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LANDSAT 7 (L7) ENHANCED THEMATIC MAPPER PLUS (ETM+) LEVEL ZERO-R DISTRIBUTION PRODUCT (L0RP) DATA FORMAT CONTROL BOOK (DFCB)

Version 8.0

April 2007

LANDSAT 7 (L7)
ENHANCED THEMATIC MAPPER PLUS (ETM+)
LEVEL ZERO-R DISTRIBUTION PRODUCT (L0RP)
DATA FORMAT CONTROL BOOK (DFCB)

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Executive Summary

This document is the Data Format Control Book (DFCB) for the Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) Level Zero Reformatted (L0R) Distribution Product (L0Rp). It focuses on the Hierarchical Data Format (HDF) of the L0Rp product available from the U.S. Geological Survey (USGS) Center for Earth Resources Observation and Sciences (EROS) Landsat Archive Manager (LAM). HDF, a self-describing format, allows L0Rp products to be shared across different computer platforms without modification and is supported by a public domain software library consisting of access tools and various utilities.

The primary user product is L0R data, which is an essentially raw data form. A Landsat 7 product, however, does contain all of the ancillary data required to perform radiometric and geometric corrections. The Landsat 7 product also includes a Calibration Parameter File (CPF) generated by the Landsat 7 Image Assessment System (IAS). The CPF, which is updated at least four times a year, provides users with enhanced processing parameters for producing rectified image data of superior quality.

This DFCB is controlled by the Landsat Configuration Control Board (LCCB) and may be updated by a Landsat Configuration Control Request (LCCR) or a revision. Comments and questions regarding this document should be directed to:

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Section 1 Introduction

1.1 Introduction

This document is the Data Format Control Book (DFCB) for the Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) Level Zero-R Distribution Product (L0Rp). It focuses on the Hierarchical Data Format (HDF) of the Landsat 7 L0R product available from the Center for Earth Resources Observation and Science (EROS) Landsat Archive Manager (LAM).

1.2 Product Overview

A Landsat 7 product contains all of the ancillary data required to perform these corrections, including a Calibration Parameter File (CPF) generated by the Landsat 7 Image Assessment System (IAS). The CPF, which is updated at least four times a year, provides users with enhanced processing parameters for producing rectified image data of superior quality.

The product delivered to Landsat 7 data users is packaged in Hierarchical Data Format (HDF). HDF is a self-describing format that allows an application to interpret the structure and contents of a file without outside information. HDF allows Landsat L0Rp products to be shared across different computer platforms without modification and is supported by a public domain software library consisting of access tools and various utilities.

1.3 Purpose

This DFCB provides a high-level description of the Landsat 7 L0Rp distribution product, the HDF structuring mechanisms employed, and a detailed layout of the image and ancillary data formats.

The L0Rp format described in this DFCB is also used as a format for data interchange between International Ground Stations (IGSs). The DFCB explicitly describes the L0Rp product created by the U.S. but is flexible in its treatment of certain data fields that are potentially unique to the U.S. processing approach. These fields exist in both the binary and metadata files and are flagged with a unique fill value. The intent is to facilitate data interchange by defining an L0Rp product format that is easier for the IGS community to use and implement.

This DFCB also contains a section of HDF example programs as well as the methodologies employed by the LAM for populating certain L0Rp fields during product creation.

To make full use of the data, refer to the Landsat 7 Science Data User's Handbook (See References).

Section 2 Pre-Archive Processing

A basic knowledge of the pre-archive ground processing leads to a better understanding of the L0Rp product.

The Landsat Ground Station (LGS) acquires Enhanced Thematic Mapper Plus (ETM+) wideband data directly from the Landsat 7 spacecraft by way of two 150-megabit-per-second (Mbps) X-band return links, separates each X-band data into two 75-Mbps channels (I and Q), and transfers the acquired Raw Computer Compatible (RCC) data to the LAM for archiving and the Landsat Processing System (LPS) for the generation of Level Zero Reformatted Archive (L0Ra) data.

The LPS processes each channel of RCC data, at lower than real-time rates, into separate accumulations of Earth image data, calibration data, Mirror Scan Correction Data (MSCD), and Payload Correction Data (PCD). Channel accumulations represented by Bands 1 through 6 and 6 through 8 become formats 1 and 2, respectively. PCD and MSCD are generated twice, once for each format. Their contents should be identical.

LPS spatially reformats Earth imagery and calibration data into L0Ra data. This involves shifting pixels by integer amounts to account for the alternating forward-reverse scanning pattern of the ETM+ sensor, the odd-even detector arrangement within each band, and the detector offsets inherent to the focal plane array engineering design. All LPS L0Ra corrections are reversible; the pixel shift parameters used are documented in the IAS CPF (See References).

During LPS processing, format 1 bands are duplicated, radiometrically corrected, and used to assess cloud cover content and to generate browse. Cloud cover scores are generated on a scene-by-scene and quadrant-by-quadrant basis. Metadata are generated for the entire subinterval and on a scene-by-scene basis. The image data, PCD, MSCD, calibration data, and metadata are structured into HDF for each format and sent to the LAM for archiving in subinterval form. The two formats of data are united when a Landsat 7 L0Rp product is ordered. The browse is used as an online aid to ordering.

Section 3 Product Types

Three sizing options are available to a user when defining the size or spatial extent of a Landsat L0Rp product ordered from the LAM (See Figure 3-1).

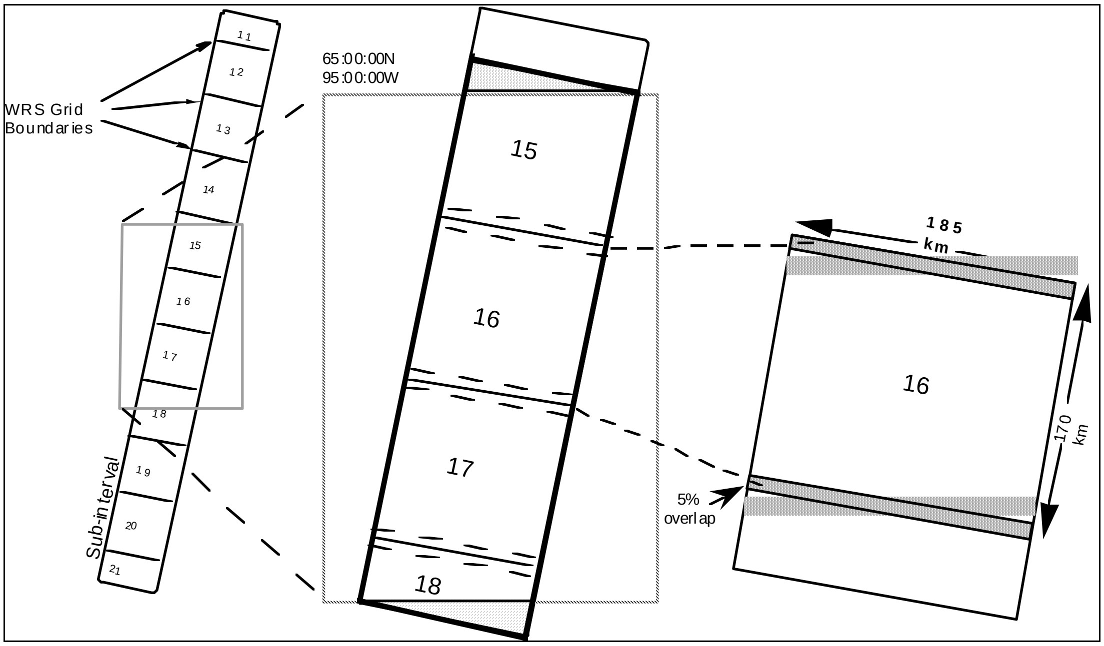

Figure 3-1. L0Rp Product Types

3.1 Standard Worldwide Reference System (WRS) Scene

The standard Worldwide Reference System (WRS) scene as defined for Landsats 4 and 5 was preserved as an orderable product for Landsat 7. The WRS indexes orbits (paths) and scene centers (rows) into a global grid system comprising 233 paths by 248 rows. The path/row notation was originally employed to provide a standard designator for every nominal scene center and allow straightforward referencing without using longitude and latitude coordinates.

The distance between WRS center points along a path is 161.1 kilometers (km). A path distance of 85 km before and after a WRS center point defines the standard scene length or ground distance of 170 km. The standard WRS scene overlaps neighboring scenes along a path by approximately five percent and has a width or cross-track distance of 185 km.

Landsat 7 browse is framed according to WRS scenes. An ordered scene will cover the same geographic extent observed in the browse. Standard WRS scenes have 375 scans. Partial scenes (fewer than 375 scans) may exist at the beginning or end of a subinterval because imaging events do not always start and end on scene boundaries. Browse and scene metadata for these occurrences accurately reflect their partial scene nature and geographic extent.

3.2 Subinterval

An interval is a scheduled ETM+ image period along a WRS path, and may be from 1 to 90 full scenes in length. A subinterval is a contiguous segment of data received during a Landsat 7 contact period. Subintervals are caused by breaks in the wideband data stream due to communication dropouts and/or the inability of the spacecraft to transmit a complete observation (interval) within a single Landsat 7 contact period. The largest possible subinterval is 35 full scenes long with a partial scene preamble and postamble. The smallest possible subinterval is a single ETM+ scene.

3.3 Partial Subinterval

The partial subinterval is dimensioned according to standard WRS scene width, is at least one half WRS scene in length (i.e., 182 scans), and can be up to an entire subinterval in length. A partial subinterval can float or be positioned at any scan starting point within a subinterval. Partial subintervals are defined by either specifying contiguous WRS locations, or defining a bounding longitude/latitude rectangle on a computerized map display. In the latter case, all scans touched by the bounding rectangle are included in their entirety.

Section 4 Product Content Overview

A complete scene-sized L0Rp product ordered from the LAM consists of 19 data sets derived from the wideband telemetry, an IAS-generated CPF, a product-specific metadata file, a geolocation index generated by the LAM, and an HDF directory. A brief description of each follows.

4.1 1–9 Earth Image Data

The unique bands of ETM+ image data comprise nine of the data sets. The data are laid out in a scan line sequential format in descending detector order (i.e., detector 16 followed by detector 15 and so on for the 30 meter bands). Table 4-1 lists the individual band characteristics. Band 6 is captured twice, once in low-gain (6L) and the other in high-gain (6H) mode. Under nominal satellite configuration, the low-gain form of Band 6 (6L) will be present in format 1.

Band Number	Wavelength (μm)	Resolution (meters)	Data Lines per Scan	Data Line Length (bytes)	Bits per Sample
1	.450–.515	30	16	6,600	8
2	.525–.605	30	16	6,600	8
3	.630–.690	30	16	6,600	8
4	.775–.900	30	16	6,600	8
5	1.550–1.750	30	16	6,600	8
6L	10.40–12.50	60	8	3,300	8
6H	10.40–12.50	60	8	3,300	8
7	2.090–2.35	30	16	6,600	8
8	.520–.900	15	32	13,200	8

Table 4-1. ETM+ Band Characteristics

4.2 10 Internal Calibrator (IC) Data – Format 1

Internal Calibrator (IC) data for format 1 consist of scan line ordered internal lamp and shutter data for Bands 1 through 5 and blackbody radiance and shutter data for Band 6L. The data are collected once per scan and structured in a band sequential format in descending detector order (e.g., detector 16 followed by detector 15 and so on for the 30-meter bands).

4.3 11 Internal Calibrator (IC) Data – Format 2

IC data for format 2 consist of scan-ordered internal lamp and shutter data for Bands 7 and 8 and blackbody radiance and shutter data for Band 6H. The data are collected once per scan and structured in a band sequential format in descending detector order (e.g., detector 16 followed by detector 15 and so on for the 30-meter bands).

4.4 12 MSCD – Format 1

A logical record of MSCD exists for each data scan present in the L0RP product ordered. Each logical record consists of three MSCD data values—the first half scan error, the second half scan error, and the scan line direction. This information, which actually applies to the previous scan, is used to compute deviations from nominal scan mirror profiles as measured on the ground and reported in the CPF. Also included in the MSCD file are scan-based values such as time code, gain status, and processing errors encountered by LPS. The MSCD are trimmed to fit the product ordered although one additional record is added to the file during the subsetting process because scan error and direction information corresponds to the previous scan.

4.5 13 MSCD – Format 2

A duplicate set of MSCD is generated when format 2 is processed and is kept with the product in the event that format 1 MSCD is lost or corrupted.

4.6 14 PCD – Format 1

The PCD for format 1 consist of attitude and ephemeris profiles as well as high-frequency jitter measurements. PCD for the entire subinterval are included with a U.S. generated L0RP product regardless of the size of the data set ordered. At a minimum, however, the PCD included will cover the time of the imagery plus at least an additional 6 seconds before and 18 seconds after the imagery start and stop times, respectively (unless limited by the boundaries of the PCD in the subinterval). The total PCD may, therefore, be less than the full subinterval when the L0Rp product is less than a subinterval. A full subinterval of PCD will always be delivered when the L0Rp product is a full subinterval.

4.7 15 PCD – Format 2

A duplicate set of PCD is generated when format 2 is processed and is kept with the product in the event that format 1 is lost or corrupted.

4.8 16 Scan Line Offsets – Format 1

During LPS processing, image data are shifted in an extended buffer to account for predetermined detector and band shifts, scan line length, and possible bumper wear. The scan line offsets represent the actual starting and ending pixel positions for valid (nonzero fill) Earth image data on a data-line-by-data-line basis for Bands 1 through 6L. The left starting pixel offsets also apply to the IC data. The right hand offsets for the Earth image and IC data do, in fact, differ and are reported separately.

4.9 17 Scan Line Offsets – Format 2

During LPS processing, image data are shifted in an extended buffer to account for predetermined detector and band shifts, scan line length, and possible bumper wear. The scan line offsets represent the actual starting and ending pixel positions for valid (nonzero fill) Earth image data on a data-line-by-data-line basis for Bands 6H through 8. The left starting pixel offsets also apply to the IC data. The right hand offsets for the Earth image and IC data do, in fact, differ and are reported separately.

4.10 18 Metadata – Format 1

During LPS format 1 processing, metadata are generated that characterize the subinterval's spatial extent, content, and data quality for Bands 1 through 6L. This file, in its entirety and original form, accompanies the L0Rp product.

4.11 19 Metadata – Format 2

Format 2 metadata are similar but not identical to format 1 metadata. The subinterval-related metadata contents are identical; the scene-related metadata are specific to Bands 6H, 7, and 8. Also, the format 2 metadata do not include cloud cover assessment data or references to browse data products. This file, in its entirety and original form, accompanies the L0Rp product.

4.12 20 Metadata – LAM

The LAM generates a third metadata file during order processing. This file contains product-specific information such as corner coordinates and the number of scans.

4.13 21 Geolocation Index

The LAM also produces the geolocation index. This table contains scene corner coordinates and their product-specific scan line numbers for bands at all three resolutions. Its purpose is to provide for efficient subsetting of an L0Rp product.

4.14 22 Calibration Parameters

The IAS regularly updates the CPF to reflect changing radiometric and geometric parameters required for Level 1 processing. These are stamped with applicability dates and sent to the LAM for storage and bundling with outbound L0Rp products.

4.15 23 HDF Directory

The HDF directory is a file containing all of the pointers, file size information, and data objects required to open and process the L0Rp product using the HDF library and interface routines.

A user may order a subset of the available bands that will affect the actual file count in an L0RP product (not on EROS's systems). In all cases, however, every product includes two PCD files, two MSCD files, three metadata files, the CPF, and the HDF directory. Only the IC, scan line offset, and Earth image file counts are affected by a product possessing less than the full complement of bands.

For non-U.S. processing systems, a product less than a full subinterval is often treated as a subinterval. The subinterval metadata will then characterize the actual subsetted data and not the parent subinterval; the scan line numbers provided in the geolocation index will then be line numbers in the product.

Section 5 Data Definition

5.1 HDF Conventions

5.1.1 File Structure

The L0Rp product files are created using the HDF function library developed by the National Center for Supercomputing Applications (NCSA). The product's design allows users to choose either low- or high-level programming tools from NCSA's HDF libraries. The product design does not preclude a user from developing original code for product access. All files are simple byte streams. There are no data records as such. Information about the basic structure of HDF files are in various NCSA and National Aeronautics and Space Administration (NASA) publications. The L0Rp product was baselined with HDF Version 4.1r1 and is compatible with HDF Version 4.1.1r2.

New users should begin with Getting Started with HDF, which provides an introduction to the concepts used in HDF file design and programming and will give the reader an appreciation for the design philosophy of the HDF software and file structure. Additionally, the HDF User's Guide and HDF Reference Manual are excellent resources for the HDF programmer. More advanced users can read NCSA HDF Specifications and Developer's Guide to learn about the low-level structure of HDF files.

5.1.2 Data Definition Terminology

Data structures are referred to using HDF terminology. Descriptions of structures relevant to the L0Rp product follow:

Scientific Data Set (SDS) – An array of data of any fixed dimensionality (rank) from 1 to 32767 and any one data type.

Vdata – A record-based structure where values are stored in fixed-length fields. Fields are defined, named, and typed individually. All records within a Vdata are identical in structure.

Vgroup – A structure for associating sets of data objects. Vgroups define logical relationships and may contain any HDF objects, including other Vgroups.

External Element – Data stored in a separate file, external to the basic HDF file. External elements allow for larger product sizes (e.g., up to 12 scenes) and the ability to read L0Rp products without using the HDF library.

5.1.3 Data Representation

Data are both binary and American Standard Code for Information Interchange (ASCII). Bit and byte ordering follow the Institute of Electrical and Electronics Engineers (IEEE) conventions. The term byte is synonymous with octet as used by the International Organization for Standardization (ISO).

5.1.4 Notation

Storage types are referred to using HDF number type nomenclature:

type#

where type is either char (character), int (integer), or float (floating point), and # is a decimal count of the number of bits used to represent the data type. The type mnemonics int and char may be preceded by the letter u, indicating an unsigned value. For example, the data type uint32 refers to an unsigned 32-bit integer value.

Table 5-1 lists the storage types relevant to the L0Rp product.

Data Type	HDF Nomenclature
8-bit character	char8
8-bit unsigned integer	uint8
16-bit signed integer	int16
16-bit unsigned integer	uint16
32-bit signed integer	int32
32-bit floating point number	float32
64-bit floating point number	float64

Table 5-1. L0Rp Storage Types

5.2 Structure Overview

The L0Rp product is packaged and distributed as a collection of external elements with an HDF data directory. It can be as large as 35 full scenes or as small as a 182-scan half scene. External elements are distinguished by the fact that they exist as separate files and contain only data. Information about their HDF structure and interrelationships is in the HDF directory.

The number of files or external elements composing an L0Rp product can vary according to product size (e.g., partial subinterval, subinterval) and the number of bands ordered. Assuming both subinterval formats have been archived, the following 10 files always accompany an L0Rp product:

1. HDF data directory
2. MSCD—format 1
3. MSCD—format 2
4. PCD—format 1
5. PCD—format 2
6. Metadata—format 1
7. Metadata—format 2
8. Metadata—LAM specific
9. CPF
10. Geolocation index

The Earth image data, IC data, and the scan line offset product components affect the file total in the following ways.

- Each Earth image band ordered is self-contained in a single file. The lone exception to this one-file-per-band rule occurs whenever a partial subinterval is ordered that is both greater than 12 scenes and includes the panchromatic band (Band 8). Due to an HDF file size restriction, the panchromatic band must be allocated to 2-gigabyte (GB) files. A 35-scene subinterval would thus require three such files or image segments.

- During LPS processing, IC Bands 1 through 6L are arranged in band sequential order in one file, while Bands 6H through 8 are arranged in a similar fashion in a second file. The IC data are subset according to scan lines and bands ordered, yet adhere to the band sequential two-file arrangement. For example, a product consisting of just one band would have a single IC file containing that band's pulse and shutter data. A product of nine bands includes the full complement of IC data in two files. A product with only two bands from different formats has two IC files with a single band each.

- Also during LPS processing, the starting and ending pixel numbers or scan line offsets are computed on a data-line-by-data-line basis for each band. The LPS stores these a separate file for each band but the LAM repackages these in a band sequential two-file arrangement similar to the IC data. The scan line offsets that accompany an L0Rp product are specific to ordered bands only.

Figure 5-1 shows the collection of external elements that compose a complete single scene L0R product. The nine bands of Earth image data are represented by nine SDS external elements. Bands sharing a common ground resolution are logically associated using the Vgroup data structure. Three Vgroups result: Bands 1 through 5 and 7, Bands 6L and 6H, and Band 8.

The nine bands of IC data follow an identical structure. Three groups are formed based on a common ground resolution. Two external elements are used to store the IC data. One file contains Bands 1 through 6L, and the other contains Bands 6H, 7, and 8.

The scan line offsets from format 1 and 2 are stored as two Vdata tables. One file contains the offsets for Bands 1 through 6L and the other contains Bands 6H through 8. The Vdata for each band are logically associated with their corresponding Earth image and IC SDS.

One geolocation index Vdata accompanies the product. Although the geolocation Vdata exists as a separate file, it is logically associated with each image and IC band using the Vgroup data structure.

The MSCD from formats 1 and 2 are stored as two Vdata tables and are logically grouped using the Vgroup data structure.

The PCD from formats 1 and 2 are stored as two Vdata tables and also are logically united.

The product also contains the two LPS-generated metadata files and a LAM-generated metadata file that is crafted during product generation. Metadata are stored as a Vdata table with one long ASCII-character field or string. The metadata files follow the Object Description Language (ODL) syntax.

The last element of the file is the IAS-generated calibration parameters. Calibration parameters are stored in a Vdata table composed of three-row ASCII-character fields or strings using the ODL syntax.

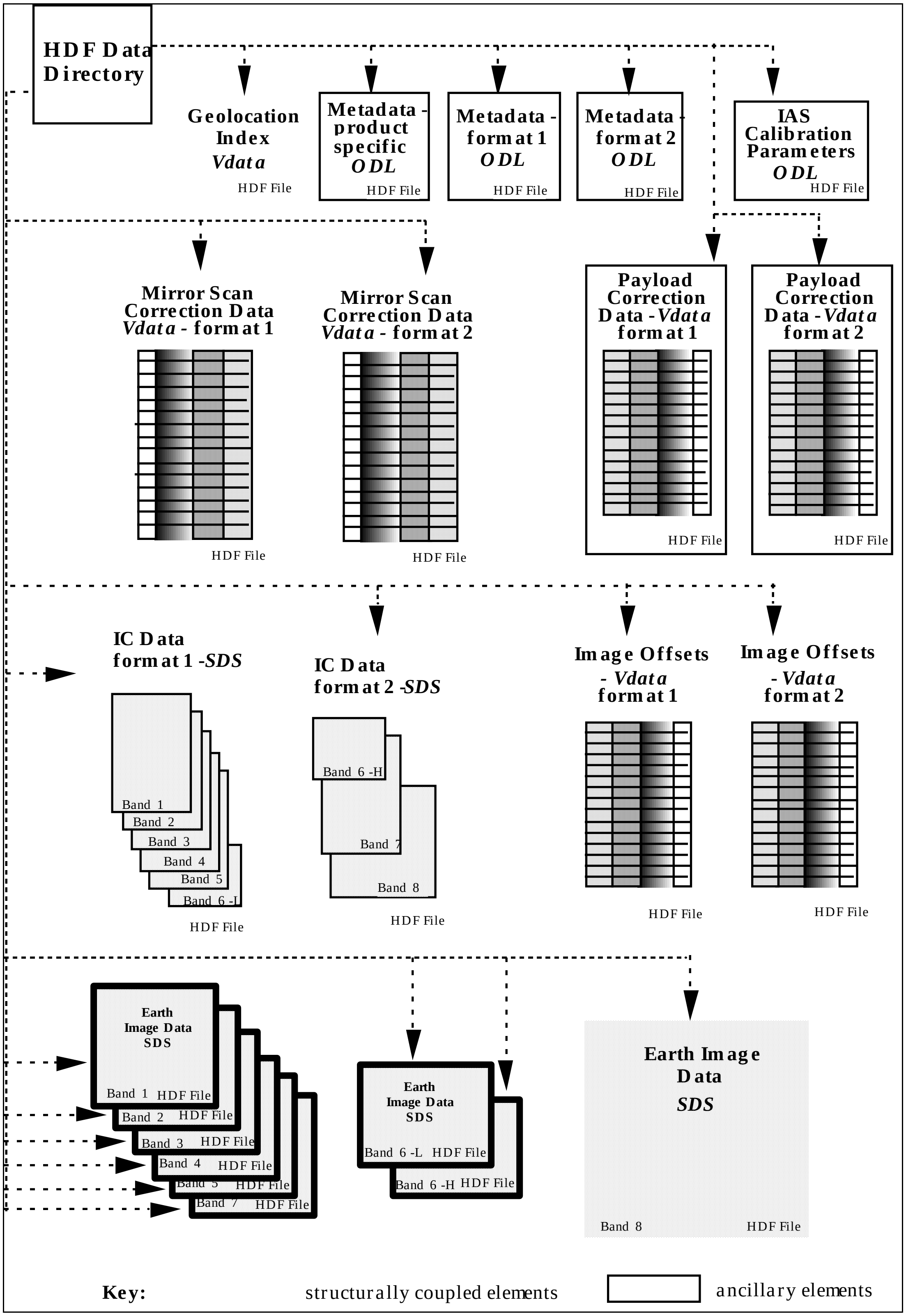

Figure 5-1. A Complete L0RP Scene Product - External Elements

5.3 Detailed Structure

5.3.1 Naming Conventions

All of the HDF data structure names, except the CPF, are derived using the following LPS file-naming notation:

Where **L7** indicates the Landsat 7 mission.

X = 0 - 9 for the Landsat 7 X-band used to downlink data to the LGS.

For LGS data, 1= XL (low frequency). 2 = XM (medium frequency). 3 = XH (high frequency). A value other than 1, 2, or 3 represents frequency unknown. For data received from other ground stations, the value in this position will be used as a unique identifier.

SSS indicates the data capture ground station such as LGS at Sioux Falls, AGS, or SGS. For a complete list of ground stations, refer to the Landsat Ground Station (GS) Identifiers document (see References).

The IGS identifier code is used for tapes received from other downlink sites. These codes can be found in the Landsat 7 to IGS Interface Control Document (ICD) (see References).

f indicates ETM+ data format (1 or 2). (The geolocation table, product-specific metadata, and HDF directory default to 1 if format 1 is present. If absent, the value 2 is used.)

n indicates processor number (0–9). For LPS, valid processors are 1-9. The value 0 indicates that the field is not applicable.

YY indicates the last two digits of the year associated with a contact period (not acquisition time).

DOY is the Julian day of year of the contact period.

HH is the hour of the contact period within a 24-hour day (00–23).

uu indicates a subinterval number within this contact period (00–99). The value 00 is used if the subinterval number is unknown.

vv indicates the data set version number (v = 00 for original or 01–99 for reprocessed data). The value 00 may also represent an unknown version number for non-U.S. processing systems.

xxx indicates the type of data [MSD for MSCD, PCD for PCD, GEO for the geolocation index B10 through B83 for Earth image data, C10 through C80 for the IC data, and O10 through O83 for the Scan Line Offsets (SLO)].

The LPS employs the B81, B82, B83 extensions for Band 8 when multiple files are required for storage. The HDF data structure name starts with B81 even if the product's Band 8 was extracted from the second or third LPS Band 8 file. Similar conventions are used when naming the scan line offsets data objects.

The CPF data structure name is derived from the CPF file name assigned by IAS. Its notation is as follows:

L7CPFYYYYMMDD_YYYYMMDD.nn

where YYYYMMDD is the effective start date and effective end date, respectively, and nn is the incrementing number within a 90-day period (00–99).

5.3.2 SDS Definitions

SDSs are used to store Earth image and IC data. These are simple byte arrays containing only image and no ancillary data. A one-to-one relationship exists for each band SDS data line and corresponding record in the scan line offset Vdata. SDS scan line time codes, scan numbers, and data line numbers exist in this Vdata and are used to unite the image data with the scan line offsets, MSCD, and PCD during Level 1 processing. One interesting note: scan and data line numbers for SDSs are referenced relative to the subinterval from which they were extracted. They do not start with the number ‘1’ unless the product includes the first scan in a subinterval.

Also worth noting is that during L0Rp processing, a fill pattern is used to distinguish good data from bad data. Two different fill patterns may be used: (1) odd detectors are filled with 0s (00000000), while even detectors are filled with 255s (11111111) or (2) all detectors (both odd and even) are filled with 0s (00000000). The LPS employs fill pattern 1. Data-filling is performed on a minor frame basis – if data are missing from part of a minor frame, the entire minor frame is filled.

When creating data objects, each object should be made appendable. Doing so will allow two similar data objects to be combined. This is necessary in order to append two Band 8 image files if they are split. Specifically, the HDF SDS image data object must be created with an unlimited dimension # 0 (first dimension). This would not affect reading or writing to the object.

5.3.2.1 ETM+ Earth Image Data

The ETM+ Earth image data for Bands 1 through 7 are structured as individual SDSs within separate files or external elements. This is true regardless of the type or size of the L0Rp product ordered (i.e., scene, partial subinterval, full subinterval). Band 8 requires special handling when a product exceeds 13 scenes in size (approximately 4734 scans) due to an HDF file size limit of 2 GB. Multiple files or external elements (up to three with a unique SDS in each) are used to store Band 8 for larger products. The L0Rp distribution product terminology employs the word segment when referring to the Band 8 data files. Table 5-2 lists the Earth image SDSs that compose the L0Rp product.

No.	SDS Name	Description	Number Type	Rank	Dimensions
1	"L7Xsss1nYYDOYHHuuvv.B10"	SDS containing 30-meter ETM+ Band 1 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
2	"L7Xsss1nYYDOYHHuuvv.B20"	SDS containing 30-meter ETM+ Band 2 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
3	"L7Xsss1nYYDOYHHuuvv.B30"	SDS containing 30-meter ETM+ Band 3 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
4	"L7Xsss1nYYDOYHHuuvv.B40"	SDS containing 30-meter ETM+ Band 4 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
5	"L7Xsss1nYYDOYHHuuvv.B50"	SDS containing 30-meter ETM+ Band 5 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
6	"L7Xsss1nYYDOYHHuuvv.B60"	SDS containing 60-meter ETM+ Band 6L Earth image data	uint8	2	Scan line count * 8 by 3300 (row major)
7	"L7Xsss2nYYDOYHHuuvv.B60"	SDS containing 60-meter ETM+ Band 6H Earth image data	uint8	2	Scan line count * 8 by 3300 (row major)
8	"L7Xsss2nYYDOYHHuuvv.B70"	SDS containing 30-meter ETM+ Band 7 Earth imagery	uint8	2	Scan line count * 16 by 6600 (row major)
9	"L7Xsss2nYYDOYHHuuvv.B81"	SDS containing ETM+ Band 8 15-m data, 1- or more segment product	uint8	2	Scan line count * 32 by 13200 (row major)
10	"L7Xsss2nYYDOYHHuuvv.B82"	SDS containing ETM+ Band 8 15-m data, 2- or more segment product	uint8	2	Scan line count * 32 by 13200 (row major)
11	"L7Xsss2nYYDOYHHuuvv.B83"	SDS containing ETM+ Band 8 15-m data, 3-segment product	uint8	2	Scan line count * 32 by 13200 (row major)

Table 5-2. L0Rp Earth Image SDSs

5.3.2.2 ETM+ IC Data

The ETM+ IC data are also structured as individual SDSs but not in a single SDS per file arrangement. Rather, one external element is used for Format 1 (i.e., Bands 1-6L) and another for Format 2 (i.e., Bands 6H, 7, and 8). The IC data are stored in a band sequential format with band numbers arranged in ascending order. The IC data that accompany a product are patterned after the image bands ordered. For example, if only Band 8 is ordered, one external element containing only Band 8 IC data is supplied. A product consisting of Bands 2, 4, 5, and 8 will be delivered with two IC external elements. One file contains SDSs for Bands 2, 4, and 5, while the other contains a single SDS for Band 8.

The number of Band 8 IC SDSs mirrors the number of Earth image SDSs in a product (i.e., a product with three Band 8 segments will have three Band 8 IC SDSs). Although all Band 8 IC data are stored in a single file, the multi-SDS data structure assists in preserving the relationships between IC data and Earth image data stored in multiple files. Table 5-3 lists the IC SDSs that compose the L0Rp product.

No.	SDS Name	Description	Number Type	Rank	Dimensions
1	"L7Xsss1nYYDOYHHuuvv.C10"	SDS containing ETM+ Band 1 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
2	"L7Xsss1nYYDOYHHuuvv.C20"	SDS containing ETM+ Band 2 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
3	"L7Xsss1nYYDOYHHuuvv.C30"	SDS containing ETM+ Band 3 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
4	"L7Xsss1nYYDOYHHuuvv.C40"	SDS containing ETM+ Band 4 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
5	"L7Xsss1nYYDOYHHuuvv.C50"	SDS containing ETM+ Band 5 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
6	"L7Xsss1nYYDOYHHuuvv.C60"	SDS containing ETM+ Band 6L calibration data	uint8	2	Scan line count * 8 by 725 (row major)
7	"L7Xsss2nYYDOYHHuuvv.C60"	SDS containing ETM+ Band 6H calibration data	uint8	2	Scan line count * 8 by 725 (row major)
8	"L7Xsss2nYYDOYHHuuvv.C70"	SDS containing ETM+ Band 7 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
9	"L7Xsss2nYYDOYHHuuvv.C81"	SDS containing ETM+ Band 8 calibration data	uint8	2	Segment 1 scan line count * 32 by 2900 (row major)
10	"L7Xsss2nYYDOYHHuuvv.C82"	SDS containing ETM+ Band 8 calibration data	uint8	2	Segment 2 scan line count * 32 by 2900 (row major)
11	"L7Xsss2nYYDOYHHuuvv.C83"	SDS containing ETM+ Band 8 calibration data	uint8	2	Segment 3 scan line count * 32 by 2900 (row major)

Table 5-3. L0Rp IC SDSs

5.3.3 Vdata Definitions

Vdata structures are employed to store MSCD, PCD, scan line offsets, metadata, and geolocation information for the product. All L0Rp Vdatas are designated full interlace, which organizes the Vdata on a record-by-record basis. This mode allows additional records to be appended.

5.3.3.1 MSCD Vdata

The number of MSCD Vdata records is equal to the number of data scans in the product plus one. The additional record is included because several fields reference the previous scan line. The spacecraft time associated with each ETM+ scan is provided in seconds since January 1, 1993, and is a Julian day, time-of-day format. The former is required for LAM software.

The Vdata format for the MSCD is neutral with respect to format 1 and format 2 data. The LPS should produce mirror copies of the MSCD file for both formats if they are received with the same MSCD minor frame words with the same errors.

Under noisy data input and poor data synchronization conditions, the values for most MSCD fields are generated through flywheel and interpolative methods. The MSCD fields SCAN_NO and TIME are examples of two such fields that can always be determined even if a major frame is entirely filled. However, some MSCD fields require fill patterns and/or flags in the event of an entirely filled ETM+ major frame. These are the GAIN_STATUS, MUX_ASSEMBLY_ID, and CAL_SHUTTER_STATUS fields. Their fill and flag values are listed below. Other affected fields that will be filled with a zero value include the EOL_LOCATION, FHS_VOTE, FHS_ERR, SHS_VOTE, SHS_ERR, CADU_SYNC, SCAN_SYNC, CADUS/VCDUS_RECEIVED, FLY_WHEEL_CADUS, BIT_SLIP_CADUS, R-S_ERR-CADUS, BCH_CORRECTED_VCDUS, BCH_UNCORRECTED_VCDUS, and MINF_FILLED fields.

Certain MSCD fields may not be observed or constructed by IGSs. The fields SCAN_DIR_VOTE, FHS_VOTE, SHS_VOTE, MINF_FAULTS, CADU_SYNC, BIT_SLIP_CADUS, R-S_ERR_VCDUS, BCH_CORRECTED_VCDUS, BCH_UNCORRECTED_VCDUS, and SCAN_SYNC will be assigned fill values if they are not computed or recorded.

Table 5-4 through Table 5-7 list the contents of the MSCD Vdatas for either format 1 or 2.

5.3.3.2 PCD Vdata

A PCD major frame is generated every 4.096 spacecraft seconds. Each record in the PCD Vdata represents a major frame and is uniquely identified by its associated spacecraft time, which is extracted or computed from raw PCD. The Vdata format for the PCD is neutral with respect to format 1 and format 2 data. The LPS produces mirror copies of the PCD file for both formats if they are received with the same PCD minor frame words with the same errors.

LPS puts out a fill value in the PCD data records when fields cannot be accurately constructed, computed, interpolated, or flywheeled from the available unpacked PCD words and minor frames in a PCD major frame. Fill values for all applicable fields are listed in Table 5-8 through Table 5-16. The fields CYCLE_COUNT and MAJF_COUNT are always calculated and thus never filled.

Certain PCD fields may not be observed or constructed by IGSs. The fields UNPACKED_PCD_WORDS, UNPACKED_WORDS_MISSING, VOTE_ERRORS, MINF_ID_ERRORS, MINF_FILLED, MAJF_FLAG, and TIMECODE_FLAG will be assigned fill values if they are not computed or recorded.

Table 5-8 through Table 5-16 list the contents of the PCD Vdatas for either format 1 or 2. All data in the table are presented in their respective engineering units except for the ETM+ thermistor temperatures. Coefficients found in the CPF are required for this conversion. See the Landsat 7 System Data Format Control Book (DFCB), Volume IV—Wideband Data for more details (see References).

5.3.3.3 Scan Line Offsets Vdata

The scan line offset tables provide the amount of zero-fill before actual scene and calibration data and after actual scene data on a data-line-by-data-line basis. Offsets result from the detector arrangement on the two focal planes, a scan line length that can vary from nominal, and the decision to include all data in the L0Rp product. There is one scan line offset Vdata per product band or band segment (i.e., Band 8). The number of Vdata records or entries is equal to the number of data lines in the corresponding band or band segment file.

Two external elements or files, one for each format, are used to store the scan line offset Vdatas. They are ordered or stacked in a band sequential format, which means all Band 1 records are followed by Band 2, followed by Band 3 and so on. Multisegment Band 8 Vdatas are sequentially ordered by ascending data line number.

Vdata Name: “L7XsssfnYYDOYHHuuvv.MSD”				
Vdata Class: LPS_MSCD				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 89				
Number of Records: One record per product scan line (major frame)				
Field Name	**Number Type**	**Order**	**Description**	**Remarks**
scan_no	uint16	1	Subinterval scan line counter values = 1–11725	Provides a sequence counter for the ETM+ scans (major frames) contained in a 0R product. This counter is referenced relative to the original subinterval, not the product ordered.
Time	float64	1	ETM+ scan time in seconds since midnight January 1, 1993, rounded to 7 decimal places	Time code conversion from scan_timecode (see next entry).
scan_timecode	char8	25	Scan line time of the format YYYY:ddd:hh:mm:ss:ttttttt where YYYY = 4-digit Julian year ddd = Day (01–366) hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds(00–59) ttttttt = Fractional seconds [0–9999375, where the clock cycle is 1/16 millisecond (ms)]	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this data record. A computed scan start time is provided if a valid time is not available from the time code minor frames. Time is expressed using the Greenwich Mean Time (GMT) standard.
timecode_flag	uint8	1	Valid timecode flag, where 0 = Valid timecode, 1 = Computed timecode	
eol_flag	uint8	1	Flag for valid End Of Line (EOL) pattern code: 0 = Valid pattern in expected minor frame location 1 = Missing EOL. The EOL pattern is not found at all. 2 = Valid pattern is found inside of the user-specified range but outside of the nominal range.	LPS needs an EOL code is needed by LPS to start calibration data extraction. If an EOL is missing, the nominal scan line length will be assumed. In this way, the pixel data may be salvaged, but the flag is needed to warn users that it may be suspect. However, calibration data would need to be filled because there is no way to know just where that started. A user-specified parameter gives the bilateral search zone around the nominal location for the EOL marker. The nominal range for the EOL marker is given in the eol_location field description.
eol_location	uint16	1	Minor frame location (number in the range: 6318–6323) The minor frame location (number) within a major frame that contains the first word of the ETM+ EOL code. The eol_flag reports eol_location errors.	The EOL is expected to occur within the vicinity of minor frame number 6,320 in each ETM+ major frame. The EOL code consists of two adjacent minor frames. The EOL indicates an end of the active scan period and start of a calibration data period past the Scan Line Data (SLD) words. If eol_flag = 1, LPS supplies the nominal location for eol_location.

Table 5-4. MSCD Vdata - Format 1 or 2 (1 of 4)

Field Name	Number Type	Order	Description	Remarks
scan_dir_vote	uint8	1	Scan direction majority vote quality 0 = All bits in all scan direction word groups are equal. 1 = At least 1 bit in the scan direction word groups is not equal to the other bits. 2 = Scan direction is not found for a missing and/or an entirely filled scan and is therefore interpolated from the previous scan if possible or is classified as unknown. 255 – May be used for fill value if not calculated.	A majority vote quality of 1 may indicate an error with the received and/or decoded scan direction value (back to back forward or reverse scans).
scan_dir	char8	1	Scan direction character F = Forward scan R = Reverse scan U = Unknown	The ETM+ scan direction is interpolated from SLD minor frames of the first valid ETM+ major frame. This scan direction is for the previous scan (major frame). If the scan direction is Unknown, the default Forward direction will be used for placing the data.
fhs_vote	uint8	1	First half scan (FHS) error majority vote quality 0 = All bits in each FHS error word group are equal. 1 = At least 1 bit in at least one FHS error word group is not equal to other bits in the group. 255 – May be used for fill value if not calculated.	A value of 1 indicates that the received/decoded fhs_err value is probably erroneous.
fhs_err	int16	1	FHS error count: –2048 to 2047 This is a 12-bit number provided in an int16 field using two's complement notation.	The FHS error is interpolated from the SLD minor frames of the ETM+ major frame. This value is for the previous scan.
shs_vote	uint8	1	Second Half Scan (SHS) error majority vote quality 0 = All bits in each SHS Error word group are equal. 1 = At least 1 bit in at least one SHS error word group is not equal to other bits in the group. 255 – May be used for fill value if not calculated.	A value of 1 indicates that the received/decoded shs_err value is probably in error.
shs_err	int16	1	SHS error count: -2048 to 2047 This is a 12-bit number provided in an int16 field using two's complement notation.	The SHS error is interpolated from the SLD minor frames of the ETM+ major frame. This value is for the previous scan.
gain_status	char8	9	"ggggggggg" where g's identify Bands 123456678 for both formats = 123456$$$ for format 1 = $$$$$$678 for format 2 where $ identifies unused fields g = L indicates a low-gain state g = H indicates a high-gain state g = Ns in all band positions indicates that gain values could not be found due to an entirely filled major frame.	For each band, the gain status is defined by the gain state value in the "PCD/Status Data" field of the first error-free Virtual Channel Data Unit (VCDU) containing data for the scan.

Table 5-5. MSCD Vdata - Format 1 or 2 (2 of 4)

Field Name	Number Type	Order	Description	Remarks
gain_change	char8	9	"ggggggggg" where g's identify Bands 123456678 for both formats = 123456$$$ for format 1 = $$$$$$678 for format 2 g = 0 in a band position indicates no gain change since last scan g = + in a band position indicates a gain from low to high g = – in a band position indicates a gain change from high to low	This value is 0 if it is the first scan of a subinterval.
mux_assembly_id	uint8	1	= 0–7, for Landsat 7 multiplexer assemblies 0–7 or = 9 to indicate that the mux_assembly_id value could not be extracted from an entirely filled major frame.	Identifies the Landsat 7 spacecraft onboard multiplexer used in the ETM+ dataflow for this major frame. The multiplexer status is obtained from the first error-free channel access data unit (CADU)/VCDU used to construct this major frame.
cal_shutter_status	uint8	1	0 = Primary shutter 1 = Backup shutter or = 9 to indicate that the cal_shutter_status value could not be extracted from an entirely filled major frame.	Identifies the Landsat 7 spacecraft internal calibration shutter status during the ETM+ data flow for this major frame. The CAL shutter status is obtained from the first error-free CADU/VCDU used to construct this major frame.
cadu_sync	uint8	1	Flag to indicate loss of CADU sync anywhere within the scan 0 = No loss 1 = Sync loss 255 – May be used for fill value if not calculated.	A sync loss condition indicates potential loss of minor frame data requiring LPS to use fill data in completing a major frame.
scan_sync	uint8	1	Flag for valid sync for current major frame 0 = Valid sync 1 = Flywheeled sync 255 – May be used for fill value if not calculated.	Valid sync = Line sync code was correctly found and decoded as specified in the Landsat 7 DFCB. Flywheeled sync: The sync in the current scan is forced "True" because the line sync code minor frame could not be correctly found and/or decoded as specified in the Landsat 7 DFCB. The presence of the line sync code was "deduced" from correctly finding/decoding the time code minor frames of an ETM+ major frame.
minf_faults	char8	1	An index (hexadecimal 0 through D and F) representing the number of minor frame faults (m) in the range: "0" for no faulty minor frames. "1" for 1 <= m <=2 "2" for 3<= m <= 4 "3" for 5<= m <= 8 "4" for 9 <= m <= 16 "5" for 17 <= m <= 32 "6" for 33 <= m <= 64	LPS computes this quality index on a major frame basis. This index provides a quick assessment regarding the number of faulty minor frames contained in a major frame. Faulty minor frames contain fill data or are extracted from VCDUs containing uncorrected BCH errors. Lower quality indices indicate better quality major frames.

Table 5-6. MSCD Vdata - Format 1 or 2 (3 of 4)

Field Name	Number Type	Order	Description	Remarks
			"7" for 65 <= m <= 128 "8" for 129 <= m <= 256 "9" for 257 <= m <= 512 "A" for 513 <= m<= 1024 "B" for 1025 <= m <= 2048 "C" for 2049 <= m <= 4096 "D" for 4097 <= m <= NNNN "F" May be used for fill value if not calculated. NNNN is an LPS operator-selectable parameter for the maximum number of minor frames possible in an ETM+ major frame.	Without bumper wear, there is a nominal of 7,473 minor frames in an ETM+ major frame. Accounting for 17 minor frames of bumper wear on each end of the scanner (LPS design assumption), there could be a maximum of 7,507 minor frames in an ETM+ major frame.
cadus/vcdus_ received	uint16	1	= 0–650 Approximately 643 VCDUs are required to build one ETM+ major frame (~7,473 minor frames).	The number of VCDUs used to construct this ETM+ major frame.
fly_wheel_cadus	uint16	1	= 0–650	The total number of flywheel CADUs/VCDUs in this ETM+ major frame.
bit_slip_cadus	uint16	1	= 0–650 65535 - May be used for fill value if not calculated.	The total number of CADUs/ VCDUs detected with bit slip errors in this ETM+ major frame.
r-s_err_vcdus	uint16	1	= 0–650 65535 - May be used for fill value if not calculated.	The number of VCDUs with Reed-Solomon error used in building this ETM+ major frame.
bch_corrected_ vcdus	uint16	1	= 0–650 65535 - May be used for fill value if not calculated.	The total number of VCDUs containing corrected BCH errors in this major frame.
bch_uncorrected_ vcdus	uint16	1	= 0–650 65535 - May be used for fill value if not calculated.	The total number of VCDUs containing uncorrected BCH errors in this major frame.
filled_scan_flag	uint8	1	0 = No fill data used in this scan 1 = Entirely filled scan 2 = Partially filled scan	This flag indicates whether any predetermined fill data were used to build this ETM+ scan (major frame). There are nominal 7,473 minor frames in a scan.
minf_filled	uint16	1	= 0–7500	The total number of filled minor frames in this ETM+ major frame. There are nominal 7,473 minor frames in a scan.
minf_received	float32	1	Number of minor frames received in the major frame including the fractional part contained in last minor frame.	There are a nominal 7,473 minor frames in a scan with a final minor frame typically being some number less than the nominal 85 bytes.

Table 5-7. MSCD Vdata - Format 1 or 2 (4 of 4)

Vdata Name: "L7XsssfnYYDOYHHuuvv.PCD"				
Vdata Class: LPS_PCD				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 26,514				
Field Name	**Number Type**	**Count**	**Description**	**Remarks**
cycle_count	uint8	1	PCD cycle number (00–99) There are approximately 52 PCD cycles in a 14-minute subinterval.	The PCD cycle number associated with PCD major frame reported in this record of the PCD file. A PCD cycle consists of a set of four consecutive PCD major frames: (0), (1), (2), and (3). This number is incremented by one for each PCD major frame.
majf_count	uint8	1	Major frame counter (001–255) The maximum number of PCD major frames in a 14-minute subinterval is 206.	The major frame counter value of the PCD major frame reported in this record of the subinterval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.
majf_id	uint8	1	PCD major frame ID (0–3) Fill value = 255	PCD major frame (0) is identified by the presence of spacecraft ID and timecode information. Other PCD major frames are identified by their ID numbers (1–3).
majf_time	float64	1	PCD major frame time in GMT integer and fractional seconds since January 1, 1993, rounded to 7 decimal places. Fill value = –10	This time is the PCD major frame time (majf_timecode; see next entry) converted by LPS to seconds since January 1, 1993.
scan_timecode	char8	25	Scan line time of the form YYYY:ddd:hh:mm:ss.ttttttt where YYYY = 4-digit Julian year ddd = Julian day (001–366) hh = Hours (00–23) ss = Seconds (00–59) ttttttt = Fractional seconds (0–9999375, where the clock cycle is 1/16 ms) Fill value = $$$$....	For PCD major frame (0), the spacecraft time is extracted from PCD major frame (0) of a PCD cycle. For PCD major frames 1–3, the spacecraft timecode is interpolated using the time received for PCD major frame (0) of the associated PCD cycle. Time is expressed using the GMT standard. Fill value occurs at the beginning of the PCD file when there has not yet been a valid major frame (0) or there is a missing cycle.
bands_state	char8	8	Indicates ETM+ bands on/off states for format 1 and format 2 data. = 12345678 for all bands "ON" state in format 1 and format 2 data. A "–" indicates an off state or a missing band (e.g., "123–5678" means Band 4 is off or missing). Fill value = $$$$$$$$	This information is extracted from the third PCD major frame, minor frame 32, word 72, bits 0–6 and major frame 2, minor frame 35, word 72, bit 0.
fac_flag	uint8	1	Full Aperture Calibration (FAC) door flag: = 0 indicates no activity = 1 indicates calibration door activity (open and/or imaging) Fill value = 255	ETM+ calibration activity status. This status is interpolated from "serial word P" of the third PCD major frame, minor frame 84, word 72, bits 2 and 3.

Table 5-8. PCD Vdata - Format 1 or 2 (1 of 9)

Field Name	Number Type	Count	Description	Remarks
PCD Major Frame Quality and Accounting Data Except for majf_flag and timecode_flag, which have fill or missing indicators, the value 0 is used for an entirely filled major frame.				
unpacked_pcd_ words	uint32	1	= 0–147,538497 unpacked PCD words received for this major frame. 4,294,967,296 – May be used for fill value if not calculated.	Count of unpacked PCD words received for this PCD major frame. For a full major frame, the range of values should be between 147,508 and 147,538.
unpacked_words_ missing	uint32	1	= 0–147,538497 unpacked PCD words missing for this major frame. 4,294,967,296 – May be used for fill value if not calculated.	Count of unpacked PCD words identified as missing due to missing VCDUs (based on 4 PCD words per VCDU). Some received PCD major frames may contain LPS filled data.
vote_errors	uint16	1	= 0–16384 packed words in a PCD major frame. 65535 - May be used for fill value if not calculated.	Count of (packed) PCD major frame words found to contain voting errors during packing a PCD word/minor frame. Some PCD major frame words may contain erroneous or LPS filled data.
minf_sync_errors	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames received with sync errors in this major frame. Some PCD words may be lost and filled due to minor frame sync errors.
minf_id_errors	uint8	1	= 0–128 (minor frames per major frame). 255 – May be used for fill value if not calculated.	Count of PCD minor frames received with incorrect minor frame IDs (counter values). Corrected IDs are filled in.
minf_filled	uint8	1	= 0–128 (minor frames per major frame). 255 – May be used for fill value if not calculated.	Count of PCD minor frames found with erroneous data in PCD words and filled by LPS with a known value.
majf_flag	uint8	1	PCD major frame flag where 0 = Valid major frame ID, may be used for fill value if classified as unknown. 1= Incorrect major frame ID 2 = Missing major frame ID; used for major frames (1), (2), and (3) only. 3=Non-Applicable; A value of 3 is only used for major frame ; (0). If in error, the PCD major frame ID is corrected by LPS. 255 – May be used for fill value if not calculated.	Indicates the quality of the PCD major frame ID found in word 72, minor frames 96–103 of PCD major frames (1), (2), and (3). PCD major frame (0) contains the timecode flag (see below).
timecode_flag	uint8	1	Valid PCD timecode flag, where 0 = Valid timecode and spacecraft ID, may be used for fill value if classified as unknown. 1 = Computed timecode 2 = Corrected spacecraft ID 3 = Flags 1 and 2 combined 4 = Fill value for timecode 5 = Fill value for timecode and spacecraft ID 255 – May be used for fill value if not calculated.	Indicates the quality of the spacecraft ID and timecode data contained in word 72, minor frames 96–103, of PCD major frames(0). For PCD major frames (1)– (3), the timecode flag is also interpolated/ derived from the timecode flag used for major frame (0).
PCD Major Frame Clock, Temperature, Ephemeris, and Attitude Data				

Field Name	Number Type	Count	Description	Remarks
PCD Major Frame Quality and Accounting Data Except for majf_flag and timecode_flag, which have fill or missing indicators, the value 0 is used for an entirely filled major frame.				
spacecraft_id	char8	1	spacecraft_id = 7	The Landsat 7 spacecraft ID is determined from bytes 0–3 of PCD timecode word 96 located in major frame (0) of each PCD cycle. For the remaining three major frames in a PCD cycle, this spacecraft ID is copied for each major frame. The spacecraft ID is also forced to "7" when an erroneous ID is read or the spacecraft ID is missing. The spacecraft ID error is noted in the s/c_id_pcd field.

Table 5-9. PCD Vdata - Format 1 or 2 (2 of 9)

Field Name	Number Type	Count	Description	Remarks
The following four parameters are used to correct the spacecraft time, reported in the PCD and video, for clock drift to within 15 ms of Universal Time Coordinated (UTC) using the following formulas. Δt = Tsc – sv_clk_last_update_time Tc = Tsc + C0 + C1 Δt + .5 C2 (Δt Δt) where Tc is correct time, Tsc is uncorrected time, Δt is spacecraft clock time relative to last update.				
sv_clk_last_update_time	float64	1	sv_clk_last_update_time = 0–31,622,400 seconds from midnight of the first day of the current year. Fill value = –1.0	The time of the last space vehicle clock update is inserted in the PCD stream by the Mission Operations Center (MOC) once per day during ETM+ nonimage periods.
time_drift_bias_c0	int16	1	Spacecraft time drift bias (C0) = –15 to +15 ms Fill value = 7FFF	Clock correction bias term—can be used to minimize the clock error over some span of time; may be set to zero if not needed.
time_drift_rate_c1	int16	1	Spacecraft clock drift rate (C1) = +/– ms/day Fill value = 7FFF	Clock correction first order coefficient (drift rate).
time_drift_acceln_c2	int16	1	Spacecraft clock drift acceleration (C2) = +/– ms/day^2 Fill value = 7FFF	Clock correction second order coefficient (drift acceleration); may be set to zero if not needed.
ETM+ Telemetry Sampled @4.096 Seconds Rate The following ETM+ telemetry is sampled every 4.096 seconds and inserted into the next PCD major frame. Major frames with missing or erroneous values are filled with ones (FF in hexadecimal for uint8 and FFFF for uint16).				
black_body_temp_iso	uint8	1	Black body temperature (Isolated)	
cfpa_heater_current	uint8	1	Cold Focal Plane Assembly (CFPA) heater current	
cal_shutr_flag_temp	uint8	1	Calibration shutter flag temperature	
backup _shutr_flag_temp	uint8	1	Backup shutter flag temperature	
black_body_temp_con	uint8	1	Black body temperature (control)	
baffle_temp_heater	uint8	1	Baffle temperature (heater)	
cfpa_control_temp	uint8	1	CFPA control temperature	
pdf_ad_ground_ref	uint16	1	PDF A/D ground reference	Only the 12 ground reference bits G_0–G_{11} are included and not the constant first four bits found in minor frame 116 of word 72.
ETM+ Telemetry Sampled @16.384 Seconds Rate The following PCD values are repeated for each PCD major frame. Major frames with missing or erroneous values are filled with ones (FF in hexadecimal).The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame.				
serial_words_a_s	uint8	18	a,b,c,d,e,f,g,h,i,j,k,l,m,n,p,q,r,s	Serial Word "A" — Bits PS 2 Therm Shutdown Enabled — 0 PS 1 Therm Shutdown Enabled — 1 SMA +Z Heater Controller ON — 2 SMA –Z Heater Controller ON — 3 Spare — 4 Shutter Link Switch A Closed — 5 Shutter Link Switch A Closed — 6 Shutter Link Switch A Closed — 7

Table 5-10. PCD Vdata - Format 1 or 2 (3 of 9)

Field Name	Number Type	Count	Description	Remarks	
serial_words_a_s (continued)				Serial Word "B"	Bits
				Band 1 ON	0
				Band 2 ON	1
				Band 3 ON	2
				Band 4 ON	3
				Band 5 ON	4
				Band 6/mir ON	5
				Band 7 ON	6
				Cold Stage Telemetry ON	7
				Serial Word "C"	Bits
				Cooler Door (CD) Closed	0
				CD Outgas Position	1
				CD Full Open	2
				CD Magnet ON	3
				CD Motor Drive ON	4
				CD Link Switch A Closed	5
				CD Link Switch A Closed	6
				CD Link Switch A Closed	7
				Serial Word "D"	Bits
				IC Lamp 1 ON	0
				IC Lamp 2 ON	1
				Spares	2,5 6,7
				IC Lamp 1 Backup ON	3
				IC Lamp 2 Backup ON	4
				Serial Word "E"	Bits
				Band P ON	0
				Spare	1
				Blackbody Heater Controller ON	2
				Blackbody T2 ON	3
				Blackbody T3 ON	4
				Blackbody Backup ON	5
				SME 1 ON	6
				SME 2 ON	7
				Serial Word "F"	Bits
				Baffle Heater Controller ON	0
				Baffle Heater Backup ON	1
				Spare	2
				Spare	3
				Spare	4
				Spare	5
				Spare	6
				Spare	7
				Serial Word "G"	Bits
				Scan Line Corrector 1 ON	0
				Scan Line Corrector 2 ON	1
				Calibration Shutter ON	2
				Calibration Shutter Phase Error	3
				Calibration Shutter Amp. Error	4
				Backup Shutter ON	5
				Backup Shutter Phase Error	6
				Backup Shutter Amp. Error	7

Table 5-11. PCD Vdata - Format 1 or 2 (4 of 9)

Field Name	Number Type	Count	Description	Remarks
serial_words_a_s (continued)				Serial Word "H" — Bits Cold Stage Heater Cont. ON 0 Cld Stge Outgas Heat. Cont. ON 1 Int. Stage Heater Controller ON 2 Int. Stage Heater Enabled 3 CFPA Heater Controller ON 4 CFPA T2 Relay ON 5 CFPA T3 Relay ON 6 CFPA Telemetry ON 7 Serial Word "I" — Bits DC Restore Normal 0 Frame DC Restore Selected 1 Telemetry Scaling ON 2 SMA +Z Heater Enabled 3 SMA –Z Heater Enabled 4 Spare 5 SME 1 Select SAM 6 Spare Opto 7 Serial Word "J" — Bits AEM Mtpx 1 Bnd 1 Gain State 0 AEM Mtpx 1 Bnd 2 Gain State 1 AEM Mtpx 1 Bnd 3 Gain State 2 AEM Mtpx 1 Bnd 4 Gain State 3 AEM Mtpx 1 Bnd 5 Gain State 4 AEM Mtpx 1 Bnd 6 PRI G State 5 AEM Mtpx 1 Band 7 Gain State 6 AEM Mtpx 1 Band P Gain State 7 Serial Word "K" — Bits AEM Mtpx 2 Bnd 1 Gain State 0 AEM Mtpx 2 Bnd 2 Gain State 1 AEM Mtpx 2 Bnd 3 Gain State 2 AEM Mtpx 2 Bnd 4 Gain State 3 AEM Mtpx 2 Bnd 5 Gain State 4 AEM Mtpx 2 Bnd 6 PRI G State 5 AEM Mtpx 2 Band 7 Gain State 6 AEM Mtpx 2 Band P Gain State 7 Serial Word "L" — Bits Cooler Door Dir. (1 = Open) 0 Cooler Door Move Enable 1 FAC Failsafe Stat Mot Pow ON 2 FAC Primary Stat Mot Pow ON 3 FAC Primary Motor Power ON 4 FAC Failsafe Motor Power ON 5 FAC Primary Contr. Direction 6 FAC Failsafe Contr. Direction 7 Serial Word "M" — Bits Mux 1/2 Anlg Power Selected 0 Mux 1/2 Digtl Power Selected 1 Spare 2 Spare 3 FAC Prim Contr Sngl Stp Sizes 4 FAC Flsfe Contr Sngl Stp Sizes 5 FAC Primary Contr Power ON 6 FAC Failsafe Contr Power ON 7

Table 5-12. PCD Vdata - Format 1 or 2 (5 of 9)

Field Name	Number Type	Count	Description	Remarks
serial_words_a_s (continued)				<u>Serial Word "N"</u> <u>Bits</u> AEM Multiplexer 1 ON 0 AEM Multiplexer 2 ON 1 AEM Mtpx 1 MDE ON Status 2 AEM Mtpx 2 MDE ON Status 3 AEM Mtpx 1 B6 RDT Gain St 4 AEM Mtpx 2 B6 RDT Gain St 5 AEM Mtpx 1 Data Priority Sel 6 AEM Mtpx 2 Data Priority Sel 7 <u>Serial Word "P"</u> <u>Bits</u> FAC Stow Position Switch PRI 0 FAC Stow Position Switch RDT 1 AEM Cal Position Switch PRI 2 AEM Cal Position Switch RDT 3 AEM Cal/Stw Mv ON Stat PRI 4 AEM Cal/Stw Mv ON Stat RDT 5 AEM Mtpx 1 Data Priority Sel 6 AEM Mtpx 2 Data Priority Sel 7 <u>Serial Word "Q"</u> <u>Bits</u> FAC Pull-Pin (PP) Heater 1 ON 0 FAC PP Heater 2 ON 1 FAC PP Heat Pwr, En PRI 2 FAC PP Heater Power 3 FAC PP Retrct Pos Swtch PRI 4 FAC PP Retrct Pos Swtch RDT 5 FAC PP Fully Ret Pos Swt PRI 6 FAC PP Fully Ret Pos Swt RDT 7 <u>Serial Word "R"</u> <u>Bits</u> FAC Prim CW Rot Swtch Stat 0 FAC Prim CCW Rot Swtch Stat 1 FAC Red CW Rot Swtch Stat 2 FAC Red CCW Rot Swtch Stat 3 Spare 4 Spare 5 Spare 6 Spare 7 <u>Serial Word "S"</u> <u>Bits</u> Command Reject, Enable 1 P 0 Command Reject, Enable 2 P 1 Command Reject, Enable 3 P 2 Command Reject, Enable 4 P 3 Command Reject, Enable 1 R 4 Command Reject, Enable 2 R 5 Command Reject, Enable 3 R 6 Command Reject, Enable 4 R 7
mux_elec_temp	uint8	1	Active Mux electronics temperature. Indicator for the active Mux is located in Serial Word "N" (bits 0 and 1).	See group comment above.
mux_ps_ temp	uint8	1	Active Mux power supply temperature. Indicator for the active Mux is located in Serial Word "N" (bits 0 and 1).	See group comment above.
mux2_elec_temtp tec_lamp_1i	uint8	1	Mux 2 electronics temperatureC Calibration lamp #1 current	See group comment above.
mux2_ps_temtp tec_lamp_2i	uint8	1	Mux 2 power supply temperatureC Calibration lamp #2 current	See group comment above.
acs_cpu_mode	uint8	1	Attitude Control System (ACS) Central Processing Unit (CPU) mode	See group comment above.

Table 5-13. PCD Vdata - Format 1 or 2 (6 of 9)

Field Name	Number Type	Count	Description	Remarks
etm_tlm_mnf_16_30	uint8	15	ETM telemetry MF(2), mfs (16–30)	See group comment above. Descriptions of the minor frames are as follows: 16 MEM Heat Sink Power Supply # 1 Temp 17 Silicon Focal-Plane Assembly Temp 18 Zero Fill 19 Baffle Temperature (Tube) 20 MEM Heat Sink Power Supply # 2 Temp 21 Cold FPA Monitor Temperature 22 Baffle Temperature (Support) 23 Cal Lamp Housing Temp 24 Scan-Line Corrector Temp 25 Cal Shutter Hub Temp 26 Ambient Preamp Temp (High Channels) 27 Band 4 Post Amp Temp 28 Zero Fill 29 Band 7 Preamp Temp 30 Ambient Preamp Temp (Low Channels)
etm_tlm_mnf_40_49	uint8	10	ETM telemetry MF(2) mfs (40–49)	See group comment above. Descriptions of the minor frames are as follows: 40 Primary Mirror Temp 41 Primary Mirror Mask Temp 42 Secondary Mirror Temp 43 Secondary Mirror Mask Temp 44 Telescope Housing Temp 45 Telescope Baseplate Temp 46 Pan Band Post Amplifier Temp 47-49 Zero Fill
etm_plus_on_time	float64	1	Time ETM+ was last on: etm_on_time = 0–31,622,400 seconds from midnight of the first day of the current year. Reported for each PCD major frame (0) record. If a PCD major frame (1, 2, or 3) does not contain the required PCD value, use –1.0 as the fill value.	Reported as an HDF double precision floating point number to accommodate the 48-bit extended precision floating point value/ sample received in major frame (0) of a PCD cycle.
etm_plus_off_time	float64	1	Time ETM+ was last off: See above for related description.	See above.
Ephemeris Data The ephemeris data, consisting of the position and velocity components, are available on a PCD major frame basis.				
ephem_position_xyz	float64	3	x,y,z position range: +/– 8.3886 x 10^6 meters Fill value = 10^7	The coordinate system is the J2000 and is defined in the Program Coordinates System Standard.

Table 5-14. PCD Vdata - Format 1 or 2 (7 of 9)

Field Name	Number Type	Count	Description	Remarks
ephem_velocity_ xyz	float64	3	x,y,z velocity range: +/– 8.0 meters/ms Fill value = 10	
Attitude Estimate The spacecraft calculates an estimate of the attitude represented as Euler parameters. Components 1–3 define the eigen-axis of rotation in Earth Center Inertial (ECI) coordinates, and component 4 defines the rotation about that axis				
attitude_est_ epa1234	float64	4	epa1, epa2, epa3, epa4 Fill value = 2	epa1, epa2, epa3 are components 1–3. epa4 is component 4.
Gyro (Inertial Measurement Unit (IMU) Axes) Data Note: The following IMU axes (x, y, z) readings are repeated 64 times in each major frame. The IMU axes values are in arc-seconds of angular motion. A total of 256 readings (samples) are collected for each PCD cycle. The Gyro data order is as follows: – all 64 roll values (Roll-1, Roll-2...) – all 64 pitch values (Pitch-1, Pitch-2...) – all 64 yaw values (Yaw-1, Yaw-2...) Each IMU axes counter value is first constructed by concatenating the 3 bytes for each axis (e.g., x1, x2, x3) and then converting to arc-seconds. For converting the IMU counter values to engineering units, each increment or decrement in the 24-bit counter value of an IMU axis represents a 0.061 arc-second change. The data are in the IMU reference frame. To convert to the spacecraft reference frame, use the Gyro to Attitude Matrix in the CPF. IMU X corresponds to s/c roll. IMU Y corresponds to s/c yaw. IMU Z corresponds to s/c negative pitch. Fill values are MAXFLOAT.				
gyro-select_x	char8	1	= "A" for gyro channel A selected, or = "B" for gyro channel B selected Fill value = $	Bit 0 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the X-axis. 1=A, 0=B as described in Section 3.2.7.4.17 of the L7 DFCB.
gyro-select_y	char8	1	= "A" for gyro channel A selected, or = "B" for gyro channel B selected Fill value = $	Bit 1 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the X-axis. 1=A, 0=B as described in Section 3.2.7.4.17 of the L7 DFCB.
gyro-select_z	char8	1	= "A" for gyro channel A selected, or = "B" for gyro channel B selected Fill value = $	Bit 2 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the X-axis. 1=A, 0=B as described in Section 3.2.7.4.17 of the L7 DFCB.
imu_x_roll_x00_x63	float64	64	= – 511705.088 to + 511705.027 arc-seconds for components x00–x63 in the PCD major frame.	See above.
imu_y_pitch_y00_y63	float64	64	= – 511705.088 to + 511705.027 arc-seconds for components y00–y63 in the PCD major frame.	See above.
imu_z_yaw_z00_z63	float64	64	= – 511705.088 to + 511705.027 arc-seconds for components z00–z63 in the PCD major frame.	See above.
Gyro Drift Data The gyro drift data are reported once per PCD cycle in major frame (0) only. The calculation is made at the PCD cycle time code minus 8.192 seconds in the ACS reference axis coordinate system.				

Table 5-15. PCD Vdata - Format 1 or 2 (8 of 9)

Field Name	Number Type	Count	Description	Remarks
gyro_drift_theta_xyz	float64	3	x, y, z gyro drift The units of gyro drift (rate) data for each axis are in radians/second. Fill value = –1.0	Further conversion using offsets in the CPF is needed before obtaining engineering units.
Angular Displacement Sensor Data (ADS) Note: The minor frame IDs are reported serially for each major frame. The 16 sets of ADS x, y, z values are reported as a distinct entry for each of the 128 minor frames in a PCD major frame. All ADS x, y, z measurements are converted to microradians and reported in ascending order of their source words and minor frames in a PCD major frame. All data are reported with single floating point precision. A total of 16 ADS measurements, each consisting of the x, y and z components, are received in a PCD minor frame. Fill value for all, including mnfm_ids_000_127, is 255.				
mnfm_ids_000_127	uint8	128	Minor frame counter or ID: 000–127	The PCD minor frame counter value/ID from word location 65 of each minor frame. There are 128 (IDs: 000–127) minor frames in a PCD major frame.
ads_xyz16_mnfm_ 000	float32	48	ADS measurement x01, y01, z01 through x16,y16,z16 received in minor frame 0	
ads_xyz16_mnfm_ 001	float32	48	ADS measurement x01, y01, z01 through x16,y16,z16 received in minor frame 1	
• • •	• • •	• • •	ADS measurements as above for minor frames 2 through 126	
ads_xyz16_mnfm_ 127	float32	48	ADS measurement x01, y01, z01 through x16,y16,z16 received in minor frame 127	
ADS Temperatures Note: The ADS x, y, z, and A/D electronic temperature values are reported on a major frame basis (i.e., every 4.096 seconds). All temperatures are reported in degrees Centigrade.				
ads_temp_xyz+a/d_plus_ ad	float32	4	See above. Includes temperature values for components: x, y, z and elec_a/d. Fill value = 255	See above.
PCD Quality and Accounting Data The following PCD quality data are LPS-produced and appended to each major frame record of the PCD file.				
sc_id_err_pcd	char8	1	Spacecraft ID error in PCD: sc_id_err_pcd = "n" for no errors "y" for errors detected in the spacecraft ID field	The error flag is true whenever the spacecraft ID is not equal to "7" and is corrected to "7".
att_data_quality	char8	1	Attitude Data Point Quality: att_data_ quality = "g" for good data "r" for rejected data "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates that the attitude data failed range check. "m" indicates missing attitude data replaced with fill data.
ephem_data_ quality	char8	1	Ephemeris Data Point Quality: ephem_data_quality = "g" for good data "r" for rejected data "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates ephemeris data failed range check. "m" indicates missing ephemeris data replaced with fill data.

Table 5-16. PCD Vdata - Format 1 or 2 (9 of 9)

As with other product tables, the scan line offset Vdatas follow similar naming conventions. However, the extensions vary so to associate each Vdata with its particular band. Table 5-17 lists the scan line offset names.

Format 1	Format 2
Band 1 – "L7XsssfnYYDOYHHuuvv.O10"	Band 6 – "L7XsssfnYYDOYHHuuvv.O60"
Band 2 – "L7XsssfnYYDOYHHuuvv.O20"	Band 7 – "L7XsssfnYYDOYHHuuvv.O70"
Band 3 – "L7XsssfnYYDOYHHuuvv.O30"	Band 8 – "L7XsssfnYYDOYHHuuvv.O81"
Band 4 – "L7XsssfnYYDOYHHuuvv.O40"	Band 8 – "L7XsssfnYYDOYHHuuvv.O82"*
Band 5 – "L7XsssfnYYDOYHHuuvv.O50"	Band 8 – "L7XsssfnYYDOYHHuuvv.O83"*
Band 6 – "L7XsssfnYYDOYHHuuvv.O60"	

*Used for multisegment Band 8 products

Table 5-17. Scan Line Offset Vdatas Naming Convention

Table 5-18 and Table 5-19 list the contents of either the format 1 or 2 scan line offsets.

5.3.3.4 Geolocation Index Vdata

Table 5-21 and Table 5-22 list the contents of the geolocation index Vdata. The data line numbers are referenced relative to the subinterval from which the product came and represent actual overlapping WRS scene corners. The line numbers are 1-based (i.e., the first line in the subinterval is line 1). A value of zero (0) indicates there are no data for that resolution or format present in the product.

5.3.4 Metadata Definitions

Three metadata files accompany an L0Rp product. They are structured using the ODL syntax as ASCII text blocks. Two of the files (LPS Metadata File or MTA files) are created by LPS and describe the subinterval used to create a product. The third file (Distribution Product Metadata file or MTP file) is created by the LAM and describes the contents of the product actually ordered.

5.3.4.1 LPS Metadata

The two LPS metadata files describe format 1 and format 2. They contain metadata for the subinterval as well as individual scenes. The subinterval metadata contain reference information on the raw wideband data source (e.g., an LGS X-band channel), the LPS resources (equipment strings) used in L0Ra processing, and identification information on the Level 0R data files produced for the archive. The scene metadata provide details on each WRS scene identified in a subinterval during L0Ra processing. Each scene is a logically separated metadata group containing identification information such as scene center and corner coordinates, cloud cover scores, and quality and accounting information on the image data and PCD associated with the scene. Up to 35 full scene groups may occur for a 14-minute maximum Landsat 7 contact period.

Vdata Name: “L7XsssfnYYDOYHHuuvv.ONN”				
Vdata Class: LPS_SLO				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 46				
Number of Records: One record per data line for the corresponding band file.				
Field Name	**Number Type**	**Count**	**Description**	**Remarks**
scan_timecode	char8	25	Scan line time of the form ‘YYYY:ddd:hh:mm:ss.ttttttt’ where YYYY = 4-digit Julian year ddd = Day (01 through 366) hh = Hours (00 through 23) mm = Minutes (00 through 59) ss = Seconds (00 through 59) ttttttt = Fractional seconds (0–9999375, where the clock cycle is 1/16 ms)	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames. The scan time code is referenced to GMT.
scan_time	float64	1	The ETM+ scan time in decimal notation seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan_time is obtained by converting the scan_timecode (last entry) to seconds. This is also referenced to GMT.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 335 nonoverlapping scans.	A sequence counter for ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file. This counter is referenced relative to the original subinterval, not the product ordered.
scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 Note: The Band 8 scan data line count is not reset between segments (1–3).	The scan line counter is incremented for each detector data line added to the product band file. There are 16 scan data lines each for Bands 1–5 and 7, 8 for Band 6, and 32 for Band 8 in each ETM+ scan. The maximum line counts are shown for a 14-minute subinterval (35 scenes).
detector_id	uint8	1	where the detector_id is in the range: = 1–16 for Bands 1–5 and 7 = 1–8 detectors for Band 6 = 1–32 for Band 8	Each scan line in an image file consists of samples from a single detector of a single band. Each detector, chosen in a descending ID order, is used once during each scan to generate a scan line.
scan_data_line_ offset_rhs	int16	1	= 0– 287 bytes for Bands 1–5 and 7 = 0– 140 bytes for Bands 6L (format 1) and 6H (format 2) = 0– 574 bytes for Band 8 The scan line data may be shifted to the right in the band data buffer after an integer-pixel alignment.	The scan line data are shifted to the right in a larger buffer to accommodate integer pixel alignment without data loss. After integer-pixel alignment, this field indicates the trailing zero fill buffer for each data line.

Table 5-18. Scan Line Offsets Vdata (1 of 2)

Field Name	Number Type	Count	Description	Remarks
scan_data_line_ offset_lhs	int16	1	= 0– 287 bytes for Bands 1–5 and 7 = 0–140 for Band 6 = 0–574 for Band 8	Note: The left-hand-side offset is not as significant as the right-hand-side margin, which can accommodate scan line length growths due to ETM+ scanner bumper wear. This value is valid for both Earth image and IC data.
scan_data_line offset_rhs_ic	int16	1	= 0–300 bytes for Bands 1–5 and 7 = 0–150 for Band 6 = 0–600 for Band 8	This value uniquely identifies the right hand offset for the IC data, which can differ from the Earth image right hand offset due to bumper wear.

Table 5-19. Scan Line Offsets Vdata (2 of 2)

Vdata Name: "L7XsssfnYYDOYHHuuvv.GEO"			
Vdata Class: Index			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record: 73			
Number of Records: One record per WRS scene in the product			
Field Name	**Number Type**	**Count**	**Description**
UlLon	float32	1	Scene longitude - upper left corner = -180.0000 through 180.0000 degrees (with a 4-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
UlLat	float32	1	Scene latitude - upper left corner = -90.0000 through 90.0000 degrees (with a 4-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
UrLon	float32	1	Scene longitude - upper right corner = -180.0000 through 180.0000 degrees (with a 4-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
UrLat	float32	1	Scene latitude - upper right corner = -90.0000 through 90.0000 degrees (with a 4-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
LlLon	float32	1	Scene longitude - lower left corner = -180.0000 through 180.0000 degrees (with a 4-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
LlLat	float32	1	Scene latitude - lower left corner = -90.0000 through 90.0000 degrees (with a 4-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
LrLon	float32	1	Scene longitude - lower right corner = -180.0000 through 180.0000 degrees (with a 4-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
LrLat	float32	1	Scene latitude - lower right corner = -90.0000 through 90.0000 degrees (with a 4-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
FirstLine_15m	int32	1	Beginning scene scan line number - 15m = 1 - 369,201. A zero indicates no data at this resolution.
LastLIne_15m	int32	1	Ending scene scan line number - 15m = 6000 - 375,200. A zero indicates no data at this resolution.
FirstLine_30m_F1	int32	1	Beginning scene scan line number - 30m. Format 1 = 1 - 184, 601. A zero indicates no data for this format.
LastLine_30m_F1	int32	1	Ending scene scan line number - 30m. Format 1 = 3000 - 187,600. A zero indicates no data for this format.
FirstLine_60m_F1	int32	1	Beginning scene scan line number - 60m. Format 1 = 1 - 92,301. A zero indicates no data for this format.
LastLIne_60m_F1	int32	1	Ending scene scan line number - 60m. Format 1 = 1500 - 93,800. A zero indicates no data for this format.

Table 5-20. Geolocation Index Vdata (1 of 2)

Field Name	Number Type	Count	Description
FirstLine_30m_F2	int32	1	Beginning scene scan line number - 30m. Format 2 = 1 - 184, 601. A zero indicates no data for this format.
LastLine_30m_F2	int32	1	Ending scene scan line number - 30m. Format 2 = 3000 - 187,600. A zero indicates no data for this format.
FirstLine_60m_F2	int32	1	Beginning scene scan line number - 60m. Format 2 = 1 - 92,301. A zero indicates no data for this format.
LastLIne_60m_F2	int32	1	Ending scene scan line number - 60m. Format 2 = 1500 - 93,800. A zero indicates no data for this format.
FullScene	char8	1	Full scene indicator flag (Y or N)

Table 5-21. Geolocation Index Vdata (2 of 2)

The Landsat 7 ETM+ Level Zero-R Archive (L0Ra) Data Format Control Book (DFCB) defines the LPS metadata file for both formats. The two LPS files undergo no content change during L0Rp product generation but are transformed from standalone ODL files to HDF external elements using the Vdata interface. The actual ODL files are identical but now HDF addresses and offsets are placed in the HDF directory file common to all product components. This allows metadata access using HDF tools if desired.

5.3.4.2 Distribution Product Metadata

The third metadata file, also an external element, is created during product generation and contains information specific to the product ordered such as corner coordinates and external element file names. Table 5-22 through Table 5-28 list the full contents of the distribution product metadata file.

5.3.4.3 ODL Conventions

All metadata are stored as ASCII text using the ODL syntax developed by the Jet Propulsion Laboratory (JPL). ODL is a tagged keyword language that was developed to provide a human-readable data structure to encode data for simplified interchange. Parameters defined by the ODL syntax can be logically grouped to aid in file organization and efficient parsing by software interpreters. For ODL details, see the Planetary Data System Standards Reference, Chapter 12, “Object Description Language Specification and Usage” (see References).

The ODL syntax employs the following conventions:

- Parameter definition is in the form of parameter = value.
- There is one parameter definition per line.
- Blank spaces and lines are ignored.
- A carriage return <CR> and line feed <LF> end each line in the file.
- Each line of comments must begin with the character /* and end with the character */, including comments embedded on the same line as a parameter definition.
- Quotation marks are required for values that are text strings, including single characters. Reference marks do not add to overall byte size of the values they surround.

- Exceptions to this rule are the GROUP, END_GROUP, OBJECT, and END_OBJECT.
  - Those Identifiers or values that do not use quotation marks.
  - Case is not significant, but uppercase is used for parameter and group names to aid in readability.
  - Indentation is not significant, but is used for readability.
  - The reserve word END concludes the file.

Vdata Name: “L7XsssfnYYDOYHHuuvv.MTP”			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record: 65535			
Number of Records: One record.			
Field Name: Metadata_Product_Specific			
Data Type: Char8 Count: 65535			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
GROUP	17	= ECS_METADATA_FILE	Beginning of the first level ODL group. It indicates the start of the LAM metadata file level group.
GROUP	18	= METADATA_FILE_INFO	Beginning of the metadata file information group.
ORIGIN	47	= "Image courtesy of the U.S. Geological Survey"	Establishes the origin of the image to be from the USGS.
PRODUCT_CREATION_ DATE_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = 4-digit Julian year (e.g., 1998 and 2001) MM = Month number of a Julian year (01–12 for January to December) DD = Day of a Julian month (01–31) T indicates the start of time information in the ODL ASCII time code format hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds (00–59) Z indicates "Zulu" time (same as GMT)	The system date and time when the metadata file for a Level 0R product set was created. For ease of human readability, this date and time information is presented in the ODL ASCII format. The time is expressed as UTC (also known as GMT). Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
STATION_ID	3	= "SSS" where SSS = EDC, AGS, SGS, or international station symbol	Unique three-letter code identifying the origination ground station.
END_GROUP	18	= METADATA_FILE_INFO	End of the metadata information group.
GROUP	16	= PRODUCT_METADATA	Beginning of the product metadata group.
PRODUCT_TYPE	3	= "L0R"	Type of product as opposed to Level-1 radiometrically corrected (L1R).
SPACECRAFT_ID	8	= "Landsat7"	Name of the satellite platform.
SENSOR_ID	4	= "ETM+"	Name of the imaging sensor.
SENSOR_MODE	6	= “SAM” = “BUMPER”	Scan Angle Monitor Mode (SAM) and Bumper Mode (BUMPER).
ACQUISITION_DATE	10	YYYY-MM-DD where (See data and time convention above.)	Date the image was acquired. The value in the case of Subinterval product is to be derived from modification (datetime to date) of the value from SUBINTERVAL_ START_TIME, and the value in the case of Scene product is to be derived from the modification of SCENE_CENTER_SCAN_ TIME.
STARTING_PATH	3	= NNN, where NNN = Path number	Starting WRS path value for product.
STARTING_ROW	3	= NNN, where NNN = Row of the first full or partial scene in the product	Starting WRS row.

Table 5-22. Distribution Product Metadata File Contents - ODL Parameter Values (1 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
ENDING_ROW	3	= NNN, where NNN = Row of the last full or partial scene in the product	Ending WRS row.
TOTAL_WRS_SCENES	5	= NN.NN, where NN.NN = Number of full and partial scenes encapsulated by the product	Maximum number is 36.99 for a subinterval product.
NUMBER_OF_SCANS	5	= NNNNN, where NNNNN = 90–12410	Total number of scans in the product.
STARTING_SUBINTERVAL_SCAN	5	= NNNNN, where NNNNN = 1–12321	Product starting scan number referenced relative to the parent subinterval.
ENDING_SUBINTERVAL_SCAN	5	= NNNNN, where NNNNN = 90–12410	Product ending scan number referenced relative to the parent subinterval.
FORMAT_SCAN_OFFSET	2	–99 through 99 ETM+ scans	This value is determined by identifying a common scan time code between format 1 and format 2 data, determining the respective scan numbers, and subtracting the format 2 number from the format 1 number. A value of 0 indicates no offset; a positive value means that Format-1 has an earlier value of SUBINTERVAL_START_TIME than Format-2; a negative value means that Format-1 has a later value of SUBINTERVAL_START_TIME than Format-2. It is important to note that this value represents the scan offset, not the scan or data line offset.
BAND_COMBINATION	9	"NNNNNNNNN", where "NNNNNNNNN" = e.g. 123456678 for all bands present, 123-----8 for Bands 1,2,3,8. A '-' is a position holder for absent bands	LAM-generated bands present indicator for the product ordered. The first 6 is format 1 Band 6. The second 6 is format 2 Band 6.
PRODUCT_UL_CORNER_LAT	8	= –90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates north latitude. A negative (–) value indicates south latitude.	Calculated latitude value for the upper left corner of the product. LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.

Table 5-23. Distribution Product Metadata File Contents - ODL Parameter Values (2 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
PRODUCT_UL_CORNER_LON	8	= –180.0000 through +180.0000 degrees (with a 4-digit precision) A positive (+) value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value for the upper left corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
PRODUCT_UR_CORNER_LAT	8	= –90.0000 through +90.0000 degrees (with a 4-digit precision)	Calculated latitude value for the upper right corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
PRODUCT_UR_CORNER_LON	9	= –180.0000 through +180.0000 degrees (with a 4-digit precision)	Calculated longitude value for the upper right corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
PRODUCT_LL_CORNER_LAT	8	= –90.0000 through +90.0000 degrees (with a 4-digit precision)	Calculated latitude value for the lower left corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
PRODUCT_LL_CORNER_LON	9	= –180.0000 through +180.0000 degrees (with a 4-digit precision)	Calculated longitude value for the lower left corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.

Table 5-24. Distribution Product Metadata File Contents - ODL Parameter Values (3 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
PRODUCT_LR_CORNER_ LAT	8	= –90.0000 through +90.0000 degrees (with a 4-digit precision)	Calculated latitude value for the lower right corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
PRODUCT_LR_CORNER_ LON	9	= –180.0000 through +180.0000 degrees (with a 4-digit precision)	Calculated longitude value for the lower right corner of the product. The LPS-calculated value is used for subinterval and standard WRS scene-based products. For floating scenes and partial subintervals, the LAM will calculate the corner coordinates based upon the TBD algorithm provided by the Landsat Project Office.
BAND1_GAIN	1	= "L" for low or "H" for high	Gain state for Band 1's first data line if part of the product.
BAND2_GAIN	1	= "L" for low or "H" for high	Gain state for Band 2's first data line if part of the product.
BAND3_GAIN	1	= "L" for low or "H" for high	Gain state for Band 3's first data line if part of the product.
BAND4_GAIN	1	= "L" for low or "H" for high	Gain state for Band 14s first data line if part of the product.
BAND5_GAIN	1	= "L" for low or "H" for high	Gain state for Band 5's first data line if part of the product.
BAND6_GAIN_F1	1	= "L" for low or "H" for high	Gain state for Band 6's first data line if part of the product - format 1.
BAND6_GAIN_F2	1	= "L" for low or "H" for high	Gain state for Band 6's first data line if part of the product - format 2.
BAND7_GAIN	1	= "L" for low or "H" for high	Gain state for Band 7's first data line if part of the product.
BAND8_GAIN	1	= "L" for low or "H" for high	Gain state for Band 8's first data line if part of the product.
BAND1_FILE_NAME	24	"L7Xsss1nYYDOYHHuuvv_B10YYDOYHHMM" (See 5.3.1 for details.)	File name for Band 1.

Table 5-25. Distribution Product Metadata File Contents - ODL Parameter Values (4 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
BAND2_FILE_NAME	24	"L7Xsss1nYYDOYHHuuvv_B20YYDOYHHMMDOYMMMP" (See 5.3.1 for details.)	File name for Band 2.
BAND3_FILE_NAME	24	"L7Xsss1nYYDOYHHuuvv_B30YYDOYHHMM" (See 5.3.1 for details.)	File name for Band 3.
BAND4_FILE_NAME	24	"L7Xsss1nYYDOYHHuuvv_B40" (See 5.3.1 for details.)	File name for Band 4.
BAND5_FILE_NAME	24	"L7Xsss1nYYDOYHHuuvv_B50" (See 5.3.1 for details.)	File name for Band 5.
BAND6_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_B60" (See 5.3.1 for details.)	File name for Band 6, format 1.
BAND6_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_B60" (See 5.3.1 for details.)	File name for Band 6, format 2.
BAND7_FILE_NAME	24	"L7Xsss2nYYDOYHHuuvv_B70" (See 5.3.1 for details.)	File name for Band 7.
BAND8_FILE1_NAME BAND8_FILE2_NAME BAND8_FILE3_NAME	24	"L7Xsss2nYYDOYHHuuvv_B81" (See 5.3.1 for details.)	File name for Band 8. The file extensions precursors B81, B82, B83, are used for a Band 8 that spans multiple files.

Table 5-26. Distribution Product Metadata File Contents - ODL Parameter Values (5 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
IC_DATA_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_CAL" (See 5.3.1 for details.)	File name for format 1 internal calibrator data.
IC_DATA_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_CAL" (See 5.3.1 for details.)	File name for format 2 internal calibrator data.
SCAN_OFFSETS_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_SLO" (See 5.3.1 for details.)	File name for format 1 scan line shifts.
SCAN_OFFSETS_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_SLO" (See 5.3.1 for details.)	File name for format 2 scan line shifts.
MSCD_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_MSD" (See 5.3.1 for details.)	File name for format 1 MSCD.
MSCD_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_MSD" (See 5.3.1 for details.)	File name for format 2 MSCD.
PCD_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_PCD" (See 5.3.1 for details.)	File name for format 1 PCD.
PCD_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_PCD" (See 5.3.1 for details.)	File name for format 2 PCD.

Table 5-27. Distribution Product Metadata File Contents - ODL Parameter Values (6 of 7)

Parameter Name	Size (ASCII bytes)	Value, Format, Range, and Units	Parameter Description/Remarks
METADATA_FILE_NAME_F1	24	"L7Xsss1nYYDOYHHuuvv_MTA" (See 5.3.1 for details.)	File name for format 1 metadata.
METADATA_FILE_NAME_F2	24	"L7Xsss2nYYDOYHHuuvv_MTA" (See 5.3.1 for details.)	File name for format 2 metadata.
METADATA_PS_FILE_NAME	24	"L7XsssfnYYDOYHHuuvv_MTP" (See 5.3.1 for details.)	File name for product-specific metadata. Although not format specific, a 1 is used in the file name if format 1 exists. Otherwise, the 2 from format 2 is used.
CPF_FILE_NAME	27	"L7CPFYYYYMMDD_YYYY MMDD_nn" where YYYYMMDD = eEffective start date and effective end date respectively. nn = incrementing version number within a 90-day period (00–99). - YYDOYHHMM DOYMM	File name for the IAS calibration parameter file. Note: The version number 00 is reserved exclusively for the prelaunch CPF.
GEOLOCATION_FILE_NAME	24	"L7Xsss1fnYYDOYHHuuvv_GEO" 1 (See 5.3.1 for details.)	File name for the geolocation table. Although not format specific, a 1 is used in the file name if format 1 exists. Otherwise, the 2 from format 2 is used.
HDF_DIR_FILE_NAME	24	"L7XsssfnYYDOYHHuuvv_HDF" (See 5.3.1 for details.)	File name for the HDF directory file. Although not format specific, a 1 is used in the file name if format 1 exists. Otherwise, the 2 from format 2 is used.
END_GROUP	16	= PRODUCT_METADATA	End of the product metadata group.
END_GROUP	17	= ECS_METADATA_FILE	End of the LAM product metadata ODL group.
END			Required standalone parameter signifying file end.

Table 5-28. Distribution Product Metadata File Contents - ODL Parameter Values (7 of 7)

5.3.4.4 ODL Examples

The three metadata files included in an L0Rp product conform to the ODL standard. Refer to the Landsat 7 ETM+ Level Zero-R Archive (L0Ra) Data Format Control Book (DFCB) for details on LPS parameter values and their formats used to construct the ETM+ format 1 and format 2 metadata files. Table 5-22 through Table 5-28 provide similar details for building the distribution product metadata file. In accordance with the ODL standard, all parameters and values are presented using ASCII standard characters.

Figure 5-2 shows an example of an ODL metadata file. The GROUP keyword and names are presented as bold text for illustration purposes only. In addition, the comment statements enclosed within "/*" and "*/" are shown to clarify the metadata format construction. They can be used but are not required in the ODL metadata file format.

5.3.4.4.1 HDF ODL Example – Distribution Product Metadata File

This file is organized into information about the file and information about the product.

```
      /* Landsat 7 LAM Product Metadata Format */

                  /*-----------------------------------*/
                  /*   Metadata File Header     */
                  /*-----------------------------------*/

GROUP=ECS_METADATA_FILE

         GROUP=METADATA_FILE_INFO
            ORIGIN = “Image courtesy of the U.S. Geological Survey”
            PRODUCT_CREATION_DATE_TIME = 1999-06-04T11:36:48Z
            STATION_ID = "EDC"

         END_GROUP=METADATA_FILE_INFO

                  /*------------------------------*/
                  /*   Product Metadata  */
                  /*------------------------------*/

         GROUP = PRODUCT_METADATA
           PRODUCT_TYPE = "L0R"
            SPACECRAFT_ID = “Landsat7”
            SENSOR_ID = “ETM+”
            SENSOR_MODE = “SAM”
            ACQUISITION_DATE = 1999-01-31
            STARTING_PATH = 029
            STARTING_ROW = 036
            ENDING_ROW = 037
            TOTAL_WRS_SCENES = 2.10
            NUMBER_OF_SCANS = 744
            STARTING_SUBINTERVAL_SCAN = 3000
            ENDING_SUBINTERVAL_SCAN = 3743
            FORMAT_SCAN_OFFSET = 0
            BAND_COMBINATION = “123456678”
            PRODUCT_UL_CORNER_LAT = 35.4950
            PRODUCT_UL_CORNER_LON = –105.2278
            PRODUCT_UR_CORNER_LAT = 35.2036
            PRODUCT_UR_CORNER_LON = –103.2219
            PRODUCT_LL_CORNER_LAT = 32.5736
            PRODUCT_LL_CORNER_LON= –106.0103
            PRODUCT_LR_CORNER_LAT = 32.292
            PRODUCT_LR_CORNER_LON = –104.0697
            BAND1_GAIN = "H"
            BAND2_GAIN = "H"
            BAND3_GAIN = "H"
            BAND4_GAIN = "H"
            BAND5_GAIN = "H"
            BAND6_GAIN_F1= "L"
            BAND6_GAIN_F2= "H"
            BAND7_GAIN = "H"
            BAND8_GAIN = "H"
            BAND1_FILE_NAME =             “L71EDC119903122010_B10”
            BAND2_FILE_NAME =             “L71EDC119903122010_B20”
            BAND3_FILE_NAME =             “L71EDC119903122010_B30”
            BAND4_FILE_NAME =             “L71EDC119903122010_B40”
            BAND5_FILE_NAME =             “L71EDC119903122010_B50”
```

```
            BAND6_FILE_NAME_F1 =          "L71EDC119903122010_B60"
            BAND6_FILE_NAME_F2 =          "L71EDC219903122010_B60"
            BAND7_FILE_NAME =             "L71EDC219903122010_B70"
            BAND8_FILE1_NAME =            "L71EDC219903122010_B81"
            IC_DATA_FILE_NAME_F1 =        "L71EDC119903122010_CAL"
            IC_DATA_FILE_NAME_F2 =        "L71EDC219903122010_CAL"
            SCAN_OFFSETS_FILE_NAME_F1 =   "L71EDC119903122010_SLO"
            SCAN_OFFSETS_FILE_NAME_F2 =   "L71EDC219903122010_SLO"
            MSCD_FILE_NAME_F1 =           "L71EDC119903122010_MSD"
            MSCD_FILE_NAME_F2 =           "L71EDC219903122010_MSD"
            PCD_FILE_NAME_F1 =            "L71EDC119903122010_PCD"
            PCD_FILE_NAME_F2 =            "L71EDC219903122010_PCD"
            METADATA_FILE_NAME_F1 =       "L71EDC119903122010_MTA"
            METADATA_FILE_NAME_F2 =       "L71EDC219903122010_MTA"
            METADATA_PS_FILE_NAME =       "L71EDC119903122010_MTP"
            CPF_FILE_NAME =               "L7CPF19990101_19990331_01"
            GEOLOCATION_FILE_NAME =       "L71EDC119903122010_GEO"
            HDF_DIR_FILE_NAME =           "L71EDC119903122010_HDF"

         END_GROUP = PRODUCT_METADATA

END_GROUP = ECS_METADATA_FILE

END
```

Figure 5-2. Example of an ODL metadata file

5.3.5 Calibration Parameter File

The CPF is stored as ASCII text that conforms to the ODL syntax. A complete description of this file currently exists in the Landsat 7 Calibration Parameter File Definition (see References). This document is on the IAS document server at http://ltpwww.gsfc.nasa.gov/IAS/htmls/review.html.

The CPF was created using the Vdata interface and specifying a single field 65,535 bytes long. Three Vdata table entries of this size are required to hold the CPF contents. Three Vdata reads would therefore be required to read the file into memory. An alternate and perhaps preferred way to manipulate the file is with an ODL interpreter. The CPF, like other product components, is an external element that allows for other forms of file access using non-HDF tools. The Vdata description is as follows:

Vdata Class: IAS_CPF
Interlace Type: FULL_INTERLACE
Bytes Per Logical Record: 65535
Number of Records: Three records
Field Name: CALIBRATION_PARAMETER_FILE
Data Type: Char8 Count: 65535

5.3.6 Vgroup Definitions

The Vgroup structure was designed to associate related HDF data objects. Any HDF data object (e.g., Vdata, SDSs, attributes) can be included in an HDF Vgroup definition. Vgroups employ Vgroup names and Vgroup classes for characterizing a collection of data objects and for searching purposes. Five classes are recognized for the L0Rp product: image data, calibration data, correction data, parameter data, and metadata.

The HDF Vgroup interface consists of routines for accessing and getting information about the 0R product Vgroups. This information is stored in the HDF data directory.

Table 5-29 and Table 5-30 show the Vgroups used to relate the different component or data objects that make up a complete L0Rp scene product.

Vgroup Name	Vgroup Class	Data Object Contents		HDF Tag	Description
		Object Name	Type		
Scene_Data_30m	Image_Data	"L7Xsss1nYYDOYHHuuvv.B10"	SDS	DFTAG_NDG	ETM+ Band 1 30m data
		"L7Xsss1nYYDOYHHuuvv.B20"	SDS	DFTAG_NDG	ETM+ Band 2 30m data
		"L7Xsss1nYYDOYHHuuvv.B30"	SDS	DFTAG_NDG	ETM+ Band 3 30m data
		"L7Xsss1nYYDOYHHuuvv.B40"	SDS	DFTAG_NDG	ETM+ Band 4 30m data
		"L7Xsss1nYYDOYHHuuvv.B50"	SDS	DFTAG_NDG	ETM+ Band 5 30m data
		"L7Xsss2nYYDOYHHuuvv.B70"	SDS	DFTAG_NDG	ETM+ Band 7 30m data
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
Scene_Data_60m	Image_Data	"L7Xsss1nYYDOYHHuuvv.B60"	SDS	DFTAG_NDG	ETM+ Band 6 60m low-gain data
		"L7Xsss2nYYDOYHHuuvv.B60"	SDS	DFTAG_NDG	ETM+ Band 6 60m high-gain data
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
Scene_Data_15m	Image_Data	"L7Xsss2nYYDOYHHuuvv.B81"	SDS	DFTAG_NDG	ETM+ Band 8 15m data, one or more segment product
		"L7Xsss2nYYDOYHHuuvv.B82"	SDS	DFTAG_NDG	ETM+ Band 8 15m data, two or more segment product
		"L7Xsss2nYYDOYHHuuvv.B83"	SDS	DFTAG_NDG	ETM+ Band 8 15m data, three segment product
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
IC_Data_30m	Calibration_ Data	"L7Xsss1nYYDOYHHuuvv.C10"	SDS	DFTAG_NDG	IC data Band 1 30m
		"L7Xsss1nYYDOYHHuuvv.C20"	SDS	DFTAG_NDG	IC data Band 2 30m
		"L7Xsss1nYYDOYHHuuvv.C30"	SDS	DFTAG_NDG	IC data Band 3 30m
		"L7Xsss1nYYDOYHHuuvv.C40"	SDS	DFTAG_NDG	IC data Band 4 30m
		"L7Xsss1nYYDOYHHuuvv.C50"	SDS	DFTAG_NDG	IC data Band 5 30m
		"L7Xsss2nYYDOYHHuuvv.C70"	SDS	DFTAG_NDG	IC data Band 7 30m
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
IC_Data_60m	Calibration_ Data	"L7Xsss1nYYDOYHHuuvv.C60"	SDS	DFTAG_NDG	IC data Band 6 60m – low gain
		"L7Xsss2nYYDOYHHuuvv.C60"	SDS	DFTAG_NDG	IC data Band 6 60m – high gain
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
IC_Data_15m	Calibration_ Data	"L7Xsss2nYYDOYHHuuvv.C81"	SDS	DFTAG_NDG	ETM+ Band 8 IC data, one or more segment product
		"L7Xsss2nYYDOYHHuuvv.C82"	SDS	DFTAG_NDG	ETM+ Band 8 IC data, two or more segment product
		"L7Xsss2nYYDOYHHuuvv.C83"	SDS	DFTAG_NDG	ETM+ Band 8 IC data, three segment product
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
Scan_Line_ Offsets_30m	Correction_ Data	"L7Xsss1nYYDOYHHuuvv.O10"	Vdata	DFTAG_VH	Scan line offsets Band 1
		"L7Xsss1nYYDOYHHuuvv.O20"	Vdata	DFTAG_VH	Scan line offsets Band 2
		"L7Xsss1nYYDOYHHuuvv.O30"	Vdata	DFTAG_VH	Scan line offsets Band 3
		"L7Xsss1nYYDOYHHuuvv.O40"	Vdata	DFTAG_VH	Scan line offsets Band 4
		"L7Xsss1nYYDOYHHuuvv.O50"	Vdata	DFTAG_VH	Scan line offsets Band 5

Table 5-29. Vgroup Definition for the Landsat 7 L0Rp Product (1 of 2)

Vgroup Name	Vgroup Class	Data Object Contents		HDF Tag	Description
		Object Name	**Type**		
		"L7Xsss2nYYDOYHHuuvv.O70"	Vdata	DFTAG_VH	Scan line offsets Band 7
		"L7Xsss2nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
Scan_Line_ Offsets_60m	Correction_ Data	"L7Xsss1nYYDOYHHuuvv.O60"	Vdata	DFTAG_VH	Scan line offsets Band 6 low
		"L7Xsss2nYYDOYHHuuvv.O60"	Vdata	DFTAG_VH	Scan line offsets Band 6 high
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
Scan_Line_ Offsets_15m	Correction_ Data	"L7Xsss2nYYDOYHHuuvv.O81"	Vdata	DFTAG_VH	ETM+ Band 8 scan line offsets, one or more segment product
		"L7Xsss2nYYDOYHHuuvv.O82"	Vdata	DFTAG_VH	ETM+ Band 8 scan line offsets, two or more segment product
		"L7Xsss2nYYDOYHHuuvv.O83"	Vdata	DFTAG_VH	ETM+ Band 8 scan line offsets, three segment product
		"L7Xsss1nYYDOYHHuuvv.GEO"	Vdata	DFTAG_VH	Geolocation table
PCD	Correction_ Data	"L7Xsss1nYYDOYHHuuvv.PCD"	Vdata	DFTAG_VH	PCD—format 1
		"L7Xsss2nYYDOYHHuuvv.PCD"	Vdata	DFTAG_VH	PCD—format 2
MSCD	Correction_ Data	"L7Xsss1nYYDOYHHuuvv.MSD"	Vdata	DFTAG_VH	MSCD—format 1
		"L7Xsss2nYYDOYHHuuvv.MSD"	Vdata	DFTAG_VH	MSCD—format 2
Product_Metadata	Metadata	"L7Xsss1nYYDOYHHuuvv.MTA"	Vdata	DFTAG_VH	Metadata—format 1
		"L7Xsss2nYYDOYHHuuvv.MTA"	Vdata	DFTAG_VH	Metadata—format 2
		"L7Xsss1nYYDOYHHuuvv.MTP"	Vdata	DFTAG_VH	Metadata—product specific
CPF	Parameter_ Data	"L7CPFYYYYMMDD_ YYYYMMDD.nn"	Vdata	DFTAG_VH	IAS calibration parameter file

Table 5-30. Vgroup Definition for the Landsat 7 L0Rp Product (2 of 2)

Section 6 Product Packaging

L0Rp products are available on various media or through transfer methods outlined in this section. End users can get products through several independent distribution systems. The parameters outlined are intended to ensure that end user products from different distribution systems are similar.

Every distributor should supply two files that contain information about the product(s) on media. They are a README file and a summary file. The README file contains information describing the type of product on media (ex: L7 L0Rp) and any conventions that are vendor-specific or out of the ordinary. The summary file contains detailed descriptions about the product on media. Information such as order identification, acquisition date, geographic location, file names, location of the files, and their size are included.

6.1 CD-ROM

Data products on Compact Disk Read Only Memory (CD-ROM) are mastered using ISO 9660 Interchange level 2, the international standard for logical file formatting a CD-ROM. Rock Ridge and Joliet extensions are present on the CD-ROM. No file unpacking is required. The files are ready for processing using HDF or other software tools.

The root directory contains a README and summary file, which describes product content, and a set of files or subdirectories. Depending upon the distribution technique, orders with only one scene may place all files in the root directory. However, if there are multiple scene units, there must be one subdirectory for each product ordered. Product subdirectories are labeled with a unique name and referenced in the summary file. All of the files associated with a product exist at a common level within the product subdirectory.

Product orders with large scenes or a number of scene units may exceed the capacity of the media. If this occurs, distribution systems span scene units across multiple volumes; a copy of the HDF directory file is included on all output volumes for user convenience.

The CD-ROM label includes the following information: order and unit number, scene identifiers (granule or entity id), Mission indicator (which is L7 or Landsat 7), start path, start row, end row, acquisition date, and product type (which is L0Rp).

6.2 DVD-R

Data products on Digital Video Disk write once (DVD-R) are mastered using ISO 9660 Interchange level 2, the international standard for file formatting a DVD-R. Rock Ridge and Joliet extensions are present on the CD-ROM. No file unpacking is required. The files are ready for processing using HDF or other software tools. DVD-R products are mastered using single-sided, single-layered technology, providing a capacity of 4.7 gigabytes. This configuration is compatible with most DVD-ROM readers.

The root directory contains a README and summary file, which describes product content, and a set of files or subdirectories. Depending upon the distribution technique, orders with only one scene may place all files in the root directory. However, if there are multiple scene units, there must be one subdirectory for each product ordered. Product subdirectories are labeled with a unique name and referenced in the summary file. All of the files associated with a product exist at a common level within the product subdirectory.

Product orders with large scenes or a number of scene units may exceed the capacity of the media. If this occurs, distribution systems span scene units across multiple volumes; a copy of the HDF directory file is included on all output volumes for user convenience.

The DVD-R label includes the following information: order and unit number, scene identifiers (granule or entity id), Mission indicator (which is L7 or Landsat 7), start path, start row, end row, acquisition date, and product type (which is L0Rp).

6.3 Digital Linear Tape (DLT)

Data products may be supplied on Digital Linear Tape (DLT). This includes a family of devices and media including DLT-IV, DLT8000, and SDLT. At this time, DLT-IV devices (DLT4000 and DLT-7000) are no longer available from vendors. There is, however, a large number of existing DLT-IV devices in use. New tape devices include DLT8000 and Super DLT (SDLT). Both are “read compatible” with media written using DLT-IV devices.

Data are written using the Tape Archive (TAR) utility format (per IEEE POSIX standard 1003.1), thus preserving directory structure and file names. The no-swap device and a fixed blocking factor of 256 512-byte blocks are used to maximize portability between platforms.

The root directory must contain a README and summary file, which describes product content, and a set of files or subdirectories. Depending upon the distribution technique, orders with only one scene may place all files in the root directory. However, if there are multiple scene units, there must be one subdirectory for each product ordered. Product subdirectories are labeled with a unique name and referenced in the summary file. All of the files associated with a product exist at a common level within the product subdirectory.

Product orders with large scenes or a number of scene units may exceed the capacity of the media. If this occurs, distribution systems span scene units across multiple volumes; a copy of the HDF directory file is included on all output volumes for user convenience.

The DLT tape label includes the following information: Mission indicator (which is L7 or Landsat 7), start path, start row, end row, acquisition date, and product type (which is

L0Rp), the DLT format (e.g., DLT4000, DLT7000, DLT8000, SDLT), the type of TAR used (e.g., IRIX, GNU), and the blocking factor.

6.4 Electronic File Transfer Protocol (FTP)

Electronic data transfer uses FTP. FTP, as described in RFC 959, is an internet standard for file transfers that supports the retrieval of files from a remote server. This distribution method may not be available to all end users by all distribution systems. In some cases, special high-speed network requirements must be arranged. Various strategies and procedures to access data may vary significantly between distribution systems.

When FTP service is available, data will be stored using the following standard. The home or initial login directory contains a set of files or subdirectories. Depending upon the distribution technique, orders with only one scene may place all files in the home directory. However, if there are multiple scene units, there must be one subdirectory for each product ordered. The product subdirectories are labeled with a unique name. All of the files associated with a product exist at a common level within the product subdirectory.

Section 7 Software Tools

A variety of public domain software tools are available for processing the 0R distribution product in either an HDF-EOS, HDF, or independent computing environment.

7.1 NCSA HDF Libraries

HDF is a library- and platform-independent data format for the storage and exchange of scientific data. It includes Fortran and C calling interfaces and utilities for analyzing and converting HDF data files. HDF is developed and supported by NCSA and is available in the public domain.

The HDF library contains two parts: the base library and the multifile library. The base library contains a general purpose interface and application-level interfaces, one for each data structure type. Each application-level interface is specifically designed to read, write, and manipulate one type. The general purpose interface contains functions, such as file Input/Out (I/O), error handling, memory management, and physical storage. HDF library functions can be called from C or Fortran user application programs.

HDF source code for UNIX, Virtual Memory Storage (VMS), Windows NT/95, and Macintosh is available via anonymous File Transfer Protocol (FTP) from http://hdf.ncsa.uiuc.edu/obtain.html. HDF reference manuals, user guides, release notes, and newsletters are Web accessible at http://hdf.ncsa.uiuc.edu.

7.2 HDF-EOS Libraries

HDF-EOS is standard HDF with LAM conventions and metadata added. The principal distinction is the specification of three geolocation data types: point, grid, and swath, which allow the file contents to be queried by Earth coordinates and time using the HDF-EOS Application Programming Interface (API). The Landsat 7 L0Rp distribution product does not employ either of these data structures. However, any application that makes use of the HDF-EOS API will, as a consequence of linking to the API, have access to the NCSA native base libraries that can be used to access the distribution L0Rp product.

EOSView is a file-viewing tool developed to examine and verify HDF and HDF-EOS data files. This tool enables users of EOS data products to view the contents of HDF files and individual objects via straightforward product access and display tools. Supported record types for view and display capability include images, multidimensional arrays, text, Vdatas, and Vgroups. EOSView users see the underlying HDF structures and are prompted for which parts of the structure they wish to view.

Landsat 7 L0Rp product users may also find the Science Data Production (SDP) Toolkit useful for follow-on processing. The SDP Toolkit consists of a set of fully tested and reliable C and Fortran language functions, customized for application to ECS product generation software. Of particular interest to Landsat 7 data users is the ODL parser, which allows for reading, writing, and manipulating product metadata and the digital elevation model software tools. The SDP Toolkit and HDF-EOS libraries are available via anonymous ftp from edhs1.gsfc.nasa.gov. Because this software was developed under a NASA contract and is intended for the use of EOS instrument teams and science investigators, access to download it is password protected. The password may be obtained via email at pgstlkit@eos.hitc.com.

7.3 ODL Parser

The ODL parser (Version 1.0) incorporated into the SDP Toolkit was originally implemented by the University of Colorado's *Laboratory for Atmospheric and Space Physics* (LASP). The Jet Propulsion Laboratory enhanced the ODL parser in building their Planetary Data System. The improved ODL software (Version 2.1), which is maintained by LASP, is available at the following Web site address: http://caster.gsfc.nasa.gov/IAS/COTS/ias_cots.html.

Version 2.1 or later should be particularly useful to those operating in a non-HDF-EOS environment. The software stands alone and can be used to read the L0Rp metadata external elements and the CPF.

Section 8 HDF Tools

8.1 HDF Data Directory Listing

A variety of tools exist for examining the contents of an L0Rp distribution product. For example, the NCSA-developed HDP utility provides quick and general information about all objects in the specified HDF file. It lists the contents of HDF files at various levels with different details and can dump the data of one or more specific objects in the file.

A second tool is the EOSView file viewing tool developed for examining and verifying HDF and HDF-EOS data files. This tool enables the user of EOS data products to view the contents of HDF files and individual objects by providing the user with the ability to read and display all metadata fields and data objects appropriately. All data objects present in the L0Rp product are supported. EOSView users will see the underlying HDF structures and will be prompted for the parts of the structure they wish to view. Additional details are in the HDF documents listed in the References.

Appendix A Methodology for L7 L0Rp Distribution Product Parameters

The purpose of this appendix is to clarify the details of the methodology employed by the LAM to populate certain parameters of the Landsat 7 L0Rp Distribution Product. In particular, this appendix describes the methodology that the LAM uses to populate the parameters of the Product Metadata (MTP) and Geolocation Index (GEO) files. The need for such clarification arose in March 1998 when the Landsat Project realized a temporal offset existed in the Format-1/Format-2 data. This offset was formalized in May 1998 through changes to the Landsat 7 Data Format Control Book (DFCB) documents. Section 5 describes the format of the MTP and GEO files; the parameter-population detail below that level is included herein.

A.1 GEO File Parameters

Table A-1 through Table A-3 detail the methodology that the LAM uses to populate the GEO file parameters.

A.2 MTP File Parameters

The methodology that the LAM uses to populate the MTP file parameters is specific to whether the Distribution Product is a single scene or an entire subinterval.

A.1.1 Scene Product Case

Table A-4 through Table A-7 detail the methodology that the LAM uses to populate the MTP file parameters for the Scene Product case.

A.2.1. Subinterval Product Case

Table A-8 through Table A-11 detail the methodology that the LAM uses to populate the MTP file parameters for the Subinterval Product case.

GEO Parameter Name	Source	Population Methodology
UlLon	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
UlLat	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
UrLon	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
UrLat	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
LlLon	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
LlLat	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
LrLon	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).
LrLat	Relevant scene of Format-2 (if present; else Format-1).	Obtained directly from the HDF-EOS structural metadata of a Format-2 Band Data file (in decreasing order of preference, Band 7, 6H, 8). If Format-2 is absent, then Format-1 is used (in decreasing order of preference, Band 1, 2, 3, 4, 5, 6L).

Table A-1. GEO File Paramters (1 of 3)

GEO Parameter Name	Source	Population Methodology
FirstLine_15m	Relevant scene of Format-2 Band 8.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed starting latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Band 8 is missing, this parameter is assigned a value of zero.
LastLine_15m	Relevant scene of Format-2 Band 8.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed ending latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Band 8 is missing, this parameter is assigned a value of zero.
FirstLine_30m_F1	Relevant scene of Format-1 Band 1.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed starting latitude of the scene is identified. This line_no value is referenced to Format-1 subinterval count. If Format-1 is missing, this parameter is assigned a value of zero. If Band 1 is missing, Band 2, 3, 4, or 5 (in that order of preference) is used as the source.
LastLine_30m_F1	Relevant scene of Format-1 Band 1.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed ending latitude of the scene is identified. This line_no value is referenced to Format-1 subinterval count. If Format-1 is missing, this parameter is assigned a value of zero. If Band 1 is missing, Band 2, 3, 4, or 5 (in that order of preference) is used as the source.
FirstLine_30m_F2	Relevant scene of Format-2 Band 7.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed starting latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Band 7 is missing, this parameter is assigned a value of zero.

Table A-2. GEO File Paramters (2 of 3)

GEO Parameter Name	Source	Population Methodology
LastLine_30m_F2	Relevant scene of Format-2 Band 7.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed ending latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Band 7 is missing, this parameter is assigned a value of zero .
FirstLine_60m_F1	Relevant scene of Format-1 Band 6.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed starting latitude of the scene is identified. This line_no value is referenced to Format-1 subinterval count. If Format-1 Band 6 is missing, this parameter is assigned a value of zero .
LastLine_60m_F1	Relevant scene of Format-1 Band 6.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed ending latitude of the scene is identified. This line_no value is referenced to Format-1 subinterval count. If Format-1 Band 6 is missing, this parameter is assigned a value of zero .
FirstLine_60m_F2	Relevant scene of Format-2 Band 6.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed starting latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Format-2 Band 6 is missing, this parameter is assigned a value of zero .
LastLine_60m_F2	Relevant scene of Format-2 Band 6.	Obtained from the HDF-EOS structural metadata of the indicated Band Data file. The line_no corresponding to the geo-indexed ending latitude of the scene is identified. This line_no value is referenced to Format-2 subinterval count. If Format-2 Band 6 is missing, this parameter is assigned a value of zero .
FullScene	Array size (specifically, the number of product-count scans) of the first-encountered Band file in the Product.	Flag (Y or N) value is based on a comparison of the number of scans in the indicated file with the number of scans in a Standard WRS Scene Product (375). If the number of scans is less than 375, the flag value is N; else Y.

Table A-3. GEO File Paramters (3 of 3)

MTP Parameter Name	Source	Population Methodology
ORIGIN	LAM-generated.	Constant string value ("Image courtesy of the U.S. Geological Survey"). Establishes the origin of the image to be from the USGS.
PRODUCT_CREATION_ DATE_TIME	LAM-generated.	LAM time-stamp for this instance of the Product. Note that this is not the same as ProductionDateTime for the granule.
STATION_ID	First-encountered MTA file in the Product.	Lifted from MTA parameter STATION_ID.
PRODUCT_TYPE	LAM-generated.	Constant string value ("L0R").
SPACECRAFT_ID	First-encountered MTA file in the Product.	Lifted from MTA parameter SPACECRAFT_ID.
SENSOR_ID	First-encountered MTA file in the Product.	Lifted from MTA parameter SENSOR_ID.
SENSOR_MODE	LAM-generated.	Scan Angle Monitor Mode (SAM) and Bumper Mode (BUMPER).
ACQUISITION_DATE	MTA file from Format having higher PCD score in its SCENE_QUALITY value (Format-1 winning any tie).	Modified form (truncated to date and expressed in form indicated in Section 5 of this document) of the value of SCENE_CENTER_SCAN_TIME from the indicated MTA file.
STARTING_PATH	MTA file from Format having higher PCD score in its SCENE_QUALITY value (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter STARTING_PATH).
STARTING_ROW	MTA file from Format having higher PCD score in its SCENE_QUALITY value (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter STARTING_ROW).
ENDING_ROW	MTA file from Format having higher PCD score in its SCENE_QUALITY value (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter ENDING_ROW).
TOTAL_WRS_SCENES	Based on value of MTP parameter NUMBER_OF_SCANS (q.v.).	Value is determined by the formula—((NUMBER_OF_SCANS-375)/355)+1 if NUMBER_OF_SCANS>375, else NUMBER_OF_SCANS/375. Note that this MTP parameter is different from the MTA parameter having the same name.
NUMBER_OF_SCANS	Based on values of ENDING_SUBINTERVAL_SCAN and STARTING_SUBINTERVAL_SCAN (q.v.).	Value is determined by the formula—(ENDING_SUBINTERVAL_SCAN - STARTING_SUBINTERVAL_SCAN +1). Note that the scan_no values used in this formula are referenced to the subinterval count (native, or translated using FORMAT_SCAN_OFFSET, q.v.) of Format-2 (if present; else Format-1).

Table A-4. MTP File Parameters - Scene Product Case (1 of 4)

MTP Parameter Name	Source	Population Methodology
FORMAT_SCAN_ OFFSET	Based on MTA parameter SUBINTERVAL_START_TIME along with the HDF-EOS structural metadata of the first-encountered Band Data file from each of the two Formats.	First, the Format having the latest value of the MTA parameter SUBINTERVAL_START_TIME is determined. From the first-encountered Band Data file of this Format, the scan_no value corresponding to that latest value is identified (it should be 1). From this same Band Data file, the Time value is noted. Then from the first-encountered Band Data file of the other Format, the scan_no value corresponding to the specified Time value is identified. Finally, the value of FORMAT_SCAN_OFFSET is calculated by the formula—(F1 scan_no - F2 scan_no).
STARTING_ SUBINTERVAL_SCAN	Based on HDF-EOS structural metadata of the first-encountered Band Data file from Format-2 (if present; else Format-1).	From the indicated Band Data file, the scan_no value corresponding to the geo-indexed starting latitude of the relevant WRS scene is identified. This scan_no value is referenced to the original subinterval count of the indicated Format.
ENDING_ SUBINTERVAL_SCAN	Based on HDF-EOS structural metadata of the first-encountered Band Data file from Format-2 (if present; else Format-1).	From the indicated Band Data file, the scan_no value corresponding to the geo-indexed ending latitude of the relevant WRS scene is identified. This scan_no value is referenced to the original subinterval count of the indicated Format.
BAND_COMBINATION	Based on Band Data files actually present in the Product.	The Product's individual filenames are examined, and the presence or absence of each Band Data file is determined.
PRODUCT_UL_ CORNER_LAT	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_UL_CORNER_LAT without LAM modification.
PRODUCT_UL_ CORNER_LON	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_UL_CORNER_LON without LAM modification.
PRODUCT_UR_ CORNER_LAT	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_UR_CORNER_LAT without LAM modification.
PRODUCT_UR_ CORNER_LON	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_UR_CORNER_LON without LAM modification.
PRODUCT_LL_ CORNER_LAT	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_LL_CORNER_LAT without LAM modification.
PRODUCT_LL_ CORNER_LON	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_LL_CORNER_LON without LAM modification.
PRODUCT_LR_ CORNER_LAT	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_LR_CORNER_LAT without LAM modification.
PRODUCT_LR_ CORNER_LON	Relevant scene of Format-2 (if present; else Format-1).	Lifted from MTA parameter SCENE_LR_CORNER_LON without LAM modification.
BAND1_GAIN	Relevant scene of Format-1.	Lifted from MTA parameter BAND1_GAIN.

Table A-5. MTP File Parameters - Scene Product Case (2 of 4)

MTP Parameter Name	Source	Population Methodology
BAND2_GAIN	Relevant scene of Format-1.	Lifted from MTA parameter BAND2_GAIN.
BAND3_GAIN	Relevant scene of Format-1.	Lifted from MTA parameter BAND3_GAIN.
BAND4_GAIN	Relevant scene of Format-1.	Lifted from MTA parameter BAND4_GAIN.
BAND5_GAIN	Relevant scene of Format-1.	Lifted from MTA parameter BAND5_GAIN.
BAND6_GAIN_F1	Relevant scene of Format-1.	Lifted from MTA parameter BAND6_GAIN.
BAND6_GAIN_F2	Relevant scene of Format-2.	Lifted from MTA parameter BAND6_GAIN.
BAND7_GAIN	Relevant scene of Format-2.	Lifted from MTA parameter BAND7_GAIN.
BAND8_GAIN	Relevant scene of Format-2.	Lifted from MTA parameter BAND8_GAIN.
BAND1_FILE_NAME	Based on original LPS-given filename.	Product Band 1 filename.
BAND2_FILE_NAME	Based on original LPS-given filename.	Product Band 2 filename.
BAND3_FILE_NAME	Based on original LPS-given filename.	Product Band 3 filename.
BAND4_FILE_NAME	Based on original LPS-given filename.	Product Band 4 filename.
BAND5_FILE_NAME	Based on original LPS-given filename.	Product Band 5 filename.
BAND6_FILE_NAME_F1	Based on original LPS-given filename.	Product Format-1 Band 6 filename.
BAND6_FILE_NAME_F2	Based on original LPS-given filename.	Product Format-2 Band 6 filename.
BAND7_FILE_NAME	Based on original LPS-given filename.	Product Band 7 filename.
BAND8_FILE1_NAME	Based on original LPS-given filename.	Product Band 8 segment-1 filename.
BAND8_FILE2_NAME	Based on original LPS-given filename.	Not populated for scene Product.
BAND8_FILE3_NAME	Based on original LPS-given filename.	Not populated for scene Product.
IC_DATA_FILE_NAME_ F1	Based on original LPS-given filename.	Product Format-1 IC_DATA filename.
IC_DATA_FILE_NAME_ F2	Based on original LPS-given filename.	Product Format-2 IC_DATA filename.
SCAN_OFFSETS__ FILE_NAME_F1	LAM -generated.	Product Format-1 SCAN_OFFSETS filename.

Table A-6. MTP File Parameters - Scene Product Case (3 of 4)

MTP Parameter Name	Source	Population Methodology
SCAN_OFFSETS__ FILE_NAME_F2	LAM-generated.	Product Format-2 SCAN_OFFSETS filename.
MSCD_FILE_NAME_F1	Based on original LPS-given filename.	Product Format-1 MSCD filename.
MSCD_FILE_NAME_F2	Based on original LPS-given filename.	Product Format-2 MSCD filename.
PCD_FILE_NAME_F1	Based on original LPS-given filename.	Product Format-1 PCD filename.
PCD_FILE_NAME_F2	Based on original LPS-given filename.	Product Format-2 PCD filename.
METADATA_FILE_ NAME_F1	Based on original LPS-given Format-1 filename.	Product Format-1 MTA filename.
METADATA_FILE_ NAME_F2	Based on original LPS-given Format-2 filename.	Product Format-2 MTA filename.
METADATA_PS_FILE_ NAME	LAM-generated.	Product MTP filename.
CPF_FILE_NAME	Based on original IAS-given filename.	Product CPF filename.
GEOLOCATION_FILE_ NAME	LAM-generated.	Product GEO filename.
HDF_DIR_FILE_NAME	LAM-generated.	Product HDF Directory filename.

Table A-7. MTP File Parameters - Scene Product Case (4 of 4)

MTP Parameter Name	Source	Population Methodology
ORIGIN	LAM-generated.	Constant string value ("Image courtesy of the U.S. Geological Survey"). Establishes the origin of the image to be from the USGS.
PRODUCT_CREATION_ DATE_TIME	LAM-generated.	LAM time-stamp for this instance of the Product. Note that this is not the same as ProductionDateTime for the granule.
STATION_ID	First-encountered MTA file in Product.	Lifted from MTA parameter STATION_ID.
PRODUCT_TYPE	LAM-generated	Constant string value ("L0R").
SPACECRAFT_ID	First-encountered MTA file in Product.	Lifted from MTA parameter SPACECRAFT_ID.
SENSOR_ID	First-encountered MTA file in Product.	Lifted from MTA parameter SENSOR_ID.
SENSOR_MODE	LAM-generated.	Scan Angle Monitor Mode (SAM) and Bumper Mode (BUMPER).
ACQUISITION_DATE	MTA file from Format having latest value of SUBINTERVAL_START_TIME (Format-1 winning any tie).	Modified form (truncated to date and expressed in form indicated in Section 5 of this document) of the value of SUBINTERVAL_START_TIME from the indicated MTA file.
STARTING_PATH	MTA file from Format having latest value of SUBINTERVAL_START_TIME (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter STARTING_PATH).
STARTING_ROW	MTA file from Format having latest value of SUBINTERVAL_START_TIME (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter STARTING_ROW).
ENDING_ROW	MTA file from Format having earliest value of SUBINTERVAL_STOP_TIME (Format-1 winning any tie).	Lifted from the indicated MTA file (parameter ENDING_ROW).
TOTAL_WRS_SCENES	Based on value of MTP parameter NUMBER_OF_SCANS (q.v.).	Value is determined by the formula—((NUMBER_OF_SCANS-375)/335)+1 if NUMBER_OF_SCANS>375, else NUMBER_OF_SCANS/375. Note that this MTP parameter is different from the MTA parameter having the same name.
NUMBER_OF_SCANS	Based on values of ENDING_SUBINTERVAL_SCAN and STARTING_SUBINTERVAL_SCAN (q.v.).	Value is determined by the formula—(ENDING_SUBINTERVAL_SCAN - STARTING_SUBINTERVAL_SCAN +1). Note that the scan_no values used in this formula are referenced to the subinterval count (native, or translated using FORMAT_SCAN_OFFSET, q.v.) of Format-2 (if present; else Format-1).

Table A-8. MTP File Parameters - Subinterval Product Case (1 of 4)

MTP Parameter Name	Source	Population Methodology
FORMAT_SCAN_ OFFSET	Based on MTA parameter SUBINTERVAL_START_TIME along with the HDF-EOS structural metadata of the first-encountered Band Data file from each of the two Formats.	First, the Format having the latest value of the MTA parameter SUBINTERVAL_START_TIME is determined. From the first-encountered Band Data file of this Format, the scan_no value corresponding to that latest value is identified (it should be 1). From this same Band Data file, the Time value is noted. Then from the first-encountered Band Data file of the other Format, the scan_no value corresponding to the specified Time value is identified. Finally, the value of FORMAT_SCAN_OFFSET is calculated by the formula—(F1 scan_no - F2 scan_no).
STARTING_ SUBINTERVAL_SCAN	Based on HDF-EOS structural metadata of the first-encountered Band Data file from the Format having latest value of MTA parameter SUBINTERVAL_START_TIME.	From the indicated Band Data file, the scan_no value corresponding to the SUBINTERVAL_START_TIME is identified. This scan_no value is then referenced to the original subinterval count of Format-2 (if present; else Format-1)—either natively or by translation using FORMAT_SCAN_OFFSET. Note that the value of this parameter is always greater than zero.
ENDING_ SUBINTERVAL_SCAN	Based on HDF-EOS structural metadata of the first-encountered Band Data file from the Format having earliest value of MTA parameter SUBINTERVAL_STOP_TIME.	From the indicated Band Data file, the scan_no value corresponding to the SUBINTERVAL_STOP_TIME is identified. This scan_no value is then referenced to the original subinterval count of Format-2 (if present; else Format-1)—either natively or by translation using FORMAT_SCAN_OFFSET. Note that the value of this parameter is always greater than zero.
BAND_COMBINATION	Based on Band Data files actually present in the Product.	The Product's individual filenames are examined, and the presence or absence of each Band Data file is determined.
PRODUCT_UL_ CORNER_LAT	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_UL_CORNER_LAT without LAM modification.
PRODUCT_UL_ CORNER_LON	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_UL_CORNER_LON without LAM modification.
PRODUCT_UR_ CORNER_LAT	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_UR_CORNER_LAT without LAM modification.
PRODUCT_UR_ CORNER_LON	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_UR_CORNER_LON without v modification.
PRODUCT_LL_ CORNER_LAT	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_LL_CORNER_LAT without v modification.

Table A-9. MTP File Parameters - Subinterval Product Case (2 of 4)

MTP Parameter Name	Source	Population Methodology
PRODUCT_LL_ CORNER_LON	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_LL_CORNER_LON without LAM modification.
PRODUCT_LR_ CORNER_LAT	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_LR_CORNER_LAT without LAM modification.
PRODUCT_LR_ CORNER_LON	Based on MTA from Format-2 (if present; else Format-1).	Lifted from MTA parameter SUBINTERVAL_LR_CORNER_LON without LAM modification.
BAND1_GAIN	First scene of Format-1.	Lifted from MTA parameter BAND1_GAIN.
BAND2_GAIN	First scene of Format-1.	Lifted from MTA parameter BAND2_GAIN.
BAND3_GAIN	First scene of Format-1.	Lifted from MTA parameter BAND3_GAIN.
BAND4_GAIN	First scene of Format-1.	Lifted from MTA parameter BAND4_GAIN.
BAND5_GAIN	First scene of Format-1.	Lifted from MTA parameter BAND5_GAIN.
BAND6_GAIN_F1	First scene of Format-1.	Lifted from MTA parameter BAND6_GAIN.
BAND6_GAIN_F2	First scene of Format-2.	Lifted from MTA parameter BAND6_GAIN.
BAND7_GAIN	First scene of Format-2.	Lifted from MTA parameter BAND7_GAIN.
BAND8_GAIN	First scene of Format-2.	Lifted from MTA parameter BAND8_GAIN.
BAND1_FILE_NAME	LAM-generated (based on original LPS-given filename and LAM Product timestamp).	Product Band 1 filename.
BAND2_FILE_NAME	Based on the original LPS-given filename.	Product Band 2 filename.
BAND3_FILE_NAME	Based on the original LPS-given filename.	Product Band 3 filename.
BAND4_FILE_NAME	Based on the original LPS-given filename.	Product Band 4 filename.
BAND5_FILE_NAME	Based on the original LPS-given filename.	Product Band 5 filename.
BAND6_FILE_NAME_F1	Based on the original LPS-given filename.	Product Format-1 Band 6 filename.
BAND6_FILE_NAME_F2	Based on the original LPS-given filename.	Product Format-2 Band 6 filename.
BAND7_FILE_NAME	Based on the original LPS-given filename.	Product Band 7 filename.
BAND8_FILE1_NAME	Based on the original LPS-given filename.	Product Band 8 segment-1 filename.
BAND8_FILE2_NAME	Based on the original LPS-given filename.	Product Band 8 segment-2 filename.
BAND8_FILE3_NAME	Based on the original LPS-given filename.	Product Band 8 segment-3 filename.

Table A-10. MTP File Parameters - Subinterval Product Case (3 of 4)

MTP Parameter Name	Source	Population Methodology
IC_DATA_FILE_NAME_ F1	Based on the original LPS-given filename.	Product Format-1 IC_DATA filename.
IC_DATA_FILE_NAME_ F2	Based on the original LPS-given filename.	Product Format-2 IC_DATA filename.
SCAN_OFFSETS__ FILE_NAME_F1	LAM-generated.	Product Format-1 SCAN_OFFSETS filename.
SCAN_OFFSETS__ FILE_NAME_F2	LAM-generated.	Product Format-2 SCAN_OFFSETS filename.
MSCD_FILE_NAME_F1	Based on the original LPS-given Format-1 filename.	Product Format-1 MSCD filename.
MSCD_FILE_NAME_F2	Based on the original LPS-given Format-1 filename.	Product Format-2 MSCD filename.
PCD_FILE_NAME_F1	Based on the original LPS-given Format-1 filename.	Product Format-1 PCD filename.
PCD_FILE_NAME_F2	Based on the original LPS-given Format-1 filename.	Product Format-2 PCD filename.
METADATA_FILE_ NAME_F1	Based on the original LPS-given Format-1 filename.	Product Format-1 MTA filename.
METADATA_FILE_ NAME_F2	Based on the original LPS-given Format-1 filename.	Product Format-2 MTA filename.
METADATA_PS_FILE_ NAME	LAM-generated.	Product MTP filename.
CPF_FILE_NAME	Based on the original IAS-given filename.	Product CPF filename.
GEOLOCATION_FILE_ NAME	LAM-generated.	Product GEO filename.
HDF_DIR_FILE_NAME	LAM-generated.	Product HDF Directory filename.

Table A-11. MTP File Parameters - Subinterval Product Case (4 of 4)

References

For a list of acronyms, please see http://landsat.usgs.gov/resources/acronyms.php

USGS/EROS. LAM-700. Landsat Archive Manager (LAM) System Requirements Document (SRD). Version 12.0, February 2005.

USGS/EROS. LPSNG-102. Landsat 7 Processing System Next-Generation (LPSNG) Software Requirements Specification (SRS). Version 4.0, July 2002.

USGS/EROS. LPSNG-103. Landsat 7 Processing System Next Generation (LPSNG) Software Design Description. Version 1.0, January 2001.

USGS/EROS. LAM-745. Landsat Archive Manager (LAM) Archive Server (AS) Database Description Document (DBDD). Version 8.0. June 2005.

USGS/EROS. LS-DFCB-02. Landsat 7 ETM+ Level Zero-R Archive (L0Ra) Data Format Control Book (DFCB). Version 10.0, September 2004.

USGS/EROS. DB-100, Landsat 7 Processing System Next Generation (LPSNG) Database Analysis and Design. December 2000.

NASA. Landsat 7 Science Data User's Handbook. http://ltpwww.gsfc.nasa.gov/IAS/handbook/handbook_toc.html.

USGS/EROS. IAS-220. IAS Landsat 7 Calibration Parameter File (CPF) Release Version Description Document (VDD). Version 20.0. April 2005.

USGS/EROS. LS-ICD-29. Landsat 7 (L7) to International Ground Station (IGS) Interface Control Document (ICD). Version 7.0. April 2005.

USGS/EROS. LS-PD-24. Landsat Ground Station (GS) Identifiers. Version 1.0. June 2005.

USGS/EROS. LS-DFCB-18. Landsat 7 System Data Format Control Book (DFCB) - Volume IV - Wideband Data. Revision L. June 1999.

USGS/EROS. IAS-207. Landsat 7 (L7) System Calibration Parameter File (CPF) Definition. Version 5.0. August 2005.

JPL D-7669 Part 2. Planetary Data System (PDS) Standards Reference. Version 3.5. October, 2002. http://pds.jpl.nasa.gov/documents/.

HDF User's Guide. Version 4.2r0. December 2003. http://hdf.ncsa.uiuc.edu/doc.html.

HDF Specification and Developer's Guide. Version 4.1r5. November 2001. ftp://ftp.ncsa.uiuc.edu/HDF/HDF/Documentation/HDF4.2r0/HDF41r5_SpecDG.pdf

HDF Reference Manual. Release 2.0. December 2003, ftp://ftp.ncsa.uiuc.edu/HDF/HDF/Documentation/HDF4.2r0/HDF42r0_RefMan.pdf