

# USV Sensor Processing

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



# 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 interface 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.

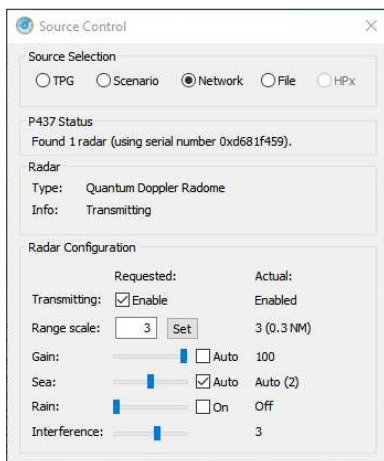
With Cambridge Pixel's modular product range it is straightforward to change radar types in a deployed solution. This permits a common software processing platform to be deployed, with different radars used for different situations.



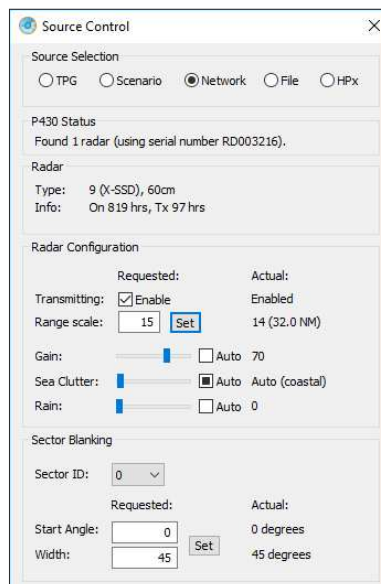
Cambridge Pixel has interfaced to numerous radars using our HPx range of radar interface hardware or directly via a network connection.

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

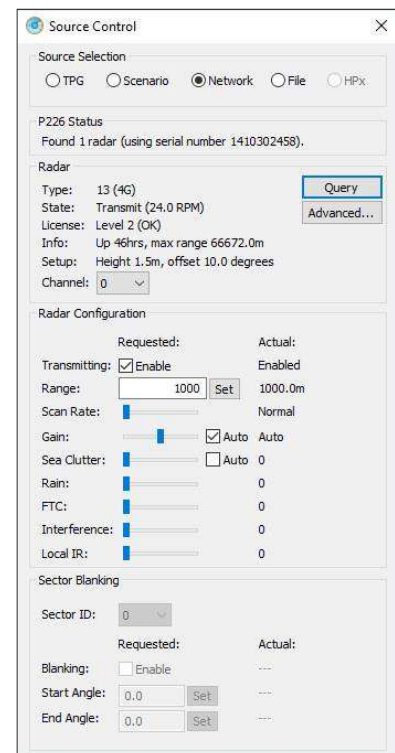
Radar-specific control panel software displays status information and provides controls such as gain, sea and rain clutter, and range scale. Control panels for supported radars are built into SPx Server, and SPx library objects are available to allow developers to implement their own.



Raymarine control panel



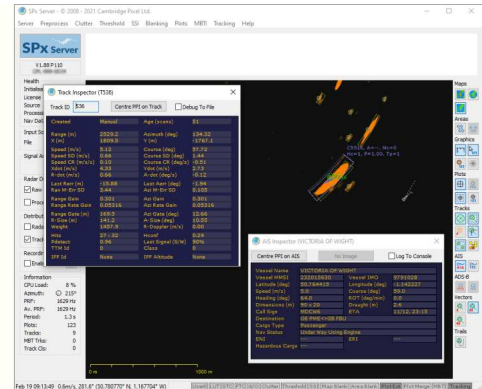
Furuno control panel



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.

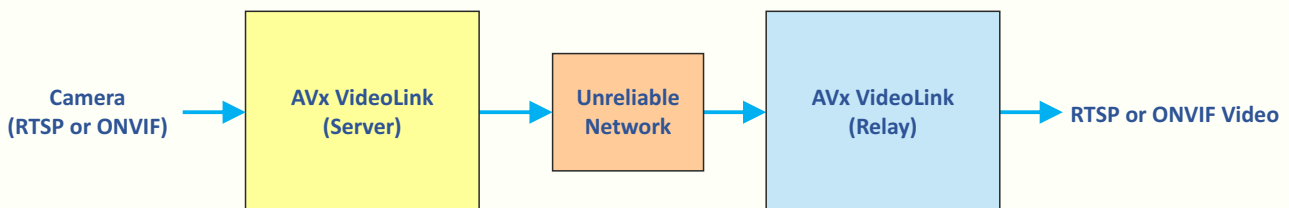
# Camera Control and Slew to Cue

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

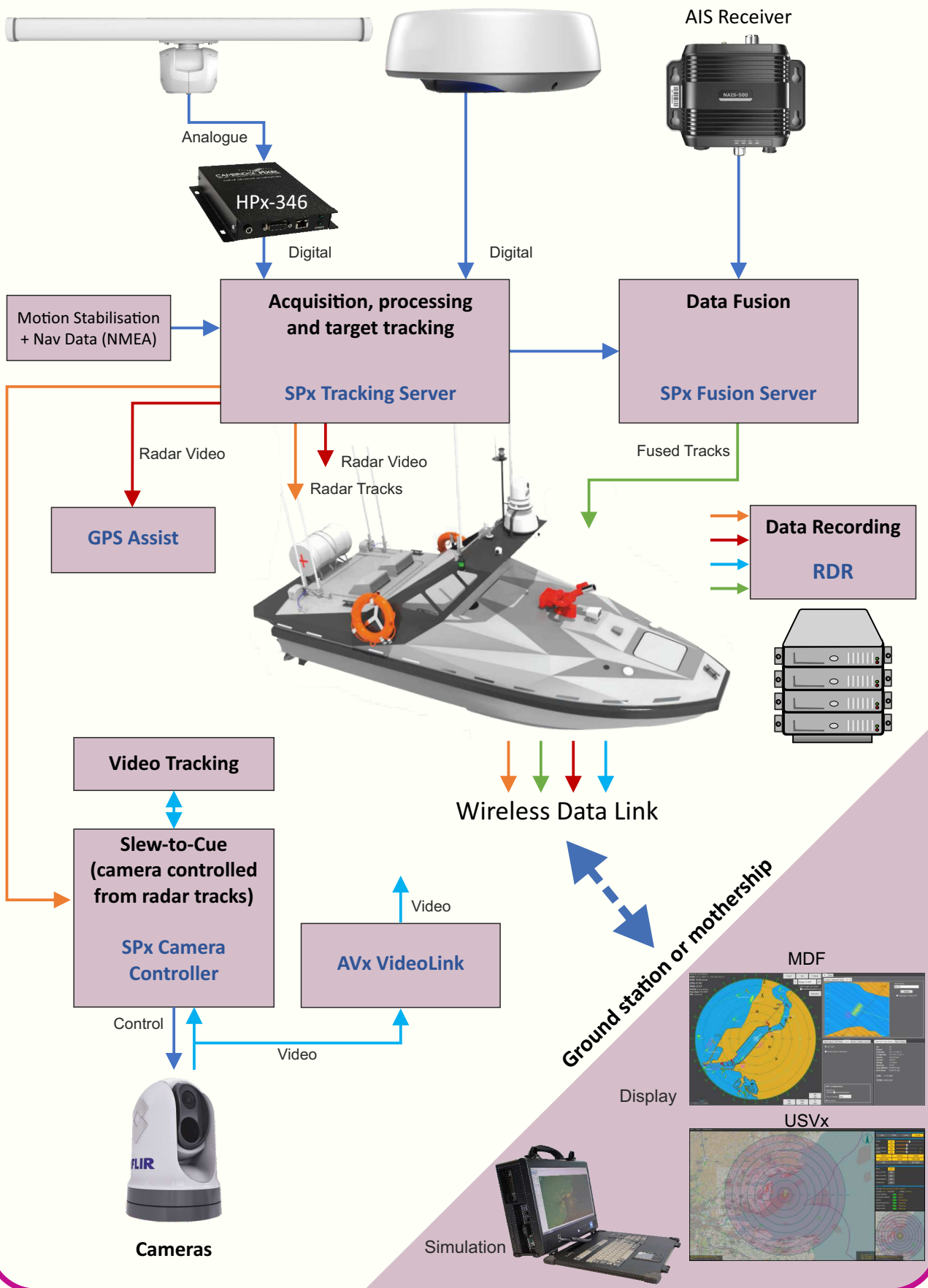
Minimise the corruption of camera video over IP datalinks with low, unreliable or variable data bandwidth, by using AVxVideoLink. Based on rates of packet loss and datalink latency, AVxVideoLink automatically adjusts the encoding parameters of the video to ensure a resilient video feed is maintained.



# GPS Spoofing Detection and GPS-Denied Autonomous Navigation

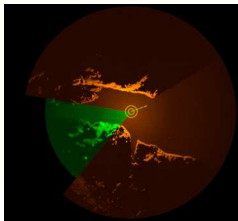
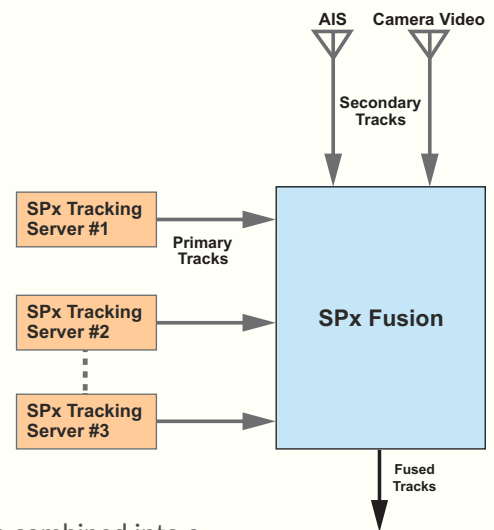
For reliable navigation in GPS-denied environments, radar-only navigation positioning is provided by GPS Assist. GPS-Assist continuously models the expected radar image and compares the modelled image to the live radar picture. Significant differences in the two images indicate GPS spoofing or jamming, 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 Operation Building Blocks



# 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).



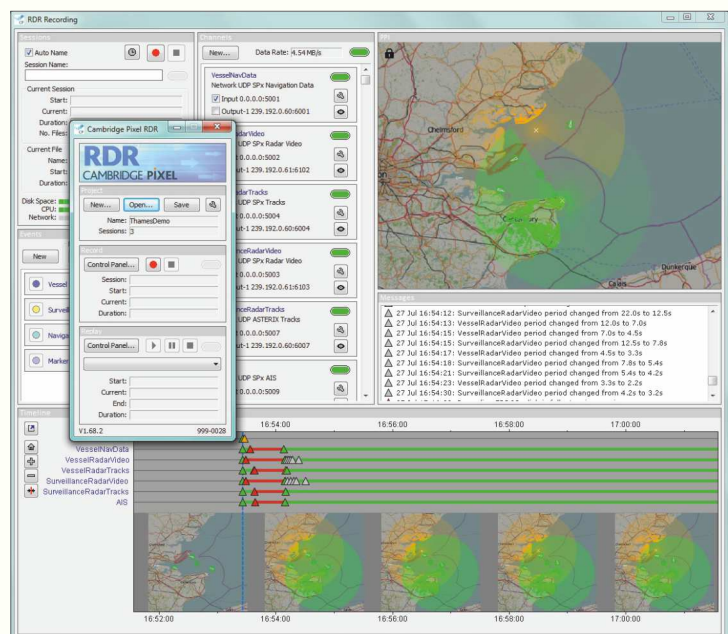
For situations where two radars need to be combined into a single video stream, SPx Radar Video Combiner is available to merge two independent and unsynchronised radar videos.

# 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.



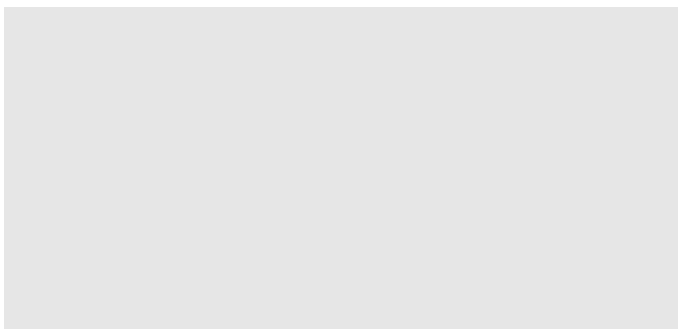
The recording process can be configured to operate in the background with no intervention, or it may be incorporated into a control system to permit recording on specific events or on demand from a remote mothership.

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.



## Product Summary

Product	Description	Part Number
HPx-346	Radar signals to network converter unit.	346-110
HPx-410	PCIe card for radar signal interfacing.	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 Video Link	Encoder/decoder for camera video distribution over unreliable communications link.	425-500
SPx Camera Control	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)
SPx Maritime Display Framework	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
SPx Radar Video Combiner	Merges two streams of network radar video, combining them into a single, unified radar video output.	367-500
SPx GPS Assist	Radar-based solution for GPS spoofing and jamming detection.	493-500



  
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