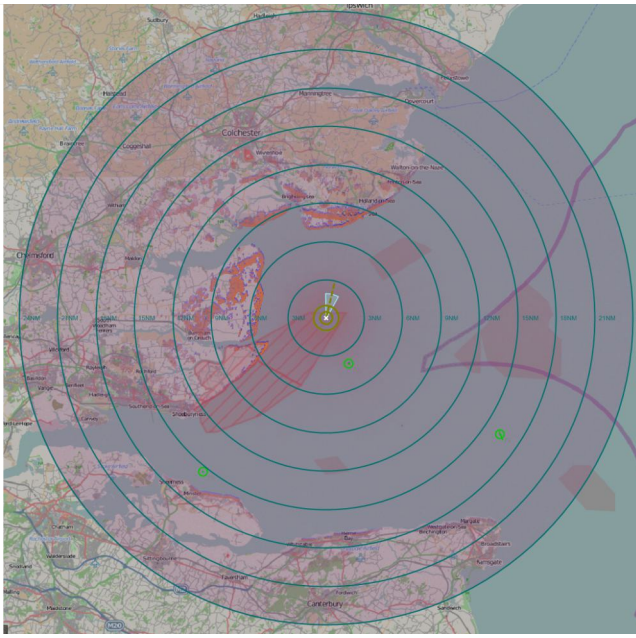
USV Sensor Processing

Sensor Processing, Distribution and Display for Uncrewed Surface Vessels (USVs)



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USV Sensor Processing

Uncrewed Surface Vessels (USVs) are a rapidly expanding area of interest for navies and commercial enterprises around the world. Cambridge Pixel is a provider of technology components for USV development, and has partnered with some of the key USV developers and manufacturers across the US, Europe and Asia.

A USV may incorporate a number of sensing technologies to assist with navigation, collision avoidance and target recognition. Cambridge Pixel's expertise and products for radar processing provides a core set of capabilities for USV developers, including:

- Radar interfacing and control options to a wide range of maritime and specialist radars
- Target tracking and video distribution using a highly configurable ARPA target tracker
- Camera control from radar, slew-to-cue and video-based tracking
- Camera video distribution from ship to shore
- GPS spoofing detection and GPS-Denied Autonomous Navigation
- Track correlation from multiple radars and auxiliary data such as AIS and cameras
- Mission recording of radar video, tracks, AIS, camera video and navigation data
- C2 Display applications for remote monitoring and control
- Simulation and training

Radar Interfacing and Control

Various radar sensing options are available for USVs, depending on the size of the craft and the nature of the mission. Maritime radars, such as those from Simrad, Furuno and Raymarine, provide a situational awareness capability with target detection out to 5NM or more. Larger craft may be fitted with larger radars to provide enhanced detection range or resolution. Cambridge Pixel's products support most commercially-available radars, either as a standard network interface (ASTERIX CAT-240) or one of the proprietary standards from Simrad, Furuno or Raymarine, or using a hardware capture product, such as HPx-346, to input radar signals.

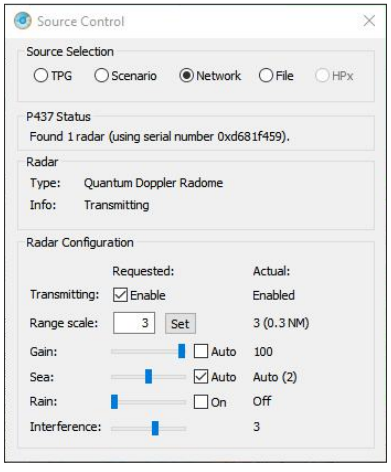
Cambridge Pixel's combination of software modules and HPx radar input cards handles most radar types from the smallest commercial maritime radars to high-end specialist surveillance radars from Hensoldt, Sperry Marine, Raytheon, JRC and Terma. For new radar types Cambridge Pixel is able to implement new import modules for custom interfaces.

With Cambridge Pixel's modular product range it is straightforward to change radar types in a deployed solution. This permits a common software processing platform to be deployed, with different radars used for different situations.

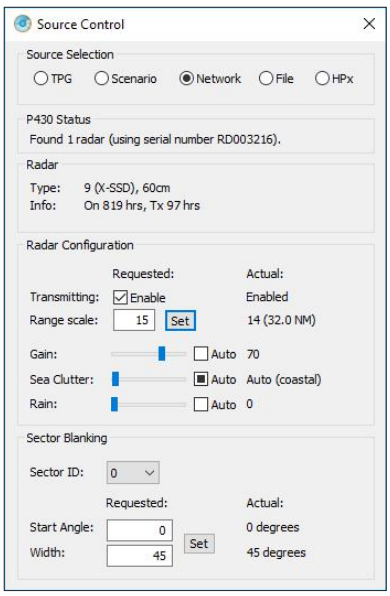
Cambridge Pixel has interfaced to numerous radars using our HPx range of radar interface hardware or directly via a network connection.

Cambridge Pixel has partnerships with leading manufacturers such as Simrad and Furuno, allowing inexpensive network radars to be 'unlocked' and controlled.

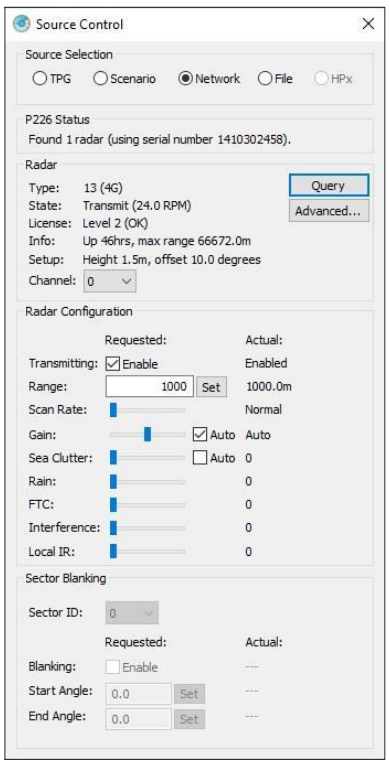
Radar-specific control panel software displays status information and provides controls such as gain, sea and rain clutter, and range scale. Control panels for supported radars are built into SPx Server, and SPx library objects are available to allow developers to implement their own.



Raymarine control panel

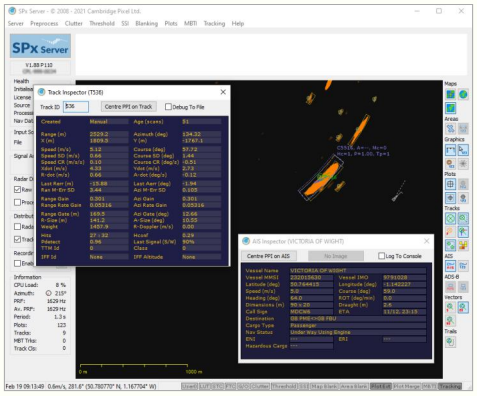


Furuno control panel



Simrad control panel

Target Tracking and Video Distribution



Radar video is processed by Cambridge Pixel's SPx Tracking Server software, which provides a full chain of processing, plot extraction, acquisition (automatic and manual) and target tracking. Navigation data from the craft in NMEA format is input to SPx Tracking Server to provide information on the boat's heading, course and speed. SPx Tracking Server then processes the radar video to identify targets of interest.

A multi-hypothesis tracker (MHT) is used to maintain tracks with the sweep of the radar. There is considerable flexibility to configure the tracker to detect and track a wide range of target types, including very small targets, provided they are visible in the radar video.

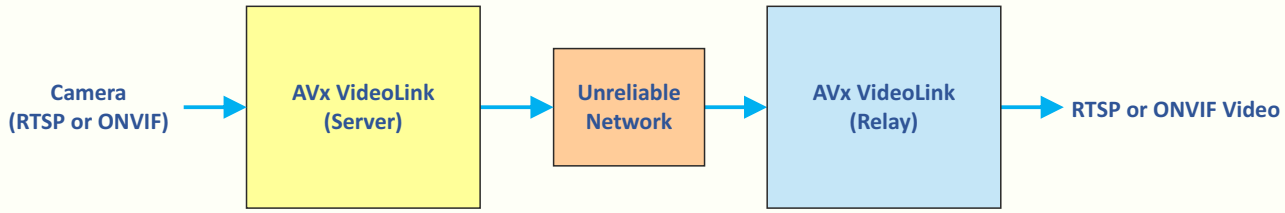
Parameters of the track processing can be used to control the speed of detection, area of interest, track dynamics and filtering. The output of the processing is track reports which may be distributed off the boat using normal communications methods, and/or used by further processing on the boat - for example, for collision avoidance or navigation.

Camera Control and Slew to Cue

Control EO/IR Camera Systems with PTZ to direct the camera at tracks (radar, AIS or fused) using SPx Camera Manager. Direct cameras to a specific selected track (slew-to-cue), or continuously cycle through a list of tracks. Camera control can be handed over to third-party video tracker systems to keep the target in the camera view automatically.

Camera Video Distribution

Minimise the corruption of camera video over IP datalinks with low, unreliable or variable data bandwidth, by using AVx VideoLink. Based on rates of packet loss and datalink latency, AVx VideoLink automatically adjusts the encoding parameters of the video to ensure a resilient video feed is maintained.



GPS Spoofing Detection and GPS-Denied Autonomous Navigation

For reliable navigation in GPS-denied environments, radar-only navigation positioning is provided by GPS Assist. GPS Assist continuously models the expected radar image and compares the modelled image to the live radar picture. Significant differences in the two images indicate GPS spoofing or jamming, and GPS Assist, (working in conjunction with an Inertial Navigation System, if available) will then provide radar-only positioning as an alternative to GPS.

USV Operational Building Blocks

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AIS Receiver

Analogue

Digital

Digital

Motion Stabilisation + Nav Data (NMEA)

Acquisition, processing and target tracking

SPx Tracking Server

Data Fusion

SPx Fusion Server

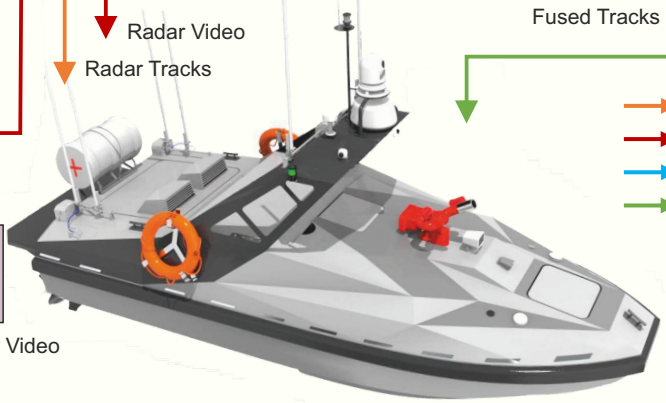
Radar Video

Radar Video

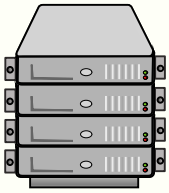
Radar Tracks

Fused Tracks

GPS Assist



Mission Recording
RDR
Data Recorder



SPx RadarLink

Radar Video

Video Tracking

Wireless Data Link

Slew-to-Cue (camera controlled from radar tracks)

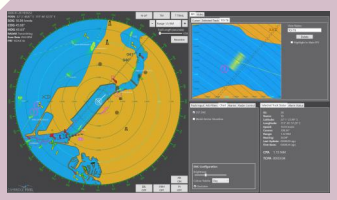
SPx Camera Manager

Video

AVx VideoLink

Ground station or mothership

MDF

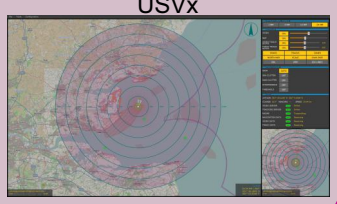


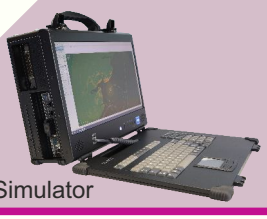
Control

Video

C2 Display Applications

USVx



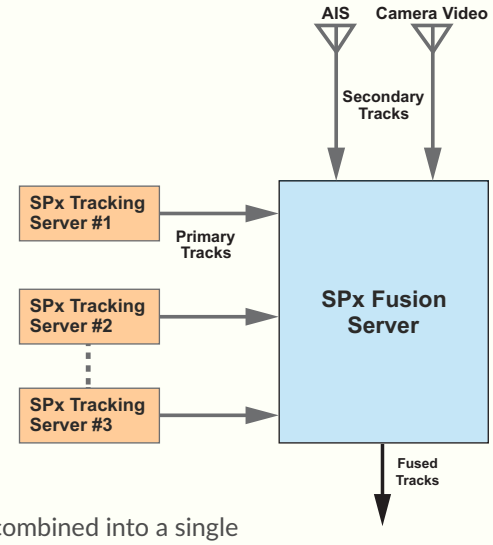


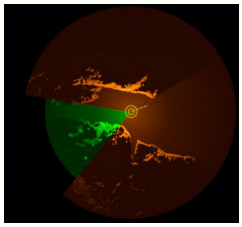
SPx Radar Simulator

Cameras

Track Correlation and Radar Video Combining

SPx Fusion Server is able to combine radar tracks with auxiliary data such as AIS. For larger boats with two radars, SPx Fusion Server can combine the two radars into a single track stream. The fused track combines the attributes of the input tracks and may be reported to a navigation or C2 system using ASTERIX standards and/or used for local camera control (slew-to-cue).





For situations where two radars need to be combined into a single video stream, Radar Video Combiner is available to merge two independent and unsynchronised radar videos.

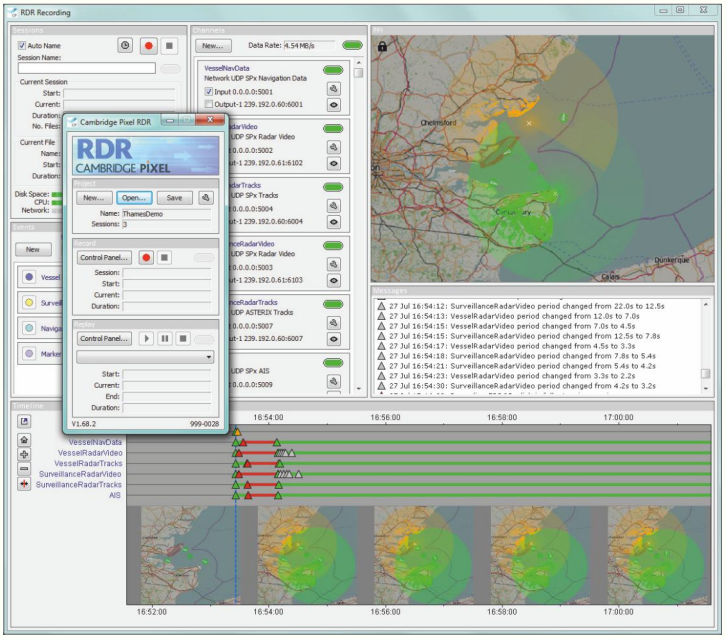
Full Mission Recording with RDR

Cambridge Pixel's RDR Data Recorder is a multi-function data recording application that is able to capture and time-synchronise a wide set of data streams, including:

- Radar video from the sensor or from SPx Tracking Server
- Radar tracks (from SPx Tracking Server or SPx Fusion Server)
- NMEA Navigation data from the GPS unit or from SPx Tracking Server
- AIS reports (NMEA)
- Camera video (direct from the sensor)
- Network data (any other data stream that is provided in a network format)
- Events (errors, status changes, alarms)

The software can be configured to continuously record all mission data, allowing full analysis of the data off-line when the mission is complete. The duration of the recording is limited only by disk space.

The recording process can be configured to operate in the background with no intervention, or it may be incorporated into a control system to permit recording on specific events or on demand from a remote mothership.



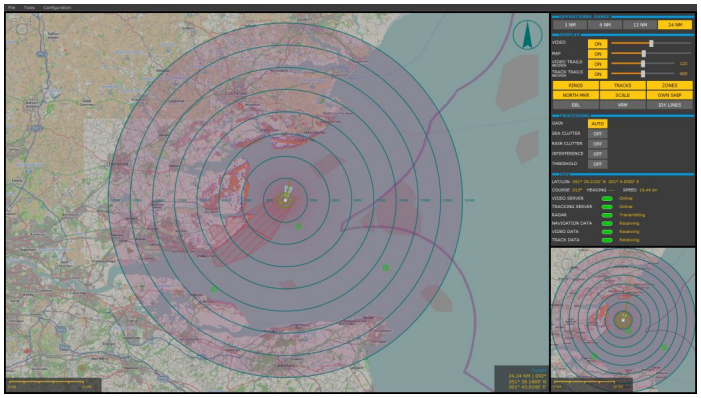
RDR is a Windows-based multi-channel, multi-format data recorder.
It can be used to capture all sensor data during trials for replay and analysis.

C2 Display Applications

Information may be transmitted from the USV to a mothership or ground station. Where it is desired to display the USV-derived data on that station, Cambridge Pixel offers a number of display application options. These range from standard applications, including USVx and MDF, which provide a display of primary radar, tracks and map, through to development packages to support customised displays. In this situation, Cambridge Pixel can provide a full toolkit of software components for radar video, tracks, AIS and map display.

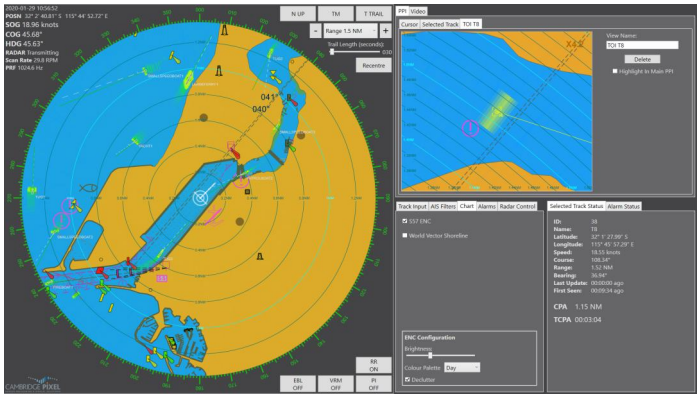
Customised or semi-customised applications can be provided by Cambridge Pixel incorporating any combination of radar video, tracks, AIS, map data, camera video and other sensors.

Radar control is typically integrated into the C2 display to allow the operator to control the radar remotely, adjusting settings and selecting the appropriate operating modes.



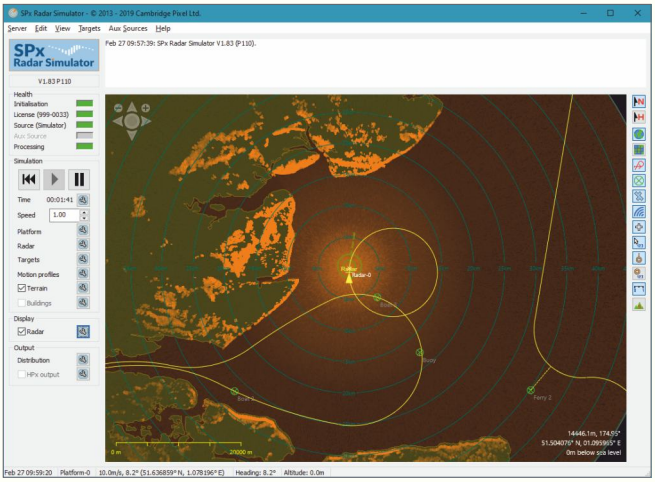
USVx is a mothership/ground station client-side application, available as an executable or development package, which provides a remote display of radar video, tracks, AIS and radar status.

MDF is a maritime client-side application, available as an executable or development package, which provides a remote display of radar video, charts, AIS, tracks and radar status.



Simulation and Training

SPx Radar Simulator combines a scenario generator and a set of output modules to convert complex real-world scenarios into representative data streams, including ASTERIX CAT-240 video, ASTERIX CAT-48 tracks, AIS, NMEA navigation data. These data streams may be input into production-ready hardware for system testing, or may be used as part of a training scenario. SPx Radar Simulator is available as a Windows software application or may be provided as part of a package with a radar signal output card (such as the HPx-310).



Product Summary

Product	Description	Part Number
HPx-346	Analogue radar to network converter.	346-110
HPx-410	PCIe radar input card.	428-110
SPx Tracking Server	Radar processing, plot extraction and target tracking.	110-703 (Windows) 110-702 (Linux)
SPx Fusion Server	Fuses multiple radars and/or radar with AIS.	110-780 (2 sensors) 110-781 (4 sensors)
RDR Data Recorder	Data recorder application for radar, tracks, camera video, NMEA and network data.	266-500
AVx VideoLink	Encoder/decoder for camera video distribution over unreliable communications link.	425-500
SPx Camera Manager	Slew-to-cue control of camera from radar tracks.	356-105
USVx Display Application	A Windows-based display application available as an executable or Framework developer version.	305-500 (Runtime) 305-520 (Developer)
Maritime Display Framework (MDF)	A development package for creating customised user interfaces for the display of radar data, aimed at the maritime market.	438-500 (Runtime) 438-510 (Developer)
SPx Radar Simulator	Simulation of radar video, tracks, AIS and navigation for system testing and training.	110-590
Radar Video Combiner	Merges two streams of network radar video, combining them into a single, unified radar video output.	367-500
GPS Assist	Radar-based solution for GPS spoofing and jamming detection.	493-500

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