

Development of JEM Payloads Data Communication System

- The PLT, a part of NASDA Payloads Data Communication System -

Takeru Yamagami

National Space Development Agency of Japan (NASDA)

2-1-1 Sengen, Tsukuba, Ibaraki, 305-8505, Japan

(e-mail: yamagami.takeru@nasda.go.jp)

Keywords:

NASDA Payloads, Data Communication System, Laptop Computer, PLT, Software, ISS, JEM, Crew interface

Abstract:

NASDA plans to operate their own payloads located in Japanese Experiment Module (JEM; we call it, KIBO), a part of International Space Station (ISS). Those payloads will be mainly operated from the ground control center at Tsukuba, and will be worked automatically by commands from it with the minimum crew operations on the ISS (ex. for maintenance, for exchanging experiment samples).

Also, NASDA has been developing JEM Payload Laptop Terminal (PLT), which is a part of NASDA Payloads data communication system. The PLT is a portable computer system (a laptop computer) for ISS crews to provide capabilities to control and monitor for NASDA payloads.

The PLT has the complementary role in NASDA payloads operations to the ground control center. NASDA will use the PLT in order to get the maximum science results of their experiment missions efficiently in limited onboard resources, when the ISS communication link is down between the Space and the Ground including troubles in the ground control center.

This paper presents overviews and features of the PLT, a part of NASDA payloads data communication system, as the complementary equipment in NASDA payloads operations. Section1 describes the role of the PLT in NASDA payloads operations and overviews of the PLT. Section2 describes features of the PLT. They can solve problems in NASDA payloads operations to get the maximum science results using limited onboard resources efficiently. This paper describes "Features to complement the Joint Operations" and "Features to improve usability for Crews" including autonomous functions of the PLT to support the crew operations. Section3 describes conclusions including future works of the PLT.

1. Introduction

1.1 The Role of PLT in NASDA P/L Operations

NASDA has plans to get science results of experiment missions operating their own payloads in the ISS program. Those payloads will be mainly operated from

the ground control center at Tsukuba, by NASDA. They have been developed based on the concept that they must be worked automatically by commands from the ground control center with the minimum crew operations on the ISS (ex. for maintenance, for exchanging experiment samples), because NASDA must get the maximum science results efficiently within their limited onboard resources.

But in the case of tele-operations between the Space and the Ground, we know experientially that we might have accidents or troubles not to be able to control and monitor for our payloads from the Ground because of the down of Space links. So, NASDA need onboard equipments in the total (from the Space to the Ground) data communication systems for NASDA payloads as a backup for the ground control center. That's why NASDA has been developing the PLT to have the complementary role in NASDA payloads operations to the ground control center. The PLT can provide ISS crews with capabilities to control and monitor for NASDA payloads. NASDA can get the maximum science results of experiment missions and keep performance with their own payloads using the PLT in their operations, when the Space link is down.

1.2 Overviews of PLT

The PLT is a portable computer system (a laptop computer in JEM) for ISS crews to provide capabilities to control and monitor for NASDA payloads. It will be used to complement NASDA payloads operations to the ground control center. (Fig.1.2-1: PLT Overview)

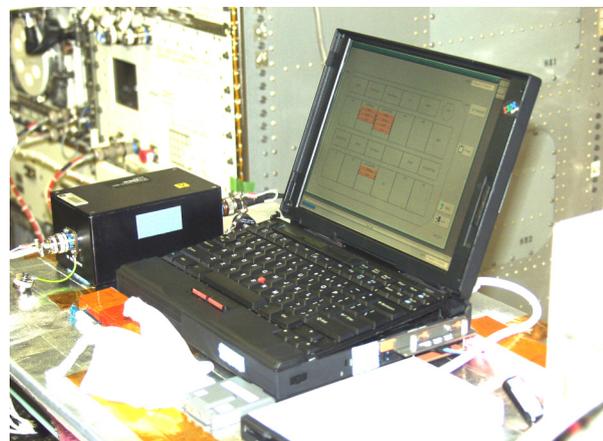


Fig. 1.2-1: PLT Overview

The PLT has an interface with the JEM Payload Local Bus as a one of NASDA payloads. It has data communication with NASDA payloads through the bus. (Fig.1.2-2: JEM Payload Bus Architecture)

The PLT hardware and Operation Software (OS) are common with ISS Portable Computer System (PCS). The PCS is an ISS standard laptop computer. NASDA has been developing the PLT Flight software using some commercial application software. The PLT Flight software consists of PLT_LBIS and PLT_ASW. The PLT_LBIS (PLT_Local Bus Interface Software) has functions to communicate with NASDA Payloads via JEM system. And the PLT_ASW (PLT_Application Software) has crew interface functions to send commands to NASDA payloads and display each telemetry data from each NASDA payload. (Fig.1.2-3: PLT Software Interface)

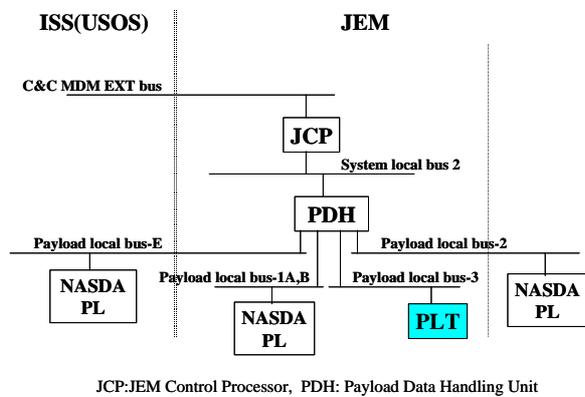


Fig. 1.2-2: JEM Payload Bus Architecture

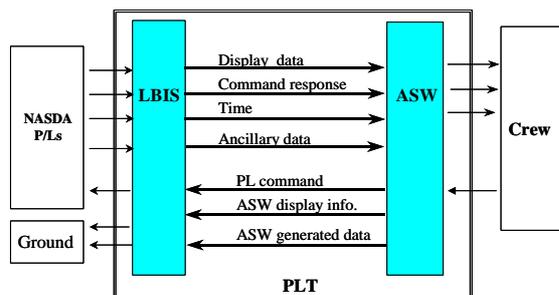


Fig. 1.2-3: PLT Software Interface

2. Features of PLT

This section describes features of PLT to complement NASDA payloads operations to the ground control center. They can solve problems in NASDA payloads operations to get the maximum science results using limited onboard resources efficiently. One is the feature to complement the joint operations smoothly between ISS crews and ground controllers. Another is the feature to improve usability for crews in a limited crew resource.

2.1 Features to complement the Joint Operations

As the onboard complementary equipment in NASDA payloads operations to the ground control center, the PLT has features to complement the joint operations smoothly between ISS crews and ground controllers. They can provide us with efficient payloads operations in limited onboard resources. These features are as follows;

- 1) Single interface for NASDA payloads operations
There will be many NASDA payloads in JEM. So, NASDA unifies functions to control and monitor for each payload on the PLT because of keeping a good usability for crews. This feature can provide crews with convenient operations for NASDA payloads using the only PLT.
- 2) To send PLT telemetry data to ground controllers
To complement the joint operations smoothly, the PLT has a function to send telemetry data to the ground including display information data for crew's operations on the PLT. This feature can provide ground controllers with supporting to understand the onboard crew's operations.
- 3) To download files of PLT command log
The PLT has a function to make command log files that are results for crews to send commands to NASDA payloads from the PLT. Ground controllers can get those log files from the PLT through the file transfer function. This feature can also prove them with supporting to understand the onboard crew's operations.
- 4) Flexibility for changing onboard configurations
NASDA has plans to add their payloads to JEM in the future. To keep the operational flexibility for changing onboard configurations, the PLT_ASW consists of unique data processing programs for each NASDA payload. They are independent CSCIs (Computer Software Configuration Items) for each other. Therefore, we can easily change software configurations of the PLT_ASW with adding a data processing program for a new payload, through the files transfer function from the ground control center. This feature can provide us with the operational flexibility for changing onboard configurations.

(Fig.2.1-1: PLT Software Structure)

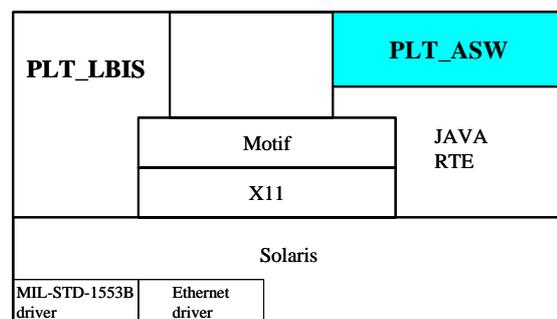


Fig. 2.1-1: PLT Software Structure

2.2 Features to improve usability for Crews

The PLT had better improve usability and easy man-machine interface for crews. It is very important that crews can operate the PLT easily in a minimum time, because crew resources are very precious on the ISS. These features to support crew operations can provide us with reliable science results keeping crews away from mistaking their operations. These features are as follows;

- 1) To apply ISS common interfaces for crews
 - a) To use the ISS Portable Computer System

The PLT hardware and OS software are common with the ISS standard PCS, because ISS crews get used to operate it. The PLT can keep easy to operate for ISS crews. This feature can provide crews with a good usability.
 - b) To apply an ISS standard requirement for design

The PLT displays are designed to apply an ISS standard requirement, SSP50313: The Display and Graphics Commonality Standard (DGCS), to keep a common look-and-feel for ISS crews.
- 2) To design displays which is easy to operate
 - a) Unique displays for each payload

The PLT has unique displays for each payload. The structure of them is multi-layered for each payload. Displays for payloads are divided the windows for every their own operation task. This feature can provide crews with easy to understand and to operate the PLT.(Fig.2.2-1: PLT Display Operations)
 - b) Easy to command operations

The PLT_ASW can provide command buttons with parameter objects for each payload. Commands can be sent to payloads by inputting parameters and clicking command buttons. Crews can easily send commands to each payload from the PLT.
 - c) To group command & data with tasks

Data fields and command buttons are organized and

layered with tasks on each display window. Crews can easily verify payload's response data related to receive commands from the PLT, after they send commands to the payload. This feature can also provide crews with easy to understand and to operate the PLT. (Fig. 2.2-2: PLT Display Layout)

- 3) Autonomous functions to support crew operations
 - a) To restrict command execution with conditions

To avoid crew's misoperations, the PLT has an autonomous function to restrict command execution with payload's conditions (that is the command inhibit function). When a payload is not satisfied with conditions to receive a command, the command button on the PLT display window will be grayed out autonomously due to a referred data value that is indicated conditions of the payload. Crews can only execute commands to payloads in the satisfied conditions. This feature can provide crews with supporting their correct operations.
 - b) To check data and display them on data fields

The PLT has an autonomous function to check data and display them on data fields. Data quality indicators will alert crews to "Out of limit", "Off-scale" and "Valid or Invalid" on data fields by using characters or colors, in accordance with results of processing in the PLT. This feature can support easy to understand payload's information for crews.
 - c) Alert Displays

The PLT has an autonomous function to show alert displays for crew's notice, in accordance with the result of its own processing. They are "Alert Bar", "Pop up dialog box" and "Status Bar". Alert Bar is shown alert messages for data quality. Pop up dialog box is shown error messages for data processing. Status Bar is shown status message of each payload. This feature can support onboard crew's operations.

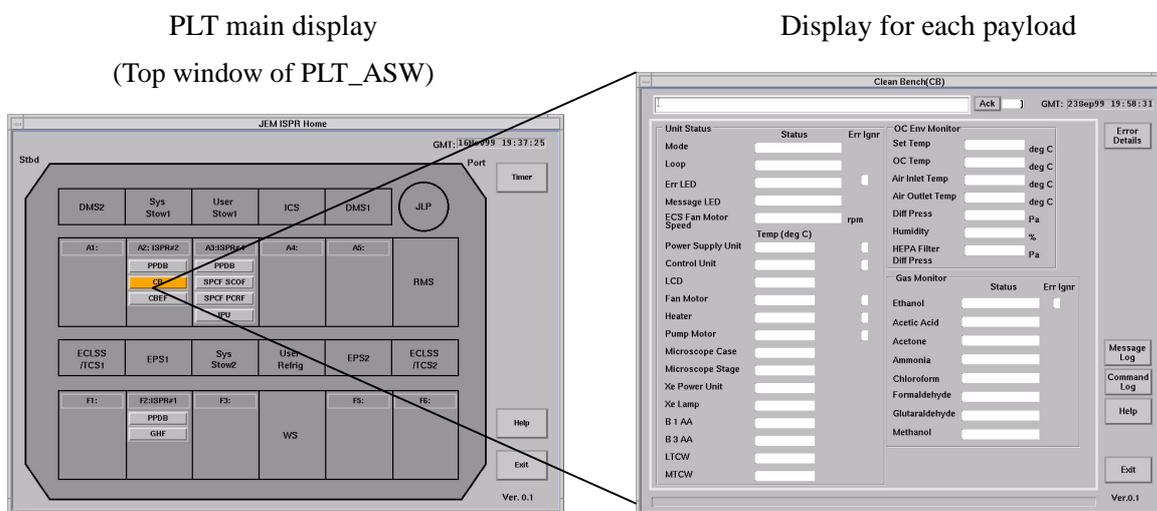


Fig.2.2-1: PLT Display Operations

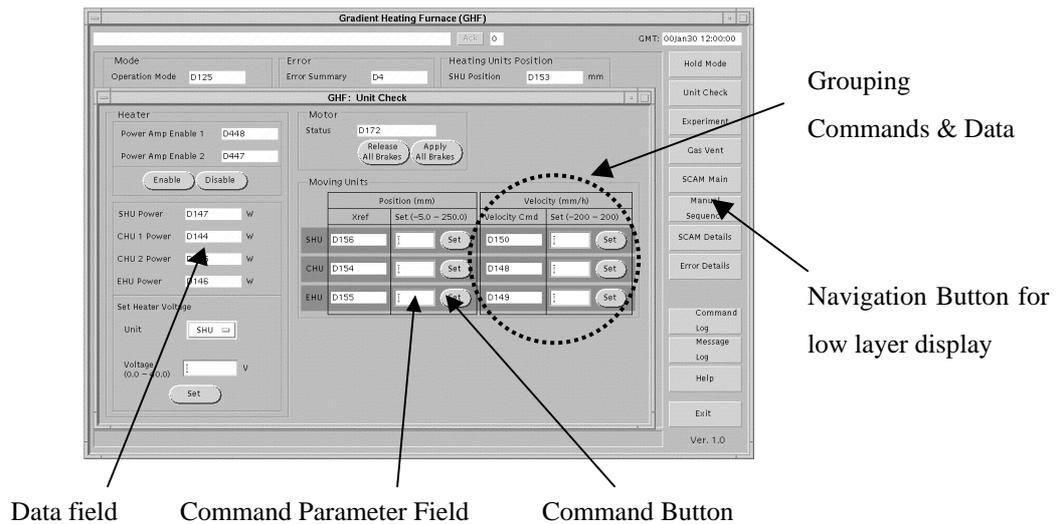


Fig. 2.2-2: PLT Display Layout

3. Conclusion (Future works)

3.1 Verification for features of PLT

We had already carried out verification tests in the development of the PLT. Features of the PLT, which are presented in this paper, have been verified in those tests. We got good results of those verification tests.

a) Verification of functions for crew interfaces

We had ISS Crew Review for PLT displays in Jan.17, 2001. ISS crew evaluated the design of PLT displays for crew operational interfaces (including features shown in section 2.2). We got good evaluations that the PLT has good usability for crews.

b) Verification of functions as a communication system

We had some verification tests for functions of PLT as a part of NASDA Payloads data communication system in 2002-2003. They are Interface Tests with NASDA payloads, and the JEM Joint Test of JEM Systems / NASDA Payloads / Ground control center. Functions including features shown in section 2.1 were verified in those tests. We had got good results.

3.2 Future works for PLT

a) New Additional functions to the PLT

As a reflection for results of verification tests, we consider a necessity of adding new functions to the PLT. Those functions can provide us to monitor and get log files of the communication data on JEM Payload Bus to complement trouble shootings for NASDA payloads to the ground control center.

b) More improved usability on PLT displays

We plan to study about more improved usability on PLT displays. We have some proposals to upgrade crew interfaces of the PLT_ASW, which design displays of PLT in accordance with crew operations procedures. Those are the display design of crew procedures oriented.

c) Apply to the new generation PCS

NASA has recently selected a new generation laptop

computer as the ISS standard PCS. The new PCS is changed hardware and OS. We plan to study about impacts to repair the PLT_LBIS. (PLT_ASW has no impacts to be repaired because of coding with Java language.)

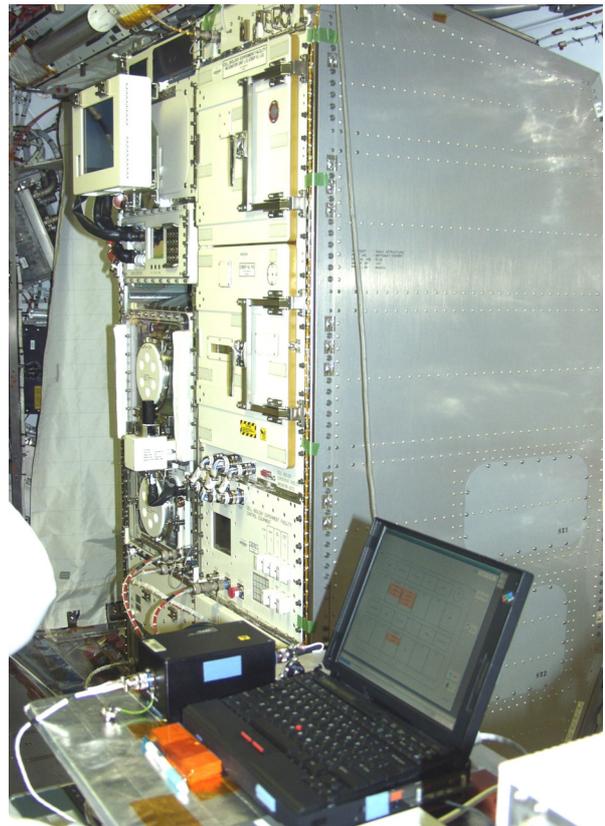


Fig.3: View of JEM Joint Test in Feb.2003
(PLT & NASDA Payloads in JEM)