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GK2A HRIT Mission Specification Document

Korea Meteorological Administration

The present document has been developed within the NMSC and may be further elaborated for the purposes of NMSC. This specification is provided for development work of GK2A HRIT receiving station.

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< GK2A, HRIT, MDUS >

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Table of Contents

List of Figures

List of Tables

Foreword

This specification document has been produced by the National Meteorological Satellite Center (NMSC).

Should NMSC modify the contents of the present document, it will be re-released by NMSC with an identifying change of release date and an increase in version number as follows:

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1 INTRODUCTION

1.1 Purpose

The High Rate Information Transmission (HRIT) specification of the GK2A was written in accordance with ISO 7498 and the CCSDS Recommendation standard. This HRIT Mission Specification defines the structure and format of the HRIT file and will provide a way to process and transmit GK2A satellite broadcast data based on the OSI hierarchy.

This document is intended to distribute detailed specifications for providing meteorological data observed through GK2A using HRIT services.

1.2 References

Applicable documents:

[AD 1] KARI: 'GK2A LRIT/HRIT/UHRIT Mission Specification for GK2A PDS Development', GK2-D0-600-012 F.03, Nov. 07 2018

[AD 2] CGMS: 'Coordination Group for Meteorological Satellites LRIT/HRIT Global Specification', CGMS03 Issue 2.6

Reference documents:

[RD 1] CGMS: 'LRIT/HRIT Global Specification', Rev 2.6.August 1999

[RD 2] ISO: 'Information Processing System - Open System Interconnection - Basic Reference Model', ISO standard 7498, Feb. 1982

[RD 3] CCSDS: 'Networks and Data Links: Architectural Specification', CCSDS Recommendation 701.0-B-3-S, June 2001

[RD 4] KMA: 'COMS LRIT Mission Specification', Issue 1.2, November 30, 2010

[RD 5] KMA: 'COMS HRIT Mission Specification', Issue 1.2, November 30, 2010

[RD 6] ISO: 'Information technology -- JPEG 2000 image coding system: Core coding system', ISO/IEC 15444-1:2004

[RD 7] CGMS: 'LRIT/HRIT Global Specification', Issue 2.8, 30 October 2013

[RD 8] CCSDS: 'Time code formats', CCSDS recommendation 301.0-B-3 January 2002

[RD 9] CCSDS: 'AOS Space Data Link Protocol', CCSDS 732.0-B-2, July 2006

[RD 10] ETSI: 'Digital Video Broadcasting (DVB) Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications', Part 1: DVB-S2, EN 302 307-1, V1.4.1

[RD 11] ISO: 'Information Processing System - Open System Interconnection Basic Reference Model', ISO standard 7498, Feb. 1982

[RD 12] CCSDS: 'TM Synchronization and Channel Coding', CCSDS Recommendation 131.0-B-3- September 2003

[RD 13] Data Encryption Standard (DES) Federal Information Processing Standard (FIPS) PUB 46-2, U.S. Dept. of Commerce, National Institute of Standards and Technology, 30/12/93

[RD 14] CCSDS: 'Space Packet Protocol', CCSDS 133.0-B-1, September 2003

Abbreviations

AMI	Advanced Meteorological Imager
APID	Application Process Identifier
APNH	Asia and Pacific in Northern Hemisphere
CADU	Channel Access Data Unit
CVCDU	Coded Virtual Channel Data Unit
CCSDS	Consultative Committee for Space Data Systems
CGMS	Co-ordination Group for Meteorological Satellite
COMS	Communication, Ocean and Meteorological Satellite
CP_PDU	CCSDS Path Protocol Data Unit
DES	Data Encryption Standard
ECB	Electronic Code Book (DES mode)
ENC	Encryption Process
ELM	Extended Local Model
ENH	Extended Northern Hemisphere
FD	Full Disk
GK2A	Geo-KOMPSAT-2A
GOCI	Geostationary Ocean Color Imager
GRIB	Gridded Binary
GTS	Global Telecommunication System
HRIT	High Rate Information Transmission
ISO	International Organization for Standardization
JPEG	Joint Photographic Expert Group
KMA	Korea Meteorological Administration
LRIT	Low Rate Information Transmission
LSB	Least Significant Bit
LSH	Limited Southern Hemisphere
MAC	Media Access Control
MSB	Most Significant Bit
NWP	Numerical Weather Prediction
M_PDU	Multiplexing Protocol Data Unit
OSI	Open Systems Interconnection
RF	Radio Frequency
S/C	Spacecraft
SDUS	Small-scale Data Utilization Station
TBC	To Be Confirmed
TBD	To Be Defined
TP_PDU	Transport Protocol Data Unit
UHRIT	Ultra High Rate Information Transmission
VCDU	Virtual Channel Data Unit
WMO	World Meteorological Organization

2 OSI REFERENCE MODEL

2.1 Communication Concept of HRIT

The GK2A HRIT dissemination service is based on the Open Systems Interconnection (OSI) Reference Model in [RD2] and the CCSDS AOS in [RD3].

Table 2.1 presents the functionalities of the each OSI layer from the view of dissemination system.

Table 2.1 OSI Layer Functionalities for GK2A HRIT Service

OSI 7 layers	Layer functionalities
Application layer	Acquisition of application data
Presentation layer	Image segmentation, HRIT file structuring
Session layer	Compression (if required) Encryption (if required)
Transport layer	Determination of APID Split of files into source packet
Network layer	Determination of VCID
Data link layer	Multiplexing, Error of block unit detection, Reed-Solomon encoding Randomization Attachment of sync marker
Physical layer	Serialization, Viterbi encoding, Modulation

This documentation defines data type of each layer as Figure S_PDU is file data of xRIT_Data compressed and encrypted, each data format including S_PDU will described corresponding chapter.

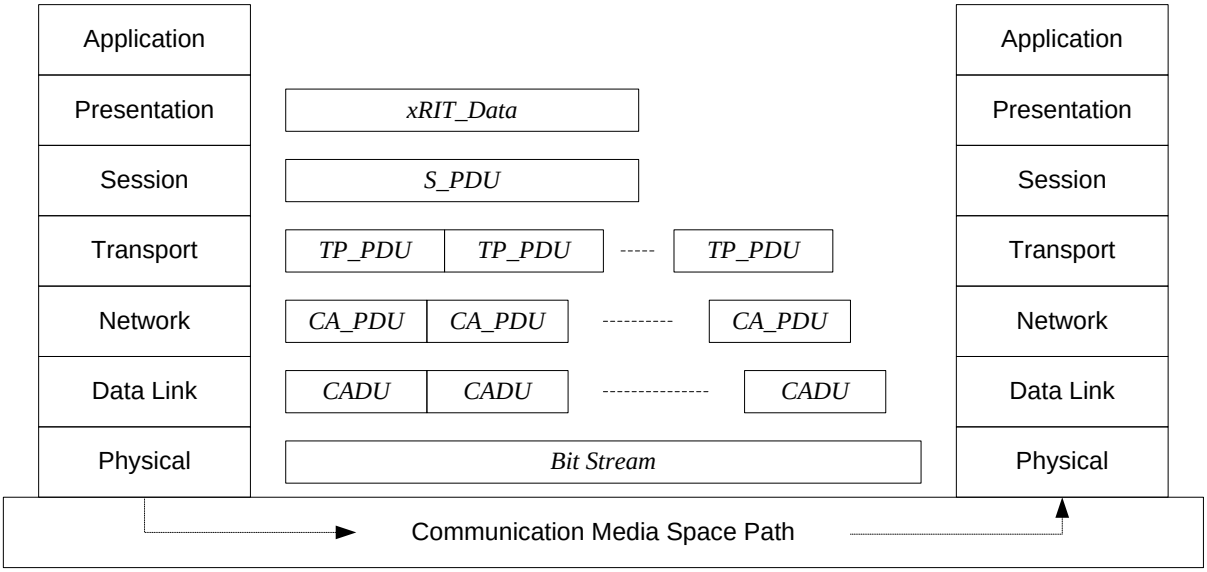


Figure 2.1 Definition of GK2A HRIT Data Type

3 APPLICATION LAYER

3.1 Data Type

The GK2A HRIT service will provide specific application data from external systemin the Application Layer as follows,

- Image Data: Full Disk(FD)
- Additional Data:
  Alphanumeric text file
  GOCI-II Data

3.1.1 Image Data

The type of image data consists of visible channel image and infrared channel image. The projection type of GK2A HRIT is GEOS. The images defining latitude, longitude, and size are distributed.

- Dissemination mode and image size:
  FD 11,000 x 11,000 (VIS)
  FD 2,750 x 2,750 (IR)

- Dissermination time:
  Within 3 minutes afer completion of observation(Observatio period: 10 minute)

Table 3.1.1 Channel and Resolution of GK2A HRIT Image Data

No.	Name	Wavelength	Resolution	Bit
1	VI006	0.64	1 km	10
2	SW038	3.90	4 km	10
3	WV069	6.95	4 km	10
4	IR105	10.3	4 km	10
5	IR123	12.3	4 km	10

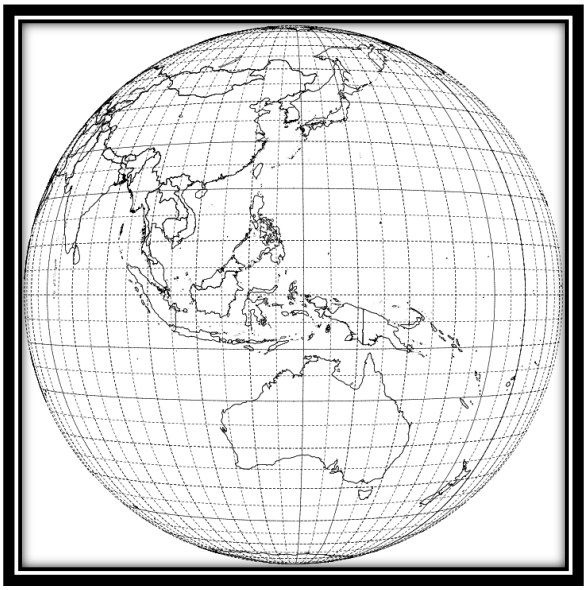


Figure 3.1 GK2A FD Image

3.1.2 Additional Data

Additional data distributed through GK2A satellite broadcasting service are Alphanumeric Text and GOCI-II data.

- Alphanumeric Text provides GK2A operation information, observation schedule, satellite broadcast distribution schedule.
- GOCI-II data is provided with Geostationary Ocean Color Imager in GK-2B observation data.

4 PRESENTATION LAYER

4.1 Segmentation of GK2A HRIT

Image segmentation is performed for GK2A HRIT dissemination services in real-time and for high flexibility with the HRIT compression/encryption schemes. Compression and encryption is processed with the unit of segment. The whole HRIT images are composed of a number of HRIT files.

- HRIT segment file size: Column x Line

Table 4.1 HRIT Image Data Segment File Structure

GK2A HRIT Image Data			
Observation Mode	Segment Files	1 Segment Size	
		VIS(1 km)	IR(4 km)
FD	Segment File 10	11,000 x 1,100	2,750 x 275

4.2 HRIT File Structure

GK2A HRIT files are formatted data as shown in figure 4.1. An HRIT files consists of one or more header records and one data field. The primary header record defines the file type and the size of the complete HRIT file. The secondary header records include various information relating with the data field.

Header		Data Field
Primary Header (0#, Mandatory)	Secondary Header (#1~#255, Optional)	

Figure 4.1 HRIT File Structure

4.3 File Type of HRIT

GK 2A HRIT file types are described in Table 4.2. The file types (0… 127) have already been defined in [RD 1]. In addition, the mission specific file types (128… 255 have been reserved for the future GK 2A HRIT service expansion.

Table 4.2 HRIT File Type

Classification	File Type Code	File Type	Application data type contained in the data field
HRIT basic data	0	Image data	FD observation data (Normalized Geostationary Projection)
	1	GTS message	Not used
	2	Alphanumeric text	Administrative messages including observation/ dissemination schedule
	3	Encryption key Message	Not used
	4~127	Reserved	For further global use
Add data space	128~255	Reserved	For further mission specific use

4.4 Header Records of GK2A HRIT File

Table 4.3 HRIT Header Type

Classification	Code	Header Record Type	Remark
Global Header Types	0	Primary header	
	1	Image structure	
	2	Image navigation	
	3	Image data function	
	4	Annotation	
	5	Time stamp	

	6	Ancillary text	Not used
	7	Key header	
	8 ~ 127	Reserved	
Mission Specific Header Type	128	Image segment definition	Image segment file information
	129	Encryption key message header	Not used
	130	Image compensation info. header	
	131	Image observation time header	
	132	Image quality info. header	
	133 ~ 255	Reserved	

4.4.1 Header Type #0 – Primary Header

This header provides the size of total HRIT file(header records + data field). The padding data with the value of "0x00" will be filled at the end of data field to be line with 64 bits alignment of DES encryption when the encryption is applied.

Table 4.4 Header Type #0 – Primary Header

Classification	Data Type	Data Size (Bytes)	Value	Remark
Header Type	unsigned integer	1	0	Fixed value
Header Record Length	unsigned integer	2	16	Fixed value
File Type Code	unsigned integer	1	Variable	0: Image data file 1: GTS message(Not used) 2: Alphanumeric text file 3: Encryption key message(Not used)
Total Header Length	unsigned integer	4	Variable	Total Header Record size(Bytes)
Data Field Length	unsigned integer	8	Variable	Data Field size(bits)

4.4.2 Header Type #1 – Image Structure

This header provides number of bits per pixel, number of columns, number of lines of image structure, and compression flag.

Table 4.5 Header Type #1 – Image Structure

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	unsigned integer	1	1	Fixed value
Header Record Length	unsigned integer	2	9	Fixed value
Number of bit per pixel	unsigned integer	1	Variable	Input valid bit according to channel
Number of columns	unsigned integer	2	Variable	Variable size according to observation area and channel
Number of lines	unsigned integer	2	Variable	Variable size according to observation area and channel
Compression Flag	unsigned integer	1	Variable	Compression method 0: No compression 1: Lossless compression 2: Lossy compression

4.4.3 Header Type #2 – Image Navigation

This header provides the information of image projection on the earth .

Table 4.6 Header Type #2 – Image Navigation

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	unsigned integer	1	2	Fixed value
Header Record Length	unsigned integer	2	51	Fixed value
Projection Name	Character	32	Variable	Projection names as defined in [RD7] GEOS(<sub_lon>)
CFAC	integer	4	Variable	Column scaling factor as defined in [RD7]
LFAC	integer	4	Variable	Line scaling factor as defined in [RD7]

COFF	integer	4	Variable	Column offset as defined in [RD7]
LOFF	integer	4	Variable	Line offset factor as defined in [RD7]

4.4.4 Header Type #3 – Image Data Function

This header provides the physical meaning of the image data. It is used to define images which require establishing a relationship between their pixel count and physical units such as radiance/temperature or albedo.

Table 4.7 Header Type #3 – Image Data Function

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	unsigned integer	1	3	Fixed value
Header Record Length	unsigned integer	2	Variable	Max. 65535
Data Definition Block	Character	variable	Variable	Max. 65532 (TBD)

4.4.5 Header Type #4 – Annotation Text

This header provides the annotation record to allow quicker and easier detection of file contents.

Table 4.8 Header Type #4 - Annotation

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	4	Fixed value
Header Record Length	Unsigned integer	2	Variable	Max. 67
Annotation Text	Character	Variable	Variable	Max. 64 File Name IMG_FD_143_VI006_20180627_030000_01.hrit ADD_ANT_143_20180627_030000__01.hrit

4.4.6 Header Type #5 – Time Stamp

This header provides processing time in session layer.

Table 4.9 Header Type #5 – Time Stamp

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	5	Fixed value
Header Record Length	Unsigned integer	2	10	Fixed value
Time Stamp (CDS P Field)	Unsigned integer	1	Variable	P-Field fixed value according to [RD8]
Time Stamp (CDS T Field)	Unsigned integer	6	Variable	T-Field fixed value according to [RD8]

4.4.7 Header Type #6 – Ancillary Text (Not used)

The header type #6 will be used for the GK2A HRIT service expansion.

4.4.8 Header Type #7 – Key Header

This header provides the number of used encryption key.

Table 4.10 Header Type #7 – Key Header

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	7	Fixed value
Header Record Length	Unsigned integer	2	7	Fixed value
Key Number	Unsigned integer	4	Variable	Index of the used encryption key 0: Encryption is not applied

4.4.9 Header Type #128 – Image Segmentation Identification

Table 4.11 Header Type #128 – Image Segmentation Identification

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	128	Fixed value
Header Record Length	Unsigned integer	2	7	Fixed value
Image Segment Seq. No.	Unsigned integer	1	Variable	Image segment sequence number
Total No. Image. Segment	Unsigned integer	1	Variable	Total number of Image segments
Line No. Image. Segment	Unsigned integer	2	Variable	Line number of Image segment

4.4.10 Header Type #129 – Encryption Key Massage(Not used)

4.4.11 Header Type #130 – Image Compensation Information

This header includes the image navigation parameters, such as COFF, LOFF, CFAC, LFAC for the entire image data.

Table 4.12 Header Type #130 – Image Compensation Information

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	130	Fixed value
Header Record Length	Unsigned integer	2	Variable	Max. 65535
Image Compensation Information	Character	Variabel	Variable	Max. 65532

4.4.12 Header Type #131 – Image Observation Time

This header includes the observation time of image data as MJD (Modified Julian Day) format.

Table 4.13 Header Type #131 – Image Observation Time

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	131	Fixed value
Header Record Length	Unsigned integer	2	Variable	Max. 65535
Image Observation Time	Character	Variable	Variable	Max. 65532

4.4.13 Header Type #132 – Image Quality Information

This header represents Error pixel number of the whole image.

Table 4.14 Header Type #132 – Image Quality Information

Classification	Data Type	Data size (Bytes)	Value	Remark
Header Type	Unsigned integer	1	132	Fixed value
Header Record Length	Unsigned integer	2	Variable	Max. 65535
Image Observation Time	Character	Variable	Variable	Max. 65532

4.5 HRIT File Name

The file name of character strings is stored in the Annotation Header (Header Type # 4). The name of image data files disseminated via HRIT is defined as follows.

4.5.1 Image Data File Name

The example of HRIT image data file name:

- IMG_AA_NNN_CHHnn_YYYYMMDD_hhmmss_NN.hrit

The HRIT file name of image data is used as follows,

Table 4.15 File Name of Image Data

	File Type	Observation Mode	Sequence No.	Spectral Channel	Dissemination Time	Segment File No.	Ext.
Form	IMG_	AAAAAAA_	NNN_	CHnnn_	YYYYMMDD_hhmmss_	NN	.hrit
Size	4 Bytes	Maximum 8 Bytes	4 Bytes	6 Bytes	16 Bytes	2 Bytes	6 Bytes
Ex)	IMG_	FD_	143_	VI006_	20180627_030000_	01	.hrit

- HRIT Image Data File Type is indicated as IMG_
- Observation mode marked as AAAAAAA_
- Video sequence number starts from 00UTC in order of observation mode, and is indicated as NNN_
- The channel is divided into 16 channels and the central wavelength is marked as CHnnn_
- The sequence number of the split file starts from 01 for each observation image and is displayed as NN

The example of HRIT additional data file name:

- ADD_AAAAAAA_NNN_ YYYYMMDD_hhmmss_NN.hrit

The HRIT file name of additional data is used as follows,

Table 4.16 Additional Data File Name

	File Type	Additional Data Type	Sequence No.	Dissemination Time	Segment File No.	Ext.
Form	ADD_	AAAAAAA_	NNN_	YYYYMMDD_hhmmss_	NN	.hrit
Size	4 Bytes	Max 8 Bytes	4 Bytes	16 Bytes	2 Bytes	6 Bytes
Ex)	ADD_	ANT_	143_	20180627_030000_	01	.hrit

- HRIT Additional Data File Type is indicated as ADD_
- Additional Data Type is marked as AAAAAAA_
- The video sequence number is NNN_ in the order of the additional data type.
- The sequence number of the split files is 01 for each additional data type.

4.6 File Type vs. Header Implementation

Table defines the GK2A HRIT mission specific use of header record types within certain HRIT file types.

Table 4.17 File Type vs. Header Implementation

File types		Header record types												
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**128**	**129**	**130**	**131**	**132**
0	Image data file	●	●	◎	◎	◎	◎		◎	◎		○	◎	○
1	GTS Message													
2	Alphanumeric text file	●				◎	◎		◎					
3	Encryption key message	●				◎	◎		◎					

● As requested by [RD7] ◎ KMA mandatory use ○ KMA optional use

0 Primary header
1 Image structure
2 Image navigation
3 Image data function
4 Annotation
5 Time stamp
6 Ancillary text
7 Key header

128 Image segment identification
129 Encryption Key message header
130 Image compensation info. header
131 Image observation time header
132 Image quality information header

5 SESSION LAYER

The session layer includes the definition of data compression and encryption for each xRIT_Data transmitted as file type from application layer. The output of the session layer to the transport layer is S_PDU containing the compressed and encrypted data field.

The Session Layer generates S_PDU by applying to each HRIT file from the Presentation Layer in the order of compression and encryption.

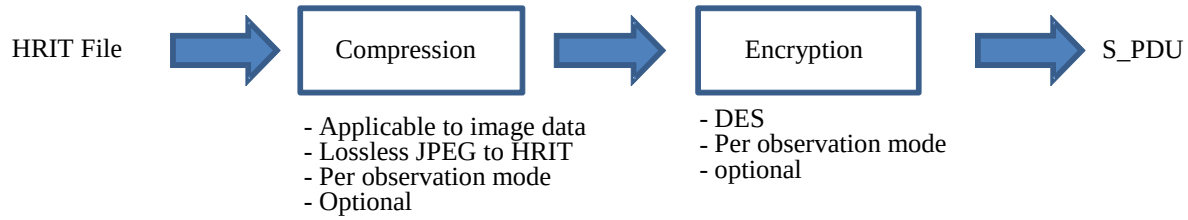


Figure 5.1 Session Layer Processing

5.1 JPEG Compression

According to [RD7], Image data file applies lossless(File type code : 0) JPEG2000 [RD6].

5.2 DES Encryption

The encryption and decryption of GK2A HRIT are based on a processing in accordance with the ECB (Electronic Code Book) mode of DES (Data Encryption Standard) [RD 13]. Figure 5.2 shows the principle of encryption and decryption.
The HRIT File is encrypted using an encryption master key managed by NMSC. The inverse process, decryption is also processed at LDUS at S/W level.

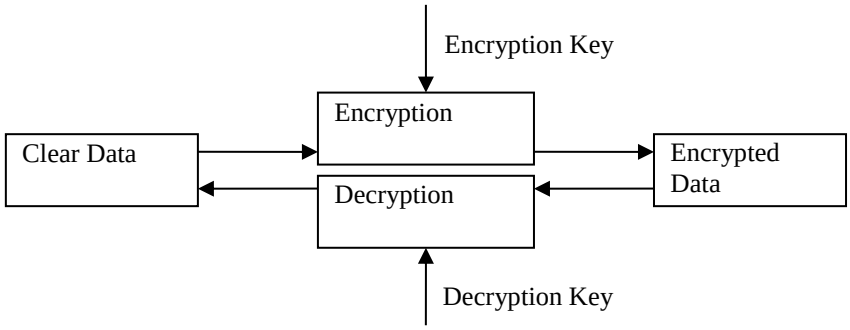


Figure 5.2 Principle of Encryption and Decryption for HRIT

6 TRANSPORT LAYER

The Transport Layer generates TP_File with S_PDUs from session layer as byte unit and splits it into one or more CP_PDU. The CP_PDU is the CCSDS Path Protocol Data Unit [RD3].

6.1 Transport File (TP_File)

In the Transport Layer, 10 bytes TP_header is attached to the beginning of S_PDU and several bits (0~7) are filled at the end of S_PDU to make it in byte units. The structure of TP_File is shown in Table 6.1 and TP_Header is described as bellows.

Table 6.1 Transport File Structure

TP_Header		**S_PDU**	**Filler**
File Counter	File Length		
16 bits	64 bits	$1 \sim (2^{64} - 1)$ bits	0~7 bits

Table 6.2: HRIT TP_Header

Field	**Bytes**	**Description**
File Counter	2	HRIT FD File Number: VI006: 0~9 SW038: 10~19 WV069: 20~29 IR105: 30~39 IR123: 40~49 Others: 255
File Length	8	File Length(bits)

File_Counter is allocated in order to classify easily TP_File when processing them in the unit of file. As maximum number of HRIT segment files is 10 files, 10 sequence numbers is allocated for each spectral band. Others counters are for the additional data.

6.2 Source Packet (CP_PDU)

The CP_PDU, output of the Transport Layer, is composed of Source Packet Header and Packet Data Field. The data field is composed of maximum 8190 bytes of TP_File and CRC. If the size of TP_File is not multiples of 8190 bytes, the length of last CP_PDU can be less than others.

Table 6.3 Source Packet Structure

<table>
<tr><td colspan="6">Source Packet Header</td><td colspan="2">Packet Data Field</td></tr>
<tr><td colspan="4">Packet Identification</td><td colspan="2">Packet Sequence Control</td><td rowspan="2">Packet Length</td><td>Data Field</td><td></td></tr>
<tr><td>Version</td><td>Type</td><td>Secondary Header Flag</td><td>APID</td><td>Sequence Flag</td><td>Packet Sequence Count</td><td>Application Data Field</td><td>CRC</td></tr>
<tr><td>3 bits</td><td>1 bit</td><td>1 bit</td><td>11 bit</td><td>2 bits</td><td>14 bits</td><td>16 bits</td><td>Var.</td><td>16 bits</td></tr>
<tr><td colspan="4">2 bytes</td><td colspan="2">2 bytes</td><td>2 bytes</td><td>Max. 8190 bytes</td><td>2 bytes</td></tr>
</table>

Table 6.4 Source Packet Header

Bits	Field	Description
3	Packet Version Number	CCSDS protocol version · 0 (fixed)
1	Packet Type	Indicates whether this is a telecommand or telemetry packet · 0 (fixed)
1	Secondary Header Flag	Indicates whether this packet has a secondary header · 1 (fixed)
11	Application Process Identifier (APID)	Identifies the specific data content of the packet
2	Sequence Flags	Flags for data segmentation · 11: Single data · 01: First segment · 00: Contained segment · 10: Last Segment
14	Packet Sequence Count	Counter that ascends sequentially for packets with the same APID
16	Packet Data Length	Packet size information (Bytes)

Sequence Flag distinguishes each file and indicates file is composed of one packet or consecutive packet. In case of consecutive packet, **Sequence Flag** is able to distinguish first and middle, last packet.

Packet Sequence Counter calculates number of packet and reiterates from 0 to 16383. **Packet Length** is the value which subtracts 1 from the size of data right after header.

CRC attaching to the last part of CP_PDU is calculated by $g(x) = x^{16} + x^{12} + x^5 + 1$.

7 NETWORK LAYER

The only function of Network Layer is to generate Virtual Channel ID (VCID) for each APID[RD7].

- Refer to Appendix B for APID and VCID

8 DATA LINK LAYER

The Data Link Layer of the CCSDS AOS space link is composed of following two sub-layers.

- Virtual channel link control (VCLC) sub-layer
- Virtual channel access (VCA) sub-layer

The VCLD sub-layer provides the multiplexing service based on the VCID from the Network Layer. It fills M_SDUs into multiplexing protocol data units (M_PDU).

The VCA sub-layer generates the virtual channel data units (VCDU) from M_PDUs and produces finally Channel Access Data Units (CADUs) by applying Reed-Solomon coding to control HRIT dissemination errors, data randomization, and attachment of synchronization marker. Fill VCDUs may have to generate for continuous data delivery to the lower layer.

The Data link Layer transfers CADUs to the Physical Layer.

8.1 M_PDU

The Source Packet is entered into the M_PDU in units of 886 Bytes. In the M_PDU Packet Zone, no Space Packet is input or multiple Space Packets can be input.

Table 8.1 M_PDU Structure

M_PDU Header		**M_PDU Packet Zone**				
RSVD Spare	First Header Pointer	End of M_SUD (N-1)	M_SUD (N)	M_SUD (N+1)	…	Start of M_SDU (1)
5 bits	11 bits	884 bytes				
886 bytes						

Table 8.2 M_PDU Header

Bits	**Field**	**Description**
5	Reserved Spare	Reserved · 0 (fixed)
11	First Header Pointer	Offset to the location of the first Space Packet that starts in the M_PDU Packet Zone (Byte)

8.2 AOS Transfer Frame

The M_PDU data is input to the AOS Transfer Frame.

Table 8.3 AOS Transfer Frame Structure

<table>
<tr><td colspan="6">Transfer Frame Primary Header</td><td rowspan="4">Transfer Frame Data Field</td></tr>
<tr><td colspan="2">Master Channel ID</td><td></td><td></td><td colspan="2">Signaling Field</td></tr>
<tr><td>Transfer Frame Version Number</td><td>Spacecraft ID</td><td>Virtual Channel ID</td><td>Virtual Channel Frame Count</td><td>Replay Flag</td><td>Spare</td></tr>
<tr><td>2 bits</td><td>8 bits</td><td>6 bits</td><td>24 bits</td><td>1 bits</td><td>7 bits</td></tr>
<tr><td colspan="3">2 Bytes</td><td>3 Bytes</td><td colspan="2">1 Bytes</td></tr>
<tr><td colspan="6">6 Bytes</td><td>886 Bytes</td></tr>
</table>

- Transfor Frame Primary Header

Table 8.4 Transfer Frame Primary Header

Bits	Field	Description
2	Transfer Frame Version Number	0 (fixed)
8	Spacecraft ID	Spacecraft ID (XXh)
6	Virtual Channel ID	Virtual Channel ID (Table 6.4)
24	Virtual Channel Frame Count	Virtual Channel Frame Count
1	Replay Flag	Replay Flag
7	Reserved Spare	Reserved Spare

- Transfer Frame Error Control Field

Refer to Section 4.4.6 of the “CCSDS 732.0-B-2, AOS Space Data Link Protocol Blue Book” [RD9].

8.3 CADU

The CVCDU is formed with VCDU and the attachment of Reed-Solomon check symbols.
The Reed-Solomon (RS) code with an interleaving depth of 4 is applied to GK2A HRIT services (255/223, 4).
The RS code performs 64 bytes error detection and correction for CVCDU.

Figure 8.1 CVCDU Structure

8.4 CADU

CADU is the addition of Sync Marker 0x1ACFFC1D (4 Bytes) to the beginning of the AOS Transfer Frame. The following shows the CADU structure.

Table 8.5 CADU Structure

Sync (0x1ACFFC1D)	AOS Transfer Frame
4 Bytes	1,020 Bytes
1,024 Bytes	

9 PHYSICAL LAYER

The Physical Layer of HRIT performs the convolution coding(r=1/2, K=7) of the serialized data stream and its modulation onto the RF up-link signal.
The GK2A system follows basically the convolution coding of [RD 12], except symbol inversion on output path of G2.

The parameter sets of the physical layer are specified in the Table 9.1.

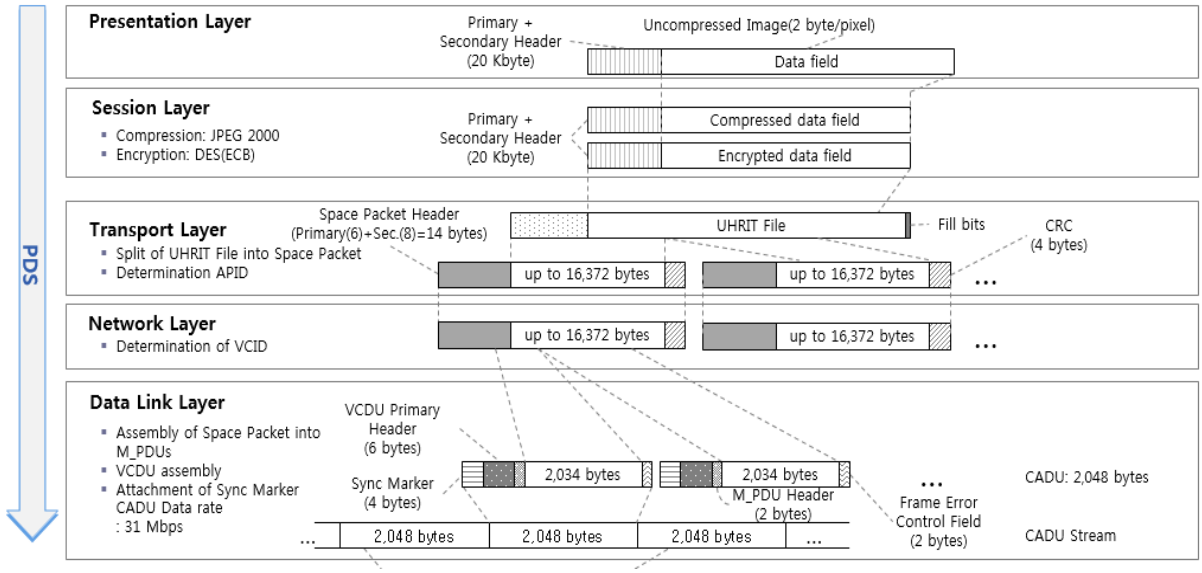
Table 9.1 Parameters of HRIT Communication Link

Parameters	Values
Downloading frequency	1695.4 MHz
Bandwidth	≤ 5.2 MHz
Information data rate*	3 Mbps
Satellite EIRP	25 dBW
Minimum G/T of ground antenna (MDUS)	11.1 dB/K
Maximum BER	10-8
Coding	Reed-Solomon (255/223, 4) and Convolution coding (1/2, K=7)
Pulse shaping	Root-Raised Cosine with 0.5 of roll-off factor
Polarization	Linear in East-West direction
Modulation	NRZ-L/QPSK
Length of one CADU	1024 bytes

* Information data rate is the HRIT CADU data rate prior to convolution encoding. Therefore, GK2A HRIT transmission data rate is 6Mbps after convolution encoding.

APPENDIX

Appendix A: GK2A HRIT Data Format and Procedures



Appendix B: GK2A LRIT/HRIT/UHRIT APID and VCID

In the future, the actual APIDs and VCIDs will be determined by NMSC's broadcasting policy. Next table shows current values of them. The APIDs and VCIDs will be deteremined w.r.t broadcasting data categories, not w.r.t broadcasting channels(LRIT/HRIT/UHRIT).

Category 1	Category 2	Category 3	APID	VCID
Image Data	FD	VI004	0	0
		VI005	1	
		…	…	
		IR113	14	
		IR133	15	
	Reserved	-	32 ~ 127	1 ~ 3
Additional Data	Alpha-numeric Text	-	128	4
	Additional Data	-	160	5