

Microamp

Portable 5G mmWave Bubble for Jamming- Resistant Tactical and Operational Communications

SOLUTION BRIEF

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In partnership with:

 **ANDURIL**

Druid

Executive Summary

Modern warfare relies on real-time communication, intelligence sharing, and situational awareness between front-line troops and command centers. However, traditional wireless systems (VHF/UHF/sub-6 GHz) are easily detected, jammed, and targeted, making them a critical vulnerability. The Microamp 5G mmWave system addresses these limitations by providing secure, low-probability-of-detection and anti-jamming connectivity between frontline units and command or medical teams in the rear. It enables reliable, real-time data exchange that supports faster decision-making and improved mission effectiveness.

The system is designed to support advanced operational concepts, including resilient frontline communication and C2 (Command and Control), ISAC (Integrated Sensing and Communication), as well as high-capacity uplink for real-time video and sensor data. It further extends network reach and flexibility through integration with HAPS-based mmWave gNB deployments and NTN (Non-Terrestrial Network) support, while enabling precise UAV control and live video transmission in contested environments.

In these high-stakes scenarios, the "5G Bubble" concept is often used – utilizing local, temporary networks to provide connectivity within a limited operational area. This enables seamless communication between field units, unmanned systems, sensors, and command centers. Microamp's end-to-end 5G mmWave solution facilitates this by offering bandwidths up to 800 MHz and enabling deterministic multi-gigabit, ultra-low latency connectivity for real-time uplink-intensive operations.

Beyond performance, the Microamp system is designed and optimized to ensure secure and resilient to jamming connectivity with Low Probability of Intercept (LPI) and Low Probability of Detection (LPD) in mission-critical scenarios, supporting rapid decision-making and improved mission performance. This provides robust resistance to electromagnetic interference and jamming, significantly increasing the system's resilience to electronic warfare. These characteristics are particularly important in scenarios requiring the real-time transmission of large volumes of data in challenging environments, such as high-resolution video streaming, sensor system integration, communication with autonomous platforms, and edge computing.

While 5G mmWave offers high throughput, it also places significant computational demands on the Core Network. In tactical scenarios, this infrastructure must be hosted on compact, ruggedized compute platforms capable of rapid deployment.

This whitepaper presents an implementation of the Microamp jamming-resistant portable 5G mmWave Bubble, integrating the Microamp 5G mmWave gNB base station with the Druid Raemis™ Core Network, hosted on the rugged Anduril VoyagerVM 4.0 server platform. The resulting architecture provides a fully functional 5G mmWave Bubble with Low Probability of Intercept (LPI) and Low Probability of Detection (LPD). This solution delivers high throughput and ultra-low latency with rapid deployment capabilities, offering a mission-ready, compact, and low-weight form factor for contested operational environments.



Adam Olesinski
Head of RAN Solutions, Microamp

Key Points:

- **Mitigating Critical Vulnerabilities**

Replaces traditional VHF/UHF and sub-6 GHz systems, which are easily detected and targeted, with a secure 5G mmWave Bubble for real-time intelligence sharing and situational awareness.

- **Contested Environment Resilience**

Optimized for Low Probability of Intercept (LPI) and Low Probability of Detection (LPD), providing robust resistance to electromagnetic interference and electronic warfare.

- **SWaP-Optimized Tactical Design**

Delivers a portable, high-performance network in a compact and low-weight form factor, designed specifically for rapid deployment in harsh mission-critical environments.

- **High-Capacity Private Networking**

A rapidly deployable, private 5G mmWave solution that provides high-capacity connectivity in environments without public network infrastructure.

- **Ultra-Wideband Tactical Performance**

Operates in the n257/n258 bands with bandwidths up to 800 MHz, enabling deterministic multi-gigabit throughput and ultra-low latency for uplink-intensive tasks.

- **Standalone (SA) Architecture**

Features a high-performance, end-to-end integration of the Microamp 5G mmWave gNB with the Druid Raemis™ Core Network in a fully Standalone (SA) configuration.

- **Ruggedized Edge Computing**

Hosted on the Anduril VoyagerVM 4.0 rugged server, which provides the high-performance computational power required for intensive 5G Core processing at the tactical edge.

Solution Overview

The Microamp 5G mmWave Bubble is a resilient 5G mmWave connectivity solution designed for real-time operations and is NTN-ready. The architecture integrates high-performance compute and core network functions into a unified, standalone system capable of rapid deployment in tactical environments.

The heart of the solution is the 5G mmWave gNB from Microamp, which provides high-capacity radio access in the mmWave spectrum (24–29 GHz), enabling ultra-high data rates and low-latency communication. Operating in Standalone mode, the mmWave gNB supports advanced features such as beamsteering on both sides (RU and UE), flexible TDD configurations, ultra-high bandwidth, and full compliance with 3GPP Release 16. Its compact and ruggedized design allows for easy deployment in the field while maintaining reliable performance under challenging conditions.

The system utilizes the Anduril VoyagerVM 4.0 rugged server configured with the Rocky Linux 9 operating system. This server hosts the Druid Raemis™ Core Network and provides the necessary environment for 5G core network functions, including signaling handling and user-plane traffic processing. The compact and rugged design of the VoyagerVM 4.0 ensures that the Microamp 5G mmWave Bubble can maintain high-throughput processing while remaining mobile and easily deployable in the field.

The Microamp 5G mmWave Bubble is finalized through a direct connection between the compute platform and the Microamp 5G mmWave gNB base station via N2/N3 interfaces. This integration forms a complete, private 5G mmWave network operating in Standalone (SA) mode. By consolidating the gNB and the Druid Raemis™ Core on a ruggedized server, the Microamp 5G mmWave Bubble delivers a functional, portable, and high-performance network infrastructure for mission-critical scenarios. The solution architecture is shown on Figure 1.

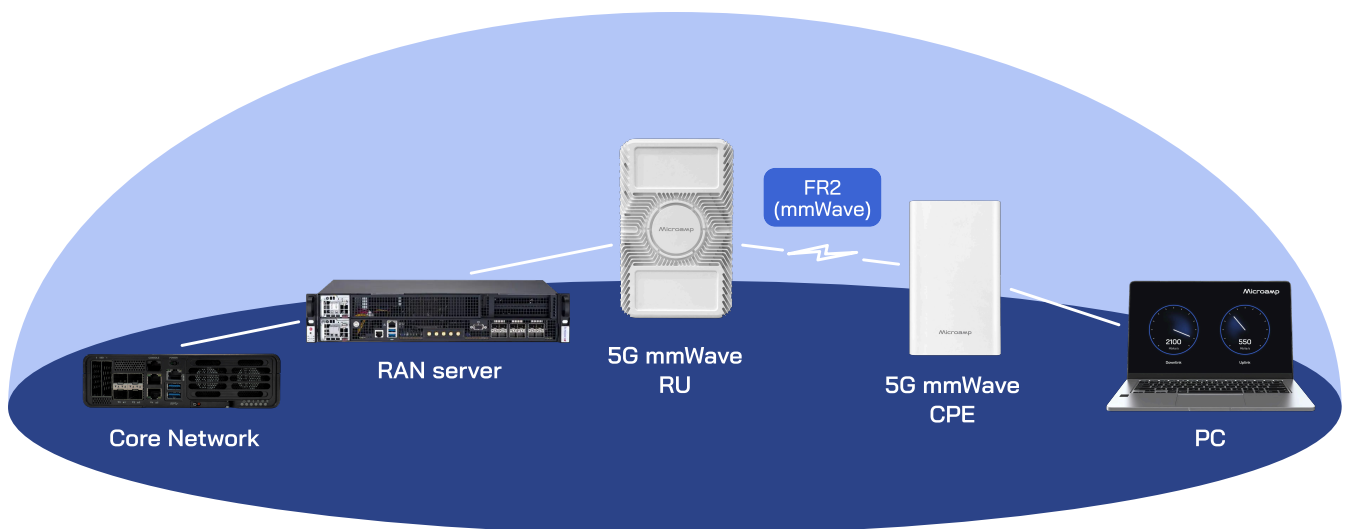


Fig. 1. 5G mmWave Bubble architecture.

The tests were conducted using a base station operating in the n257 band, with a center frequency of 27.6 GHz, configured with 2 Component Carriers of 200 MHz each, resulting in an aggregated bandwidth of 400 MHz*. The radio frame configuration used a TDD scheme with a DDDSU pattern, enabling efficient utilization of radio resources in scenarios with high throughput demand.

* The configuration selected does not fully exploit product capability of 800 MHz with which the throughput is doubled.

Key Components

System Identity	Microamp 5G mmWave Bubble
mmWave gNB	Microamp 5G mmWave CellBox Air gNB
User Equipment	Microamp M202 5G mmWave CPE
Core Network	Druid Raemis™
Core Network Server	Anduril VoyagerVM 4.0 (Rugged)

Microamp 5G mmWave CellBox Air Radio

A resilient, portable 5G mmWave radio optimized for outdoor and macro-cell deployment. Featuring advanced beamforming and acceleration algorithms, the CellBox Air ensures extended range and signal stability across diverse environments. The system is engineered for Low Probability of Intercept (LPI) and Low Probability of Detection (LPD), leveraging directional mmWave characteristics to minimize electronic signatures and provide robust resistance to jamming in contested areas.

Microamp 5G mmWave RAN

A 3GPP-compliant, 5G mmWave-optimized RAN, powered by the unique algorithms accelerating performance in the L1 Phy layer providing high computing capacity.

Druid Raemis™ Core Network

Druid Software provides the 3GPP-compliant mobile core platform Druid Raemis™, supporting 5G mmWave Standalone deployments. Designed for mission-critical communications, this scalable solution allows the rapid deployment of small or large tactical networks.

Anduril VoyagerVM 4.0 Server

The Anduril VoyagerVM 4.0 rugged edge server is used to host the Druid Raemis™ Core Network. The platform provides high-performance compute and networking capabilities in a compact military-grade form factor, enabling reliable deployment of the 5G core in tactical environments.

Performance

The configuration includes the Microamp 5G mmWave CellBox Air radio unit that accelerates unique algorithms in the 3GPP-compliant L1 Phy layer, and a ruggedized enclosure housing the telco server running the RAN stack, along with the Anduril VoyagerVM 4.0 server (top) hosting the Druid Raemis™ Core Network. Figure 2 illustrates the system setup used to deploy the 5G mmWave Bubble during the performance tests.



Fig. 2. Fully ruggedized setup used for the 5G mmWave Bubble deployment.

Performance tests included measurements of maximum downlink (DL) and uplink (UL) throughput, as well as Round-Trip Time (RTT) latency. Throughput was measured using the iperf3 tool in UDP mode, while RTT measurements were performed using the ping tool, generating ICMP packets every 20 ms, enabling continuous monitoring of network latency during the tests.

Based on the collected data, the stability and variability of the achieved transmission parameters over time were analyzed. The measurement results are presented in Figures 3–5, showing the downlink throughput, uplink throughput, and RTT values throughout the duration of the tests.

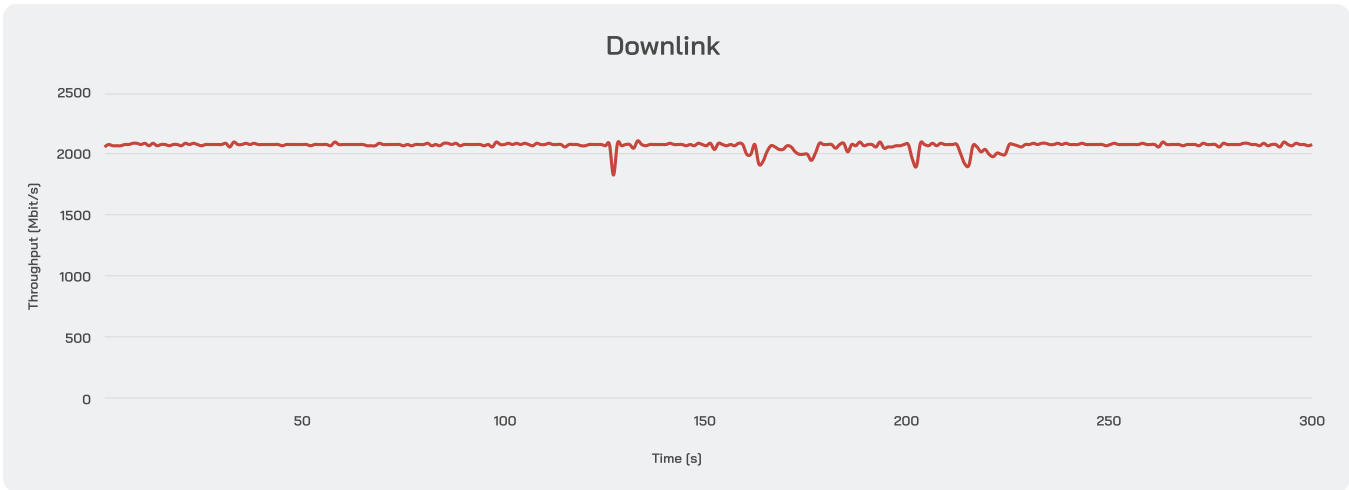


Fig. 3. Downlink performance over time.

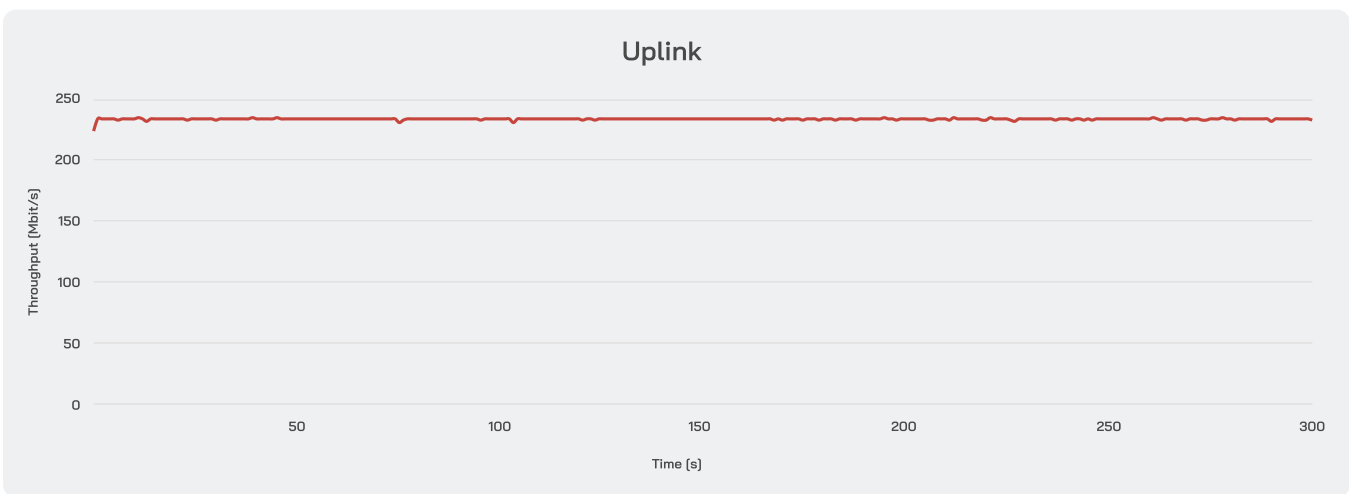


Fig. 4. Uplink performance over time.

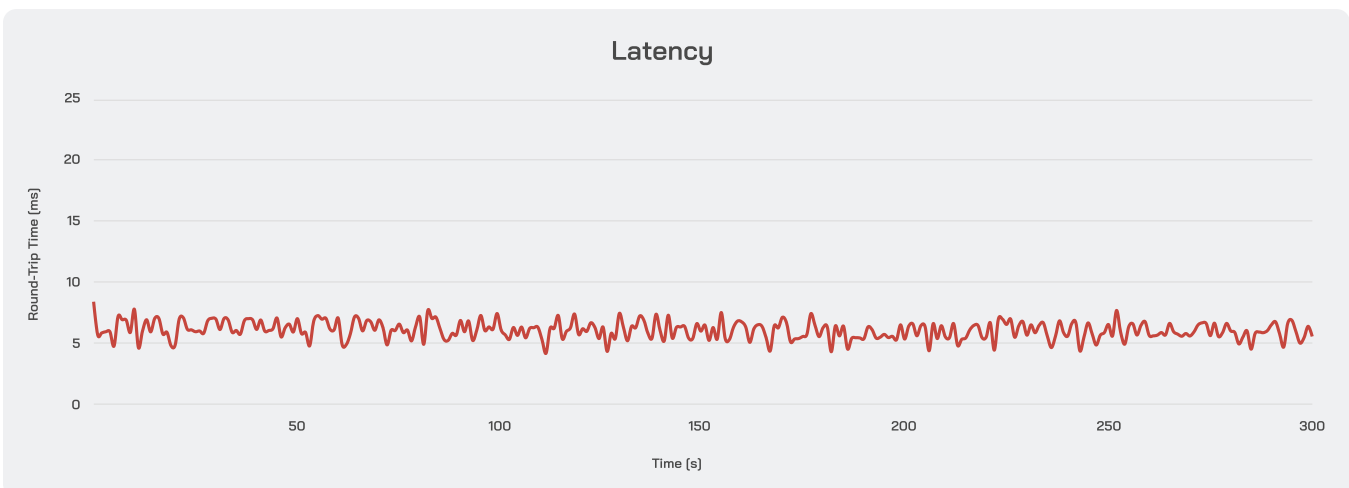


Fig. 5. RTT performance over time.

The average performance results (400 MHz bandwidth) were as follows:

	Average	Standard deviation
Downlink	2070.31 Mbit/s	32.56
Uplink	233.85 Mbit/s	0.74
Latency (RTT)	6.07 ms	0.73

The achieved results demonstrate that high-throughput 5G mmWave networks can be successfully deployed on compact, rugged platforms (specifically the Anduril VoyagerVM 4.0) with very high performance and stability.

This architecture enables the real-time operation of high-bandwidth military assets, such as high-definition sensor arrays and autonomous platforms, while significantly strengthening situational awareness and command coordination. Furthermore, the integration of LPI/LPD capabilities within this portable form factor ensures that these high-performance capabilities remain resilient and difficult to detect in contested environments. Ultimately, the solution proves that mission-critical, data-intensive connectivity can be rapidly established at the tactical edge without the need for traditional, static infrastructure.

Defence Use-Case Scenarios for Microamp 5G mmWave Bubble

The Microamp 5G mmWave Bubble architecture delivers high-capacity, ultra-low latency communications for mission-critical operations where fixed or public infrastructure is unavailable. By converging wideband mmWave connectivity with edge computing on ruggedized platforms, this solution enables the rapid deployment of high-performance tactical networks. The resulting infrastructure provides the deterministic throughput required for real-time data exchange and the most demanding advanced battlefield applications at the tactical edge.

Aerial and Drone-Integrated Networks

Persistent Command and Control (C2) connectivity with large observation drones via mast-mounted radio systems in operational camps.

Ad-hoc network deployment using tethered drones to extend C2 reach and high-resolution video streaming.

HAPS-integrated radios for wide-area C2 connectivity and live high-resolution data backhaul.

NTN-ready architecture supporting seamless integration with satellite and non-terrestrial communication layers.

Autonomous and Unmanned Systems

High-speed connectivity for various autonomous and remotely operated platforms, including UAVs and UGVs.

Low-latency control links for the precise remote operation of unmanned systems in critical environments.

High-throughput data exchange between autonomous platforms and centralized command systems.

Tactical Communications and Sensing

Rapid deployment of forward-deployed 5G mmWave bubbles for mobile command posts and tactical headquarters.

Support for mobile and temporary operational bases with a compact footprint.

Secure communication infrastructure independent of commercial and public networks.

High-bandwidth battlefield connectivity for units operating in contested environments (frontline communication with 10+ km range).

Localization and positioning facilitating precise tracking of friendly and adversary units, enabled by real-time signal control, RF feedback loops, and simultaneous sensing and data transmission.

Object detection and classification providing early warning and situational awareness, supported by adaptive waveforms, reflection analysis, and low probability of detection/intercept.

ISR and Situational Awareness

Real-time video transmission from Unmanned Aerial Vehicles (UAVs), ground sensors, and body-worn cameras.

Integration of multi-source Intelligence, Surveillance and Reconnaissance (ISR) data for a comprehensive operational view.

High-resolution sensor data distribution across tactical units for immediate coordination.

Edge processing for localized situational awareness and continuous battlefield monitoring.

Maritime and Littoral Operations

Secure, long-distance, high-bandwidth ship-to-shore and ship-to-ship communication for mission coordination.

Stable, high-throughput connectivity over water utilizing sea-surface reflections to enhance signal propagation.

Interference-resistant and difficult-to-detect network operations in contested maritime environments.

Command and Control (C2)

Real-time operational data sharing to support high-performance battle management systems.

Synchronization of distributed command post operations through high-bandwidth data exchange.

Integration of diverse tactical data sources into a unified, real-time operational picture.

Expeditionary and Rapid Deployment Operations

Ad-hoc tactical network setup in austere environments for immediate connectivity.

Portable edge computing infrastructure for forward-deployed high-performance processing.

Rapid setup of high-capacity communications in infrastructure-limited areas.

Reliable frontline communication for medical evacuation and casualty care coordination under drone and electronic threat conditions.

Summary

This whitepaper presents the Microamp 5G mmWave Tactical Bubble—a portable, highly jam-resistant network designed to ensure secure communications for critical battlefield applications. The solution has also been field-tested at ranges exceeding 10 km line-of-sight, demonstrating stable performance and resilience in real-world conditions. For organizations requiring resilient, mission-critical connectivity, the Microamp 5G mmWave private network leverages advanced beamforming to remain extremely difficult to intercept or jam (LPI/LPD), ensuring operational reliability and superior performance in contested environments.

The "5G mmWave Bubble" Architecture

Designed for defense and infrastructure-denied environments, the "5G mmWave Bubble" provides a secure, localized operational area for seamless communication between deployed units, unmanned systems, sensors, and command centers. The proposed solution integrates the Microamp 5G mmWave gNB with the Anduril VoyagerVM 4.0 rugged edge server, which hosts the Druid Raemis™ 5G Core Network. Running on Rocky Linux 9, the Anduril platform provides the high-performance compute environment required for 5G core functions while maintaining a compact, lightweight, and field-deployable form factor optimized for tactical operations.

Validated Performance Results

Rigorous testing confirms that high-capacity 5G mmWave networks can be deployed on compact, rugged platforms without performance degradation. The system achieved (with 400 MHz bandwidth):

- **Average downlink throughput:** 2070 Mbit/s
- **Average uplink throughput:** 234 Mbit/s
- **Average round-trip latency:** ~6 ms

These results demonstrate that the combination of Microamp 5G mmWave RAN, Anduril VoyagerVM 4.0, and the Druid Raemis™ Core enables rapid deployment of tactical networks capable of supporting modern ISR, Command-and-Control (C2), and high-bandwidth applications in contested zones.

Mission-Critical Advantages

The Microamp system delivers ultra-low latency connectivity with Low Probability of Intercept (LPI) and Low Probability of Detection (LPD). Key operational benefits include:

- **Resilience:** High resistance to electromagnetic interference and electronic warfare.
- **Uplink-Heavy Optimization:** Essential for real-time AI-driven analytics and high-resolution video/sensor feeds from autonomous platforms.
- **Tactical Versatility:** Ideal for real-time links between command posts, drones, and edge devices.
- **Strategic Impact:** Vital for medical evacuation (MEDEVAC) and casualty care coordination under drone and electronic threats, where persistent connectivity is a life-saving requirement.

Conclusion

The implementation of the Microamp 5G mmWave Tactical Bubble validates the feasibility of deploying secure, multi-gigabit connectivity in the most demanding electromagnetic environments. By successfully integrating high-performance radio and compute functions into a ruggedized, portable architecture, Microamp provides a definitive technological advantage at the tactical edge. This architecture establishes a persistent, secure communications baseline, ensuring mission continuity across contested and infrastructure-limited operational environments.

With the upcoming All-In-One (AIO) gNodeB supporting 1200 MHz, the Microamp 5G mmWave Tactical Bubble will become more compact (having CU/DU/RU in the same enclosure) and will increase the performance by a factor of 3 (to 6+ Gbps in downlink for DDDSU pattern and 4+ Gbps in uplink for DSUUU pattern), maintaining ultra-low latency, even under the significant computational load of a Standalone (SA) 5G Core.

Solution Specification

Microamp CellBox Air 5G mmWave gNodeB | Microamp

Throughput: 4+ Gbps

Latency: < 5 ms

Frequency bands: n257 (26.5-29.5 GHz), n258 (24.25-27.5 GHz), n261 (27.5-28.35 GHz)

Bandwidth: 800 MHz

Duplex: TDD

Deployment: Outdoor, macro cell

Anduril VoyagerVM 4.0 rugged server | ANDURIL

VoyagerVM 4.0 is a server virtualization module for use with Nutanix, VMware ESXi, Citrix XenServer or Microsoft Hyper-V.

Processor: Intel® Icelake 10-Core Processor with 128 GB RAM

Storage: Removable drives with custom enclosure (2 drives 3.84 TB)

Storage module: Removable 1 TB NVMe Voyager Ignition Key (VIK+)

Ports: 4 x 25 Gbps SFP28, 2 x 2.5 Gbps RJ45 Ethernet, 1 Gbps RJ45 Ethernet

Druid Raemis™ Core |

3GPP-compliant 4G/5G core

open RESTful API

Enterprise Slicing

Microamp M202 5G mmWave CPE | Microamp

Operating frequency: n257/n258

MIMO: 2x2

Chipset: Qualcomm SDX65

Antenna: Two (2) QTM547 mmWave antennas

Ethernet: 10GbE, PoE

Waterproof level: IP65

Microamp

About Microamp

Microamp is a leading tech innovator designing and delivering multi-gigabit and ultra-low latency 5G mmWave wireless networks based on purpose-built radios.

The company merges deep tech know-how and a broad portfolio of technology partners, empowering industries, system integrators, MNOs, DSPs, governments and research institutions with new dimensions of wireless connectivity.

Microamp's cutting-edge networks enable the implementation of the most bandwidth-hungry and technologically advanced use cases across verticals such as energy, mining, logistics, production, entertainment, public service and defence.

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