

# **GK2A LRIT Mission Specification Document**

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**Korea Meteorological  
Administration**

Keywords

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< GK2A, LRIT, SDUS >

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## 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:

Issue x.y

where:

- x the first digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the second digit is incremented when editorial only changes have been incorporated in the document.

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# 1 INTRODUCTION

## 1.1 Purpose

The Low Rate Information Transmission (LRIT) specification of the GK2A was written in accordance with ISO 7498 and the CCSDS Recommendation standard. This LRIT Mission Specification defines the structure and format of the LRIT 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 LRIT 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 LRIT

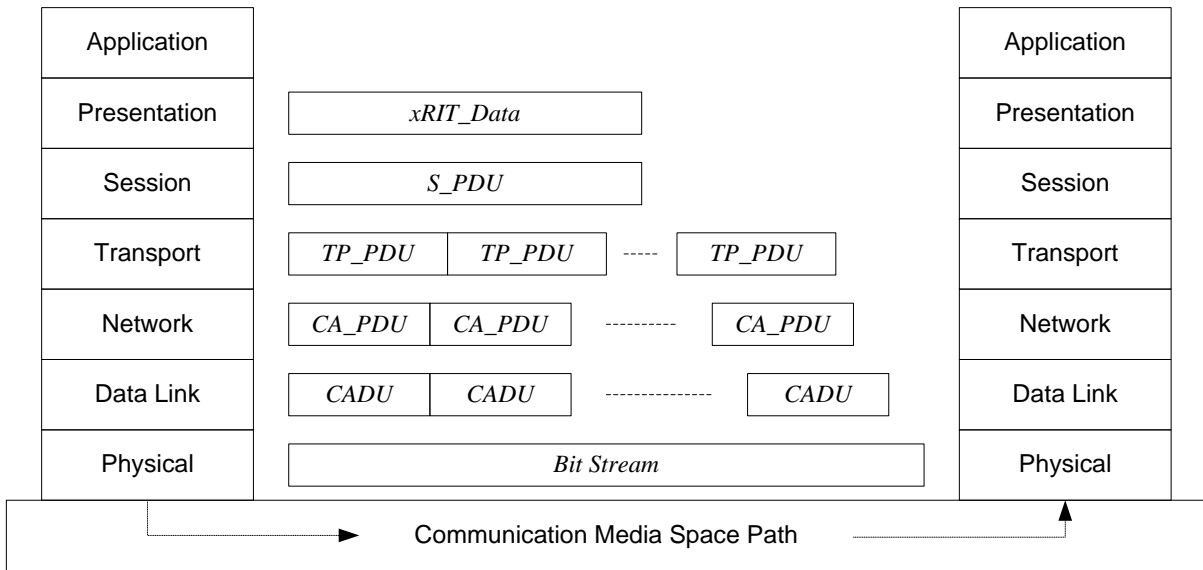
The GK2A LRIT dissemination service is based on the Open Systems Interconnection (OSI) Reference Model in [RD2] and the CCSDS AOS in [RD3].

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 LRIT Service**

OSI 7 layers	Layer functionalities
Application layer	Acquisition of application data
Presentation layer	Image segmentation, LRIT 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 LRIT Data Type**

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## 3 APPLICATION LAYER

### 3.1 Data Type

The GK2A LRIT service will provide specific application data from external system in the Application Layer as follows,

- Image Data: Full Disk(FD)
- Additional Data:
  - Alphanumeric text file
  - Sea surface information
  - Weather chart
  - Sea weather information text
  - Etc.

#### 3.1.1 Image Data

The image data of GK2A LRIT is provide true color image of 8 bit and the projection type is GEOS.

- Dissemination mode and image size:
  - FD 2,200 x 2,200 (May be changed in the future)
- Dissemination time:
  - Dissemination time of GK2A LRIT is not bound to absolute time and the size of GK2A LRIT is varied according to product.

#### 3.1.2 Additional Data

Additional data distributed through GK2A satellite broadcasting service are Alphanumeric Text, sea weather information and GOCI-II data. (GOCI-II data provided after 2020)

- Alphanumeric Text are provides GK2A operation information, observation schedule, satellite broadcast distribution schedule.
- Sea information data are provides sea surface information, weather chart, sea weather information text and Etc.
- GOCI-II data is provided with Geostationary Ocean Color Imager in GK-2B observation data.

## 4 PRESENTATION LAYER

### 4.1 Segmentation of GK2A LRIT

Image segmentation is performed for GK2A LRIT dissemination services in real-time and the segment file number are one or more. Compression and encryption is processed with the unit of segment.

### 4.2 LRIT File Structure

GK2A LRIT files are formatted data as shown in figure 4.1. An LRIT 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 LRIT 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 LRIT File Structure

### 4.3 File Type of LRIT

GK 2A LRIT file types are described in Table 4.1. 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 LRIT service expansion.

Table 4.1 LRIT File Type

Classification	File Type Code	File Type	Application data type contained in the data field
LRIT 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 LRIT File

Table 4.2 LRIT 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 ~ 255	Reserved	For further mission specific use

#### 4.4.1 Header Type #0 – Primary Header

This header provides the size of total LRIT 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 4.3 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 4.4 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
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### 4.4.3 Header Type #2 – Image Navigation

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

**Table 4.5 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 4.6 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 4.7 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.lrit ADD_ANT_143_20180627_030000__01.lrit

#### 4.4.6 Header Type #5 – Time Stamp

This header provides processing time in session layer.

**Table 4.8 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 LRIT service expansion.

#### 4.4.8 Header Type #7 – Key Header

This header provides the number of used encryption key.

**Table 4.9 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 4.10 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 Message(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 4.11 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 4.12 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	Variabl e	Max. 65535
Image Observation Time	Character	Variable	Variabl e	Max. 65532

#### 4.4.13 Header Type #132 – Image Quality Information

This header represents Error pixel number of the whole image.

**Table 4.13 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 LRIT 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 LRIT is defined as follows.

### 4.5.1 Image Data File Name

The example of LRIT image data file name:

- IMG\_AA\_NNN\_CHHnn\_YYYYMMDD\_hhmmss\_NN.lrit

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

**Table 4.14 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	.lrit
Size	4 Bytes	Maximum 8 Bytes	4 Bytes	6 Bytes	16 Bytes	2 Bytes	6 Bytes
Ex)	IMG_	FD_	143_	VI006_	20180627_030000_	01	.lrit

- LRIT 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 LRIT additional data file name:

- ADD\_AAAAAAA\_NNN\_YYYYMMDD\_hhmmss\_NN.lrit

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

Table 4.15 Additional Data File Name

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

- LRIT 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 LRIT mission specific use of header record types within certain LRIT file types.

Table 4.16 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      | 128 Image segment identification     |
| 1 Image structure     | 129 Encryption Key message header    |
| 2 Image navigation    | 130 Image compensation info. header  |
| 3 Image data function | 131 Image observation time header    |
| 4 Annotation          | 132 Image quality information header |
| 5 Time stamp          |                                      |
| 6 Ancillary text      |                                      |
| 7 Key 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 LRIT file from the Presentation Layer in the order of compression and encryption.

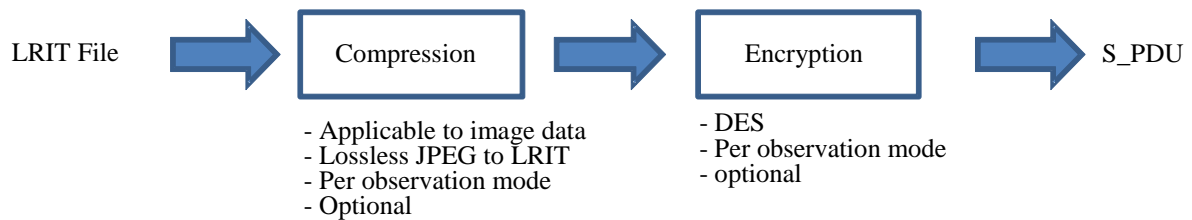


Figure 5.1 Session Layer Processing

### 5.1 JPEG Compression

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

### 5.2 DES Encryption

The encryption and decryption of GK2A LRIT 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 LRIT File is encrypted using an encryption master key managed by NMSC. The inverse process, decryption is also processed at LDUS at S/W level.

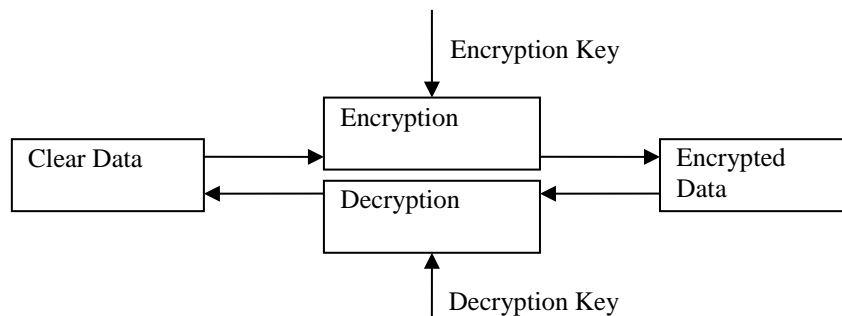


Figure 5.2 Principle of Encryption and Decryption for LRIT

## 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: LRIT TP\_Header**

Field	Bytes	Description
File Counter	2	LRIT 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 LRIT 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**

Source Packet Header							Packet Data Field	
Packet Identification				Packet Sequence Control		Packet Length	Data Field	
Version	Type	Secondary Header Flag	APID	Sequence Flag	Packet Sequence Count		Application Data Field	CRC
3 bits	1 bit	1 bit	11 bit	2 bits	14 bits	16 bits	Var.	16 bits
2 bytes				2 bytes		2 bytes	Max. 8190 bytes	2 bytes

**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 Identifier (APID) Process	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  $g(x) = x^{16} + x^{12} + x^5 + 1$ .



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## 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 VCLC 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 LRIT 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_SUD (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**

Transfer Frame Primary Header						Transfer Frame Data Field
Master Channel ID			Signaling Field			
Transfer Frame Version Number	Spacecraft ID	Virtual Channel ID	Virtual Channel Frame Count	Replay Flag	Spare	
2 bits	8 bits	6 bits	24 bits	1 bits	7 bits	
2 Bytes			3 Bytes	1 Bytes		
6 Bytes						886 Bytes

- Transfer 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 LRIT services (255/223, 4). The RS code performs 64 bytes error detection and correction for CVCDU.

VCDU	Reed-Solomon Check Symbols
892 octets	128 octets

**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**

<b>Sync (0x1ACFFC1D)</b>	<b>AOS Transfer Frame</b>
4 Bytes	1,020 Bytes
1,024 Bytes	

## 9 PHYSICAL LAYER

The Physical Layer of LRIT 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.

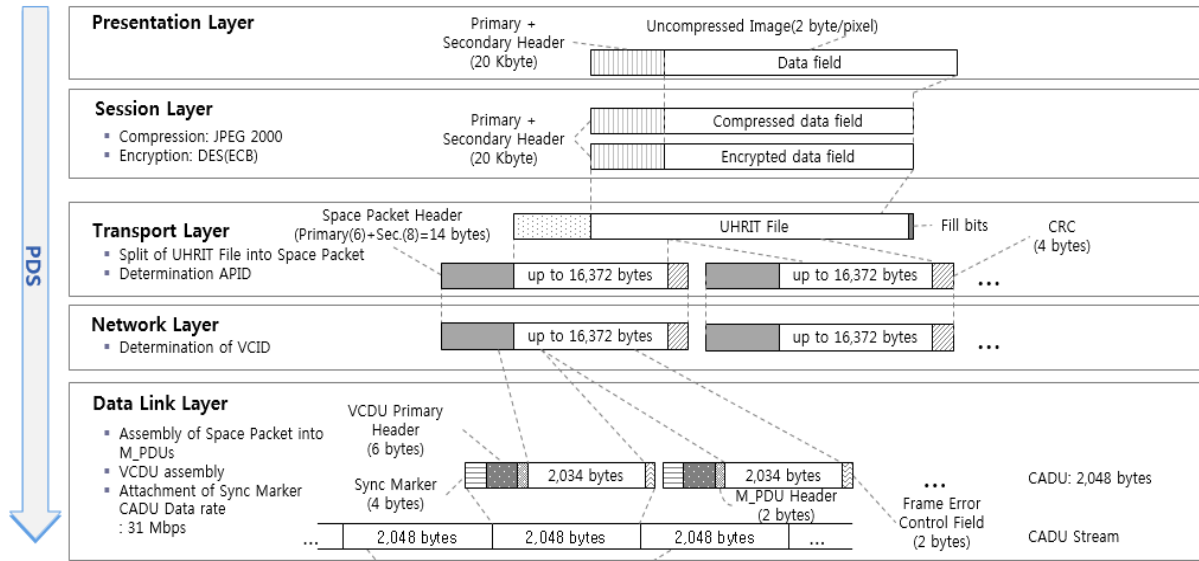
**Table 9.1 Parameters of LRIT Communication Link**

Parameters	Values
Downloading frequency	1692.14 MHz
Bandwidth	$\leq 1$ MHz
Information data rate*	$\leq 64$ kbps
Satellite EIRP	25 dBW
Minimum G/T of ground antenna (MDUS)	1.9 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/BPSK
Length of one CADU	1024 bytes

\* Information data rate is the LRIT CADU data rate prior to convolution encoding.

# APPENDIX

## Appendix A: GK2A LRIT 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 determined 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