RFnest™ API

Intelligent Automation, Inc.

Version 3.3.6

RFview 2.11+, D5-series (rev1), and A208

www.i-a-i.com/rfnest

15400 Calhoun Drive, Suite 190, Rockville, MD 20855 | Phone: 301-294-5200 | Fax: 301-294-5201

Revision History

Version	Date	Author	Section(s)	Description
2.1	10/20/14	jyackoski	4.1	Clarified Doppler shift calculation
2.2	11/5/14	jyackoski	4.1, 4.1.1, 4.1.2, 5.3, 5.7, 6.2.1, 6.2.1, 7.2, 8.1, 10.2	4.1 – clarify de-confliction between matrix and delay profile 4.1.1 – change region boundary to 120 channels, increase Doppler to 4 bytes, delay to 4 bytes 4.1.2 – delete 5.3 – clarify coefficients file size and regions, update seq # / out of to 4 bytes 5.7 - # taps is resource profile dependent, change to control field, amplitude, phase, delay, and Doppler per tap 6.2.1/6.2.2 – firmware version # added at beginning of reserved field 6.2.1 - defined error code 1 7.2/8.1 – update Doppler to 8 bytes 10.2 – increase Doppler to 4 bytes
2.2.1	1/9/15	jyackoski	All	Changed document format, corrected references
2.2.2	1/9/15	jyackoski	5.7	Clarified amplitude is signed but only positive values should be used
2.2.3	1/13/15	jyackoski	7.1, 10.1	Changed Latitude, Longitude, and altitude to doubles
2.2.4	1/23/15	nlenzi	4.1	Fixed byte length in Channel Matrix Update message
2.2.5	2/9/15	jyackoski	5.7	Clarified allowed delay values in Set Delay Profile
2.2.6	2/16/15	jyackoski	7.4, 7.6	Clarified offset range and added state export message
2.11.7	5/26/15	jyackoski	6.1	Update frequency field in SSU message
3.0.0	6/8/15	jyackoski	5.2 6.2.1	Add reprogram API to set resource profile, update CEB status response with reprogramming and diagnostic fields
3.0.3	1/20/16	nlenzi	7.4	Updated Set Group Parameters message to include information about pathloss models
3.0.3	1/27/16	nlenzi	3.1	Added legacy Channel Matrix Update (for analog)
3.1.1	2/15/16	ejensen	6.2.1	Expanded CEB status response

Revision History

Version	Date	Author	Section(s)	Description
3.2.0	4/12/16	nlenzi	9	Removed section on 'RFview statistical/performance info'
3.2.3	6/21/16	twiederkehr	5.1, 6.1, 8.1	Updated sections for Set Port Properties and Signal Status Update message to include firmware API 1.1. Updated sections for DCU Notification Message: Type A and DCU Request: Type A to include CEC API 3.3.
3.2.3	7/8/16	twiederkehr	5.6, 6.4	Marked swimlanes sections as deprecated.
3.2.4	7/12/16	twiederkehr	7.2, 7.8, 8.3	Added Position Velocity Update, Query CEC Status, and CEC Status Response.
3.2.4	7/13/16	twiederkehr	5.11, 5.12, 6.3, 8.2, 5.13, 6.6, 8.5	Added Set Long Delay, Query Long Delay, Long Delay Response, and Position Velocity Acknowledgement.
3.2.4	7/22/16	twiederkehr	6.2.2	Added DDB Status Response for API 1.1.
3.3.0	10/24/16	twiederkehr	6.2.1, 6.2.2	Updated Temperature and Voltage coefficients for CEB and DDB status response for API 1.1.
3.3.0	11/9/16	twiederkehr	5.1	Added configuration bytes to Set Port Properties API 1.1.

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1. INTERFACE Overview

Figure 1 shows the producer and consumer of each type of RFnest interface. These interface numbers are referenced in the remainder of the document to indicate their place and use within the system.

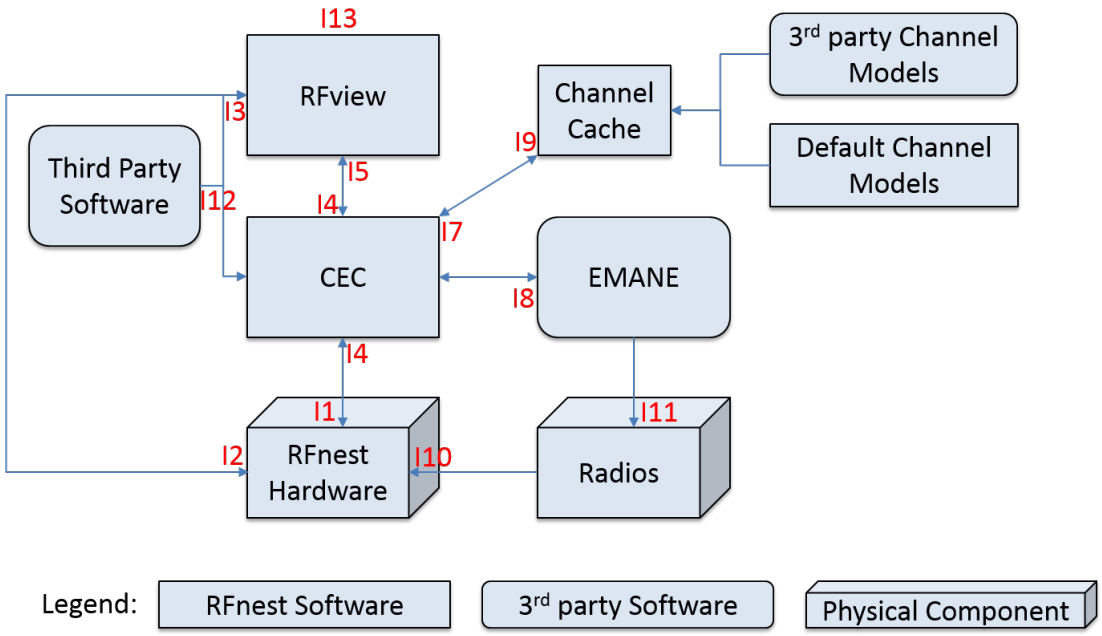

Figure 1: System context for System Data Sources / Interfaces

1.1 General Interface Conventions

- All identifiers are 0-based.
- All integer fields are in network byte order.
- Floating point or "double" fields use IEEE standard byte formats.

1.2 Ports and Addresses Used

- All packets to hardware are sent to 224.1.2.200 port 20850
- All packets sent from hardware are sent to 224.1.2.208 port 20850
- All packets sent from the CEC to the GUI are sent to 224.1.2.208 port 20852
- All packets sent from the GUI to the CEC are sent to 224.1.2.209 port 20852 **except position updates which are sent to 20851**
- CCR requests are sent to 224.1.2.9 port 20010
- CCR replies are sent to 224.1.2.10 port 20010

1.3 API Message Capture and Analysis Using Wireshark

RFnest provides a plugin for Wireshark and tshark that dissects all API messages for display. Refer to the User Manual for installation of his plugin.

2. Differences between D-Series and A-Series APIs

The A- and D-Series RFnest hardware have differences in capability and function which required different APIs. The top-level sections indicate whether the APIs are applicable to the D-Series or A-Series hardware. With the exception of the CCR Reply message, all APIS sent to the software are agnostic to whether the A- or D-Series hardware is present.

3. CEC to A-Series Hardware (Interface I1)

Communication with the FPGA is via 100M Ethernet. Gigabit Ethernet is **NOT** supported. The FPGA will listen for multicast UDP packets sent to the IPv4 address 224.1.2.208 port 20850. The FPGA ignores Ethernet frames that are not IPv4, any IP packets not having a matching destination IP address or not containing UDP, and any UDP packets not having the correct UDP destination port. No fragmented packets should be sent.

3.1 A-Series Channel Matrix Updates

The PC on which the channel calculations are performed sends these messages to periodically update the FPGA with the current channel. The most recently received update is immediately applied and over-writes any previous values for the matrix entries. The number of entries must be 28. Channel matrix updates must be sent as a group, individual matrix entries cannot be updated individually.

The upper half (excluding the diagonal) of the 8x8 channel matrix is provided. The first row of the matrix is specified (channel from node 1 to node 2, node 1 to node 3, . . . , node 1 to node 8), followed immediately by the second row (channel from node 2 to node 3, . . . , node 3 to node 8), . . . and finally the eleventh row (channel from node 7 to node 8). The channels are symmetric (making the bottom half of the matrix implied by the top half), and nodes do not receive their own transmissions (making the diagonal unnecessary).

Table 1: A-Series Channel Matrix Update format (firmware version 3.0+)

Field Name	Length	Format/Value
Type	1 byte	1 = channel matrix update type A
Token	1 byte	Arbitrary value, returned in a response message from the hardware
Reserved	2 bytes	0
Reserved	2 bytes	0
Number of entries	1 byte	28
Region_updates	Number of channels * 16 bytes (number of channels depends on number of ports active in hardware)	See below

Table 2: Region Update entry format (16 bytes)

Field Name	Length	Format
Reserved	2 bytes	Reserved
Reserved	1 byte	Reserved
Reserved	1 byte	Reserved
Reserved	2 bytes	Reserved
Attenuator 1 Value	1 Byte	Unsigned integer 0 to 31, attenuation setting for first attenuator in dB
Attenuator 2 Value	1 Byte	Unsigned integer 0 to 31, attenuation setting for second attenuator in dB
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved

Table 3: A-Series Channel Matrix Update format (firmware version 2.11+ (legacy))

Field Name	Length	Format/Value
Type	1 byte	0 = channel matrix update type A
Reserved	2 bytes	0
Reserved	2 bytes	0
Number of entries	1 byte	28
Region_updates	Number of channels * 16 bytes (number of channels depends on number of ports active in hardware)	See below

Table 4: Region Update entry format (16 bytes)

Field Name	Length	Format
Reserved	2 bytes	Reserved
Reserved	1 byte	Reserved
Reserved	1 byte	Reserved
Reserved	2 bytes	Reserved
Attenuator 1 Value	1 Byte	Unsigned integer 0 to 31, attenuation setting for first attenuator in dB
Attenuator 2 Value	1 Byte	Unsigned integer 0 to 31, attenuation setting for second attenuator in dB
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved
Reserved	2 bytes	Reserved

4. CEC to D-Series Hardware (interfaces I1 and I10)

Communication with the FPGA is via Gigabit Ethernet. The FPGA ignores Ethernet frames that are not IPv4, any IP packets not having a matching destination IP/multicast group address or not containing UDP, and any UDP packets not having the correct UDP destination port. No fragmented packets should be sent. The values in all multi-byte Integer fields are in big-endian, or network, byte order. Floating point or "double" fields use IEEE standard byte formats.

Every packet starts with a one byte "Type" field. All commands from the CEC/GUI to the FPGA 2.a type in the 0 to 127 range (MSB set to zero), and from the FPGA to the PC, GUI to PC, and PC to GUI have a type in the 128 to 255 range (MSB set to one). Messages sent between CEC and GUI do not specifically need a type field as they can be sent/received on different ports.

The system is designed in such a way, that every part of information provided to the GUI, CEC, or hardware could be provided by a third party software or scripted. Thus, effectively every interface in the system is external, and is accessible by third party software.

4.1 D-Series Channel Matrix Updates

These messages are sent by the PC on which the channel calculations are performed (CEC) to periodically update the FPGA with the current channel values. The update will be performed per group of nodes that share the same properties, use the same frequency for communication, and the same model. First, a group/node identifier will be sent, it will set the hardware to receive channel updates for that group of nodes.

The matrix will be variable, i.e. not all 96 ports will communicate with each other. Thus, some channel values do not need to be specified based on the groups in the resource profiles. These unused channels are not included in the matrix updates.

A full matrix update of all active channels will have variable size and format. Depending on the profile used in hardware (number of filters), the update will have different formats. Format Type A will be used when the user supplies a delay profile and the CEC only updates pathloss and Doppler, letting the hardware apply real and imaginary gains.

De-confliction between the matrix updates and the delay profile occurs as follows. The delay specified in the matrix update is the line of sight delay, applied before (in addition to) all taps. The Doppler specified in the matrix update is merged with the per-tap Doppler, thus the maximum Doppler range cannot be exceeded by the sum of the matrix update's Doppler and the delay profile's Doppler for each tap. The gain specified in the matrix update is applied before the delay profile, i.e. scales all taps.

The CEC will invoke the necessary channel models to compute the matrix of channel properties based on the resource profile. Note that if a port isn't active from the software's perspective but is present in the resource profile, the CEC need not calculate its value but must still send some value for those channels if part of an update message as the hardware still expects that region to contain the channels (and doesn't know that those ports are not currently used). If no channels within a given region are relevant for a scenario, the CEC need not update that region (such an update would have no effect), but can if desired.

Since the hardware is built in reference to a CEB, each CEB views the world from the perspective of itself. This includes its own (up to) 24 ports and possibly the ports of the CEB with which it shared a backplane. Each CEB always views its own ports as 0-23.

This type of grouping can be achieved by notifying or setting the group prior to sending each matrix update. Thus the hardware will update only the group that it set prior to received channel update.

The calculation of Doppler is done using the following formulas:

Ground-ground	**Air-air**	**Air-ground**
$f_{shift} = 0$	$f_{shift} = \frac{\Delta v}{C} f_C$	$f_{shift} = \frac{\Delta v}{C} f_C$
$f_{spread} = \frac{v}{C} f_C$	$f_{spread} = 0$	$f_{spread} = \frac{v}{C} f_C$

where f_C is the transmit frequency of the radio (as opposed to the sampling frequency), C is 299,792,458 m/s, v is the faster of the two absolute velocities of the radios comprising the channel, and Δv is the relative velocity between the two radios.

Given these frequencies, the values to set into the API message are as follows:

$phaseincrement = \frac{f_{shift}}{doppler\_increment}$ (resource profile dependent, see Section 5.3 of the user manual)

$spreadperiod = \frac{2x10^3}{f_{spread}} - 1$ if $f_{spread} > 0$, and 0 if $f_{spread} = 0$

4.1.1 Type A: Update of only Pathloss, Delay, and Doppler

Average projected use: At 12 bytes per filter we send up to 120 filters in one message, requiring 3 messages for updating a 24x23 port group. All but the last region's update for a given CEB must have 120 entries. The regions and their definitions are fixed for a given resource profile. Regions are defined sequentially based on the group in the CEB's resource profile. Assuming 4 node groups, the first group's channels are included starting with the channel from 0-1, 0-2, 0-3, 1-2, 1-3, 2-3, followed by the next group's channels, etc. until all groups are exhausted. Region boundaries occur whenever a multiple of 120 entries using this ordering occurs.

One exceptional case is the 48 port resource profile, in which the CEB specified by the CEB ID assumes a matrix is sent with its own ports numbered first, followed by the other CEB's ports. Each CEB is sent a matrix with 24 rows and 48 columns, with the "self" entries in the lower half of the left half of the matrix omitted. Assuming ports labeled 0-23 are CEB #1's and labeled 24-47 are CEB #2's, CEB #1 is then sent 0-1, 0-2 … 0-47, then 1-2, 1-3 … 1-47 , … , 22-1, 22-2 … 22-47, 23-24, 23-25 … 23-47. The other CEB is then sent 24-25, 24-26 … 24-47, 24-1, 24-2 … 24-23, 25-26, 25-27 … 25-47, 25-1, 25-2 … 25-23, … , 46-47, 46-1 … 46-23, 47-1 … 47-23.

Size: 6 + #_of_channels * 12 bytes

Table 5: Channel Matrix Update Type A

Field Name	**Length**	**Format/Value**
Type	1 byte	0 = channel matrix update type A
Token	1 byte	Arbitrary value, returned in resource profile response
CEB ID	1 byte	CEB identifier configured via set resource profile
Number of entries	1 byte	Unsigned integer value between 1 and 120
Update region	1 byte	Unsigned Integer
(out of)Total number of regions	1 byte	Unsigned Integer
Region_updates	Number of channels * 12 bytes (number of channels depends on number of ports active in hardware)	See below

Table 6: Region format Type A

Field Name	Length	Format/Value	Meaning
Channel 1 – Pathloss	2 bytes	Unsigned short integer (0 to 65535)	Gain
Channel 1 – Doppler Shift	4 bytes	signed integer (-2147483647 to 2147483647)	Shift increment, -200kHz to +200kHz, see Section 4.1
Channel 1 – Doppler Spread	2 bytes	Unsigned short integer (0 to 65535)	Spread period, 0 to 200 Hz, see Section 4.1
Channel 1 – Delay	4 bytes	Unsigned integer (5 to 2^{32})	Increment and range dependent on resource profile, increments of sampling rate. If value below minimum is specified, minimum is assumed.
(repeated for each channel)			

5. RFview to D-Series Hardware (INTERFACE I2)

Communication with the FPGA is via Ethernet. The FPGA ignores Ethernet frames that are not IPv4, any IP packets not having a matching destination IP address or not containing UDP, and any UDP packets not having the correct UDP destination port. No fragmented packets should be sent. The values in all multi-byte Integer fields are in big-endian, or network, byte order. Floating point or "double" fields use IEEE standard byte formats.

Every packet starts with a one byte "Type" field. All commands from the GUI to the FPGA have a type in the 0 to 127 range (MSB set to zero), and from the FPGA to the PC have a type in the 128 to 255 range (MSB set to one).

5.1 Set Port Properties

This message sets the carrier frequency, gains, signal power, and bandwidth of each active RF port.

This message resets the signal status counter.

If two ports are in the same group, their RF frequency must be the same.

Size: 243 bytes

Table 7: Set Port Properties (API 1.0)

Field Name	Length	Format/Value
Type	1 byte	13
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Long delay of port 0	4 bytes	Unsigned integer 0 to 16,777,215 (lower 24-bits), 40ns resolution
Long delay of port 4	4 bytes	Same as port 0
Long delay of port 8	4 bytes	Same as port 0

Long delay of port 12	4 bytes	Same as port 0
Long delay of port 16	4 bytes	Same as port 0
Long delay of port 20	4 bytes	Same as port 0
RF frequency of port 0	2 bytes	Unsigned integer (0 to 600) in 10's of MHz. I.e., setting to 10 = 100 MHz
Sampling offset of port 0	2 bytes	Signed integer in MHz. Set to 0 if port's bandwidth (from resource profile) is 100 MHz or more. Set to 40 + (desired_center_frequency modulo 10) otherwise. I.e. to set the center frequency to 402 MHz, the RF frequency field above is set to 36 (360 MHz) and the sampling offset is set to 42 (40 + 2), giving 402 MHz (360 + 42).
Port config of port 0	1 byte	Bit 7: Reserved *1/0 for AGC on/off* Bit 6: Reserved *1/0 for power fixed/variable (-10dBm)* Bit 5: Reserved *loopback mode (for self-testing)* Bit 4: Reserved *manual switch control (0 = auto, 1 = manual). In auto mode, if RF frequency is below 300, one-port mode is used, otherwise two-port mode.* Bit 3: Reserved *0 = one-port mode, 1 = two port mode (this bit is only used if bit 4 = 1)* Bit 2 = Force switch control rssi in CEB for impulse response testing, 0=normal operation, 1=test mode. Bit 1 = Switch control rssi state in CEB used in conjunction with Bit2. 0=Force input port signal to 0, 1=signal always indicates activity Bit 0: reserved
Port fixed power value of port 0 (input gain)	1 byte	Signed integer -40 to +10 dBm (only valid for normal use if bit 6 in power config is set) (if bit 5 in power config is set and bit 6 is not, AGC is off and this field specifies input gain)
Port output gain (for loopback mode use only, not for normal use)	1 byte	Signed integer in dBm **Ignored** unless bit 5 in power config is set
Noise gain	2 bytes	Unsigned short integer (0 to 65535)
The above 6 fields are repeated for ports 1 thru 23		

Size: 271 bytes

Table 8: Set Port Properties (API 1.1)

Field Name	**Length**	**Format/Value**
Type	1 byte	13
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Configuration Bytes	4 bytes	byte1 (head) = 0 -> 64ns, 1 -> 128ns, 2 -> 256ns, 3 -> 1us byte2 (tail) = 0 -> 512ns, 1 -> 1us, 2 -> 2us, 3 -> 4us, 4 -> 8us, 5 -> 32us, 6 -> 128us, 7 -> 1ms byte3 (reserved) byte4 (reserved)

RF frequency of port 0	2 bytes	Unsigned integer (0 to 600) in 10's of MHz. I.e., setting to 10 = 100 MHz
Sampling offset of port 0	2 bytes	Signed integer in MHz. Set to 0 if port's bandwidth (from resource profile) is 100 MHz or more. Set to 40 + (desired_center_frequency modulo 10) otherwise. I.e. to set the center frequency to 402 MHz, the RF frequency field above is set to 36 (360 MHz) and the sampling offset is set to 42 (40 + 2), giving 402 MHz (360 + 42).
Port config of port 0	1 byte	Bit 7: Reserved *1/0 for AGC on/off* Bit 6: if fixed/dynamic noise floor threshold used (1/0) Bit 5: Reserved *loopback mode (for self-testing)* Bit 4: Reserved *manual switch control (0 = auto, 1 = manual). In auto mode, if RF frequency is below 300, one-port mode is used, otherwise two-port mode.* Bit 3: Reserved *0 = one-port mode, 1 = two port mode (this bit is only used if bit 4 = 1)* Bit 2 = if half duplex is on/off (1/0) Bit 1 = Switch control rssi state in CEB used in conjunction with Bit2. 0=Force input port signal to 0, 1=signal always indicates activity Bit 0: Only used if bit 6 is on. If bit 6 is on and bit 0 is on, use provided noise floor. Otherwise, use default noise floor.
Port fixed power value of port 0 (input gain)	1 byte	Signed integer -40 to +10 dBm (only valid for normal use if bit 6 in power config is set) (if bit 5 in power config is set and bit 6 is not, AGC is off and this field specifies input gain)
Port output gain (for loopback mode use only, not for normal use)	1 byte	Signed integer in dBm **Ignored** unless bit 5 in power config is set
Noise gain	2 bytes	Unsigned short integer (0 to 65535)
Fixed Noise Threshold	2 bytes	Signed integer in dBm
The above 7 fields are repeated for ports 1 thru 23		

5.2 Set Resource Profile

This message sets the hardware profile from some file or image. This is done either via a tftp server, or by directly sending the image via UDP messages.

Any message with sequence #0 MUST be sent to the CEC in addition to being sent to the hardware so that the CEC knows the resource profile (and channel matrix layout).

Size: 42 + payload bytes

Table 9: Set Resource Profile

Field Name	Length	Format/Value	Meaning
Type	1 byte	15	Self-explanatory
Token	1 byte	Arbitrary	Self-explanatory
CEB MAC Address	6 bytes	Arbitrary	Bytes as given in resource profile response
CEB0 Rate	1 byte	Unsigned integer	Decimation rate (0-5) used by DDBs associated with CEB0
CEB1 Rate	1 byte	Unsigned integer	Decimation rate (0-5) used by DDBs associated with CEB1
DDB ID Map	26 bytes	Unsigned integer	Assigns DDB ID and associated CEB ID based on ATCA hardware address. Bytes are ordered DDBID, CEBID for HW-ADDR 42, DDBID, CEBID for HW-ADDR 43, etc.
(Sequence number)	2 bytes	Unsigned integer	Data sequence #, when one less than "out of", that is the last one
(Out of)	2 bytes	Unsigned integer	# of values that will be sent
(Length)	2 bytes	Unsigned integer 0 to 1450	Always 1450 except for last sequence #
(Data)	Variable	Arbitrary	Data from resource profile file being loaded. When out of is 1 and length is 2, first byte is mode (0 = load from flash, 1 = load from SRP, 2 = write SRP to flash) and second byte is value (slot ID) from 0 to 3. Currently only mode 0 is supported.

5.3 Set Statistical Coefficients

The same file is sent to all CEBs so there is no CEB ID. If any CEB does not receive the file correctly, it can be re-sent. CEB that already have it successfully will ignore re-sends until they are power cycled. **The coefficients must be sent on power up of the CEB or any time the resource profile changes.** The coefficients are split into 4 equal, fixed size regions totaling 800 MB.

Size: variable, 12 + payload bytes

Table 10: Set Statistical Coefficients

Field Name	Length	Format/Value	Meaning
Type	1 byte	26	Self-explanatory
Token	1 byte	Arbitrary	Self-explanatory
Sequence number	4 bytes	Unsigned integer	Data sequence #, when one less than "out of", that is the last one
Out of	4 bytes	Unsigned integer	# of values that will be sent
Length	2 bytes	Unsigned integer 0 to 1450	Always 1450 except for last sequence #
Data	Variable	Arbitrary	Data from resource profile file being loaded

5.4 Query CEB Status

This message requests the CEB status from hardware. ALL connected CEBs respond.

This message does NOT contain a token.

Size: 1 byte

Table 11: Query CEB Status

Field Name	Length	Format/Value
Type	1 byte	16

5.5 Reserved Message

Reserved for future use. Currently unused.

Size: 2 bytes

Table 12: Reserved Message

Field Name	Length	Format/Value

Type	1 byte	17
Token	1 byte	Arbitrary
Reserved		

5.6 Swimlane control Message

Signals the hardware to control swimlane recording behavior. Always contains 24 ports.

This message resets ALL swimlane timestamp counters

Size: 27 bytes

Table 13: Swimlane Control Message (API 1.0) - Deprecated

Field Name	Length	Format/Value
Type	1 byte	18
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Port 0 status	1 byte	0 = stop sending swimlane data 1 = start sending swimlane data
(the above field is repeated for ports 1 thru 23)		

5.7 Set Delay Profile

This message sets delay profile for a channel. Each channel must be specified separately, but only at initialization. The set delay profile message must be sent for each channel in use in order for the channel to function properly.

The delay increment (inverse of sampling rate), MaxDelay, and the number of paths is determined by the resource profile. Not all resource profiles use the per-tap Doppler values in this message.

Size: 6 + 12 * # of paths bytes

Table 14: Set Delay Profile

Field Name	Length	Format/Value
Type	1 byte	19
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Port 1	1 byte	Unsigned int 0 to 23 (smaller port ID always first)
Port 2	1 byte	Unsigned int 0 to 23 (larger port ID always second)
Number of Paths	1 byte	Unsigned int (# of taps in resource profile, see Section 5.3 of the user manual)
Control1	2 bytes	0 = Doppler spread off, 1-4 = use specified statistical distribution
Amplitude1	2 bytes	Signed integer (0 to 32767). If negative values are specified, phase is shifted by 180 degrees
Phase1	2 bytes	Unsigned integer (0 to 65535), 0 = 2 PI, 32768 = PI, 65535 = 2 PI - δ
Doppler1 Or Reserved, depending on resource profile	4 bytes	signed short integer (-2147483647 to 2147483647) Shift increment, -200kHz to +200kHz, see Section 4.1

Delay1	2 bytes	Unsigned integer (3 to MaxDelay), in increments defined by resource profile. If a smaller value is specified than allowed, the minimum value is assumed.
(the above 5 fields are repeated for each path)		

5.8 Signal Record

This message is sent by the GUI which is modeling the interference that should be received by a specified node. At the end of recording, FPGA will send back the recorded samples to PC through a different message. The signal record and signal replay for a given DDB and buffer (radio Tx = replay subtype 0, radio Rx = replay subtype 1) are mutually exclusive. Only one total may be active per DDB/buffer at a time.

Size: 12 bytes

Table 15: Signal Record

Field Name	Length	Format/Value
Type	1 byte	21
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Port	1 byte	Unsigned integer (0 to 23)
Start/stop	1 byte	Unsigned integer, 0 = stop, 1 = start
Capture mode	1 byte	Unsigned integer, 0 = capture radio Tx, 1 = capture radio Rx
Length	4 bytes	Unsigned integer, # of I&Q sample pairs in 256 pair blocks, 1 to 1000
Trigger mode	1 byte	Unsigned integer, 0 = immediate, 1 = on radio Rx, 2 = on radio Tx
Reserved	1 byte	

5.9 Signal Load

This message loads the interference or noise buffer of the FPGA with a pre-recorded signal. The buffer length is variable and sampling resolution is variable depending on profile and bandwidth settings.

Size: 1037 bytes

Table 16: Signal Load

Field Name	Length	Format/Value
Type	1 byte	22
Token	1 byte	Arbitrary

CEB ID	1 byte	ID of CEB
Sub-type	1 byte	Unsigned integer, 0 = load for a port (which will be triggered), 1 = load for a DDB (noise)
DDB ID	1 byte	Unsigned integer 0-5
Total length	4 bytes	Unsigned integer, # of I&Q sample pairs in 256 pair blocks, 1 to 1000
Sequence number	4 bytes	Unsigned integer, 0 to total length - 1
Samples	256 * 4 bytes	See below

Table 17: I/Q sample format (Signal Load)

Field Name	Length	Format/Value
I sample	2 bytes	Signed integer (-32768 to 32767)
Q sample	2 bytes	Signed integer (-32768 to 32767)

5.10 Signal Replay Start/Stop

This message starts or stops the signal replay in the FPGA. It sets a variable delay and also specifies which node the interference should collide with (trigger node). Each DDB's loaded signal and actions are independent and cannot be triggered by ports on other DDBs. The signal record and signal replay for a given DDB and buffer (radio Tx = replay subtype 0, radio Rx = replay subtype 1) are mutually exclusive. Only one total may be active per DDB/buffer at a time.

Size: 10 bytes

Table 18: Signal Replay Start/Stop

Field Name	Length	Format/Value
Type	1 byte	24
Token	1 byte	Arbitrary
CEB ID	1 byte	ID of CEB
Sub-type	1 byte	Unsigned integer, 0 = for a port (which will be triggered), 1 = for a DDB (noise)
Port ID / DDB ID	1 byte	Unsigned integer, 0 – 23 if port ID or 0-5 if DDB ID
Start/stop	1 byte	Unsigned integer, 0 = stop, 1 = start
Trigger mode	1 byte	Unsigned integer, 0 = immediate, 1 = on receive, 2 = on transmit. Immediate loops until stop command is received. 1 & 2 loop by playing signal once then reset and wait until trigger condition again, etc.

Trigger port	1 byte	Unsigned integer, port parameter if sub-type is 1
Delay	2 bytes	Unsigned integer, delay in microseconds, n/a if mode = 0

5.11 Set Long Delay

This message sets a long delay for all DDBs.

Size: 26 bytes

Table 19: Set Long Delay (Firmware API 1.1 only)

Field Name	Length	Format/Value
Type	1 byte	30
CEB ID	1 byte	ID of CEB
Long Delay DDB0	4 bytes	in increments, as defined by the resource profile
Long Delay DDB1	4 bytes	in increments, as defined by the resource profile
Long Delay DDB2	4 bytes	in increments, as defined by the resource profile
Long Delay DDB3	4 bytes	in increments, as defined by the resource profile
Long Delay DDB4	4 bytes	in increments, as defined by the resource profile
Long Delay DDB5	4 bytes	in increments, as defined by the resource profile

5.12 Query Long Delay

This message requests the long delay from hardware.

Size: 2 bytes

Table 20: Query Long Delay (Firmware API 1.1 only)

Field Name	Length	Format/Value
Type	1 byte	31
CEB ID	1 byte	ID of CEB

5.13 RFview Component/User Action Summary Table

Table 21: RFview to HARDWARE summary table

Section	Msg Code	When to send
5.1 Set Port Properties	13	User presses button on Port Configuration Wizard

5.2 Set Resource Profile	15	User uses Hardware/Resource Profile Wizard
5.3 Set Statistical Coefficients	26	After set resource profile.
5.4 Query CEB Status	16 (response is msg 130)	After setting profile to double check that changes have been made and see other status (e.g. token, etc.)
5.5 Reserved	17	Reserved
5.6 Swimlane control message	18	To turn swimlane data collection on/off for each port
5.7 Set Delay Profile	19	User presses button on Delay Profile Configuration Wizard
5.8 Signal Record	21 (response is msg 133)	User presses Signal Record button, and chooses options
5.9 Signal Load	22	User presses Signal Load button, and chooses options
5.10 Signal Replay Start/Stop	24	User presses Signal Replay Start/Stop button, and chooses options
5.11 Set Long Delay	30	Set long delay
5.12 Query Long Delay	31 (response is msg 132)	Get long delay

6. D-Series Hardware to RFview Messages (INTERFACE I3)

6.1 Signal Status Update

This message is sent automatically once per second and in every update the DDBs notify the GUI the status of signal parameters defined below.

Size: 36 bytes

Table 22: Signal Status Update (API 1.0)

Field Name	Length	Format/Value
Type	1 byte	128
CEB ID	1 byte	CEB ID
DDB ID	1 byte	DDB ID
Signal status current counter	4 bytes	Unsigned integer, seconds since last set port properties message
Port 0 last TX activity	2 bytes	Unsigned integer (0 to 32767) in ms
Port 0 last RX activity	2 bytes	Unsigned integer (0 to 32767) in ms
Port 0 signal TX strength	1 byte	Signed integer (-100 to +10) in dBm
Port 0 frequency	2 bytes	Unsigned integer (0 to 1000 in 10's of MHz, e.g. 240 = 2400 MHz)

(the above 4 fields are repeated for ports 1-3)		
Reserved	1 byte	Reserved

Size: 48 bytes

Table 23: Signal Status Update (API 1.1)

Field Name	Length	Format/Value
Type	1 byte	128
CEB ID	1 byte	CEB ID
DDB ID	1 byte	DDB ID
Signal status current counter	4 bytes	Unsigned integer, seconds since last set port properties message
Port config of port 0	1 byte	See 'Per port config of port 0' of section 5.1 for details
Port 0 last TX activity	2 bytes	Unsigned integer (0 to 32767) in ms
Port 0 last RX activity	2 bytes	Unsigned integer (0 to 32767) in ms
Port 0 signal TX strength	1 byte	Signed integer (-100 to +10) in dBm
Port 0 frequency	2 bytes	Unsigned integer (0 to 1000 in 10's of MHz, e.g. 240 = 2400 MHz)
Current noise floor threshold	2 bytes	Signed integer in dBm
(the above 6 fields are repeated for ports 1-3)		
Reserved	1 byte	Reserved

6.2 Status Response

Each CEB and DDB independently report their status to the GUI.

6.2.1 CEB Status Response

The hardware notifies the GUI of the current resource profile and other CEB-wide status.
Size: 38 bytes

Table 24: CEB Status Response Firmware API 1.0

Field Name	Length	Format/Value
Type	1 byte	130
CEB MAC Address	6 bytes	Arbitrary (coded into firmware or set via some other method on board during bring-up)
CEB ID	1 byte	0-254 if assigned, 255 if unassigned
Last Type Received	1 byte	Type code of last message received addressed to this CEB

Last Token Received	1 byte	Token value of last message received addressed to this CEB
Profile #	1 byte	Unsigned integer (read from data contained in the loaded resource profile) value is 1 to 255 if resource profile is loaded, 0 if none or an error occurred during loading requiring complete re-send
Coefficient load status	1 byte	0 = not loaded, 1 = loaded
Signal status current counter	4 bytes	Unsigned integer, seconds since last set port properties message
Swimlane current counter	4 bytes	Unsigned integer, microseconds since last swimlane control message
Error code	1 byte	Unsigned integer. Set to zero if no error, set to non-zero if an error condition exists indicating the error code. 1 = coefficients out of order, first four reserved bytes are first missing sequence number. Sent unsolicited if hardware notices this. Resets back to 0 if this sequence number is seen.
Version	2 bytes	Hardware firmware revision
EDK Revision	1 byte	EDK revision number (for internal use only) ***NOTE: If the error code == 1, this field and the following 3 bytes are instead the expected sequence number**
SDK Revision	1 byte	SDK revision number (for internal use only)
Active Profile ID	1 byte	Current profile ID number
Active Profile Revision	1 byte	Current profile revision number
Slot 0 Profile ID	1 byte	Profile ID of profile available in slot 0
Slot 0 Profile Revision	1 byte	Revision of profile available in slot 0
Slot 1 Profile ID	1 byte	Profile ID of profile available in slot 1
Slot 1 Profile Revision	1 byte	Revision of profile available in slot 1
Slot 2 Profile ID	1 byte	Profile ID of profile available in slot 2

Slot 2 Profile Revision	1 byte	Revision of profile available in slot 2
Slot 3 Profile ID	1 byte	Profile ID of profile available in slot 3
Slot 3 Profile Revision	1 byte	Revision of profile available in slot 3
PLL Lock Status	1 byte	PLL Lock Status (for internal use only)
Fabric Channel Status	1 byte	Fabric Channel Status (for internal use only)
Fabric Channel Errors	1 byte	Fabric Chanenl Errors (for internal use only)

Size: 1024 bytes

Table 25: CEB Status Response Firmware API 1.1

Field Name	Length	Format/Value
Type	1 byte	130
CEB MAC Address	6 bytes	Arbitrary (coded into firmware or set via some other method on board during bring-up)
CEB ID	1 byte	0-254 if assigned, 255 if unassigned
Last Type Received	1 byte	Type code of last message received addressed to this CEB
Last Token Received	1 byte	Token value of last message received addressed to this CEB
Profile #	1 byte	Unsigned integer (read from data contained in the loaded resource profile) value is 1 to 255 if resource profile is loaded, 0 if none or an error occurred during loading requiring complete re-send
Coefficient load status	1 byte	0 = not loaded, 1 = loaded
Signal status current counter	4 bytes	Unsigned integer, seconds since last set port properties message
Swimlane current counter	4 bytes	Unsigned integer, microseconds since last swimlane control message
Error code	1 byte	Unsigned integer. Set to zero if no error, set to non-zero if an error condition exists indicating the error code. 1 = coefficients out of order, first four reserved bytes are first missing sequence number. Sent unsolicited if hardware notices this. Resets back to 0 if this sequence number is seen. 2 = channel emulation FPGA busy loading. Resets back to 0 when load is complete.
API Version	2 bytes	API version compatibility. Upper byte is minor version number, lower byte is major version number. For example, 0x31 would be version 1.3.
Firmware Version	1 byte	Control FPGA firmware revision
Software Version	1 byte	Control FPGA embedded software revision
Active Profile	1 byte	Profile number currently loaded in emulation FPGA

Active Profile Version	1 byte	Active profile revision
AvailableProfile[0]	1 byte	Available profile number in flash location 0
AvailableProfileVersion[0]	1 byte	Revision of profile in flash location 0
AvailableProfile[1]	1 byte	Available profile number in flash location 1. 0xFF if not applicable.
AvailableProfileVersion[1]	1 byte	Revision of profile in flash location 1. 0xFF if not applicable.
AvailableProfile[2]	1 byte	Available profile number in flash location 2. 0xFF if not applicable.
AvailableProfileVersion[2]	1 byte	Revision of profile in flash location 2. 0xFF if not applicable.
AvailableProfile[3]	1 byte	Available profile number in flash location 3. 0xFF if not applicable.
AvailableProfileVersion[3]	1 byte	Revision of profile in flash location 3. 0xFF if not applicable.
PLL Lock Status	1 byte	PLL lock status bits. 1=Lock, 0=Unlocked or not applicable. Bits 5:0 correspond to DDB channels[5:0]. Bit 7:6 for data and initialization clocks, respectively.
Channel Status	1 byte	40 Gbps backplane link status. 1=ChannelUp, 0=ChannelDown or not applicable. Bits 5:0 correspond to DDB channels[5:0]. Bit 7:6 channel up count lsbs.
Channel Link Error	1 byte	40 Gbps backplane link errors. 1=ErrorDetected, 0=NoError or not applicable. Bits 5:0 correspond to DDB channels[5:0]. Bit 7:6 link reset count lsbs.
Channel Data Error	1 byte	40 Gbps backplane data errors. 1=ErrorsDetected, 0=NoError or not applicable. Bits 5:0 correspond to DDB channels[5:0]. Bit 7:6 are unused.
ATCA Hardware Address	1 byte	Slot's ATCA hardware address with odd parity msb
CPLD Version	1 byte	CPLD firmware revision
Firmware Build Date	3 bytes	Control FPGA firmware build date 0xYYMMDD
Software Build Date	3 bytes	Control FPGA software build date 0xYYMMDD

Temperature Sensor Measurements	8 bytes	Discrete temperature sensor (0-to-8) values in degrees C
VCCINT-0 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCCINT-1 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCCINT-2 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCCINT-3 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC3V3 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC1V8 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC1V5 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC1V2 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
Fiber XCVR Status	6 bytes	TBD
ATCR-250 Primary Hold-up Voltage	1 byte	Hold-up voltage (x*0.2915 V)
ATCR-250 Primary Current	1 byte	A and B inputs combined current (x*0.0273 A)
ATCR-250 Primary Voltage A	1 byte	Primary voltage A (x*0.2817 V)
ATCR-250 Primary Voltage B	1 byte	Primary voltage B (x*0.2817 V)
ATCR-250 Secondary Voltage (3.3V)	1 byte	Secondary 3.3V (x*0.0170 V)
ATCR-250 Secondary Voltage (12V)	1 byte	Secondary 12V (x*0.0598 V)
ATCR-250 Secondary Current	1 byte	Secondary 12V current (x*0.1327 A)
ATCR-250 Secondary Temperature	1 byte	Secondary temperature (x*0.5 - 10 C)
ATCR-250 Primary Temperature	1 byte	Primary temperature (x*0.5 - 10 C)
Kintex Temperature	2 bytes	Controller FPGA internal temperature (x*7.69e-3 - 273.15 C)
Kintex Min Temperature	2 bytes	Controller FPGA minimum internal temperature (x*7.69e-3 - 273.15 C)
Kintex Max Temperature	2 bytes	Controller FPGA maximum internal temperature (x*7.69e-3 - 273.15 C)

Kintex VCCINT	2 bytes	Controller FPGA internal voltage (x*45.776e-6 V)
Kintex VCCINT Min	2 bytes	Controller FPGA minimum internal voltage (x*45.776e-6 V)
Kintex VCCINT Max	2 bytes	Controller FPGA maximum internal voltage (x*45.776e-6 V)
Kintex VCCAUX	2 bytes	Controller FPGA auxilary voltage (x*45.776e-6 V)
Kintex VCCAUX Min	2 bytes	Controller FPGA minimum auxiliary voltage (x*45.776e-6 V)
Kintex VCCAUX Max	2 bytes	Controller FPGA maximum auxiliary voltage (x*45.776e-6 V)
Kintex VCCBRAM Min	2 bytes	Controller FPGA minimum block RAM voltage (x*45.776e-6 V)
Kintex VCCBRAM Max	2 bytes	Controller FPGA maximum brock RAM voltage (x*45.776e-6 V)
Virtex Temperature	2 bytes	Emulator FPGA internal temperature (x*7.69e-3 - 273.15 C)
Virtex Min Temperature	2 bytes	Emulator FPGA minimum internal temperature (x*7.69e-3 - 273.15 C)
Virtex Max Temperature	2 bytes	Emulator FPGA maximum internal temperature (x*7.69e-3 - 273.15 C)
Virtex VCCINT	2 bytes	Emulator FPGA internal voltage (x*45.776e-6 V)
Virtex VCCINT Min	2 bytes	Emulator FPGA minimum internal voltage (x*45.776e-6 V)
Virtex VCCINT Max	2 bytes	Emulator FPGA maximum internal voltage (x*45.776e-6 V)
Virtex VCCAUX	2 bytes	Emulator FPGA auxilary voltage (x*45.776e-6 V)
Virtex VCCAUX Min	2 bytes	Emulator FPGA minimum auxiliary voltage (x*45.776e-6 V)
Virtex VCCAUX Max	2 bytes	Emulator FPGA maximum auxiliary voltage (x*45.776e-6 V)
Virtex VCCBRAM Min	2 bytes	Emulator FPGA minimum block RAM voltage (x*45.776e-6 V)
Virtex VCCBRAM Max	2 bytes	Emulator FPGA maximum block RAM voltage (x*45.776e-6 V)
Kintex MGT-AVCC Regulator Current	2 bytes	Controller FPGA MGT-AVCC regulator current (x*7.15256e-2 mA)

Kintex MGT-AVTT Regulator Current	2 bytes	Controller FPGA MGT-AVTT regulator current (x*7.15256e-2 mA)
Virtex MGT-AVTT-1 Regulator Current	2 bytes	Emulation FPGA MGT-AVTT-1 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVTT-2 Regulator Current	2 bytes	Emulation FPGA MGT-AVTT-2 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-1 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-1 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-2 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-2 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-3 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-3 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-4 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-4 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-5 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-5 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-6 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-6 regulator current (x*7.15256e-2 mA)
2.5V Regulator Voltage	2 bytes	2.5V regulator voltage (x*4.77243e-5 V)
DDR3 Memory Termination Voltage	2 bytes	0.75V DC-DC voltage (x*7.15256e-2 V). Note: not available in first revision of CEB.
CEB Fabric Channel (FC) Frequency	4 bytes	Fabric Channel reference frequency (Hz).
FC1 Recovered Frequency	4 bytes	FC1 clock recovery frequency (Hz).
FC2 Recovered Frequency	4 bytes	FC2 clock recovery frequency (Hz).
FC3 Recovered Frequency	4 bytes	FC3 clock recovery frequency (Hz).
FC4 Recovered Frequency	4 bytes	FC4 clock recovery frequency (Hz).
FC5 Recovered Frequency	4 bytes	FC5 clock recovery frequency (Hz).

FC6 Recovered Frequency	4 bytes	FC6 clock recovery frequency (Hz).
Reserved	674 bytes	Reserved / future / debug

Size: 23 bytes

Table 26: ZL9117M DC-DC Status

Field Name	Length	Format/Value
Status Word	2 bytes	See ZL9117M datasheet for bit field definitions
Status Byte	1 byte	See ZL9117M datasheet for bit field definitions
VOUT Status	1 byte	Output voltage status. See ZL9117M datasheet for bit field definitions
IOUT Status	1 byte	Output current status. See ZL9117M datasheet for bit field definitions
VIN Status	1 byte	Input voltage status. See ZL9117M datasheet for bit field definitions
Temperature Status	1 byte	Device temperature status. See ZL9117M datasheet for bit field definitions
CML Status	1 byte	Communication, memory, and logic status. See ZL9117M datasheet for bit field definitions
MFR Status	1 byte	Manufacturer status. See ZL9117M datasheet for bit field definitions
VIN Value	2 bytes	Measured input voltage (L11 V)
VOUT Value	2 bytes	Measured output voltage (L16u V)
IOUT Value	2 bytes	Measured output current (L11 A)
Temperature Value	2 bytes	Measured internal temperature (L11 C)
Duty Cycle Value	2 bytes	Measured duty cycle (L11 percent)
Frequency Value	2 bytes	Measured reference frequency (L11 kHz)
VDRV Value	2 bytes	Hardware firmware revision

6.2.2 DDB Status Response

The hardware notifies the GUI of the signal load/record/reply condition of each port and other DDB-wide status.

Size: 28 bytes

Table 27: DDB Status Response (API 1.0)

Field Name	Length	Format/Value
Type	1 byte	131
DDB MAC Address	6 bytes	Arbitrary (coded into firmware or set via some other method on board during bring-up)
CEB ID	1 byte	0-254 if assigned, 255 if unassigned

DDB ID	1 byte	0-254 if assigned, 255 if unassigned
DDB Incoming record/replay status	1 byte	Bit 7: 1 if signal loaded Bit 6: 1 if replay active Bit 5: 1 if record active Bits 4-0: reserved
DDB Outgoing record/replay status	1 byte	Same as above
Error code	1 byte	Unsigned integer. Set to zero if no error, set to non-zero if an error condition exists indicating the error code. No known error codes exist currently, this is mostly a reserved field.
Version	2 bytes	Hardware firmware revision
Reserved	14 bytes	Reserved / debugging use

Size: 1024 bytes

Table 28: DDB Status Response (API 1.1)

Field Name	**Length**	**Format/Value**
Type	1 byte	131
DDB MAC Address	6 bytes	Arbitrary (coded into firmware or set via some other method on board during bring-up)
CEB ID	1 byte	0-254 if assigned, 255 if unassigned
DDB ID	1 byte	0-254 if assigned, 255 if unassigned
DDB Incoming record/replay status	1 byte	Bit 7: 1 if signal loaded Bit 6: 1 if replay active Bit 5: 1 if record active Bits 4-0: reserved
DDB Outgoing record/replay status	1 byte	Same as above
Error code	1 byte	Unsigned integer. Set to zero if no error, set to non-zero if an error condition exists indicating the error code. No known error codes exist currently, this is mostly a reserved field.
API Version	2 bytes	Hardware firmware revision
PLL Lock Status	1 byte	PLL lock status bits. 1=Lock, 0=Unlocked or not applicable.
Channel Status	1 byte	40 Gbps backplane link status. 1=ChannelUp, 0=ChannelDown or not applicable.

Channel Link Error	1 byte	40 Gbps backplane link errors. 1=ErrorDetected, 0=NoError or not applicable.
Channel Data Error	1 byte	40 Gbps backplane data errors. 1=ErrorsDetected, 0=NoError or not applicable.
ATCA Hardware Address	1 byte	Slot's ATCA hardware address with odd parity msb
CPLD Version	1 byte	CPLD firmware revision
Firmware Build Date	3 bytes	FPGA firmware build date 0xYYMMDD
Temperature Sensor Measurements	9 bytes	Discrete temperature sensor (0-to-8) values in degrees C
VCCINT-0 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC3V3 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC1V8 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
VCC1V5 DC-DC Converter Status	23 bytes	See field definitions in Table ZL9117M DC-DC Status
ATCR-250 Primary Hold-up Voltage	1 byte	Hold-up voltage (x*0.2915 V)
ATCR-250 Primary Current	1 byte	A and B inputs combined current (x*0.0273 A)
ATCR-250 Primary Voltage A	1 byte	Primary voltage A (x*0.2817 V)
ATCR-250 Primary Voltage B	1 byte	Primary voltage B (x*0.2817 V)
ATCR-250 Secondary Voltage (3.3V)	1 byte	Secondary 3.3V (x*0.0170 V)
ATCR-250 Secondary Voltage (12V)	1 byte	Secondary 12V (x*0.0598 V)
ATCR-250 Secondary Current	1 byte	Secondary 12V current (x*0.1327 A)
ATCR-250 Secondary Temperature	1 byte	Secondary temperature (x*0.5 - 10 C)
ATCR-250 Primary Temperature	1 byte	Primary temperature (x*0.5 - 10 C)
Virtex Temperature	2 bytes	Emulator FPGA internal temperature (x*7.69e-3 - 273.15 C)
Virtex Min Temperature	2 bytes	Emulator FPGA minimum internal temperature (x*7.69e-3 - 273.15 C)

Virtex Max Temperature	2 bytes	Emulator FPGA maximum internal temperature (x*7.69e-3 - 273.15 C)
Virtex VCCINT	2 bytes	Emulator FPGA internal voltage (x*45.776e-6 V)
Virtex VCCINT Min	2 bytes	Emulator FPGA minimum internal voltage (x*45.776e-6 V)
Virtex VCCINT Max	2 bytes	Emulator FPGA maximum internal voltage (x*45.776e-6 V)
Virtex VCCAUX	2 bytes	Emulator FPGA auxilary voltage (x*45.776e-6 V)
Virtex VCCAUX Min	2 bytes	Emulator FPGA minimum auxiliary voltage (x*45.776e-6 V)
Virtex VCCAUX Max	2 bytes	Emulator FPGA maximum auxiliary voltage (x*45.776e-6 V)
Virtex VCCBRAM Min	2 bytes	Emulator FPGA minimum block RAM voltage (x*45.776e-6 V)
Virtex VCCBRAM Max	2 bytes	Emulator FPGA maximum block RAM voltage (x*45.776e-6 V)
Virtex MGT-AVTT-1 Regulator Current	2 bytes	Emulation FPGA MGT-AVTT-1 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVTT-2 Regulator Current	2 bytes	Emulation FPGA MGT-AVTT-2 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-1 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-1 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-2 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-2 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-3 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-3 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-4 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-4 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-5 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-5 regulator current (x*7.15256e-2 mA)
Virtex MGT-AVCC-6 Regulator Current	2 bytes	Emulation FPGA MGT-AVCC-6 regulator current (x*7.15256e-2 mA)

2.5V Regulator Voltage	2 bytes	2.5V regulator voltage (x*4.77243e-5 V)
DDR3 Memory Termination Voltage	2 bytes	0.75V DC-DC voltage (x*7.15256e-2 V). Note: not available in first revision of DDB.
DDB Fabric Channel (FC) Frequency	4 bytes	Fabric Channel reference frequency (Hz).
FC1 Recovered Frequency	4 bytes	FC1 clock recovery frequency (Hz).
Reserved	841 bytes	Reserved / future / debug

6.3 Long Delay Response

This message is the response to the Query Long Delay command.

Size: 26 bytes

Table 29: Long Delay Response (Firmware API 1.1 only)

Field Name	Length	Format/Value
Type	1 byte	132
CEB ID	1 byte	ID of CEB
Long Delay DDB0	4 bytes	in increments, as defined by the resource profile
Long Delay DDB1	4 bytes	in increments, as defined by the resource profile
Long Delay DDB2	4 bytes	in increments, as defined by the resource profile
Long Delay DDB3	4 bytes	in increments, as defined by the resource profile
Long Delay DDB4	4 bytes	in increments, as defined by the resource profile
Long Delay DDB5	4 bytes	in increments, as defined by the resource profile

6.4 Recorded Signal Response

This message is the response to the “Signal Record” command. After the recording is done, the FPGA sends back the recorded samples to GUI. The format is similar to the “Interference Load” command.

Size: 1036 bytes

Table 30: Recorded Signal Response

Field Name	Length	Format/Value
Type	1 byte	133
CEB ID	1 byte	ID of CEB
Port ID	1 byte	Unsigned integer (0 to 23)
Total length	4 bytes	Unsigned integer, # of I&Q sample pairs in 256 pair blocks 1 to 250,000 (256 to 64,000,000) if port
Sequence number	4 bytes	Unsigned integer, 0 to total length
Samples	256 * 4 bytes	Each four bytes is one I/Q pair (see below)
Reserved	1 byte	Reserved

Response)

Table 31: I/Q samples format (Recorded Signal

Field Name	Length	Format/Value
I sample	2 bytes	Signed integer (-32768 to 32767)
Q sample	2 bytes	Signed integer (-32768 to 32767)

6.5 Swimlane message

This message, when on, reports low granularity samples from nodes at around 5 microseconds per sample interval. This message contains a compressed view of the samples on the assumption that the signal power is the same for many consecutive samples, exhibiting a step-like behavior.

.MessageSize: variable (up to 8 + 180 * 8 = 1448) bytes

Table 32: Swimlane message (API 1.0) - Deprecated

Field Name	Length	Format/Value
Type	1 byte	135
CEB ID	1 byte	ID of CEB
Port	1 byte	Unsigned integer (0 to 23)
Timestamp	4 bytes	Unsigned integer (0 to 4294967295) microseconds since swimlane measurement was started via start command
Number of data points	1 byte	Unsigned integer (0 to 180)
Signal power	1 byte	Signed integer (dBm)
Tx/Rx flag	1 byte	Unsigned integer 0=idle, 1=radio Tx, 2 = radio Rx
Start Clock	4 bytes	Unsigned integer (0 to 4294967295) microseconds since swimlane measurement was started via start command (i.e. clock value at the time the power and/or Tx/Rx flag values changed to these values)
Reserved	2 bytes	Reserved
Last 4 fields repeated for each data point...		

6.6 RFview Component/User Action Summary Table

Table 33: Hardware to RFview Messages summary table

Section	Msg Code	When received
6.1 Signal Status Update	128	1/second continuously
6.2.1 CEB Status Response	130	After sending CEB Status Query
6.2.2 DDB Status Response	131	After sending CEB Status Query
6.3 Long Delay Reponse	132	After sending Query Long Delay
6.4 Recorded Signal response	133	After sending Signal Record message and a signal is recorded
6.5 Swimlane message	135	Periodically if swimlane is turned on

7. RFview to CEC Messages (INTERFACE I4)

7.1 Position Update

This message is used by the GUI to send position updates to the CEC for calculation of channel properties. Only 36 nodes should be in a message. If more than 36 nodes have moved in the last timeslice multiple messages should be sent.

Size: 2 + 38 * #_of_nodes bytes

Table 34: Position Update

Field Name	Length	Format/Value
Type	1 byte	140
Number of nodes	1 byte	Signed integer (1 to 48)
Node 1	2 bytes	Signed integer (0 to 1000)
Node 1 Longitude	8 bytes	Double (Degrees)
Node 1 Latitude	8 bytes	Double (Degrees)
Node 1 Altitude	8 bytes	Double (meters, using WGS 84)
Node 1 Roll	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Yaw	4 bytes	Float (-180.0000 to 180.0000)
...	...	...
Node X	2 byte	Signed integer (0 to 1000)
Node X Longitude	8 bytes	Double (Degrees)
Node X Latitude	8 bytes	Double (Degrees)
Node X Altitude	8 bytes	Double (meters, using WGS 84)
Node X Roll	4 bytes	Float (-180.0000 to 180.0000)
Node X Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node X Yaw	4 bytes	Float (-180.0000 to 180.0000)

7.2 Position Velocity Update

This message is used by the GUI to send position velocity updates to the CEC for calculation of channel properties. Only 27 nodes should be in a message. If more than 27 nodes have moved in the last timeslice multiple messages should be sent.

Size: 2 + 50 * #_of_nodes bytes

Table 35: Position Velocity Update (CEC API 3.3 only)

Field Name	Length	Format/Value
Type	1 byte	142
Number of nodes	1 byte	Signed integer (1 to 48)
Node 1	2 bytes	Signed integer (0 to 1000)
Node 1 Longitude	8 bytes	Double (Degrees)
Node 1 Latitude	8 bytes	Double (Degrees)
Node 1 Altitude	8 bytes	Double (meters, using WGS 84)
Node 1 Roll	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Yaw	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Azimuth	4 bytes	Float (0.0000 to 360.0000)
Node 1 Elevation	4 bytes	Float (-90.0000 to 90.0000)
Node 1 Velocity	4 bytes	Float (meters per second)
...	...	...

Node X	2 byte	Signed integer (0 to 1000)
Node X Longitude	8 bytes	Double (Degrees)
Node X Latitude	8 bytes	Double (Degrees)
Node X Altitude	8 bytes	Double (meters, using WGS 84)
Node X Roll	4 bytes	Float (-180.0000 to 180.0000)
Node X Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node X Yaw	4 bytes	Float (-180.0000 to 180.0000)
Node X Azimuth	4 bytes	Float (0.0000 to 360.0000)
Node X Elevation	4 bytes	Float (-90.0000 to 90.0000)
Node X Velocity	4 bytes	Float (meters per second)

7.3 DCU Request Message: Type A

A DCU request is sent from the GUI to the CEC with new channel values to be applied. Type A DCU message corresponds with the system set to use type A channel update message.

Size: 32 bytes

Table 36: DCU Request Message: Type A (CEC API 3.2)

Field Name	Length	Format/Value
Type	1 Byte	141
Node 1	4 bytes	Unsigned integer (0 to 1000)
Node 2	4 bytes	Unsigned integer (0 to 1000)
Average PathLoss	8 bytes	double, 0 to -100, base loss applied to all taps (dB)
Doppler shift	8 bytes	double in Hz, -200 kHz to +200 kHz, see Section 4.1, should be displayed set in realistic increments for phase increment
Doppler spread	2 bytes	Unsigned short integer (0 to 65535) in Hz, 0 to 200 Hz
Delay	4 bytes	Unsigned int, in ns
Manual Control	1 byte	0 (disabled) or 1 (enabled)

Size: 36 bytes

Table 37: DCU Request Message: Type A (CEC API 3.3)

Field Name	Length	Format/Value
Type	1 Byte	141
Node 1	4 bytes	Unsigned integer (0 to 1000)
Node 2	4 bytes	Unsigned integer (0 to 1000)
Average PathLoss	8 bytes	double, 0 to -100, base loss applied to all taps (dB)

Doppler shift	8 bytes	double in Hz, -200 kHz to +200 kHz, see Section 4.1, should be displayed set in realistic increments for phase increment
Doppler spread	2 bytes	Unsigned short integer (0 to 65535) in Hz, 0 to 200 Hz
Delay	8 bytes	double, in ns
Manual Control	1 byte	0 (disabled) or 1 (enabled)

7.4 Set Radio Parameters

This message is sent to the CCR Request IP and port.

Size: 2 + 4 * #_of_ports bytes

Table 38: Set Radio Parameters

Field Name	Length	Format/Value
Type	1 byte	143
# of ports	1 byte	unsigned integer (0 to 95)
Port ID	2 bytes	Port ID or virtual radio ID
Antenna Type	1 byte	Unsigned integer
Air/ground indicator	1 byte	0 = air, 1 = ground
(the above three fields are repeated for each port)		

7.5 Set Group Parameters

This message is sent to the CCR Request IP and port.

This message sets the model and radio parameters for a group of nodes. Each model also has a model variable associated with it. Freespace has wavelength(floating point), Longdistance has an exponent(double), hata models have frequency(integer), and two-ray model has no extra variable, thus the field should be set to all zeros when using two-ray.

Size: variable, 132 + 2 * # nodes bytes

Table 39: Set Group Parameters

Field Name	Length	Format/Value	Section
Type	1 byte	146	Heading / group-wide
# of nodes	1 byte	Signed integer (0 to 95)	
List of nodes	2 bytes per node	Signed integer (0 to 95)	
Transmit Power Offset	1 byte	Signed integer (-128 to 127)	

Frequency	2 bytes	Unsigned integer (20 to 10000)	Air-air
Model	1 byte	Model ID (1 to 8)	
Model Variables	40 bytes	Format is based on the model. See table below.	
Frequency	2 bytes	Unsigned integer (20 to 10000)	Ground-ground
Model	1 byte	Model ID (1 to 8)	
Model Variables	40 bytes	Format is based on the model. See table below.	
Frequency	2 bytes	Unsigned integer (20 to 100000)	Air-ground
Model	1 byte	Model ID (1 to 8)	
Model Variables	40 bytes	Format is based on the model. See table below.	

7.5.1 Freespace Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.2 Two-Ray Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.3 Log Distance Pathloss Model

Field Name	Length	Format/Value
Exponent	4 bytes	float
Shadowing Enabled	4 bytes	int; 0 = false, 1 = true
Sigma	4 bytes	float
Update rate	4 bytes	int, seconds
Reserved	24 bytes	0

7.5.4 Hata Urban Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.5 Hata Suburban Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.6 Hata Rural Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.7 Hata PCS Urban Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.5.8 Hata PCS Suburban Pathloss Model

Field Name	Length	Format/Value
Reserved	40 bytes	0

7.6 Request Gain vs. Distance info

This message is sent to CEC to obtain visualization information for the nodes listed in the message. This information will be used to visualize signal strength/propagation (how far away from the node can this signal be heard) in the GUI. The calculation is made by "duplicating" the node at various distances from itself.

It is recommended that only one port/radio per group/type be requested.

Size: 4 bytes

Table 40: Request Gain vs. Distance info

Field Name	Length	Format/Value
Type	1 byte	145
Port ID	2 bytes	Unsigned integer, port ID or virtual radio ID
Link type flag	1 byte	0 = A-A, 1 = A-G, 2 = G-G

7.7 CEC State Export

This message is sent to CEC to instruct it to dump the current state to standard error for debugging or validation purposes. The message contains only the type field.

Size: 1 byte

Table 41: CEC State Export

Field Name	Length	Format/Value
Type	1 byte	255

7.8 Query CEC Status

This message requests the status from the CEC.

Size: 1 byte

Table 42: Query CEC Status (CEC API 3.3 only)

Field Name	Length	Format/Value
Type	1 byte	147

7.9 RFview Component/User Action Summary Table

Table 43: RFview to CEC Messages summary table

Section	Msg Code	When to Send
7.1 Position Update	140	Sent periodically, when mobile nodes are present and active in a scenario
7.2 Position Velocity Update	142	Sent periodically, when mobile nodes are present and active in a scenario
7.3 DCU Request Message Type A	141	Sent when user manually sets channel properties
7.4 Set Radio Parameters	143	When user changes radio antenna or air/-ground indicator
7.5 Set Group Parameters	146	When user changes group model parameters
7.6 Request Gain vs. Distance Info	145	User presses Gain vs Distance visualization button on the GUI
7.8 Query CEC Status	147	Sent when user requests CEC status

8. CEC to RFview (INTERFACE I5)

8.1 DCU Notification Message: Type A

A DCU notification is sent from the CEC to the GUI with updated channel values now being applied. The manual control field is ignored by the GUI. Type A DCU message corresponds with the system set to use type A channel update message.

Size: 32 bytes

Table 44: DCU Notification Message: Type A (CEC API 3.2)

Field Name	Length	Format/Value
Type	1 Byte	150
Node 1	4 bytes	Unsigned integer (0 to 1000)
Node 2	4 bytes	Unsigned integer (0 to 1000)
Average PathLoss	8 bytes	double, 0 to -100, base loss applied to all taps (dB)
Doppler shift	8 bytes	double in Hz, -200 kHz to +200 kHz, see Section 4.1, should be displayed set in realistic increments for phase increment
Doppler spread	2 bytes	Unsigned short integer (0 to 65535) in Hz, 0 to 200 Hz
Delay	4 bytes	Unsigned int, in ns
Manual Control	1 byte	(disabled) or 1 (enabled)

Size: 36 bytes

Table 45: DCU Notification Message: Type A (CEC API 3.3)

Field Name	Length	Format/Value
Type	1 Byte	150
Node 1	4 bytes	Unsigned integer (0 to 1000)
Node 2	4 bytes	Unsigned integer (0 to 1000)
Average PathLoss	8 bytes	double, 0 to -100, base loss applied to all taps (dB)
Doppler shift	8 bytes	double in Hz, -200 kHz to +200 kHz, see Section 4.1, should be displayed set in realistic increments for phase increment
Doppler spread	2 bytes	Unsigned short integer (0 to 65535) in Hz, 0 to 200 Hz
Delay	8 bytes	double, in ns
Manual Control	1 byte	(disabled) or 1 (enabled)

8.2 Position Velocity Acknowledgement

This message is used by the CEC to notify the GUI that a position velocity message was received.

Size: 2 + 50 * #_of_nodes bytes

Table 46: Position Velocity Acknowledgement (CEC API 3.3 only)

Field Name	Length	Format/Value
Type	1 byte	148
Number of nodes	1 byte	Signed integer (1 to 48)
Node 1	2 bytes	Signed integer (0 to 1000)
Node 1 Longitude	8 bytes	Double (Degrees)
Node 1 Latitude	8 bytes	Double (Degrees)
Node 1 Altitude	8 bytes	Double (meters, using WGS 84)
Node 1 Roll	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Yaw	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Azimuth	4 bytes	Float (0.0000 to 360.0000)
Node 1 Elevation	4 bytes	Float (-90.0000 to 90.0000)
Node 1 Velocity	4 bytes	Float (meters per second)
...	...	...
Node X	2 byte	Signed integer (0 to 1000)
Node X Longitude	8 bytes	Double (Degrees)
Node X Latitude	8 bytes	Double (Degrees)

Node X Altitude	8 bytes	Double (meters, using WGS 84)
Node X Roll	4 bytes	Float (-180.0000 to 180.0000)
Node X Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node X Yaw	4 bytes	Float (-180.0000 to 180.0000)
Node X Azimuth	4 bytes	Float (0.0000 to 360.0000)
Node X Elevation	4 bytes	Float (-90.0000 to 90.0000)
Node X Velocity	4 bytes	Float (meters per second)

8.3 Gain vs. Distance info

This message is sent to the GUI to visualize the range of some radio. This information will be used to visualize signal strength/propagation (how far away from the node can this signal be heard) in the GUI.

Point 0 is at a distance of 1.0 meters, the multiplier to get subsequent points' distances is 1.0357.

Size: 1004 bytes

Table 47: Gain vs. Distance info

Field Name	**Length**	**Format/Value**
Type	1 byte	153
Port ID	2 bytes	Unsigned integer
Link type flag	1 byte	0 = A-A, 1 = A-G, 2 = G-G
Point 1	2 bytes	Unsigned short integer
...	...	...
Point 500	2 bytes	Unsigned short integer

8.4 CEC Status Response

The CEC notifies the GUI of the current status.

Size: 149 bytes

Table 48: CEC Status Response (CEC API 3.3 only)

Field Name	Length	Format/Value
Type	1 byte	154
Status Code	4 bytes	int, error code
Version Major	2 bytes	short, first number of version
Version Minor	2 bytes	short, second number of version
Revision	2 bytes	short, third number of version
SVN	4 bytes	int, fourth number of version
API Version Major	2 bytes	short, first number of API version
API Version Minor	2 bytes	short, second number of API version
API Revision	2 bytes	short, third number of API version
Reserved	128 bytes	*Reserved for future use*

8.5 RFview Component/User Action Summary Table

Table 49: CEC to RFview summary table

Section	Msg Code	When received
8.1 DCU Notification Message: Type A	150	GUI to display current channel properties on users request. Sent each time a new channel value is calculated
8.2 Position Velocity Acknowledgement	148	Sent after position velocity update has been received
8.3 Gain vs. Distance Info	153	Response to Gain vs Distance Request
8.4 CEC Status Response	154	Response to Query CEC Status

9. CEC, Channel Cache, and External Model Interface (INTERFACES I7 and I9)

These Channel Calculation Request/Response (CCR) messages allow the CEC to request the calculation of a channel model between nodes at two positions. The CEC provides an internal, basic model that calculates channel properties using a variety of pathloss and fading formulas. By disabling the CEC's internal model and implementing this interface, other models can be used. The CCR interface is stateless, and a CCR reply with request_id=1 will be accepted even if no request has been sent, allowing third party software to drive the entire scenario via this API.

Channel Cache will also utilize CCR messages. CCR responses will be saved in the channel cache and can be used at a later time to replay a given experiment. In cases where real time calculation of channel properties is not feasible the Channel Cache will save CCR responses from some model (default internal or external) and after all positions and relative CCR requests have been sent out and model calculation are complete, the CCR responses can be replayed in real time to conduct an experiment.

9.1 CCR Request

This message delivers node location information to the model calculation thread/process, which uses this information to compute the channel properties. This allows use of an external or third party software for modeling. The format includes the two node IDs and their position in EMANE format. Whenever a node moves, a CCR Request is sent for all of its channels.

Size: 84 bytes

Table 50: CCR Request

Field Name	Length	Format/Value
Request ID	4 bytes	Sequential, copied to corresponding reply message. Has to be set to 1 if coming from an external source.
Node 1	4 bytes	Unsigned integer, 0-based node ID
Node 1 Longitude	8 bytes	Double (Degrees)
Node 1 Latitude	8 bytes	Double (Degrees)
Node 1 Altitude	8 bytes	Double (meters, using WGS 84)
Node 1 Roll	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node 1 Yaw	4 bytes	Float (-180.0000 to 180.0000)
Node 2	4 bytes	Unsigned integer, 0-based node ID
Node 2 Longitude	8 bytes	Double (Degrees)
Node 2 Latitude	8 bytes	Double (Degrees)
Node 2 Altitude	8 bytes	Double (meters, using WGS 84)
Node 2 Roll	4 bytes	Float (-180.0000 to 180.0000)
Node 2 Pitch	4 bytes	Float (-180.0000 to 180.0000)
Node 2 Yaw	4 bytes	Float (-180.0000 to 180.0000)

9.2 CCR Reply

This message delivers channel properties to be applied. These settings are sent to the FPGA for immediate update using the channel matrix update format. **This message contains a matrix update entry, which differs between the A- and D-Series.**

Size: 33 for D-Series or 37 for A-Series

Table 51: CCR Reply

Field Name	Length	Format/Value
Request ID	4 bytes	Sequential, copied from corresponding request message. Has to be set to 1 if coming from an external source

Node 1	4 bytes	Unsigned integer, 0-based node ID
Node 2	4 bytes	Unsigned integer, 0-based node ID
Channel Info		

Size: 19 for D-Series or 25 for A-Series

Table 52: Channel Info (CCR Reply)

Field Name	Length	Format/Value
Matrix Update Entry	12 or 16 bytes	See Table 2 for A-Series and Table 38 for D-Series.
Pathloss	8 bytes	double, average loss to display in GUI
Reserved	1 byte	Reserved

Size: 12

Table 53: D-Series CCR Entry (CCR Reply)

Field Name	Length	Format/Value	Meaning
Pathloss	2 bytes	Unsigned short integer (0 to 65535)	Gain
Doppler Shift	4 bytes	signed integer (-2147483647 to 2147483647)	Shift increment, -200kHz to +200kHz, see Section 4.1
Doppler Spread	2 bytes	Unsigned short integer (0 to 65535)	Spread period, 0 to 200 Hz, see Section 4.1
Delay	4 bytes	Unsigned integer, in nanoseconds	In nanoseconds. **Note: Must be converted to format used by the current resource profile for that channel before being sent to hardware in a matrix update**

10. EMANE and Other Third Party Software (INTERFACES I8, I11, I12)

EMANE position updates in the format descried in the EMANE API will be accepted and sent by the CEC when enabled (see `http://labs.cengen.com/emane/doc/documentation.html`). AWSim scenarios can be loaded to GUI directly using the AWSim log output and the GUI AWSim scenario import functionality.

11. Mobility/Channel property external scripts

The RFnest software is designed to be as open as possible. To write an external mobility or channel properties script for a specific simulation one needs to simply follow the API as outlined in this document and send out messages at times that a change of position or channel properties is desired.

External mobility script has to utilize the CCR requests and send those to the CEC at desired rate. The CEC will then calculate channel properties based on the set model, update the hardware, and update the GUI visualization via the DCU messages.

External channel properties script can either utilize the Channel Matrix Update format and send the updates directly to the hardware at desired times. Or, utilize the CCR reply format and send the messages to the CEC, which will in turn update the hardware.

12. Acronyms

A2D Analog to Digital.

API Application Programming Interface.

AWSIM Air Warfare Simulation.

CCR Channel Calculation Request/Response.

CEC Channel Emulation Controller.

DCU Direct Control Unit.

EMANE Extendable Mobile Ad-hoc Network Emulator (NRL's).

FPGA Field Programmable Gate Array.

GUI Graphical User Interface.

IEEE Institute of Electrical and Electronics Engineers.

IP Internet Protocol.

MAC Media Access Control.

MSB Most Significant Bit.

PC Personal Computer.

RF Radio Frequency.

UDP User Datagram Protocol.

Intelligent Automation, Inc.

15400 Calhoun Drive, Suite 190, Rockville, MD 20855 | Phone: 301-294-5200 | Fax: 301-294-5201