WHITE PAPER

Mission-Ready Physical AI

Addressing Challenges
Facing Modern Drone Programs

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EXECUTIVE SUMMARY

Today's drones must think, not just fly, requiring real-time perception, autonomous decision-making, multi-sensor fusion, and AI inference within a power envelope measured in single-digit watts and a form factor measured in grams.

SiMa.ai's Physical AI platform combines the purpose-built Modalix MLSoC with the Palette software suite — delivering 50 TOPS for CNN perception under 5W and LLM/SLM inferencing under 10W, while enabling seamless AI development and deployment across the full application lifecycle. Wind River eLxr Enterprise with Linux Kernel 6.18 provides a security-hardened OS foundation with real-time or standard kernel variations.

DRONE ADDRESSABLE MARKET — FOUR TARGET SEGMENTS

SiMa.ai targets segments where it delivers the strongest advantage with decisive differentiation.

Segment	2024 Market[1]	2030 Projection[1]	CAGR	Key AI Driver
Loitering Munitions / ISR*	$2.5B	$12B	40%	Terminal guidance, target classification
Counter-UAS (C-UAS)	$1.8B	$6B	35%	Drone detection and discrimination
Micro-ISR / Reconnaissance	$1.2B	$4B	28%	SLAM, GPS-denied navigation
Inspection & Agriculture	$4.5B	$14B	22%	Defect detection, multi-spectral analytics

*see Appendix B for all acronym definitions

All four segments share a common platform requirement: local AI inference without cloud connectivity, tight power budget, and rich I/O to connect various sensors and peripherals.

Why Intelligence at the edge is Non-Negotiable

- Latency — sub-20ms inference required for navigation, avoidance, and tracking. Local decisions cannot wait for cloud roundtrips.
- Power — every watt of compute reduces flight time. GPU-based solutions consume 30–75W incompatible with drone SWaP constraints.
- Connectivity — RF-contested and bandwidth-limited environments are the norm. All AI decisions must be made locally in real time; cloud links cannot be relied upon for mission-critical functions.

INSIGHT	At the end it is about efficiency. A Modalix-based platform with 50 TOPS and extensive I/O capabilities running CNN and LLMs at less than 10W, while simultaneously delivering high performance to facilitate easy development and deployment processes.

SENSORS, IMU, AND NAVIGATION — THE PERCEPTION FOUNDATION

Autonomous drone intelligence is only as good as the sensors feeding it. Understanding which sensors are used in which contexts and how they are fused is essential to understanding why the Modalix platform is architected the way it is.

IMU — The Always-On Navigation Foundation

The Inertial Measurement Unit (IMU) is the single most critical sensor in any autonomous drone system. A typical drone IMU combines a 3-axis accelerometer and 3-axis gyroscope operating at 200Hz to 1kHz.

The IMU serves two indispensable functions in drone autonomy:

- Dead reckoning: when all other sensors fail or are temporarily unavailable, the drone propagates its state (position, velocity, attitude) from IMU measurements alone, maintaining flight stability and navigation continuity for short intervals.
- Sensor fusion anchor: Every VIO navigation scheme including SuperVINS — uses IMU measurements as the high-rate prediction backbone that bridges lower-rate updates from cameras, radar, and LiDAR.

IMU data is also used for gimbal stabilization, vibration compensation in camera systems, rotor health monitoring, and flight controller attitude estimation. The IMU's noise density and bias stability directly determine navigation accuracy and drift rate.

IMU ROLE	Every navigation scheme in this white paper is fundamentally an IMU-aided system. Without it, the other sensors cannot navigate reliably in dynamic flight conditions. The IMU serves as the connective tissue of drone autonomy.

Where Radar-Based Navigation Is Used

4D mmWave radar is the preferred ranging and velocity sensor for outdoor GPS-denied navigation where cameras may degrade. Key advantages for drone navigation include:

- All-weather operation: unaffected by fog, rain, dust, smoke, or darkness
- Direct Doppler velocity measurement: measured without the accumulating drift of visual odometry
- RF jamming resistance: 77GHz mmWave frequencies are distinct from GPS and communication bands
- Long-range obstacle detection: 50–200m range even in zero-visibility conditions

Where LiDAR-Based Navigation Is Used

LiDAR provides high-density 3D point clouds with centimeter-level range accuracy — a capability cameras and radar cannot fully replicate. However, LiDAR adds weight, cost, and power consumption that make it impractical for small or expendable drone platforms. LiDAR is used selectively where its capabilities justify the SWaP cost:

- Indoor and structured GPS-denied environments; warehouses, industrial facilities, building interiors requiring dense 3D mapping and precise localization
- High-end ISR platforms; larger platforms where mission requires centimeter-accurate 3D terrain mapping or change detection
- Search and rescue in complex terrain; real-time 3D scene reconstruction for path planning through dense obstacles
- Precision landing; LiDAR altimeters providing accurate ground clearance on uneven terrain

Sensor Selection by Use Case

Use Case	RGB / NIR/ Thermal	4D Radar	LiDAR
Military ISR / Loitering Munitions	Yes	Yes	Optional
Micro-ISR / Nano	Yes	Lightweight	Too heavy
Commercial Inspection (Outdoor)	Yes	Yes	Optional
Indoor / Warehouse Logistics	Yes	Limited	Yes
Full ISR / High-End Autonomous	Yes	Yes	Yes
Agriculture / Precision Spray	Yes	Altimeter only	Optional

Sensor Fusion Navigation Schemes by Use Case

Navigation Scheme	Primary Use Cases	How It Works
Visual-Inertial Odometry (VIO)	Micro-ISR, nano drones, lightweight platforms	EO camera features + IMU integration. Lightweight, no radar/LiDAR needed. Drifts over long distances without correction.
Radar-Visual-Inertial Odometry (RVIO)	Military ISR, loitering munitions, outdoor GPS-denied	4D radar Doppler + EO camera features + IMU. All-weather, robust to lighting and visual degradation.
LiDAR-IMU SLAM	Indoor logistics, warehouse, underground	LiDAR point cloud registration + IMU prediction. Accurate 3D mapping in structured environments.
GNSS + Visual-Inertial Fallback	Commercial inspection, agriculture	GNSS primary; VIO activates on GNSS loss. Simple, cost-effective for benign outdoor environments.
SuperVINS (Full Hybrid Fusion)	High-end ISR, full autonomous platforms	Tight fusion of EO camera + IMU + 4D radar + LiDAR. Best accuracy and robustness across all conditions.
ROS2 + Nav2	All drones	ROS2 is the middleware backbone connecting all subsystems via pub-sub topics. Nav2 is the path planning and obstacle avoidance layer. Both run on Modalix alongside VIO/RVIO/SuperVINS localization and MAVLink flight control.

TECHNICAL CHALLENGES — WHAT DRONE SYSTEMS MUST SOLVE

1. Flight Duration, Platform Efficiency, and Deployment Cost

Every drone program confronts the same hard constraint: flight duration and mission capability are proportional to power, weight, and size of the drone. A heavier compute module reduces payload. A higher-power processor drains the battery faster. A costly chip prices out commercial and high-volume defense programs. GPU-based solutions consume 30–75W incompatible with drone SWaP constraints.

The Modalix architecture provides a solution at the system level. With 50 TOPS of AI inference in a 10W power envelope, the MLSoC efficiently runs CNN perception workloads under 5W and LLM/SLM reasoning tasks under 10W. To accelerate development, the Modalix SoM offers the quickest route to a validated platform, with options ranging from SoM form factor boards to chip-down designs for reducing both size and weight in high-volume production. Furthermore, the rich I/O connectivity including MIPI CSI-2, PCIe, USB3, UART, SPI, I2C, and GbE is built-in, which eliminates the need for separate interface hardware. So Modalix based solutions address SWaP constraints and also helps maintain a low overall system bill of materials.

MODALIX EFFICIENCY	Modalix maximizes mission capability per watt with key specs: 50 TOPS and total LLM/SLM processing under 10W, CNN perception under 5W. SoM for fast integration and chip-down provides SWaP advantage along with quick time to market.

2. Navigation in GPS-Denied, Jammed, and Contested Environments

In military, industrial, and urban environments, drone operations frequently face conditions where the GPS signal is either unavailable, unreliable, or disturbed. Traditional autopilot systems, which rely on GPS, become operationally useless in the most critical environments such as tunnels, dense urban canyons, indoor facilities, underground locations, and RF-contested battlefields when that signal is denied.

Modalix provides a complete, hardware-accelerated autonomous navigation stack running on-device with Wind River eLxr and ROS2. ROS2, the standard middleware for autonomous drones, uses apublish-subscribe architecture to connect all subsystems (e.g., camera, IMU, flight controller, perception) into a unified, modular, and maintainable software bus. Modalix also supports Nav2 (ROS2 NavigationStack) for path planning and obstacle avoidance, addressing the "how to get from A to B" problem via aglobal path planner, local trajectory optimizer, behavior tree, and costmap. SiMa.ai's design uses Nav2alongside the SiMa.ai navigation stack (VIO, RVIO, and SuperVINS), which solves the GPS-denied "where am I?" localization problem. MAVLink bridges the planned trajectory to the flight controller.The complete autonomous flight stack on a single Modalix chip consists of:

- **ROS2**: Middleware connecting all subsystems.
- **VIO / RVIO / SuperVINS**: Localization (GPS-denied position/attitude from sensors).
- **Nav2**: Navigation and planning (path planning, trajectory optimization, mission execution).
- **MAVLink v2**: Interface to the flight controller (translates commands for PX4/ArduPilot).

GPS-DENIED NAVIGATION	Complete autonomous navigation on one chip: ROS2 + Nav2 + VIO/RVIO (Q3'26) + VIO/RVIO, LiDAR-IMU SLAM, and SuperVINS fusion (Q4'26) + MAVLink v2 interface with no external processor needed.

3. Obstacle Detection in Challenging Conditions: Dark Spots, Fog, Wires, and Shadows

Conventional drone vision systems struggle precisely in the challenging conditions most critical for operational safety. Detecting thin, reflective electric power lines against complex backgrounds is especially difficult and poses a major hazard. Environmental factors like fog, smoke, and haze degrade image contrast by scattering light, while poor lighting in tunnels, under bridges, and shaded areas causes standard RGB perception models to lose accuracy. Furthermore, shadows in images and blind spots in thermal coverage create momentary detection gaps that a reactive, frame-by-frame pipeline cannot effectively address.

SiMa.ai's Modalix platform uses a two-layer approach: deep learning perception and on-device language model reasoning. The CNN perception stack runs on the MLA at 700+ FPS with sub-1.5ms latency, handling object detection, segmentation, and depth estimation. Concurrently, an on-device Vision-Language Model (VLM) like Gemma 3 4B or edge-optimized options (Moondream2/Phi-3 Vision) provides chain-of-thought reasoning, connecting observations, reasoning about occlusion, and adapting to degraded visuals capabilities pure CNNs lack.

PERCEPTION + REASONING	Traditional vision sees; edge agentic AI on Modalix acts. Real-time CNN (>200 fps) detection and on-device scene reasoning (Gemma 3 4B / Moondream2 / Phi-3 Vision) run simultaneously ensuring autonomy without cloud latency.

4. Transitioning to New Use Cases and Demanding Environments: Need for Agentic AI

The drone industry is shifting its focus from platforms executing pre-programmed waypoints to those operating in unpredictable, dynamic environments. Missions like search and rescue in unfamiliar terrain, Intelligence, surveillance, and reconnaissance (ISR) in contested airspace, autonomous inspection of infrastructure for unknown defects, and logistics in facilities with changing inventory layouts now require advanced capabilities. The limitation of conventional autopilot-plus-camera systems is reactive: drones simply respond to their current visual input and follow existing instructions, lacking the ability to reason, adapt, or initiate independent action.

SiMa.ai addresses the needs of drone systems with its agentic AI environment that runs on Modalix. This framework supports all key drone functions; perception, navigation, mission planning, communication, and sensor fusion, enabling complex agentic behavior while preserving modularity and ease of updates.

The framework offers two deployment models:

1. **Runtime Architecture:** Each function runs independently. This is the primary model for complex autonomous platforms.
2. **Deployment Pipeline via Palette:** This model is for teams that prioritize the speed of Over-The-Air (OTA) updates.

Crucially, Modalix minimizes the porting effort for existing AI workloads, allowing easy deployment of open-source SLAM libraries, proprietary mission planners, and customer-trained SLMs.

AGENTIC AI ON MODALIX	The Agentic AI environment shifts drone operation from simple route following to complex mission execution. Perception, navigation, planning, and communication are independent, updatable modules. OTA updates via Palette maintain deployed fleets without downtime.

5. Program Risk, Safe, Reliable and Time to Market

Drone programs, especially those in defense, government, and critical commercial sectors, face major program risks due to issues with operating system (OS) reliability, security vulnerabilities, and a lack of official commercial support. The community Linux distributions currently used in most embedded systems do not provide a guaranteed maintenance timeline, a clear path for Safety and reliability when vulnerabilities emerge.

Modalix utilizes Wind River eLxr Pro, an enterprise Linux distribution, which offers a security-hardened kernel, commercial support with lifecycle guarantees, and real-time Linux extensions, with certifications for FIPS 140-2, FIPS 140-3(In process), CIS Benchmark, and others via professional services.

To significantly speed up time-to-market, the reference design includes full MAVLink v2 integration with the flight controller. This pre-validated foundation allows customers to focus on their application layer development, bypassing the need to integrate flight control from scratch. Key features provided out-of-the-box include: MAVLink companion computer command mode, sensor offload to the flight controller's EKF (Extended Kalman Filter), and mission injection for enabling agentic behavior.

WIND RIVER + MAVLINK	Wind River eLxr OS provides security-hardened, real-time capability with commercial support. SiMa.ai reference design brings out-of-the-box MAVLink v2 integration with PX4/ArduPilot, enabling bidirectional telemetry, companion computer command mode, sensor offload, and mission injection.

6. Mechanical Reliability in High-Vibration and Harsh Environments

Drone platforms used in military, industrial, and agricultural applications are deployed in harsh environments that subject their electronics to significant mechanical stress. The vibration generated by rotors, the impact of hard landings, and general rough handling can compromise the stability of a traditional System-on-Module (SoM) design. These designs, which rely on high-density connectors to link the compute module to a carrier board, introduce potential mechanical failure points, a critical risk that is unacceptable for mission-critical programs. Additionally, the Modalix MLSoC comes in both industrial grade (-40 to +85 °C) and commercial (0 to +70 °C) to ensure suitability in any type of thermal environment.

The Modalix chip-down solution provides the highest level of mechanical robustness and vibration tolerance required for demanding military, law enforcement, and industrial drone applications. This is achieved by mounting the Modalix MLSoC directly onto the customer’s board, eliminating the SoM-to-carrier connector interface through standard board-level assembly. Crucially, this robust deployment method maintains full feature parity: all Modalix capabilities, including the Wind River eLxr OS and the Palette software suite with agentic AI environment, remain identical to those available with the SoM option, with no compromise in compute performance or software functionality.

THE MODALIX PLATFORM — BUILT FOR INTELLIGENT DRONES

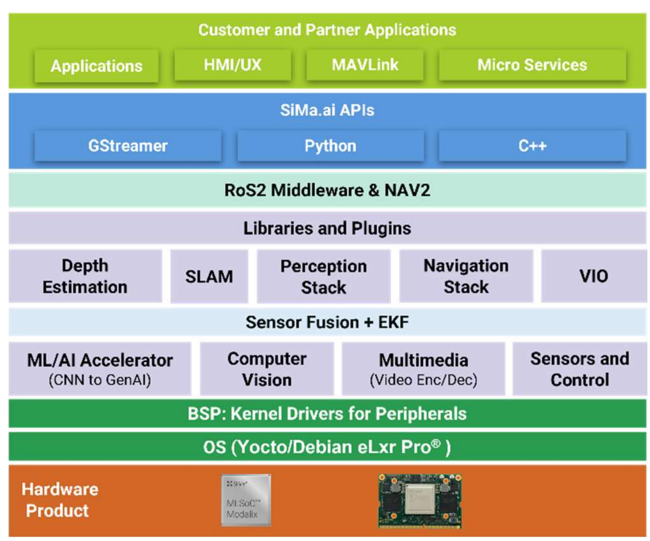
Architecture Overview

Component	Specification	Drone Application Benefit
CPU Cluster	Arm A65 x 8 dual threaded 1.4GHz; 32K DMIPS	OS, ROS2 middleware, Nav2 navigation stack, MAVLink, VIO/RVIO state estimator
MLA (ML Accelerator)	50 TOPS, INT8/BF16	AI inference under 10W
ISP	8-24 bit RGB/RGB-IR	RGB/NIR/thermal camera pipeline processing
Memory	LPDDR5/4X/4 64-bit (up to 6400 Mbps)	Concurrent multi-sensor fusion data flows
OS	Wind River eLxr Enterprise Linux	Security-hardened, real-time capable
Vector Processing	Synopsys EV74 Vector DSP	Legacy computer vision algorithms (optical flow, stereo matching, image processing)
AI Framework	Agentic AI with Full Stack Offering	Modular drone functions: OTA updates; ecosystem compatibility
Video Enc/Dec	H.264/H.265	Reduce bandwidth for telemetry and streaming, Local storage
Interfaces	MIPI CSI-2, PCIe, USB, UART, SPI, I2C, GbE	Native connectivity to all drone peripherals
Temperature	Industrial grade temperature range from -40 to +85 °C	Can operate in any type of environment

Full Stack Offering

SiMa.ai provides a full software stack that includes BSP, Libraries, middleware, and APIs for customers/partners to build systems and get to the market quickly.

Accelerated ROS Nodes	Performance
Stereo Depth Calculation (LightStereo)	333 FPS
Feature Point Detector (SuperPoint)	425 FPS
Feature Matcher (SuperGlue)	126 FPS
Loop Closure (NetVlad)	429 FPS
Obstacle Awareness (OamNet)	280 FPS
Obstacle Detection / Segmentation / Pose (YoloV8)	770 FPS



Hardware Products

Modalix SoM — Fastest Time to Market

The Modalix System-on-Module (SoM) provides a compact, validated platform by integrating the Modalix MLSoC with essential components such as memory, power management, and key interfaces. This design facilitates migration from existing GPU-based SoM solutions, requiring only minimal carrier board modifications. Comprehensive support, including a full Board Support Package (BSP), Software Development Kit (SDK), Palette with an agentic AI environment, and Wind River eLxr available immediately upon boot-up.

Modalix Chip-Down — Maximum Ruggedization

By eliminating the System-on-Module (SoM) connector, the primary mechanical failure point in high-vibration military and industrial settings, the direct placement of Modalix MLSoC silicon onto the customer's carrier board enhances reliability. Customers receive comprehensive hardware design support and reference schematics from SiMa.ai. Furthermore, all software features, including Wind River eLxr and the Agentic AI environment, remain consistent with the SoM deployment.

Q3 2026 RELEASE	Supports MAVLink v2 (UART/PX4/ArduPilot). ROS2/Nav2 integration guide and Sensor fusion (radar+camera+IMU) for GPS-denied flight operation. BSP drivers for: flight controller, GPS/GNSS, IMU, barometer, RGB camera (MIPI CSI-2), 4D radar (UART), WiFi, LTE/5G. Runs Wind River eLxr OS and an Agentic AI environment.

ROADMAP ADDITIONS	Thermal (LWIR) camera integration and RGB+thermal fusion. LiDAR-IMU SLAM for indoor/structured GPS-denied environments. Full SuperVINS multi-modal fusion. LTE/5G modem integration for BVLOS C2 and streaming. Multi-Object Tracking and semantic segmentation models. Vision-Language Model (VLM) deployment for on-device agentic reasoning. Customer-trained SLM deployment via Palette.

PALETTE — THE SOFTWARE LIFECYCLE LAYER

SiMa.ai's Palette software manages the full AI application lifecycle on Modalix, from development through fleet-scale deployment:

- Model Import and Optimization — import from PyTorch, TensorFlow, ONNX; automatic MLA compilation including customer-trained SLMs
- Development Environment — simulation, profiling, and debugging before physical hardware is available
- Modules for Deployment — packages AI models and drone system functions for deployment to Modalix hardware
- OTA Updates — update AI models, navigation algorithms, and system functions over the air as drone fleets scale
- Performance Monitoring — runtime telemetry and fleet-level performance dashboards

COMPETITIVE POSITIONING

Platform	Strengths	Limitations	SiMa.ai Advantage
NVIDIA Jetson	GPU performance, broad ecosystem	25–75W, high cost, no chip-down, no Wind River OS	Chip-down + SoM options vs Jetson SoM-only; 3–5x perf-per-watt; CNN <5W + LLM <10W; Wind River eLxr; Palette software suite; Docker Agents
Qualcomm RB5/QCS8550	Cellular integration	Using mobile and automotive-AI in drones	Higher-performance with low-power inference; unified Palette software suite; drone-native stack with VIO/RVIO support; progressive roadmap
Hailo-8	Inference efficiency	Accelerator only — no CPU/ISP/OS/nav/LLM support	Full SoC: CPU + MLA + ISP + OS + Agentic AI + navigation; Unified Palette software suite for development to deployment
Generic ARM SBC	Low cost, community	No AI acceleration, no nav stack, no OS support, no ruggedization	Purpose-built MLSoC with heterogeneous compute (CPU + MLA + ISP + EV74 VPE); 50 TOPS <10W; Unified Palette software suite; Wind River eLxr; chip-down ruggedization

ECOSYSTEM AND PARTNERSHIP MODEL

Drone System Integrators

SiMa.ai works with drone system integrators building platforms for military, commercial, and industrial customers. Partners receive early access to Modalix hardware, Palette SDK, Wind River eLxr, the Agentic AI environment, reference design, and co-engineering support. The progressive release model ensures partners always have a stable, validated baseline to build on.

Component and Sensor Partners

The reference design is co-developed with key peripheral partners covering flight controllers, GPS modules, 4D radar, LiDAR, and connectivity components. These partnerships ensure BSP drivers are validated against production hardware and that new capability modules integrate cleanly with partner components as they are released.

Software and AI Algorithm Partners

The Agentic AI environment, Palette Neat, enables software partners to deploy navigation algorithms, detection models, SLMs, and mission planning software on Modalix as containers — without custom silicon expertise. This dramatically expands the software ecosystem available to Modalix-based drone programs and enables partners to distribute their software to any Modalix customer.

CONCLUSION

The drone market is undergoing a significant transformation. Truly autonomous intelligence—the ability to perceive, reason, and act without reliance on the cloud—is now a reality for drones. SiMa.ai's Modalix platform is the complete solution making this possible, delivering the essential compute performance, power efficiency, OS trust, and software architecture.

- Exceptional Power Efficiency: CNN perception runs under 5W; LLM/SLM reasoning is achieved with a total power consumption of under 10W.
- Comprehensive Software Stack: Features include ROS2 middleware, Nav2 path planning, Wind River eLxr OS, and Agentic AI Environment, Palette Neat.
- Seamless Integration: Includes MAVLink integration.
- Advanced Navigation Roadmap: NAV2 navigation is targeted for Q3’26, with a full suite of VIO/RVIO/ LiDAR-SLAM/SuperVINS fusion scheduled for Q4’26.
- Flexible Hardware: Available as a Modalix System-on-Module (SoM) for rapid deployment or a chip-down design for ruggedization.
- Operational in Extreme Environments: Industrial temperature range from -40 to +85 °C and 12 years longevity.

SiMa.ai offers a full stack including reference designs, comprehensive collateral or drone developers who require faster time-to-market, superior performance, and the confidence to scale solutions across the commercial, industrial, and defense sectors.

THE BOTTOM LINE	SiMa.ai brings a deep understanding of real-world use cases and evolving market dynamics — translating that insight into vertically integrated solutions that reduce complexity, accelerate deployment, and deliver exceptional value to customers and developers alike.

For more information, partnership inquiries, or to request access to the Modalix evaluation kit:

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APPENDIX & REFERENCE

Sources:
[1] - Drone Addressable Market source is a combination of following articles
https://www.mordorintelligence.com/industry-reports/loitering-munition-market
https://www.researchandmarkets.com/report/loitering-munitions-market
https://www.emergenresearch.com/industry-report/loitering-munitions-market
https://www.arizton.com/market-reports/anti-drone-market
https://www.marketsandmarkets.com/Market-Reports/unmanned-aerial-vehicles-uav-market-662.html
https://www.grandviewresearch.com/industry-analysis/agriculture-drones-market
https://natlawreview.com/press-releases/drone-inspection-and-monitoring-market-grow-19-cagr-2026-2030-reaching-3694b

[2] - Software matrix provided as a reference based on a particular AI model or workload.

APPENDIX B — ACRONYM GLOSSARY

All acronyms and abbreviations used in this white paper are defined below in alphabetical order.

Acronym	Full Definition
AI	Artificial Intelligence — computer systems that perform tasks typically requiring human intelligence, including perception, reasoning, learning, and decision-making.
BVLOS	Beyond Visual Line of Sight — drone operations where the remote pilot cannot see the aircraft directly with the naked eye; requires special regulatory approval.
BSP	Board Support Package — software layer providing OS and driver support for a specific hardware platform, enabling peripherals and interfaces to function correctly.
CAGR	Compound Annual Growth Rate — the mean annual growth rate of a market or metric over a specified period.
C2	Command and Control — the system by which a commander exercises authority and direction over assigned forces to accomplish a mission.
CNN	Convolutional Neural Network — a class of deep learning model particularly effective for image and video analysis, used in object detection, segmentation, and classification.
CPU	Central Processing Unit — the primary general-purpose processor in a computing system, responsible for running the operating system, application logic, and control functions.
CSI	Camera Serial Interface — a high-speed serial interface standard (MIPI CSI-2) used to connect image sensors to processors in embedded systems.
DO-178C	Software Considerations in Airborne Systems and Equipment Certification — the leading international standard for aviation software safety certification.
DSP	Digital Signal Processor — a specialized processor optimized for mathematical operations on digital signals, used in audio, radar, and computer vision workloads.
EKF	Extended Kalman Filter — a nonlinear state estimation algorithm widely used in navigation and sensor fusion to combine noisy measurements into an optimal state estimate.
EO	Electro-Optical — a broad category of camera sensors that convert electromagnetic radiation (visible, NIR, multispectral) into electrical signals; commonly paired with thermal (IR) sensors in drone payloads.
EV74	Synopsys EV74 — a vector DSP (Digital Signal Processor) integrated in the Modalix MLSoC, used to accelerate legacy computer vision algorithms such as optical flow, stereo matching, and image processing.
FP16	16-bit Floating Point — a numerical precision format used in AI inference that reduces memory bandwidth and compute requirements versus 32-bit float while maintaining adequate accuracy for most models.
GbE	Gigabit Ethernet — a networking standard providing 1 Gbps data transfer, used in drones for high-bandwidth sensor data transmission and ground station connectivity.
GNSS	Global Navigation Satellite System — the broad category of satellite-based positioning systems including GPS (US), GLONASS (Russia), Galileo (EU), and BeiDou (China).
GPS	Global Positioning System — the US satellite-based navigation system providing position, velocity, and timing data; the primary navigation reference for outdoor drone operations where available.
GPU	Graphics Processing Unit — a parallel processor originally designed for graphics rendering, widely adapted for AI training and inference; high performance but power-hungry (30–75W typical at edge).

Acronym	Full Definition
I2C	Inter-Integrated Circuit — a two-wire serial communication protocol commonly used for low-speed sensor interfaces (IMU, barometer, magnetometer) in embedded drone systems.
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems — the foundational international standard for functional safety certification across industries.
IMU	Inertial Measurement Unit — a sensor combining a 3-axis accelerometer and 3-axis gyroscope that measures acceleration and angular velocity; the foundational sensor for all drone navigation and stabilization.
INT8	8-bit Integer — a numerical precision format used in optimized AI inference that dramatically reduces memory and compute requirements; the primary precision format for MLA-class accelerators.
IR	Infrared — electromagnetic radiation with wavelengths longer than visible light; in drone contexts refers to thermal (LWIR) imaging for heat-signature detection.
ISP	Image Signal Processor — a dedicated hardware block that processes raw camera sensor data into usable images, handling functions like demosaicing, noise reduction, exposure control, and color correction.
ISR	Intelligence, Surveillance, and Reconnaissance — the coordinated acquisition and processing of information about adversaries, terrain, and operational environments; a primary drone mission category.
ISS	International Space Station — referenced as an example platform running Wind River OS, illustrating the OS's heritage in mission-critical aerospace applications.
LiDAR	Light Detection and Ranging — a sensor that uses pulsed laser light to measure distances and produce high-accuracy 3D point clouds; used for precise mapping, SLAM navigation, and obstacle avoidance.
LLM	Large Language Model — a generative AI model trained on large text/vision datasets capable of reasoning, instruction following, and semantic understanding; Gemma 3 4B, Phi-3 Vision are examples used on Modalix.
LPDDR4X	Low Power Double Data Rate 4X — a high-bandwidth, power-efficient memory standard used in mobile and embedded SoC platforms; Modalix uses 8GB LPDDR4X at 102 GB/s bandwidth.
LTE	Long-Term Evolution — the 4G cellular standard providing wide-area wireless connectivity; used in drones for BVLOS command and control links and live video streaming.
LWIR	Long-Wave Infrared — the 8–14μm thermal infrared band used in thermal cameras for heat-signature imaging; detects temperature differences independent of visible light conditions.
MAVLink	Micro Air Vehicle Link — the de facto lightweight messaging protocol for communication between autopilots (PX4, ArduPilot) and companion computers; used for telemetry, commands, and sensor offload.
MIPI	Mobile Industry Processor Interface — a standards body defining high-speed interfaces for mobile and embedded systems; MIPI CSI-2 is the primary camera interface standard for drone imaging sensors.
ML	Machine Learning — a subset of AI where systems learn patterns from data rather than being explicitly programmed; the foundation of modern drone perception and navigation algorithms.
MLA	Machine Learning Accelerator — the dedicated AI inference engine in the Modalix MLSoC delivering 50 TOPS; optimized for CNN inference, VLM execution, and depth estimation workloads.
MLSoC	Machine Learning System-on-Chip — SiMa.ai's purpose-built SoC architecture integrating CPU, MLA, ISP, and EV74 VPE for Physical AI applications at the edge.

Acronym	Full Definition
NDVI	Normalized Difference Vegetation Index — a remote sensing index calculated from multispectral imagery to measure crop health and vegetation density; a primary output of agricultural drone missions.
NIR	Near-Infrared — the electromagnetic spectrum band just beyond visible red (700–1000nm); used in drone cameras for low-light imaging and crop health assessment.
ONNX	Open Neural Network Exchange — an open format for representing machine learning models, enabling portability between frameworks (PyTorch, TensorFlow) and deployment tools like Palette.
OS	Operating System — the software layer managing hardware resources and providing services to applications; Modalix runs Wind River eLxr enterprise Linux.
OTA	Over-the-Air — wireless delivery of software updates, AI model updates, or configuration changes to deployed drone systems without physical access; a key Palette capability.
PX4	PX4 Autopilot — an open-source flight controller firmware widely used in commercial and research drones; communicates with companion computers like Modalix via MAVLink.
RC	Remote Control / Receiver — the radio control receiver on a drone that accepts pilot commands from a hand-held transmitter; interfaces via SBUS or ELRS protocols.
RF	Radio Frequency — electromagnetic signals used for drone communication, GPS, and radar; RF-contested environments where jamming or interference is present are a primary challenge for GPS-denied navigation.
RGB	Red, Green, Blue — the standard visible-spectrum color camera producing images in the three primary colors; a subset of the broader EO (Electro-Optical) sensor category.
ROS2	Robot Operating System 2 — the de facto middleware framework for autonomous drones and robots, providing a publish-subscribe messaging architecture that connects all subsystems; used by PX4, ArduPilot, and virtually every commercial drone autonomy platform.
RVIO	Radar-Visual-Inertial Odometry — a GPS-denied navigation scheme tightly fusing 4D radar Doppler measurements, EO camera visual features, and IMU data; robust to lighting degradation and adverse weather.
SAM	Serviceable Addressable Market — the portion of the total available market that a company's products and capabilities can realistically serve.
SBC	Single-Board Computer — a general-purpose computer built on a single PCB (e.g., Raspberry Pi); low cost but lacks dedicated AI acceleration, navigation stack, and ruggedization for demanding drone programs.
SDK	Software Development Kit — a collection of tools, libraries, and documentation enabling developers to build applications for a specific platform; SiMa.ai provides a Modalix SDK as part of the Palette suite.
SLAM	Simultaneous Localization and Mapping — a computational technique enabling a drone to build a map of an unknown environment while tracking its own position within that map; foundational for GPS-denied autonomous navigation.
SLM	Small Language Model — a compact version of a language model optimized for edge deployment; customer-trained SLMs can be deployed on Modalix via Palette for domain-specific reasoning tasks.
SoC	System-on-Chip — an integrated circuit combining multiple compute components (CPU, GPU/MLA, ISP, memory interfaces) on a single die; Modalix MLSoC is SiMa.ai's purpose-built drone AI SoC.

Acronym	Full Definition
SoM	System-on-Module — a compact, self-contained hardware module integrating an SoC with memory, power management, and key interfaces onto a PCB that plugs into a customer's carrier board.
SPI	Serial Peripheral Interface — a synchronous serial communication protocol used for high-speed sensor interfaces (IMU, barometer) in embedded drone systems.
SuperVINS	Super Visual-Inertial Navigation System — a hybrid SLAM framework tightly fusing EO camera, IMU, 4D radar, and LiDAR measurements for robust GPS-denied localization across all operating conditions.
SWaP	Size, Weight and Power — the three governing constraints of any drone design; every additional gram or watt directly impacts mission capability, flight time, and program economics.
TOPS	Tera Operations Per Second — the standard measure of AI inference throughput; Modalix delivers 50 TOPS from the MLA within a 10W total power envelope.
UART	Universal Asynchronous Receiver-Transmitter — a serial communication protocol used for flight controller (MAVLink), GPS, and radar interfaces in drone systems.
UAS	Unmanned Aircraft System — the complete system including the drone airframe, ground control station, communication links, and support equipment; the formal regulatory term for drone systems.
UAV	Unmanned Aerial Vehicle — the aircraft component of a UAS; commonly used interchangeably with 'drone' in commercial and military contexts.
USB3	Universal Serial Bus 3.x — a high-speed interface standard (5–20 Gbps) used for connecting cameras, modems, and storage devices to Modalix in drone systems.
VIO	Visual-Inertial Odometry — a GPS-denied navigation scheme fusing EO camera visual feature tracking with IMU motion measurements to estimate position and attitude without external reference.
VLM	Vision-Language Model — a multimodal AI model processing both visual and language inputs to perform semantic scene understanding, reasoning, and instruction following; Moondream2 and Phi-3 Vision are examples.
VPE	Vector Processing Engine — a DSP-class compute block (Synopsys EV74 in Modalix) optimized for vector and SIMD operations used in legacy computer vision algorithms such as optical flow and stereo matching.