



OAK DEFENSE — EW SUITE

Electronic-warfare, SIGINT & cyber training / analysis / wargaming platform — Technical Data Sheet

UNCLASSIFIED · ITAR-FREE
Representational / educational

Doc OAK-EWS-DS - Rev B
48 applications · v1.0

The EW SUITE is an **integrated software platform of forty-eight applications** spanning electronic warfare, SIGINT, EO/IR and cyber/CEMA. Each application pairs a quantitative 2-D analysis workspace with a model-driven 3-D view, and all share one scenario, one map and one auto-generated briefing. Outcomes are computed from **transparent, published physics and probability models**; cyber content is **conceptual** (risk / kill-chain / decision support) with no operational exploit content. Delivered as a single offline Windows executable.

APPLICATION MODULES & PRINCIPAL FUNCTIONS

Module	Function	Key parameters / outputs
1 · ECM	Jamming-effectiveness assessment	J/S, burn-through, noise & deception, technique × ECCM matrix; EW-101 dB link budget (self-protect / stand-off); radar EP/ECCM (agility, pulse-compression, coherent integration, burn-through, home-on-jam); over-water / two-ray propagation
2 · ELINT	Pulse analysis & Emitter Studio	PDW scoring / deinterleave (purity, completeness); multi-mode emitters, pulse groups, 16 trigger/sync flags; DF AoA; LPI / intra-pulse (CW/FMCW STFT); TDOA/FDOA geolocation (CEP); full OAK RX track-list parameters incl. FM-on-pulse deviation & slope ; 8-class intra-pulse LPI recognition (CW/LFM/NLFM/BPSK/Frank/P3/P4/Costas) & NLFM chirp-law estimation
3 · Radar	Echo generator + receiver	Pulse compression (Frank/Barker, PSL/ISL, compression ratio); Doppler/MTI; CA/OS-CFAR Pd/Pfa; range-Doppler map; A-scope; cognitive-radar toolset — adaptive dwell/resource allocation, adversarial-radar inference; advanced waveform design (low-ISL/PSL codes, spectral notch, orthogonal MIMO, matched-illumination)
4 · Threat Sim	PDW generation → instrument	Scenario → PDW stream → signal generator (SCPI/TCP); mode-switching SAM; pulse groups; circular/conical/helical scans; pulse drop-out
5 · Comms RX	COMINT receiver	20 MHz – 6 GHz; IQ capture, RRC shaping; demod, constellation, EVM/MER; modulation classification; blind symbol-rate (cyclic + OBW/(1+α)) & AM/FM/PM family ID ; spectrum + waterfall
6 · Comms Jam / GNSS	Comms & navigation denial	Comms-deny range; GPS jamming; GNSS spoof covert power window & pull-off; LOS-capped capture (radio horizon + altitude)
7 · CEMA Modeller	Cyber threat modelling (conceptual)	Attack graph, kill-chain, risk matrix; mitigations; mitigation ROI & greedy hardening order; threat-informed defence via a live CTI pipeline — defang-aware IOC extraction, STIX 2.1 indicator import/export, CTI-weighted attack graph
8 · Cyber Wargame	Red-vs-blue engagement (conceptual)	Stochastic kill-chain runs; Monte-Carlo; monitoring-vs-success curve; multi-target campaign; MITRE ATT&CK reference
9 · Detection Lab	Detection trainer	Synthetic telemetry; ROC / PR curves; AUC; threshold & operating-point trade-offs
10 · COA Planner	Course-of-action decision aid	Weighted-utility COA comparison over the engagement model; trade-off visualisation (defensive)
11 · Tactical Console	EW/cyber common operating picture	Map COP; effect tasking (jam / GNSS-deny / cyber) scored by suite models; LOS gating; missile-seeker engagement; DTED/SRTM theatres ; 3-D laydown editor (X/Y/Z placement) ; 6-DOF platform motion ; time slider
12 · Joint Wargame	Force-on-force wargame	Turn-based BLUE/RED; EW + cyber suppression; ASM raids (hard/soft-kill, decoys, channel saturation); DTED/theatre board ; 3-D altitude layers; Monte-Carlo; OOB
13 · EO/IR	Infrared search & track	Graybody radiometry; MWIR/LWIR transmission; NETD; MRTD vs spatial frequency; Johnson DRI ranges; Missile Warning System (rocket-plume detection, IR vs solar-blind UV, reaction time)
14 · Training	Assessment & AAR	Multiple-choice quizzes computed live from the ecm/elint/cyber models; topics incl. ECM/ELINT/Cyber/Fundamentals/ Modulation & IQ ; per-topic scoring; after-action review
15 · Video Tracker	EO motion tracking	Staring-camera frame-difference detection; constant-velocity Kalman tracks + gated association; UAV / fighter / missile / projectile classification from kinematics; EO operator display (reticle, gates, PPI)
16 · EO Tracker Workstation	Live EO tracking	Real-feed counterpart: same detect/track/classify pipeline on a live frame stream (simulator / file / TCP / camera); EO operator console; optional INS/GNSS mount feed (ANPP) slews az/el from platform attitude; standalone executable
17 · ELINT Receiver Workstation	Live PDW analysis	Real-feed counterpart to ELINT: live deinterleave + OAK RX track-list from a PDW stream off a real receiver (TCP / UDP uni-multicast / SCPI), a file, or the simulator; standalone executable
18 · Space (SDA / SATCOM-EW)	Space domain awareness & SATCOM electronic warfare	Two-body Keplerian propagation (J2) → ground track; pass prediction over a ground site (AOS/TCA/LOS, max elevation, sky track); SATCOM link budget (FSPL, EIRP, G/T, C/N0, C/N, margin vs elevation); uplink-jamming geometry (J/S at the transponder, off-axis antenna discrimination); counter-space threat taxonomy
19 · Counter-UAS	C-UAS kill-chain engagement	DETECT → TRACK → IDENTIFY → MITIGATE scored against the five DoD UAS groups ; layered sensing (radar by RCS, passive RF link detection, EO/IR, acoustic); RF control-link jam & GNSS denial scored by the suite's own jammer models; soft-kill Pk + drone response; saturation-raid leakers; named EW-systems reference
20 · IADS / SEAD-DEAD	Air-defence strike planner	SAM order-of-battle laydown; terrain/horizon-masked threat rings ; route survivability vs ingress altitude; SEAD/DEAD option scoring (geolocate via ELINT intercept-range, stand-off jam via ECM burn-through, decoys, anti-radiation); tactical-AI planners — weapon-target assignment, min-Pk routing, sequential-EW MDP, zero-sum game & sensor-placement/GDOP, each verified vs the known optimum
21 · Cognitive EW	Adaptive sense-decide-act loop	Closed loop: ELINT sense → learning technique-selection policy (ε-greedy bandit) → ECM act → emitter adapts EP mode; learned technique-vs-mode policy; cognitive jammer out-learns a fixed technique vs an adaptive threat
22 · Spectrum Manager / EMCON	Own-force spectrum deconfliction	Frequency assignment & co-channel conflicts; EMI/fratricide matrix (emitter→receiver margin); greedy band deconfliction; EMCON posture vs own-force detectability (hostile-ESM intercept range)
23 · RF Coverage / Propagation	Terrain-masked coverage planner	Coverage footprints over DTED — radar / jammer (J/S) / GNSS-denial / comms / ESM — with free-space & two-ray path loss, radio-horizon cut-off and multi-knife-edge Deygout diffraction over the real DEM (terrain-shaped footprints, soft shadow edges); path-profile cross-sections; spatialises the suite's link budgets
24 · Multi-INT Fusion	Common track picture	Correlates ELINT / COMINT / EO-IR / radar observations into fused entities (inverse-variance position); confidence by corroborating INTs; majority-vote class; completeness/purity vs the association gate
25 · Scenario & Threat Library	Shared-scenario authoring	Unified threat catalogue (ELINT library + SAM order-of-battle + named EW systems); instantiate emitters into a scenario; save/load the shared bundle every app opens — one scenario / threat DB for the suite

26 · NAVWAR / PNT	Navigation warfare & resilience	Multi-constellation GNSS denial (J/N vs geometry & per-signal robustness incl. M-code); INS holdover drift by IMU grade + aiding (eLORAN/vision/odometer); composite PNT-resilience score
27 · Sonar (undersea)	Acoustic / undersea warfare	Passive & active sonar equations ; transmission loss (spherical→cylindrical spreading + Thorp absorption); deep-water convergence zones ; figure of merit & detection range vs sea state — the acoustic domain alongside the RF tools
28 · Multi-Domain Synchroniser	Cross-domain effects integration	Schedule & deconflict effects across all domains (SIGINT/EW/cyber/NAVWAR/space/EO-IR/acoustic); effects timeline (prep + dwell); own-force spectrum-fratricide check; SIGINT/EO-IR cueing uplift; combined mission-effect probability — the integration capstone
29 · AI EW Advisor	AI decision support	ML classifies each emitter , scores threat & priority, and recommends an EW course of action with predicted effectiveness — temperature-calibrated confidence + an out-of-distribution ' unknown ' flag , feature-level explainability, a what-if threat-vs-range sweep and an exportable assessment report
30 · AI Model Trainer	ML training & benchmarking	Generate labelled datasets from the emitter physics; train/evaluate five pure-numpy classifiers (softmax / kNN / naive-Bayes / random forest / MLP) — accuracy, confusion matrix, ROC, k-fold cross-validation , permutation feature importance , learning curve, model export; a real-data mode benchmarks on 11 public datasets (RadioML, HisarMod, RML22, DroneDetect, ORACLE, Panoradio HF, CSPB.ML, RadChar, Turing radar PDW)
31 · AI EW Assistant	Natural-language analyst aid	Plain-language Q&A over the scenario ("classify the emitters", "highest-priority threat", "what Chinese radars do you know?") answered from the suite's models; cites its sources ; offline rule-based engine
32 · Cognitive-EW Agent	Autonomous learning loop	A closed-loop agent that senses every emitter, learns which technique beats which emitter class, acts and adapts — out-performing a fixed doctrine once it has learned the threat picture
33 · CBRN Hazard Prediction	Atmospheric transport & dispersion	Gaussian-plume dispersion of a chemical / biological / radiological release; downwind concentration & dosage footprint with stability class and wind; hazard-area prediction
34 · Information / Influence Ops	Cognitive-domain modelling	Narrative diffusion through a population (SIR), bot amplification, and counter-messaging / inoculation; a transparent bot-detection scorer with an ROC — conceptual / defensive
35 · ISR Collection Manager	Collection management	Task ISR sensors against named areas of interest ; coverage / revisit; collection-deck optimisation against the priority list
36 · CASEVAC / Combat Health	Golden-hour MEDEVAC planning	Route & sequence MEDEVAC assets against a casualty laydown; time-to-care per casualty; expected survivors from a severity-vs-time survival curve
37 · Artillery & Munition ID	Counter-battery identification	Identify the munition / firing-system from a weapon-locating radar's track features; counter-battery localization (Point of Origin / predicted Point of Impact, warning only); open-source example; counter-fire priority; export into Multi-INT Fusion
38 · AI Campaign Planner	Minimax force-allocation (wargame)	AI allocates combat power across contested objectives and picks a posture by minimax vs RED's best response; re-plans each phase vs an adaptive RED to beat a fixed doctrine. Representational wargaming / rehearsal — both sides modelled, no operational targeting
39 · AI COA Generator	Generate / score / rank COAs	Enumerates ingress COAs vs an IADS (altitude / stand-off / jamming / decoys / axis), scores each on survivability / mission effect / speed via the air-defence model, ranks them, maps the route and explains the trade-off with a top-COA confidence
40 · Force-mix Optimizer	Air-defence siting (force protection)	Greedy places a budget of air-defence assets to maximise weighted coverage of the defended area against a weighted threat-axis laydown (low-altitude penetrators), vs a naive even-ring placement — defensive
41 · Strategic ISR / I&W	Indications & warning fusion	Fuses strategic indicators (mobilisation, logistics, comms, air/naval, ISR, leadership) into a warning picture: per-indicator anomaly (z vs baseline), composite warning level + drivers, and a timeline that rises ahead of an event
42 · CIMIC / Civil-Military	Civil-dimension estimate	PMESII/ASCOPE civil-factor estimate; behaviour-centric audiences & levels of interaction; a seven-baseline-requirement host-nation resilience scorecard with sector interdependencies; DIME converging effects (NATO CIMIC Handbook)
43 · Adversarial ML / Counter-AI	Stress-test & harden the AI	Attacks the suite's own emitter classifiers (FGSM/PGD/measurement-noise/class-mimicry/physically-constrained evasion + data poisoning) and evaluates defences (adversarial training, randomised smoothing, OOD guard); synthetic features only, no exploit content (NIST AI 100-2)
44 · World Map / Global Terrain	Offline global geospatial picture	Fully- offline basemap — real ETOPO5 shaded relief & ocean bathymetry, tiered Natural Earth 110/50/10 m vectors; plate-carree map, orthographic globe, a true draggable 3-D globe , theatre zoom and polar-stereographic Arctic/Antarctic charts; site laydown with geodesic threat rings & great-circle routes — the common map backdrop
45 · Battlespace Management System	One live operating picture (capstone)	The integration shell — also a standalone product: a single live, time-stepped battlespace fed by real feeds (track-link, Cursor-on-Target/TAK , multi-sensor ELINT geolocation, INS, PXA, EO). Multi-INT fusion + a Kalman tracker on a layered theatre→tactical→3-D COP with MIL-STD-2525 symbology, MGRS & geofence zones; TEWA threat-evaluation/weapon pairing; effects scored on the suite's own physics & synchronised; record/replay/AAR, KML/CoT export, multi-operator picture; role-based access, classification banners & audit; requirements-traceable V&V gated in CI
46 · Advanced Geolocation	Estimation-theory geolocation	CRLB 95% error ellipses + CEP for AOA / TDOA / FDOA sensor geometries; GDOP accuracy heatmap over the area; MUSIC super-resolution array DF for close co-channel emitters; passive, receive-side — sensor-geometry trade studies
47 · EW Test & Evaluation Planner	EW T&E design & assessment	The M&S → SIL → HITL → ISTF → open-air-range resource continuum; MOP/MOE library by EW class with the jammer-effectiveness chain (reduction in shots → lethality); statistical test design (Clopper-Pearson confidence, trials needed); threat-simulator fidelity / VV&A scorecard
48 · 3-D Battlespace Wargame (Panda3D, 6-DOF)	Real-time engine-rendered wargame	Platforms fly full six-degree-of-freedom motion, rendered by the Panda3D engine (terrain, sea, sky, lit models). The whole sensing-and-combat chain runs live every frame: radar/ESM detection (Swerling-1 Pd, terrain-masked LOS, clutter, ducting) → filtered track picture (M-of-N confirmation, coasting, DRFM false tracks, datalink fusion) → IADS command hierarchy & EMCON → fire-control doctrine → PN missiles with dynamic WEZ → EW terminal fight (chaff, towed decoy, DRFM pull-off, home-on-jam, burn-through) → graded damage; weather, NAVWAR, campaign, scenario builder, save/replay, LAN multiplayer

Signal & Parameter Coverage	
Comms / COMINT tuning	20 MHz – 6 GHz
Radar / EW bands	HF–Ka; NATO & ECM band-letter mapping
Emitter classes	EWB (Emitter Workbench) / TSWB (Threat Scenario Workbench) / PWB (Platform Workbench) / RWB (Receiver Workbench) / SWB (Simulator Workbench) (Emitter Studio)
Scan types	Circular, sector, conical, helical
Pulse coding	Frank, Barker; pulse groups; trigger/sync

Analysis Outputs	
- J/S & burn-through curves; ECCM matrix - CFAR Pd vs SNR (CA vs OS, with interferers) - Range-Doppler maps; pulse-compression metrics - IQ constellations; EVM / MER; spectrum & waterfall - Deinterleave purity / track completeness - GNSS covert-power window & LOS capture geometry - MRTD vs spatial frequency; Johnson D/R/I ranges	

LPI waveforms	CW, FMCW, PMCW (STFT intercept)
Modulations	BPSK...256-QAM, FSK/MSK (classifier)
IR / EO bands	MWIR (3–5 μm), LWIR (8–12 μm), solar-blind UV
DRI criteria	Johnson 0.75 / 3 / 6 cycles (D/R/I)
EO tracking	frame-diff detect · Kalman track · kinematic classify
Symbol-rate ID	cyclic (non-linear + FFT); OBW/(1+α)
Jamming-type ID	noise / DRFM false-target / chaff (feature-based)
C-UAS	DoD UAS Groups 1-5; detect-track-ID-mitigate
Geolocation	AoA, TDOA, FDOA (multi-sensor CEP)
Platform motion	6-DOF (X/Y/Z + yaw/pitch/roll & rates)

Parameter ranges are representative defaults for training/analysis; all are user-configurable in the application UI.

- ROC / PR & AUC; mitigation ROI
- Monte-Carlo saturation × EW leakage; attrition



INTERFACES & DATA FORMATS

Instrument control	SCPI over TCP/IP (PDW download & play); simulated-instrument fallback
Instrument library	45+ interfaces — Keysight / R&S / Tektronix / Anritsu analyzers, Signal Hound / USRP / RTL-SDR, Tabor AWT, I/Q recorders, comm receivers, generators — over SCPI / VITA-49 / SigMF
Live track feeds	ADS-B (SBS-1), AIS (NMEA AIVDM), drone Remote ID (ASTM F3411) — receive-only, onto the COP
Emitter geolocation	Networked DF (AOA + TDOA) → lat/lon fix + error ellipse
Tactical interop	Cursor-on-Target (TAK/ATAK), Link 16 / JREAP, DIS (IEEE 1278); GeoJSON / KML / QGIS
Cyber threat intel	STIX 2.1 indicator import/export; defang-aware IOC extraction (IP / domain / URL / hash / CVE / ATT&CK IDs) from unstructured reporting
Scenario file	oak-ew-scenario (JSON) — emitters, own assets, terrain, notes
Suite bundle	oak-ew-bundle (JSON) — scenario + wargame order of battle
Terrain import	DTED .dt0/.dt1/.dt2; SRTM .hgt; .npy; PNG/TIFF/JPG
Named theatres	Built-in set + drop-in tile folder; procedural fallback
Report output	Self-contained HTML + A4 PDF briefing
Figure export	PNG via the embedded matplotlib toolbar

TERRAIN & LINE-OF-SIGHT

- Hill-shaded hypsometric relief in 2-D and 3-D
- Bilinear elevation; gradient hill-shade
- LOS / viewshed with earth curvature (4/3 refraction)
- Terrain masking gates effect outcomes on the map

STANDARDS & REFERENCES

- MITRE ATT&CK technique reference (cyber)
- Johnson criteria (EO/IR DRI)
- NATO & ECM band-letter conventions
- CA/OS-CFAR, Frank/Barker pulse-compression theory

48 integrated apps

3-D view in every app

Shared scenario bus

DTED / SRTM terrain + LOS

SCPI instrument control

Monte-Carlo benches

Requirements-traceable V&V

Real-time 3-D wargame

HTML + PDF report

Single offline .exe

SYSTEM REQUIREMENTS

Operating system	Windows 10 / 11 (64-bit)
Packaged build	Standalone .exe — no Python install required
Source build	Python 3.12 + NumPy + Matplotlib (+ Pillow for image terrain)
Memory	4 GB RAM (8 GB recommended)
Display	1920 × 1080 or higher
GPU	Not required (discrete GPU recommended for the real-time 3-D wargame)
Network	None — fully offline; no telemetry
Disk	~1 GB (packaged suite incl. the 3-D wargame engine)
Optional HW	SCPI/TCP signal generator (Threat Sim)

ARCHITECTURE & PACKAGING

- Python / Tkinter UI; Matplotlib 2-D & 3-D; NumPy; Panda3D engine (PyQt5 + OpenGL) for the real-time 3-D wargame
- Model / app split per discipline — reusable, headlessly testable
- Shared scenario_io / terrain_io; suite_report capstone
- PyInstaller one-folder build; deep-link dispatch --app KEY [bundle] [--tab NAME]

VERIFICATION & VALIDATION

- 700+ automated tests run in CI; deterministic Monte-Carlo seeds
- Requirements-traceable V&V harnesses — requirements mapped to automated checks, gated in CI, one-click HTML evidence reports
- Adversarial review + property-based fuzzing of the physics models

DEPLOYMENT & LICENSING

- Copy-and-run; air-gap / classroom friendly
- Per-seat or site licence (schoolhouse / department)
- Content packs — theatres, threat libraries, scenarios
- Services — instructor enablement, custom scenarios, branded builds

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