Compensated Phase History Data
Extended
Description Document

1.0 Summary

The phase history data collected by Synthetic Aperture Radar (SAR) systems is without exception sampled and formatted in sensor specific formats. The supporting metadata is also in sensor specific with respect to both format and content. The sensor specific nature of the raw phase history data and the supporting metadata make the initial steps of the data processing unique to the sensor. The initial processing includes compensations for the motion of the platform. The initial processing may also include compensations for the characteristics of the specific components of the radar system.

Compensated Phase History Data is a phase history data product that has all sensor specific corrections applied. The CPHD product has the following attributes:

(1) Full support for both monostatic imaging and bistatic imaging collections.

(2) Support for multiple phase history data channels that are collected and/or formed from the same imaging collection.

(3) For each data channel, the CPHD is a two-dimensional array of vectors and samples. The vector dimension is increasing “slow time”. The sample dimension is one of two options: (1) increasing frequency or (2) increasing Time Of Arrival (TOA).

(4) Each data vector of the CPHD has had motion compensation processing applied.

(5) Each CPHD sample is complex-valued with a real and imaginary components. Samples may be formatted with 1, 2, or 4 bytes per component (2, 4 or 8 bytes per complex sample).

2.0 File Structure

The CPHD product file contains the following components. All components are present in all CPHD product files.

(1) File Header
(2) XML Metadata Block
(3) Vector Based Metadata Block
(4) Compensated PHD Block

The file components are ordered as listed above and as shown in Figure 2-1. The File Header and XML Metadata components are placed in adjacent bytes in the file (no separation or fill allowed). The Vector Based Metadata Block and the Compensated PHD Block may be proceeded by optional file bytes. The logical hierarchy of the format of a CPHD product file is described below in Backus-Naur form.

<cphd file>	:=	<file header>	
		<xml metadata block>	
		<fill>**	** ⇔ optional
		<vector based metadata>	
		<fill>**	** ⇔ optional
		<compensated phd>	

CPHD File Structure

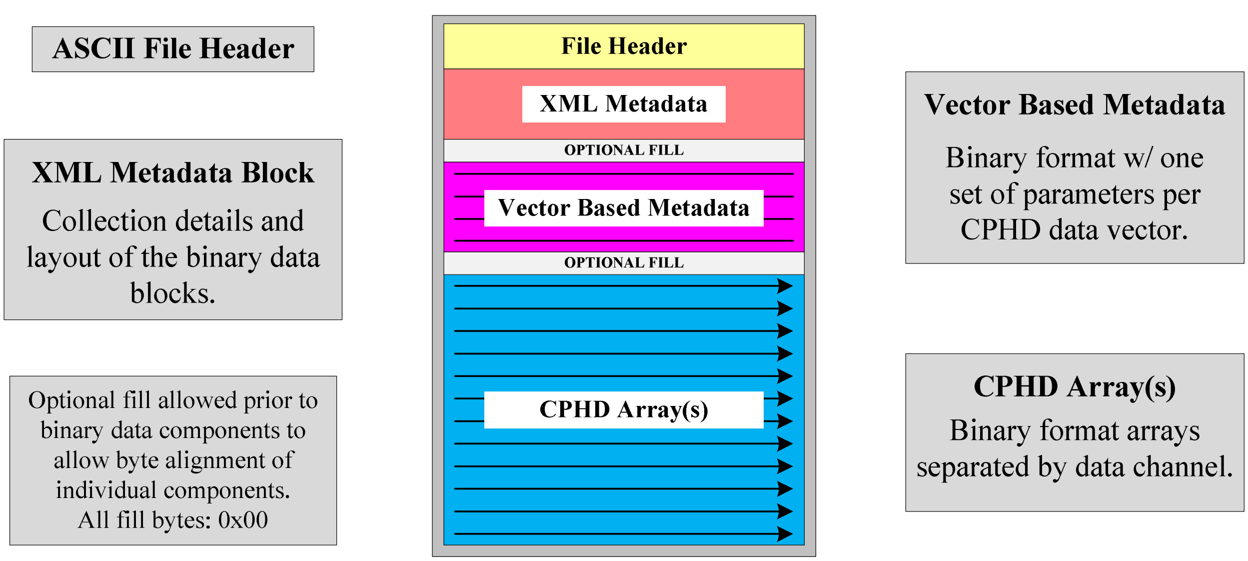

Figure 2-1. CPHD File Structure. All product files include 4 file components.

The File Header is an ASCII block of data that identifies the file type and version number. The File Header also includes a set of parameters expressed as key-value pairs that include the sizes and byte offsets of the other components. The XML Metadata describes imaging collection as well as the content of the subsequent components. The XML metadata block is expressed using the eXtensible Markup Language, Version 1.0. The XML metadata includes the number of CPHD channels, the size of the CPHD array(s) and the metadata provided for each channel. The Vector Based Metadata contains metadata parameters for each vector of the CPHD. The Compensated PHD contains the two dimensional array(s) of CPHD.

The Vector Based Metadata and the Compensated PHD are stored in binary format. All binary parameters are formatted with the Most Significant Byte (MSB) stored first (i.e. referred to as Big Endian format). The Vector Based Metadata contains one set of parameters for each vector of the CPHD. The order of the Vector Based Metadata is the same as the order of the vectors of the CPHD. See Figure 2-2. Both are separated first by CPHD data channel and then by vector within the data channel. Optional fill bytes may be included prior to either of the two binary data components (see Figure 2-1). Optional fill may be used to byte align the start of either or both of the data components. Fill placed prior to either data component is restricted to an integer number of bytes. All fill bytes shall be restricted to 0x00 (null characters).

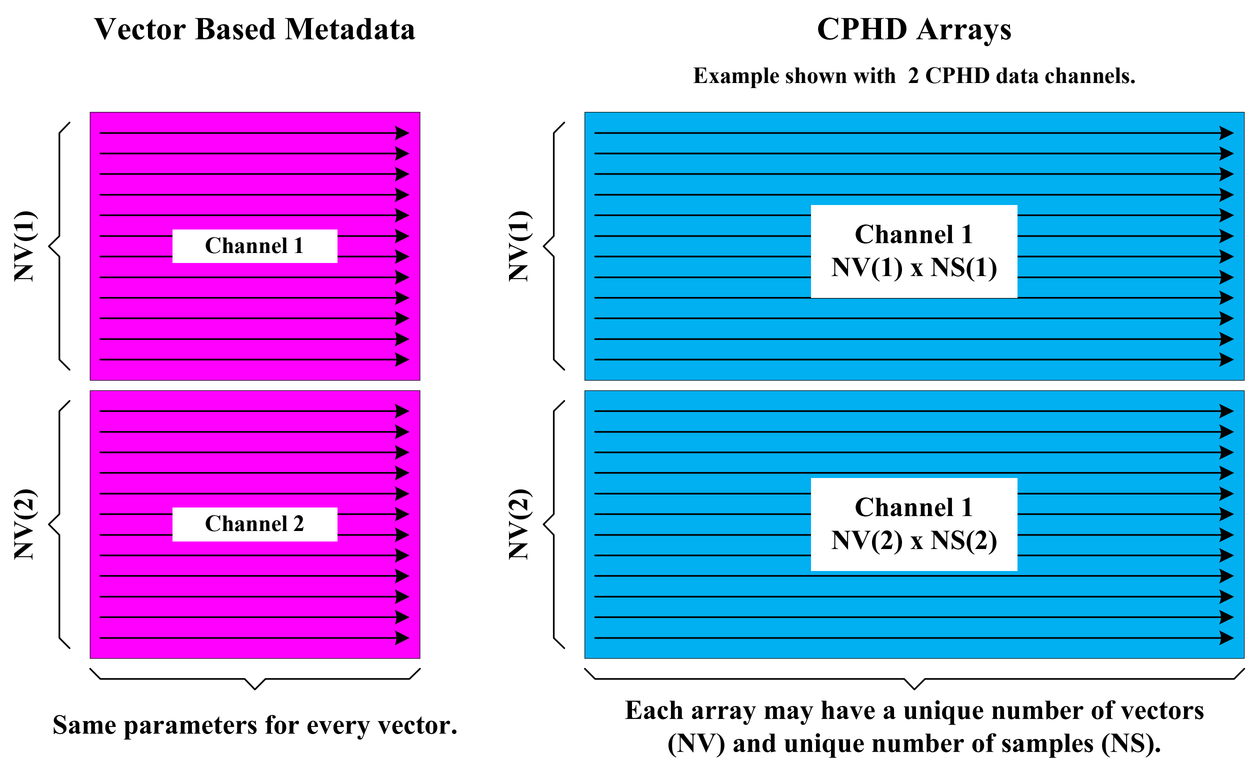

Figure 2-2. Vector Based Metadata & CPHD Arrays
Data separated by channel then by vector.

2.1 File Header

The File Header consists of the concatenation of 3 blocks of ASCII characters: (1) File Type Header, (2) Key-Value Pair List and (3) Section Terminator. The structure of the File Header block is shown below.

<file header>	:=	<file type header> <key-value pair list> <section terminator>
<file type header>	:=	<CPHD> “/” <version> “\n”
<key-value pair list>	:=	(<key-value pair> “\n”)* * ⇔ multiple occurrences
<key-value pair>	:=	<kvp key> “ := ” <kvp value>
<section terminator>	:=	“\f\n”

The File Type Header is a variable length field of the form:

<“ CPHD”> < “/”> <“version”> <”\n”>

The “version” field is a text field that identifies the version of the CPHD product. The slash “/” (0x2F) separates the version field and the newline “\n” (0x0A) terminates the File Type Header.

The Key-Value Pair List is also a variable length block. The set of available KVP keys is listed in Table 2.1. The set of keys includes both required and optional keys. Each KVP is a variable length field of the form:

<Key_Name> < “ := ”> <“Value”> <”\n”>

The Key-Value pairs are formatted per the following rules and restrictions. Key-value pairs are separated by a 4 character sequence “ := ” (0x20, 0x3A, 0x3D, 0x20), and terminated by a newline “\n” (0x0A). All files will include the set of required KVPs. A given product may also include any number of optional KVPs. A given KVP will occur only once in a given product. The KVPs may occur in any order. The KVPs that have text-based values may not use the “\n” or “\f” in the text string that is the value.

The two byte section terminator “\f\n” (0x0C, 0x0A) marks the end of the file header. The section terminator enables a reader application to identify the end of the block and enables viewing of the file header using standard functions on some systems (e.g. the “more” command on a UNIX system).

Table 2.1 File Header Key-Value Pair Parameters		
Key Name	**Req/Opt**	**Description**
XML_DATA_SIZE	REQ	Size of the XML Metadata (in bytes, decimal integer format). Does not include the 2 bytes of the section terminator. Section terminator = ASCII "\f \n" = 0x0C, 0x0A
XML_BYTE_OFFSET	REQ	Offset to the first byte of the XML Metadata (in bytes, decimal integer format).
VB_DATA_SIZE	REQ	Size of the Vector Based Metadata (in bytes, decimal integer format).
VB_BYTE_OFFSET	REQ	Offset to the first byte of the Vector Based Metadata (in bytes, decimal integer format).
CPHD_DATA_SIZE	REQ	Size of the Compensated PHD arrays (in bytes, decimal integer format).
CPHD_BYTE_OFFSET	REQ	Offset to the first byte of the CPHD data (in bytes, decimal integer format).
CLASSIFICATION	OPT	Product classification information (text-based field) that is the human-readable banner. Fields to be defined per Program Specific Implementation Document. Note: If included in the file header, value must match XML field CPHC.CollectionInfo.Classificiation. See Table 3.1.
RELEASE_INFO	OPT	Product release information (text-based field). Fields to be defined per Program Specific Implementation Document.

2.2 XML Metadata Block

The XML block is the concatenation of the XML Metadata block and the section terminator. The form of the XML Metadata block is shown below.

< xml metadata block > := <xml metadata>
<section terminator>

The content of the XML metadata block fully described in Section 3 below.

2.3 Vector Based Metadata Block

Binary metadata – one set of parameters per vector of the CPHD. Table 2-2 lists the possible parameters. The XML Metadata identifies the set of parameters included, the specific order and the size (in bytes) of each parameter. A given parameter may only be included once in the set.

(1) One set of parameters are provided for each vector of each CPHD array.

(2) Vector parameters are separated first by channel and then by vector within the channel.

All parameters are composed 64 bit floating point parameters. Positions are 3 64-bit FPs. Scalars are 1-64 bit FP.

2.4 Compensated PHD Block

Table 2-2 Vector Based Parameters					
Tag	**Req/Opt/ Cond**	**Size**	**Type**	**Units**	**Description**
TxTime	REQ	8 Bytes	Float64	sec	Time of transmit relative to collection start (sec). Time associated with TxPos.
TxPos TxPos_X TxPos_Y TxPos_Z	REQ	24 Bytes	 Float64 Float64 Float64	 m m m	Transmit Aperture Position at time of transmit in ECF (m). Order is X, Y, Z.
RcvTime	REQ	8 Bytes	Float64	sec	Time of receive relative to collection start (sec). Time associated with RcvPos.
RcvPos RcvPos_X RcvPos_Y RcvPos_Z	REQ	24 Bytes	 Float64 Float64 Float64	 m m m	Receive Aperture Position at time of receive in ECF (m). Order is X, Y, Z.
SRPTime	OPT	8 Bytes	Float64	sec	Time used to compute the SRP position relative to collection start (sec). Time associated with SRPPos. Included when SRP positions are computed from a position vs. time vector polynomial.
SRPPos SRP_X SRP_Y SRP_Z	REQ	24 Bytes	 Float64 Float64 Float64	 m m m	Stabilization Reference Point in ECF (m). Order is X, Y, Z.
TropoSRP	OPT	8 Bytes	Float64		Tropospheric delay (sec) used to compute the SRP signal TOA at the receive platform. Delay is the sum of the delay on transmit (TxPos to SRP) and the delay on receive (SRP to RcvPos).
AmpSF	OPT	8 Bytes	Float64	none	Amplitude Scale Factor to be applied to the samples of the vector. Each sample is multiplied by AmpSF to yield the correct sample value. Primary use is for fixed point sample formats.
Frequency Parameters – Included when CPHD Domain Type = FX					
Fx0	COND/ REQ	8 Bytes	Float64	Hz	RF frequency associated with sample s = 0 (Hz).
Fx_SS	COND/ REQ	8 Bytes	Float64	Hz	RF frequency sample spacing (Hz/sample). RF frequency of sample s is: Fx(s) = Fx0 + Fx_SS * s Note: Require Fx_SS > 0
Fx1	COND/ REQ	8 Bytes	Float64	Hz	First valid RF frequency value (Hz). Valid frequency range is from Fx1 to Fx2.
Fx2	COND/ REQ	8 Bytes	N/A	Hz	Last valid RF frequency value (Hz).
TOA Parameters – Included when CPHD Domain Type = TOA					
DeltaTOA0	COND/ REQ	8 Bytes	Float64	sec	Difference in Time Of Arrival (sec) relative to the SRP echo for sample s = 0.

Table 2-2 Vector Based Parameters

Tag	Req/Opt/ Cond	Size	Type	Units	Description
TOA_SS	COND/ REQ	8 Bytes	Float64	sec	Time Of Arrival sample spacing (sec) for computing TOA relative the SRP echo. $\Delta TOA(s) = \Delta TOA0 + TOA\_SS * s$ Note: Require TOA_SS > 0.

3.0 XML Metadata Parameters

Table 3.1 Collection Info Parameters

Parameter Name	Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
CPHD.CollectionInfo	R		1	This block contains general information about the collection.		
CollectorName	R	TXT	1	Radar platform identifier. For Bistatic collections, list the Receive platform.		
IlluminatorName	O	TXT	1	Radar platform identifier that provided the illumination. For Bistatic collections, list the transmit platform.		
CoreName	R	TXT	1	Collection & imaging data set identifier. Uniquely identifies imaging collections per Program Specific Implementation Doc.		
CollectType	O	ENU	1	Collection type identifier. Monostatic collections include single platform collections with unique transmit and receive apertures.		Allowed values: "MONOSTATIC", "BISTATIC"
RadarMode	R		1			
ModeType	R	ENU	1	Radar imaging mode.		Allowed Values: "SPOTLIGHT", "STRIPMAP", "DYNAMIC STRIPMAP"
ModeID	O	TXT	1	SAR system specific mode identifier.		Allowed values per Program Specific Implementation Document.
Classification	R	TXT	1	Text based field containing human-readable banner. Classification, file control & handling and file releasing, including proprietary markings.		Allowed values per Program Specific Implementation Document. Default value: "UNCLASSIFIED"
CountryCode	O	TXT	1	List of country codes for region covered by the collection.		
Parameter	O	TXT	1+	Text field that can be used for user defined parameter name(s) & value(s).		Attribute: name = "xxx", name is a descriptive identifier for this information.

Table 3.2 CPHD Data Parameters

Parameter Name	Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
CPHD.Data	R					
SampleType	R	ENU	1	Indicates the PHD sample format of the PHD array(s). All arrays have the sample type. Real and imaginary components stored in adjacent bytes, real component stored first. All binary data parameters are stored with Most Significant Byte first (i.e. “Big Endian”).	-	Allowed Values: “RE08I_IM08I”, “RE16I_IM16I”, “RE32F_IM32F” RE08I_IM08I: Each component is an 8 bit signed integer parameter, 2’s complement format. 2 Bytes Per Sample RE16I_IM16I: Each component is a 16 bit signed integer parameter, 2’s complement format. 4 Bytes Per Sample RE32F_IM32F: Each component is a 32 bit floating point parameter, IEEE format. 8 Bytes Per Sample
NumCPHDChannels	R	INT	1	Number of CPHD channels stored in the product file. Channels indexed: n = 1, 2, . . . , NumCPHDChannels	-	Allowed Values: NumCPHDChannels ≥ 1
NumBytesVBP	R	INT	1	Number of bytes per set of Vector Based Parameters. One set of VBPs for each CPHD vector.	-	
ArraySize	R		1+	CPHD array size parameters. Parameters repeated for each CPHD data channel (index n = 1 to NumCPHDChannels).	-	Attribute: index = “n” where n is the channel index.
NumVectors	R	INT	1	Number of slow time vectors in the PHD array for channel n. Vectors indexed: v = 0, 1, 2, . . . , NumVectors(n) -1		
NumSamples	R	INT	1	Number of samples per vector in the PHD array for channel n. Samples indexed: s = 0, 1, 2, . . . , NumSamples(n) -1		

Table 3.3 CPHD Global Parameters						
Parameter Name	**Req/ Opt**	**Type**	**Num**	**Description**	**Units**	**Attributes & Allowed Values**
CPHD.Global	R					
DomainType	R	ENU	1	Indicates the domain represented by the sample dimension of the PHD arrays. All CPHD channels are the same domain type.		Allowed Values: FX, TOA FX: Frequency domain. $Fx(s) = Fx(0) + FxSS \times s$ TOA: Time of Arrival domain. $\Delta TOA(s) = \Delta TOA(0) + TOASS \times s$
PhaseSGN	R	ENU	1	Phase SGN associated target phase and positive ΔTOA^{TGT}. In FX domain: $Phase(fx) = SGN \times fx \times \Delta TOA^{TGT}$ In TOA domain: $Phase(\Delta TOA) = SGN \times fx\_Ctr \times \Delta TOA^{TGT}$		Allowed Values: SGN = +1 or -1
RefFreqIndex	O	INT	1	Indicates if the RF frequency values are expressed as offsets from a reference frequency (RefFreq). RefFreqIndex = 0 ⇔ No offset used and all frequency values are true values. RefFreqIndex > 0 ⇔ All RF frequency values are offsets from a reference frequency (RefFreq (Hz)).		Index indicates the value of the reference frequency used. Allowed values of the index and reference frequency per Program Specific Implementation Document.
CollectStart	R	XDT	1	Collection start date and time (UTC) on the Collector platform. Time t = 0 for all times measured relative to collection start. XDT Format: YYYY-MM-DDThh:mm:ss.s+”	UTC	Fractional part of the seconds may include as many digits of precision as desired. Number of digits does not imply what the accuracy may.
CollectDuration	R	DBL	1	Collection duration (sec) for the Collector platform The CPHD array(s) in the file may or may not span the whole collection.	sec	

Table 3.3 CPHD Global Parameters

Parameter Name	Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
TxTime1	R	DBL	1	Earliest TxTime for any CPHD vector in the file. Time relative to collection start.	sec	
TxTime2	R	DBL	1	Latest TxTime for any CPHD vector in the file. Time relative to collection start.		
ImageArea	R		1	Parameters describing the ground area covered by this product.		
Corners	R		1	Set of 4 corner points in LLH.		
ACP	R	LLH	4	Corner point parameters. Corners indexed x = 1, 2, 3, 4 clockwise. -90.0 < Lat < 90.0, -180.0 < Lon < 180.0	dd, dd, m	
Plane	O		1	Parameters describing a rectangular area in a geo-referenced display plane.		
RefPt	R		1	Reference Point in the display plane. Optional name attribute identifies the Reference Point.		Optional: name = “xxx” Optional name attribute identifies the Reference Point.
ECF	R	XYZ	1	Reference Point in ECF.	m	
Line	R	DBL	1	Reference Point line grid location.	-	
Sample	R	DBL	1	Reference Point sample grid location.	-	
XDir	R		1	Parameters in the X direction of the geo-referenced display plane. X direction is also the increasing line direction.		
UVectECF	R	XYZ	1	The unit vector in the geo-referenced plane X direction (ECF).	-	
LineSpacing	R	DBL	1	Display line spacing for the geo-referenced plane in the X direction.	m	
NumLines	R	INT	1	Number of lines in the geo-referenced plane X direction	-	

Table 3.3 CPHD Global Parameters										
Parameter Name					Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
				FirstLine	R	INT	1	First line in the geo-referenced plane X direction	-	
			YDir		R		1	Parameters in the Y direction of the geo-referenced display plane. Y direction is also the increasing sample direction.		
				UVectECF	R	XYZ	1	The unit vector in the geo-referenced plane Y direction (ECF).	-	
				SampleSpacing	R	DBL	1	Sample spacing for the geo-referenced plane in the Y direction.	m	
				NumSamples	R	INT	1	Number of samples in the geo-referenced plane Y direction		
				FirstSample	R	INT	1	First sample in the geo-referenced plane Y direction.		
			DwellTime		O		1	Parameters describing the time the signal from the imaged scene is present in the CPHD array(s). Includes for all stripmap collections.		
				CODTimePoly	R	2D POLY	1	Time of Center Of Dwell (t_COD) polynomial as a function ground plane location. The polynomial is a function of ground plane coordinates X (variable 1) and Y (variable 2). Note: Coefficient (0,0) is the RefPT COD time.	sec, sec/m, sec/m^2, etc.	
				DwellTimePoly	R	2D POLY	1	Time of Dwell (T_DWL) polynomial as a function ground plane location. The polynomial is a function of ground plane coordinates X (variable 1) and Y (variable 2). Time of Dwell is useable time the signal from a ground point is present in the CPHD array(s). Note: Coefficient (0,0) is the RefPT dwell time.	sec, sec/m, sec/m^2, etc.	

Table 3.4 CPHD Channel Data Parameters						
Parameter Name	**Req/ Opt**	**Type**	**Num**	**Description**	**Units**	**Attributes & Allowed Values**
CPHD.Channel	R		1	Channel specific parameters for CPHD channels n = 1 to NumCPHDChannels		
Parameters	R		1+	Channel dependent parameter list for channel n. Block repeated for index n = 1 to NumCPHDChannels.	-	index = "n" where n = CPHD channel index.
SRP_Index	R	XYZ	1	Index to identify the SRP position function used for the channel.	-	
NomTOARateSF	R	DBL	1	Scale factor to indicate the fraction of the Doppler spectrum that is clear.		
FxCtrNom	R	DBL	1	Nominal center transmit frequency associated with the channel (Hz). For DomainType = TOA: FxCtrNom is the center frequency for all vectors.	Hz	
BWSavedNom	R	DBL	1	Nominal transmit bandwidth associated with the channel (Hz). For DomainType = TOA: BWSavedNom is the bandwidth saved for all vectors.	Hz	
TOASavedNom	R	DBL	1	Nominal span in TOA saved for the channel. For DomainType = FX: TOASavedNom is the bandwidth saved for all vectors.	sec	
TxAnt_Index	O	INT	1	Indicates the Transmit Antenna pattern for data collected to form the CPHD channel.		
RcvAnt_Index	O	INT	1	Indicates the Receive Antenna pattern for data collected to form the CPHD channel.		
TWAnt_Index	O	INT	1	Indicates the Two-way Antenna pattern for data collected to form the CPHD channel.		

Table 3.5 SRP Parameters									
Parameter Name			Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
CPHD.SRP			R					
	SRPType		R	ENU	1	Indicates the type of Stabilization Reference Point (SRP) position vs. time/vector function used. All CPHD data channels use the same SRP type. PVTPOLY and PVVPOLY indicate smoothly varying SRP positions are used for all channels. STEPPED allows for arbitrary variation. Expected use for collections with blocks of contiguous vectors stabilized to a common SRP. SRP position steps block to block.	-	Allowed Values: “FIXEDPT”, “PVTPOLY”, “PVVPOLY”, “STEPPED” FIXEDPT: The SRP is a fixed point for all vectors within a CPHD channel. All channels use a fixed SRP. PVTPOLY: The SRP positions are computed from a position vs. time polynomial for all vectors within a CPHD channel. All channels use a SRP position vs. time polynomial. PVVPOLY: The SRP positions are computed from a position vs. vector index polynomial for all vectors within a CPHD channel. All channels use a SRP position vs. vector index polynomial. STEPPED: The SRP positions are not constant for all vectors. Variation vector to vector unconstrained.
	NumSRPs		R	INT	1	Number of unique SRP position functions used. SRPs are indexed: SRP_Index = 1, 2, . . ., NumSRPs	-	
	FIXEDPT		C		1+	SRP position parameters for SRPType = FIXEDPT. Block repeated for index x = 1 to NumSRPs.	-	index = “x” where x = SRP_Index
		SRPPT	R	XYZ	1	Fixed point SRP position in ECF coordinates.	m	

Table 3.5 SRP Parameters								
Parameter Name			Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
	PVTPOLY		C		1+	SRP position parameters for SRPType = PVTPOLY. Block repeated for index x = 1 to NumSRPs.		index = "x" where x = SRP_Index
		SRPPVTPoly	R	XYZ POLY	1	SRP position in ECF polynomial vs. time (sec) for SRP_Index = x. Time t = 0 is collection start time.	m, m/sec, m/sec^2	order1 = "M"
	PVVPOLY		C		1+	SRP position parameters for SRPType = PVVPOLY. Block repeated for index x = 1 to NumSRPs.	-	index = "x" where x = SRP_Index
		SRPPVVPoly	R	XYZ POLY	1	SRP position in ECF polynomial vs. vector index for SRP_Index = x. Vector v = 0 is first vector of the CPHD array.	m, m/vec, m/vec^2	order1 = "M"

Table 3.6 Antenna Parameters

Parameter Name	Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
CPHD.Antenna	O			Antenna parameters that describe antenna orientation, mainlobe steering and gain patterns vs. time.		Note: Include only one-way patterns or only two-way patterns.
NumTxAnt	R	INT	1	Number of Transmit Antenna parameter sets included. Transmit Antenna parameter sets indexed by: TxAnt_Index = 1, 2, . . , NumTxAnt	-	Allowed Values: Set NumTxAnt = 0 indicate no Transmit Antenna patterns are included.
NumRcvAnt	R	INT	1	Number of Receive Antenna parameter sets included. Transmit Antenna parameter sets indexed by: RcvAnt_Index = 1, 2, . ., NumRcvAnt	-	Allowed Values: Set NumRcvAnt = 0 indicate no Receive Antenna patterns are included.
NumTWAnt	R	INT	1	Number of Two-way Antenna parameter sets included. Two-way Antenna parameter sets indexed by: TWAnt_Index = 1, 2, . ., NumTWAnt	-	Allowed Values: Set NumTWAnt = 0 indicate no Two-way Antenna patterns are included.
Tx	C		1+	Transmit Antenna Pattern Parameters Block repeated for index x = 1 to NumTxAnt.		index = “x” where x = TxAnt_Index
XAxisPoly	R	XYZ POLY	1	Aperture X-Axis direction in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M
YAxisPoly	R	XYZ POLY	1	Aperture Y-Axis direction (in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M
FreqZero	R	DBL	1	RF frequency (f0, Hz) for the HP beamwidths, array and element patterns and EB steering direction cosines.	Hz	
EB	O		1	Electrical boresight (EB) steering directions for an electronically steered array.		
DCXPoly	R	POLY	1	Electrical boresight steering X-axis direction cosine (DCX) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M

Table 3.6 Antenna Parameters

Parameter Name					Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
				DCYPoly	R	POLY	1	Electrical boresight steering Y-axis direction cosine (DCY) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M
			HPBW				1	Half power beamwidths. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		
				DCX	R	DBL	1	Half power beamwidth in the X-axis direction cosine (DCX).		
				DCY	R	DBL	1	Half power beamwidth in the Y-axis direction cosine (DCY).		
			Array		O		1	Mainlobe array pattern polynomials. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		
				GainPoly	R	2D POLY	1	One-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = "M" order2 = "N"
				PhasePoly	R	2D POLY	1	One-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = "M" order2 = "N"
			Elem		O		1	Element array pattern polynomials for electronically steered arrays.		
				GainPoly	R	2D POLY	1	One-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = "M" order2 = "N"

Table 3.6 Antenna Parameters

Parameter Name	Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
PhasePoly	R	2D POLY	1	One-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = "M" order2 = "N"
GainBSPoly	O	BOOL	1	Gain polynomial (dB) vs. frequency for boresight (BS) at DCX = 0 and DCY = 0. Frequency ratio ((f-f0)/f0) input variable (variable 1). Constant coefficient = 0.0 always. GainBS(f) = c1*((f-f0)/f0) + c2*((f-f0)/f0)**2 + etc.	dB	order1 = "M"
EBFreqShift	O	BOOL	1	Parameter indicating the EB shifts with frequency for an electronically steered array. false ⇔ No shift with frequency. true ⇔ Shift with frequency per ideal array theory.		Allowed values: "false", "true"
MLFreqDilation	O	BOOL	1	Parameter indicating the mainlobe (ML) width changes with frequency. false ⇔ No change with frequency. true ⇔ Change with frequency per ideal array theory.		Allowed values: "false", "true"
Rcv	C		1+	Receive Antenna Pattern Parameters Block repeated for index x = 1 to NumRcvAnt.		index = "x" where x = RcvAnt_Index
XAxisPoly	R	XYZ POLY	1	Aperture X-Axis direction in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M
YAxisPoly	R	XYZ POLY	1	Aperture Y-Axis direction (in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M

Table 3.6 Antenna Parameters

Parameter Name					Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
			FreqZero		R	DBL	1	RF frequency (f0, Hz) for the HP beamwidths, array and element patterns and EB steering direction cosines.	Hz	
			EB		O		1	Electrical boresight (EB) steering directions for an electronically steered array.		
				DCXPoly	R	POLY	1	Electrical boresight steering X-axis direction cosine (DCX) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M
				DCYPoly	R	POLY	1	Electrical boresight steering Y-axis direction cosine (DCY) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M
			HPBW				1	Half power beamwidths. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		
				DCX	R	DBL	1	Half power beamwidth in the X-axis direction cosine (DCX).		
				DCY	R	DBL	1	Half power beamwidth in the Y-axis direction cosine (DCY).		
			Array		O		1	Mainlobe array pattern polynomials. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		
				GainPoly	R	2D POLY	1	One-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = “M” order2 = “N”
				PhasePoly	R	2D POLY	1	One-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = “M” order2 = “N”

Table 3.6 Antenna Parameters						
Parameter Name	**Req/ Opt**	**Type**	**Num**	**Description**	**Units**	**Attributes & Allowed Values**
Elem	O		1	Element array pattern polynomials for electronically steered arrays.		
GainPoly	R	2D POLY	1	One-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = "M" order2 = "N"
PhasePoly	R	2D POLY	1	One-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = "M" order2 = "N"
GainBSPoly	O	BOOL	1	Gain polynomial (dB) vs. frequency for boresight (BS) at DCX = 0 and DCY = 0. Frequency ratio ((f-f0)/f0) input variable (variable 1). Constant coefficient = 0.0 always. GainBS(f) = c1*((f-f0)/f0) + c2*((f-f0)/f0)**2 + etc.	dB	order1 = "M"
EBFreqShift	O	BOOL	1	Parameter indicating the EB shifts with frequency for an electronically steered array. false ⇔ No shift with frequency. true ⇔ Shift with frequency per ideal array theory.		Allowed values: "false", "true"
MLFreqDilation	O	BOOL	1	Parameter indicating the mainlobe (ML) width changes with frequency. false ⇔ No change with frequency. true ⇔ Change with frequency per ideal array theory.		Allowed values: "false", "true"
TwoWay	C		1+	Two-way Antenna Pattern Parameters Block repeated for index x = 1 to NumTWAnt.		index = "x" where x = TWAnt_Index

Table 3.6 Antenna Parameters									
Parameter Name					Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
			XAxisPoly		R	XYZ POLY	1	Aperture X-Axis direction in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M
			YAxisPoly		R	XYZ POLY		Aperture Y-Axis direction (in ECF as a function of time (variable 1). Time t = 0 at collection start.	-, 1/s. $1/s^2$	order1 = M
			FreqZero		R	DBL	1	RF frequency (f0, Hz) for the HP beamwidths, array and element patterns and EB steering direction cosines.	Hz	
			EB		O		1	Electrical boresight (EB) steering directions for an electronically steered array.		
				DCXPoly	R	POLY	1	Electrical boresight steering X-axis direction cosine (DCX) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M
				DCYPoly	R	POLY	1	Electrical boresight steering Y-axis direction cosine (DCY) as a function of slow time (variable 1).	-, 1/s. $1/s^2$	order1 = M
			HPBW					Half power beamwidths. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		
				DCX	R	DBL	1	Half power beamwidth in the X-axis direction cosine (DCX).		
				DCY	R	DBL	1	Half power beamwidth in the Y-axis direction cosine (DCY).		
			Array		O			Mainlobe array pattern polynomials. For electronically steered arrays, the EB is steered to DCX = 0 and DCY = 0.		

Table 3.6 Antenna Parameters						
Parameter Name	**Req/ Opt**	**Type**	**Num**	**Description**	**Units**	**Attributes & Allowed Values**
GainPoly	R	2D POLY	1	Two-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = "M" order2 = "N"
PhasePoly	R	2D POLY	1	Two-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = "M" order2 = "N"
Elem	O			Element array pattern polynomials for electronically steered arrays.		
GainPoly	R	2D POLY	1	Two-way signal gain (in dB) as a function of DCX (variable 1) and DCY (variable 2). Gain relative to gain at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	dB	order1 = "M" order2 = "N"
PhasePoly	R	2D POLY	1	Two-way signal phase (in cycles) as a function of DCX (variable 1) and DCY (variable 2). Phase relative to phase at DCX = 0 and DCY = 0. Constant coefficient = 0.0 always.	cycles	order1 = "M" order2 = "N"
GainBSPoly	O	BOOL	1	Gain polynomial (dB) vs. frequency for boresight (BS) at DCX = 0 and DCY = 0. Frequency ratio ((f-f0)/f0) input variable (variable 1). Constant coefficient = 0.0 always. GainBS(f) = c1*((f-f0)/f0) + c2*((f-f0)/f0)**2 + etc.	dB	order1 = "M"

Table 3.6 Antenna Parameters								
Parameter Name			Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
		EBFreqShift	O	BOOL	1	Parameter indicating the EB shifts with frequency for an electronically steered array. false ⇔ No shift with frequency. true ⇔ Shift with frequency per ideal array theory.		Allowed values: “false”, “true”
		MLFreqDilation	O	BOOL	1	Parameter indicating the mainlobe (ML) width changes with frequency. false ⇔ No change with frequency. true ⇔ Change with frequency per ideal array theory.		Allowed values: “false”, “true”

Table 3.7 Vector Based Parameters						
Parameter Name	**Req/ Opt**	**Type**	**Num**	**Description**	**Units**	**Attributes & Allowed Values**
CPHD.VectorParameters	R					
TxTime	R	INT	1	Tag to indicate parameter TxTime is included in the Per Vector binary data.	-	Allowed value: 8 ➔ TxTime binary parameter is 8 bytes
TxPos	R	INT	1	Tag to indicate parameter TxPos is included in the Per Vector binary data.		Allowed value: 24 ➔ TxPos binary parameter is 24 bytes
RcvTime	R	INT	1	Tag to indicate parameter RcvTime is included in the Per Vector binary data.		Allowed value: 8 ➔ RcvTime binary parameter is 8 bytes
RcvPos	R	INT	1	Tag to indicate parameter TxPos is included in the Per Vector binary data.		Allowed value: 24 ➔ RcvPos binary parameter is 24 bytes
SRPTime	O	INT	1	Tag to indicate parameter SRPTime is included in the Per Vector binary data.		Allowed value: 8 ➔ SRPTime binary parameter is 8 bytes
SRPPos	R	INT	1	Tag to indicate parameter SRPPos is included in the Per Vector binary data.		Allowed value: 8 ➔ SRPPos binary parameter is 24 bytes
AmpSF	O	INT	1	Tag to indicate parameter AmpSF is included in the Per Vector binary data.		Allowed value: 8 ➔ AmpSF binary parameter is 8 bytes
TropoSRP	O	INT	1	Tag to indicate parameter TropoSRP is included in the Per Vector binary data.		Allowed value: 8 ➔ TropoSRP binary parameter is 8 bytes
FxParameters	C		1	**Frequency parameters included when DomainType = FX**		
Fx0	R	INT	1	Tag to indicate parameter Fx0 is included in the Per Vector binary data.		Allowed value: 8 ➔ Fx0 binary parameter is 8 bytes
Fx_SS	R	INT	1	Tag to indicate parameter Fx_SS is included in the Per Vector binary data.		Allowed value: 8 ➔ Fx_SS binary parameter is 8 bytes
Fx1	R	INT	1	Tag to indicate parameter Fx1 is included in the Per Vector binary data.		Allowed value: 8 ➔ Fx1 binary parameter is 8 bytes
Fx2	R	INT	1	Tag to indicate parameter Fx2 is included in the Per Vector binary data.		Allowed value: 8 ➔ Fx2 binary parameter is 8 bytes
TOAParameters	C		1	**Frequency parameters included when DomainType = TOA**		
DeltaTOA0	R	INT	1	Tag to indicate parameter DeltaTOA0 is included in the Per Vector binary data.		Allowed value: 8 ➔ DeltaTOA0 binary parameter is 8 bytes

Table 3.7 Vector Based Parameters									
Parameter Name			Req/ Opt	Type	Num	Description	Units	Attributes & Allowed Values
		TOA_SS	R	INT	1	Tag to indicate parameter TOA_SS is included in the Per Vector binary data.		Allowed value: 8 → TOA_SS binary parameter is 8 bytes