PARASANTI

ANY SENSOR. ANY NETWORK. ANYWHERE.

Understanding UNITE as an Agentic AI Agent

Version 1.0

UNITE

INTELLIGENT TACTICAL EDGE

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1. Introduction

Parasanti's UNITE AIoT (Artificial Intelligence of Things) Platform enhances edge effectiveness through innovative fleet management, workload optimization, data orchestration, and autonomous operations. UNITE creates a cohesive operational environment where interconnected edge systems function as a unified, distributed entity. This platform ensures that edge systems can integrate, operate, and adapt to rapidly changing mission requirements, reducing information delivery and decision-making latency. By leveraging AIoT, UNITE promotes real-time data and information sharing, improves operational efficiency, and minimizes errors, costs, and system latency while enhancing mission performance and adaptability in denied, degraded, intermittent, or limited (DDIL) communication environments.

The complexity of modern operational environments, marked by a multidomain landscape and an increasing number of sensors and edge devices, require advanced computing solutions that can quickly adapt to changing conditions. Traditional AI operates passively, needing human input, while UNITE signifies a transition to agentic AI**,** a model in which autonomous systems actively evaluate environments, make decisions, and perform actions to achieve mission goals.

UNITE is designed as an agentic AI system that enhances edge effectiveness through autonomy, goal-oriented decision-making, and real-time adaptability. It is an independent agent capable of sensing its environment, making decisions, and taking actions to improve mission effectiveness and overall operational efficiency. Ultimately, it offers cognitive offloading to better support decision-makers.

1.1. Agentic AI Patterns

Based on the customer use case, UNITE can be modified to support any number of distinct agentic AI patterns, each defining a way to interact with the environment that is best for the given use case:

1. **Solo Autonomous Agent**
   A single AI agent operates independently to achieve a specific goal. It uses tools to perceive, decide, and act within a narrow domain.

   - **How It Works**: The agent follows predefined rules or learns from data to optimize outcomes.

     - **Self-Contained**: Operates independently at the edge (no reliance on cloud or central servers).

     - **Closed-Loop Automation**: Makes decisions and executes actions without human input. Improves overtime using federated learning on local data.

- **Deliberate or Hybrid Mode**: This mode plans actions based on strategic goals and predictive analytics or combines real-time responsiveness with long-term planning for optimal decision-making.

- **Example**: A customer service chatbot that resolves queries by accessing FAQs, processing user intent, and escalating complex issues to humans. A single AI-powered drone is deployed in a denied, GPS-jammed, or high-risk environment to autonomously collect, analyze, and transmit critical intelligence data without direct operator control.

2. **Multi-agent Systems**
A **multi-agent system** involves multiple AI agents collaborating to achieve complex goals. Each agent specializes in a task but shares information and resources with others. There are several common characteristics of multi-agent systems, including:

- **Decentralized Control**: No single point of failure; agents act independently but collaborate.

- **Scalability**: New agents (e.g., for sustainability tracking) can join the system without disrupting existing workflows.

- **Conflict Resolution**: Agents resolve competing priorities (e.g., maintenance vs. production) through negotiation.

- **Resilience**: If one agent fails (e.g., logistics), others adapt (e.g., reroute via alternate suppliers).

Moreover, there are various multi-agent system patterns, with design and implementation typically informed by a problem's complexity, data sensitivity, and the necessity for human involvement. These patterns include:

a. **Hierarchical Agent Systems**

Multiple agents are organized in a tiered structure, where higher-level agents delegate tasks to subordinate ones.

- **How It Works**: A "manager" agent oversees strategy (e.g., factory output goals), while "worker" agents manage subtasks (e.g., calibrating machines).

- **Examples**:

  - In agriculture, a top-level agent might optimize crop yields, directing soil-monitoring agents to adjust irrigation and pest-control agents to deploy treatments.

- A smart power grid manages electricity distribution by coordinating generators, storage, utilities, and consumers. A more defense focused use case is A team of autonomous UAVs is deployed in a contested battlespace to conduct ISR, disrupt enemy communications, and execute precision strikes in coordination with ground forces. UAVs operate without centralized human control, making them resilient in denied environments.

b. **Collaborative Swarm Agents**

Decentralized agents work in parallel, sharing minimal data but collectively achieving a global objective.

- **How It Works**: Each agent acts independently but aligns with group incentives (e.g., maximizing efficiency).
- **Example**: Delivery drones in a swarm reroute dynamically around traffic or weather disruptions without centralized control.

c. Federated Agent Systems

Agents operate across decentralized data sources, collaborating without sharing raw data (ideal for privacy-sensitive contexts).

- **How It Works**: Agents train locally on their data and share only aggregated insights.
- **Examples**:
    - Banks use agents to detect fraud by analyzing transaction patterns across branches without exposing customer details.
    - Medical collaboration tools are another example, sharing federated information to protect patient privacy yet allowing collaboration. A defense focused use case would be In a multi-domain battlefield, the DoD must integrate Army, Navy, Air Force, Space Force, and Cyber Command assets to rapidly process and share information. Federated AI agents enable real-time coordination by autonomously gathering, translating, and distributing mission-critical data across different networks and security domains.

3. **Human-AI Teaming**: Agents augment human decision-making by providing insights or managing routine tasks.
    - **How It Works**: Humans set goals while the agent executes tasks and offers recommendations.

- C**omplementary Strengths**:
    - AI manages high-speed data processing and pattern recognition.
    - Humans provide contextual knowledge, intuition, and ethical oversight (e.g., overriding false positives).
- **Shared Responsibility**:
    - Final decisions require human approval, ensuring accountability.
    - AI acts as a "co-pilot," reducing the cognitive load for workers.

- **Examples**:
    - A medical diagnosis agent analyzes patient data and suggests treatment options, with doctors making final decisions.
    - Project Maven is one example of how DOD and now the National Geospatial-Intelligence Agency use this category of HMT to autonomously detect, tag, and trace objects or humans of interest from various forms of media and collected intelligence,5 enabling human analysts and operators to prioritize their areas of focus.

4. **Adaptive Learning Agents**

Agents evolve their strategies in real time by continuously learning from feedback.

- **How It Works**: They use reinforcement learning to refine actions based on success or failure.
    - **Context Awareness**: Adjusts to dynamic variables like weather, grid prices, and machine health.
    - **Self-Improvement**: Uses reinforcement learning to evolve strategies without manual reprogramming.
    - **Resilience**: Learned from failures (e.g., overloading circuits) to avoid repeating mistakes.
- **Examples**:
    - An e-commerce pricing agent adjusts product costs dynamically based on demand, competition, and inventory levels. “Mission planning system" that dynamically adjusts flight paths and target priorities for unmanned aerial vehicles (UAVs) based on real-time battlefield intelligence, learning from previous missions and adapting

to changing enemy tactics; essentially, the system would continuously improve its decision-making based on new data and feedback from the environment, optimizing mission effectiveness in dynamic situations.

1.2. Problem Definition

Presently, the edge is a patchwork of costly custom solutions (e.g., legacy and proprietary systems), data protocols that lack interoperability between and within vendors, and need more flexibility (meaning reconfigurable post-deployment). However, definitions of the edge vary across solution providers. To provide a shared context for discussing the edge, Parasanti defines it as a compute space in terms of three factors: echelon, proximity, and connectivity:

- **Echelon:** This spans from high-level headquarters to individual soldiers in the field, highlighting the diverse levels at which computing can be deployed;
- **Proximity:** This pertains to both the physical and logical closeness of computing resources to data sources and their users, such as sensors, weapon systems, or personnel; and
- **Connectivity:** This involves the strength and reliability of network links that connect sensors and operational assets like drones, robots, and decision-makers.

The further away from any combination of these factors one moves, the closer one approaches the "extreme edge," where computing resources and data availability may be significantly limited. Problems related to the edge center around limited interoperable and adaptable systems, often resulting in less-than-desired mission outcomes.

Modern operations, particularly in defense and industrial IoT, encounter challenges stemming from the increasing number and complexity of edge-deployed systems. Existing systems frequently suffer from data silos, proprietary architectures, and limited adaptability, complicating real-time decision-making. Many operations rely on uninterrupted connectivity to centralized infrastructures, which presents risks in environments with poor communication. These limitations impair system interoperability, delay response times, and reduce overall efficiency. UNITE addresses these issues with an agentic AI design that offers autonomous, adaptable, and resilient operational support to edge devices and decision-makers.

1.3. UNITE's Value Proposition

UNITE, as an agentic AI capability, enhances operational efficiency by reducing reliance on human intervention. It optimizes processes to minimize resource waste and costs while ensuring seamless scalability for managing complex, distributed systems. With its dynamic adaptability, UNITE responds to evolving mission requirements, enabling organizations to stay agile. Additionally, it fosters collaboration through integrated, multi-agent and human-machine coordination, empowering high-impact decision-making.

2. Universal Intelligent Tactical Edge (UNITE) as an Agentic AI

UNITE is an AI-driven agent that has autonomous reasoning, decision-making, and execution capabilities within dynamic operational environments. By leveraging real-time data and AI models, UNITE adapts to rapidly changing conditions, ensuring seamless integration and responsiveness in mission-critical situations.

UNITE's autonomy enables it to function in complex environments without constant human oversight. Designed and implemented as an agentic AI, UNITE integrates machine learning, reinforcement learning, and symbolic reasoning to enhance processes and data synthesis while assisting human operators through cognitive offloading. This leads to potentially faster decision-making, positioning it as a vital enabler for modern, data-driven operations.

Key design takeaways include:

- **Modularity and Scalability:** Agentic AI systems are designed to be adaptable and can scale to manage complex tasks with multiple agents.
- **Adaptability:** Agents possess the ability to learn from their experiences and refine their behaviors over time.
- **Multimodal Interaction:** The capacity to interact with both digital and physical environments expand the potential applications of agentic AI.
- **Collaboration:** The shared memory mechanism enhances collaboration among agents, leading to more effective problem-solving and decision-making.

2.1. UNITE a Multi-Agent System

While UNITE can function as an independent autonomous agent, it typically operates as a multi-agent system (MAS), where multiple UNITE instances interact to achieve complex objectives, or where specialized agents are integrated with enhanced knowledge or functionality to expand UNITE's operational capabilities. UNITE can operate in two distinct MAS modes, each offering different operational characteristics that promote broader distributed intelligence, task specialization, and improved scalability across operations:

1. **Cooperative MAS**: Multiple UNITE agents collaborate to optimize workflows and resource allocation.
2. **Competitive MAS**: In resource-constrained environments, UNITE agents operate independently while pursuing competing objectives, ensuring efficiency without central oversight.

By applying MAS principles, UNITE improves resilience, scalability, and operational effectiveness, positioning itself as a key integrator of complex, large-scale deployments of multi-vendor systems.

2.2. How UNITE Works as an Agentic AI

Agentic AI interactions involve the collaboration of communicating agents, each equipped with internal mechanisms for sensing, reasoning, planning, and acting. In a multi-agent system, these agents collaborate through shared memory, leveraging various data sources and knowledge representations to interact effectively with digital and physical environments. shows a representation of a multi-agent system, much like UNITE.
Figure 1 outlines UNITE's structured agentic AI workflow, which includes the following functions:

1. **Sensing/Perception:** UNITE gathers information from the operational environment context through their respective "sense" components, such as sensors, databases, and other external systems.
2. **Reasoning:** UNITE processes the collected information using its "reason" components, often relying on an LLM to understand and interpret language-based data, recognize patterns, and assess operational needs.
3. **Decision-making/Planning:** Based on reasoned insights, UNITE autonomously formulates optimal action plans using predefined rules, optimization techniques, and AI-driven inference.
4. **Coordination:** In the "coordinate" phase, UNITE shares its plans and relevant information through shared memory, ensuring collaborative decision-making.
5. **Acting:** UNITE performs its planned actions on the environment by interacting with external tools and interfaces to execute commands, coordinate with other agents, and optimize performance.
6. **Feedback, Learning, and Adaptation:** UNITE updates its individual memories and potentially the shared memory based on the outcomes of its actions, enabling learning and adaptation over time.

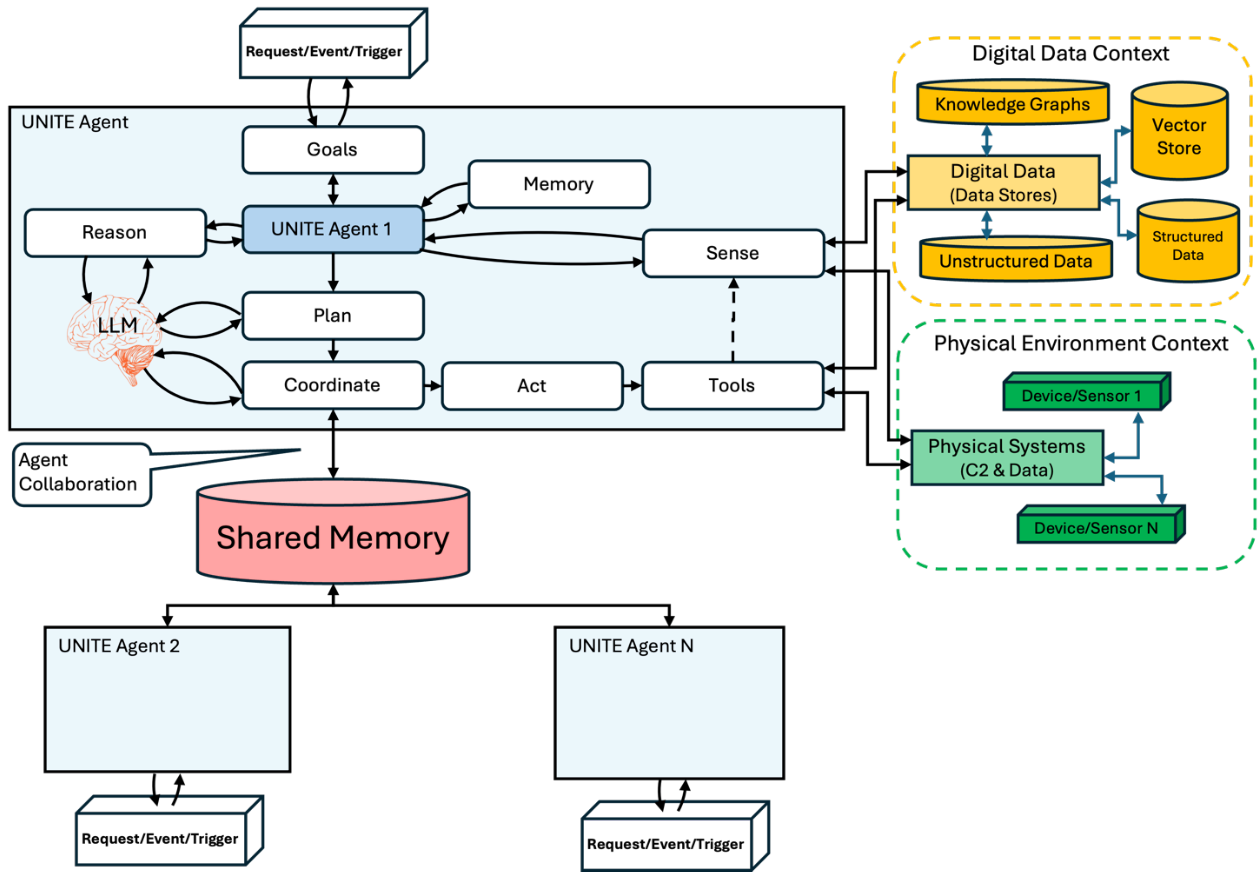

Figure 1: Agentic Anatomy (Derived from Dr. Ali Arsanjani)

Requests or events sent to UNITE become its **goals**, defined as the objectives or desired outcomes it seeks to achieve. These goals are not static; they are dynamically updated based on feedback from the environment and UNITE's internal states.

Through the **sensory** component, UNITE collects data from its environment. This sensory information can originate from digital sources, such as data feeds, and physical sources, like cameras or IoT devices. The reasoning component then processes the collected data. Here, UNITE evaluates the information using its stored knowledge and utilizes **LLMs** for complex language-based reasoning and inference.

Once the situation is understood, the agent transitions to the **planning** stage, which formulates a series of actions designed to achieve its goals. This planning is grounded in a rational understanding and situational context.

The coordinate component plays a vital role in effectively operating a multi-agent system. It enables the agent to share information and align its plans with other agents through shared memory, ensuring collaborative efforts toward common goals.

When it comes to execution, the **act** component is responsible for implementing the planned actions. UNITE employs various **tools** to interact with its environment, from collecting data to sending commands to remote devices. UNITE's LLM continues to facilitate language-based reasoning and decision-making throughout these processes.

2.3. Agentic AI Tools and Their Roles in UNITE

Agentic AI tools serve as the functional components that enable autonomous AI agents to perceive their environment, process information, make decisions, and execute actions effectively. Unlike standalone AI models that passively analyze data or generate insights, agentic AI tools enhance the agent's ability to interact with, manipulate, and optimize its surroundings. These tools function as extensions of the agent, allowing it to dynamically respond to real-world conditions, execute commands, and achieve predefined objectives.

In the **UNITE AIoT Platform**, agentic AI tools are essential for facilitating autonomous decision-making, execution, and adaptation. UNITE utilizes several tools vital to its operations, and the following sections describe their characteristics and types.

2.3.1. Core Characteristics of Agentic AI Tools

1. **Passive by Nature, Activated by Agents**—Tools do not operate independently; they require activation by UNITE, which uses them to accomplish specific tasks.

2. **Modular and Interoperable** – Designed to be integrated across different AI frameworks, environments, and use cases.

3. **Specialized Functions** – Each tool has a defined purpose, such as data collection, transformation, communication, or task execution.

4. **Optimized for Autonomy** – Tools facilitate decision-making without direct human involvement, enabling agents to operate independently in complex environments. LLMs and other AI-based models are interchangeable and can be fine-tuned or distilled from larger, more generalized models.

5. **Scalable and Adaptable** – Tools can be scaled, altered, or substituted to satisfy changing operational needs.

2.3.2. Categories of Agentic AI Tools

Agentic AI tools can be classified into several categories based on their functionality:

1. **Perception and Data Processing Tools**

   These tools enable an AI agent to collect, interpret, and process raw data from sensors, databases, and real-world sources.

- **Data Orchestration Tools** – Collect environmental data from IoT devices, cameras, or other input sources, determine consumer formats and routing, and store and retrieve data to improve agent knowledge.

- **Data Translation and Fusion** – Standardizes, correlates, and merges data from disparate sources to form a unified operational picture.

- **Natural Language Processing (NLP) Tools** – Enables UNITE to process and understand human language input for communication and decision-making.

2. **Decision-Making and Reasoning Tools**
   These tools assist UNITE in analyzing data, predicting outcomes, and selecting optimal actions.

   - **Predictive Analytics Tools** – Uses machine learning models to forecast events and anticipate potential failures (e.g., predictive maintenance).
   - **Resource Optimization** – Helps agents allocate resources efficiently in constrained environments.
   - **Reinforcement Learning Models** – Enables agents to improve decision-making over time through learned experiences.

3. **Execution and Control Tools**
   Execution tools allow UNITE to take actions, interact with physical or digital systems, and manipulate environments.

   - **Autonomous Software Delivery** – Automates the deployment, updating, and security patching of AI models and software applications.
   - **Task Automation and Workflow Orchestration** – Enables AI-driven execution of complex workflows across multiple systems.
   - **Actuator Control Interfaces** – Controls robotic arms, drones, and other hardware components for real-world interaction.

4. **Communication and Coordination Tools**
   These tools enable UNITE to collaborate with other agents, human operators, or external systems.

   - **Multi-Agent Communication Frameworks** – Facilitates data sharing and coordination between AI agents in a distributed system, often using a mesh network overlay for inter-agent communication resilience.
   - **Secure Messaging Protocols** – Ensures encrypted, low-latency communication in high-security environments.

- **Human-Agent Interaction Interfaces** – Provides dashboards, alerts, and interactive tools for human oversight.

By integrating these tools, UNITE is a fully autonomous agentic AI capable of operating independently in **mission-critical, industrial, and defense environments**.

3. Use Cases for UNITE's Agentic AI Capabilities

UNITE's agentic AI capabilities enable multiple use cases that enhance operational efficiency and decision-making in various industries. Key use cases include:

1. **Predictive Maintenance**
   A prime application of UNITE's agentic AI capabilities is predictive maintenance in industrial IoT. UNITE autonomously monitors equipment performance, anticipates failures, and schedules maintenance operations:

   - **Perception**: Collects real-time data from industrial sensors monitoring machine performance.
   - **Processing and Understanding**: Analyzes sensor data to detect anomalies and predict potential failures.
   - **Decision-Making**: Autonomously schedules maintenance, orders replacement parts, or reconfigures workflows.
   - **Execution**: Deploys maintenance actions, communicates with logistics agents, and ensures minimal operational disruption.
   - **Feedback and Learning**: Refines predictive models based on maintenance outcomes, improving future performance.

2. **Autonomous Software Delivery**
   UNITE enables fully autonomous software deployment and management across distributed edge and traditional IT environments, ensuring continuous system updates and security without human intervention:

   - Automates software installation, updates, and patches across all connected devices.
   - Uses AI-driven validation to ensure operational stability before deployment.
   - Enhances security by autonomously managing software integrity and compliance.

3. **Data Translation and Fusion**
   UNITE autonomously integrates data from multiple proprietary systems, translating disparate formats and creating a cohesive operational picture:

   - Converts and standardizes data from diverse sources for interoperability.

- Uses AI models to correlate and fuse incoming data, enhancing situational awareness.
- Reduces latency in decision-making by providing a unified data stream for analytics.

4. **Decision Support**
   UNITE acts as a real-time decision-support system, providing insights and recommendations for operators based on mission objectives and operational data:

   - Evaluates complex scenarios by analyzing diverse data sources.
   - Generates AI-driven recommendations for optimal actions.
   - Reduces cognitive load on human operators, enabling faster, more informed decision-making.

3.1. Business/Mission Benefits

UNITE addresses the challenges currently faced by the defense sector and is strategically prepared to manage future obstacles with greater agility and foresight by offering:

1. **Enhanced Interoperability and Integration** – UNITE's advanced interoperability capabilities allow seamless integration of diverse systems, from sensors to command centers, ensuring that all components work harmoniously. This eliminates silos and enhances the effectiveness of joint operations across defense sectors and allied forces.
2. **Optimized Resource Utilization** – By intelligently orchestrating and optimizing workloads, UNITE ensures that computational and data resources are utilized to their maximum potential. This reduces operational costs and energy consumption, creating a more sustainable military footprint.
3. **Improved Decision-Making Speed and Accuracy** – UNITE's edge computing capabilities allow for real-time data processing and analysis at the source. This drastically reduces latency, enabling quicker response times and more accurate decision-making in critical situations.
4. **Increased Operational Resilience in Challenging Environments** – Designed to function effectively in DDIL (Denied, Degraded, Intermittent, Limited) communication environments, UNITE ensures that operations can continue smoothly without total reliance on cloud connectivity, thus enhancing battlefield resilience.
5. **Adaptable to Changing Mission Requirements** – UNITE's modular architecture allows for rapid adaptation to changing operational needs and technologies, making it a future-proof solution that can scale as required by mission dynamics.
6. **Reduction in Total Cost of Ownership** – By improving the efficiency of data, user, and resource management, UNITE reduces the need for extensive hardware deployments and maintenance, leading to significant cost savings over time.

7. **Accelerated Mission Outcomes** – UNITE's capabilities in efficiently managing and deploying workloads allow for faster, more predictable results and higher success rates in achieving mission outcomes.
8. **Global Defense Network Enablement** – UNITE's ability to integrate and manage assets across a Combined Joint All-Domain Command and Control (CJADC2) environment makes it a cornerstone for establishing a unified global defense network, enhancing collective security and strategic operations.

4. Summary

UNITE leverages the transformative advancements in artificial intelligence, moving beyond passive AI models to a fully autonomous, agentic AI system. By enabling real-time decision-making, seamless interoperability, and autonomous execution, UNITE significantly enhances the effectiveness of edge-deployed and traditional IT systems in industrial IoT and defense operations.

Through its multi-agent system (MAS) design, UNITE ensures that distributed agents collaborate effectively, optimizing workflows, reducing latency, and enabling proactive decision support. Its key capabilities—Autonomous Software Delivery, Data Translation and Fusion, and Decision Support—demonstrate its adaptability in addressing complex, real-world challenges.

By reducing reliance on centralized infrastructures, UNITE improves operational resilience, ensuring systems remain effective even in communication-degraded environments. The platform's ability to autonomously monitor, analyze, and act upon data enables faster response times, increased mission success rates, and reduced operational costs.

As organizations continue to face evolving technological and operational demands, UNITE provides a scalable, intelligent solution designed to enhance efficiency and adaptability across industries. This agentic AI-driven approach positions UNITE as a cornerstone for the future of autonomous, intelligent systems, ensuring that businesses and defense sectors remain agile, resilient, and ready for the challenges ahead.

Appendix A: Glossary of Terms

Term	Meaning
Agentic AI	A type of artificial intelligence (AI) that can make decisions, solve problems, and can automate tasks that would otherwise require human intervention.
Autonomous Data Fusion	The ability to integrate disparate data sources into a unified, comprehensive view, enhancing situational awareness.
Autonomous Data Translation	The ability to facilitate seamless integration of various data formats, enhancing interoperability across different platforms/sensors.
Autonomous Software Delivery	The ability to deploy and manage updates automatically without human intervention.
Edge	Traditionally, a realm of isolated, proprietary solutions lacking interoperability and adaptability.
Intelligent Decision Support	AI-driven decision support tool, this feature offers deep insights for smarter, faster decision-making in critical scenarios, ensuring that every decision is data-driven and strategically sound.
Mesh Network	A local network topology in which the infrastructure nodes connect directly, dynamically, and non-hierarchically to as many other nodes as possible with one another to efficiently route data from/to clients.
Smart Data Orchestration	The ability to coordinate complex data streams, enabling more informed decisions and efficient system operations. It streamlines the flow of data across various military systems, ensuring that every piece of information is utilized to its fullest potential.
Internet of Battlefield Things (IoBT) Fleet Management	The ability to perform seamless operations and enhanced battlefield awareness by integrating and managing a multitude of IoBT devices effectively.
Workload Optimization	The ability to optimize workload distribution for peak performance. This feature ensures that resources are utilized effectively and efficiently, enhancing the overall efficiency of military operations.
Workload	Customer-provided software capabilities or functionalities that need to operate at the edge.
Optimistically Concurrent	Referring to the ability of multiple operations to complete without interfering with each other.
Software Development Kit	A collection of software development tools in one installable package, used by developers to facilitate the creation of applications
Large Language Model	A large language model (LLM) is a type of artificial intelligence (AI) program that can recognize and generate text, among other tasks. LLMs are built on large data sets using machine learning models.

Appendix B: Acronyms and Abbreviations

Acronym	Meaning
AIoT	Artificial Intelligence - Internet of Things
ATE	Autonomous Translation Engine
CR	Cognitive Radio
DDIL	Denied, Degraded, Intermittent, Limited
DoD	Department of Defense
ETL	Extract, Transform, Load
F2T2EA	Find, Rix, Track, Target, Engage, Assess
GPS	Global Positioning Systems
IoBT	Internet of Battlefield Thing
IoT	Internet of Things
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
LLM	Large Language Model
ML	Machine Learning
OTA	Over-the-air
OT	Operational Technology
SDR	Software Defined Radio
SNS	Simple Notification Service
SWaP	Space, Weight, and Power
TCPED	Tasking, Collection, Processing, Exploration, Dissemination

Appendix C: Document Revision History

Date	Version	Description	Author
February 28, 2025	1.0.0	Initial Release	Trigg Borgerson - CTO