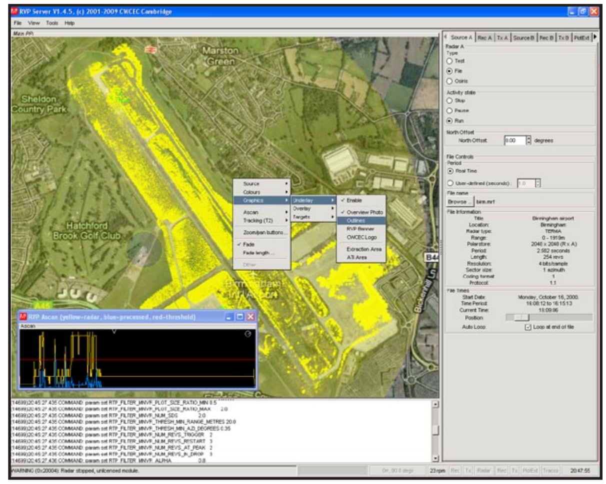
Data Sheet

RVP

Radar Video Processing



Features

- High-performance radar video processing (RVP) servers
- Optimal software modules for
  - Radar video distribution
  - Plot extraction
  - Radar tracking
- Radar video acquisition from analog and/or digital signals
- Supports broad range of radar video formats
- Variety of system packaging options
  - Industrial 4U 9" rackmount
  - Naval qualified enclosures
  - OEM card supply
- Interfaces to a wide variety of radar types
- 0-500 NV range
- Unattended operation using local configuration parameters and optional remote control
- Clutter processing
- Call averaging CFAR
- Radar video distribution on LAN
- Optional moving platform support
- Optional radar video recording
- Multi-channel support
- Radar video PPI display engineering and control interface

Radar Video

The RVP product family spans a range of capabilities from radar video servers to full auto-tracking solutions for naval, air traffic control and vessel traffic applications. Based on proven solutions for radar acquisition and processing, RVP builds on Curitss-Wright Controls Embedded Computing's experience in offering integrated and OEM-level solutions that meet demanding requirements. Modular software design and open-systems hardware allows a rich set of capabilities to be provided in a compact and cost-effective form factor built on standard COTS hardware platforms. At the heart of RVP is a set of integrated software modules that provide radar processing capabilities. Theses software modules are designed to work on industry-standard operating systems and computing platforms, ensuring that systems can be upgraded and maintained over their operating life.

The RVP software modules are typically built into an RVP server system. The configurations of these systems represent an integration of software modules with an appropriate computing platform and set of radar acquisition and display hardware. These systems configurations are broadly classified as RVP Radar Video Distribution Server, RVP Plot Extractor and RVP Tracker.

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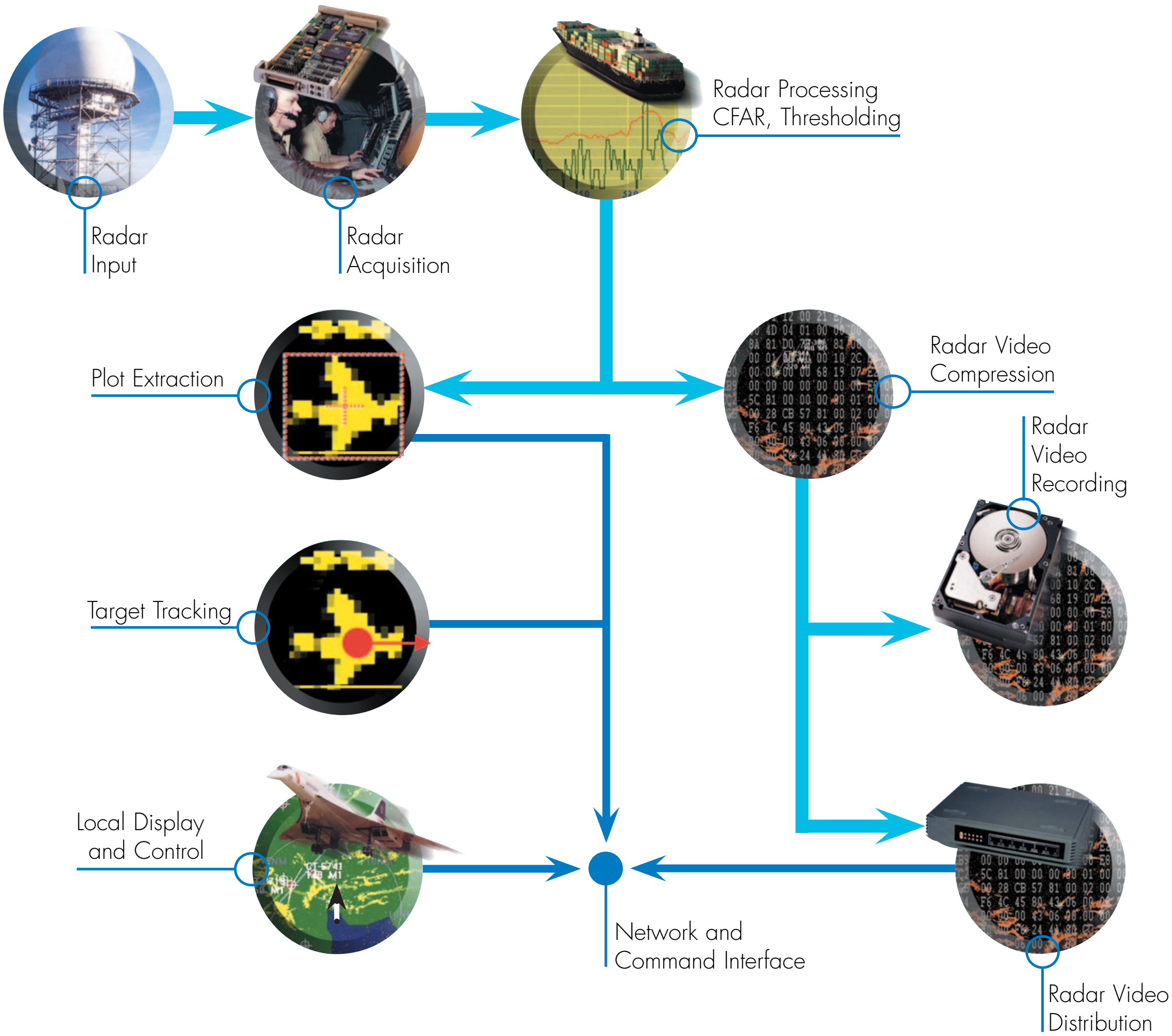
Figure 1: The Flow and Extent of RVP's Capabilities



Radar Video Distribution

An RVP Radar Video Distribution server allows primary radar video to be received in a central location and distributed across a standard Ethernet based local area network (LAN) to any number of client displays, where it can be scan-converted and displayed.

Radar Video Acquisition

RVP can receive radar video from a Curtiss-Wright radar input card, for example Osiris, or through a network interface. Radar turning signals and analog/digital video are received by the radar input card and processed to generate integrated digital data for subsequent analysis. An extensive range of radar input types are supported, including ACP/ARP, Synchro, RADDS, ASDE-3 and various parallel and serial azimuth formats.

Radar Video Compression

Digitized radar video is compressed using Curtiss-Wright's RACE radar coding scheme, which is based on a one-dimensional variable length encoder. Under configuration control, the parameters of the RACE compression may be adjusted to balance network bandwidth usage with data loss. An adaptive compression scheme supports automatic adjustment of the compression ratio to meet an average channel capacity. In the lossless case, RACE is able to encode 8-bit video from the polar store or in the other extreme the compression parameters may be set up to compress to 1-bit video, minimizing network utilization at the expense of image quality.

Network Distribution

The RVP Radar Video Distribution server is designed to use standard network technologies and protocols to send radar video and receive control commands. Typical configurations can use 10/100/1000Base-T networks to send encoded radar video as multicast UDP packets over Ethernet, allowing any number of workstations on the network to receive the video. Because the RVP Video Server sends the complete polar store of radar data, each display client can scan-convert and display its own independent view of the radar video. Significantly, loading on the server and the network remains constant as additional client displays are added.

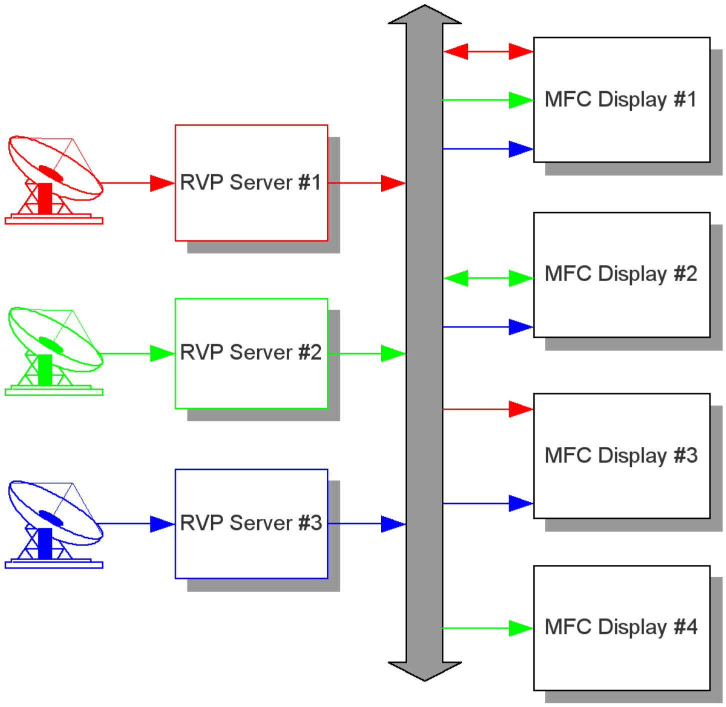
The network loading depends on the acceptable level of image loss and the level of detail in the original video. Sample figures for an air search radar, 20 rpm, 2k x 4k polar store, per video, are: 15 Mbits/s (no loss), 2.5 Mbits/s (some loss of low-level noise etc), 0.8 Mbits/s (thresholded video).

Figure 2 below shows a typical system where there are requirements for multiple RVP Servers and client displays (or Multi-function Console [MFC] Displays).

Client Displays

The compressed radar video needs to be decompressed and scan-converted on each client console and Curtiss-Wright is able to supply software and hardware modules to support this. RVP Video Receiver is a set of software functions that receive the network radar video and decompress it to reconstruct the polar-format data. Application software running on the client can then access this data for processing or display.

Figure 2: RVP Facilitates the Creation of Multi-Radar Multi-Console Networks



KEY:

MFC #1 receives and displays RVP data from RVP Server #1, #2 and #3. MFC #1 is also used to control RVP Server #1.

MFC #2 receives and displays RVP data from RVP Server #2 and #3. MFC #2 is also used to control RVP Server #2.

MFC #3 receives and displays RVP data from RVP Server #2. MFC #3 is used as a passive display and is not used to control any of the RVP Servers.

In a typical application, each client display contains a radar scan-converter, which converts the reconstructed polar-format data into a PPI image in one or more windows. The control of the window position and view of the radar video within the window is entirely under the control of the client application. Curtiss-Wright supplies a full range of radar scan-converters for VME, PMC and PCI form factors as well as the GPU-based SoftScan product. For example, in a PCI system an Advantage Xi radar scan-converter accepts the polar-format radar video and scan-converts into one or more PPI windows that may then be combined with underlay and overlay maps. A VME or VPX-based system might use the Eagle-2 scan converter PMC. Application software using Curtiss-Wright's range of scan-converters will use the RVL+ software library to transfer the radar video decompressed with RVP Video Receiver into the scan converter. This library, which is available for a range of operating systems including Windows® and Linux®, provides the application programming interface (API) to control the presentation of radar video in a window. In addition to custom application software developed using the RVP Video Receiver and RVL+ library, Curtiss-Wright offers METROview, a complete turnkey application package for the display of radar video on a Windows-based PC display.

RVP Set-up & Maintenance Display

All configurations of RVP provide a graphical user interface GUI to configure and maintain the server. The user interface provides a full set of tools for visualization of the primary radar video, plots and track data, in addition to supporting the display of ancillary information, such as maps and range rings. A maintenance operator interacts with RVP GUI using a keyboard and mouse.

RVP Remote Control Interface

The RVP Remote Control Interface supports network-based control of an RVP system. A complete command interpreter is provided to allow full remote control of all aspects of the operation of the system, including distribution, plot extraction, tracking and radar recording, according to the installed options. The control protocol is based on simple ASCII command strings, which are packaged into UDP datagrams according to Curtiss-Wright's standard message-passing protocol. It is straightforward to write software to send commands to RVP and sample code is provided with the RVP release for Linux and Windows-based clients.

Figure 3: Structure of a Typical RVP-based Radar Video Application

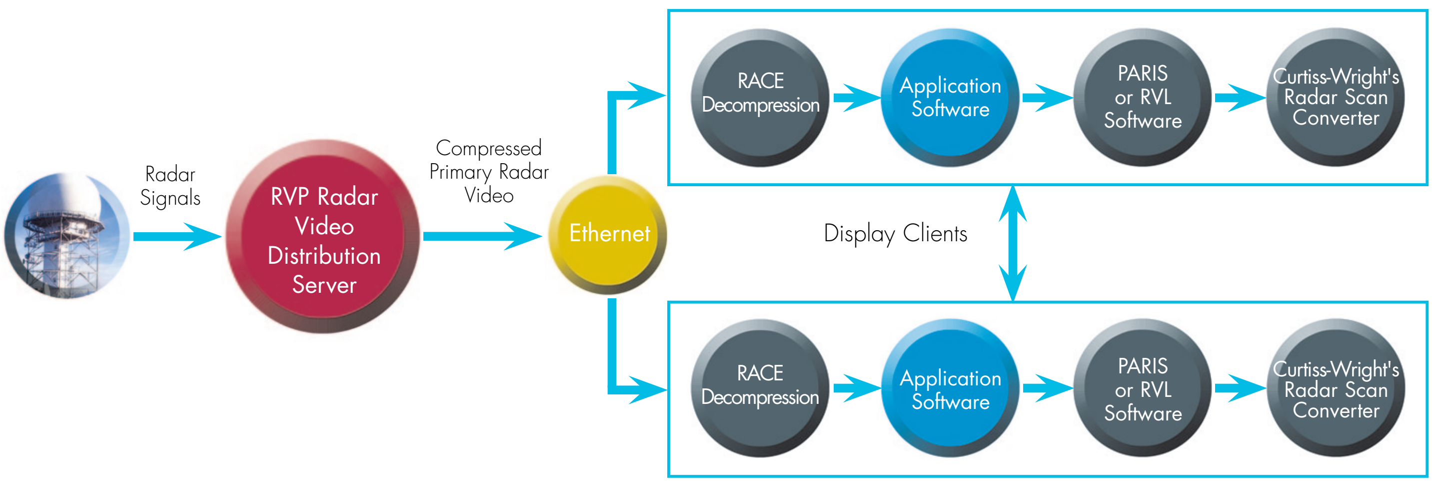
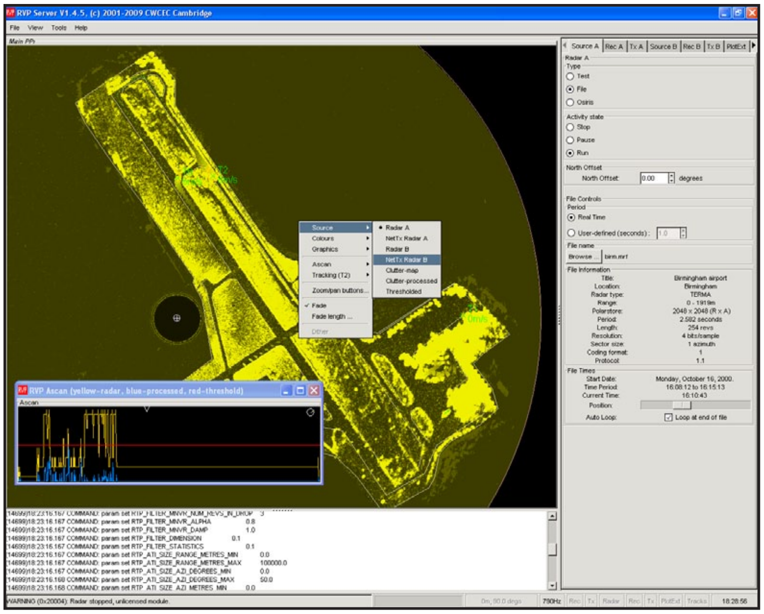


Figure 4: The RVP Engineering Display Presents the Radar in PPI and A-Scan Format and is Used for Configuring RVP



RVP Radar Recording

Radar video that is encoded with the RACE compression scheme may be stored on a local disk, in data files that may subsequently be replayed back through the front-end of RVP for processing. The recording and replay process may be done through the RVP GUI, or else remotely through the RVP network command interface. The capability to record radar video is a licensed software option, which may not be available with all combinations of hardware and software.

RVP Plot Extractor

The RVP Plot Extraction module processes radar video in defined areas-of-interest to identify candidate targets. The areas-of-interest may be set in polar or Cartesian coordinates and plots are extracted as areas of connected video that exceed local thresholds which are user configurable. Once extracted, the plots are characterized by their position, size, weight and time-stamp. Plot data may then be distributed on the network to a remote tracker or fusion system, or may be passed directly to the RVP Tracker process.

Clutter Processing

RVP Plot Extractor can automatically generate a high-resolution clutter map as an integration of video over time. Stationary objects build up in the clutter map as their returns integrate, and this may be used as the basis of a moving target detector, which differentiates moving targets from a stationary background. A simple application of the clutter map is to subtract it from incoming video, to emphasize the moving targets. In more complex situations, for example in ship-board processing, the clutter map may be updated in both radar-relative modes (eliminating clutter that is tied to the ship's frame of reference) and world-based modes (eliminating clutter from land for example). The gain and time-constant of the clutter map processing are configurable and may be adjusted during operation of the unit. For moving platform applications, clutter processing is performed in both ship-relative and world coordinate systems.

CFAR Detection

To identify a detection threshold for candidate targets, RVP uses either a fixed-level or cell-averaging CFAR (CA-CFAR) detector that calculates a local cell average as a function of range for each of the azimuths in the polar store. RVP's implementation of CA-CFAR supports either a single or dual window, providing enhanced control of false target rejection at both the leading and trailing edge of clutter cells. In keeping with the philosophy of RVP, all parameters of the CA-CFAR moving window averager may be configured at start-up and changed at run time across the network interface.

Plot Extraction

The plot extraction process itself operates on the thresholded radar video and seeks to identify target like signals derived from targets of interest. The plot extraction process is highly configurable and flexible.

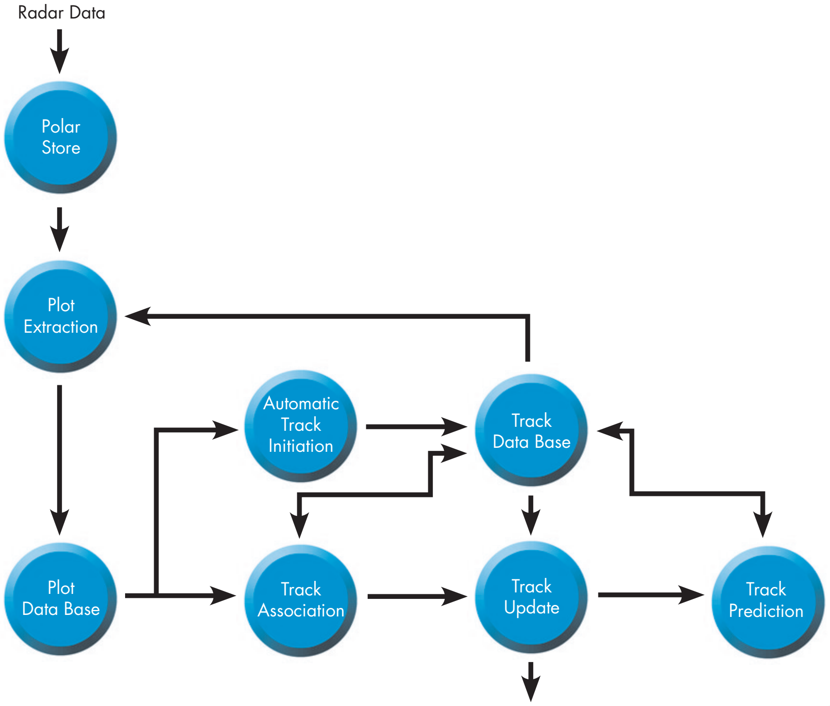
Initially, an extraction area is defined as a combination of polar-format (range-azimuth) and Cartesian polygons, which may add to or subtract from the active area. In an airport ground-movement application, for example, a map of the airport runways and taxiways can serve as a definition of the areas for plot extraction. When an area of interest has been defined, the plot extraction process extracts connected regions of signal that exceed the detection threshold. A set of range-dependent minimum and maximum limits are imposed on the extracted plots to eliminate unwanted returns.

A typical target may be detected as a number of separate but closely-spaced plots. Although in some cases it may be required to output these broken plots directly, it is more usual for RVP to be configured to automatically merge these plots together. The merging rules are designed to allow parts of a real target to be combined into a single plot, whilst minimizing the possibility of plots from two adjacent targets being combined. An extracted plot is characterized by a centroid, bounding box, size and time-stamp. This information is packaged into a message that is sent onto the network using Curtiss-Wright's Message Passing Format (MPF), which is a simple byte-oriented general-purpose message format comprising a header and a data block.

RVP Radar Tracking

The RVP Tracking module is designed to accept plots from the RVP Plot Extractor or from a separate plot extractor. These plots are used to update a database of targets of interest, in addition to generating new tracks through a process of Automatic Track Initiation (ATI). Tracks are created either through manual initiation from an external system, or through automatic initiation from the tracker itself, and are maintained in an active track database. Each rotation of the radar creates a new set of plot data which is used to update entries in the database and estimate filtered position, speed and accelerations of the target. Typically there are far more plots generated than targets maintained, so one responsibility of the RVP Tracking module is to select the appropriate plots to match with the entries in the track database. Plots that remain after this matching process are potentially new targets, and may be initiated as new tracks if they pass acceptance rules on their motion. Updated track data is reported on the network in the form of a track report.

Figure 5: Data Flow Through the Plot Extraction and Target Tracking Modules





Plot Extraction – Tracking

The area of radar coverage to be used for ATI is programmed in polar or Cartesian coordinates. In the simplest sense this can be programmed as the complete radar coverage, or in the other extreme a complex map of polygonal or range azimuth segments may be used. Plots that are within the active area and are not required to maintain tracking on existing tracks are inputs to the ATI process. An M out of N integrator is used to require that a valid plot is visible from M out of N scans, and that within this period the apparent motion of the candidate track conforms to restrictions of minimum and maximum speeds and accelerations. When a candidate track meets the M from N criterion it is promoted to a primary track and thereafter maintained by a tracking process that updates the estimated and predicted state of the target on each update.

Tracking Filter

When a new track is created, either through ATI or manual initiation, the tracker builds a dynamic model of the track motion so it may be followed by subsequent measurements. Like the ATI area, the active tracking area is defined using polygonal and polar segments, allowing complex tracking areas that are independent of the ATI areas to be defined. RVP's tracker is based on an adaptive alpha beta model, which supports a number of gain control modes to implement different strategies for dynamic adjustment of the filter gains for different applications. In one mode, for example, there are steady-state filter gains, which are switched to maneuver gains when the filter detects a significant change in the motion of the target. Other filter modes support more specialized models of tracking, such as adapting the filter gains in accordance with the measured speed of the target. RVP Tracker provides considerable flexibility in the parameters associated with the filter gains, and even permits dynamic switching of the gain control mode.

Each rotation of the radar generates a number of plots that become associated with a track. In the simple case, a target is sensed as a single plot, which becomes a single measurement update for the track filter. After the update, a prediction stage follows to anticipate the motion of the target ahead of the next detection. In other situations, there may be no plot detections for a track, a situation that causes the filter to coast the measurement by predicting its position for next detection based on the current estimate of dynamics. If there are multiple plot detections for an update, the tracker must decide which, if any, is the best association, or whether the individual plots need to be merged to achieve a single observation.

Track Reports

Whether effected using a new plot measurement or by estimation, a new estimate of the track's state becomes available once per scan and is reported to an external system over the network interface. Track reports are formatted in Curtiss-Wright's standard message passing format as a UDP datagram. In keeping with normal UDP addressing, these datagrams may be sent to a single address or sent to a multicast address that can be received by any number of clients. The internal details of the track report are configurable within RVP Tracker. This allows as much or as little state information as is required to be sent on to the network.

RVP Specifications

General

- Interfaces to a wide variety of radar types
- Range up to 1000 km (500 NM)
- Programmable polar-store sizes
- Unattended operation using local configuration parameters and optional remote control
- Samples analog video at up to 50 MHz and 8-bits per sample

Radar Distribution

- Compression and coding of video distribution on LAN using RACE algorithm
- Compression ratios typically 2:1 to 10:1 (Situation-dependent)
- Uses standard UDP/IP protocol on Ethernet networks
- Delivery to single (unicast) or multiple (multicast) clients
- Optional library software (RVP Video Receiver) to support receipt and decompression on host processor
- Programmable compression and network bandwidth
- Local display of raw or transmitted video
- Remote control of distribution process over network interface



Plot Extraction

- Automatic extraction of plot data in real-time
- Up to 10,000 plots per scan
- Fixed or dynamic thresholding using single or dual-window cell-averaging CFAR
- Centroiding (range and azimuth), bounding box, time-stamping
- Programmable minimum and maximum size of plots
- Programmable extraction area in polar or Cartesian coordinate system
- Automatic plot merging
- Automatic calculation of clutter map, with programmable time constant
- Programmable combination of clutter with main polar store
- Low latency of plot report transmission to network
- Support for platform-relative and absolute clutter maps

Tracking

- Alpha-beta filter with maneuver detection and adaptive filter gains
- Tracking capacity over 500 targets
- Tracking speeds up to 1000 kts (subject to minimum tracking range and radar rpm)
- Programmable minimum and maximum tracking speed
- Programmable tracking area in polar or Cartesian coordinate system
- Programmable report structure
- Optional moving platform support
- Manual or automatic track initiation
- Programmable ATI area (independent from tracking area) in polar or Cartesian coordinate system
- Programmable minimum and maximum ATI speeds
- Programmable M from N initiation criteria
- Optional rejection of plots from clutter map

Packaging

- Industrial (e.g. 19" rackmount enclosure)
- Naval/airborne (typically ruggedized enclosure)
- OEM board-level (VME, VPX, CompactPCI)

Figure 6: Typical RVP Systems

Warranty

This product has a one year warranty.

Contact Information

To find your appropriate sales representative:

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Technical Support

For technical support:

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