**Rune Technologies**
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## Company Introduction

Rune Technologies is an innovative and non-traditional defense technology company building cutting-edge software to solve the most critical sustainment and logistics challenges faced by the U.S. military and its allies in contested environments. For Rune, the enablement and modernization of logistics and sustainment is not an afterthought or a secondary business focus, it is Rune's sole mission.

Rune is backed by some of the biggest names in the defense technology venture capital space: Andreessen Horowitz, Point72 Ventures and XYZ Ventures, and Rune's founding team comes with deep experience in the military and defense technology space. The Rune team is more than 75% software engineers and product professionals, and more than 60% military veterans, all singularly committed to moving fast to meet the needs of the DoD and the mission. Rune combines elite Silicon Valley software expertise with over 80 years of combined experience working in and with the Department of Defense building solutions for the tactical edge and with mesh network architectures. Rune is here to support the military logistics and sustainment communities with cutting-edge software to meet needs for the next fight.

Rune's flagship product is TyrOS, a next-generation logistics operating system for field logistics consisting of a middleware platform of logistics algorithms and a graphical common operating picture that provides increased situational awareness of available resources and logistics movement in the battlespace; predictive analytics on resource consumption and availability at each logistics node; and automated supply planning, optimizing over resources and transportation. TyrOS captures previously untapped tactical and operational logistics data currently stored in spreadsheets and whiteboards and adds analytics, data warehousing, supply optimization and open application programming interfaces.

Via TyrOS, Rune leverages predictive analytics, artificial intelligence, and dynamic optimization techniques to transform slow and reactive supply chains into fast and efficient supply webs that adapt proactively and operate at machine speed. Rune's open and secure platform is engineered for the complexity of denied, degraded, intermittent and latent (DDIL) environments, providing the U.S. military with a transformative tool ready to meet the emerging logistics requirements necessary to sustain the force in a near-peer or peer adversary conflict scenario.

## Problem Framing

Current military logistics planning and execution at the tactical and operational levels use analog processes and systems that served the military well during the Global War on Terrorism (GWOT) but are not as well-suited for the next fight against a potential peer or near-peer adversary. Current logistics planning systems and processes are slow to adapt to the dynamic, contested environments expected in future fights; are inefficient, due to missing situational awareness of distribution platforms and in-transit visibility of resources in the battlespace and follow a reactive “pull” model that is incongruent with new doctrines across the Joint Force.

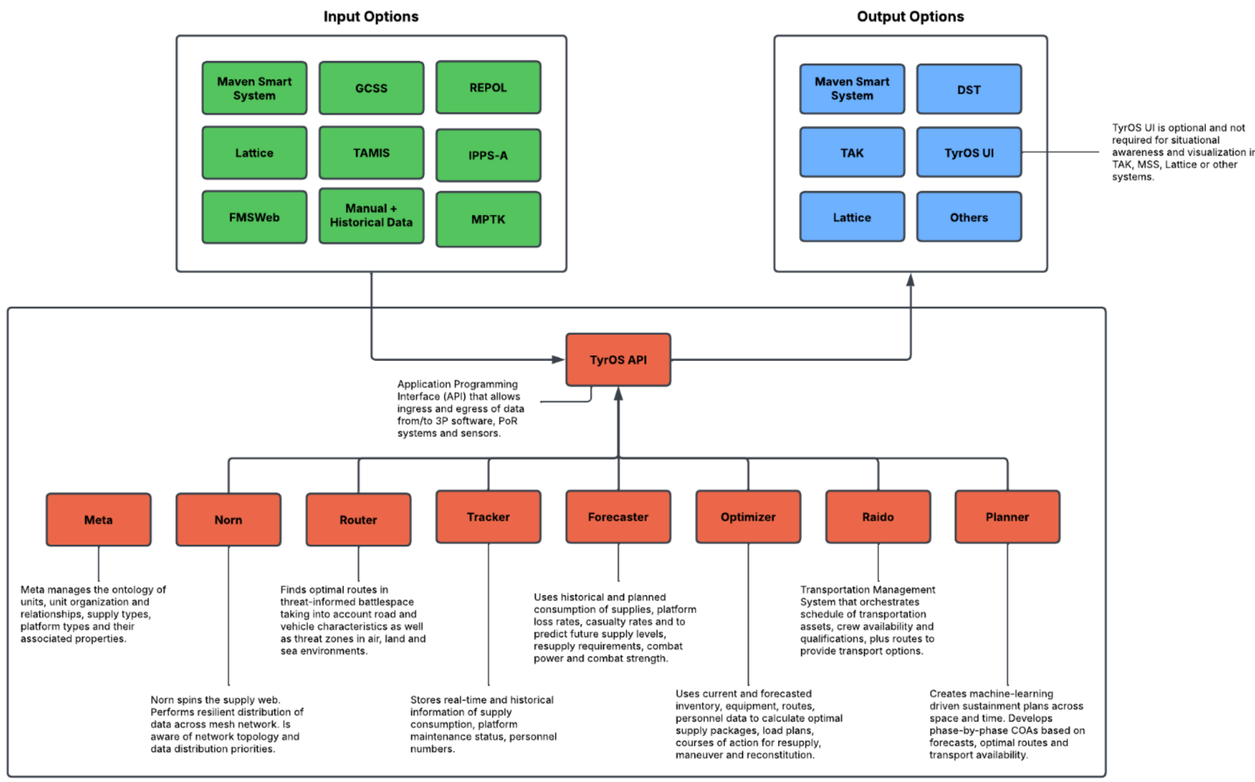
TyrOS looks to solve the following problems for sustainers at echelons three through six:

- Lack of real-time inventory visibility
- Lack of real-time platform fleet visibility
- Lack of automated supply package generation
- Lack of in-transit resupply visibility
- Lost time on swivel chair workflows

Sustainment processes must be modernized at the tactical level to increase the operational agility of units, maintain operational momentum and increase operational reach while reducing risk to mission from undersupply. Today’s legacy concepts of large, aggregated supply areas in targetable locations worked during the GWOT era but are not suited for a next-generation environment against a peer adversary. Systems must advance to allow the distribution and redistribution of supplies horizontally and vertically at the pace and scale required for the operation in question. Current systems also do not enable an integrated sustainment mission command and a common operating picture of sustainment that answers the questions of ‘who has what, where, and what’s the most efficient way of supplying units?’ in a contested environment.

The first step to reach the desired future state of supply webs efficiently allocating supplies across the battlespace is effectively collecting, aggregating and distributing inventory, platform and supply route data at tactical and operational echelons. The collection of such data enables visualizations and machine-driven workflows that accelerate sustainment from human speed to machine speed, increasing both the efficiency and precision of sustainment. Truly distributed sustainment operations at the speed and scale required to support operations in a peer adversary scenario cannot rely on human aggregation of data and human-only decision making. Human-machine teaming can drive substantially more effective and efficient sustainment operations at the tactical edge, allowing sustainers to look up-and-out and focus on higher cognitive tasks that truly require and leverage human experience and decision making.

## Technology Description




TyrOS

TyrOS is a next-generation logistics operating system developed to meet the sustainment and operational planning demands of modern military forces in contested, disconnected, and rapidly evolving environments. Engineered as a modular, distributed software platform, TyrOS integrates predictive analytics, mathematical optimization, geospatial intelligence, and secure data exchange to enable machine-speed logistics decision-making across the tactical and operational spectrum. This section provides an in-depth, technical, module-by-module overview of the core architectural components that power TyrOS—detailing the functionality, data flow, and solution approaches behind each subsystem to demonstrate how they collectively enable responsive, scalable, and intelligent logistics support in the most complex operational contexts.

### Meta

The Meta module serves as the foundational data layer of TyrOS, providing a structured and extensible ontology for all core logistics entities and relationships across the operating system. It captures and manages metadata for military units, supply classes, platforms, and organizational hierarchies, enabling the rest of TyrOS to reason over structured representations of the battlespace. Units types can be tracked by Special Reporting Codes (SRCs) and specific units by Unit Identification Codes (UICs), and supply items are identified by National Stock Numbers (NSNs) and Department of Defense Identification Codes (DODICs), ensuring compatibility with existing DoD data standards. The module also models platform types—such as vehicles, aircraft, and maritime assets—by Line Item Number (LIN), with associated performance characteristics like speed, dimensions, cargo volume, and load capacity. It encodes organizational control structures such as Operational Control (OPCON), Tactical Control (TACON), and Administrative Control (ADCON) between units, offering a real-time, accurate view of command relationships. Meta includes configurable tables of equipment, derived from sources like Modified Tables of Organization and Equipment (MTOE), which can be dynamically updated to reflect changes in mission requirements or operational conditions. This highly structured metadata architecture underpins TyrOS's ability to deliver predictive, optimized, and contextually aware logistics operations across tactical and operational echelons.

**Norn**


The Norn module is the decentralized communications engine of TyrOS, designed to ensure resilient, secure, and efficient data exchange across highly constrained tactical networks. It establishes a peer-to-peer, Layer 3 virtual network that connects all TyrOS nodes without reliance on centralized infrastructure—ideal for operations in denied, degraded, intermittent, and latent (DDIL) environments. Norn employs a zero-trust architecture enforced by revokable certificates and secures all communications using elliptic curve Diffie-Hellman (ECDH) key exchange paired with AES-256-GCM encryption, ensuring both confidentiality and data integrity across the mesh.

Norn has no fixed bandwidth requirements; it is fully adaptive and operates with whatever bandwidth is available, transmitting as much data as conditions allow. Bandwidth ceilings per node are configurable, giving operators control over data flow to match mission constraints. To maximize efficiency, Norn compresses data using Zstandard (Zstd), one of the most performant modern compression algorithms, providing high compression ratios with low latency—crucial for bandwidth-starved environments. Norn also features configurable prioritization across both network topology and data type: it ensures that critical nodes, such as higher-echelon units, receive updates before lateral units, and that high-priority data types (like platform readiness or supply changes) are sent ahead of lower-urgency information. The module tracks the state of each data transmission and can resume interrupted transfers without retransmitting completed segments, ensuring robust performance even in unstable or intermittent networks. By combining advanced encryption, compression, prioritization, and topology awareness, Norn enables TyrOS to operate as a secure, intelligent logistics network at the tactical edge—without compromise.

**Tracker**

The Tracker module is the data aggregation and persistence layer of TyrOS for operational sustainment state, maintaining both real-time and historical records of supply consumption, platform maintenance status, and personnel strength. It ingests and processes structured tactical reports such as LOGSTATs, PERSTATs, and combat SLANTs, serving as the authoritative source of truth for the current and past logistical posture of a force across distributed environments. Unlike traditional unit-centric tracking systems, Tracker organizes data by supply area—rather than strictly by unit—enabling it to support concurrent and geographically dispersed sustainment nodes. For example a Division Support Area (DSA) and a Forward Logistics Element (FLE), both associated with a division unit.

Tracker performs automatic, hierarchical aggregation of sustainment data, allowing subordinate unit reports to be rolled up into higher echelons without manual intervention. This includes not only aggregation across units (e.g., multiple companies reporting to a battalion) but also across supply areas supporting the same unit, offering a holistic view of resource availability and consumption trends at every organizational level. To support efficient long-term storage and retrieval, Tracker performs periodic compaction of historical rollups—reducing storage overhead while preserving fidelity for time-series analysis and retrospective queries. The module provides a structured, queryable interface to historical data, which feeds downstream systems such as the Forecaster and Optimizer, enabling predictive modeling and planning based on accurate, time-indexed operational inputs.

By decoupling sustainment tracking from rigid unit structures, automating aggregation, and employing intelligent compaction strategies, Tracker enables TyrOS to provide logistics and operations planners with a continuously updated, battlespace-wide understanding of resource status—forming a critical foundation for responsive, data-driven sustainment in dynamic operational conditions.

**Forecaster**

The Forecaster module is the predictive analytics engine of TyrOS, built to deliver accurate, real-time projections of supply availability, platform readiness, and personnel strength in complex, high-tempo operational environments. At its core is a flexible, modular ensemble architecture that incorporates a variety of time series and machine learning models. The exact composition of models within the ensemble is refined internally. Model families that have been evaluated and selected from include autoregressive models for temporal trends and seasonality such as ARIMA and SARIMA, recurrent neural networks like Long Short-Term Memory (LSTM) models for capturing long-range dependencies, and gradient-boosted decision tree techniques for modeling high-dimensional, sparse data with shifting operational regimes – XGBoost being an industry favorite. The composition of this ensemble is continuously evaluated for predictive accuracy and robustness across data densities, with best technologies incorporated as they are developed.

Underlying models were initially trained on a combination of commercial inventory and resupply datasets, synthetic military stockage scenarios, and curated historical LOGSTAT data. Platform damage and repair models, along with personnel attrition forecasts, were trained using data from real-world exercises, incorporating PERSTAT and combat SLANT reporting. The Forecaster operates in an online learning mode, ingesting real-time data updates from LOGSTATS, combat SLANTs, and PERSTATs. To avoid reacting to noise or anomalous short-term fluctuations, the module applies smoothing techniques—including Exponential Moving Averages—across incoming mini-batches. Forecasts are not merely reactive; they are context-aware, incorporating known future events and mission plans. These include expected changes in operational posture, scheduled fire missions, human-in-the-loop guidance on anticipated consumption, and critically, scheduled resupply operations—ensuring that projected supply levels reflect both anticipated usage and replenishment timelines.

Designed with edge execution in mind, Forecaster is adaptable to the available hardware footprint. In CPU-constrained environments, computationally efficient models are used to preserve performance, while in GPU-enabled settings, it can deploy more complex model architectures for higher fidelity. The architecture is extensible, allowing third-party models or custom components to be integrated by the Rune team. This adaptability ensures the forecasting engine remains at the forefront of capability, continuously evolving with new operational data and advances in machine learning. Forecaster empowers TyrOS to provide commanders with predictive, mission-aligned insights—driving proactive decision-making at machine speed in the most demanding operational contexts.

**Router**

The Router module is the geospatial routing and mobility engine within TyrOS, designed to compute optimal, threat-informed paths across land, air, and sea domains. It generates mission-feasible routes by fusing infrastructure data, platform mobility constraints, and geospatial threat intelligence, enabling logistics movements that are both efficient and survivable in contested environments. The Router is capable of modeling platform-specific constraints—such as maximum speed, vehicle dimensions, and road classification compatibility—ensuring that route selection is tailored to the capabilities and limitations of each transport asset, including autonomous capabilities.

For terrestrial routing, the module leverages global OpenStreetMap (OSM) data to provide detailed road networks and landmark references, forming a scalable and open-source geospatial foundation. Vehicle profiles are fully configurable to reflect differences in mobility, clearance requirements, and weight classifications, allowing the system to exclude roads that are infeasible for a given platform. Basic routing capabilities for air and sea domains are also included (rail being on the roadmap), supporting multi-domain mobility planning as part of joint or distributed operations.

Crucially, the Router integrates geospatial threat overlays to avoid known or suspected hostile areas. These threat zones can be imported from third-party intelligence platforms such as MIDB or Maven Smart System, allowing TyrOS to incorporate dynamic threat intelligence into its pathfinding logic. All routing data—including maps, vehicle constraints, and precomputed routing graphs—can be stored and accessed offline, enabling continued operation in disconnected or bandwidth-constrained environments.

Designed for modularity and extensibility, the Router forms a critical component of TyrOS's ability to deliver logistics plans that are operationally sound, threat-aware, and executable even in DDIL conditions.

**Optimizer**

The Optimizer module in TyrOS is built to solve complex logistics and sustainment challenges through various optimization techniques. At its core, it addresses a generalized form of the Inventory Routing Problem (IRP), optimizing over the combined space of inventory management, transport routing, and load planning across time, geography, and transportation modalities. The module leverages a combination of methods that is flexible and adaptable to the available compute infrastructure. Methods that were evaluated for selection and incorporated within TyrOS include mathematical optimization techniques such as linear programming (LP) and mixed-integer programming (MIP), heuristics-based algorithms (e.g., greedy approaches, Clarke-Wright savings), and more computationally intensive strategies including Simulated Annealing and Reinforcement Learning.

The Optimizer is engineered to strike a deliberate balance between solution optimality, computational efficiency, and real-world dynamism—the ability to respond quickly to changing conditions on the ground. In contested or time-sensitive environments, a fast, good-enough solution often outperforms a perfectly optimal one that arrives too late. As such, the Optimizer is designed to be pragmatic: it uses models and algorithms that scale with mission needs, adapt to available compute resources, and converge rapidly to feasible and tactically sound solutions. The selected algorithms are capable of computing supply allocations, transport assignments, and resupply strategies using both current operational data and predictive inputs from the Forecaster module, ensuring logistics plans remain executable, adaptive, and aligned with operational tempo.

Under the hood, the Optimizer is built on top of proven toolkits that provide scalable and extensible primitives for expressing and solving large, real-world logistics planning problems. These solvers handle complex constraints, including vehicle capacity, route feasibility, platform availability, delivery time windows, compatibility of supply types, and threat-aware routing informed by the Router module. The module's load planning capability includes a multi-constraint 3D bin-packing algorithm that accounts for cargo dimensions, weight, pallet structure, orientation restrictions, and Net Explosive Weight (NEW). It integrates this with detailed cargo profiles sourced from the Meta module, including an expanding dataset of ground, air, and maritime platforms (e.g., LMTVs, CH-47s, C-17s). The Optimizer supports multi-modal optimization across land, air, and sea (with future support for rail), and can extend or incrementally adjust existing supply plans without full re-optimization, enabling agile replanning in evolving operational contexts.

The internal configuration space includes encoded preference models—for example, prioritizing the use of autonomous systems due to lower manpower constraints, or favoring logistics units (e.g., FSCs) over combat elements to preserve combat effectiveness. These preferences are included into the optimization logic and reflect operational doctrine and sustainment priorities.

By integrating real-time forecasting, platform metadata, and mathematically grounded optimization techniques, the Optimizer produces high-fidelity, executable logistics plans that are both tactically sound and computationally efficient—enabling TyrOS to support decision dominance at the speed of battle.

**Raido**

The Raido module is the Transportation Management System (TMS) of TyrOS, providing a robust control layer for orchestrating the scheduling and execution of logistics missions across multiple domains. It manages the full lifecycle of transportation operations, from real-time, ad-hoc pull logistics requests to pre-planned, push-style requirements generated by the Planner module. Raido is responsible for maintaining temporal consistency across all missions and serves as the authoritative scheduler for transportation assets and associated personnel. Raido tracks and manages the assignment of transport platforms and crews to each mission, supporting the explicit association of personnel based on availability and qualification. It provides APIs for integration with authoritative systems of record—such as GCSS and TCPT—to import and validate personnel qualifications, ensuring that only appropriately certified individuals are assigned to mission-critical transport roles. While Raido itself does not perform automated decision-making, it provides a clean API surface that allows the Optimizer module to operate over its mission data—creating, updating, and aggregating missions based on evolving operational needs.

To support operational coordination and visualization, Raido enables both GANTT and Kanban-style views aligned with the Sync Matrix, giving commanders and logisticians a clear temporal and status-oriented representation of all logistics missions. It also supports geographically rendered in-transit visibility by virtualizing mission timelines—displaying expected transport movements on the map using pre-scheduled departure and arrival windows. This ensures situational awareness even in the absence of real-time position tracking. Additionally, Raido enforces structured approval workflows to reflect unit-level standard operating procedures, allowing for alignment with established command processes before missions are executed. By serving as the centralized coordination layer for transport operations, Raido enables TyrOS to tightly couple planning, scheduling, and execution—ensuring that logistics missions remain synchronized, accountable, and fully integrated with the broader operational picture.

**Planner**

The Planner module is the sustainment planning engine of TyrOS, designed to generate machine learning–driven, phase-by-phase courses of action (COAs) for logistics support across time and battlespace. It integrates predictive forecasts, optimized routing, and transport availability to produce detailed sustainment plans that reflect real operational constraints and intent. These plans include estimates for basic loads, anticipated supply consumption, and timing of resupply operations, while allowing for fine-grained configuration of controlled supply rates, replenishment thresholds, and unit-specific planning parameters.

At its core, Planner leverages standard doctrinal planning factors—for example those defined in Army ST 4-2—as initial baselines for estimating consumption rates, but refines these factors dynamically using machine learning techniques. As operational data is ingested from the Tracker module (via LOGSTATs, PERSTATs, and Combat SLANTs), Planner continuously updates its models through online learning upon plan completion, enabling iterative improvement over time. This results in a feedback loop where each executed plan enhances the accuracy of future estimates—driving convergence between doctrinal assumptions and real-world operational behavior.

Planning factors are exposed via both API and UI, enabling controlled configuration of variables like consumption rates, time-phased thresholds, and mission-specific logistics assumptions. Additionally, Planner allows developers and sustainment staff to define the priority of support (e.g., which units receive supplies first) and priority of supply (e.g., which classes of supply are favored under constraint), which are used by the Optimizer module to shape COA generation according to the commander’s intent and mission context.

By combining learned consumption models, operational forecasts, and domain-aware configuration, the Planner provides a data-informed, continuously improving foundation for proactive sustainment planning—enabling units to anticipate needs, mitigate risk, and sustain combat power in complex, distributed environments.

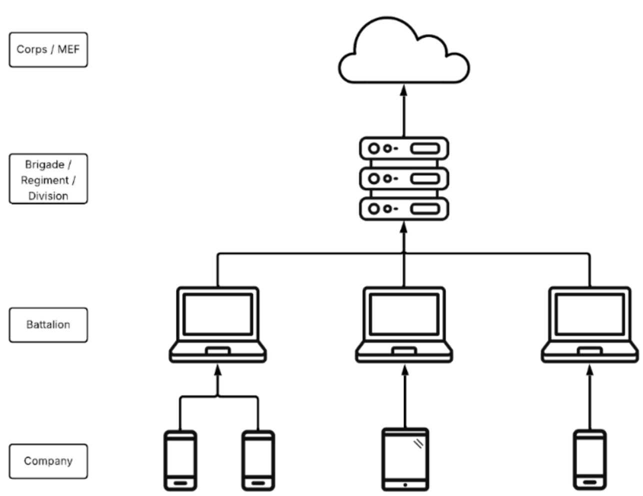
**API**

The Application Programming Interface (API) is the integration backbone of TyrOS, enabling open, standardized communication between TyrOS and third-party software systems, programs of record (PoRs), and external data sources such as sensors and C2 platforms. It establishes TyrOS as an open architecture system, designed from the ground up to interoperate seamlessly within a complex defense software ecosystem. This openness allows TyrOS to function not only as a standalone logistics operating system but also as a foundational component within larger, multi-system architectures for sustainment and operational planning.

The module supports both HTTP REST—with a fully documented OpenAPI (Swagger) specification—and gRPC via Protocol Buffers, offering flexibility for a wide range of integration use cases. REST endpoints ensure accessibility and compatibility with existing enterprise systems, while gRPC provides a performant, strongly typed interface for low-latency, high-throughput communication with modern microservices and edge-deployed software. All interfaces enforce robust data validation, access control, and auditability to meet operational security requirements.

The API serves as the primary interface for developers building on the TyrOS platform. The Software Development Kit (SDK) provides prebuilt integration tools and documentation to accelerate integration efforts and reduce development overhead. By making TyrOS programmatically accessible and developer-friendly, we ensure sustainment mission command remains extensible, interoperable, and mission-adaptable in support of both current and future operational needs.

**Deployment**



TyrOS is built with a scalable deployment architecture that supports operations across the full spectrum of tactical and strategic environments. All components of TyrOS are containerized using Docker and can be orchestrated via Kubernetes for clustered deployments or Docker Compose for simpler, single-node configurations. This modular approach allows each core module—Meta, Norn, Router, Tracker, Forecaster, Optimizer, Raido and Planner—to be deployed independently or as part of a complete system tailored to the needs and constraints of a specific unit or mission.

The TyrOS deployment footprint is designed to scale with echelon and operational complexity. At lower echelons—such as company or battalion level—TyrOS can run on small-form-factor edge compute devices or ruggedized laptops like Toughbooks, supporting basic forecasting, routing, optimization and tracking functionality in disconnected environments. As data aggregation and planning complexity increase at higher echelons (e.g., brigade, division, corps), TyrOS can scale up to more performant hardware footprints, including multi-core server blades or mobile data centers. Stationary units with reliable cloud connectivity can also access TyrOS in a cloud-enabled configuration, leveraging centralized compute and storage while still interfacing with forward-deployed edge nodes.

All development is supported by automated CI/CD pipelines that handle container builds, testing, and security validation. These pipelines include continuous integration testing, vulnerability scanning with Nessus and Aikido, and automated containerization of each module. TyrOS is fundamentally cloud-agnostic and not dependent on any single provider, with proven multi-cloud compatibility across AWS, Azure, GCP, and government cloud environments. This ensures TyrOS can operate in the most demanding, DDIL conditions while remaining interoperable with modern cloud-native architectures when available—providing a deployment model as flexible and resilient as the missions it supports.

## Leadership Biographies

**David Tuttle – Cofounder & Chief Executive Officer**
David began his career as a U.S. Army officer, leaving active duty for the private sector and working as an investment banker covering aerospace and defense clients. He then returned to active military service as an Operations Officer for a Special Missions Unit within the Joint Special Operations Command (JSOC). Following this operational assignment, he led a software development team within JSOC. After leaving active service for a second time, David joined Anduril Industries where he led the company’s C4 business before departing to found Rune. David holds a BS from Cornell University and an MBA from Georgetown University. He continues to serve as an officer in the New York Army National Guard.

**Peter Goldsborough – Cofounder & Chief Technology Officer**
Peter was handpicked by Facebook AI Research at the age of 19, following internships at Google, Bloomberg, and Facebook during his university years. As a core developer on Facebook’s PyTorch AI team, he played a pivotal role in advancing one of the world’s leading AI

frameworks before contributing to the Realtime Data Processing team as a senior software engineer. Peter's exceptional technical skills and leadership abilities then led him to Anduril Industries, where he was a founding engineer on the machine learning platform. He went on to serve as the lead software engineer for the company's Command and Control (C4) initiatives and ultimately as Chief Engineer for Anduril's Army C2 Next program. With a deep mastery of AI/ML systems and real-time data processing, Peter is a proven innovator and problem-solver in both commercial and defense tech landscapes.

**Kyle Haire – Head of Growth**
Kyle began his career in the U.S. Marine Corps, where he served for two decades as an F/A-18 Weapon Systems Officer. A graduate of TOPGUN, he spent over eight years with the Naval Special Warfare Development Group and the Counterterrorism Joint Task Force, providing leadership in some of the most challenging operational environments. After his military service, Kyle transitioned to the private sector, joining Anduril Industries as Director of Business Development. In this role, he focused on C2 initiatives and successfully built a qualified sales pipeline valued at over $100 million. In October 2024, Kyle joined Rune as Head of Growth, where he leverages his unique blend of military and industry expertise to drive strategic expansion and innovation. Kyle holds a BS from the Virginia Military Institute and an MBA from George Mason University.

## Points of Contact

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