerial Vehicle, high-altitude images of the forest are captured, the data link device transmits real-time aircraft telemetry, visible light, infrared videos to the load ground station to monitor whether a fire occurs, and conducts fire source identification. In addition, ZW-5B can also carry a visible light camera to conduct regularly forest census, and produce forest map, so as to provide data support for the forestry management department, it mainly completes the following:

a. Appliance loading ZW-5B Unmanned Aerial Vehicle provides onboard loading platform, such as task load, data link, power supply unit;

b. MFC Task implementation flight ZW-5B Unmanned Aerial Vehicle remote flight being controlled by the ground station personnel, it can also conduct self-flight along the route according to the default GPS coordinates. It can conduct one- touch self take off,

self-landing to complete the forest monitoring work;

c. Return video: ZW-5B Unmanned Aerial Vehicle can carry a small double-light pods to conduct flight operations along the default route, transmit ethereal-time visible light and infrared videos back to the load ground station for display, and carry out fire identification and forest monitoring according to the fire monitoring software;

d. Enable GPS Real-time positioning: Equipped with GPS positioning function, it can send real-time telemetry information through the data link back to the ground station to ensure real-time control of Unmanned Aerial Vehicle flight conditions, load working conditions;

e. Fail Safe operation Safe flight: When the link fails, the aircraft can conduct self-return, self-landing, to avoid flight accidents, and protect the safety of the task load.

5.2.2.1.2 Feasibility analysis of the project purchase

ZW-5B fixed wing Unmanned Aerial Vehicle system is a medium-sized fixed-wing Unmanned Aerial Vehicle system, it can be equipped with visible light camera, small double-light pods and other task load, and can conduct remote sensing monitoring of specific areas of selected forest, it uses the Unmanned Aerial Vehicle task load equipment to carry out real-time collection of forest information, and through the airborne data link device, it transmits images, videos and other information to the portable ground station for analysis and processing, so as to achieve the forest area monitoring.

Table 5- 8 ZW-5B Unmanned Aerial Vehicle appearance

a. Functions are as follows:

1) Cruise flight: ZW-5B Unmanned Aerial Vehicle remote flight being can be controlled by the ground station personnel; it can also conduct self-flight along the route according to the default GPS coordinates. It can conduct one- touch self take off and, self-landing to complete the forest monitoring work. During the Unmanned Aerial Vehicle autonomous flight process, the ground station staff can adjust the flight route in real time;

2) Enable GPS real-time positioning: Unmanned Aerial Vehicle GPS information can be transmitted in real-time through the data link back to the ground station to ensure real-time control of Unmanned Aerial Vehicle flight situation;

3) Flight safety security: When the link fails, the aircraft can carry out self-return, and self-landing (can also continue to fly according to the route set, and carry out self-return, and self-landing after the completion of the task);

4) Dual light monitoring: With visible / infrared real-time monitoring functions, being able to mount a small photoelectric pod for target area real-time observation, and achieve the high-precision imaging of the target area;

5) HD Photo: With high-definition visible light camera function, can mount high-definition camera to take the fixed time and distance photo of the forest area, after the post-processing, it can generate orthophoto map, and complete the survey of the forest.

b. Its main performance indexes are as follows:

Name	Parameter	Name	Parameter
Full length	3.5m	Full height	1m
Wing span	5.1m	Maximum takeoff weight	100Kg
Max load	20Kg	Take off and landing method	Slide, takeoff and landing (200-300 meters)
Takeoff speed	60Km/h	Landing speed	80Km/h
Maximum climb rate:	5m/s	Cruise speed	100-140Km/h
Maximum level flight speed	150Km/h	Maximum endurance time	5.5h
Maximum operation height	Altitude 4000m	Measuring radius	50Km
Maximum lifting wind resistance capacity	Level 7	Autonomous flight mode	GPS / INS navigation
Dynamical system	Piston petrol engine	Engine/ motor	17.5HP

5.2.2.2 Small Photoelectric Pod Selection

5.2.2.2.1 Sharing Tasks Undertaken

The ZW-S miniature light pod is the core mission load of the Cambodia Unmanned Aerial Vehicle forest monitoring system, which integrates a visible light camera / infrared camera and is responsible for capturing the visible / infrared videos of the specified monitoring target; Through the ZW-5B Unmanned Aerial Vehicle platform equipped with a small photoelectric pod, you can have access to high-altitude images of the forest, real-time aircraft telemetry, visible light, infrared videos are transmitted to the portable ground station through the data link device to monitor whether there is a fire, and identify the fire point and its location, generate fire monitoring report, and provide a basis for leader's real time decision-making.

a. Shooting Visible Video: Pod integrates with a visible light camera, can have access to real-time images, and transmit visible light image to the ground load station for display;

b. Shoot infrared video: Pod integrates infrared camera, can have real-time access to infrared images of the target area, and transmit to the ground load station for display, so as to provide information for fire detection software to determine the fire point.

5.2.2.2.2 Feasibility Analysis of the Project Purchase

ZW-S small double-light pods assumes the mission of the core mission load in the Cambodia Unmanned Aerial Vehicle forest monitoring system, according to project requirements, it is required to integrate visible light cameras and infrared cameras. The Unmanned Aerial Vehicle can carry out real-time monitoring of the visible / infrared video images of the target in the course of the mission, and transmit the real-time two-way video to the ground station through the airborne data link for displaying and saving, so as to monitor whether there is a fire, and to provide a basis for real-time decision-making for the leadership.

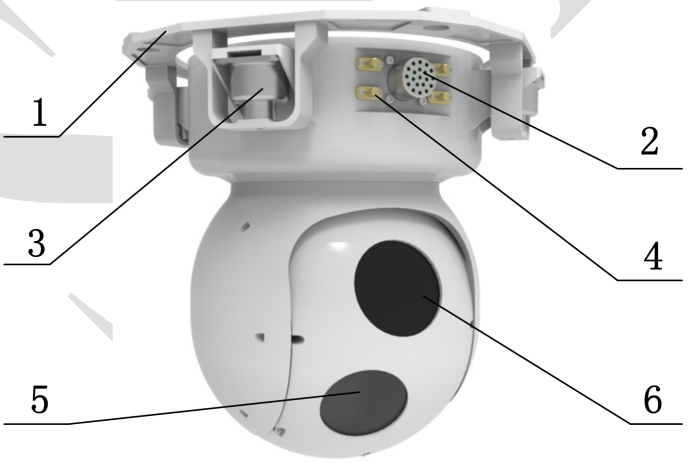

Figure 5- 1 ZW-S small photoelectric pod appearance

Serial number	Name	Description
1	Fixed adapter plate	Used for fixing pod turret and carrier
2	Aviation plug	37-core aviation plug
3	Vibration isolator	Isolation carrier vibration and vibration isolator size and shape are different, so installation way is different, and the actual installation sees real turret.
4	Video interface	Output visible video and infrared video, the interface definition sees physical label
5	Visible light observation window	Visible light camera observation window
6	Infrared observation window	Infrared thermal imager observation window

Functions are as follows:

a. Install photoelectric imaging sensor in photoelectric pod stability platform, which can achieve visible light collection;

b. Install thermal infrared imager in photoelectric pod stability platform, which can achieve infrared video capture;

c. Stable platform comes with bracket and cover, which can be mounted on the fixed wing Unmanned Aerial Vehicle portably through the bracket, and the cover can protect the imaging sensor, to preserve dust and light rain;

d. In the high vibration environment of airborne, it can isolate the disturbance through the internal high precision MEMS gyro stabilization platform, so that the optical axis of the imaging sensor can keep high precision and stability;

e. Driven by the external control command, it will achieve stable platform rotation, so that the optical axis of the imaging sensor will point to specific direction.

6. System Design

6.1 Remote Sensing Application Service System

The Remote Sensing Application Service Platform (RSASP) is mainly used to complete the corresponding levels of product generation, image analysis and advanced processing for the remote sensing data of China satellites source and international satellite source which are gained through coordination and sharing, provide the remote sensing application product generation and thematic mapping function aiming at some application industries. The Remote Sensing Application Service Platform can be divided into Image Processing System (IPS), Data Management System (DMS), Typical Application System (TAS), Public Service System (PSS), Operation Service System (OSS), and Computer and Network Safety System (CNSS).

6.1.1 Main Function

a. Produce the remote sensing products of the corresponding levels of remote sensing data from China satellite source and international satellite source;

b. Unified storage and management for the coordinate remote sensing image data, multi-level processing products and remote sensing application products provided by the authorized users, and push the metadata information to PSS and DCS for querying and browsing by domestic and foreign users in each country;

c. Comprehensively utilize the domestic and international satellite source data to conduct processing, analysis and advanced processing for remote sensing image data. on such basis, it can also and provide remote sensing application product production and thematic mapping functions for fields such as agricultural remote sensing monitoring, water resource remote sensing monitoring and evaluation, forestry remote sensing monitoring, spill oil monitoring above the sea, coastal zone monitoring, river basin flood monitoring, river basin drought monitoring etc.

d. Provide a unified distribution capability of remote sensing data products; the domestic users can use the services provided on website to browse the product information, submit the product order and download data products;

e. Provide the remote sensing application service platform with such functions as process monitoring, log management, fault alarm, access control and system configuration, and remote technical services support.

f. Provide a reliable virtual hardware platform for the remote sensing application service platform, together with stable data and service network security assurance;

g. Provide coordination and sharing functions of remote sensing data among the data providers in domestic and China and other data divisions within the Lancang-Mekong River Basin.

6.1.2 Main Specification

a. Support Level 2-4 image products production of some China satellite sources, Level 2-4 image products production of SPOT6, and Level 3-4 image products production of Landsat8;

b. The bare online storage capacity is 80TB (for more than 100 days);

c. Develop seven categories of thematic applications：

1) Provide 6 types of crop remote sensing monitoring products, namely, crop growth remote sensing monitoring, crop planting area remote sensing estimation, crop unit yield remote sensing estimation, crop yield remote sensing estimation, crop plantation structure monitoring and multiple cropping index monitoring;

2) Provide 6 types of water resource remote sensing monitoring products, namely, land surface water area remote sensing monitoring, rainfall space-time distribution remote sensing monitoring, chlorophyll-α concentration remote sensing monitoring, water suspended matter concentration remote sensing monitoring, water transparency remote sensing monitoring and water eutrophication degree remote sensing monitoring;

3) Provide 5 types of forestry remote sensing monitoring products, namely, forest remote sensing classification, forest change monitoring, fire point monitoring, burned area monitoring and wetland information monitoring;

4) Provide 3 types of marine oil spilling remote sensing monitoring products, namely, oil spilling monitoring, oil slick characteristic extraction, and oil slick diffusion predication;

5) Provide 7 types of coastal zone remote sensing monitoring products, namely, sea water extraction, reclamation domain monitoring, coastal land use monitoring, offshore water

color abnormal monitoring, red tide monitoring, enteromorpha monitoring and mangrove monitoring;

6) Provide 2 types of river basin flood monitoring products, namely, basin flooding area monitoring and flood disaster damage evaluation;

7) Provide 6 types of river basin drought remote sensing monitoring products, namely, one map of drought monitoring, drought monitoring change analysis, drought monitoring timing sequence analysis, surface evaporation estimation, drought index remote sensing monitoring and soil moisture remote sensing monitoring.

d. The public service system supports at least 200 users online at the same time;

e. The data coordinating and sharing system supports at least 500 users online at the same time, with average response time being shorter than 5s;

f. The overall reliability of the system is superior to 99.7%.

6.1.3 Platform Composition

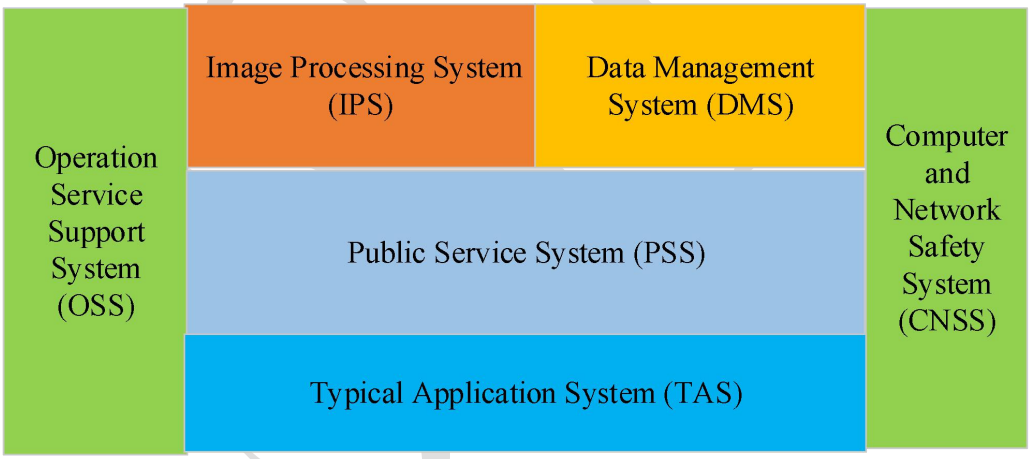

Figure 6- 2 Software composition of RSASP

Image processing system (IPS) can conduct the Level 2-4 data production as per the product production order sent by PSS and the corresponding image data sent by DMS, and then after the production is completed, DMS will conduct the archival storage of data product.

Typical application system (TAS) can comprehensively utilize the domestic and international satellite data to conduct processing, analysis and advanced processing for remote sensing image data. On such basis, it can also provide remote sensing application product generation and

thematic mapping for 7 fields including agricultural remote sensing monitoring, water resource remote sensing monitoring and evaluation, forestry remote sensing monitoring, marine oil spilling monitoring, coastal zone monitoring, river basin flood monitoring, river basin drought monitoring.

Data management system (DMS) is the data center of the intranet of the remote sensing application service platform. DMS is responsible for completing storage and management of China and international satellites data product, to provide data support for image processing system, typical application system and public service system.

Public service system (PSS) is the remote sensing date product service center of the remote sensing application service platform, which is responsible for providing remote sensing date product distribution service to authorized users. Users can realize data retrieval, data browsing, data subscription, data download and other services through the Web service deployed on the internet.

Operation service system (OSS) consists of log management subsystem, workflow monitoring subsystem, fault alarm reporting subsystem, system management subsystem and so on. It mainly provides log collection and analysis, order processing flow monitoring, unified fault alarm reporting management, user access control, and system parameter configuration and so on.

Computer and network safety system (CNSS) is designed for the remote sensing application service platform to provide reliable virtual hardware platform support and network safety design guarantee. Using VMware virtualization technology to consolidate servers can provide more reasonably hardware support for application software. The main purpose of network connectivity design is to meet the network access demand of each sub-system of RSASP, ensuring the interconnectivity of each subsystem on the network and ensure data communication of Web application publishing services and Ftp services with Internet. Network safety system is to ensure the network and Internet communication security.

6.2 Unmanned Aerial Vehicle Forest Monitoring System

6.2.1 Main Function

The functions of Cambodia Unmanned Aerial Vehicle forest monitoring system can be divided into emergency monitoring functions, aerial shooting and mapping function, data processing

functions and transportation guarantee functions.

6.2.1.1 Emergency Monitoring Function

a. With visible / infrared real-time monitoring functions, being able to mount a small photoelectric pod to Unmanned Aerial Vehicle system for target area real-time observation, and achieve the high-precision imaging of the target area;

b. It can plan monitoring plan of Unmanned Aerial Vehicle system based on monitoring mission requirements, forest environment, weather forecast and other information, to determine the Unmanned Aerial Vehicle route and task load work plan;

c. It is with real-time generation, sending and telemetry information receiving function of Unmanned Aerial Vehicle, task load and other remote control information;

d. The ground station of loaf is deployed fire monitoring software, which can identify fire sources and locate fire point in the forest in real-time, to achieve real-time monitoring of fire.

6.2.1.2 Aerial Shooting and Mapping Function

a. It can use the Unmanned Aerial Vehicle being equipped with visible light camera, to shoot with fixed time and distance in the forest area during the flight process. After processing, generate orthophoto map to complete the general survey and mapping of forest area;

b. It can plan the surveying and mapping scheme of Unmanned Aerial Vehicle system and determine track and work plan such as mission load for Unmanned Aerial Vehicle according to information such as forest region, requirement of surveying and mapping and geographical environment.

6.2.1.3 Data Processing Function

a. The load ground station can save and display the visible light/infrared video data received by airborne mission equipment of Unmanned Aerial Vehicle in real-time;

b. The system has the ability of image data handling capacity for Unmanned Aerial Vehicle to generate orthophoto map and DSM data product in scale of 1:5000, 1:2000 and 1:1000.

c. It has the ability of ground object information extraction and vectorization of forest region in orthophoto map;

d. The fire monitoring software can generate fire report document.

6.2.1.4 Transportation Guarantee Function

The system is equipped with transport vehicle to meet transportation guarantee function for air crew and Unmanned Aerial Vehicle system.

6.2.2 Main Specification

a. Outspread and fold of system: The whole system can be spread and folded after task termination in 30 minutes;

b. Number of Unmanned Aerial Vehicle: 1 ZW-5B fixed wing and 1 spare body;

c. Number of transport vehicle: 1 transport vehicle, having transportation function for air crew and Unmanned Aerial Vehicle;

d. Control and navigation mode of Unmanned Aerial Vehicle: Having remote control and autonomous navigation mode;

e. Payload type: Visible-light high-definition camera and small bifocal pod;

f. Radius of system measuring and controlling: 50km;

g. Can provide real-time transmission function for remote measuring and remote controlling to transmit high-definition (visible light) and standard-definition (infrared) video in real time;

h. Data processing: Can handle, display and store the video downloaded by Unmanned Aerial Vehicle in real time;

i. Output achievements results: Visible light video, infrared video, DOM, DSM and fire monitoring report, etc.

j. Acquisition capability: The outspread time of the system is no more than 30 minutes, the effective operation time is no more than 4 hours in single flight and the area of surveying and mapping is 50-70 km^2;

k. Data processing capability:

1) The system can generate fire monitoring report (real time);

2) The system can generate DOM standard surveying and mapping results with scale of 1:1000 and over. (1 km^2/day), after software & hardware configuration is upgraded, it will be 10 km^2/day at most.

6.2.3 Platform Composition

Figure 6- 3 Schematic diagram of System architecture

Cambodia Unmanned Aerial Vehicle forest monitoring systems consist of Unmanned Aerial Vehicle subsystem and information processing subsystem consisting of two: Including, the Unmanned Aerial Vehicle subsystem is composed of ZW-5B fixed wing Unmanned Aerial Vehicle platform, 50 km data chain, mission load, ground station and transportation support guarantee equipment; Information processing subsystem is composed of Unmanned Aerial Vehicle image data processing software, raster image vectorization software and hardware support platform. The system compositions are as shown in the following figure.

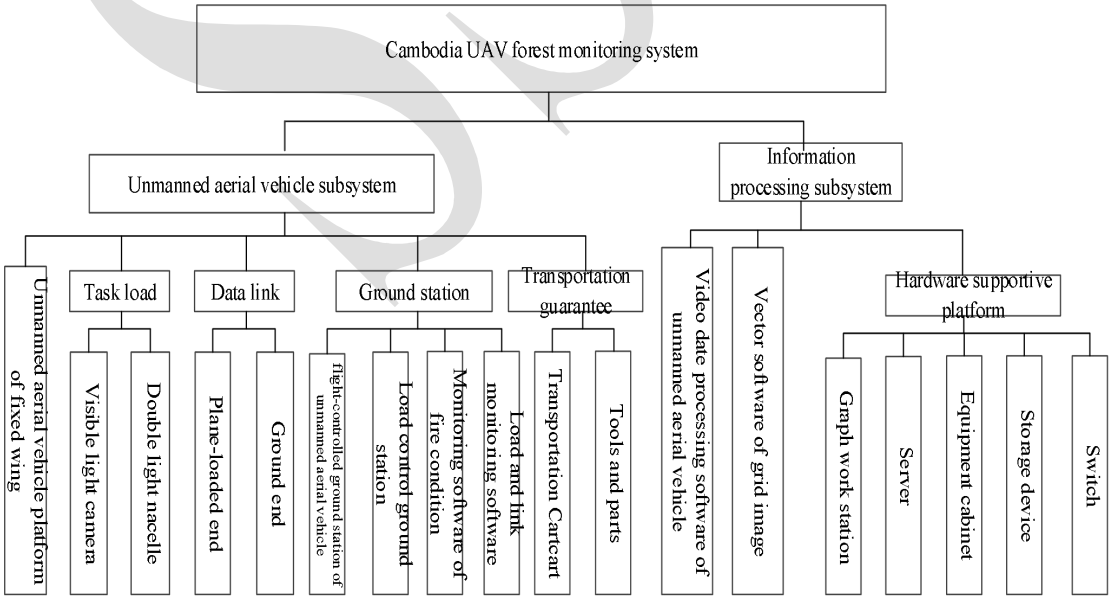

Figure 6- 4 System composition diagram

7. System Layout Design

The main cooperative construction content of “MeSIC” in Cambodia indicates the remote sensing application service platform (RSASP) and Unmanned Aerial Vehicle Forest Monitoring System (UAVFMS). DCS will be constructed in Yunnan, China.

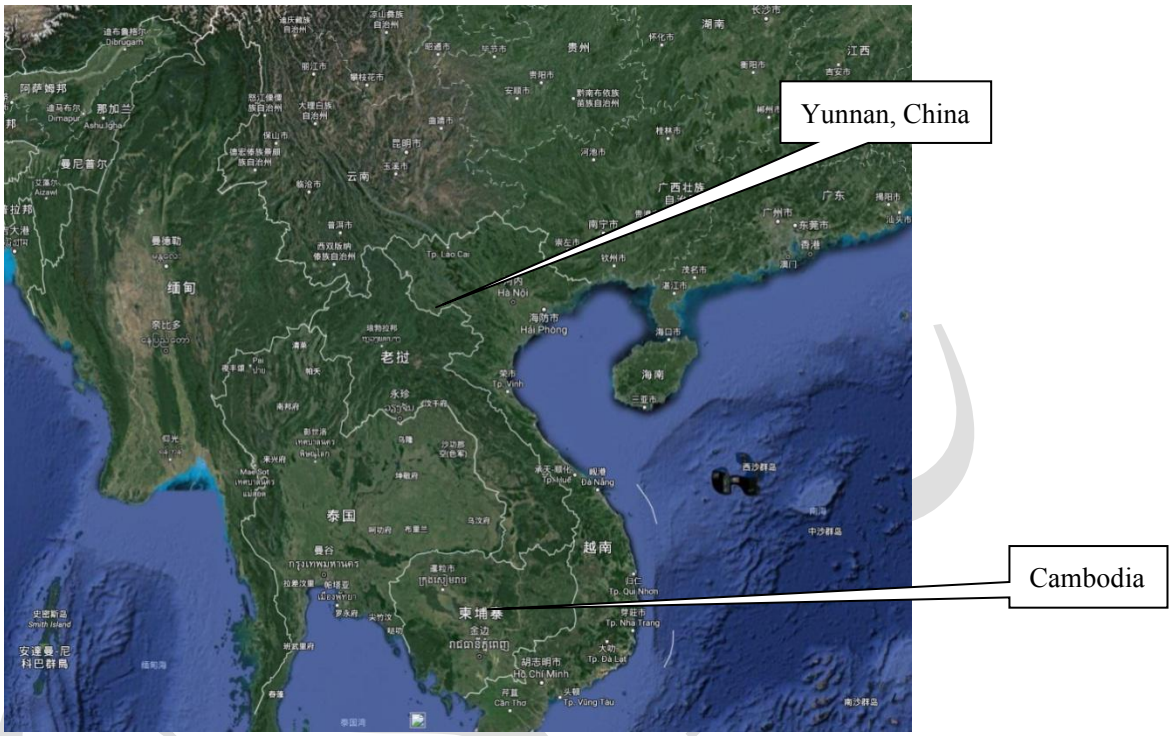

Figure 7- 1 Location of MeSIC

7.1 Technical Requirements of Infrastructure

The infrastructure requirements of the system are as shown in the following table:

Table 7- 1 Infrastructure Requirements Table

No.	System	Installation Address	Infrastructure Requirements	Remarks
1	RSASP	Cambodia	**Occupied area:** operation and equipment room: not less than 60m^2; Height requires more than 3m; UAV warehouse: 10m×6m×4m;With the conditions of laying cables; **Power supply and distribution:** 380±10%VAC,50Hz, 40.15kW; **Temperature and humidity:** 23℃±5℃;30%~%-70%, with no condensation; **Lightning protection:** Lightning protection facilities are set; **Grounding:** Ground connecting resistance is less than 14 Ω. **Prevent rodents:** Having measures for prevent rodents from entering in.	The power supply and distribution only includes the power of equipment in the rack and the operating platform. Other power should be considered by Cambodia.
2	UAVFMS			

The responsibility matrix in Technical Agreement makes clear that Cambodia provides supporting operation rooms, equipment rooms and other infrastructure. China provides detailed infrastructure requirements in accordance with the international standard for the construction of computer rooms.

7.2 Equipment Reference Layout Plan for Cambodia

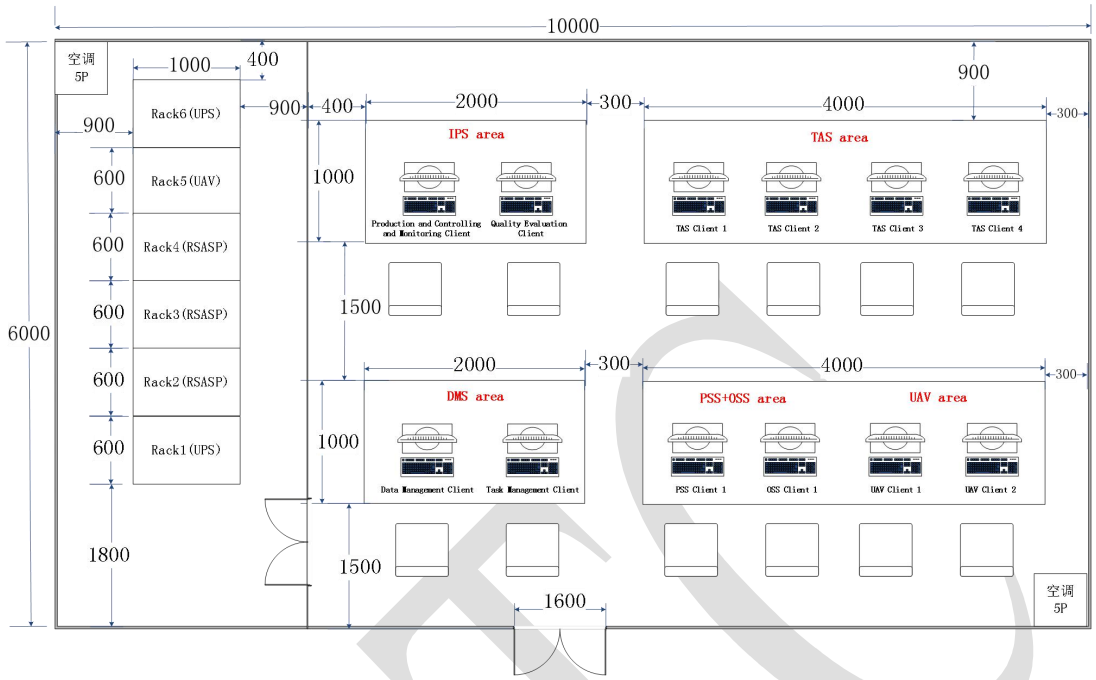

Figure 7-2 Layout plan of operation and equipment room

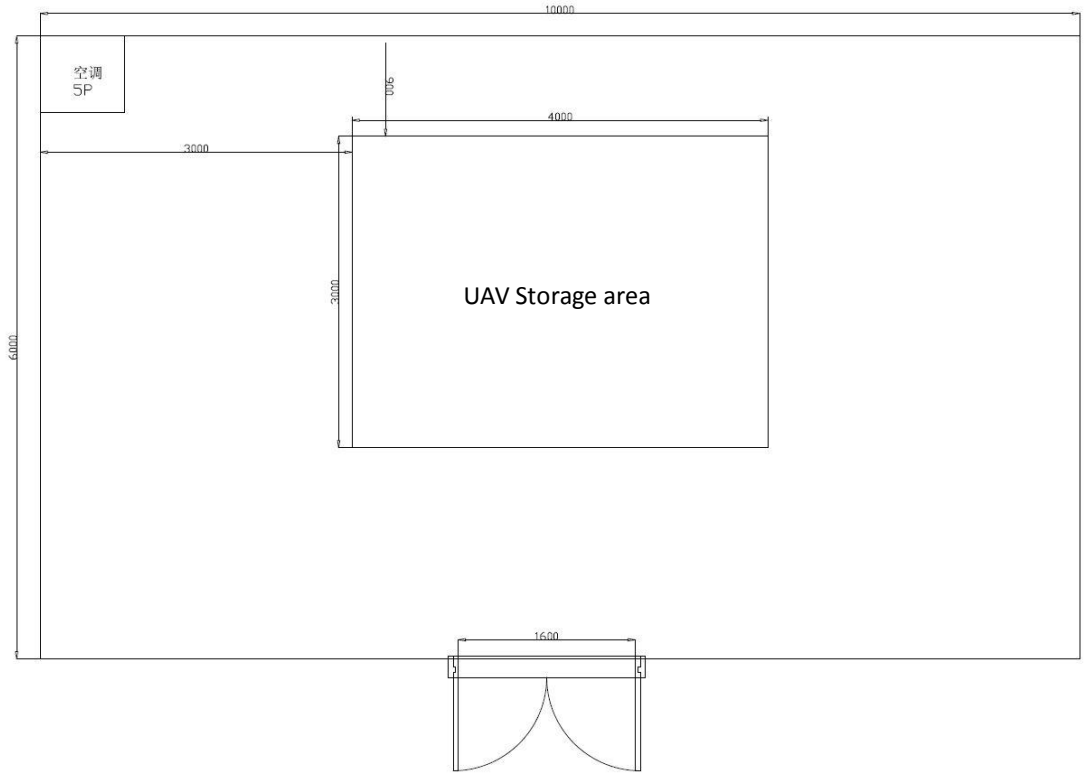

Figure 7-3 Layout plan of UAVFMS warehouse

8. System Test

The integration test of MeSIC includes the following contents:

a. Installation and integration in China: Rack installation, equipment installation, cable connection, equipment power supply and single-machine test, etc.;

b. Sub-system acceptance test: sub-system function and performance, internal and external interfaces, process test;

c. Integration test of MeSIC in China: interfaces between sub-systems, system process etc.;

d. Factory acceptance test;

e. Installation and integration in Cambodia: Rack installation, equipment installation, cable connection, equipment power supply and single-machine test etc.;

f. System test: Function and performance of equipment, subsystem and MeSIC system, internal and external interface, system process;

g. Pre-acceptance test: system function, performance, interface, process test;

h. Final acceptance review: system function, performance, interface, process test.

9. Training

9.1 Training Objective

a. Cambodia learners are familiar with the basic principles of the MeSIC;

b. Cambodia learners familiar with the operation of equipment and software;

c. Cambodia learners familiar with the Maintenance and management of equipment;

d. Cambodia learners could solve the simple fault of system;

9.2 Training Features

9.2.1 Training Language

The training materials (system design file, operation manual etc.) should be translated into English.

At the same time, the training teacher should communicate with Cambodia learners in English.

9.2.2 Training Contents

This training Contents includes the theoretical basic knowledge and operation training of RSASP. The basic and specialized courses includes remote sensing application, computer network, UAV surveying, etc. The software and hardware operation training and in-station training in Cambodia mainly involves the hardware and software operation of each subsystem.

9.2.3 Training Arrangement

The total number of learners is 15, and the whole training lasts for 7 weeks. The training arrangement is shown as follows:

a. The training is divided into 2 stages: training in China and Cambodia;

b. Training time is 7 weeks: 3 weeks training in China, 4 weeks training in Cambodia;

Table 9- 1 Training Arrangement

No.	stage	Training contents	Training way method	Training period (day)
1	Training in China	Basic courses training	Classroom teaching	4 (RSASP) 2(UAVFMS)
2		Specialized courses training	Classroom teaching	4
3		Software and hardware operation training	Class + live explanation	8(RSASP) 10(UAVFMS)
4	In-Station training in Cambodia	System test/fault diagnosis training	Class + live explanation	22
Note: The working hours are calculated by 22 days per month, exclusively of Saturday and Sunday.				

9.3 Training Scheme

9.3.1 Chinese Domestic Training Program

9.3.1.1 Basic Courses Training

The training for basic courses lasts for 4 days. Classroom training is adopted and is arranged in Chengdu, China. Detailed content of the basic courses training are shown as follows.

Table 9- 2 Arrangement of the basic courses training

No.	Training courses	Learner	Training location	Training Time (day)
1.	Introduction to remote sensing	Remote sensing group	China	4
2.	Remote sensing satellite ground system			
3.	Remote sensing satellite application			
4.	Introduction of UAV system	UAV group		2
Note: The working hours are calculated by 22 days per month, exclusively of Saturday and Sunday.				

9.3.1.2 Specialized Course Training

The training for specialized courses lasts for 4 days. Classroom training is adopted and is arranged in Chengdu, China. Detailed content of the specialized courses training is shown in the following table.

Table 9- 3 Arrangement of the specialized courses training

No.	Training courses	Learner	Training Location	Training time (day)
1.	IPS design	Remote sensing group	China	4
2.	TAS design			
3.	DMS design			
4.	OSS design			
5.	PSS design			
6.	CNSS design			
7.	Principle and application of load	UAV group		4
8.	Principle and application of data link			
9.	Principle and application of ground station			
10.	Introduce of ground station software			
11.	Introduce of image processing system			

9.3.1.3 Software and Hardware Operation Training

The software and hardware operation training lasts for 8 days. Classroom training and operation training are adopted. The training site is Chengdu, China. The detailed content of the hardware and software operation training is shown in the following table.

Table 9- 4 Arrangement of the hardware and software operation training

No.	Training courses	Learner	Training Location	Training time
1.	IPS operation training	Remote sensing group	China	8
2.	TAS operation training			
3.	DMS operation training			
4.	OSS operation training			
5.	PSS operation training			
6.	CNSS operation training			
7.	UAV operation training	UAV group		10

9.3.2 On-Station Training

The on-station training lasts for 22 days. The training is performed by combining the classroom teaching and operation training. The detailed content of the on-station training is shown in the following table.

Table 9- 5 Arrangement of on-station operation training

No.	Training courses	Learner	Training L location	Training time
1.	Operation process, testing, fault diagnosis, operation and maintenance training for IPS	Remote sensing group	Cambodia	22
2.	Operation process, testing, fault diagnosis, operation and maintenance training for TAS			
3.	Operation process, testing, fault diagnosis, operation and maintenance training for DMS			
4.	Operation process, testing, fault diagnosis, operation and maintenance training for OSS			
5.	Operation process, testing, fault diagnosis, operation and maintenance training for PSS			
6.	Operation process, testing, fault diagnosis, operation and maintenance training for CNSS			
7.	Operation process, testing, fault diagnosis, operation and maintenance training for UAV	UAV group		

9.4 Demands of Learners

Demands of Learners are as follows:

a. Bachelor degree or above;

Engineering background: electronic, remote sensing, communication, UAV, computer specialty, with work experience over two years;

Proficient English listening, speaking, reading and writing skills.

10. Transportation

10.1 Responsibility of Packing and Transportation

Table 10- 1 Responsibility of Packing and Transportation

No.	Work	Responsible part	Time arrangement	Remarks
1	Primary packing	SSTC	25-30 days before shipment	Check the equipment and its installation accessories that need to be packed and transported, And all equipment is packed in original packaging as much as possible.
2	Secondary packing	SSTC	20-25 days before shipment	The package of precision instrument should be anti-pressured. There are fumigation sign on the wooden box. Anti-pressure protection pad need to be put inside the packing box and anti-collision and anti-handstand signs be stuck.
3	Determine the transport company and route	SSTC	30 days before shipment	Confirm the main mode of transportation and the time node with the transport company, and sign the transport contract.
4	Provide equipment list for the transport company	SSTC	15 days before shipment	1. Product inspection (handled by the manufacturing plant); 2. Cambodia user is in charge of export license; 3. Customs declaration and other documents that may be required
5	Booking space	Transport company	15 days before shipment	After determining shipping schedule, shipping space and other reference information, Transport company need to send that information to SSTC.
6	Transport from Chengdu/Tianjin to Tianjin Port and Port	SSTC	8-12 days before shipment	SSTC coordinates transport companies to transport equipment to designated port.
7	Packing	Transport company	5-10 days before shipment	The secondary packing equipment is put into the container which is free for use 10 days before the shipment. After being put into the container, lead sealing. The container shall not be opened in transit.
8	Custom entry	Transport company	1-3 days before	Verification Sheet, commercial

			shipment	invoice, packing list (unit price, total price, total amount, details, contracts). Note: The Customs has the right to inspect the goods. If the goods violated the regulations, the customs shall have the right to cancel the goods.
9	Shipment	Transport company	0-2days before shipment	After the equipment was put on the ship, the shipping company issues the bill of lading (Cautious！！ Its equivalent to the certificate of right of goods) to SSTC by fax or mail. After the goods arrive at the destination, they cannot be picked up with no bill of lading.
10	Transportation tracking	Transport company	After shipment	
11	Destinations (Vientiane)	Transport company	About 45-50 days after shipment	We need to apply to local government and provide all required documents. This process is under the supervision of Cambodia customs.
12	Customs clearance	Cambodia		SSTC is responsible for inland transportation after customs clearance
13	Picking up equipment	Cambodia		When SSTC personal are present, Cambodia user can check and take delivery of equipment according to equipment list.
14	Settlement	The transport company and SSTC		Settlement

10.2 Equipment Checking

When making an inventory for goods, both the Cambodia user and Chinese staff must be present.

Both sides should sign on the goods shipment sheet provided by the Chinese side.

10.3 Customs Clearance

MeSIC belongs to Chinese assistance project, and does not involve import tariff and vat. SSTC will submit equipment list and packing list one month prior to equipment enters the customs.

The future equipment repair will use foreign spare parts or the equipment will be sent back to the

Chinese side. The return of equipment to the foreign party does not involve tax payment.

The Cambodia side should be responsible for customs clearance after the goods arrives in Cambodia.

10.4 Equipment Storage Requirements

10.4.1 Storage Site Requirements

a. The storage place should be away from the source of pollution and other places where toxic and harmful substances are stored;

b. The storage place and surrounding environments should have effective anti-rat facilities, and the ground should be flat and hardened, with smooth drainage, good ventilation, sanitation and hygiene and no vector insect breeding ground;

c. The warehouse shall be constructed by non-toxic, sturdy material and shall minimize the deterioration of the stored goods to prevent contamination, and to be kept clean with prevention device (e.g. mouse plate set in the warehouse door and exhaust) for animal ingress;

d. The storage warehouse should have good ventilation and moisture-proof facilities, to prevent the equipment from being affected with damp and damaged.

10.4.2 Rain Proof Requirements

All electronic equipment should be stored indoors and not be exposed to rain in case of equipment damage.

10.4.3 Equipment Storage Condition

Table 10- 2 Equipment storage condition

Item Project	Indicator
Temperature ℃	-10℃~40℃
Relative humidity %	10%~85%

11. After-Sale Service

After completing final acceptance review, the MeSIC has entered the 1 year after-sales service phase.

During the after-sales service phase, SSTC provides free after-sales services within specified terms of the contract. After that phase, SSTC will provides paid services for Cambodia.

11.1 After-Sales Service Contents

The contents of 2 year after-sales service phase are as follows.

a. Provide free maintenance and replacement for system fault caused by reason other than human improper operation within two year after system delivery, and solve system fault problems by using spare parts of hardware, software remote update and system remote maintenance, etc.;

b. Within two year warranty, the fixed contact person and contact information (phone, email) should be set to provide follow-up technical support;

c. Within two year warranty, carry out site inspection for the system for one time (internal control of our side).

d. Within two year warranty, provide remote technical support service, and make response within 24 hours by phone, email after receiving fault report.

11.2 Team Organization

Both parties shall establish a communication mechanism, and the operation and maintenance team of the user side of Cambodia shall designate the contact person to communicate effectively with the after-sales team of China.

11.3 Methods and Means of After-Sales Service

The whole after-sales service phase can be divided into two parts: after-sales maintenance phase and beyond the warranty period:

a. **2 year after-sales maintenance phase**

According to requirement of project contract, when the system has technical supporting problem unsolved by the site personnel within two year after system delivery, SSTC shall arrange the assistant to provide technical support to ensure such problems can be solved timely. And all cost thereof shall be borne by the SSTC, and if necessary, the staff shall be sent to the site. Provide free maintenance and replacement for fault caused by reason other than human improper operation within two year after system delivery, and mainly via spare parts of hardware, system remote maintenance, etc.:

1) Replacement of spare parts: When the hardware equipment malfunctions, spare parts at the site can be used for replacement;

2) Remote update and maintenance: Remote fault diagnosis, troubleshooting and software upgrade and other work can be conducted by remote maintenance system.

b. **Beyond the warranty period**

SSTC will use the remote maintenance system to timely understand and identify on-site failures and problems, and provide payment solutions and measures

12.Development Plan

Table 12- 1 Development Plan of MeSIC

No.	Milestone	Time	Remarks
	System Design	20161230	
	Detailed Design	20170730	
	Subsystem Development	20170330	
	Factory Acceptance Test (FAT)	20180830	
	Final Acceptance Review (FAR)	20190331	
	Acceptance by State Administration of Science, Technology and Industry for National Defence, RPC	20190530	

13.Deliverables

13.1 Deliverables of Equipment

Table 13- 1 Deliverables of Equipment (RASAP)

No.	Name of Deliverable	Unit	Quantity	Note
1.	Image Process System（IPS）			
2.	Client PC	Set	2	
3.	Linux Advanced Platform	Set	6	
4.	Windows 10	Set	2	
5.	IPS software package	Set	1	
6.	Typical Application System（TAS）			
7.	Workstation	Set	4	
8.	Network Switch	Set	1	
9.	Windows 10	Set	4	
10.	ArcGIS Engine 10.2 License	Set	4	
11.	TAS Software Package	Set	1	
12.	Data Management System			

13.	Client PC	Set	2	
14.	Windows 10	Set	2	
15.	Optical Fiber Switches	Set	2	
16.	Metadata Equipment (Including Two Metadata Servers)	Set	1	
17.	SAN Disk Array	Set	1	
18.	Hot Standby Software	Set	4	
19.	Oracle Database software	Set	2	
20.	Linux Advanced Platform	Set	6	
21.	Data Management Software Package	Set	1	
22.	Public service system			
23.	Client PC	Set	1	
24.	Windows 10	Set	1	
25.	Linux Advanced Platform	Set	10	
26.	Public Service System Software Package	Set	1	
27.	Operation service system			
28.	SMS Broadcast Equipment	Set	1	
29.	Workstation	Set	1	
30.	Windows 10	Set	1	
31.	Windows Server 2012	Set	3	
32.	Operation Service Software Package	Set	1	
33.	Computer and network safety system			
34.	Server	Unit	7	
35.	KVM	Unit	3	
36.	Stacked Cable	Unit	4	

37.	Network Switch	Unit	2	
38.	Fire Wall	Unit	1	
39.	Router	Unit	2	
40.	VPN Gateway	Unit	1	
41.	Web Firewall	Unit	1	
42.	Core Switch	Unit	2	
43.	Rack	Unit	5	
44.	UPS Battery Pack	Unit	1	
45.	Database Audit	Unit	1	
46.	VMware software package	Unit	1	
47.	Antivirus software	Unit	1	
48.	Authentication software	Unit	1	

Table 13- 2 Deliverables of Equipment (UAVFMS)

Serial No.	Equipment name	Unit	Quantity	Remarks
I	**UAV forest monitoring system**			
(I)	**UAV subsystem**			
1.	Unmanned aerial vehicle platform	Set	1	
2.	Ground station	Set	1	
3.	Data link	Set	1	
4.	Visible light camera	Set	1	
5.	Compact dual light pod	Set	1	
6.	Carrier	Set	1	

(II)	Information processing subsystem			
1.	Graphics workstation	Set	2	
2.	Server	Set	2	
3.	Rack	Set	1	
4.	KVM	Set	1	
5.	Storage device	Set	1	
6.	Switch	Set	1	
7.	UAV image data processing software	Set	1	
8.	vectorization software	Set	1	

13.2 Deliverables of Document

The delivery document package mainly includes the System Design, the Operation and Maintenance Manuals, the equipment shipment list in PDF format.

Table 13- 1 Delivery document list

No.	Phase	Document name	Language
1.	System design phase	Detailed Design Scheme of Remote Sensing Application and Service System	English
2.		Detailed Design Scheme of Unmanned Aerial Vehicle Forest Monitoring System	English
3.	System development and acceptance phase	System Operation Manual of Remote Sensing Application and Service System	English
4.		System Installation and Maintenance Manual of Remote Sensing Application and Service System	English
5.		System Operation Manual of Unmanned Aerial Vehicle Forest Monitoring System	English
6.		Installation and Maintenance Manual of Unmanned Aerial Vehicle Forest Monitoring System	English
7.	Package transportation	Shipment List of MeSIC	English