The Requirements of ARGO Operation System

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Abstract

Korea Astronomy and Space Science Institute (KASI) has developed one mobile and one fixed SLR system since last year named as ARGO-M and ARGO-F, respectively. KASI is in the step of making the system requirements. The requirements describe the definition and scope of the various software and hardware subsystem, which are necessary for developing the ARGO operation system. It also defines function, performance and interface requirements. The operation system consisting of ARGO-M site, ARGO-F site and Remote Operation Center (ROC) inside KASI is designed for un-manned remote access and the automatic tracking and control system which are the main operation concept of ARGO system. To accomplish the un-manned remote operation, we are considering the remote access to ARGO-F and ARGO-M from ROC. The mobile-phone service allows us to access the ARGO-F remotely and to control the system in an emergency. To implement the fully automatic tracking and control function in ARGO-F, we has investigated and described the requirements about the automatic aircraft detection system and the various meteorological sensors.

Introduction

KASI had a meeting for ARGO System Requirements Review (SRR) on fifth Sep., 2008. After having a SRR meeting, ARGO Operation System working group submitted the SRR documents which describe the sub-system definition, functional & performance requirements and interface requirements to Project Management part. As for H/W, we derived the general requirements and some specifications. This paper addresses the requirements of ARGO Operation System.

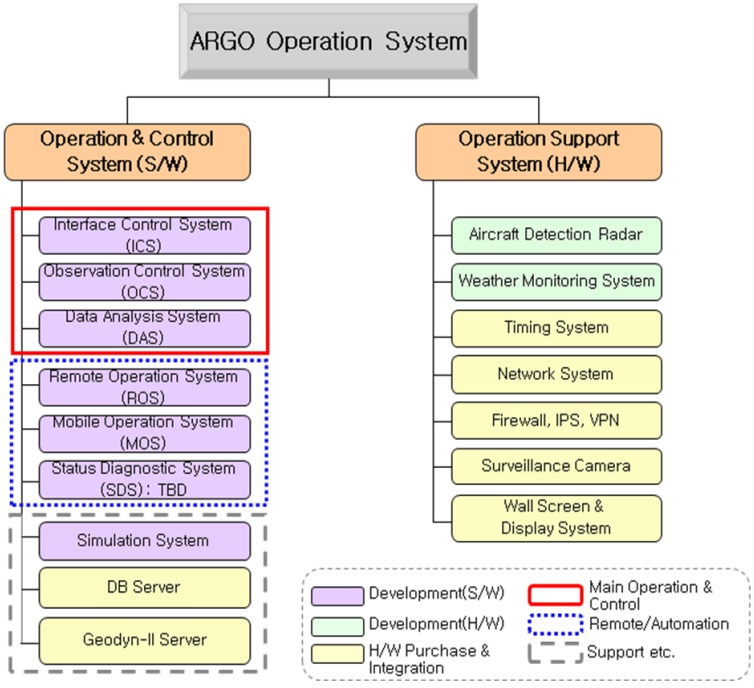

Figure 1. The configuration of ARGO Operation System

ARGO Operation System is classified into two categories, as this is illustrated in Figure 1: i) Operation & Control System (S/W part), ii) Operation Support System (H/W part).

ICS, OCS and DAS in the solid box, are main systems for satellite tracking and the acquired data processing in fixed-ARGO or mobile-ARGO sites. And another three systems in the dotted box are necessary for automatic and remote control function from Remote Operation Center (ROC). We are going to set up ROC inside KASI headquater. ARGO-F and ARGO-M will be controlled remotely from this center. Operation Support System is composed of several H/W systems necessary for an automatic SLR system. Radar system and a part of weather monitoring sensors will be manufactured by order.

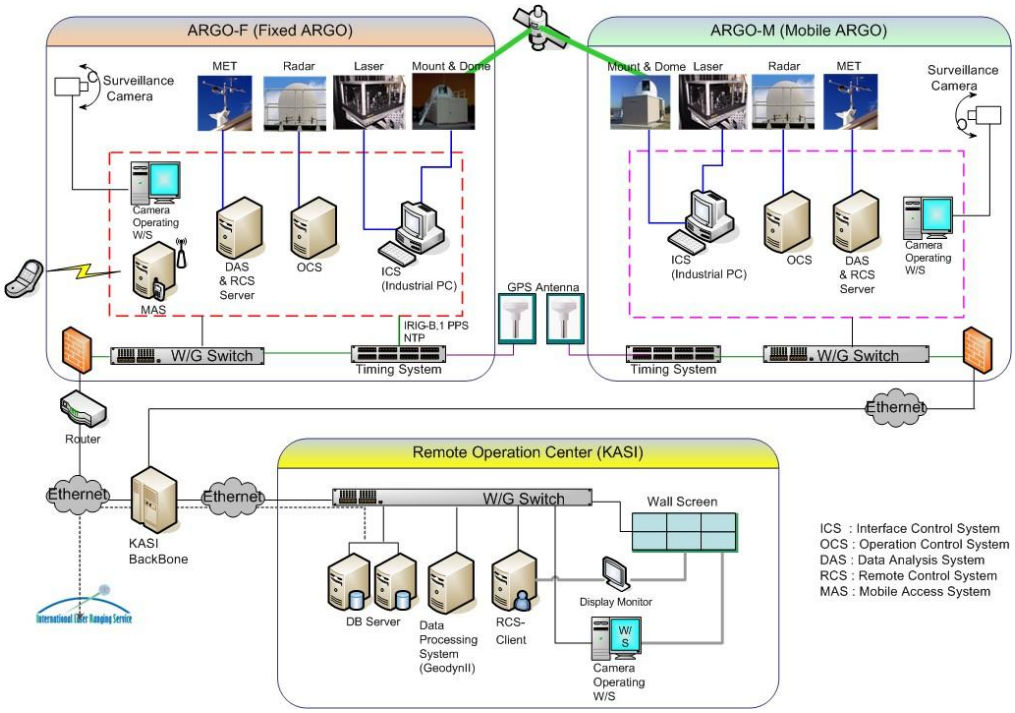

Figure 2. The Block diagram of ARGO Operation System

The block diagram in Figure 2 shows what system shall be installed to ARGO-F, ARGO-M and ROC. ARGO-M will have a same configuration as ARGO-F except for mobile server which is expected to be applied to ARGO-F firstly. This means that ARGO-F can be controlled from ROC by using the mobile phone. Wall-Screen will be installed in ROC for displaying the progress status of observation and image transferred from ARGO-F or ARGO-M. And ROC will also have "Remote Operation System" for connection to ARGO-F or ARGO-M.

Requirements – Operation & Control System(S/W)

(1) Interface Control System (ICS)

ICS has several interface cards of ISA or PCI type for delivering the commands or calculated values to several systems (Laser, Tracking Mount, FPGA card and Star Camera). All delivering data on ICS shall be passed to and from OCS. The software runs under RTOS. The main functions are Mount

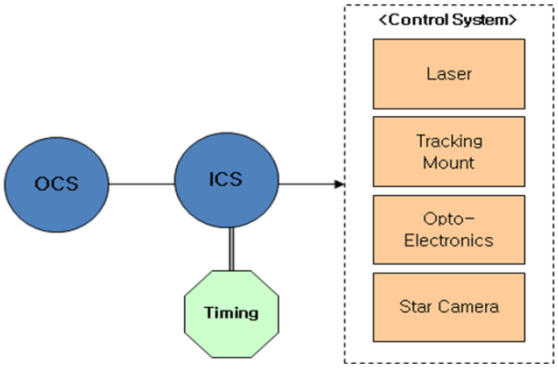

Figure 3. Interface diagram of ICS

control, Star Camera control, Laser control, Timing synchronization, and collection of system status check value from related systems.

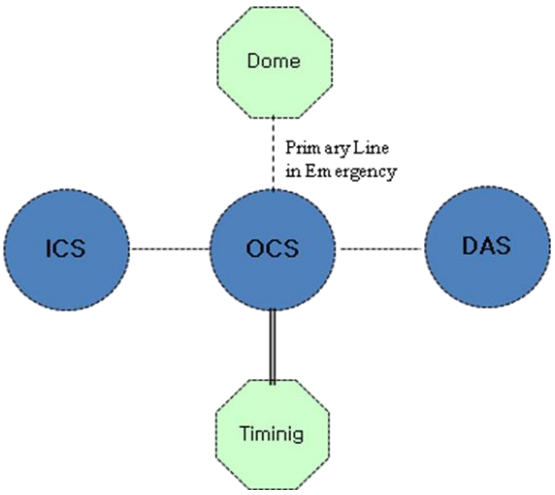

Figure 4. Interface diagram of OCS

(2) Operation Control System (OCS)

OCS is the main system which reflects operator's decision and makes the real-time prediction and scheduling. OCS shall perform star & ground calibration, and command Dome to be closed in emergency. The software runs under non-RTOS. But, because OCS is supplied the time code signal from timing system, it shall be synchronized to other system (ICS) and maintain the exact time. For ARGO system, OCS will be free of processing burden because Opto-Electronics part will perform the measurement of the laser round trip time and many computation logics required the tracking in real-time.

(3) Data Analysis System (DAS)

DAS shall generate "Full-rate" data and the final data product ("Normal Points") after observing one pass of satellite, and send Normal Points data to ILRS periodically. DAS shall collect the meteorological data from Weather Monitoring System and system status data from several systems. DAS shall undertake a role of "Server" for remote access from ROC or anywhere available for internet.

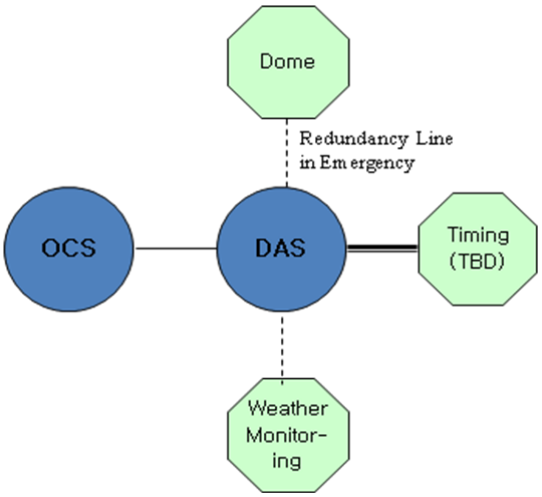

Figure 5. Interface diagram of DAS

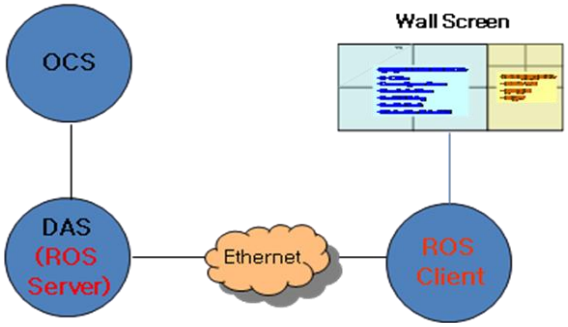

Figure 6. Interface diagram of ROS

(4) Remote Operation System (ROS)

ROS shall be able to monitor or control the observation process in real-time. ROS has a Server-Client structure. The received observation data through ROS client shall be displayed on Wall Screen in ROC located in KASI headquarter.

(5) Mobile Access System (MAS)

MAS shall be able to control "ARGO-F" remotely by using mobile-phone. MAS shall consist of "Server" in ARGO-F and "mobile-phone" for user, which needs cooperation with Telecommunication Service Company in order to use the mobile network.

Figure 7. Interface diagram of MAS

Requirements – Operation Support System (H/W)

(1) Aircraft Detection Radar

Because we use the Nd: VAN Laser, not eye-safe, it is necessary to establish the RF radar and other device for detecting the aircraft to prevent an accident. (Beam does harm to the pilot's eyes.) Radar shall be able to detect the military & civilian aircraft (including helicopter) and a hang-glider for prevent an accident. The available data shall be position (including height) and speed of aircraft. And the period of transmitting output shall be controlled manually by an operator. Let us suppose that the maximum altitude which the aircraft can cruse is 15km. Thus radar shall be able to cover airspace above 20 deg elevation and the maximum length of target detection shall be about 40km (Figure 8).

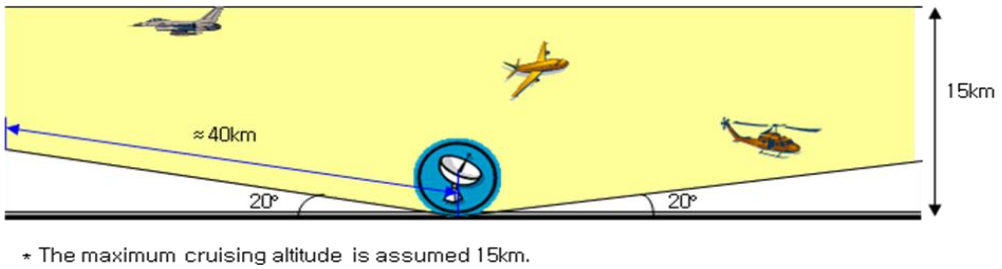

Figure 8. Coverage range requirements of Aircraft Detection Radar

Radar shall be able to receive the pointing data from OCS and synchronize two directions, the laser beam and radar pointing. And radar shall be able to recognize the Start/Stop signal from OCS. But radar shall not be pointed below the horizontal level.

Before radar is installed, it shall be needed for RF analysis to prevent damage about Opto-Electronics detector and other electronic equipments. Radar shall be installed at place which is not harmful to telescope and mount system.

(2) Weather Monitoring System (WMS)

For autonomous system, we are going to install the several kinds of sensors for acquiring the meteorological data. Pressure, Temperature and Humidity data is used to correct range measurements of refraction. Precipitation, Fog and Wind data is needed for system health

and safety (ex. Dome Closing). Visibility and All sky cloud sensors are also needed for a fully autonomous system.

The output from each sensor shall be processed and displayed to an operator all at once by using the Total Integrated Solution. The operator shall control the sampling rate of data collected from several meteorological sensors.

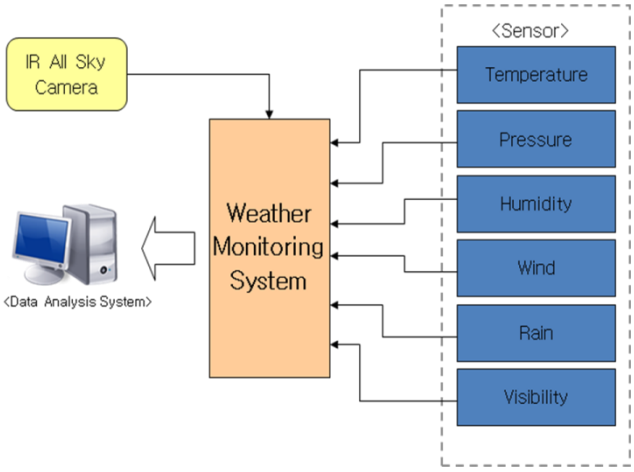

Figure 9. Weather Monitoring System

(3) Network & Fire-wall

If ARGO-M can connect to a network of the closest facility equipped with internet conditions, ARGO-M shall be allocated minimum 3 static IP from facility nearby. ARGO-F shall be built up the new network with the considering the minimum construction cost for connecting the dedicated line when ARGO-F site is selected. ROC shall be located in KASI and have to follow the disciplines of KASI networking and communication security.

(4) Timing System

Timing system is needed for synchronizing the system time to reference time from GPS. And timing system is composed of several equipments, GPS antenna & receiver, Oscillator, NTP Server & Client and interface card for receiving the distributed time signal in computer system (Table 1).

Table 1. General requirements for Timing System

GPS Antenna & Receiver	- GPS Antenna with over-voltage protector. - GPS Antenna Operating Temp. : –50°C ~ +80°C - Better than RG-59/U connecting cable - 12 channel GPS receiver - Acquisition time: Cold Start < 20 min. - 1PSS Output Accuracy : UTC(USNO): ±30ns RMS 100ns peak - Freq. Output Accuracy : 1 x 10^{-12}@ 1 day
Oscillator	- Maintain the accuracy over 5 days without GPS signal
Output & Distribution	- UTC(IRIG-B) - 1PPS - Selectable Frequencies (1, 5, 10MHz)
NTP	- Client time Accuracy ≤ 10ms
Interface Card	- Support to RTOS system

(5) Surveillance Camera

Table 2. General requirements for Surveillance Camera

Functional Requirements	- Available in night time - Automatic Zooming & Focusing Control - Pan : ±170°, Max Speed 100°/sec - Tilt : -30°~ 90°, Max Speed 90°/sec - Remote control from ROC(KASI)
Installation & Housing Requirements	- Operating Temperature: -20℃~50℃ - Including Fan & Heater & Waterproof - Exposed wire shall be covered with Shielding Tube.
Operating W/S & S/W Requirements	- The imaging data shall be transmitted by wire/wireless network (Wireless is optional) - Monitor & store the minimum 4 cameras simultaneously. - Image storage capacity: within 1TB in a week (4 Cameras). - Image replay using MPEG-4 media player. - Image capture according to preset time interval - Auto-Scheduling function which is changeable by surveillance object, purpose and method

(6) Wall Screen & Display System

Wall Screen & Display System will display the status of the observation which is processing in ARGO-F or ARGO-M in real-time. And the image transferred from surveillance camera is also displayed on Wall Screen.

Table 3. General requirements for Wall Screen & Display System

Wall Screen	- Resolution per cell : more than 1,400 × 1,050 - Luminance Accuracy : more than 95% - Screen Gap : within 1 mm
Wall Controller	- Maximize, Minimize and PIP control - Hybrid duplex composition with RGB Matrix Swircher - Quadrant Viewer
RGB Matrix Switcher	- Video input/output signal is controlled by LAN or RS-232
PC Interface	- Branch off the video signal to RGB Matrix Switcher without a loss.
Integrated Control System	- Supplys Touch Panel for operator's console - Changes the display layout easily

Future Work

According to development schedule of ARGO program, "System Design Review (SDR)" meeting for ARGO-M will be held on end of April 2009. For this SDR, in S/W part, we are going to review the system configuration and main algorithm needed for automatic tracking more specifically. For analysis of the established requirements, we will draw "Usecase

Diagram" and then feed back to the requirements again. In H/W part, we are going to review and determine the specification for selecting the proper equipments. For the interface requirements, we are going to survey and discuss the interface between the related subsystems.

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