COMS LRIT Mission

Specification

Signature Field				
	Name	Role	Signature	Date(MM/DD/YY)
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Change Control Sheet

Rev. No	Date	Affected Section/Paragraph/Page	Description
New		all	First official release
A	4/September/2006	10	1.2 Document Structure(Chapter is modified and added)
		13	3.1 Data Type(Title is modified) Figure 2(modified)
		14	3.1.1.2.1 APNH Image(Image size is changed) Figure 3(modified) 3.1.1.2.2 ENH Image(Image size is changed) Figure 4(modified)
		15	3.1.1.2.3 LSH Image(Image size is changed) Figure 5(modified) 3.1.1.2.4. LFH Image(deleted) Figure 6(deleted) 3.1.2. Ancillary Data(Explanation of ancillary data is modified and added) Table 1(LFH is deleted, Ancillary data is added) Table 2(deleted) 4.1 File Name(4.1 is moved to 4.4)
		16	4.1.1 Segmentation of Image Data (Explanation of segmentation is modified) 4.2 COMS LRIT File type(Title is modified) Table 2(Title is modified, Contents of file type are added and modified, LFH is deleted)
		18	Table 3(File Type_code is added and modified)
		19	4.3.2. Header Type #1-Image Structure(The value of NC, NL are changed, LFH is deleted) 4.3.3. Header Type #2-Image Navigation(Projection_Name is changed, the value of CFAC, LFAC, COFF, LOFF is changed)
		20	Table 7(Header_Record_Length is changed)
		21	Table 10(Header_Record_Length is changed) Table 11(Key_Number is modified)
		22	4.3.9.Header Type #128-Image Segmentation Identification(Explanation of segmentation is modified) Table 13(Enc_Key_Number is modified) 4.4.2 Projection Name(LFH is deleted)
		23	4.4.3. Spectral Channel(File name of spectral is changed) Table 15 (Content of File type is added and modified)
		25	Figure 8(modified)
		26	5.2.1. Structure of DES Encryption Key(Explanation is modified) Figure10(modified)

		27	Figure 11(modified) 6. TRANSPORT LAYER(File_Counter is changed)
		28	Table 16(APID is changed and added)
		30	9.PHYSICAL LAYER(Explanation is added)
		31	Figure 18(modified)
B	15/November/2006	32	11.APPENDIX B(Table 17 is added)
C	12/January/2007	13	3.1.1.2.1 APNH Image(Image size is changed) 3.1.1.2.2 ENH Image(Image size is changed) 3.1.1.2.3 LSH Image(Image size is changed)
		14	3.1.1.3 Segmentation of Image Data (Segmentation number is changed)
		15	Table 1 (Data is added)
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		18	4.1.2.2 Header Type #1 - Image Structure (NC, NL is changed)
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		22	4.2.3 Spectral Channel (Spectral channel is modified) 4.2.5 Sequence Number (Sequence number is modified) Table 18 (File Type is added)
		25	Figure 10 (modified)
		26	Figure 11 (modified)
		27	6. Transport layer (modified)
		28	Table 16 (APID is modified)
		35	Adding Table 17. Parameters of LRIT communication link according to [RID MF-3]
		36	Figure 19 (new)
		37	Table 18 (new)
D	14 Jan, 2008		Projection name: The COMS orbit is fixed as 128.2 degree east.
E	31 March, 2009	Section 4.1.2	COMS LRIT Header Types were updated
		Table 5, section 4.4.7	Header type #6 is not used
F	12 May, 2009	Section 4.4.1	Padding data information caused from DES encryption is appended to the data size
G	6 July, 2009	Section 4.5.1	Fixing typos

H	30 July, 2009	Section 9	The formal polarization direction is not changed to E-W. (COMS.ICD.00015.DP.T.ASTR Issue 3)
I	14 January, 2010	Section 9	The maximum information data rate and polarization direction was changed according to COMS.ICD.00015.DP.T.ASTR Issue 4
			Add detailed information about Convolutional coding with Viterbi decoding

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List of Acronyms

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
CP_PDU	CCSDS Path Protocol Data Unit
DES	Data Encryption Standard
ECB	Electronic Code Book (DES mode)
ENH	Extended Northern Hemisphere
FD	Full Disk
GRIB	Gridded Binary
GTS	Global Telecommunication System
LRIT	High Rate Information Transmission
IDCS	Internal Data Collection System
IMPS	Image Preprocessing Subsystem
ISO	International Organization for Standardization
JPEG	Joint Photographic Expert Group
KARI	Korea Aerospace Research Institute
KMA	Korea Meteorological Agency
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
VCDU	Virtual Channel Data Unit

1. INTRODUCTION

1.1 IDENTIFICATION

The COMS system will basically follow the global specification of the Coordination Group of Meteorological Satellites (CGMS) [AD1] in the low/high rate information transmission services (LRIT/LRIT).

This document is COMS LRIT Mission Specification which presents the communication procedures for the COMS LRIT services in both global and COMS mission specific characteristics.

The data communication structure will be described in the view of LRIT generation system (LHGS).The LRIT receiving system, small-scaled data utilization station (SDUS), can interpret them in reverse.

This document is parts of KARI's COMS GS documents and more detail information will be prepared by KMA, who is responsible for the COMS LRIT/LRIT services.

1.2 DOCUMENT OVERVIEW

This document is consisted as follows,

Chapter 1: Introduction
Chapter 2: COMS LRIT Communication Model
Chapter 3: Application Layer
Chapter 4: Presentation Layer
Chapter 5: Session Layer
Chapter 6: Transport Layer
Chapter 7: Network Layer
Chapter 8: Data Link Layer
Chapter 9: Physical Layer
Chapter 10: APPENDIX A – COMS LRIT DATA STRUCTURE OF EACH LAYER

1.3 APPLICABLE DOCUMENT

[AD1] CGMS, Coordination Group for Meteorological Satellites LRIT/LRIT Global Specification, CGMS03 Issue 2.6

1.4 REFERENCE DOCUMENTS

[RD1] ISO: 'Information Processing System - Open System Interconnection - Basic Reference Model' ISO standard 7498, Feb. 1982.
[RD2] CCSDS: 'Advanced Orbiting Systems, Networks and Data links: Architectural Specification' CCSDS Recommendation 701.0-B2, Nov. 1992.
[RD3] KMA, 'COMS-1: Requirements for Proposal in Meteorological Observation Mission', KMA/COMS/URD/001, Apr. 2004.
[RD4] KMA,'COMS MI LRIT Contents and Format', COMS GS-IPT-004, 13 Nov. 2006.
[RD5] KMA, COMS MI 사용자용 conversion table 서비스 방안, COMS GS LHGS-002, 24 Apr. 2007.
[RD6] CCSDS: 'Time code formats', CCSDS recommendation 301.0-B-1 April 1990
[RD7] ISO: 'Information Technology - Digital Compression and Coding of Continuous-tone Still Image - Requirements and Guidelines, Compliance Testing and Extensions' ISO standards 10918-1, 10918, DIS 10913-3
[RD8] 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
[RD9] CCSDS: 'Telemetry channel coding', CCSDS recommendation 101.0-B-4, May 1999.

2. COMS LRIT COMMUNICATION MODEL

The COMS LRIT dissemination service is based on the Open Systems Interconnection (OSI) Reference Model in [RD1] and the CCSDS AOS in [RD2].

Table 1 presents the functionalities of the each OSI layer from the view of dissemination system.

Table 1. OSI Layer Functionalities for the COMS LRIT Service

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

Figure 1 shows hierarchical data structures of each layer of the LHGS/SDUS systems through the COMS LRIT dissemination services. Remained sections in this document will describe details of each layer in top-down direction in the corresponding chapter.

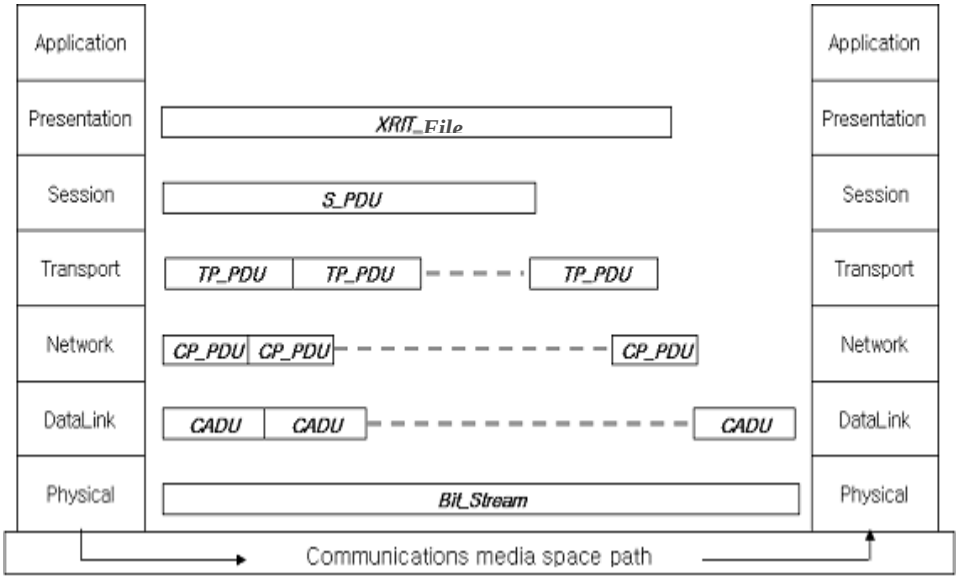


Figure 1. COMS LHGS/SDUS Communication Models

3. APPLICATION LAYER

The COMS LHGS is provided specific application data from external systems in the Application Layer as follows,

- Image data : COMS MI_1B_BLOCK files from IMPS
- Additional data:
  - Alphanumeric text file from IDCS
  - Encryption key message from IDCS
  - CMDPS analysis data
  - Numerical weather product (NWP) model from IDCS
  - GOCI image data
  - Typhoon information from IDCS

3.1 Image Data

The COMS MI is an ITT imager which has been proven through GOES series and MTSAT-2. The MI raw data received on ground is pre-processed in blocks of several lines to follow real-time operation requirements. The image data for generating HRIT is MI_1B_BLOCK which is geometrically and radiometrically preprocessed MI image data delivered from IMPS to generate LRIT files.

The image data of COMS LRIT has following observation modes,

- FD : Full disk
- ENH : Extended Northern Hemisphere
- LSH: Limited Southern Hemisphere
- APNH : Asia and Pacific in Northern Hemisphere

The MI will also perform LA (Local Area) around Korean Peninsula but processed LA images are not in the dissemination lists using S/C according to [RD3].

(a) FD

(b) ENH (Bold) (c) LSH (Dotted Line)

(d) APNH

Figure 2. Observation Modes in COMS LRIT Image Data (Source: [RD3])

The image data of COMS LRIT has different spectral channels w.r.t the dissemination time; (visible, IR1, WV) for day time and (SWIR, IR1, WV) for night times. Every image is GEOS projection image at COMS geosynchronous orbit, 128.2 degrees east. The MI_1B_BLOCK images of LRIT are 8-bit reduced resolution of MI images in the sub-sets of spectral bands and all observation modes.

Table 2 presents image sizes in each band and observation mode. The size of image is in order of width x height.

Table 2. Image Size in COMS LRIT Image Data [RD4]

Observation modes	Visible/Infrared Channels
FD	2,200 x 2,200
ENH	1,547 x 1,234
LSH	1,547 x 636
APNH	810 x 611

3.2 Additional Data

Alphanumeric Text
The alphanumeric text is a service operational message such as MI observation schedule, its corresponding LRIT dissemination schedule, newsletters and coefficients/algorithms update information. This file can be based on text files or images according to the KMA's policy.

Encryption Key Message
The encryption key message is certain sets of encrypted user keys which are required for description process at SDUS. This text messages is conform to the KMA's policy.

CMDPS analysis data
The sea surface temperature, fog, cloud information are disseminated through LRIT signal. The dissemination frequencies of each product are different from hourly to daily.

Numerical weather product (NWP) model
The atmospheric pressure, temperature, wind, atmospheric stability generated by KMA are disseminated twice a day in the format of GRIP or BURF.

GOCI image data

Another payload of the COMS, geostationary ocean color imager (GOCI), performs observation onto Korean peninsular ocean 10 times a day. The processed image data is disseminated to end-users through LRIT 8 times a day.

Typhoon information

The typhoon track prepared by KMA is disseminated twice a day in typhoon seasons. This file can be based on images.

4. PRESENTATION LAYER

The Presentation Layer handles image segmentation and LRIT file formatting. Both main functionalities and COMS LRIT file/header types will be explained in this chapter.

4.1 Segmentation of COMS LRIT Image Files

In case of MI_1B_Block, the files are gone through image segmentation process before being formatted into LRIT file. As one MI_1B_BLOCK pixel file has smaller line numbers rather than one segment, several MI_1B_BLOCK files are collected for generating one image segments.

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

Figure 3 shows the image segment structure of COMS LRIT FD. The column direction will be from West to East and the line direction will be from North to South.

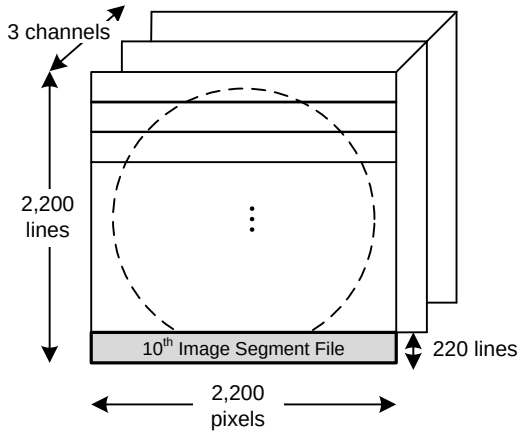


Figure 3. Segmentation of COMS LRIT Image (FD)

Table 3 presents image segment information of each observation mode. APNH image is not segmented.

Table 3. Segment Information of COMS LRIT Images

Observation modes	Segment files	1 segment size
		Visible/infrared channel
FD	10	2,000 x 200
ENH	4	1,547 x 309 (for 1st, 2nd) 1,547 x 308 (for 3rd, 4th)
LSH	2	1,547 x 318
APNH	1	810 x 611

4.2 Structure of COMS LRIT File

In the Presentation Layer, the application data from external systems in Chapter 3 is formatted into LRIT files. Figure 4 shows the COMS LRIT file structure. An LRIT file is composed of one or more header records and one data field. The primary header record defines file type and size of the complete LRIT file. The secondary header records include various information relating with the data field.

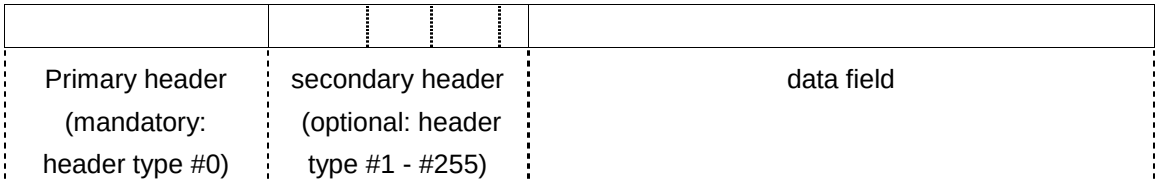


Figure 4. COMS LRIT File Structure

4.3 File Type of COMS LRIT File

Table 4 describes COMS LRIT file types. For the moment, three kinds of files mentioned in chapter 3 are contained in the data field of each LRIT file.

Global file types (0 ~ 127) have been defined for global uses according to [AD1] and mission specific file types (128~255) have been reserved for the future COMS LRIT service expansion.

Table 4. COMS LRIT File Types

File type code	File type	Application data in the data field
Global file types		
0	Image data	COMS MI Image Data (FD, APNH , ENH, LSH) in GEOS projection
1	GTS message	(Not used)
2	Alpha-numeric text	Administrative messages including observation/dissemination timetables and newsletter
3	Encryption key Message	Encrypted keys supporting COMS encryption scheme
4 ... 127	Reserved	(For further global use)
Mission specific file type		
128	CMDPS analysis data	Image data
129	NWP model	GRIB or BURF file
130	GOCI image data	Image data
131	Typhoon information	Image data
132 ... 255	Reserved	(For further mission specific use)

4.4 Header Records of COMS LRIT File

Table 5 shows COMS LRIT header types including primary and secondary header records. The header types from #0 to # 127 have already been defined in [AD1] and remained header types (from # 128 to # 255) are defined for the COMS LRIT missions.

Table 5. COMS LRIT Header Types

Code	Header types	Structure
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	(for further global usage)
Mission specific header types		
128	Image segment definition	Image segment file information
129	Encryption key message	(not used)
130 ... 255	Reserved	(for further mission specific use)

4.4.1 Header Type #0 – Primary Header

The structure of the COMS LRIT header type #0 is described in Table 6. This header provides the file type of 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 6. Primary Header

Primary Header Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 0
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to 16
File_Type_Code	::= unsigned integer (1byte), file type in Table 4 0 : Image data file 1 : GTS Message (not used) 2 : Alphanumeric text file 3 : Encryption key message 128 : CMDPS analysis data 129 : NWP data 130 : GOCI image data 131 : Typhoon information
Total_Header_Length	::= unsigned integer (4bytes), variable, total size of all header records.
Data_Field_Length	::= unsigned integer (8bytes), variable, total size of the LRIT file data file in bits, the value is finalized after the compression/encryption of data field

4.4.2 Header Type #1 - Image Structure

The structure of the COMS LRIT header type #1 is described in Table 7. This header provides number of bits per pixel (NB), number of columns (NC), number of lines (NL) of the image structure, and compression flag.

Table 7. Image Structure

Image Structure Record

Header_Type	::= unsigned integer (1byte), fixed value, set to 1
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to 9
NB	::= unsigned integer (1byte), number of bits per pixel
NC	::= unsigned integer (2bytes) number of columns
NL	::= unsigned integer (2bytes) number of lines
Compression_Flag	::= unsigned integer (1byte), compression method 0 : No compression 1 : Lossless compression 2 : Lossy compression

Explanations:

NB

The value of NB will be 8 bits for LRIT image data.

NC

The value of NC wil be :

FD : 2,200
ENH: 1,547
LSH: 1,547
APNH: 810

NL

The value of NL wil be the line number of one segment size:

FD : 200
ENH: 309 or 308
LSH: 318
APNH: 611

Compression_Flag

The value of flag will be defined according to the compression methods [RD7].

4.4.3 Header Type #2 - Image Navigation

The structure of the COMS LRIT header type #2 is described in Table 8. This header provides the information of image projection.

Table 8. Image Navigation

Image Navigation Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 2
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to 51
Projection_Name	::= character (32bytes), projection names defined in [AD 1] "GEOS(<sub_lon>)" ,
CFAC	::= integer (4bytes), column scaling factor defined in [AD 1]
LFAC	::= integer (4bytes), line scaling factor as defined in [AD 1]
COFF	::= integer (4bytes), column offset as defined in [AD 1]
LOFF	::= integer (4bytes), line offset as defined in [AD 1]

Explanations:

Projection_Name is “GEOS(128.2)”.

CFAC, LFAC, COFF, LOFF are identical for separate LRIT segment files.
Example values are as follows in case of FD,,
COFF = 1.37500000000E+03
CFAC = 1.02331285000E+07
LOFF = 1.37500000000E+03
LFAC = -1.02331285000E+07

4.4.4 Header Type #3 - Image Data Function

The structure of the COMS LRIT header type #3 is described in Table 9. This header provides the physical meaning of image pixels. It is the MI conversion table in piecewise linear format to define images which require establishing a relationship between their pixel count and physical units such as temperature or albedo.

Table 9. Image Data Function

Image Data Function record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 3
Header_Record_Length	::= unsigned integer (2bytes), variable value, max. 65535
Data_Definition_Block	::= character [ ], variable size and contents in accordance with [AD1]

Explanations:

Data_Definition_Block
Example is a conversion table in piecewise linear format as follows in [RD5]

```
CHANNEL:=IR1
$HALFTONE:=16
_NAME:=INFRARED
_UNIT:=KELVIN
0:=330.06
30:=327.69
60:=325.29
89:=322.92
117:=320.60
144:=318.32
171:=316.01
197:=313.74
```

4.4.5 Header Type #4 – Annotation Text

The structure of the COMS LRIT header type #4 is described in Table 10. This header provides the annotation record to allow more quick and easy detection of file contents. Image data shall be satisfied with chapter 4.1 and other files are set up appropriately.

Table 10. Annotation

Annotation Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 4
Header_Record_Length	::= unsigned integer (2bytes), variable value, max. 67
Annotation_Text	::= character [ ] used as file name

Explanations:

Annotation_Text

The file name of LRIT files is contained.

Examples are as follows,

IMG_APNH_01_IR1_20000912_061700.lrit	for image data
ADD_AMV_00_20000912_052500_00.lrit	for alphanumeric text
ADD_ENCMEG_00_20000912_052500_00.lrit	for encryption key message

Refer to section 4.5 for the formats of file name. ,

4.4.6 Header Type #5 – Time Stamp

The structure of the COMS LRIT header type #5 is described in Table 11. This header provides time information after compression and encryption processing in the Session Layer.

Table 11. Time Stamp

Time Stamp Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 5
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to10
CDS_P_Field	::= unsigned integer (1byte), P-Field fixed value according to [RD6] bit 0 (MSB) = '0' bits 1-3 = '100' bits 4-7 = '0000'
CDS_T_Field	::= unsigned integer (6bytes) 6 octets T-field according to [RD6]

Explanations:

According to CCSDS time format, the time code can be represented using Preamble (P) Field and Time Specification (T) Field. The P_Field defines the structure of T-Field and detailed information on the code.

CDS_P_Field

When bit 1-3 of P_Field is '100', it indicates that the time code is identified with CCSDS Binary Day Count Code (CDS).

CDS_T_Field

16 bits	Contiguous day counter from 1 January 1958 starting with 0
32 bits	Milliseconds of day

Submiliseconds segment is not used.

4.4.7 Header Type #6 – Ancillary Text

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

4.4.8 Header Type #7 – Key Header

The structure of the COMS LRIT header type #7 is described in Table 12. This header provides the number of used encryption key.

Table 12. Key Header

Key Header Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 7
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to 7
Key_Number	::= unsigned integer (4bytes), index of the used encryption key

Explanations:

Key_Number
The key number of used encryption key is contained. The key numbers for user stations are managed by KMA and the key groups will be regenerated regularly for security.

This value is '00 00 00 00' when encryption is not applied.

4.4.9 Header Type #128 – Image Segmentation Identification

The structure of the COMS LRIT header type #128 is described in Table 13. This header provides information of the region for image-segmentation.

Table 13. Image Segment Identification

Image Segment Identification Record	
Header_Type	::= unsigned integer (1byte), fixed value, set to 128
Header_Record_Length	::= unsigned integer (2bytes), fixed value, set to 7
Image_Segm_Seq_No	::= unsigned integer (1byte),image segment sequence number
Total_No_Image_Segm	::= unsigned integer (1byte), total number of Image segments
Line_No_Image_Segm	::= unsigned integer (2bytes), line number of the image segment

Explanations:

Image_Segm_Seq_No
FD : 1 ~ 10
ENH : 1 ~ 4
LSH: 1 ~ 2
APNH: 1

Total_No_Image_Segm
FD : 10
ENH : 4
LSH: 2

APNH: 1

Line_No_Image_Segm
FD : 200
ENH : 309 or 308
LSH: 318
APNH: 611

4.4.10 Header Type #129 – Encryption Key Message Header

Not used for COMS LRIT services.

4.5 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 File Name of Image Data

The example of LRIT file name of image data is,
ex) IMG_FD_01_VIS_20000912_061700_03.LRIT

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

	File type	Observation Mode	Sequence #	Spectral Channel	Dissemination Time	Segment File #	Extension
	IMG_	AB_	NN_	CH_	YYYYMMDD_hhmmss_	NN	.xrit
size	4 bytes (fixed)	Maximum 8 bytes	3 bytes (fixed)	Maximum 5 bytes	16 bytes (fixed)	2 bytes (fixed)	5bytes (fixed)
ex)	IMG_	FD_	01_	VIS_	20000912_061700	03	.lrit

The observation mode can be one of followings,
: FD_
: APNH_
: ENH_
: LSH_

The sequence number has maximum two digits to indicate dissemination order of each observation mode a day.

The spectral channel can be one of followings,
: VIS_
: SWIR_
: WV_
: IR1_
: IR2

The segment file number can be determined according to the observation mode,
: 01 ~ 10 (FD)
: 01 ~ 04 (ENH)
: 01 ~ 02 (LSH)

: 01 (APNH)

4.5.2 File Name of Additional Data

The example of LRIT file name of additional data is,
ex) ADD_ENCMEG_00_20000912_052500_00.LRIT

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

	File type	Abbreviation of Additional Data	Sequence #	Dissemination Time	Segment File #	Extension
	ADD_	AB _	NN_	YYYYMMDD_hhmmss_	NN	.xrit
size	4 bytes (fixed)	Maximum 8 bytes	3 bytes (fixed)	16 bytes(fixed)	2 bytes (fixed)	5bytes (fixed)
ex)	ADD_	ENHMEG _	00_	20000912_052500_	00	.hrit

The abbreviation of additional data can be one of followings,
: ANT_
: ENHMEG_
: AMV_
: NWP_
:GOCI_
:TYP_

4.6 File Type vs. Header Implementation

Table 14 defines the COMS LRIT mission specific use of header record types within certain LRIT file types.

Table 14. Use of Header Records vs. File Type

File types	Header record types								
	0	1	2	3	4	5	6	7	128
0: Image data file	●	●	◎	◎	◎	◎		◎	◎
2: Alphanumeric text file	●				◎	◎		◎	
3: Encryption key message	●				◎	◎		◎	
128: CMDPS analysis data	●				◎	◎		◎	
129: NWP data	●				◎	◎		◎	
130: GOCI image data	●				◎	◎		◎	
131: Typhoon information	●				◎	◎		◎	

● **As requested by** [AD 1] ◎ **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 generates S_PDU by applying to each LRIT file from the Presentation Layer in the order of compression and encryption.

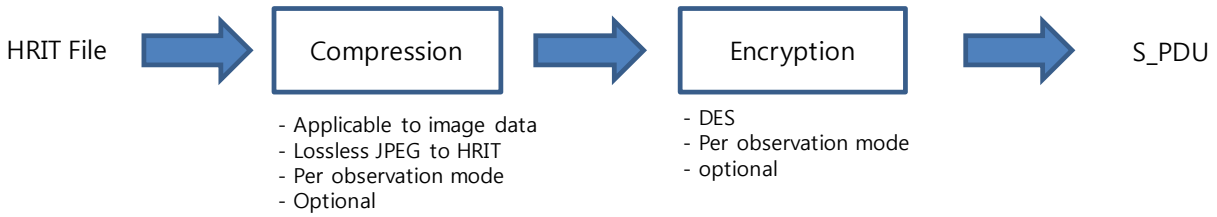


Figure 5. Session Layer Processing

The output is S_PDU containing the compressed and encrypted data field as shown in next figure.

Figure 6. Session Layer Output (S_PDU)

5.1 JPEG Compression

The JPEG is chosen as the compression for the COMS LRIT service. KMA can choose one of lossy and lossless schemes and basically lossy JPEG is applied for COMS LRIT service.

The Compression_Flag of Header_Type #1 is set from 0 to 2 as below.

Header Type #1 - Compression_Flag of Image Structure

No compression: 0
JPEG lossless compression: 1
JPEG lossy compression: 2

5.2 DES Encryption

The encryption and decryption of COMS LRIT are based on a processing in accordance with the ECB (Electronic Code Book) mode of DES (Data Encryption Standard) [RD8]. The LRIT file is encrypted using an encryption master key managed by KMA. The inverse process, decryption, is also processed at SDUS at S/W level managed by KMA.

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 with size of 8190 bytes. The CP_PDU is the CCSDS Path Protocol Data Unit [RD2].

6.1 Transport File (TP_File)

In the Transport Layer, 10 byte TP_header is attached to the beginning of S_PDU and several bits (1~7) are filled at the end of S_PDU to make it in byte units. The structure of TP_File is shown in Figure 7 and TP_Header is described as below.

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

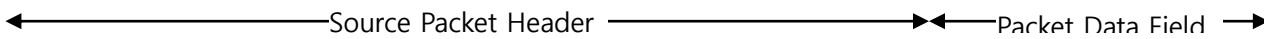
Figure 7. Transport File Structure

TP_Header (10 bytes)
- File_Counter (2 bytes)
  - VIS : 0 ~ 9
  - SWIR : 10 ~ 19
  - WV : 20 ~ 29
  - IR1 : 30 ~ 39
  - IR2 : 40 ~ 49
  - Others: 255
- File_Length (8 bytes): 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 COMS 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. The structure of CP_PDU is shown in Figure 8.



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 octets				2 octets		2 octets	Max. 8190 octets	2 octets

Figure 8. Source Packet Structure

Source packet header is described as below.

Source Packet Header (6 bytes)
- Version (3 bits) : 0 (fixed)
- Type (1 bit) : 0 (fixed)
- Secondary Header Flag (1 bit) : 1 (include header)
  0 (not include header)
- APID (11 bits)
- Sequence Flag (2 bits) : 11 (single data)
  01 (first segment)
  00 (continued segment)
  10 (last segment)
- Packet Sequence Counter (14 bits)
- Paket Length (16 bits)

APID of COMS LRIT is defined as Table 15. **APID** is allocated to each channel of image data and additional. Fill packet is defined as 2047.

Table 15. APID of COMS LRIT

Application Process Identifier (APID)	Application
0 : VIS 32: SWIR 64 : WV 96 : IR1 128 : IR2 160 : Alpha-numeric text 192 : Encryption key message 224: CMDPS analysis data 256 : NWP data 288 : GOCI data 320 : Binary data 352 : Typhoon information	COMS LRIT application data
353 ~ 2015	Reserved for COMS LRIT service expansion
2016 ~ 2046	Reserved by CCSDS
2047	Fill Packets

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 $g(x) = x^{16}+ x^{12}+x^5+1$ [AD 1].

7. NETWORK LAYER

The only function of Network Layer is to generate Virtual Channel ID (VCID) for each APID. According to [AD]1, The VCID is calculated by dividing APID by 32. The APIDs in Table 15 are mapped to VCIDs of Table 16. They are distributed between 0 ~ 62.

Table 16. VCID of COMS LRIT

Virtual Channel ID (VCID)	Application
0d : VIS 1d: SWIR 2d : WV 3d : IR1 4d : IR2 5d : Alphanumeric text 6d : Encryption key message 7d: CMDPS analysis data 8d : NWP data 9d : GOCI data 10d : Binary data 11d : Typhoon information	COMS LRIT application data
63d	Fill Packets

The CP_PDU in Figure 8 is transparently routed as multiple CCSDS Packets (M_SDU) to the Data Link Layer.

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 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.

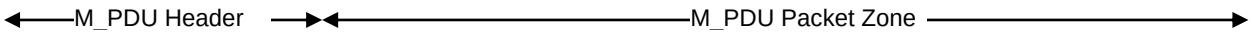
8.1 M_PDU

The M_PDU is composed of 884 bytes of multiple M_SDUs from the Transport Layer and 2 byte M_PDU Header. The M_PDU Header is defined as below.

M_PDU Header (2 bytes)
Spare (5 bits) : 0 (fixed)
First Header Point (11 bits)

First Header Point is the point which indicates the location of header of M_SDU. In case the consecutive M_SDUs are filled in the packet zone, it is 07FFh. Unless 07FFh, that means other M_SDU begins in the packet zone. When M_PDU has no more M_SDU, a fill packet is generated to complete the M_PDU in the size of 884 bytes. Refer to section of 5.3.8.2.2.3 [RD2] for fill packet generation.

The Structure of M_PDU is described in Figure 9 and the M_PDUs are passed to the VCA sub-layer service in (M_PDU, VCDU-ID).



Spare 5 bits	First Header Pointer 11 bit	End of M_SDU # (k-1)	M_SDU # (k)	M_SDU # (k+1)	…	Starting of M_SDU # (l)
2 octets		884 octets				

Figure 9. M_PDU Structure

8.2 VCDU

The M_PDUs are assembled in to VCDU according to [AD1].
The VCDU structure is shown in Figure 10 and VCDU primary header is defined as below.

VC_Header (6 bytes)
Version No (2 bits): 1 (fixed)
VCDU ID
S/C_ID (8 bits): C3h (11000011) [AD 2]
ID version for AOS (version 01: fixed)

VCID (6 bits): APID/32 (63d for Fill VCDUs)
VCDU Counter (24 bits)
Signal Field (7 bits): 0 (fixed)

VCDU Counter is the number of VCDU and reiterates from 0 to 16777215. **Signal Field** is not used and fixed in 0.

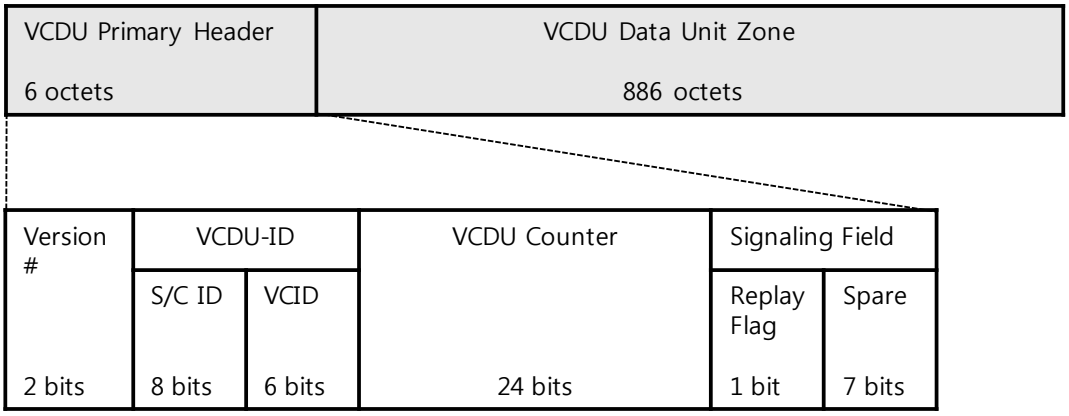


Figure 10. VCDU Structure

8.3 CVCDU

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 COMS LRIT services (255/223, 4). The RS code performs 64 bytes error detection and correction for CVCDU. The structure of CVCUD is shown in Figure 11.

Figure 11. CVCDU Structure

The randomization is applied to one CVCDU through the bitwise exclusive-OR process with the following polynomial to prevent random errors during LRIT transmission.

The pseudo-noise sequence is generated with this polynomial [AD],
$h(x) = x^8 + x^7 + x^5 + x^3 + 1$

8.4 CADU

The CADU is made of attachment of synchronization word (1ACFFCIDh') followed by randomized CVCDU. The structure of CADU is described in Figure 12.

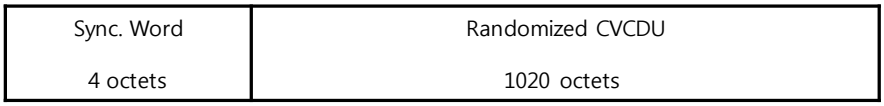


Figure 12. CADU Structure

The packetized data rate of CADU level is less than 3Mbps (including 3Mbps).

9. PHYSICAL LAYER

The Physical Layer of COMS LRIT performs the convolutional coding(r=1/2, K=7) of the serialized data stream and its modulation onto the RF up-link signal.
The COMS system follows basically the convolutional coding of [RD9], except symbol inversion on output path of G2.
The parameter sets of the physical layer are specified in the Table 17.

Table 17. Parameters of LRIT Communication Link

Parameters	Values
Downloading ceter frequency	1692.14 MHz
Bandwidth	≤ 1 MHz
Maximum Information data rate*	256 kbps
Satellite EIRP	55.0 dBm
Minimum G/T of ground antenna (SDUS)	1.9 dB/K
Maximum BER	10-8
Coding	Reed-Solomon (255/223, 4) and Convolutional 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 convolutional encoding.

APPENDIX A – COMS LRIT DATA STRUCTURE OF EACH LAYER

Following Figure describes the layer structure of COMS LRIT on the base of the data size.

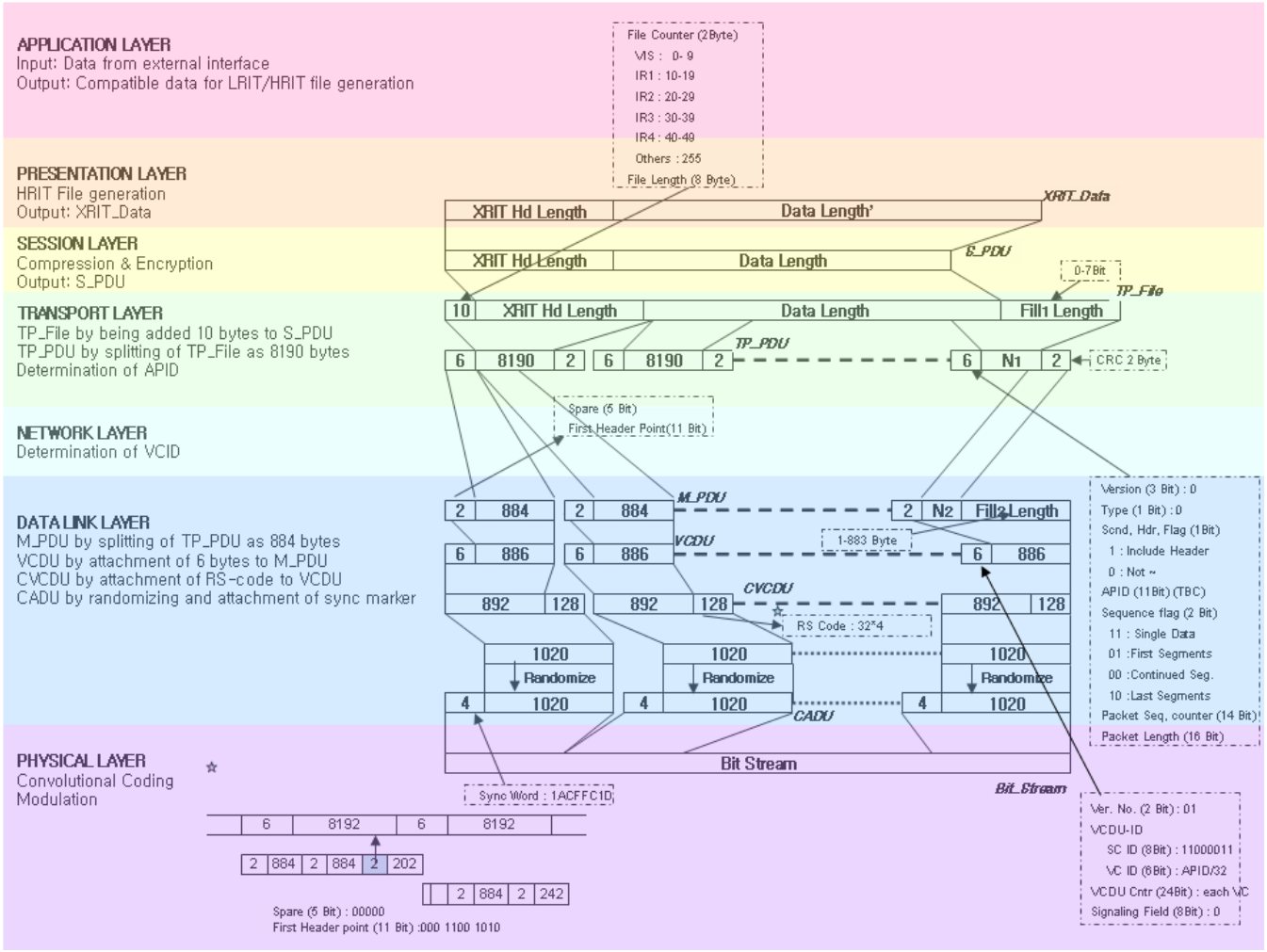


Figure 13. COMS LRIT Data Process of Each Layer