# SOE Display System and Event Timer System

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**The tracking and control of spacecrafts has been conducted by members from different organizations working together. During the critical phase (e.g. Launch and Early Orbit Phase), the operation organization consists of the Mission Management team, Launch Site team, Spacecraft Operations team, Ground Station Operations team and other support teams. The number of members during LEOP is larger than during the nominal operation phase. Therefore, it is very important that all members can share and utilize the necessary information for space operations in real time. For SELENE (SELenological and Engineering Explore, JAXA, L/O: 2007) and IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun, JAXA, L/O: 2010) operations, SOE Display System and Event Timer System were developed. These systems were used as operations support tools. All teams and operation members were able to utilize and share same information by using these tools. As a result, all the operations were conducted by established procedure with certain timing. And also, the necessary information was provided appropriate timing to JAXA's management team and general public. The systems also reduced the time lag for sharing of information among the teams. The SOE Display System has functions that show the visibility from the ground station, spacecraft status, operation procedure steps, ground operation system configuration and other information. The Event Timer System has functions that show the current time (UTC and JST (Japan Standard Time)), event item, event time, time between the event and the current time, and triggering the alarm sound. To synchronize the event item, the SOE Display System has functions to export the event time. The Event Timer System has functions to import the event item. This paper presents functions and provides examples of the system's utilization in real operation, and modifications planned for the SOE Display System and Event Timer System..**

## I. Introduction

SPACECRAFT operation has been conducted by team consisted by some members and some teams. Therefore, it is very important that all members can share and utilize the necessary information for space operations in real time. . For SELENE (SELenological and Engineering Explore, JAXA, L/O: 2007) and IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun, JAXA, L/O: 2010) operations, SOE Display System and Event Timer System were developed. These systems were used as operations support tools.

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## II. SOE Display System

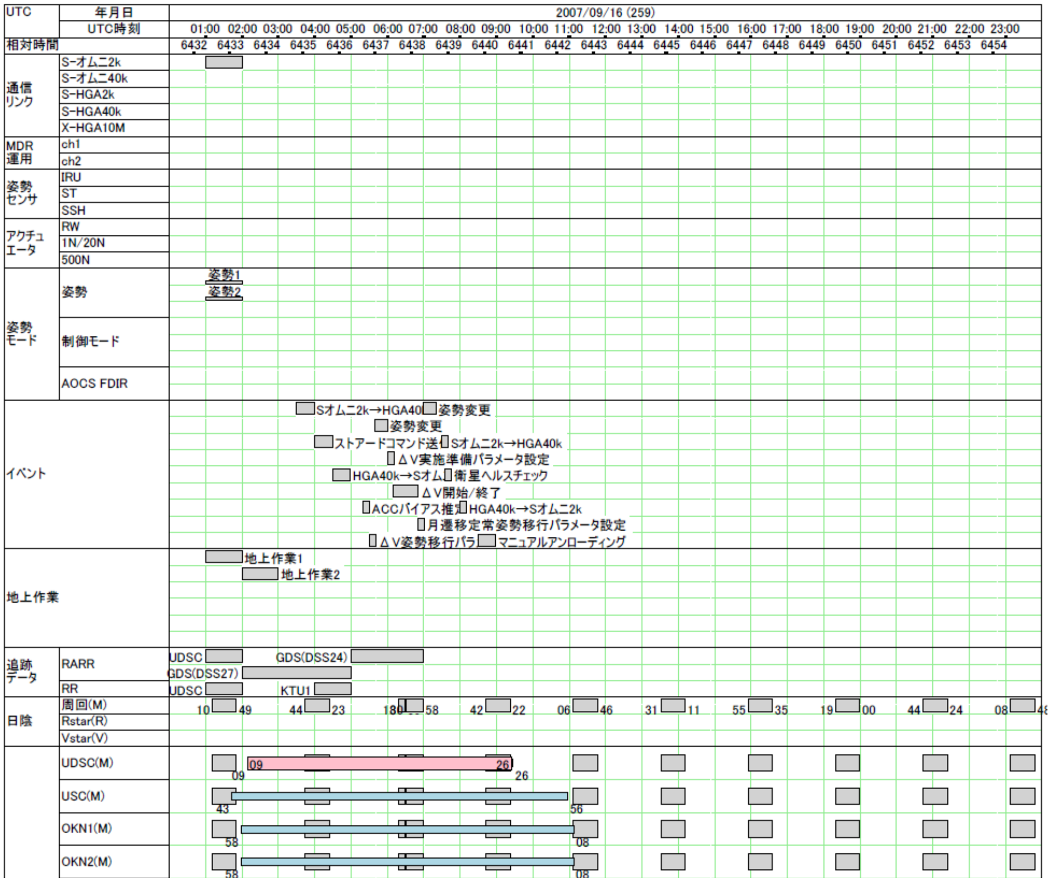
### A. Purpose

The purpose of SOE Display system is to share information of spacecraft operation for each members and teams, by showing information.

### B. Main Function

SOE display system's main functions are as follows and the main screen is shown in Figure1.

- -Display the visibility time from ground station to the spacecraft
- -Spacecraft operation event sequence
- -Spacecraft status plan
- -Display the contents in real time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年月日
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UTC時刻
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相対時間
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通信リンク
S-オムニ2k
S-オムニ40k
S-HGA2k
S-HGA40k
X-HGA10M
MDR運用
ch1
ch2
姿勢センサ
IRU
ST
SSH
アクチュエータ
RW
1N/20N
500N
姿勢モード
姿勢
姿勢1
姿勢2
制御モード
AOCS FDIR
イベント
Sオムニ2k→HGA40
姿勢変更
姿勢変更
ストアードコマンド送
Sオムニ2k→HGA40k
ΔV実施準備パラメータ設定
HGA40k→Sオム
衛星ヘルスチェック
ΔV開始/終了
ACCバイアス推
HGA40k→Sオムニ2k
月遷移定常姿勢移行パラメータ設定
ΔV姿勢移行パラ
マニュアルアンローディング
地上作業
地上作業1
地上作業2
追跡データ
RARR
UDSC
GDS(DSS24)
GDS(DSS27)
RR
UDSC
KTU1
日陰
周回(M)
Rstar(R)
Vstar(V)
10 49 44 23 180 58 42 22 06 46 31 11 55 35 19 00 44 24 08
UDSC(M)
09 26
USC(M)
43 56
OKN1(M)
58 08
OKN2(M)
58 08

Figure 1. SOE Display system main screen

### C. Details of main functions

1) Display the visibility time from ground station to the spacecraft

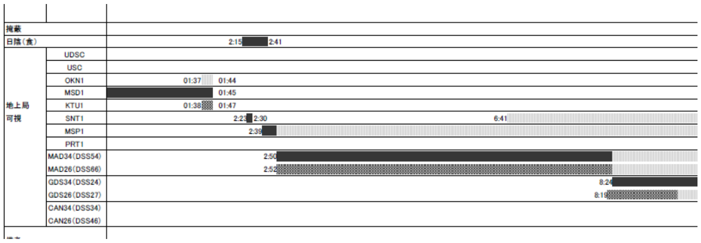

**Figure 2. Visibility time from ground station to the spacecraft**

To share and understand operation time, this system shows the visibility time by horizontal bar.

The visibility time from flight dynamics system is imported by this system via LAN or USB flash memory devise. Many ground station is necessary only in critical phases and events. Other operation phase, not so many ground stations are enough. Therefore, the ground station displayed for screen effective use can be chosen.

Especially, SELENE was lunar circular spacecraft. This system displayed visibility time with occultation time (behind of the moon). This information was so useful for real time operation to down load mission data from the data recorder of the spacecraft.

2) Spacecraft operation event sequence

To share and understand Spacecraft operation event sequence, this system shows the visibility time by level style graph with text. The text can be used to show event number, event name and so on. The event sequence can be inputted by manually using the text file and also imported from the event timer's exported text file.

The text only time and event number, this system can sort this information. In case that there are many events, this system displays offset events to avoid overlapping them.

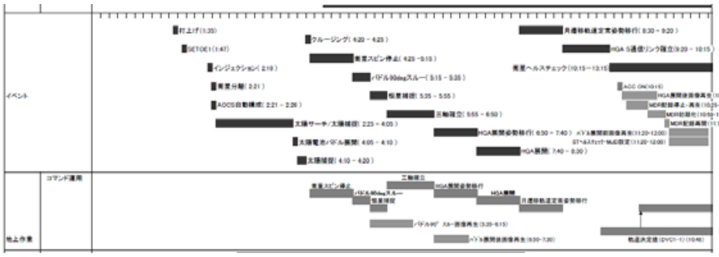

**Figure 3. Spacecraft operation event sequence**

3) Spacecraft status plan

To share and understand plan of spacecraft status, this system shows the planed status by level style graph in the each sub system of the spacecraft. (ex. Down link bit rate (Hi or Low rate), and so on) This information should be inputted by manually using this system user interface.

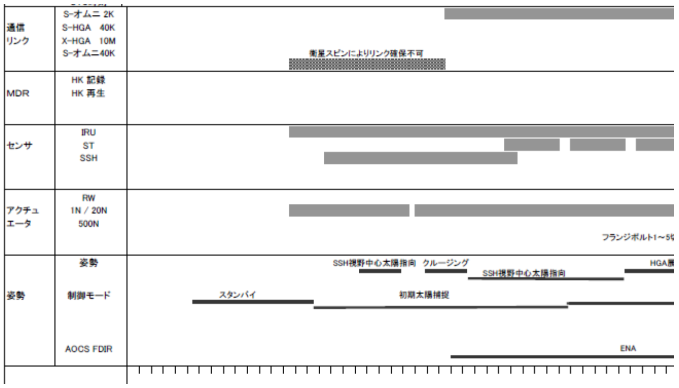

**Figure 4. Spacecraft status plan**

4) Display the contents in real time

For real time spacecraft operation, it is important to understand operation these information in real time. This system shows current time by red line and screen will move by time span. The display time span also is collective. 24H, 12H and 4H. And this system shows also can show information by non-real time

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### D. Other functions

1) The graph shows by several colors.
2) Export the screen by PDF to provided to other team
3) Time unit can be showed by UTC and elapsed time from lift off time.
4) Import and export the event time from Event Timer System
5) Export screen by English version

## III. Event Timer System

### A. Purpose

The purpose of Event Timer System is to share and alert operation event time to spacecraft operation team.

### B. Main Function

Event Timer System 's main functions are display information as follows and alert and buzzer.
- Current time (UTC and JST)
- Event time and event name elapsed time to the event

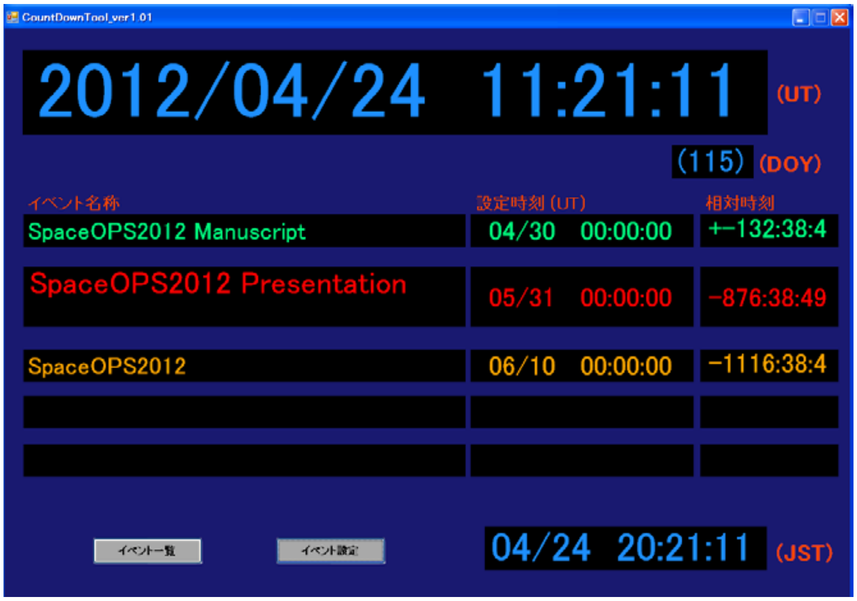
The main screen is shown in Figure 5.

### C. Details of main functions

1) Display Current time (UTC and JST)

Because Space craft operation is conducted according to UTC, this system shows UTC and JST.

In SELENE operation, the system configured show the United Western Time since NASA/DSN support was necessary.



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| SpaceOPS2012 Presentation | 05/31 00:00:00 | −876:38:49 |
| SpaceOPS2012 | 06/10 00:00:00 | −1116:38:4 |
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**Figure 5. Event timer system main screen**

2) Display Event time, event name and elapsed time to the event

To share Spacecraft operation event and procedure in operation team, this system shows event items and event times. These information is described in the content file includes some events and also each event can be added after importing the content file.

3) Alert and buzzer

To notice the event time is spacecraft operation team for conduct procedure on time, this system alert using buzzer sound.

The alert timing can be set 5minutes before the event and also it is enable to change the alert timing.

## IV. Conclusion

SOE Display system and Event timer system as operation support system are useful in SELENE and IKAROS could share and conduct spacecraft operation to share and utilize the necessary information for space operations in real time.

We are continuing to progress these systems after SELENE and IKAROS. The progress points are as follows.

-More attractive relation between both systems
-More attractive relation with spacecraft operation system
-Share the information via internet
-But secure information is the most important concerning

## Appendix A
## Acronym List

| | |
|---|---|
| **SOE** | Sequence Of Event |
| **L/O** | Lift Off |
| **IKAROS** | Interplanetary Kite-craft Accelerated by Radiation Of the Sun |
| **JAXA** | Japan Aerospace Exploration Agency |
| **SELENE** | SELenological and ENgineering Explore |