

# Advanced Ionospheric Model (AIM) ICD

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Version 3.0

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## Revisions

- 1.0:
  - Created 31-Oct-2017
- 2.0:
  - Created 31-Dec-2017
- 3.0:
  - Created 31-Jan-2018

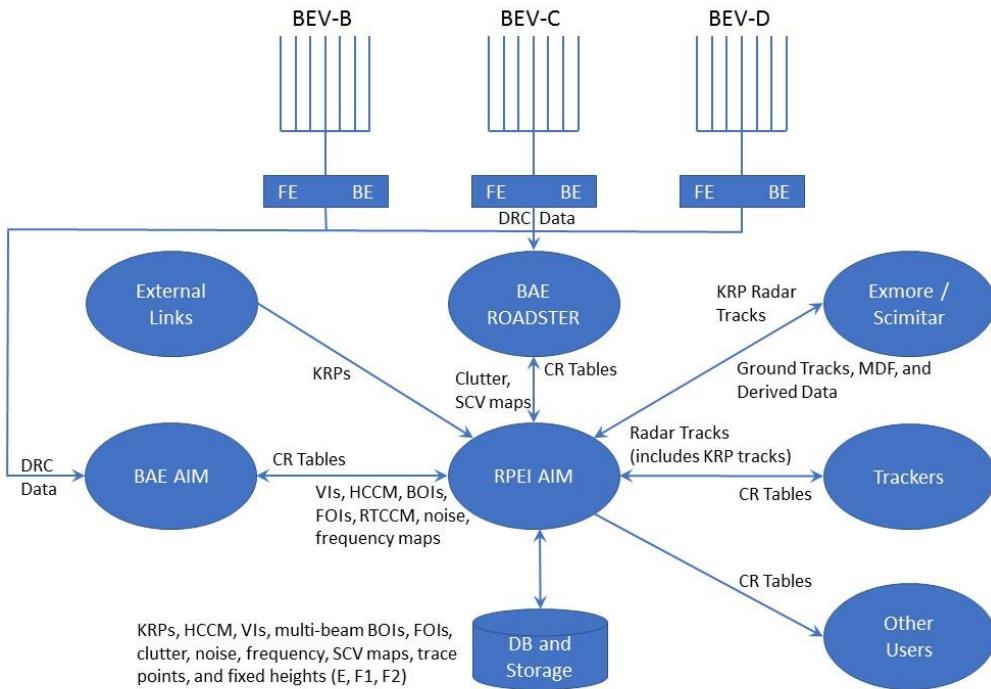
## References

1. Real-time RPEI Prototype ICD, MIT/LL, 2017 Sep 11

## Open Issues

## Introduction

This document describes the interfaces to the RPEI Advanced Ionospheric Model (AIM). Figure 1 presents a high-level view of these interfaces.



(U) Figure 1 - RPEI AIM Interfaces

This document describes two versions of the interface: a streaming interface used for real-time processing and a file-based interface used for offline processing.

## Types of information transferred

As shown in Figure 1, RPEI AIM interfaces with the BAE AIM, External Links, BAE ROADSTER, Exmore, Scimitar, Trackers, and other users. The formats for each data type are described within this document.

## Interface Protocol

The interfaces to RPEI AIM will incorporate the RTI Data Distribution Service (DDS) to publish and subscribe to topics and data types. For new development such as BAE AIM and ROADSTER, DDS will be incorporated into the application. For legacy systems such as Exmore, and Scimitar the team will develop a DDS process within these systems that converts legacy messages to/from DDS.

## BAE AIM

The BAE AIM system will publish the following DDS topics to RPEI AIM:

- Online Sounder Data - The VI, beam formed backscatter, or forward scatter oblique sounder data consisting of time delay as a function of frequency and as a function of angle.
- Online RTCCM Data – The RTCCM data.

- Online HCCM Data – The Historical CCM data.
- Online Beam Formed Noise Map – The beam formed RTCCM data consisting of noise levels as a function of angle for a specified time in KMZ format.
- Online Beam Formed Frequency Map – The beam formed RTCCM data consisting of power vs frequency as a function of angle for a specified time in KMZ format.
- Offline Sounder Data - The VI, beam formed backscatter, or forward scatter oblique sounder data consisting of time delay as a function of frequency and as a function of angle for import into a Scimitar ADS.

## Sounder Data Requests

Sounder data is taken on a regular schedule. At any given time, each antenna array is collecting a BOI sounding, collecting a FOI sounding, or waiting for the next collection to start. A schedule file on the system indicates exactly when each sounder collection starts and which receivers it uses. The VI soundings are received by the legacy delta antenna and are not beam-formed. The BOI/FOI soundings are received by several elements and are beam-formed into a small number of beams referred to as “sectors”. The number of beams to be produced by the beamforming operation and their values will be defined in a configuration file on the system. In addition to the beam values specified in the configuration file, the RPEI system will produce an additional beam whose azimuth is specified by the operator.

The BOI soundings are collected from one of two transmitting antennas while the FOI soundings are collected from a down range transponder that supports the FOI capability. The RPEI software will determine which sounder transmitting antenna to use for the BOIs by looking at the requested azimuth value (i.e. OI north for azimuths  $\leq$  72 degrees, OI south for azimuths  $>$  72 degrees).

The number of frequencies, frequency increment, number of delays and delay increment are set in a configuration file. For the first release the values are set to be compatible with Scimitar:

- Frequencies go from 8 MHz and ending with 35 MHz in 20 kHz steps, for a total of 1350 frequencies for OIs.
- Time delays should correspond to ranges of 0 to 12000 km for a total of 1600 delays for OIs. (range = delay/speed of light)
- These will be different for the VIs (i.e. frequency range will be 1 MHz to 16 MHz in 20 kHz steps).

There are two methods of transferring sounder data – Online transfer and offline transfer. For online transfer the client will subscribe for a data stream containing data from the sounder being collected currently. For offline processing, the user can convert raw DRC sounder data into a form which can be read in by Scimitar.

## Sounder Scheduling

Sounder transmissions happen on a fixed schedule, with the time between successive sounders being 5 minutes. The current implementation uses a schedule file to indicate when soundings are scheduled to start. When the client subscribes for the next online sounding, the BAE AIM software will wait until the next sounding is scheduled and publish this to the client.

## Online Sounder Processing

In online processing the following workflow will occur:

- 1) The client will subscribe to online soundings.
- 2) The client will receive the next online sounding based on the sounder schedule.

## Online Sounder Data

This command will subscribe to RPEI BOI, FOI, and VI soundings.

DDS Participant: RPEI AIM subscribe to Online Sounding Data from BAE AIM

DDS Topic: OnlineSoundingOpRequest

DDS Data Type: OnlineSoundingOpRequest

The OnlineSoundingOpRequest subscription response will contain the following information:

Parameter	Type	Notes
OnlineSoundingOpRequest	uint64	OnlineSounding Op Request reference
Start Frequency	float	MHz
Stop Frequency	float	MHz
Ion Type	enum	0=VI, 1=BOI, 2=FOI
Sounder transmitter	enum	North, South, VI, Transponder
Transponder id	String[25]	Name of transponder (FOI only)
Bev	enum	B,C,D (OI, FOI only)
Elements	long array[64] octet	Absolute elements used to capture the sounding (OI, FOI only)
Start Time	uint64	msecs start time since Jan 1 1970
Stop Time	uint64	msecs start time since Jan 1 1970
Min dBm value	float	Smallest dB value in spectral data
Max dBm value	float	Largest dB value in spectral data
Beamwidth	float	Sounding beamwith (8 degrees) (OI only)

Parameter	Type	Notes
Azimuth	float	Azimuth (center beam) of the sounding, (OI only)
Freq Resolution x	float	Frequency step size (i.e. 20kHz)
Range Resolution y	float	Range step size (i.e. 7.5km)
Number of Values	long	The number of sounder values being returned
Sounder data	float array[freq, range] vector	The sounder data power values in dB. These will be organized into sweeps for a specific frequency for all ranges in that sweep

## Online RTCCM Data

This command will subscribe to online RTCCM data.

DDS Participant: RPEI AIM subscribe to online RTCCM data from BAE AIM

DDS Topic: RTCCMOpRequest

DDS Data Type: RTCCMOpRequest

The following input parameters must be specified with the RTCCMOpRequest:

Paramater	Type	Notes
RTCCMOpRequest	uint64	RTCCM Op Request reference
Centre frequency	float	8-25 MHz
Bandwidth	float	1-2.5MHz, 100kHz
Azimuth	float	0-359 degrees
Beamwidth	float	1-359 degrees

The RTCCMOpRequest subscription response will contain the following information and will be received every 2.5 seconds:

Parameter	Type	Notes
RTCCMOpRequest	uint64	RTCCM Op Request reference
Centre frequency	float	8-35 MHz
Azimuth Beamwidth	float	1 - 359 degrees
Bandwidth	float	1-2.5MHz, 100kHz
Num samples	uint64	
Frequency bin size	float	Frequency per Bin
Power_dBm	float array[num_samples] vector	This is the RTCCM data
Min dBm value	float	Smallest power
Max dBm value	float	Largest power
Bev	enum	B,C,D
Time Generated	uint64	msecs since Jan 1, 1970 when the RTCCM data was collected
Elements	long	Number of elements used to collect the RTCCM data

## Online HCCM Data

This command will subscribe to the online HCCM data.

DDS Participant: RPEI AIM subscribes to Online HCCM Data from BAE AIM

DDS Topic: HCCMOpRequest

DDS Data Type: HCCMOpRequest

The HCCMOpRequest subscription response will contain the following information and will be received every 2.5 seconds:

Parameter	Type	Notes
HCCMOpRequest	uint64	HCCM Op Request reference
Start Frequency	ulong (Hz)	The starting frequency in Hz.
End Frequency	ulong (Hz)	The ending frequency in Hz.
Num samples	long	Number of HCCM samples
Power_dBm	long array[num_samples] vector	This is the HCCM data. A scaled value in dBm * 100 (e.g. 123 represents 1.23dBm). The data stream will contain Data Bytes/2 samples per block
Time Generated	uint64	msecs since Jan 1, 1970 when the HCCM data was collected

## Online Beam Formed Noise Map

This command will subscribe to the online beam formed noise map.

DDS Participant: RPEI AIM subscribes to Online Noise Map from BAE AIM

DDS Topic: RTCCMOpRequest

DDS Data Type: RTCCMOpRequest

The noise map is comprised of the beam formed RTCCM data consisting of noise levels as a function of angle for a specified time in KMZ format. The noise map will appear as a geospatial overlay of power versus angle regardless of ground range i.e. entire “finger beam” will be displayed in one color representing the average power from a specific azimuth. These maps are published at the same time the RTCCM data is published and uses the same parameters from the associated RTCCM request.

The RTCCMOpRequest subscription response will contain the following information and will be received every minute:

Parameter	Type	Notes
RTCCMOpRequest	uint64	RTCCM Op Request reference
Bev	enum	B,C,D
Number of KMZ values	long	The number of bytes being returned for the KMZ
Noise map	byte data[Number of KMZ values] octet	The KMZ data corresponding to the noise map
Time Generated	uint64	msecs since Jan 1, 1970 when the map was generated
Elements	long	Number of elements used to collect the noise map data
Frequency	float	Center frequency
Beamwidth	float	Beamwidth used for beam forming

## Online Beam Formed Frequency Map

This command subscribes to the online beam formed frequency map.

DDS Participant: RPEI AIM subscribes to Online Frequency Map from BAE AIM

DDS Topic: FreqMapOpRequest

DDS Data Type: FreqMapOpRequest

The frequency map is comprised of the beam formed OI sounding data consisting of power vs frequency as a function of angle for a specified time in KMZ format. The frequency map is a KMZ file consisting of color coded frequency (with color intensity for return power) with the highest power (after removing spurious emitters) for a specific range and azimuth. The frequency map will be provided for each active transmitter every 5 minutes.

The Online Frequency Map subscription response will contain the following information and will be received every 5 minutes:

Parameter	Type	Notes
FreqMapOpRequest	uint64	FreqMap Op Request reference
Bev	enum	B,C,D
Number of KMZ values	long	The number of bytes being returned for the KMZ
frequency map	byte data[Number of KMZ values] octet	The KMZ data corresponding to the frequency map
Time Generated	uint64	msecs since Jan 1, 1970 when the map was generated
Elements	long array[64] octet	Absolute elements used to capture the soundings used to generate the frequency map

## Offline Sounder Data

This command will request RPEI beam formed BOI, FOI, and non-beam formed VI soundings.

DDS Participant: RPEI AIM request Offline Sounding Data from BAE AIM

DDS Topic: OfflineSoundingOpRequest

DDS Data Type: OfflineSoundingOpRequest

The following input parameters must be specified with this request:

Parameter	Type	Notes
OfflineSoundingOp Request	uint64	OfflineSounding Op Request reference
Start Time	uint64	msecs since Jan 1 1970
Stop Time	uint64	msecs since Jan 1 1970

Parameter	Type	Notes
Ion Type	enum	0=VI, 1=BOI, 2=FOI
Azimuth	float	0 – 359 degrees BOI, FOI only
Beamwidth	float	1 - 359 degrees BOI, FOI only

The following represents the offline sounding data format:

Parameter	Type	Notes
OfflineSoundingOpRequest	uint64	OfflineSounding Op Request reference
Start Frequency	float	MHz
Stop Frequency	float	MHz
Ion Type	enum	0=VI, 1=BOI, 2=FOI
Sounder transmitter	enum	North, South, VI, Transponder
Transponder id	String[25]	Name of transponder (FOI only)
Bev	enum	B,C,D (OI, FOI only)
Elements	long array[64] octet	Absolute elements used to capture the sounding (OI, FOI only)
Start Time	uint64	msecs start time since Jan 1 1970
Stop Time	uint64	msecs start time since Jan 1 1970
Min dBm value	float	Smallest dB value in spectral data
Max dBm value	float	Largest dB value in spectral data
Beamwidth	float	Sounding beamwith (8 degrees) (OI only)
Azimuth	float	Azimuth (center beam) of the sounding, (OI only)
Freq Resolution x	float	Frequency step size (i.e. 20kHz)

Parameter	Type	Notes
Range Resolution y	float	Range step size (i.e. 7.5km)
Number of Values	long	The number of sounder values being returned
Sounder data	float array[freq, range]  vector	The sounder data power values in dB. These will be organized into sweeps for a specific frequency for all ranges in that sweep

## BAE ROADSTER

The BAE Roadster system will publish the following DDS topics to RPEI AIM:

- Online Beam Formed Clutter Map – The beam formed radar data consisting of ground return as a function of angle and range for a specified time in KMZ format.
- On line Beam Formed Sub-Clutter Visibility (SCV) Map – The beam formed radar data consisting of the ratio of clutter to noise as a function of angle for a specified time in KMZ format.

### Online Beam Formed Clutter Map

This command requests an online clutter map.

DDS Participant: RPEI AIM subscribes to Clutter Map from BAE ROADSTER

DDS Topic: ClutterMapOpRequest

DDS Data Type: ClutterMapOpRequest

The clutter map is a KMZ file containing a clutter map consisting of the transmit power (backscatter return) averaged over azimuths as a function of ground range. The clutter map will be provided for each active transmitter every 5 minutes.

The inputs to the clutter map request are

- A CR table for converting radar range to ground range. The clutter map function will use this table as an interpolation table. If the user does not specify a table the function will return a clutter map in which the range is equal to radar range rather than ground range. The CR table will be published by RPEI AIM and subscribed to by BAE AIM.
- The beam widths for all clutter maps will be 40 degrees centered on their respective slewed transmitter antenna azimuths.

The return data will contain the following:

Parameter	Type	Notes
ClutterMapOpRequest	uint64	Clutter Map Op Request reference
Transmitter Antenna id	enum	Identifier of the transmit antenna. This will match the legacy system resource enumerated types
Tx antenna slew	float	+/- 30deg
Tx Power	float	10-500 kW
Bev	enum	B,C,D
Number of KMZ values	long	The number of bytes being returned for the KMZ
clutter map	byte data[Number of KMZ values] octet	The KMZ data corresponding to the clutter map
Time Generated	uint64	msecs since Jan 1, 1970 when the map was generated
Elements	long octet	Number of elements used to collect the clutter map data.

## Online Beam Formed Sub Clutter Visibility (SCV) Map

This command requests an online SCV map.

DDS Participant: RPEI AIM subscribes to SCV map from BAE ROADSTER

DDS Topic: SCVMapOpRequest

DDS Data Type: SCVMapOpRequest

The SCV map is a KMZ file containing a SCV map consisting of the transmit power sub-clutter visibility, or clutter to noise ratio, averaged over azimuths as a function of ground range. The SCV map will be provided for each active transmitter every 5 minutes.

The inputs to the SCV map request are

- A CR table for converting radar range to ground range. The SCV map function will use this table as an interpolation table. If the user does not specify a table the function will return a SCV map in which the range is equal to radar range rather than ground range. The CR table will be published by RPEI AIM and subscribed to by BAE AIM.
- The beam widths for all SCV maps will be 40 degrees centered on their respective slewed transmitter antenna azimuths.

The return data will contain the following:

Parameter	Type	Notes
SCVMapOpRequest	uint64	SCV Map Op Request reference
Transmitter Antenna id	enum	Identifier of the transmit antenna. This will match the legacy system resource enumerated types
Tx antenna slew	float	+/- 30 degrees
Tx Power	float	10-500 kW
Bev	enum	B,C,D
Number of KMZ values	long	The number of bytes being returned for the KMZ
SCV map	byte data[Number of KMZ values] octet	The KMZ data corresponding to the SCV map
Time Generated	uint64	msecs since Jan 1, 1970 when the map was generated
Elements	Long octet	Number of elements used to collect the SCV map data.

## Trackers, Exmore, and Scimitar

The Trackers, Exmore, and Scimitar will publish the following DDS topics to RPEI AIM:

- Radar Tracks – Extracted tracks in radar coordinates. These can include KRP tracks that contain extracted points with a known ground location which will be used by RPEI AIM and the CR model to update the CR tables based on the KRP track truth data (i.e. adjust height and tilt).

## Radar Track Data

This command subscribes to radar track data.

DDS Participant: RPEI AIM subscribes to radar track data from Trackers, Exmore, or Scimitar

DDS Topic: RadarTrackOpRequest

DDS Data Type: RadarTrackOpRequest

The radar tracks are tracks that contain the radar coordinates, specifically radar range and cone angle.

The return data will contain the following:

CLASS	FIELD	TYPE	NOTES
	RadarTrackOpRequest	uint64	Radar Track Op Request reference
XTR_TRACK_CLASS	Track id #	long	
For each mode (1+, Mixed, 1-)			Only mixed mode
XTR_TRACK_MODE_CLASS	# segments	long	
ROP_PARAMS_CLASS	Elevation angle	float	
ROP_PARAMS_CLASS	PRF	float	
ROP_PARAMS_CLASS	Center recorded range	float	
ROP_PARAMS_CLASS	Max recorded range	float	
ROP_PARAMS_CLASS	Min recorded range	float	
ROP_PARAMS_CLASS	Max unambiguous range	long	
ROP_PARAMS_CLASS	Number range bins	short	
ROP_PARAMS_CLASS	Mechanical boresight	float	
ROP_PARAMS_CLASS	Boresight azimuth (receive azimuth)	float	
ROP_PARAMS_CLASS	Tilt angle	float	
ROP_PARAMS_CLASS	Beam element	long	
ROP_PARAMS_CLASS	RX Beamwidth	float	

CLASS	FIELD	TYPE	NOTES
ROP_PARAMS_CLASS	Collection type	float	
XTR_TRACK_SEGMENT_CLASS	Number track points	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Amplitude	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Noise	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Doppler	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Integrated velocity	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Total phase/slant azimuth	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	SNR	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	True radar range	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Start time seconds	uint	
XTR_TRACK_SEGMENT_CLASS	Initial range	float	
XDD_DERIVED_DATA_POINT_CLASS	Azimuth	float	
XDD_DERIVED_DATA_POINT_CLASS	Rx ground range	float	
XDD_DERIVED_DATA_POINT_CLASS	Tx ground range	float	
XDD_DERIVED_DATA_POINT_CLASS	Rx path length	float	
XDD_DERIVED_DATA_POINT_CLASS	Tx path length	float	
XDD_DERIVED_DATA_POINT_CLASS	Latitude	float	
XDD_DERIVED_DATA_POINT_CLASS	Longitude	float	

## RPEI AIM

RPEI AIM will publish the following DDS topics to Trackers, Exmore, Scimitar, BAE AIM and ROADSTER:

- Ground Tracks – Extracted tracks in ground coordinates.
- Derived Data – Data created by the AIM CR model from extracted track data. This includes Doppler, azimuth, radar range, integrated velocity, SNR, etc. and is expected to be included in the same track file that provided the radar coordinates

- MDF File – Metric data file, used in Oilstock to present track plots on the map.
- CR Tables – Coordinate registration tables for both direct and sky wave modes.

## Ground Track and Derived Data

This command subscribes to ground track and derived data.

DDS Participant: Exmore and Scimitar subscribe to ground track and derived data from RPEI AIM

DDS Topic: GroundTrackOpRequest

DDS Data Type: GroundTrackOpRequest

The ground tracks and derived data contain the ground coordinates, specifically latitude and longitude.

The return data will contain the following:

CLASS	FIELD	TYPE	NOTES
	GroundTrackOpRequest	uint64	Ground Track and Derived Data Op Request reference
XTR_TRACK_CLASS	Track id #	long	
For each mode (1+, Mixed, 1-)			Only mixed mode
XTR_TRACK_MODE_CLASS	# segments	long	
ROP_PARAMS_CLASS	Elevation angle	float	
ROP_PARAMS_CLASS	PRF	float	
ROP_PARAMS_CLASS	Center recorded range	float	
ROP_PARAMS_CLASS	Max recorded range	float	
ROP_PARAMS_CLASS	Min recorded range	float	
ROP_PARAMS_CLASS	Max unambiguous range	long	
ROP_PARAMS_CLASS	Number range bins	short	
ROP_PARAMS_CLASS	Mechanical boresight	float	
ROP_PARAMS_CLASS	Boresight azimuth (receive azimuth)	float	
ROP_PARAMS_CLASS	Tilt angle	float	

CLASS	FIELD	TYPE	NOTES
ROP_PARAMS_CLASS	Beam element	long	
ROP_PARAMS_CLASS	RX Beamwidth	float	
ROP_PARAMS_CLASS	Collection type	float	
XTR_TRACK_SEGMENT_CLASS	Number track points	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Amplitude	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Noise	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Doppler	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Integrated velocity	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Total phase/slant azimuth	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	SNR	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	True radar range	float	
XTR_EXTRACTED_TRACK_POINT_CLASS	Start time seconds	uint	
XTR_TRACK_SEGMENT_CLASS	Initial range	float	
XDD_DERIVED_DATA_POINT_CLASS	Azimuth	float	
XDD_DERIVED_DATA_POINT_CLASS	Rx ground range	float	
XDD_DERIVED_DATA_POINT_CLASS	Tx ground range	float	
XDD_DERIVED_DATA_POINT_CLASS	Rx path length	float	
XDD_DERIVED_DATA_POINT_CLASS	Tx path length	float	
XDD_DERIVED_DATA_POINT_CLASS	Latitude	float	
XDD_DERIVED_DATA_POINT_CLASS	Longitude	float	

## Metric Data File (MDF) Data

This command subscribes to MDF data.

DDS Participant: Exmore and Scimitar subscribe to MDF data from RPEI AIM

DDS Topic: MDFFDataOpRequest

DDS Data Type: MDFFDataOpRequest

The MDF data can be loaded into Oilstock to present a plot of a track on the map.

The return data will contain the following:

CLASS	FIELD	TYPE	NOTES
	MDFFDataOpRequest	uint64	MDF Data Op Request reference
The following data is repeated for each track point:			
PAM_MAP_CLASS	Plot Type	char(2)	Sa plot type
PAM_MAP_CLASS	Track Color	char(1)	Track Color
PAM_MAP_CLASS	Track Symbol	char(4)	Track Symbol
PAM_MAP_CLASS	SACC	char(3)	U00 for UNCLASS, S00 for SECRET
PAM_MAP_CLASS	CRCM	char(6)	Control and Release Marking
PAM_MAP_CLASS	Latitude	char(7)	DDMMSS[N/S]
PAM_MAP_CLASS	Longitude	char(8)	DDDDMMSS[E/W]
PAM_MAP_CLASS	Altitude (meters)	char(8)	<blank>
PAM_MAP_CLASS	Event Time (Time of track point)	char(11)	YYDDDHMMSS
PAM_MAP_CLASS	Track ID	char(24)	Track ID
PAM_MAP_CLASS	Track Name	char(16)	Track Name (same as Track ID)
PAM_MAP_CLASS	Target Type	char(16)	Target Type
PAM_MAP_CLASS	Event Time – Hundreds of Sec	char(2)	0-99
PAM_MAP_CLASS	Alternate Location	char(20)	DD:MM:SSA/DDD:MM:SSA
PAM_MAP_CLASS	Integrated Velocity	char(7)	NNNN.NN km

CLASS	FIELD	TYPE	NOTES
PAM_MAP_CLASS	Radar Range	char(7)	NNNN.NN km
PAM_MAP_CLASS	Azimuth	char(6)	NNN.NN degrees
PAM_MAP_CLASS	Smoothed Azimuth	char(7)	NNN.NNN degrees
PAM_MAP_CLASS	Velocity	char(8)	+/-NNNNN.N meters/sec
PAM_MAP_CLASS	Virtual Height	char(6)	NNN.NN km
PAM_MAP_CLASS	Vertical Velocity	char(8)	+/-NNNN.NN meters/sec
PAM_MAP_CLASS	Total Phase	char(8)	+/-NNNN.NN radians
PAM_MAP_CLASS	True Velocity	char(7)	+/-NNNN.N meters/sec
PAM_MAP_CLASS	Altitude Change	char(7)	+/-NNNN.N meters
PAM_MAP_CLASS	Heading	char(5)	NNN.N degrees
PAM_MAP_CLASS	Event Time (Seconds past midnight)	char(8)	NNNNN.NN seconds
PAM_MAP_CLASS	Mode Source	char(3)	+M-
PAM_MAP_CLASS	Mode 1 Radar Range	char(7)	NNNN.NN km
PAM_MAP_CLASS	Mode 1 Integrated Velocity	char(7)	NNNN.NN km
PAM_MAP_CLASS	Mode 1 Doppler	char(7)	+/-NNNN.N Hz
PAM_MAP_CLASS	Mode 1 Radial Velocity	char(8)	+/-NNNNN.N meters/sec
PAM_MAP_CLASS	Mode 1 SNR	char(5)	NNN.N dB
PAM_MAP_CLASS	Mode 2 Radar Range	char(7)	NNNN.NN km
PAM_MAP_CLASS	Mode 2 Integrated Velocity	char(7)	NNNN.NN km
PAM_MAP_CLASS	Mode 2 Doppler	char(7)	+/-NNNN.N Hz
PAM_MAP_CLASS	Mode 2 Radial Velocity	char(8)	+/-NNNNN.N meters/sec
PAM_MAP_CLASS	Mode 2 SNR	char(5)	NNN.N dB
PAM_MAP_CLASS	Mode 3 Radar Range	char(7)	NNNN.NN km

CLASS	FIELD	TYPE	NOTES
PAM_MAP_CLASS	Mode 3 Integrated Velocity	char(7)	NNNN.NN km
PAM_MAP_CLASS	Mode 3 Doppler	char(7)	+/-NNNN.N Hz
PAM_MAP_CLASS	Mode 3 Radial Velocity	char(8)	+/-NNNNNN.N meters/sec
PAM_MAP_CLASS	Mode 3 SNR	char(5)	NNN.N dB
PAM_MAP_CLASS	Ionospheric Layer	char(5)	FIXED, E F1, F2
PAM_MAP_CLASS	Tx Ray Elevation Angle	char(5)	NN.NN degrees
PAM_MAP_CLASS	Rx Ray Elevation Angle	char(5)	NN.NN degrees
PAM_MAP_CLASS	Target Ray Receive Angle	char(5)	NN.NN degrees
PAM_MAP_CLASS	Target Ray Reflect Angle	char(5)	NN.NN degrees
PAM_MAP_CLASS	Tx Ground Range	char(8)	NNNNNN.NN km
PAM_MAP_CLASS	Rx Ground Range	char(8)	NNNNNN.NN km
PAM_MAP_CLASS	Tx Path Length	char(8)	NNNNNN.NN km
PAM_MAP_CLASS	Rx Path Length	char(8)	NNNNNN.NN km

## CR Table Data

This command subscribes to the CR table data.

DDS Participant: Trackers, BAE AIM, BAE ROADSTER, and other users subscribe to CR tables from RPEI AIM

DDS Topic: CRTableOpRequest

DDS Data Type: CRTableOpRequest

The CR tables convert radar coordinates into ground coordinates.

The return data will contain the following:

Parameter	Type	Notes
CRTableOpRequest	uint64	CRTable Op Request reference

Parameter	Type	Notes
Registration table size	long	size of the registration table, greater than 2
Radar Range Table	float[registration table Size]	Positive, monotonically increasing, radar range values in km
Ground Range Table	float[registration table Size]	Positive, ground range values in km

## External Links

The external links will provide known reference points (KRPs) to AIM. These systems will publish the following DDS topic to RPEI AIM:

- KRPs – Known reference points (i.e. ADS-B). This will be developed as part of the RPEI AIM KRP effort.

## Network protocol for online operation

The BAE AIM system will use DDS publish and subscribe for transferring data streams to the RPEI AIM.