PTCP-SARAHAI: Buffer-Safe Physical AI for Air-Domain Awareness

Radar + EO/IR fusion, PTCP low-latency governance, and SARAHAI operator intelligence for Barksdale-like UAS scenarios

Passive / advisory | air-gap-ready | buffer-safe

Detect. Track. Cue. Prove.

Prevent a drone incursion from becoming an awareness failure.

PTCP-SARAHAI transforms high-volume radar, EO/IR, video, network, and operator telemetry into a coherent physical-AI state. It protects the metadata that matters most - fused tracks, confidence, covariance, and PTZ cue commands - while shaping bulk video and evidence before defensive networks become overwhelmed.

Passive / advisory | **RF-independent kinematics** | **UAS swarm aware** | **Buffer-safe hot path**

What it solves

UAS/UAP detection latency, RF-silent drone tracking, stale PTZ cues, packet-drop/bufferbloat, fragmented evidence, and operator overload during multi-vector swarm events.

How it helps

Prioritizes tracklets and cue metadata; fuses radar and EO/IR; predicts target motion during slew; visualizes 2D, horizon, and 3D airspace; preserves audit-ready evidence.

What it is not

Not a jammer, interceptor, cyber-effect tool, kinetic system, or autonomous countermeasure. Live PTZ movement remains gated, logged, and fail-closed.

Barksdale lesson

Unauthorized drone activity can stress both the air picture and the defender network. PTCP-SARAHAI focuses on current track state, low-latency cueing, and after-action proof.

Barksdale-like scenario: convert surprise into measured state

DETECT

Radar + EO/IR ingest
RF-independent kinematics

PRIORITIZE

P1 tracks + P2 cues
P3/P4 video shaped

TRACK

Autonomous PTZ dry-run
stale-cue prediction

PROVE

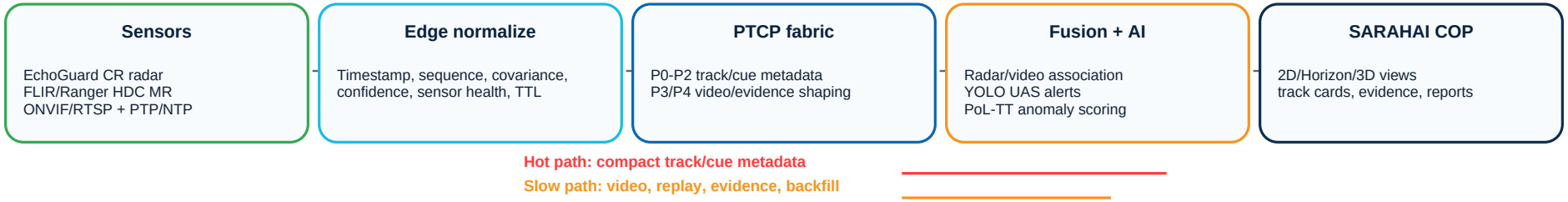
Track history + clips
OSI/BDOC proof pack

Effect: fewer blind spots, fewer stale cues, better evidence continuity - not a kinetic or jamming function.

Reference Architecture: Hot-Path Track State + Slow-Path Evidence

Edge normalization, priority lanes, track fusion, and operator-centric SARAHAI workflows

Reference architecture: hot-path track state + slow-path evidence



PRIORITY LANES

Lane	Purpose	Examples
P0	Safety / control health	Heartbeat, time sync, critical health
P1	Fused track state	Track ID, position, velocity, covariance, TTL
P2	Cue-to-slew	PTZ dry-run command, target motion during slew, lock/reacquire
P3/P4	Preview + evidence	Bounded preview, ROI video, replay, vault replication

Multi-sensor fusion

EchoGuard CR radar and FLIR MK 2 / Ranger HDC MR EO/IR observations become covariance-bearing tracks.

Autonomous PTZ cueing

Radar-to-camera assignment, pan/tilt/zoom dry-run commands, slew timing, deadband/FOV checks, and fail-closed gates.

YOLO UAS awareness

Approved local model path with hash checks; red UAS/UAP boxes and yellow context boxes with probability labels.

2D / Horizon / 3D

2D map, horizontal look-out, and 3D airspace views share the same mission truth and preserve operator selections.

PTCP governance

PoL-TT anomaly scoring, queue-aware link pricing, CVaR routing, and P1/P2 reservation under burst load.

Evidence and AAR

Local-first vault, trace hashes, operator acknowledgements, OSI/BDOC case packages, and replay-based validation.

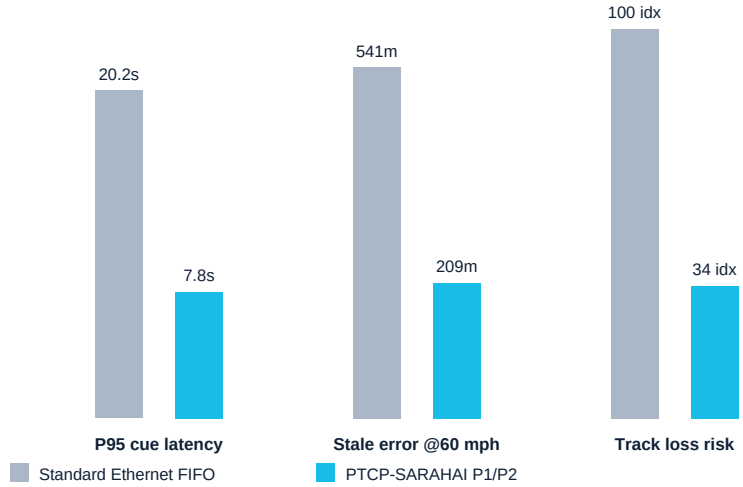
Barksdale-Type Resilience: Prevent Defender-Side Failure

The product cannot guarantee drones never appear; it can help prevent late, fragmented, or stale awareness.

How PTCP-SARAHAI could change the outcome

Multi-wave arrival	Sector-sharded track IDs, group hypotheses, and swarm centroid rather than one overloaded sensor view.
RF silence / weak RF	Radar/EO/IR kinematics and optical-flow confirmation remain available without signal exploitation.
Camera fan-out	P2 cue commands are protected; video preview drops to ROI/keyframe/snapshot if the network tightens.
Evidence storm	Raw clips and replay remain local-first; hashes verify later replication without starving track state.
Operator uncertainty	Track cards show confidence, covariance, TTL, source sensors, detection probability, and alternatives.

Modeled planning target: cue-to-slew under swarm load



Planning target - field validation required.

Public Barksdale lesson for product design

Official Air Force public information confirmed several unauthorized drone incursions at Barksdale beginning March 9, 2026; public reporting also described multiple waves over sensitive areas. PTCP-SARAHAI uses that scenario as a stressor, not an attribution finding: the objective is to maintain current fused track truth, bounded PTZ cueing, and evidence continuity when many sensors, cameras, operators, and evidence jobs surge at once. [1][2][3]

- RF missing or unreliable -> kinematic radar/EO/IR fusion still works.
- Full video overwhelms links -> ROI/keyframes/slow-path evidence protect cue metadata.
- Operators see too much -> track cards, probability labels, alerts and 2D/Horizon/3D views simplify decisions.
- Investigation needs evidence -> trace-bound proof packs preserve metadata, detections, camera cues and operator actions.

Deployment, Boundary, and Dual-Use Applications

Single-server, edge/cloud, or air-gapped deployment for defense and critical infrastructure protection

Deployment datasheet

Primary mission	Buffer-safe Physical AI for air-domain awareness, UAS/UAP detection/tracking, BDOC/OSI reporting.
Sensors	EchoGuard CR radar; FLIR MK 2 / Ranger HDC MR PTZ EO/IR; ONVIF/RTSP; switch telemetry; PTP/NTP.
Core outputs	Fused tracks, covariance, confidence, TTL, cue-to-slew commands, probability labels, evidence packages.
UI/UX	2D Map, Horizon look-out, 3D Airspace, video wall, red/yellow boxes, alert/haptic rail, replay/simulation.
Deployment	Single high-end GPU server, edge server, multi-node personas, cloud, or air-gapped recorded-trace mode.
Safety boundary	Passive/advisory; no kinetic, jamming, spoofing, interdiction or ungated live PTZ actuation.

Dual-use commercial applications

Airports & airfields

Drone, wildlife, runway, perimeter, and FOD awareness.

Energy & utilities

Substations, power plants, pipeline facilities, and water assets.

Ports & rail yards

UAS, trespass, vehicle, and cargo-area safety monitoring.

Data centers

Perimeter awareness, unauthorized drone detection, and evidence retention.

Public safety events

Temporary airspace and crowd perimeter awareness.

Hospitals & campuses

Safety, critical access monitoring, and emergency response awareness.

Readiness Package and Validation Boundary

Measured deployment should be tied to approved traces, sensor SDKs, network telemetry, and ATO artifacts.

Recommended “next Barksdale” readiness package

Deploy as a measured, replayable validation program: certified EchoGuard/FLIR ingest, recorded-trace simulation, local YOLO model package, queue telemetry, P1/P2 latency metrics, PTZ cue dry-run/live comparison, OSI case-pack workflow, and ATO/RMF evidence bundle. This prevents the defender-side failure mode of stale tracks, overloaded video, fragmented operator views, and unprovable post-event records.

1. Instrument

Radar, EO/IR, switch queue, PTP/NTP, video ROI, operator actions.

2. Replay

Barksdale-like multi-wave traces, false positives, weather/clutter, bulk evidence storm.

3. Certify

P1/P2 latency, P3/P4 adaptation, sensor conformance, UI usability, zero trust.

4. Handover

BDOC/OSI workflows, training/AAR, sustainment, RMF/ATO artifacts.

Sources and validation boundary

[1] Air Force Global Strike Command, Fact Check: Barksdale Drone Incursion, 31 Mar 2026.
[2] ABC News, Multiple waves of unauthorized drones recently spotted over strategic U.S. Air Force base, 20 Mar 2026.
[3] PTCP-SARAHAI Buffer-Safe Multi-Sensor Air-Domain Awareness White Paper, 10 Jun 2026.
[4] SARAHAI-PTCP Sensor Fusion & Kinematic C-UAS Defense Integration SoW, 2026.
[5] PTCP paper: PoL-TT telemetry, risk-aware geodesic routing, D_topo, 2026.
[6] U.S. Patent No. 9,696,404 B1, Real-Time Camera Tracking System Using Optical Flow Feature Points.

Modeled performance figures are planning targets unless bound to approved hardware traces, sensor SDKs, switches, servers, time sync, and accreditation boundary.