PARASANTI

ANY SENSOR. ANY NETWORK. ANYWHERE.

Product Overview

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1. Executive Summary

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, thereby reducing information delivery and decision-making latency. By leveraging AIoT, UNITE promotes real-time data and information sharing and improves operational efficiency, minimizing errors, costs, and overall system latency while enhancing mission performance and adaptability in denied, degraded, intermittent, or limited (DDIL) communication environments.

The ability to quickly respond to constantly evolving and emerging mission requirements placed on deployed assets is essential to mission success. UNITE's autonomous software delivery will be a key capability to achieve the necessary level of adaptability for edge systems. The strategic advantage of autonomous software delivery goes beyond immediate operational efficiency; it also fosters a more cohesive and flexible command structure. This flexibility is crucial for maintaining dominance on the battlefield, where swift reconfiguration and response can significantly influence the outcome of operations.

The ability to rapidly adapt to changing mission requirements is essential in an ever-evolving environment, and UNITE's Autonomous Software Delivery (ASD) capability supports this adaptability. ASD significantly reduces downtime and minimizes the risk of human error by enabling quick deployment, configuration, reconfiguration, updating, and deletion or sanitization[1] across various platforms without manual intervention. Additionally, this capability enhances the reliability and security of software deployments. By utilizing Continuous Integration, Continuous Delivery (CI/CD), and ML/AI Ops techniques that automate testing and deployment processes and employing autonomous software delivery as the "last mile" of a deployment, overall management of deployed devices becomes more effective and efficient. Moreover, ASD facilitates consistent updates and patching across all edge devices, ensuring uninterrupted, secure operations and mission-critical functionality.

While ASD is the first capability UNITE implemented, two additional capabilities are currently in development: 1) Sensor Data Translation and Fusion and 2) Decision Support. These advanced capabilities give decision-makers a more comprehensive and detailed view of the operational landscape. By utilizing this enriched perspective, the platform will analyze the data and recommend courses of action based on mission objectives and desired outcomes. With these sophisticated capabilities, UNITE is evolving into an "agentic AI." Agentic AI refers to artificial intelligence systems designed to act autonomously, make decisions, and take goal-oriented actions without continuous

[1] As defined in National Institute of Standards and Technology (NIST) Special Publication (SP) 800-88 Rev.1 "Guidelines for Media Sanitization"

human oversight. UNITE will demonstrate this by proactively interpreting environments, planning steps, and adapting strategies in real-time to achieve mission objectives.

2. Introduction

The complexity of modern warfare, characterized by a multidomain environment with a growing array of sensors and shooters that continually enter and exit the tactical edge, demands advanced computing solutions capable of quickly adapting to changing conditions and autonomously interoperating with one another. AIoT (the convergence of Artificial Intelligence and the Internet of Things) offers the necessary capabilities for achieving this dynamic responsiveness. AIoT facilitates autonomous operations, real-time data and information sharing, and optimized coordination, thereby enhancing mission success, operational efficiency, and risk reduction for warfighters. However, successfully deploying AIoT systems needs more than just connected devices and AI; it requires a robust platform for continuous software delivery, secure operations, and scalable integration.

Currently, DoD operations are constrained by isolated and proprietary systems, leading to inefficiencies and diminished operational effectiveness. The presence of data silos, fixed asset configurations, latency issues, and overreliance on reach-back connectivity limits situational awareness, decision-making, and system interoperability, impacting the overall mission success. These challenges are magnified when operating with international partners, where cohesive data integration is vital.

Parasanti is leveraging its UNITE AIoT platform to provide a secure, scalable, and autonomous solution explicitly designed to address these operational demands. By offering continuous software delivery, adaptive integration, and secure operations, UNITE overcomes these limitations, creating a resilient, cohesive, and high-performance tactical ecosystem at the edge. Through this approach, Parasanti addresses today's operational gaps and sets a foundation for future-proofing defense capabilities to ensure that the DoD and its allies remain prepared and responsive to evolving threats.

The UNITE AIoT Platform aims to increase the effectiveness of tactical edge systems by addressing the constraints and limitations of today's edge-deployed systems. It is an acronym describing not only what it is but what it does:

- **Universal**: UNITE bridges disparate, proprietary systems at the command and data levels, linking any sensor to any shooter across any network.
- **Intelligent**: Adaptability is key. UNITE autonomously adapts to changing objectives by delivering and installing new software, modifying existing software, and creating data translators to bridge diverse systems.
- **Tactical**: Intended for military use, UNITE facilitates dynamic actions and immediate objective achievement.
- **Edge**: Designed to run on small form factor, decentralized devices with low space, weight, and power constraints, operating in communication-contested environments, meaning denied, degraded, intermittent, and limited bandwidth (DDIL).

UNITE is designed to operate in austere environments, leverage autonomous operations to increase system interoperability and adaptability while boosting the performance of edge devices by optimizing Space, Weight, and Power (SWaP), reducing latency, and

minimizing reliance on reach-back connectivity. UNITE will enhance the effectiveness and lower the operating cost of edge computing through key functionality such as:

- **Smart Fleet Management (IoBT/Edge Devices)**: Strategically managing the Internet of Battlefield Things (IoBT) and edge devices—ensuring secure deployment, updates, and monitoring;
- **Smart Data Orchestration**: Establish a mesh network overlay that enables effective coordination and management of data;
- **Smart Workload Optimization**: Maximizing the performance of each workload in relation to a device's available resources;
- **Autonomous Data Translation**: Bridging different data formats autonomously;
- **Autonomous Data Fusion**: Generating a cohesive view from diverse data sources; and
- **Intelligent Decision Support**: Offering AI-powered, real-time, data-informed insights and recommendations for decision-making.

Based on this functionality, Parasanti has developed or is developing three primary capabilities for UNITE: 1) **Autonomous Software Delivery**, which increases the relevant adaptability of deployed systems necessary to respond to changing mission requirements in a time-critical manner; 2) **Sensor Data Translation and Fusion**, the autonomous integration of diverse proprietary systems through the transformation and correlation of distinct data formats into an overall comprehensive picture, especially crucial in environments with limited connectivity; and 3) **Decision Support**, which raises decision-makers awareness and situational understanding while recommending courses of action in an attempt to reduce decision latency. These capabilities will be used to address various use cases that represent the highest demand seen from customers (See 0 UNITE AIoT Blueprint and 0 Use Cases for more details).

3. Problem Definition

Edge computing is of intense interest to strategic and tactical planners alike, but definitions vary across solution providers. This is also true when differentiating between IoBT and edge devices, i.e., hardware. 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.

To address the different interpretations of the Internet of Battlefield Things (IoBT) versus edge devices, Parasanti generally identifies IoBT and edge devices as small form factor, decentralized, resource-limited hardware (e.g., minimum CPU, memory, storage, bandwidth). However, the configuration and amount of available resources distinguish between IoBT and edge devices, where an IoBT device tends to have a single purpose or function (e.g., camera, temperature sensor, radar, software-defined radio) with little to no compute resources beyond supporting the single function, whose form factor could be considered man-packable in size. An edge device tends to be multipurpose and larger, such as a vehicle-mounted computer. Edge devices also tend to have more computing resources. Still, less than a traditional full rack-mounted server typically found in data centers, which are often susceptible to high or low temperature and humidity conditions.

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). Additionally, with the increase in the number of devices being deployed, an effective method of device management needs to be developed. Finally, these systems are often dependent on connectivity to a cloud or centralized processing resources and, therefore, lack resiliency, cannot operate reliably in communications-contested environments, and cannot adapt to changing or emerging mission requirements.

In addition to the above military-specific problem, *Gartner* has developed a chart describing key commercial edge computing technologies, their expectations, and timelines for adoption (see Figure 1: *Gartner* Hype Cycle for Edge Computing, 2023[2]). Parasanti has addressed four technologies in its product offering: Peer-to-Peer Edge, Edge AI Software, Edge Management and Orchestration, and information technology and operational technology (IT/OT) Integration. While not representing problems per se, incorporating these emerging commercial technologies into Parasanti's solution demonstrates alignment with current industry trends and highlights the dual-use nature of UNITE.

[2] Gill, Bittman, Dawson, *Hype Cycle for Edge Computing 2023,* Gartner July 2023

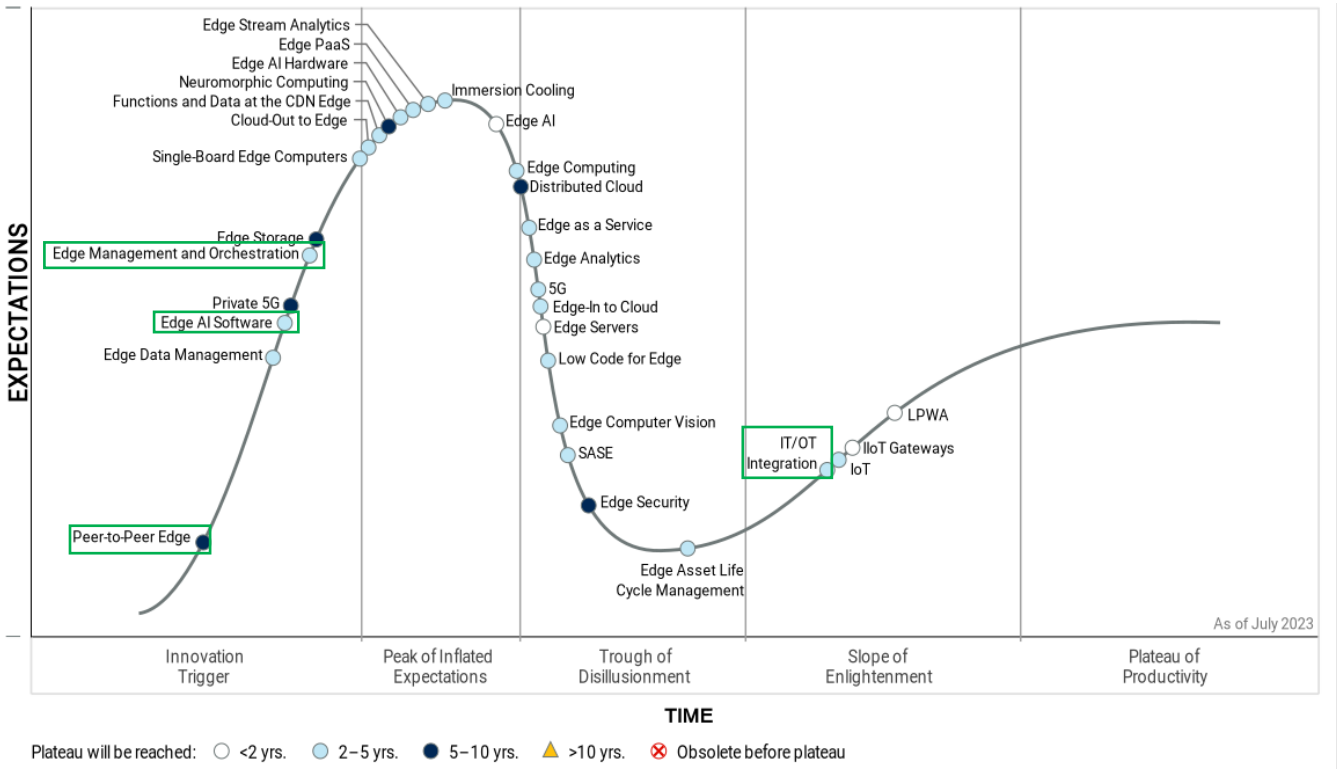

Figure 1: Gartner Hype Cycle for Edge Computing, 2023

Peer-to-Peer Edge: peer-to-peer edge computing enables distributed computing across an edge environment for resilience, workload orchestration, horizontal scaling, swarm learning, and interaction and cooperation between edge computing nodes using local or mesh networking as an enabling technology. Much of the early focus on edge computing has been extending intelligent things to the cloud and extending cloud capabilities closer to users and things at the edge. As more things connect at the edge, there will be a growth in capability, processing, interaction, and decision-making across things — creating systems of interaction at the edge. These systems can leverage each other for resilience, horizontal scaling, and orchestration of work.

Edge AI Software: Gartner defines Edge AI as a class of analytics and inferencing techniques utilized within endpoint devices, gateways, and local servers. This approach is driven by reducing latency, minimizing data transport requirements, and enhancing local processing capabilities. It supports a range of applications, from autonomous vehicles to streaming video analytics, focusing on AI inference. Fielding an AI model that operates at the edge is key to enabling edge systems to operate more independently, resulting in a more adaptable, lower latency system that can keep pace with the speed and uncertainty of military operations.

Edge Management and Orchestration: Gartner defines Edge Management and Orchestration (EMO) as solutions encompassing edge infrastructure software stacks and application management, particularly for remote or distributed deployments. These solutions are essential for managing the edge computing infrastructure without needing on-location IT staff. They address critical challenges in deploying and managing

distributed edge computing resources by enabling zero-touch deployments, updates, and remote management, facilitating a more flexible and scalable computing capability across various locations.

IT/OT Integration: "Unfortunately, today, the Department of Defense (DoD) struggles to liberate even the simplest data streams from our weapon systems. These machines are talking, but the DoD is unable to hear them."[3] And if they did hear them, the volume of data being generated would quickly saturate existing bandwidth, causing unacceptable data delivery latency to decision-makers. For all this data to effectively support today's warfighters, information technology (IT) systems must be converged with operational technology (OT) systems, often weapon systems.[4] IT systems are used for data-centric computing. OT systems monitor events (i.e., ISR) and equipment and track logistics, making or recommending adjustments to ongoing operations or during mission planning. Ultimately, this is what pushing processing to the edge means.

IT/OT convergence represents the shift of data processing from a data center or cloud to edge systems. Therefore, Parasanti's goal is to create a solution that accelerates IT/OT convergence by leveraging and integrating advances in communication networks, the Internet of Things (IoT) or the Internet of Battlefield Things (IoBT), edge computing, and artificial intelligence. This solution would merge mission objectives, battlefield awareness, and command and control into a single uniform environment.

4. Solution

Data and data processing are not shifting from the cloud or data centers to the edge. Instead, the edge has become a crucial hub for the net-new creation and processing of unique data, allowing for delivering high-value outcomes.[5] By effectively managing edge data at the edge, the probability of achieving desired mission outcomes increases. With edge systems able to integrate, interoperate, and adapt as an autonomous yet distributed, cohesive system, missions can improve efficiency, minimize errors, lower costs, adapt to changing requirements, and decrease overall system latency.

To solve the problem definition and create a cohesive, distributed system, Parasanti developed a tactical edge platform that connects, orchestrates, and optimizes any edge device across any configured network to achieve IT/OT convergence and empower decision-makers to understand and influence operations. The productized solution is known as UNITE (Universal Intelligent Tactical Edge). Designed as an agentic AI solution, it is recognized as an AIoT platform comprising a deployment console and a deployed agent. UNITE is built for continuous operations even in the event of loss of communications, either between UNITE-enabled devices or reach-back to a cloud/data center (i.e., independent operations, self-discovery, self-organization, and self–healing). However, when a reach-back link is available, the cloud ecosystem of services *can* be leveraged, as necessary, to extend deployed capabilities, such as logging, additional

[3] Dr. Josh Lospinoso, CEO Shift5, *Transcript of Senate Subcommittee Hearing to Receive Testimony on the State of AI and ML Applications to Improve DoD Operations*, p21.
[4] Bigelow and Lutkevich, *What is IT/OT convergence? Everything you need to know*, TechTarget, Oct 2023
[5] Pfeifer, *No Your Data Is Not Moving To The Edge*, Forbes, June 2023

processing, and operational monitoring/status. The only caveat is that during device setup, a link back to the cloud is required to initialize a device—the first UNITE *Agent* installation.

At Parasanti, security is paramount. Our security strategy is comprehensive, prioritizing the protection of mission and system data. Key elements of our security architecture include the principle of least privilege, which restricts device access to essential functions only, thereby minimizing potential attack surfaces. We also focus on secure credential storage, using advanced cryptographic techniques to protect device tokens, certificates, and keys while at rest, dependent on available hardware. Additionally, our comprehensive device lifecycle management ensures continuous monitoring and adjustment of access control in response to evolving threats. By taking a holistic view of data security that covers both data at rest and in transit, along with stringent management of firmware and software updates, we proactively address vulnerabilities, ensuring the confidentiality, integrity, and availability of sensitive data throughout the mission.

UNITE is designed around the key functions of fleet management, workload optimization, data orchestration, and autonomous operations. This collective functionality represents building blocks that can be utilized individually or in combination with delivering comprehensive capabilities. Customers use these capabilities to solve previously stated problems and create a robust system that enhances edge systems' interoperability and adaptability, reducing information delivery and decision-making latency.

4.1. Capabilities

UNITE is designed to offer three primary capabilities: autonomous software delivery, sensor data translation and fusion, and decision support.

4.1.1. Autonomous Software Delivery

The ability to respond quickly to constantly evolving mission requirements placed on deployed assets is essential for mission success. Autonomous Software Delivery will be vital for achieving the necessary adaptability for edge systems. e systems. As operations increasingly depend on the speed of information and rapid response capabilities, Autonomous Software Delivery is a foundational component that directly influences mission outcomes by ensuring that all technological resources are current and fully optimized and that the right tool for the job is deployed.

Autonomous Software Delivery will also benefit joint missions that include international partners. Missions often require restricted software, such as products under International Traffic in Arms Regulations (ITAR) control. In these situations, UNITE can deliver restricted software to devices during a mission and delete that software before the end of a mission. These activities are executed either after the device leaves the restricted environment or before it returns.

UNITE's Autonomous Software Delivery capability will significantly reduce downtime and minimize human error by facilitating software's rapid deployment, configuration, reconfiguration, and updating across various platforms without manual intervention. Moreover, this capability will increase the reliability and security of software deployments. By leveraging Continuous Integration, Continuous Delivery (CI/CD) techniques that automate testing and deployment processes and then using autonomous software delivery as the "last mile" of a deployment, overall management of deployed devices will be more effective and efficient. Furthermore, Autonomous Software Delivery enables consistent updates and patching across all edge devices, ensuring continuous secure operations and mission-critical functionality.

4.1.2. Sensor Data Translation and Fusion

Sensor Data Translation and Fusion merge data from multiple sensory inputs to deliver a unified and more accurate operational picture. This integration enhances information reliability, boosting operational capabilities on the ground. Sensor data translation and fusion are vital technological advantages that provide a comprehensive view supporting everything from high-level strategic planning to critical tactical field operations.

UNITE's Autonomous Data Translation and Fusion capability seamlessly integrates various proprietary military systems and their data formats by converting source-to-consumer formats and compiling the resulting dataset into a comprehensive overview, enhancing operational coherence and effectiveness. Additionally, joint operations with international allies will benefit from exchanging real-time transformed data between systems. UNITE acts as a software bridge that provides the interoperability necessary to utilize the many proprietary sensors and weapon systems commonly found in the mission space. While UNITE offers this functionality today, it is not fully AI-enabled. The AI-enabled approach is in development and will significantly expand the scope and speed of translation while reducing costs.

4.1.3. Decision Support

Decision Support solutions are critical in enhancing the mission effectiveness of military operations. This capability bolsters decision-making with rich, data-driven analytic insights and recommendations, ensuring mission leaders have the most comprehensive and timely information. During crises, incoming data streams are evaluated from a unified operational view, and decision-makers are provided with recommended courses of action based on mission objectives and desired mission outcomes. This capability is crucial for strategic decision-making, resource management, and tactical planning, significantly impacting the success of operations across both peacetime and combat missions. UNITE's agentic AI functionality is essential for implementing this capability and is currently in development.

4.2. Enabling Functionality

UNITE is designed to provide a solution that reduces the latency of information delivery and decision-making. It achieves this by leveraging a set of key enabling functionalities

that enhance the interoperability and adaptability of edge systems. This functionality encompasses fleet management, data orchestration, workload optimization, and autonomous operations. Autonomous operations are facilitated by Parasanti's agentic AI initiative, which includes data translation, data fusion, and decision support. Overall, UNITE's features represent the essential building blocks that can be used individually or in combination to deliver the required capabilities.

4.2.1. Smart Fleet Management (IoBT/Edge Devices)

Smart Fleet Management functionality provides full life-cycle management for UNITE Agent software, device system software, customer workloads deployed to edge devices, and operational monitoring of the device hardware. Along with a zero-touch approach to deployments, updates, and remote management, this functionality addresses critical challenges in deploying and managing a large number of distributed edge computing devices. It is essential for managing edge computing infrastructure without needing on-location IT staff.

4.2.2. Smart Data Orchestration

Smart Data Orchestration is the ability of edge devices to collect and route data from any number of sources to any number of data consumers. This removes central data pipelining, reduces operational bottlenecks, and promotes real-time data streaming over batch processing. Depending on the mission software, these local devices can also process and analyze the collected data. Smart Data Orchestration effectively unites disparate data sources and links them together through mission-defined data sharing and governance guidelines. This functionality includes controlling how collected data is accessed, who accesses it, and in what formats it is accessed.

Furthermore, data can be transformed at the edge into consistent, reliable, and useful formats according to mission requirements. Traditional data transformation methods achieve this; however, Parasanti is evolving this functionality into an agentic AI approach that will automate the translation process in real-time. Agentic AI is currently under development.

Smart Data Orchestration is enabled using a mesh network to connect all devices across a customer's network. The mesh network is designed as an overlay on a communications network provided to the configured devices. It is intended to create a fully connected network between all UNITE-enabled devices (nodes) across a given communications network. Nodes use this mesh network to securely pass messages/events between all nodes that contain status, commands, data, or other payloads that coordinate activities and actions necessary to execute and operate software workloads (i.e., mission-focused components, for example, data collection from a sensor; data ETL jobs; run analytics, including ML, against the data collected). It is fully connected and self-healing so that if one or more nodes are lost or gained, the mesh will accommodate the change to ensure all nodes remain or become linked.

4.2.3. Smart Workload Optimization

UNITE is a flexible workload orchestrator that enables an organization to quickly deploy and manage any containerized or legacy application using a single, unified workflow. Smart Workload Optimization is further enabled by using the mesh network to connect all devices across a network. This is a crucial enabler of autonomous software delivery. UNITE can run a diverse workload of Docker, non-containerized, microservice, and batch applications. Its workload orchestration is optimistically concurrent, increasing throughput and reducing workload latency. Furthermore, UNITE enables developers to use declarative infrastructure-as-code to deploy applications, providing efficient scheduling of jobs optimized for maximum resource utilization. This flexibility as an orchestrator allows a customer developer to create and deploy mission-specific applications that can be run together on the same edge device or across edge devices in a team.

4.2.4. Autonomous Operations

To achieve autonomous operations, UNITE is designed as an agentic AI. Agentic AI represents a transformative evolution in artificial intelligence, characterized by systems capable of autonomous, goal-driven decision-making and proactive behavior. Unlike traditional AI, which typically follows predefined rules or reacts to specific inputs, UNITE agents operate with a degree of independence, dynamically perceiving environments, analyzing real-time data, and taking calculated actions to achieve desired objectives.

Once fully implemented, the agentic AI functionality will serve as a powerful tool for command and control, offering critical insights to battlefield commanders at every level. To achieve this, UNITE will provide the following agentic AI-based services:

1. **Near-real-time Autonomous Data Ingest and Translation** – By bridging communication gaps between diverse systems, UNITE's autonomous data translation enhances interoperability among data generators, like sensors, data consumers, such as analytical software, and decision-makers. The seamless integration of various data formats improves interoperability across different platforms. It allows for transforming data collected from multiple sources with differing formats into a common format that can be combined for a more comprehensive overview. This "universal translator" relies on agentic AI to understand mission requirements, identify a common format, and transform or write code to convert each incoming data format as needed.

2. **Near-real-time Data Fusion** – Building on the agentic AI's data translation capability, the translated data can now be correlated, overlaid, and fused to comprehensively represent the operational environment. The agentic AI will merge individual data sources into a unified overview by comparing metadata such as timestamps, GPS coordinates, and dimensions. This enhanced operational awareness improves situational understanding and aids a decision-maker's cognitive offloading, potentially leading to faster decisions.

3. **Near-real-time Intelligent Decision Support** – Using individual data sources or a unified operational overview for situational awareness, the agentic AI compares

the situation to predefined mission, business, or process profiles. It then offers decision-makers actionable recommendations or courses of action. The agentic AI can also independently interact with other capabilities at the edge or, if reach-back connectivity is available, with capabilities hosted on the UNITE Console to achieve successful outcomes. This enhances military operations by enabling faster decision-making through cognitive offloading and quicker responses to evolving operational requirements.

5. The Product – Universal Intelligent Tactical Edge (UNITE)

The UNITE AIoT Platform is Parasanti's flagship product. It is software designed to enhance the effectiveness of tactical edge systems by addressing the constraints and limitations of today's edge-deployed systems. UNITE improves the edge's effectiveness by enhancing edge devices' interoperability, flexibility, and latency. Its modular architecture ensures rapid adaptability and integration with existing or new customer applications. The objective of UNITE is to deliver relevant information to decision-makers more quickly and respond to emerging, changing situations with greater speed.

UNITE comprises two key components: a cloud-based Deployment Console and an Agent, where the agent is deployed and provides for the intelligent operation of each edge device. The Console provides a user interface for Mission Operators to define, deploy, and monitor their edge agents. Customer developers build mission workloads and complete integration and testing activities within their preferred development environment. Then, these workloads are registered with the Console for deployment to Agents. Mission Operators will also use the Console to monitor the health of their deployed edge assets.

5.1. UNITE Central Deployment Console

The UNITE Central Deployment Console ("the Console") allows operators to manage deployed edge device software and their workloads throughout their lifecycles. Mission Operators can use the Console and other services to create teams of edge devices, deploy applications to these teams for local operation, and conduct remote operational monitoring. The Console can also provide access to cloud-hosted AI-based services that can collaborate with UNITE Agents to extend their agentic AI functionality.

Edge devices are registered with the Console before missions and are monitored whenever reach-back connectivity is available. UNITE provides built-in functionality for device monitoring and will introduce future customization, such as integration with operational analytic applications that offer greater insights into the health of the devices and software. Additionally, UNITE allows for setting alarms based on metrics that trigger actions like notifications when thresholds are crossed, improving operational responsiveness and oversight.

If communication between edge devices and the Console is lost, the devices will synchronize once communication is re-established. Synchronization involves sending cached telemetry data and executing maintenance jobs queued during the outage. Maintenance jobs include rotating security tokens and patching or updating software.

Customer application developers can import their mission-specific applications, including Docker containers or executable binaries, into the Console for deployment to a UNITE Agent or a team of Agents. The Console also offers an interface for Mission Operators to input values for mission-specific parameters, supporting both pre-mission planning and on-mission modification.

5.1.1. UNITE Field Deployment Console

A deployable version of the Central Deployment Console. It is to be used in the field and connected to the local network to perform edge deployment management and monitoring in case of loss of reach-back connectivity to the Central Deployment Console. This field version will provide operators with local functionality to perform basic deployment, monitoring, and troubleshooting activities. This feature is designated as a roadmap item and represents a future enhancement.

5.2. UNITE Agent

The UNITE Agent is designed to orchestrate operations within a mesh network, enabling effective control and collaboration among other UNITE Agents. Additionally, UNITE Agents are built with agentic AI functionality by integrating advanced technologies such as machine learning, adaptive algorithms, and contextual reasoning to learn from interactions, refine strategies, and navigate complex, unpredictable situations. Their primary function is to maintain observability of their operational environment, ensuring a comprehensive understanding of the current situational context and adapting Agent operations to achieve mission goals by adjusting to changes in situational or mission requirements.

The UNITE Agent brings local processing, messaging, software management, synchronization, and mesh networking features to edge devices and can be deployed to either ARM or x86 hardware architectures. This enables local devices to collect and analyze mission data closer to the source, react autonomously to local events, and communicate securely with each other on local networks. Local devices can also communicate securely with the UNITE Deployment Console and export device data, as telemetry, to the Deployment Console for display and alerting.

A UNITE Agent is a control plane that establishes a service mesh overlay linking local devices and their Agent software across a customer’s communication network. Additionally, Agents generate event messages and route them between devices depending on operational needs and a mission profile. A mission profile defines the operational scope of how Agents and mission software can interact with each other and their surroundings. The event messages control the Agent's behavior, execute the mission software, and route any output to the correct consumer. Events could relate to software management, e.g. installing, updating, starting, stopping, and deleting mission software, initializing a mesh network, establishing a reach-back link, or rotating security tokens. Furthermore, a UNITE Agent is a data plane. It can collect and route data from any number of sources to any number of consumers, and depending on the mission software, it can process and analyze data on edge devices.

In addition to its agentic AI functionality, UNITE Agents are a collection of services. For instance, an Agent can act as a message broker that provides access to the underlying communication hardware, system and application logging, device metrics, an event message handler, and encryption/decryption features. These services, among others, are available to customer developers, allowing them to save time by not needing to develop these components as part of their mission software. The UNITE Software Development Kit (SDK) makes each service accessible to customer developers. While developing mission software in their environments, they can download and utilize the UNITE SDK as part of their code. The SDK can reduce development time and establish guardrails that prevent developers from misusing resources or unintentionally creating security vulnerabilities in the Agent or the customer’s software.

5.3. Customer/Mission Workloads

Parasanti uses the term "workload" to describe customer-provided software capabilities or functionalities that need to operate at the edge. UNITE deploys, monitors, and manages these workloads and provides the runtime environments essential for executing the customer's software. This approach grants access to a standard set of services that, if used, guarantees effective computing at the edge, minimizing SWaP (Space, Weight, and Power), latency, and dependency on reach-back connectivity.

The customer, a third party, or Parasanti Professional Services will use the UNITE SDK to develop mission-specific "logic or code" that provides the functionality the mission end-users need to support a mission outcome. This code is separate from the UNITE code base and hosted by UNITE through the exposed services provided by the SDK. UNITE provides the framework to execute, control, and monitor the workload code.

6. Business/Mission Benefits

UNITE addresses the challenges currently faced by the defense sector and is strategically prepared to handle 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. **Robust Security Protocols** – With comprehensive security features integrated into every layer, UNITE safeguards sensitive data and operations against cyber threats, ensuring the integrity and confidentiality of mission-critical information.
7. **Advanced AI and Machine Learning** –UNITE provides advanced decision support, data fusion, and situational awareness, empowering operators with superior cognitive tools to anticipate and react to dynamic operational scenarios.

8. **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.
9. **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.
10. **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.

7. Summary

In today's rapidly evolving defense landscape, Parasanti's UNITE AIoT Platform serves as a cornerstone for transforming operational capabilities at the tactical edge. By integrating Artificial Intelligence and the Internet of Things into a unified, resilient, and scalable solution, UNITE empowers the DoD and allied forces with real-time data and information sharing, seamless interoperability, and autonomous operations—all crucial for achieving mission success.

UNITE's Autonomous Software Delivery (ASD) capability enables rapid, automated deployment, configuration, and updating of software across distributed assets without manual intervention. For instance, during a mission with limited connectivity, ASD can autonomously deliver critical software updates to deployed units, ensuring they possess the latest capabilities to respond to emerging threats. This capability is especially valuable in joint operations where international partners need secure software deployed and removed on demand. By reducing downtime and minimizing human error, ASD offers a level of adaptability at the edge that directly enhances mission readiness and resilience.

Senser Data Translation and Fusion is another critical feature of UNITE, merging data from various sensors and systems to create a unified, accurate operational picture. Imagine a scenario on a remote airfield: sensors dispersed around the airfield – such as radar, cameras, and weather monitors – collect diverse data types in different formats. UNITE's fusion capability integrates these data streams into a cohesive view, enhancing situational awareness for decision-making and ground teams. By autonomously translating and merging diverse data formats, UNITE enables commanders to make informed, time-sensitive decisions without being hindered by incompatible data sources, significantly improving mission coordination and response.

In high-stakes environments, Decision Support functionality within UNITE leverages AI-driven insights and provides mission leaders with actionable recommendations. For instance, in an urban operation scenario, UNITE can analyze incoming data from multiple sources, such as satellite imagery, ground sensors, and local intelligence. The platform then presents recommended courses of action based on mission objectives, enhancing strategic and tactical decision-making. By delivering accurate, data-driven insight quickly,

UNITE's Decision Support reduces the cognitive load on commanders, allowing them to focus on mission-critical tasks and respond to evolving threats effectively.

Beyond individual capabilities, UNITE's underlying architecture supports Smart Fleet Management and Smart Data Orchestration, which together optimize resource utilization and maintain connectivity across edge devices in a denied, degraded, intermittent, or limited (DDIL) communication environment. For example, suppose a group of unmanned ground vehicles needs to adjust their tasking due to an unexpected environmental change. In that case, UNITE's smart orchestration allows them to shift workloads dynamically and prioritize tasks without relying on reach-back to command. This autonomous coordination optimizes available resources and strengthens operational continuity, even under restricted network conditions.

By fusing autonomous operations, real-time data and information sharing, and secure, adaptable software delivery, UNITE provides a comprehensive solution to modern warfare challenges. It establishes a resilient, cohesive, and future-proof platform that meets today's operational needs while paving the way for continued advancements in edge computing. With its ability to address complex scenarios in a range of mission-critical environments, Parasanti's UNITE AIoT platform ensures that the DoD and allied forces remain prepared, responsive, and strategically dominant on tomorrow's battlefield.

UNITE AIoT Blueprint

The idea for UNITE started with a vision: to increase interoperability and adaptability to the Internet of Battlefield Things (IoBT) and edge devices, resulting in faster information delivery and decision times.

Like many industry terms, labels, or concepts, their true meanings become blurred or incorrectly interchanged over the years, complicating communication between two or more parties. Parasanti has opted to use the definitions for each of the terms listed on the left side of Figure 2 below.

First, functionalities were derived from the vision. This led to a solution design that was decomposed and implemented as a set of features. Most of the design features needed to be implemented in UNITE's Agent component, while others became the foundation for the Deployment Console, i.e., the user interface. With a minimum viable product (MVP) now defined, an effort to find concrete use cases within our vision's problem definition was started. The use cases with the most customer demand signal are listed in Figure 2 and further described in Appendix B: Use Cases.

Ultimately, the use cases coalesced into three capabilities, which are also listed in Figure 2, that UNITE could support based on its current functionalities.

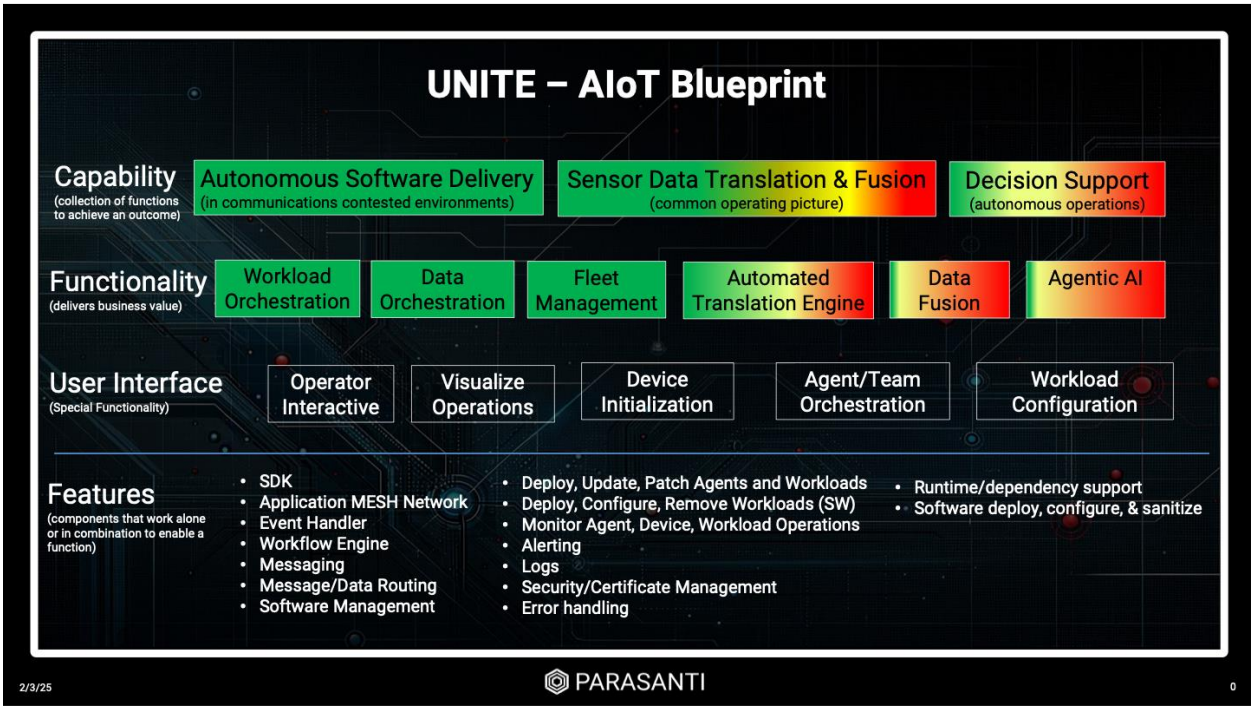

Figure 2: UNITE Blueprint

Use Cases

The UNITE AIoT Platform provides dynamic workload and data orchestration at the edge for various defense and commercial applications. From autonomously sending software packages to fusing complex sensor feeds, UNITE provides a flexible edge platform to make the edge more effective. Below are just a few examples of how UNITE can be used to solve real-world edge challenges.

Workload Orchestration for Autonomous Systems: Autonomous systems and edge devices are size, weight, and power (SWaP) constrained, making computing resources scarce at the edge. These SWaP constraints make it challenging to respond dynamically to changing environments and mission requirements. For example, if an autonomous system is in operation and encounters a new situation, it needs a method to receive real-time updates.

UNITE allows autonomous systems, such as a swarm of UAS, to share information and applications. If a UAS device is assigned a different role and requires an update, another device can share that application in real time without reach-back connectivity. Similarly, if a new UAS joins the team, it can update the software of the existing team members. UNITE enables workloads to be deployed and orchestrated across several edge devices.

Event Handling and Configuration Updates in a Multi-Domain Operation Environment (MDO): In complex multi-domain operations (MDO) with hundreds of sensors and shooters, the ability to analyze and share information is critical. Current systems are heavily siloed, preventing the right person from getting the correct information at the right time. UNITE creates a common data layer that connects data producers with data consumers in real-time and orchestrates software workloads to process this data in real time in compute-constrained environments.

UNITE can be deployed to various Soldier-worn devices, vehicle systems, and servers in the operations center. UNITE provides the capability to intelligently send information where it is most needed. For example, the Intelligence, Surveillance, and Reconnaissance (ISR) resources overhead of the Forward Observers (FOs) can provide a time-sensitive alert to the FOs if enemy targets are identified and then share the information with other elements when bandwidth is available. Prioritizing information transfer is critical in bandwidth-constrained or contested environments, which is expected in MDO.

Additionally, systems need to be able to respond to events in real-time by orchestrating software workloads on an edge device and across teams of devices. Usually, each device has a static workload. However, UNITE enables dynamic workload orchestration, allowing multiple software workloads to be dynamically turned off and on as data is received. Devices can also be updated remotely if necessary, increasing the capabilities of resource-constrained edge devices.

Sensor Fusion on Remote Airfields: Sensor fusion across distributed sensor systems is critical in time-sensitive applications, but it is incredibly challenging when handling data

of diverse types and formats. For example, data from several dispersed sensors around an airfield can be overlayed with cloud-based data sources. These data types range from simple JSON files to complex radar or raw audio data. The data sources must be fused for analytics, alerting, and visualization.

The UNITE edge software can be deployed to the various airfield sensors, providing a common data layer to perform standard extract, transform, and load (ETL) tasks and complex data fusion between several sensors. This data processing at the edge decreases data transfer and network bandwidth requirements. UNITE enables sensor fusion, creating one unified data layer for various edge systems and sensors.

Software Defined Radios: Dynamic Swapping Across Multiple SDRs - Dynamically swap across hardware devices operating in different frequency bands based on quality-of-service metrics. UNITE provides a key part to the solution by enabling:

- Event Handling – UNITE can dynamically choose which SDR has the best quality of service metrics, optimizing network communications in a denied or degraded environment.

- Command and Control – Out-of-band control channel can synchronize devices when switching between different SDRs, ensuring continuous communication.

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 in 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.
Smart 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.
Smart 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.

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

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April 15, 2024	1.0.1	Updated content	Tom Sheffield
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