PROCUREMENT INTELLIGENCE BRIEF

FACS-Based Emotion Recognition in Defence

A technical and commercial guide for defence procurement, CISO, and intelligence leadership teams

Published by Cavefish Ltd | April 2026 | Version 1.0

echodefence.com | defence@cavefish.co.uk

Company Reg. 15127122 | Cardiff, Wales, UK

CONTENTS

SECTION 01

Executive Summary

EchoDepth is a camera-based emotion recognition AI platform developed by Cavefish Ltd in Cardiff, Wales. It analyses 44 FACS-compliant facial Action Units per frame in real time, detecting stress, deception, cognitive overload, and operator fatigue using existing camera infrastructure. No wearables. No physical sensors. Approximately 700ms detection latency. Fully on-premise and air-gap deployable. UK data residency as standard.

This brief covers the scientific basis of EchoDepth, its processing architecture, deployment requirements, compliance posture, and procurement pathway for defence, intelligence, and security organisations.

44	~700ms	14	6
Facial Action Units per frame	End-to-end latency	Cultural cohorts	Countries trained across

“EchoDepth addresses the one risk dimension that no existing security infrastructure currently monitors: the emotional and cognitive state of the people operating within it.”

SECTION 02

The Human Risk Gap in Defence

Every major security framework acknowledges that human behaviour is the most significant and least-monitored variable in organisational security risk. Networks, devices, and physical perimeters are extensively monitored. The cognitive and emotional state of the people operating within them is entirely invisible to existing infrastructure.

The Statistical Case

82% of cyber breaches involve a human (Verizon DBIR 2024)	**60%** of data breaches involve insiders (ISACA 2024)	**14 months** average precursor gap before first malicious act (CERT)	**47%** polygraph false negative rate (NAS 2003)

What Existing Systems Cannot See

UEBA and SIEM platforms detect anomalous digital behaviour after a digital act has occurred. Carnegie Mellon CERT's analysis of 150 insider cases found a 14-month average gap between the first observable emotional or behavioural precursor and the first malicious digital act. The signals were there. The monitoring infrastructure was looking the wrong way.

Polygraph attempts to address credibility assessment but the US National Academy of Sciences concluded in 2003 that it shows false negative rates reaching 47% in controlled studies — unacceptable for security-critical applications.

SECTION 03

The Facial Action Coding System (FACS)

FACS is a comprehensive taxonomy of facial muscle movements developed by Paul Ekman and Wallace Friesen in 1978. It defines 44 Action Units (AUs), each corresponding to a specific muscle or muscle group. Because FACS is grounded in anatomy rather than subjective emotion labels, it is the most scientifically defensible framework for emotion recognition AI.

Key Action Units in Defence Applications

Action Unit	Muscle Activated	Signal	Application
AU1 + AU4	Inner brow raise + lowerer	Worry, distress — hard to fake	Credibility assessment
AU6 + AU12	Cheek raiser + lip puller	Genuine positive affect (Duchenne)	Engagement monitoring
AU9 + AU17	Nose wrinkler + chin raiser	Disgust, contempt	Deception indicators
AU20 + AU26	Lip stretcher + jaw drop	Fear, acute stress	Operator readiness
AU46	Eyelid droop (levator pal.)	Fatigue onset	Fatigue monitoring

Why FACS Beats Discrete Emotion Classification

Most commercial emotion AI classifies faces into discrete labels (happy, sad, angry). For defence applications, three critical failures apply: (1) Discrete classifiers fail on suppressed or blended operational expressions. (2) Labels produce non-auditable output that cannot be legally or procedurally challenged. (3) They cannot detect suppression — the deliberate inhibition of emotional expression that is a primary indicator in credibility assessment.

FACS-based output — "AU4+7+17 at intensity 3, onset frame 847, peak 862, offset 891" — is a reproducible, legally reviewable record suitable for procurement justification and legal proceedings.

SECTION 04

The VAD Model: From Action Units to Emotional State

EchoDepth maps combinations of 44 Action Units to the Valence-Arousal-Dominance (VAD) model (Mehrabian and Russell, 1977). Rather than a discrete emotion label, EchoDepth produces three continuous scores per frame:

Valence — positivity or negativity of emotional state (–1.0 to +1.0)

Arousal — activation intensity from calm to agitated (–1.0 to +1.0)

Dominance — perceived control from submissive to dominant (–1.0 to +1.0)

VAD enables discrimination discrete classifiers cannot achieve. Fear and anger share similar valence and arousal but differ sharply in dominance — operationally significant in credibility assessment. VAD output enables anomaly scoring against individual baselines rather than population-level thresholds.

“{"frame":1847,"timestamp":"2026-04-10T14:23:07Z","valence":-0.52,"arousal":0.81,"dominance":0.14,"au_active":[4,7,17,20],"confidence":0.87,"suppression_flag":true}”

Sample structured JSON output per frame

SECTION 05

EchoDepth: Platform Architecture and Capabilities

Processing Pipeline

Stage	Process	Latency
1. Camera input	Standard RGB at 720p minimum	—
2. Landmark detection	68-point facial mapping per frame	~80ms
3. AU extraction	44 FACS AUs with intensity scoring (1–5)	~250ms
4. Temporal analysis	Onset/apex/offset for suppression detection	~180ms
5. VAD mapping	AU combinations to VAD via culturally-calibrated model	~90ms
6. JSON output	Structured per-frame with confidence weightings	~100ms

Core Capabilities

Credibility Assessment / Deception Detection — 44 AU analysis including micro-expression detection. Per-question timestamped stress/suppression mapping. DSAT-compatible structured output. No contact. No examiner dependency.

Insider Threat Monitoring — Individual emotional baseline profiling (2–4 weeks). Continuous anomaly scoring. SIEM integration: Splunk, Sentinel, QRadar. Pre-digital signal detection 14 months ahead of digital acts.

Operator Readiness / Fatigue Monitoring — Pre-mission readiness scoring. Live fatigue detection via AU46 and VAD arousal. Post-incident timeline reconstruction. UAS, SOC, and control room operators.

Training Effectiveness / Compliance — Real-time engagement scoring during mandatory training. DSAT-compatible records. LMS integration.

Deepfake Detection (POKERFACE) — AU temporal coherence analysis across video frame sequences. Identifies synthetic video by detecting physiologically implausible AU timing patterns.

SECTION 06

Capability Comparison

Capability	Polygraph	UEBA/SIEM	Wearables	EyeDetect	EchoDepth
Measures emotional/cognitive state	Indirect	No	Partial	1 channel	**44 AUs**
Non-contact / no wearable	No	Yes	No	No	**Yes**
Works on existing cameras	No	No	No	No	**Yes**
Real-time continuous output	Session only	Post-event	Yes	Test only	**Yes ~700ms**
Air-gap / SCIF deployable	Partial	Partial	No	No (US cloud)	**Yes**
UK data residency	No	Varies	Varies	No (US)	**Yes (default)**
SIEM integration	No	Native	Partial	No	**Yes**
Scientific validity	NAS 2003: No	Yes	Varies	Limited	**40yr FACS**
Insider threat (continuous)	No	Digital only	No	No	**Yes**
Structured audit output	Subjective	Log events	Raw data	Partial	**JSON/DSAT**
UK-developed	No	Varies	Varies	No (USA)	**Yes (Cardiff)**

SECTION 07

Deployment: On-Premise, Air-Gap, and SCIF

What SCIF-Compatible Means

A SCIF-compatible AI system must operate with zero external network connectivity. EchoDepth deploys fully on-premise via Docker containers. All inference runs locally. No API calls. No telemetry. No outbound network traffic. The deployment image can be transferred to an isolated network via approved removable media and verified against a published cryptographic hash.

Hardware Requirements

Component	Minimum Requirement	Notes
Camera	Standard RGB, 720p	Existing CCTV, interview room, or webcam
Server CPU	Multi-core server-class	No GPU required for standard single-camera
RAM	16GB+	32GB recommended for multi-camera deployments
Storage	50GB+	Model weights, audit logs, session data
OS	Linux (Ubuntu 20.04+) or Windows Server 2019+	Docker required
Network	None required	Fully air-gap deployable — zero outbound calls

SECTION 08

Compliance: UK GDPR, NCSC, and DSAT

Biometric data processed by EchoDepth — including facial Action Unit data — is classified as special category data under UK GDPR Article 9. EchoDepth is designed from the ground up for compliant processing in security contexts.

Pseudonymisation — Biometric data is pseudonymised by default. Individual records are assigned artificial identifiers; re-identification requires a separate key held under RBAC.

Role-Based Access Controls — Granular RBAC governs who can access individual-level scores versus aggregate metrics versus raw AU data.

Full Audit Logging — All data access and processing events are logged with ISO 8601 timestamps. Audit logs are immutable and exportable.

UK Data Residency — All processing occurs within UK borders as standard. For SCIF deployments, processing occurs within the facility.

NCSC Alignment — Aligned with NCSC principles for on-premise deployment and supply chain security.

DSAT Compatibility — Output structured to meet Defence and Security Accelerator Technology audit record standards.

ISO 27001 — Cavefish Ltd is on the ISO 27001 certification pathway.

> *"A full Data Processing Agreement covering biometric data under UK GDPR and the Data Protection Act 2018 is available under NDA. Contact defence@cavefish.co.uk."*

SECTION 09

Procurement Pathway

Stage	What Happens	Timeline
1. Initial enquiry	Submit at echodefence.com/contact. Response within one working day.	1 day
2. NDA	Mutual NDA before any technical detail shared. Standard or customer template.	1–3 days
3. Technical briefing	45–60 min structured briefing: architecture, deployment, compliance, use case.	1–2 weeks
4. Air-gap demo	Hands-on evaluation in network-isolated environment for vetted teams.	2–4 weeks
5. Pilot agreement	Scoped agreement: objectives, success metrics, data governance, exit conditions.	4–8 weeks
6. Pilot deployment	On-premise Docker deployment, SIEM integration, baseline establishment.	4–12 weeks
7. Commercial agreement	Annual licence or usage-based arrangement based on pilot outcomes.	Post-pilot

Contact

Email: defence@cavefish.co.uk

Web: echodefence.com/contact

PDF: echodefence.com/echodepth-defence-procurement-guide.pdf

Address: 15 Neptune Court, Vanguard Way, Cardiff CF24 5PJ, Wales, UK

SECTION 10

Evidence Base and Key References

Statistic / Finding	Source	Reference
82% of breaches have a human at the centre	Verizon DBIR 2024	verizon.com/dbir
60% of breaches involve insider threats	ISACA 2024	isaca.org
Average cost per insider incident: £3.2M	Ponemon Institute 2023	ponemon.org
Polygraph false negative rate up to 47%	NAS 2003	nap.edu/catalog/10420
21–23% of military incidents involve fatigue	Caldwell et al.	PMC8451537
14-month precursor-to-act gap in insider cases	Carnegie Mellon CERT	sei.cmu.edu
74% forget training within a month	Skillup 2025	skillup.online
FACS: 40+ years peer-reviewed research	Ekman and Friesen 1978–2002	paulekman.com
VAD model validated cross-culturally	Mehrabian & Russell 1977	APA PsycNet

SECTION 11

About Cavefish Ltd

Cavefish Ltd (Reg. 15127122) is a Welsh AI company founded in September 2023 and headquartered in Cardiff, Wales. The company develops EchoDepth — the only UK-built, FACS-based emotion recognition AI platform purpose-built for classified defence and security environments.

Founder: Jonathan Prescott — CEO & Co-founder

Former Director of Digital at The Royal Mint. Former Director of Digital Performance at Assurant ($10bn global insurance, US). MBA, Bayes Business School (Leadership Communication). B.Eng Computer Systems Engineering. Guest lecturer, NYU Stern School of Business. Strategy Director, AI Wales CIC. Winner, ECSO Cyber Solution Days 2026. ITEC 2026 Speaker (ExCeL London). Featured in The Daily Telegraph, Authority Magazine, and Research Live.

Company Registration	15127122 (England and Wales)
ICO Registration	ZB915623
UKPRN	10096263
Registered Address	15 Neptune Court, Vanguard Way, Cardiff CF24 5PJ
Contact	defence@cavefish.co.uk
Product website	echodefence.com
Company website	cavefish.co.uk
LinkedIn	linkedin.com/company/cavefish-ai

“CONFIDENTIAL — This document is intended for the named recipient only and may not be reproduced or distributed without written permission from Cavefish Ltd. echodefence.com | defence@cavefish.co.uk”

Cavefish Ltd | Reg. 15127122 | Cardiff, Wales, UK | April 2026