Data Sheet

Radar Acquisition and Display Systems

Features

- Capture and display of radar video
- Support for numerous radar makes and models
- Modular, extensible system architectures
- Configurable, optional processing of radar video including:
  - Clutter processing
  - Recording
  - Plot extraction and tracking
  - Network distribution
- Hardware- and software-based solutions for rendering PPI, A-Scan and B-Scan displays
- Adjustable display features include radar color, fade rate and zoom factor

Overview

Curtiss-Wright Controls Embedded Computing is an established supplier of high-resolution radar acquisition and display products to the air traffic control (ATC) and naval market sectors. Curtiss-Wright offers a wide range of radar video products capable of providing full "capture-to-display" radar video solutions.

Access to the full Curtiss-Wright range of products has facilitated a new generation of integrated, modular highly functional systems. Curtiss-Wright's single board computers (SBC) include Intel® and Power Architecture™ processors and multiple operating systems on VME, VPX and CompactPCI (cPCI) form factors, with display controllers including state-of-the-art graphics processing units (GPU), providing hardware acceleration for fast display updates and complex image transformations.

Radar data can originate from a variety of sources, including Curtiss-Wright's radar input cards, network radar distribution server, or even a custom source. This data can then be processed and passed to scan conversion hardware or software for display.

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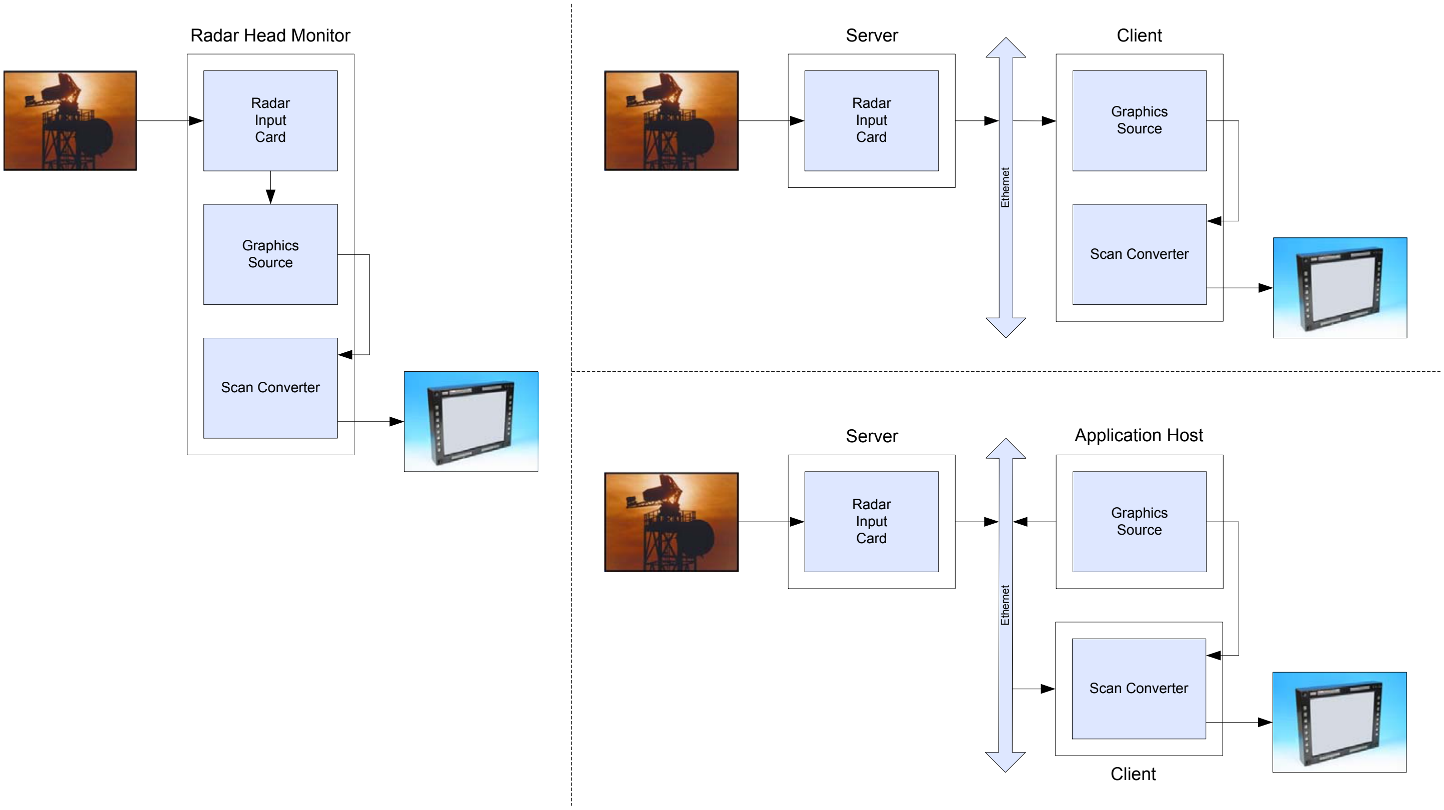
Curtiss-Wright's modular approach to radar acquisition, processing and display means that many configurations (see Figure 1) are possible using common hardware and software. For example, the radar input card, processing software, graphics source and scan converter may all reside on the same host, providing a compact, self-contained radar head monitor.

Alternatively, the radar input card together with RVP software may form a server that distributes radar video to multiple clients, where each client produces its own graphics and scan-converts the radar video. It is even possible for the graphics source and scan converter to reside on different hosts.

Figure 1: Flexible Configurations



Analog versus Digital Radar Distribution

Many older multi-function console architectures have radar video distributed as analog signals to each console, where a radar interface board within the console then accepts the signal and digitizes it. This typically requires a switch-board or equivalent distribution unit to buffer a single set of signals from a radar and provide multiple outputs to each of a group of consoles (Figure 2).

Analog distribution typically requires more hardware than the equivalent digital system. Analog systems also require more cabling and can be comparatively inflexible, because each console requires a direct wire to each radar source it may be required to display. However, Curtiss-Wright can offer a number of distribution and buffer products to support analog distribution of radar. These products can be combined into systems which provide a compact, straightforward distribution system which is both easy to install and simple to maintain. A digital approach to radar video distribution offers a number of important benefits over analog distribution. Firstly, each multi-function console receives a common radar format broadcast over a common communication link (Figure 2), so all information is available to all displays. In this way, each console has the flexibility to display different sensor types, without "pre-wired" constraints. This allows the console to accommodate additional or upgraded sensor types without itself being upgraded or re-wired. With the radar interface confined to being within a "radar video server(s)", consoles can be upgraded or changed independently of the sensors. Secondly, the cabling itself becomes much simpler with each radar video server and console being connected to a common (often dedicated) Ethernet network to which additional consoles may readily be added.

Curtiss-Wright's approach to digital radar video distribution is to use a client-server architecture, at the heart of which our RVP software provides control of the radar input hardware, and the compression and network distribution function. On the display side, the radar video may be decompressed, scan-converted and displayed in a multi-function console, based on VME, PMC or PCI products. A typical digital distribution architecture is shown in Figure 3.

Figure 2: Analog vs. Digital Radar Distribution

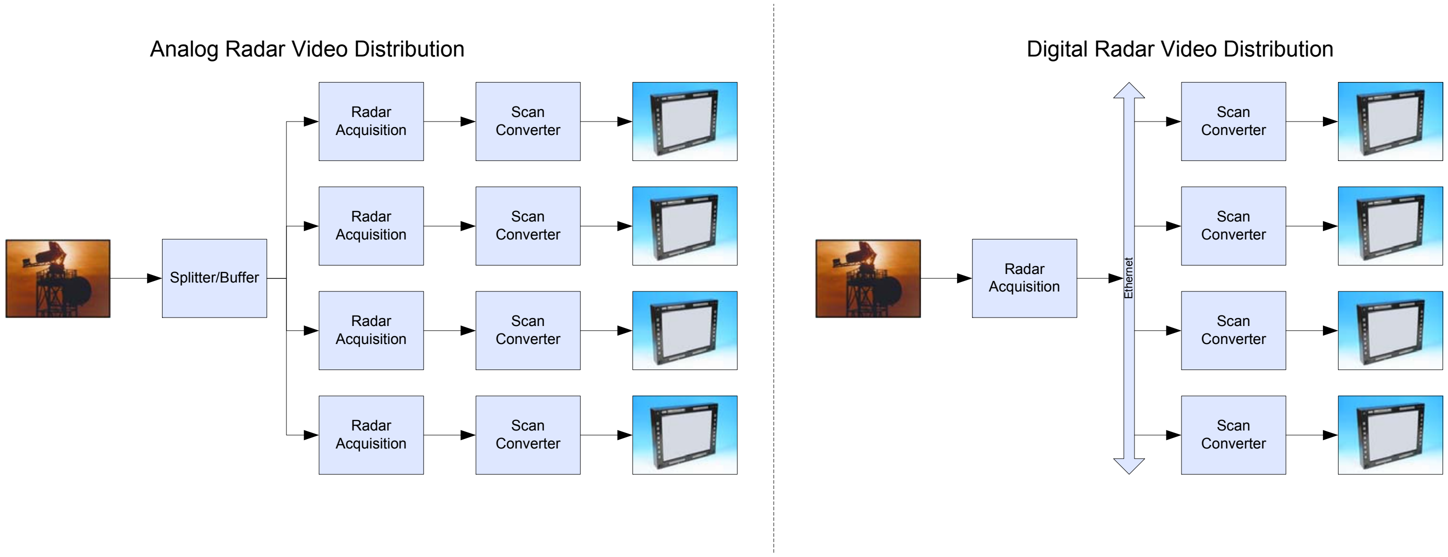
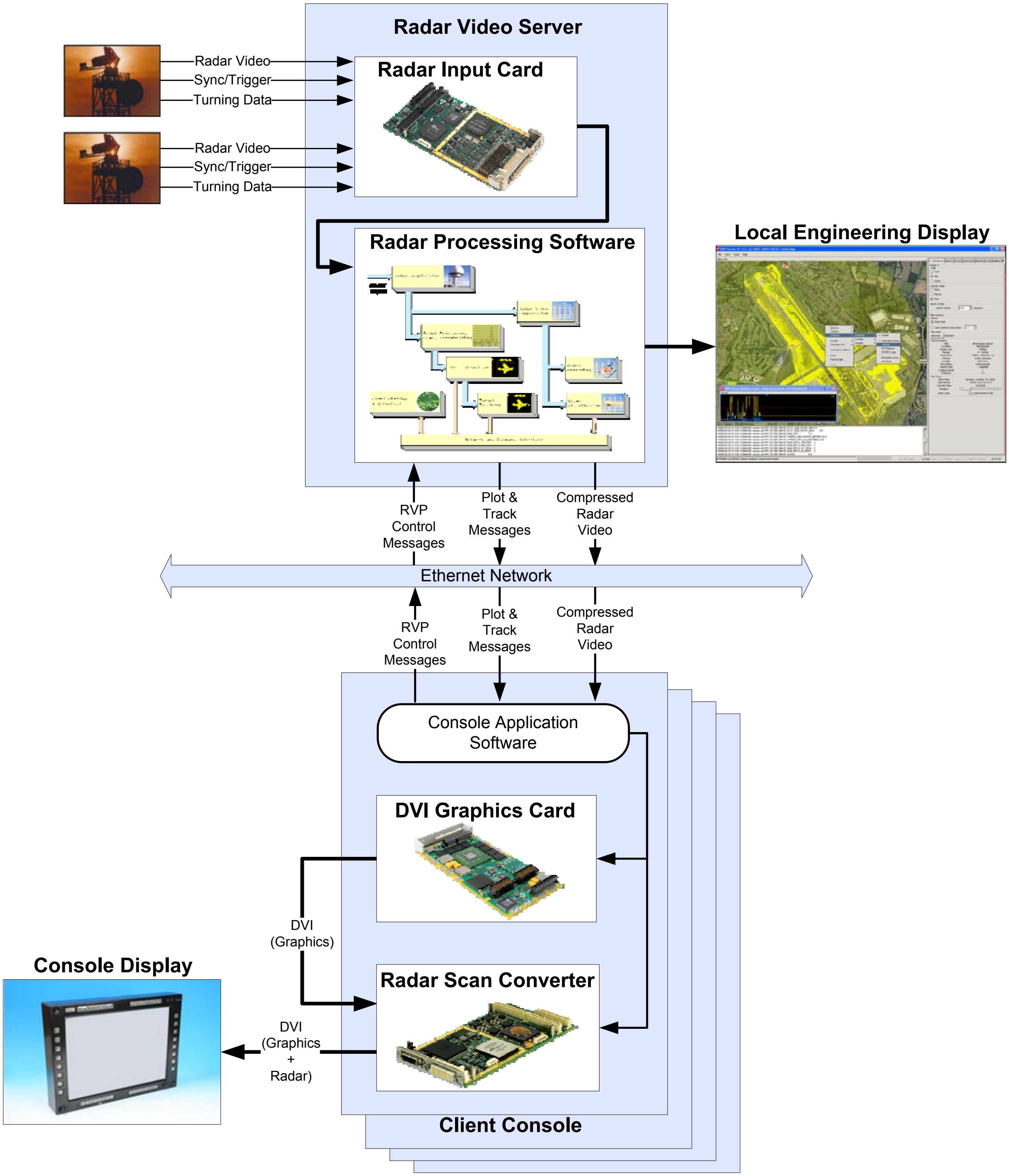


Figure 3: Typical Digital Distribution System



Radar Input

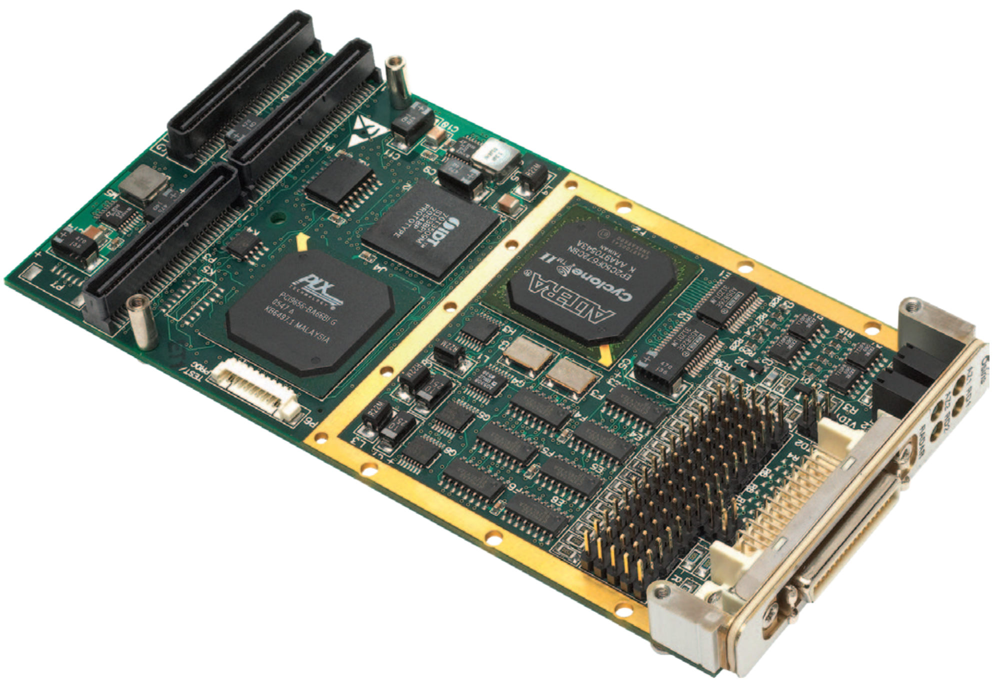
It is the function of the radar input card to interface directly to the video, sync and turning data signals from the radar, in order to digitize the radar video and tag it with an appropriate azimuth label. The output of these cards may then be passed into processing software or directly to a scan converter for display.

Curtiss-Wright's range of radar input cards, such as Osiris shown in Figure 4, accept a wide range of radar input types and characteristics. Digitized analog videos and digital inputs from the same antenna may be combined. The analog video can be sampled and pre-processed with, for example, input look-up tables, and gain and offset with range function before being passed to Curtiss-Wright's RVP software for processing.

Supported turning data types include:

- ACP/ARP
- Serial
- UYQ-21
- RADDS
- Parallel (e.g. 12-bit + 1 strobe pulse)
- Synchro/Resolver (via daughter board/additional hardware)

Figure 4: Osiris PMC Dual Channel Radar Input Card

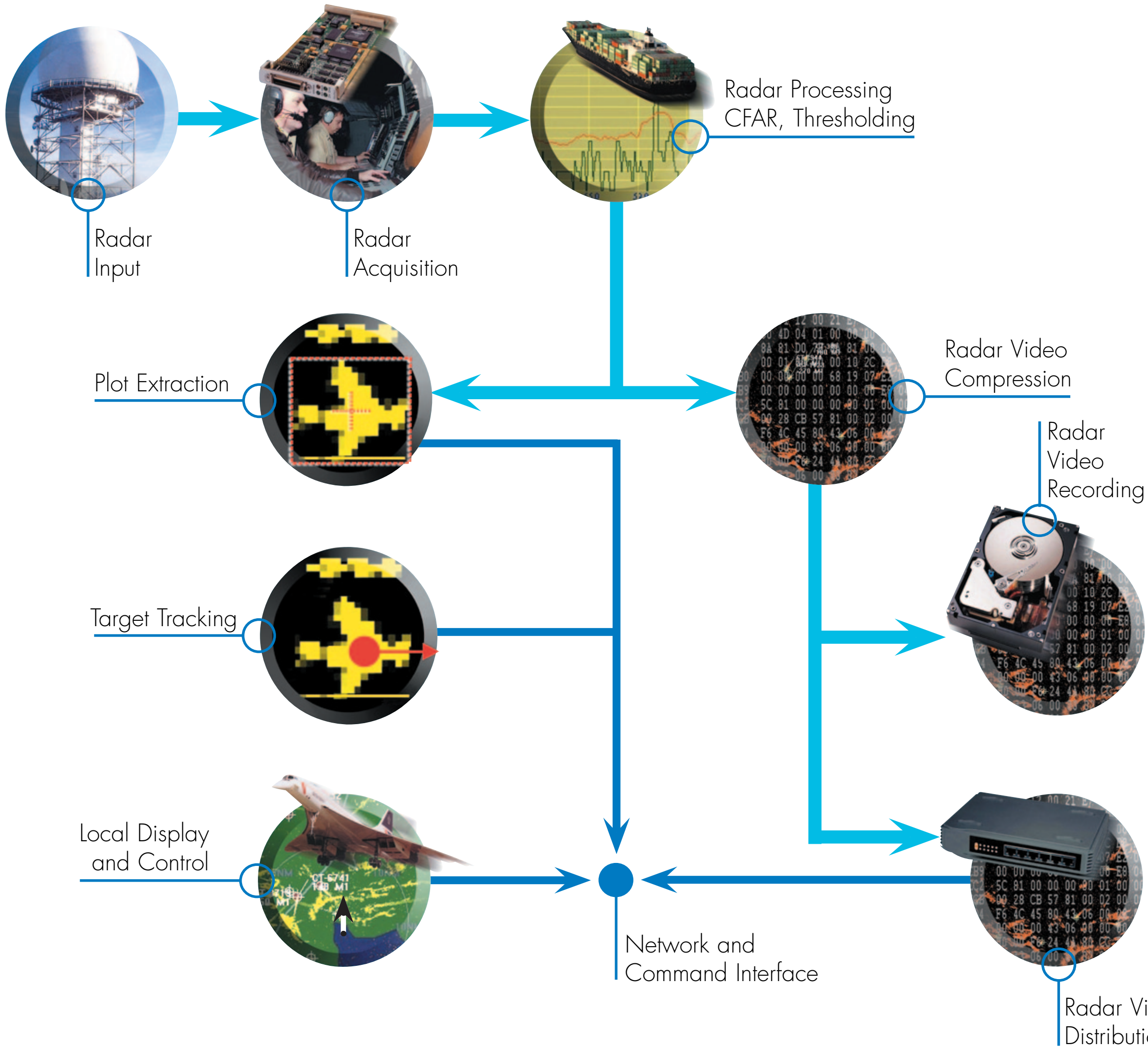


Radar Video Processor

RVP can be used to supply clients with a variety of radar data typically required in multifunction console displays. RVP packages primary radar data, track reports and status information as UDP messages and transmits them digitally over Ethernet. Radar video data is compressed using a proprietary Curtiss-Wright algorithm called RACE. RACE compression can be lossless and is also dynamically adjustable, allowing any network loading to be monitored and controlled.

RVP provides a number of possible functions, besides network radar video distribution, including plot extraction, tracking and recording (Figure 5), and also gives users the option of a local "engineering" display at the server itself. Systems built using RVP may readily be upgraded to add these additional functions.

Figure 5: RVP Processing Pipeline



Radar Compression

In order to provide the client consoles with the most flexibility in what they may display, it is desirable to transmit the radar data in its entirety in its native polar format. Transmitting polar format data gives each console the capability to construct a view that is appropriate for its operator's needs. Transmitting Cartesian format images has the benefit of requiring a single scan converter which may be centralized in the server, but at the same time severely limits the capability to present operators with independent views of the radar coverage.

A full polar-store (i.e. one revolution's worth of range versus azimuth data) of a long-range surveillance radar may typically require around 8 Mbytes of storage per scan. Some degree of compression of this signal can be achieved without loss, perhaps giving 4:1 compression. With a 15 rpm turning rate, this gives a compressed data rate on the network of 0.5 MB/s (~4 Mbps). Additional compression will offer reduced bandwidth, but this process must be sensitive to the possibility of critical data loss.

Curtiss-Wright's RACE coding scheme provides a run-length encoder. The compression function may be adaptive, so that changes in signal complexity (from high clutter areas for example) do not introduce excessive latency into the distribution process. RACE may be configured for lossless coding of polar-stores, or may pre-process the data to increase the compression ratio at the expense of some data loss. RVP servers may even transmit clutter-processed or thresholded video, instead of the raw, unprocessed video, to further reduce network bandwidth usage.

Radar video is processed and distributed in programmable sector sizes, which may be as small as a single azimuth spoke. This ensures that when the video is reconstructed for display on the client, the display updates can give a smooth updating sweep that closely follows the antenna with the least possible latency.

Radar Scan Converter

When the compressed radar data reaches the client console, it may be decompressed to reconstruct the polar-format data. From here, it may be scan-converted to a high-resolution display with integrated graphics and, optionally, a number of video windows. Curtiss-Wright offers a range of products to provide the heart of a multi-function console. The latest scan conversion hardware, Eagle-2, is shown in Figure 6.

Figure 6: Eagle-2 PMC Radar Scan Converter Card

The role of the scan converter is to transform captured radar video from polar to Cartesian format, suitable for a standard raster graphics display. The basic scan conversion process is depicted in Figure 7. All of Curtiss-Wright's scan conversion products use algorithms which ensure that there are no holes in the displayed image, even when zoomed in, and no missed targets, even when zoomed out. All of Curtiss-Wright's scan converters feature the ability to control common aspects of the radar presentation such as fade rate and radar color.

The scan converter places video from the graphics source as either an underlay or overlay with respect to the radar data, in one or more display windows. The scan converter can simultaneously mix multiple input sources with digital graphics, and display the result in a number of distinct windows on a standard display. In the case of hardware scan conversion, digital graphics are fed into the scan converter card through a standard DVI-D input cable where they are mixed, using a unique keying technique, with the radar data by the scan converter.

In addition to continuously rotating antennas, input can be taken from sector-scan, reverse-scan and random-scan phased-array antennas. Data can be displayed in the usual PPI format, A-scan and B-scan formats. A typical video output from a scan converter is shown below in Figure 8. In this example, scan-converted radar data is programmed to be displayed in orange and green. The resultant video is displayed in two PPI windows, although multiple input sources and multiple display windows are supported.

Figure 7: Scan Conversion Process

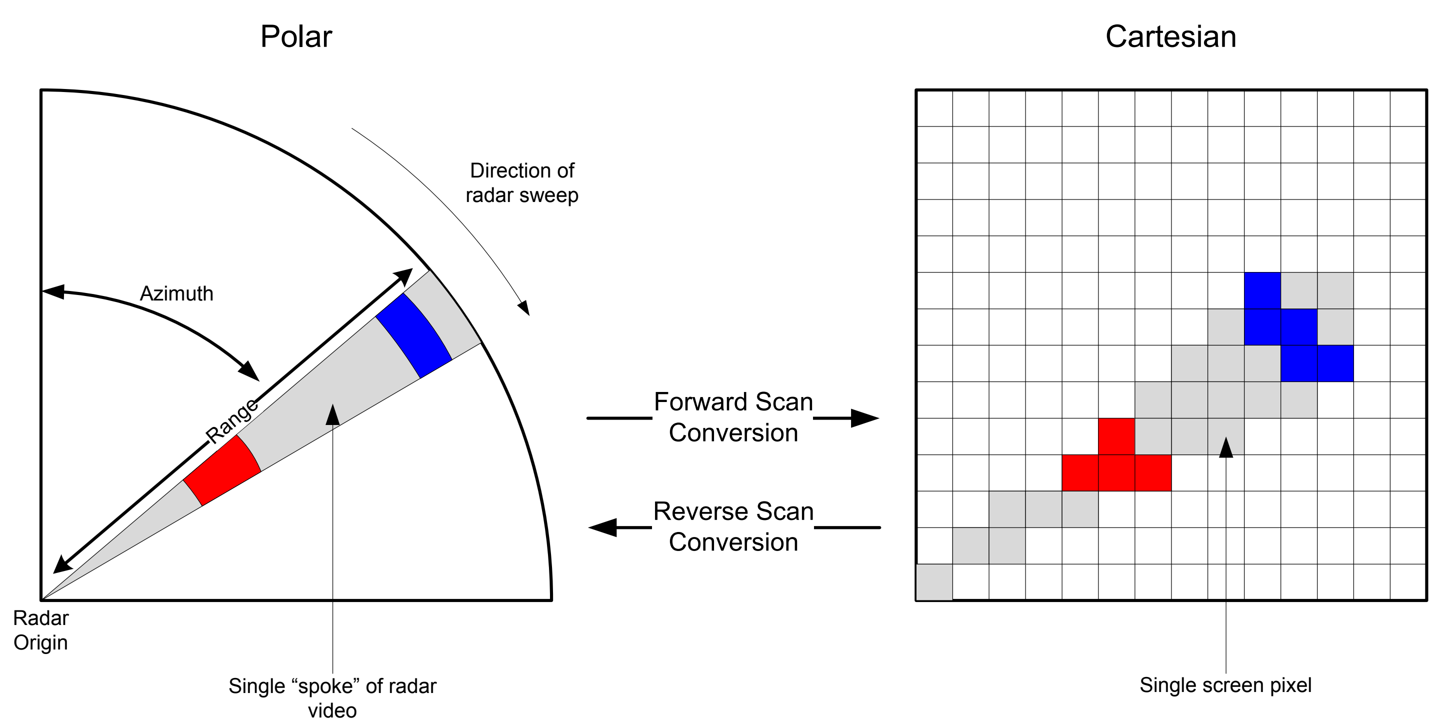
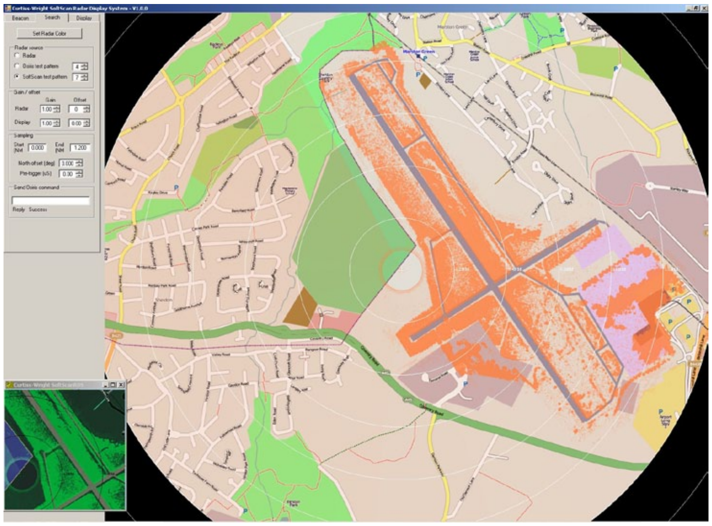




Figure 8: Typical Scan-Converted Radar Display



SoftScan versus Hardware Scan Conversion

SoftScan is a leading-edge high-performance software scan conversion solution which utilizes OpenGL® 2.0 graphics acceleration, to exploit the processing power available on modern commercial graphics hardware. Unlike other software scan converters, this means that SoftScan has a very low CPU usage, since the scan conversion algorithms run largely on the graphics processing unit (GPU).

In terms of polar store sizes and rotation rates supported, SoftScan performance already exceeds that of current dedicated scan conversion hardware. As GPU performance increases so will the actual capability of SoftScan. The graphics card typically does not care where each radar display is drawn, meaning that for graphics cards which provide dual head output, scan-converted radar may be drawn on either or both heads.

Table 1: Comparison of Hardware and Software Scan Conversion

Hardware	Software
◆ Software compatibility with previous generation solutions ◆ Easy integration with graphics (de-coupled architecture) ◆ Graphics library type and version independent ◆ Only requires DVI-D source	◆ GPU-acceleration provides equivalent or higher performance compared to hardware solution ◆ Supports display on high-resolution monitors with no effect on scan conversion performance ◆ Runs on COTS hardware ◆ Requires OpenGL 2.0 compatible GPU hardware ◆ Cost-effective solution

Thin Clients

The ultimate thin-client console comprises a high-performance general purpose processor, a display card and a network interface. With a high capacity network carrying command and control information and sensor data streams, coupled with sufficient processor power to handle the decoding and display of the sensor data, such a console provides an ideal combination of performance and ease of maintenance.

Curtiss-Wright has a fully software-based solution for the thin-client console. Based on our SoftScan radar scan converter and embedded RACE decompression software, the functions of an integrated multi-layer console with multi-channel radar video may be implemented. With compressed radar video distributed across a network, the console is able to decompress, scan-convert and support the expected map and target display functions of a console. The physical footprint of this solution may be no more than a single VME slot, with a corresponding increase in reliability and reduction in power, heat and maintenance. Alternatively, a standard PC-based platform with a commercial graphics card can provide a basis for a very low-cost, highly functional radar display console.

Summary

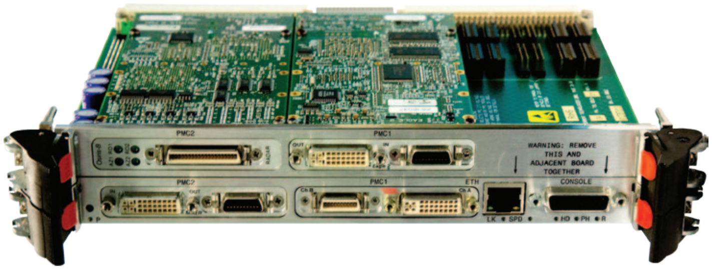
Curtiss-Wright's line of hardware and software products offers a modular and flexible solution for a range of requirements for the acquisition, distribution and display of radar video. Curtiss-Wright's radar acquisition, processing and display products have been extensively used in a number of different roles, including ship-based console display systems for navies and coast guards, land-based coastal surveillance systems and air traffic control (ATC) centers. These systems embrace a range of different sensor types in the server, and support flexible client display options, including multi-head high-resolution console displays, and cost-conscious PCI displays.

Curtiss-Wright can provide the libraries and APIs necessary for writing applications which receive, decompress and display radar video data. Alternatively, we can provide a complete COTS RVP client display solution, tailored to meet specific requirements.

Case Study

A recent application, targeted at an ATC upgrade in a naval environment, called for a VME-based radar acquisition, scan conversion and graphical display subsystem for display on high-resolution 2k x 2k monitors. Curtiss-Wright's solution offers high-performance from a flexible modular design, based on a single SBC and a set of PMC/XMC cards. The Osiris PMC radar input card provides two channels of high-resolution radar digitization coupled with additional digital radar video inputs. The captured radar video is transferred across the PMC/PCI interface to the processor and then sent to the Eagle-2 scan converter, which generates PPI and Ascan (used within display for precision approach) displays. The system's graphics capability is provided by the XMC-710 dual-head display controller. In this case, the two heads of the XMC-710 are combined by a PMC-285 video mixer card to form a single 2k x 2k display with overlay and underlay capability. The Eagle-2 combines its own scan-converted displays with the output of the video mixer to present a single dual-link DVI-I video output to the console's monitor.

Figure 9: A Cougar Used in a Naval ATC Upgrade



The resulting system is compact, occupying just two VME slots, and provides the customer with a modified COTS solution with well-defined hardware and software interfaces, and leading-edge scan conversion and display capabilities. The system can also be upgraded to include Curtiss-Wright's RVP radar processing technology that can add additional processing, plot extraction and tracking capabilities, as required.

Warranty

This product has a one year warranty.

Contact Information

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