VERIFICATION OF TECHNICAL ELEMENTS OF THE ADVANCED SPACECRAFT BASED UPON THE CCSDS RECOMMENDATION

*1Hideo Hara, *1Sigeo Yamada, *1Yoshikatsu Yamamoto
*2Seiichi Fujii, *2Kaoru Tumura, *2Masato Yokomizo, *2Hiroyuki Ogasawara

*1National Space Development Agency of Japan
Tracking & Data Acquisition Department
Dai-ichi Daimon Bldg. 2-10-1 Shiba-Daimon,
Minato-ku,Tokyo 105,Japan

*2Fujitsu Limited
Systems Section, Space Systems Dept.
Systems Engineering Group
1-17-25, Shinkamata, Ota-ku,Tokyo 144, Japan

ABSTRACT

We are going to meet the era when advanced spacecrafts such as the space stations are developed and operated.In the era, the current system of the satellite operations control will change largely. We consider that the future system is required to have the function as follows: the function for interchanging data between international agencies, processing the various kind of space data, and distributing data as a lot of unspecified users require.

However, We have now the following problems in order to satisfy these requirements: the problems for standardization of space data communication protocol, establishment of multimedia data management method, and standardization of user interface. This paper describes three technique to solve the above-mentioned problem. That is,
a. Standardization of the data communication protocol between space and ground by AOS(Advanced Orbiting System) protocol of CCSDS(Consultative Committee for Space Data Systems) Recommendation,
b. Management of multimedia data by catalog reference,
c. Standardization of user interface by SFDU(Standard Formatted Data Unit) of CCSDS Recommendation.

Key Words:CCSDS, AOS, SFDU, multimedia, spacecraft

1. INTRODUCTION

NASDA(Nation Space Development Agency of Japan) schedules the launch of space station JEM(Japan Experiment Module) in the summer of 1998. Now, we can say the subject for space development is changing from current spacecraft such as satellite to advanced spacecraft such as space station and platform type spacecraft. The advanced spacecraft is different from the current spacecraft by the following characteristic.
At First, advanced spacecraft program is the international program; it is necessary to cooperate internationally because the development size and cost of it becomes much larger. The next, a lot of payload is frequently exchanged on advanced spacecraft for implementing various experiments. The number of payload users is increasing according to the variety. The last, multimedia data occurs such as experiment data, video data monitoring the experiment, voice data, and text data including mission plan etc. besides telemetry data. As a result, it is thought that the future system for the advanced spacecraft operations control is changing.

We have done the following work in order to acquire technical elements necessary to develop the future system.
1. Analyzed the technical problems of the future system
2. Developed the prototype system introducing some technique
3. Evaluated the availablity of the technique
This paper intends to describe technical elements we have acquired through these works.

2. ANALYSIS

In this section, we are going to analyze technical problems of the future system from the viewpoint of the system development.

2.1 Requirement

To sum up the characteristic of advanced spacecraft (described in section 1.), the following requirement is thought to be more important in the future system:
- Interoperability
- Multimedia data management
- User interface

That is to say, the current system has data communication protocol conforming to the standard of Japan and/or NASDA, mainly processes the digital data such as telemetry, and distributes the experiment data to a few of sepcified users within NASDA.
On the other hand, the future system is required to intercahnge space data between international agencies, process the various kinds of space data shch as video and voice, and distribute data as a lot of unspecified users require.

2.2 Problem

As a result, we have found that it is necessary to solve the following problems in order to satisfy these requirement.

The first, it is necessary to determine which protocol we use, and verify the availability of the protocol. The next, it is necessary to determine how we synchronize one data with another, because space data such as telemetry, image, orbital element is relevant to each other.The last, it is necessary to determine by which method we exchange data with users, and verify the availability of the method.
To sum up, the following are problems:
- Standardization of space data communication protocol
- Establishment of multimedia data management method
- Standardization of user interface

2.3 Approach

Next, we have implemented two experiments to approach the above-mentioned technical problems. One experiment is concerning a real-time processing system that we call CS-3(Communication Satellite type 3) experiment, and the other is concerning an off-line processing system that we call ADKAS(Advanced tamokuteki(multi-purpose, in English) data KAnri(management, in English) System) experiment.

2.3.1 CS-3 experiment

A real-time processing system experiment is relevant to the technical problem a.: standardization of data communication protocol.

In this experiment, we have adopted the AOS protocol. We use three of the different kinds of service that AOS protocol provides. The purpose of the experiment is to verify whether the AOS protocol is effective to the actual data communication.

The experiment's overview is shown in figure 2-1. In this experiment, we confirmed whether a operator who were distant from a manipulator could monitor it via CS-3. Telemetry was forwarded by the Path service of the AOS protocol, command of tele-operation by the Internet service, and the compressed image data by the Bit-stream service. The AOS Internet service is simulated on TCP/IP protocol by the application software.

2.3.2 ADKAS experiment

A off-line processing system experiment is relevant to technical problem b. and c.: establishment of multimedia data management method and standardization of user interface.

In this experiment, we developed the prototype and evaluated it. The purpose of the experiment is to verify whether the data relevant by catalog reference is applicable to multimedia data management and SFDU of CCSDS Recommendation is effective to data distribution.

The experiment's overview is shown in figure 2-2.

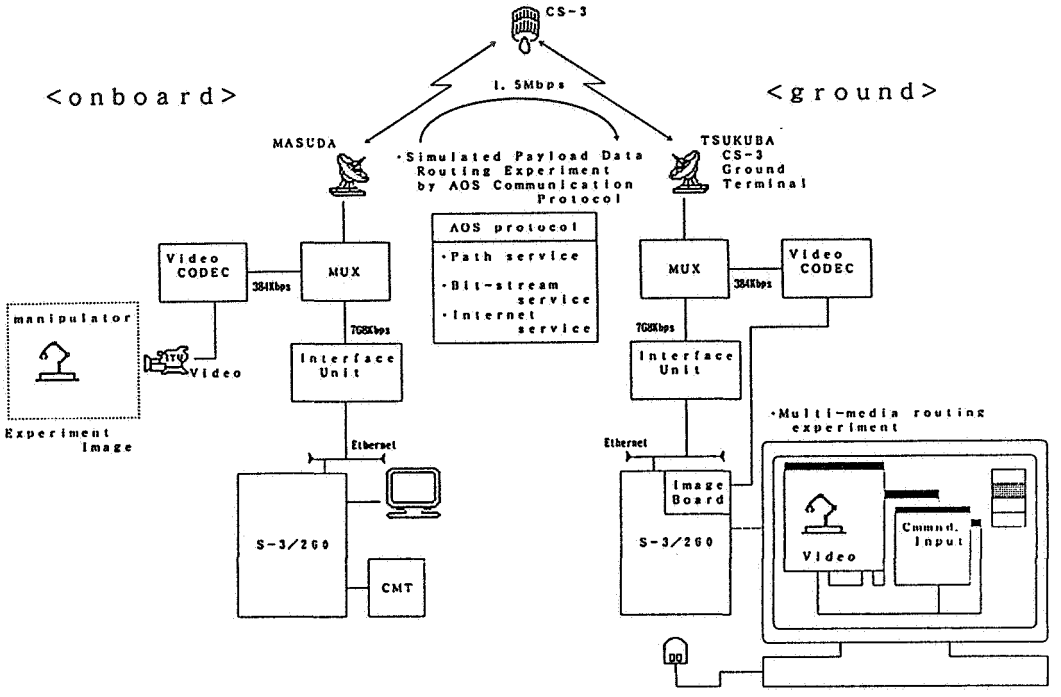

Figure 2-1 : OVERVIEW OF CS-3 EXPERIMENT

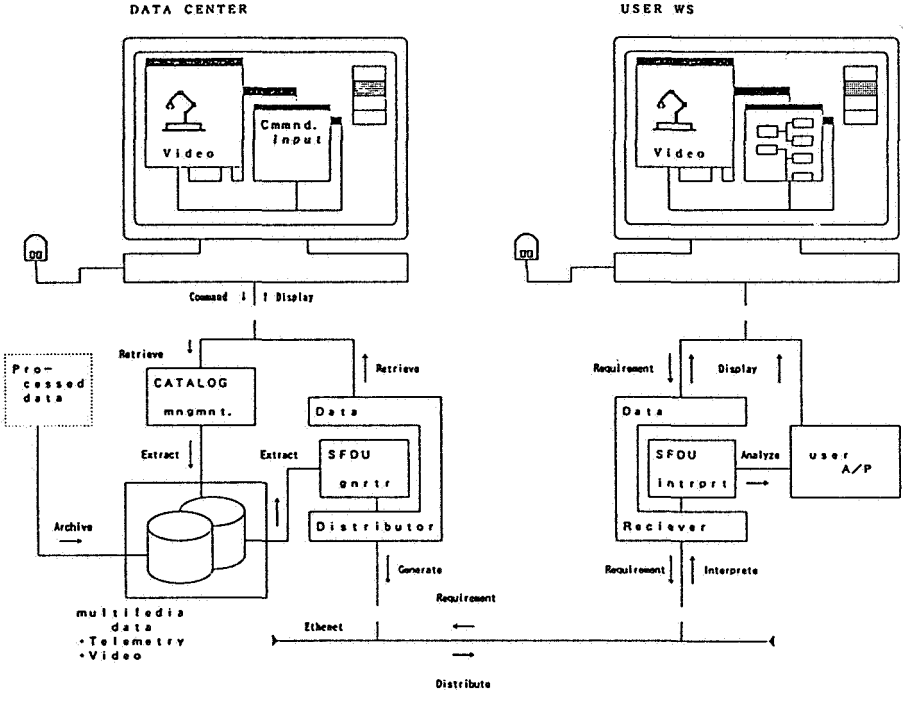

Figure 2-2 : OVERVIEW OF ADKAS EXPERIMENT

We constructed the relational data base to make the catalog reference that relate each multimedia data. Moreover, we adopted SFDU, and developed the software of automatic SFDU generation/interpretation on CCSDS Recommendation.

In this paper, the report of AOS experiment concerning a real-time processing system is omitted becauseof introducing it in other papers. The following sections describe the ADKAS experiment concerning off-line processing system in detail.

3. Prototype

3.1 Technical elements

The ADKAS solves technical problems b. and c. (described in section 2.2). That is,
b. establishment of multi-media data management method,
c. standardization of user interface.

The technical elements in ADKAS prototype are as follows:
Technical element #1: management of the multimedia data

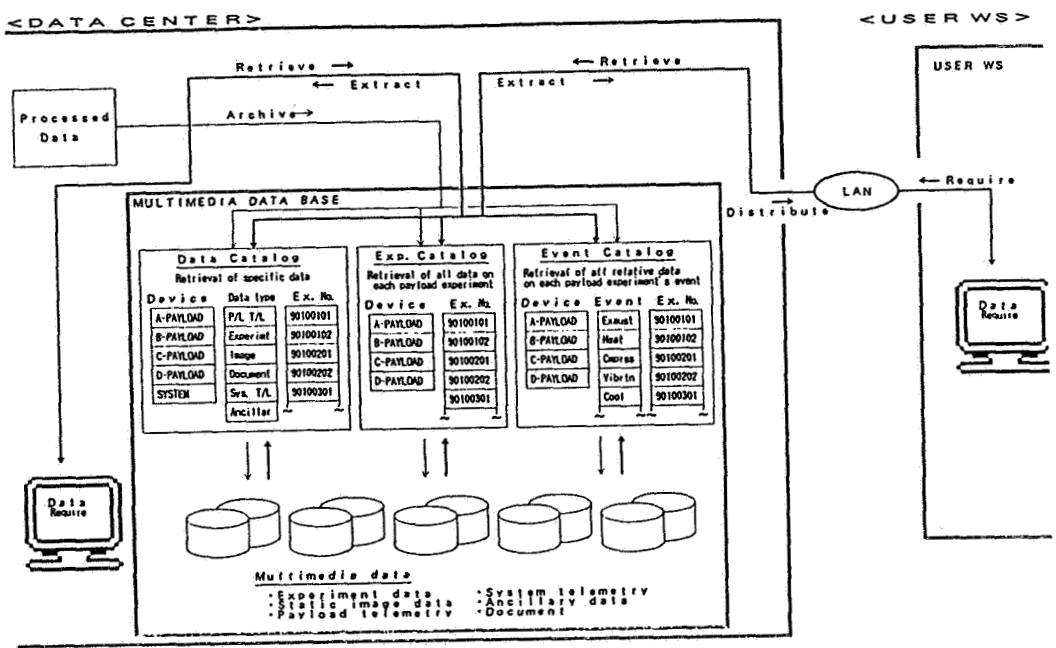

Figure 3-1: CONFIGURATION OF MULTIMEDIA MANAGEMENT SYSTEM

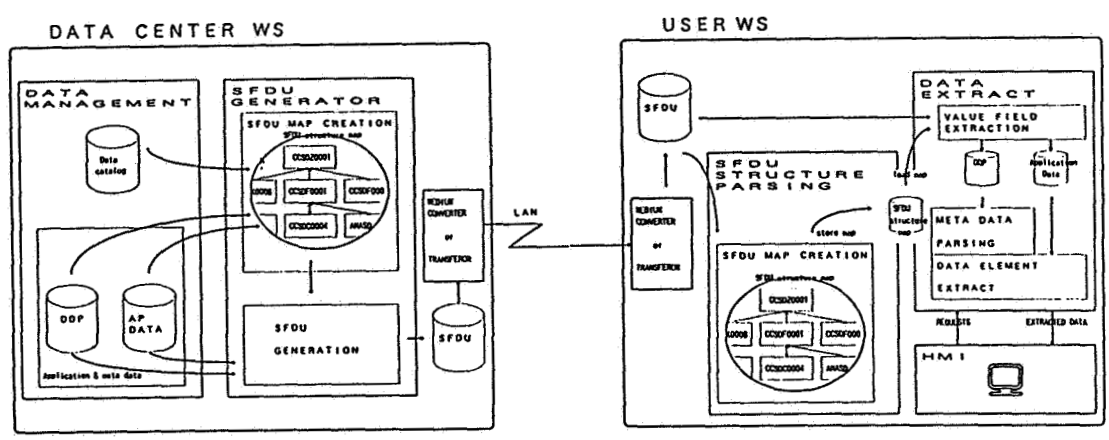

Figure 3-2: CONFIGURATION OF DATA DISTRIBUTION SYSTEM

C-7

-integrated digital data and the related analog data from the viewpoint of payload experiment or payload experiment event.
-extracted the catalog reference(constructed by relational data base) from the above-mentioned data set group.
As a result, we can retrieve all the multimedia data relevant to one another.
Technical element #2: data distribution as a lot of unspecified users require
-Developed the software of automatic SFDU generation/interpretation on CCSDS Recommendation
-Extracted SFDU generated automatically from the transmission medium and accumulated it in the multimedia data base
As a result, we can exchange multimedia data generated automatically with a lot of unspecified users by LAN or CMT

Next, we intend to describe the overview of ADKAS. The configuratuion of multimedia management and data distibution system is shown in Figure 3-1 and Figure 3-2.

3.2 SFDU description

In this section, we explain what is SFDU.

SFDU is defined as a method for packaging supplementary data and meta data with space related science and engineering data to create data products that contain complete sets of information for the purpose of information interchange.
Any type of data can be integrated into the SFDU domain; what is standardized is the technique of packaging together the various data objects into an SFDU data product. There is no constraint on the format of the user data.
Data instances are of little value without descriptions of their contents and organization. The SFDU concept integrates data and meta data and provides a technique to identify the different types of packaged information.

4. TESTING

This section describes the evaluation of ADKAS prototype.

4.1 Evaluations

We test the availability of the approach to the technical problems.

Evaluation #1: management of multimedia data
-Is it possible to retrieve data of each payload-experiment or payload-experiment-event?
-Is the processing time suitable?
Evaluation #2: data distribution to a lot of unspecified users in the standard format
-Is the algorithm of SFDU software suitable?
-Is SFDU able to be generated correctly?
-Is SFDU able to be interpreted correctly?
-Is the composition rule of SFDU suitable?

4.2 Results

As a result, what we learned is the following:

Result #1: management of multimediadata
-The catalog registration time becomes more long according to increasing of data number and operation-time. Moreover, the CPU load rate is increased.
-The processing time is generally proportional to the number of selected data.
Result #2: data distribution to a lot of unspecified users
-The use of SFDU structural map was effective as the interface with the data management program.
-The following functions are necessary as the user interface with SFDU generator:
- Specific structure generation function; for generating SFDU by in putting parameter concerning constant composition pattern and thedata source when the data is frequently exchanged and data structureneed not be changed.
- Variable structure generation function; for generating SFDU by deciding SFDU structure interactively when the data is not frequently exchanged and data structure is changed.
- SFDU propriety check function; checking propriety of SFDU structure generated and updating it.
- Meta data generation function; for converting local meta data description into the standard meta data description language.
- Medium conversion function; for converting SFDU generated into the medium demanded and adding map information on the medium.

5. Conclusion

We has been learned that the our approaches are effective to the technical problems in Advanced Spacecraft era.
For catalog reference, it is proved that we are able to retrieve data that is synchronized

with each other, and for SFDU, it is proved that the interpretation algorithm and real-data structure are available.
It is necessary to examine the following matters so that the approach described in this paper is applied to the system in the future.
- Management of mass storage data
- Data exchange between different machines
- Automatic meta-data generation from telemetry data base
- Automatic judgement which analysis software applied to real-data in SFDU

6. Reference

[1]Standard Formatted Data Units ··· structure and construction rules(May 1992)
CCSDS 620.0-B-2
Consultative Committee for Space Data Systems

[2]Standard Formatted Data Units ··· A tutorial (May 1992)
CCSDS 621.0-G-1
Consultative Committee for Space Data Systems

[3]Introduction to CCSDS Panel2 (Oct 1992)
CCSDS A23.M-Y-1.0
Consultative Committee for Space Data Systems