

# the Development of the MAXI Monitoring System

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## ABSTRACT

Our company, SEC, is software company that is specialized for real-time system and involved in space exploration also. We provide control systems of rocket launch, on-board systems and ground-based systems of satellites, taking advantage of our skills in developing real-time systems. We have developed many satellite systems so far, starting from N-I rocket. In this paper, we present the development of the MAXI monitoring system.

We have to monitor and control MAXI through the telemetry data while observing for the stable MAXI operation. Therefore, the MAXI telemetry data include not only observation data for scientific purpose, but also the ancillary data as system status. Basically, the monitoring system is required to receive and to display telemetry data continuously in real-time without loss. We have developed the real-time monitoring system to satisfy these requirements. And also, our monitoring system has good look-and-feel and flexibility of the display design, display format and monitored telemetry data.

We will report the characteristic of the present monitoring system and the future plan.

**KEY WORDS:** System QL, Monitoring

## 1. Introduction

We offer various software in mainly five business fields (mobile network, wireless, internet, infrastructure system and advanced space technology system) based on real-time technology skill with a slogan of "For the social safety and evolution". For examples, we provide the transportation system such as spot control system of an airport, intelligent transport system (ITS) and those systems running for the social safety and evolution by making use of our own specialized field. In advanced space technology business field, we offer a wide-ranging system such as MAXI system QL, the astronomical application and embedded software for satellite-mounted detector. We have approximately thirty years of experience in this business field where high-quality products are required.

## 2. MAXI

MAXI that will be mounted on the JEM exposure part, communicates with a ground-based system by receiving commands and sending the Telemetry Data through the JEM as shown in a Fig1. The MAXI Flight system consists mainly of the Mission Data Processor (MDP), the Support Systems and the Data Processor (DP). The DP receives commands from a ground-based system and controls the MDP and the Support System.

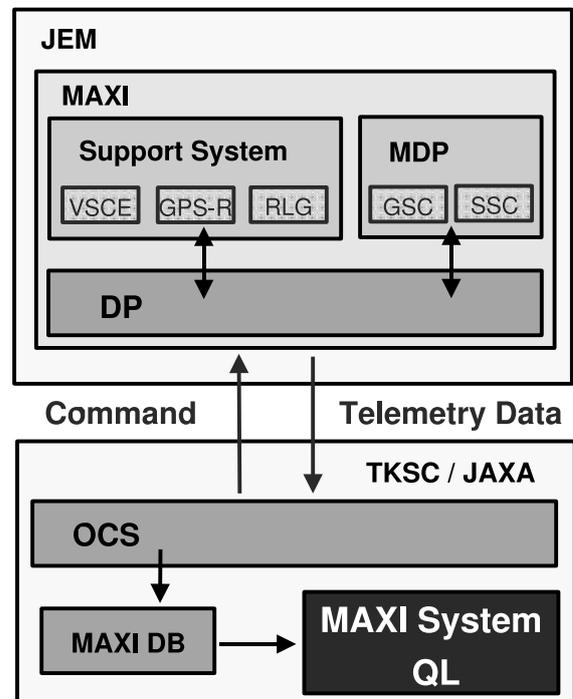


Fig. 1. The MAXI data flow

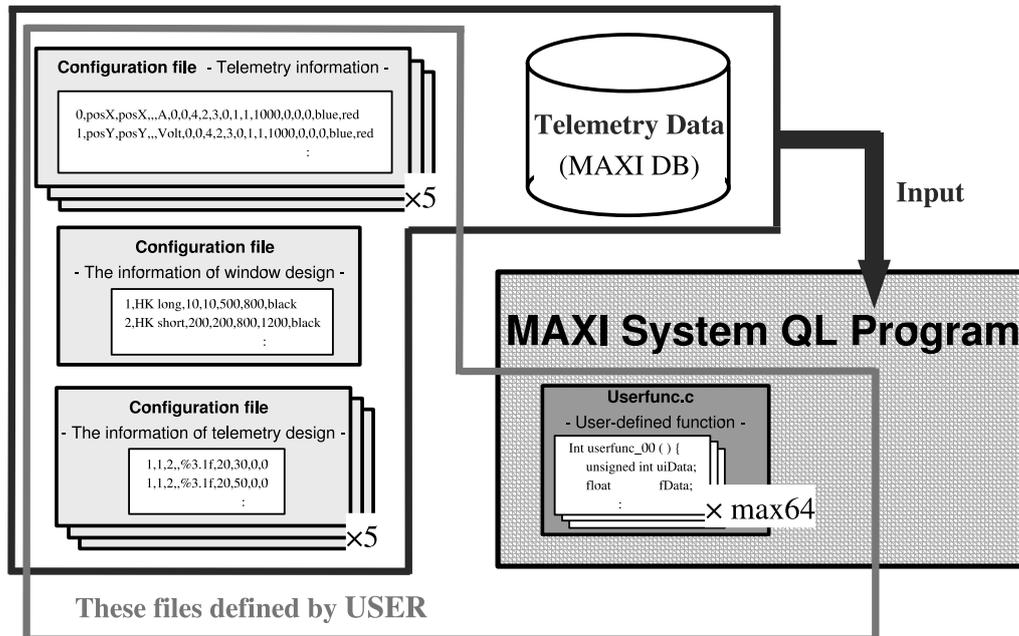


Fig. 2. The MAXI System QL configuration

At the same time, the DP controls many kinds of data taken from the MDP and the Support Systems, and sends them back to ground-based system as the telemetry. These data are stored in MAXI DB (Data Base) through the OCS (Operational Control System) and sent to the MAXI System QL (Quick Look) for monitoring the status of the MAXI flight system. The QL displays the status information in real time after receiving the telemetry data.

Our company supports to develop the MAXI DP, OCS, MAXI DB and MAXI system QL. Here, we especially focus the feature and the future plan of the system QL.

### 3. The MAXI system QL

#### 3.1. The requirement

The telemetry data from the MAXI flight system include the H&S (Health and Status) data and HK (House Keeping) data of astronomical observational equipment, the unique data for the attitude control, the data of GPS time, the scientific data taken from the MDP and the data taken from the ISS (International Space Station).

For the steady observation, it is required to constantly monitor these data in real-time and to display the system status. If some of the equipments go into alert state,

operators should be able to find the abnormal state and know more detailed information easily.

The persons who are responsible for the development of each equipment also monitor these information in real-time if needed. Therefore, it is required for the system QL to be flexible to change and customize the display design easily for each user.

#### 3.2. The structure

As shown in a Fig2, the MAXI system QL program reads three kind of configuration files written in csv format by a user and displays the telemetry data on the screen by using these information. The designs of the display are completely defined by these configuration files. It is possible to handle following requirements easily simply by modifying these files.

- Customizing the displayed item of telemetry data for each user's requests
- Customizing the display design for each user's requests.
- Changing the number of display windows

The MAXI system QL is possible to display not only the raw telemetry data itself without any conversion but

The defined information	The detail
<b>Configuration file</b>	
<b>Telemetry information</b>	A text file of csv format, which defined the following information <ul style="list-style-type: none"> <li>· For identifying the telemetry data</li> <li>· For extracting the displayed data from telemetry data set such as byte offset</li> <li>· For converting telemetry data from the raw value to the engineering value</li> <li>· For checking the status of the equipment</li> <li>· For displaying the telemetry data</li> </ul>
<b>The window design</b>	A text file of csv format, which defined the window information of the MAXI system QL such as the position and size in the display.
<b>The telemetry design</b>	A text file of csv format, which defined the design of telemetry data displayed in one window. These file have the type, the ID, the display position, the width and the height of the displayed telemetry data.
<b>Program file</b>	
<b>The user-defined function</b>	The source programs with C-language, which define the function for converting telemetry data to engineering values. The MAXI system QL has six functions by the default and it is possible to add functions defined by a user.

Table 1. The detail of user-defined file

also converted data in engineering values from raw data. The QL has the six functions by the default for the conversing purpose. As shown in a Fig2, it is also possible to handle special conversion easily simply by programming a function and including it to the MAXI system QL program.

### 3.3. The user defined file

As previously mentioned in a section3.2., it is possible to modify four kind of file (three kind of configuration file and one kind of program file) in total. The configuration file is a text file of csv format, which define the telemetry information, the window design and the telemetry design, respectively. And the program file includes the user-defined function. The details of these files are put together in a Table1.

### 3.4. The QL display

The QL display samples of the raw telemetry data and the engineering value are shown in a Fig3 and a Fig4, respectively. The raw telemetry data itself are displayed mostly in hexadecimal form without any conversion. And the Engineering Value that is converted from raw data is displayed in the certain format. The display formats of both data type are also defined in configuration file, for example "%3d" and "%s".

The MAXI system QL has a status check feature for the specified telemetry data. These data are classified into three level of state (normal level, warning level and error level). The classified data are shown in the display

with different colors, which are also defined in configuration file. The ongoing QL display designed are like shown in the Fig3 and the Fig4. Their background color is black and the font color of fixed text is white. The font color of the variable telemetry data that belongs in the normal level, the warning level and the error level is green, yellow and red, respectively. These telemetry data are updated every 0.5 seconds with the default setting. It is possible to fine-tune the update interval of the QL display depending on the receiving cycle of shown data.

The MAXI system QL has capabilities of printing and saving the display image. If user would like to use these functions, it is possible to do by just modifying the configuration file. The "Save" and "Print" buttons are show up in the QL display by adding one line written with the certain format. If user clicks these buttons, the display image is automatically saved with certain file name under certain directory, which are defined in the configuration file, or printed on the default printer.

## 4. The future plan

### 4.1. A tool for designing a display by GUI

The position information wrote in the configuration files are currently defined manually with a fine-tuning by user. It takes non-negligible time for making the configuration file and a user can make a mistake. Therefore, we are planning to develop a tool which can reflect a display design by using GUI into the definition file.

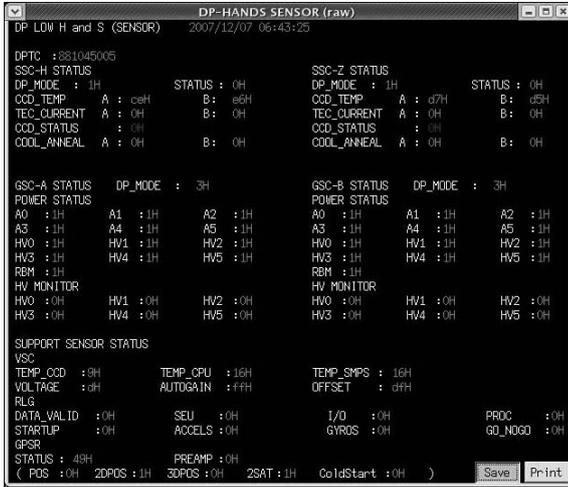


Fig. 3. The sample of QL display (Raw Value)

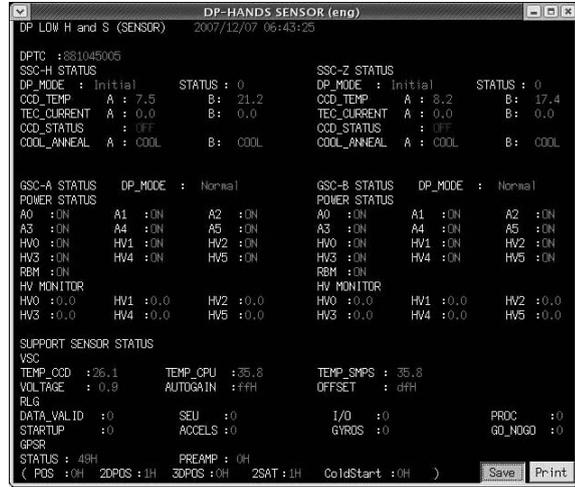


Fig. 4. The sample of QL display (Engineering Value)

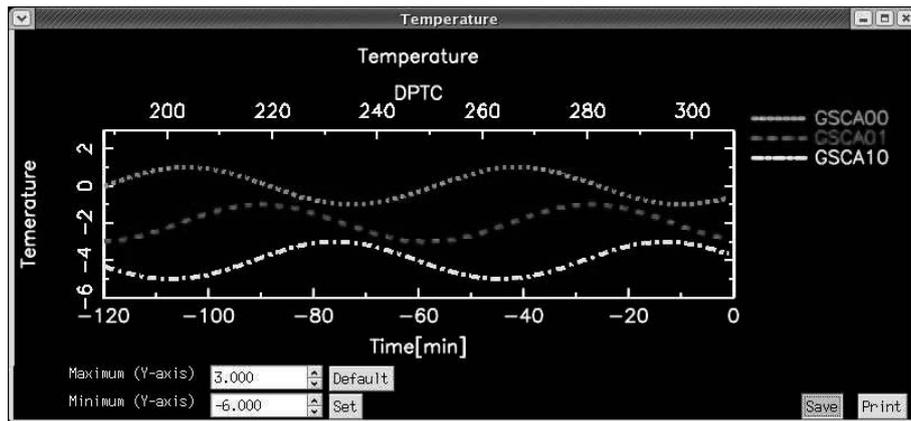


Fig. 5. The sample of graphs display

#### 4.2. A tool for visualizing the telemetry data

The telemetry data are displayed on a screen as shown in the Fig3 and the Fig4 in real-time in the current system. We are planning to develop a tool, which can show the time variation and the distribution for each telemetry data simply by modifying the configuration file such as QL display. The sample of the graphs display is shown in a Fig5.

The each graph of telemetry data are distinguished by the combinations of the line type and the line color. This tool has the function for changing the scale of Y-axis. Two numerical input fields and two buttons are shown in the graph display. If user clicks the "set" button after inputting maximum and minimum value into the fields, these value are reflected in the scale of Y-axis. If user clicks the "Default" button, the scale of Y-axis come to default condition.