amarisoft

AMARI-Sphere
From 3GPP to O-RAN and AI-RAN

Version: 2026-01

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1 General Description

AMARI-Sphere integrates BubbleRAN's O-RAN and AI-RAN stack with Amarisoft's industrial-grade, software-defined 4G/5G stack. Amarisoft provides a proven 3GPP-compliant RAN/CN/IMS/UE foundation known for simplicity and ease of deployment. BubbleRAN extends this foundation with O-RAN–compliant programmability, cloud-native automation, and AI-driven network intelligence and optimization, while preserving Amarisoft's established workflows and user experience. By combining both technologies, **AMARI-Sphere enables users to design, deploy, and operate end-to-end O-RAN networks powered by AI-RAN services, from laboratory environments to production deployments**. It supports O-RAN standardized interfaces (E2, A1, R1) for real-time monitoring, control, and coordination, and delivers AI-for-RAN and AI-on-RAN services to jointly improve network performance and operational efficiency.

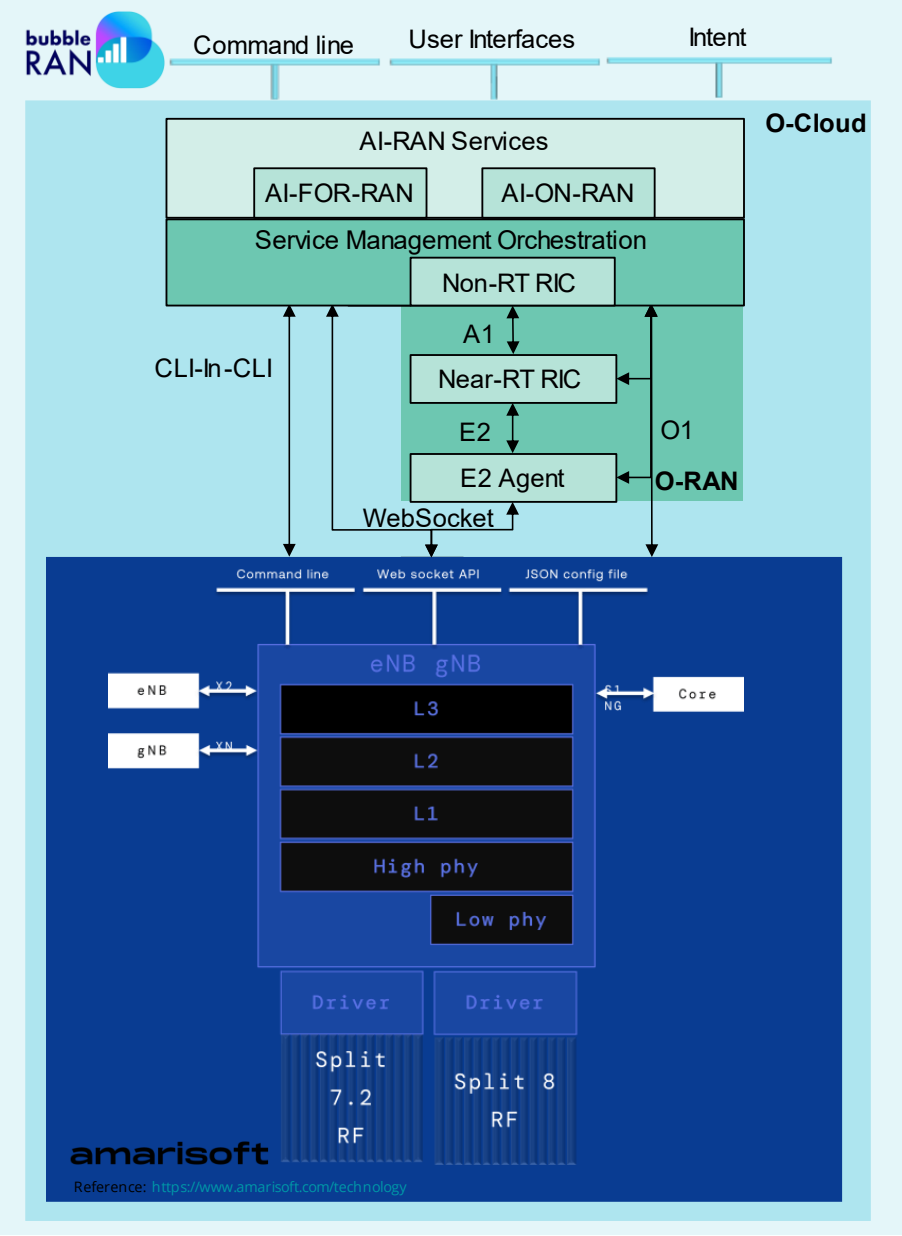


Figure 1: AMARI-Sphere Software Stack

As shown in the figure below, Amarisoft 4/5G stack is extended as follows:

1. **O-RAN stack**
    a. **RAN Intelligent Controller (RIC):** Providing programmability layer with the O-RAN Compliant Near-RT RIC and Non-RT RIC with E2, A1, and R1 interfaces, xApp/rApp catalog, and their associated SDKs.
    b. **Service Management and Orchestration (SMO):** providing automation layer from Day 0 to Day 2+ operations and streamlines RAN (eNB, gNB), UE, CN, and IMS lifecycle management and network slicing at scale.
2. **AI-RAN Stack:** Providing an intelligent layer with the AI-FOR-RAN and AI-ON-RAN Services with pre-built workflow to streamline RAN optimization, AI/ML pipelines, data collection and analytics, network insight, and agent toolkit and catalog.

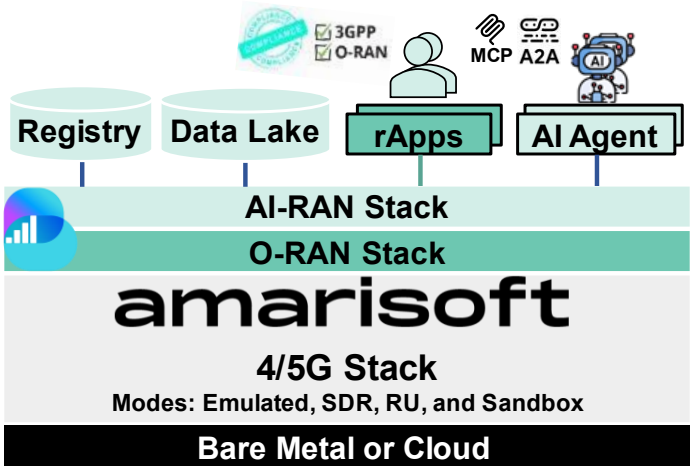
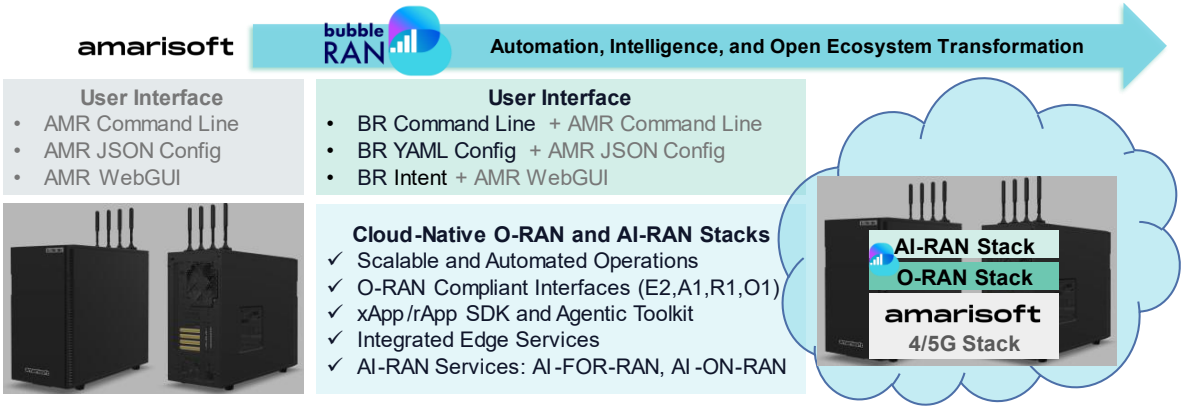


Figure 2: AMARI-Sphere Ecosystem

In addition, by extending the Amarisoft user interfaces with Intent-driven network operations, command-line, user interface, software development kit, and network assistant, customers are now able to seamlessly benefit from:

1. Agility, flexibility and performance of a fully software-based 4G/5G network deployment in both bare-metal and Kubernetes-based private cloud infrastructure.
2. Extended capabilities in terms of observability, programmability, automation, and intelligence provided by the BubbleRAN AI-RAN, O-RAN, and Cloud technologies.
3. Efficient design, development, and deployment of xApps/rApps/AI-Agents with BubbleRAN software development kits (SDKs) and Agentic ToolKit.



2 Software Components

2.1 BubbleRAN RIC

BubbleRAN RIC product, **RIC-Sphere**, follows the O-RAN architecture and specifications, where the Near-RT RIC resides on the RAN side (controlling O-CU/O-DU/E2 nodes via the E2 interface) and the Non-RT RIC is a logical function in the SMO framework, providing long-term policy, analytics and AI/ML orchestration via A1 and R1. **RIC-Sphere** includes the following distinct software components:

- **Non-RT RIC:** enables latency sensitive services such as policy enforcement and AI/ML capabilities for the RAN elements and their resources by means of rApps. It exposes the R1 interface to rApps and A1 to Near-RT RIC. In addition, it supports custom south-bound interface for legacy RAN.
- **Near-RT RIC:** responsible for fast loop control down to sub-milli-second latency of the RAN network functions. It can host and deploy specialized xApps logic for monitoring, control, coordination, and optimization. It has E2 and A1 interfaces terminations.
- **Proxy-E2 Agent:** Provides O-RAN E2 adaptor for legacy RAN and E2 Node emulation capabilities.
- **xApp and rApp SDKs**, development kits and reusable xApps/rApps samples with built-in tests and interface to DB.

The following tables list the features sets of the **RIC-Sphere** software components.

Non-RT RIC Feature Sets

Non-RT RIC	Feature Set	
Control Latency	10-100ms	
Interfaces	A1 Interface (A1AP v4.04, A1-P) R1 Interface (R1AP v8.0, or K8s CRD)	
R1AP	• A1-P related services • R1 OAM related services • AI/ML related services • R1 Data management Service • R1 Data exposure services	
rApp	**Capabilities**	• Intent-driven RAN Automation (performance, monitoring, Data collection, Policy Job) • QoS/QoE Optimization (A1 Services) • CM Optimization (OAM Services) • AI-powered Slice Enforcement (A1 Services) • AI/ML deployment capabilities • SLA Assurance (A1 Services) • Slice Provisioning & Assurance (OAM & A1 Services)
	Dev. Kit	rApp SDK
	Language	Python

Near-RT RIC Feature Sets

Near-RT RIC	Feature Set	
Control Latency	300us-1ms	
Interfaces	E2 Interface (E2AP v3.0) A1-Related APIs (A1AP v4.04, A1-P) E2-Related Open APIs	
Service Models	• O-RAN Key Performance Measurement (KPM v3.0) • O-RAN RAN Control (RC v1.03) • O-RAN Cell Configuration and Control (CCC v3.01) • O-RAN Low Layer Control (LLC v1.0)	
xApp	**Example Capabilities**	• RAN and UE performance measurement (traffic steering) • UE handover control (inter/intra cell) • RAN reconfiguration (band, bandwidth part) • RAN Sensing via SRS I/Q signal samples • Interference detection • Object Detection
	Dev. Kit	xApp User SDK xApp Developer SDK
	Language	C, C++, Python
	Database	• VictoriaMetrics, VictoriaLogs, VictoriaTrace • MySQL, SQLite3 (Optional)

Proxy-E2 Agent Feature Sets

Proxy-E2 Agent	Feature Set
Control Latency	300us-1ms (E2-Agent to Amarisoft RAN via WS)
Interfaces (south-bound)	• Websocket • Rest APIs • Customizable APIs via IO Callbacks Dataset File
Interface (North bound)	• E2 Interface (E2AP v3.0)
Service Models	• O-RAN Key Performance Measurement (KPM v3.0) • O-RAN RAN Control (RC v1.03) • O-RAN Cell Configuration and Control (CCC v3.01)
Mode	• Test • Operational

Proxy-E2 Agent maps the E2 interface to the Amarisoft WebSocket allowing third-party xApps to monitor, control, and coordinate the Amarisoft 5G RAN stack in Near-RT (<10 ms) via the Near-RT RIC. With this capability, advanced O-RAN compliant use cases such as mobility management, load balancing, interference mitigation, and energy efficiency become feasible, while preserving the native performance and features of Amarisoft.

2.2 BubbleRAN SMO

BubbleRAN SMO product, **SMO-Sphere**, is an O-RAN compliant, cloud-native Service Management and Orchestration platform designed as a declarative, intent-driven automation framework built on top of Kubernetes. It enables end-to-end lifecycle management of disaggregated, multi-vendor RAN and CN allowing to design, deploy, operate, automate, and optimize networks from Day 0 to Day 2+ at any scale, while reducing operational complexity, accelerating service rollout, and eliminating vendor lock-in. **SMO-Sphere** supports seamless onboarding of third-party network functions (NFs), including CU, xApps, and rApps, through a Container Development Kit (CDK), enabling both brownfield integration and greenfield deployments.

SMO-Sphere Feature Sets

SMO-Sphere	Feature Set
Operation Latency	1-10s intent-processing latency (excluding Infra. provisioning)
Interfaces	• Kubernetes CRD (YAML format) • REST APIs • O1 Interface (<2s deployment time) • RedFish APIs (PDU)
Ops	• Day 0: Resource Discovery, Provisioning, NF Onboarding, NS Planning & Design. • Day 1: NS Scheduling, NS Deploy, NS Configuration, • Day 2+: NS/NS Reconfiguration, Test, Upgrade, Observability.
Observability	Multi-source data lake with RAN stats, logs, traces, infra resource usage, and energy consumption.
Security	• Network Isolation • Signed, Unprivileged, Rootless Artifacts • Role-Based Access Control (RBAC) • Runtime Network & Process Security • Software Bill of Materials (SBOM)
User Interface	• Comprehensive REST API • BubbleRAN CLI (BRC) • Dashboards (Grafana)
Image Registry	Harbor
Networking	Cilium (CNI), Multus (multi-networking)
Storage	VictoriaMetrics (time-series), Rook & Ceph (persistent storage)
Infrastructure	Kubernetes distribution based on Kubeadm
Container Runtime	Docker and Snap (Optional: Containerd, Podman)
Dev. Kit	CDK

SMO-Sphere enables agile deployment of multi-cell multi-instance Amarisoft 4G and 5G RAN, CN, IMS, and UE stacks at any scale. It provides automated lifecycle management and operations such as network design and planning, configuration, reconfiguration, and fault management. RAN instances can be deployed with multiple slice configurations and connected to multiple CN from different vendors (typically with the Amarisoft RAN and Open5GS CN). Cells can be grouped into neighbor relations to support automatic handover configurations for both inter-cell and intra-cell scenarios. Within the cluster, supported Amarisoft SDRs are automatically detected, while a cloud-native license server supports the management of various Amarisoft license types for both in-cluster and external deployments.

SMO-Sphere can deploy Amarisoft RAN, CN, IMS, and UE components in private cloud infrastructures. In addition, the BRC provides direct access for extraction of logs/configs/PCAPs files as well as all the commands in the vanilla Amarisoft command-line interface and WebGUI, hence preserving the user experience.

2.3 BubbleRAN AI-RAN Services

BubbleRAN AI-RAN services enable closed-loop automation and intelligence through AI-for-RAN and AI-on-RAN capabilities and a network assistant on top of Amarisoft 5G networks. The solution is an extensible software stack with toolkits that allow customers to develop new telco agents, or to reuse, extend, and customize existing AI agents. It streamlines RAN optimization, AI/ML pipelines, RAN analytics and insights, and dataset collection.

AI-RAN Feature Sets

AI-RAN	Feature Set
Decision Latency	1s-1m
AI-RAN Services	• **AI-for-RAN:** Intelligence executed outside the RAN software (e.g., in orchestration layers or rApps) • **AI-on-RAN:** AI-based applications and services are co-located with RAN infrastructure (e.g., edge GPUaaS)
Agent Catalog	• K8s API Agents (all operations) • Observability Agent • SLA/Performance/Anomaly Agent (EXP) • Network Configuration (EXP)
Supported Protocols	• A2A (agent to agent communication) • MCP (access external tools, prompts, datasets)
User Interface	API, CLI, UI.
Agentic ToolKit	BAT with prebuilt Agentic Workflow
Programming Languages	Python, Go

2.4 Amarisoft Network and UE Series with License Server

To operate the BubbleRAN solution, customers must obtain the required Amarisoft software stack licenses:

- AMARI Floating License Server (FLS) and Keys
- AMARI vRAN/eNodeB/gNodeB and 4G/5G CN/IMS software licenses, such as NW 200/600/2000/4000/8000
- AMARI UE SimBox Series (optional)

These licenses are prerequisites for integrating BubbleRAN with the Amarisoft 4G/5G stack. For detailed information about the Amarisoft vRAN/eNodeB/gNodeB, UE Simbox, and 4G/5G CN/IMS software components, please refer to AMR 4G-5G-VRAN-Technology and AMR-UE-Simbox.

BubbleRAN supports running an Amarisoft license server for both internal and external deployments for the cluster as a deployment in the cluster with the support for multiple types of Amarisoft licenses. Additional information on how to set up and troubleshoot the configuration of the license server.

Links

- AMARI 4G-5G-VRAN-Technology Additional information.
- AMARI CallBox Series
- AMARI UE SIMBox E Series
- BubbleRAN SMO-Sphere Family
- BubbleRAN RIC-Sphere Family
- BubbleRAN MX-Product Family

3 Hardware Options

3.1 Compute Node

3.1.1 Option 1: Deploy on AMARI Callbox Series

BubbleRAN provides the capability to set up the O-Cloud infrastructure on top of existing AMARI callbox hardware (AMARI Callbox Advance onwards recommended).

3.1.2 Option 2: Deploy on Customized Compute Nodes with Amarisoft SW License

- **Compute Nodes**
  High-performance Intel- or AMD-based servers (Ryzen, EPYC, i9, Xeon) supporting AVX512 SIMD instructions. Minimum Recommended Spec:
    - CPU: >3.7GHz, >16 cores
    - Memory: >64GB RAM
    - Storage: NVMe or SSD (write intensive)
    - Form Factor: Tower or Rack or Server
    - Cooling: Fan or liquid cooling
    - CPU: < 2 years old (recommended)
- **Operating System:** Ubuntu recommended (RHEL supported).
- **Cluster Setup:** At least one compute node for a typical deployment (3 compute nodes recommended).
- **Edge Devices:** Quectel modem with SIM cards and required accessories.

3.1.3 Option 3: Deploy on BubbleRAN O-Cloud with Amarisoft SW License

High performance RACK servers with cabinet or high-performance workstations.

- **Compute Node Example for Workstation**
    - **PSU:** Corsair RM1000x (2024) — 1000 W
    - **Motherboard:** MSI MAG X670E Tomahawk WIFI (AM5)
    - **CPU:** AMD Ryzen 9 9950X (100-100001277WOF)
    - **CPU Cooler:** Noctua NH-D15 G2 LBC
    - **Memory:** Kingston DDR5 Fury Beast Black **EXPO** 64 GB (2×32 GB) **5600 MT/s**
    - **Storage:** Samsung SSD M.2 “990 EVO Plus” **1 TB** (NVMe)
- **Operating System:** Ubuntu 22.04.5 (RHEL supported).
- **Cluster Setup:** Minimum 3 compute nodes (up to 8 with base license).
- **Edge Devices:** Quectel modem with SIM cards and required accessories.

For Server, we use Dell and Supermicro server (2U-4U). Please contact BubbleRAN for more information about the server spec.

3.2 RF Options

3.2.1 Option 1: AMARI SDR

Amarisoft provides two SDR Cards products (SDR50 and SDR100) operating with the Amarisoft software components. Available SDR cards include:

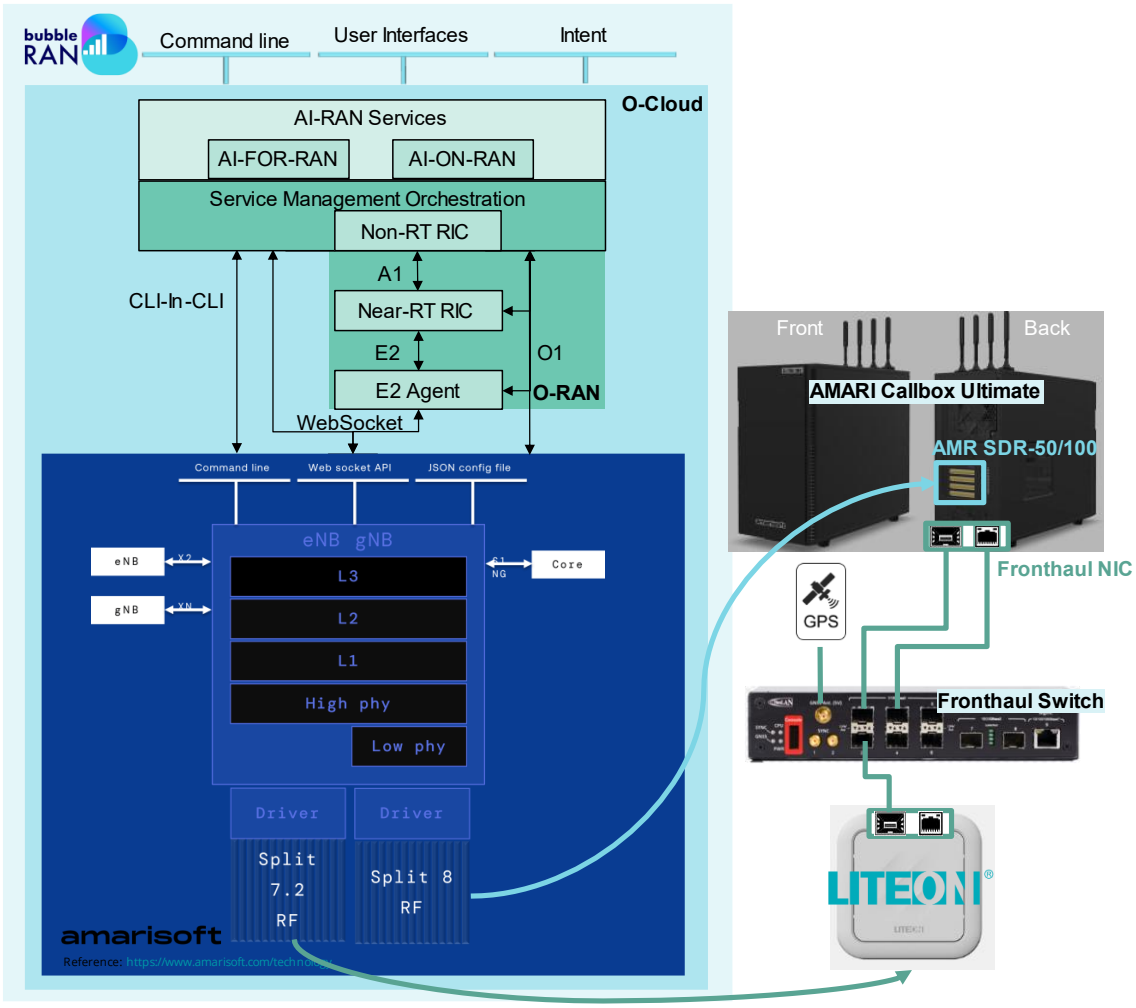
- AMARI PCIe SDR 2x2 Card
- AMARI PCIe SDR 100 4x4 Card

USRP can be used, but not recommended.

Links: [Amarisoft Device Products, AMARI PCIe SDR 2x2 Card, AMARI PCIe SDR 100 4x4 Card.]

3.2.2 Option 2: O-RU (O-RAN Split 7.2) or RRH (CPRI Split 8)

In addition, Amarisoft 5G stack supports both the O-RU (O-RAN Split 7.2) and RRH (Split 8). For example, it can be connected to the LITEON FlexFi O-RU for bands n77/n78/n79 or AW2S RRH (e.g. JAGUAR or PANTHER). For more information, please contact Amarisoft. Example of an O-RAN setup with the O-RAN 7.2 split is shown in the figure below.

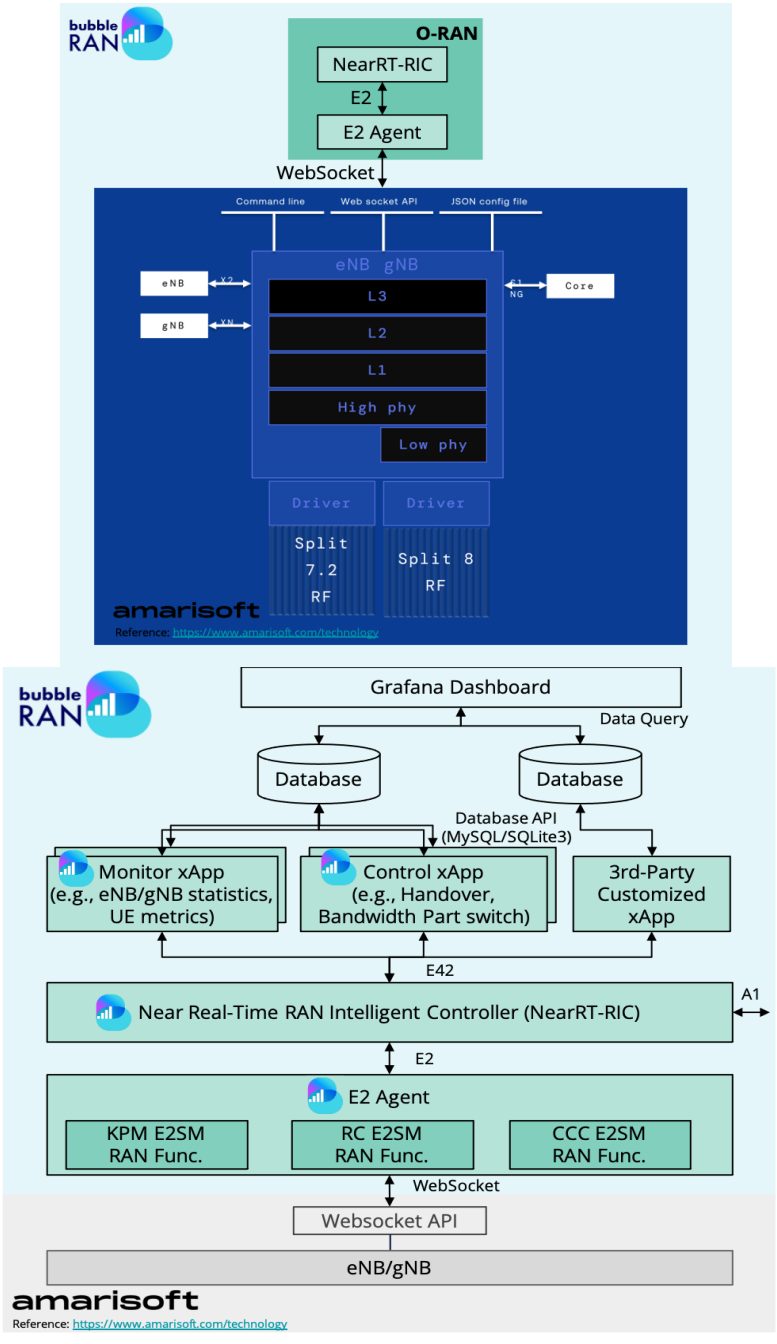


4 Installation Options

4.1 Option1: AMR-RIC (Amarisoft-Near-RT RIC-xApp)

In this deployment, the user experience with Amarisoft software components remains the same, as the O-RAN Near-RT RIC stack is deployed on bare metal. This ensures that all native features and performance characteristics of Amarisoft are preserved.

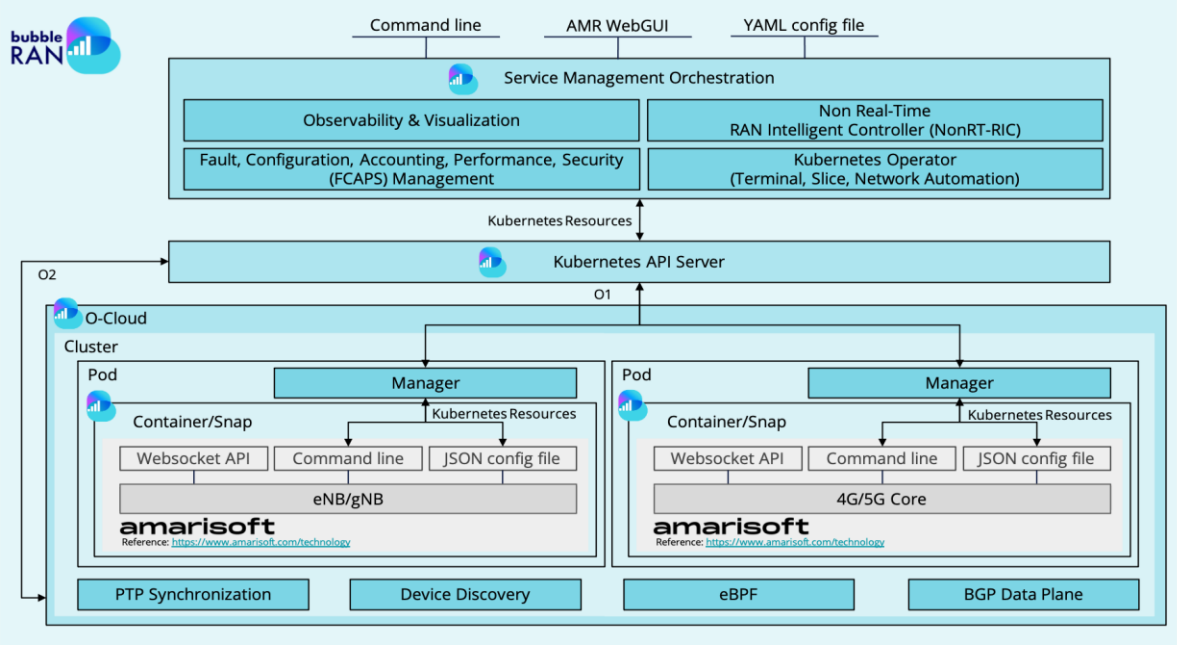
- **Example Usage:** For O-RAN compliant programmability (monitoring, control, coordination), use-case driven xApp development, observability and dataset-collection.
- **Interfaces:** O-RAN E2AP, JSON/YAML Config, WS API Config, WebGui.



4.2 Option 2: AMR-SMO (Amarisoft -SMO-Cloud)

In this option, Amarisoft RAN, CN, IMS, and UE are deployed in a private Kubernetes-based cloud infrastructure, together with the BubbleRAN SMO. The Amarisoft user experience remains unchanged by leveraging the CLI-in-CLI (CIC) feature provided by the BubbleRAN SMO, ensuring that users can continue to interact with the 4G/5G stacks through the built-in Amarisoft CLI interface.

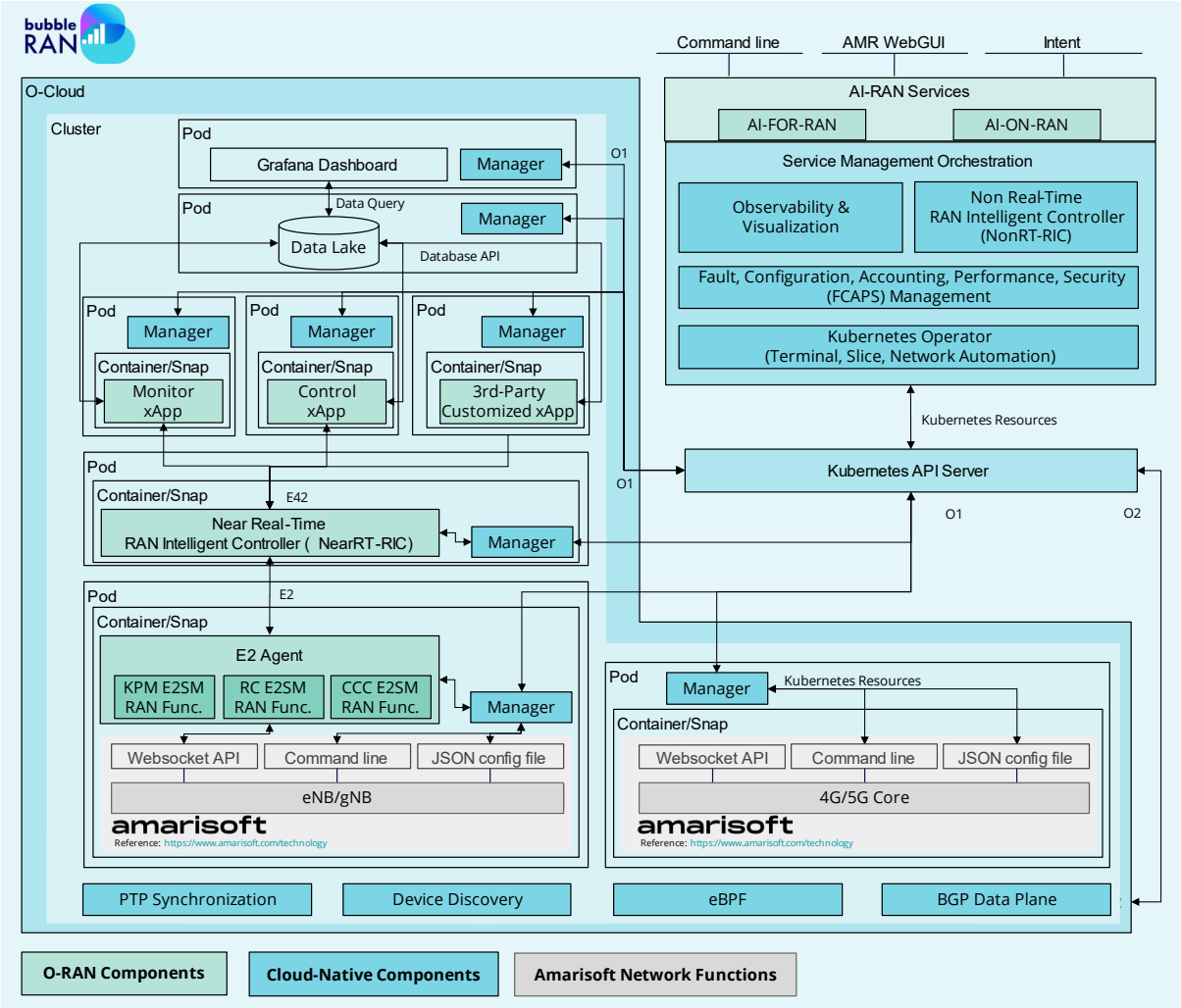
- **Example Usage:** For Network Service and Slice Automation and lifecycle management (4 levels), Data lake, scalable and agile deployment, CI/CD/DevOps.
- **Interfaces:** SMO/NMS APIs, K8s APIs, Data APIs.



4.3 Option 3: AMR-O-RAN-AI-RAN

In this option, Amarisoft stack is extended with the complete O-RAN stack and deployed in O-Cloud, optionally extended with the AI-RAN stack (see section 2.3). This demonstrates that the BubbleRAN solution enables O-RAN– and AI-RAN–compliant automation and intelligence on top of the Amarisoft 4G/5G stack, while significantly simplifying the additional operational complexity introduced by O-RAN and AI-RAN technologies.

- **Example Usage:** Option 1 + Option 2 + rApp development, policies enforcement, network optimization, MLOps, data Analytics, Dataset generation and collections.
- **O-RAN Interfaces:** Option 1 + Option 2, A1AP, R1AP, O1.
- **AI-RAN Interfaces:** A2A, MCP, R1AP, Telco APIs.



4.4 Notes applicable to all options:

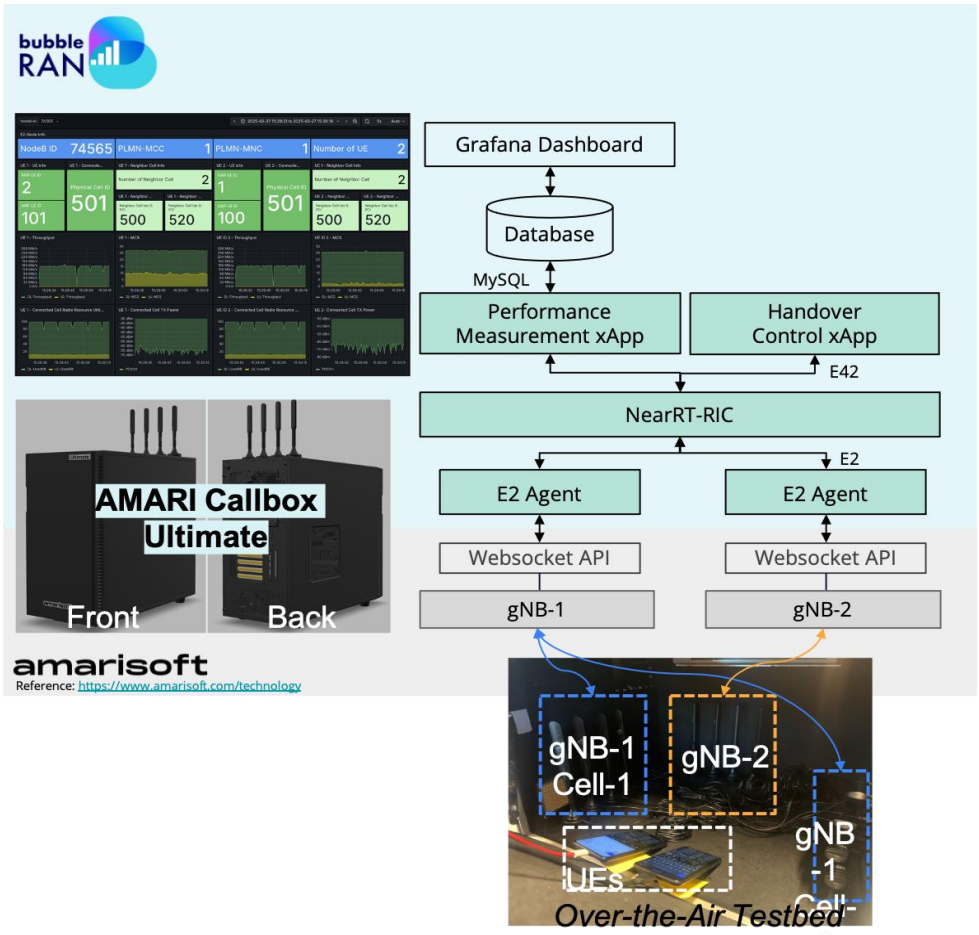
- **Compatibility:** Vanilla AMR on bare-metal remains fully supported in every scenario. You can keep a standard AMR installation and add on bare-metal, or deploy AMR with SMO-Sphere in O-Cloud with/without the RIC-Sphere.
- **Licensing and prerequisites:** The customer brings required Amarisoft licenses (e.g., AMARI vRAN/eNB/gNB, UE Simbox, 4G/5G Core/IMS). BubbleRAN can host the license server in-cluster and support both in-cluster and external deployments.
- **Supported targets:** Ubuntu-based bare-metal and Kubernetes clusters; AMARI Callbox hardware can be onboarded to O-Cloud if desired.
- **Operational model:** Choose bare-metal for tight hardware control/low latency and minimal change; choose O-Cloud for agility, automation, and multi-site scalability; choose the combined O-Cloud-O-RAN option for full cloud-native ops plus programmable control loops.
- **Ready-made installation:** available as described above. For custom installation please contact BubbleRAN sales.

5 Example Use-case: ECO-RAN

To showcase the real-world potential of the BubbleRAN solution with Amarisoft, we developed a proof-of-concept demonstration called ECO-RAN. This use case highlights how our solution enables energy-efficient mobility management and load balancing in a 5G RAN environment.

In ECO-RAN, leveraging the O-RAN stack, an xApp is developed using the xApp Developer SDK to monitor user mobility patterns and dynamically adjust cell activation based on real-time traffic and load conditions. The xApp interacts with the Amarisoft 5G RAN to handover connected UEs to neighboring cells before powering down underutilized cells during low-traffic periods, without compromising user experience. This approach enables significant energy savings, reduced operational costs, and enhanced network sustainability.

The demonstration illustrates how the BubbleRAN solution can support custom, intelligent RAN control strategies that align with operator priorities such as green networking, cost efficiency, and AI-driven optimization.



Links: *ECO-RAN,* Lab 9: Amarisoft NR intra Frequency Handover, xApp Developer SDK.

6 Frequently Asked Questions

Q1: I have already bought an Amarisoft license, do I need to buy another license?

A: No, if you only need the O-RAN stack of your Amarisoft testbed, there is no need for an extra license. If you need the O-Cloud stack, there is a need to update your existing license to license server.

Q2: How does the Amairsoft license server work?

A: BubbleRAN supports running an Amarisoft license server (for which you will need an Amarisoft License that supports it) for both internal and external deployments for the cluster as a deployment in the cluster with the support for multiple types of Amarisoft licenses.

Q3: How does my AMARI CallBox work on O-Cloud?

A: On O-Cloud, BubbleRAN runs your Amarisoft solution as a cloud-native stack: we containerize it and orchestrate it with Kubernetes. Our SMO auto-detects supported Amarisoft SDRs and a cloud-native license server supports in-cluster or external licenses.

Q4: Do I need to re-set up my Amarisoft testbed?

A: Depending on your deployment interests you can either install BubbleRAN's O-RAN stack on top of your current Amarisoft testbed with the help of our technical team. In the case you are interested in the O-Cloud platform you will need to install BubbleRAN's custom OS from scratch on top of your existing infrastructure. The installation is performed 'remotely' leveraging our local servers for configuration and it will automatically deploy the Amarisoft License server on the cluster and include BubbleRAN's O-RAN stack natively.

Q5: What are the benefits of Near-RT RIC for Amarisoft?

A: BubbleRAN offers a complete O-RAN solution on the top of Amarisoft in that the Near-RT RIC not only ensures O-RAN compliance but also enables interoperability between the Near-RT RIC and RANs from different vendors. Moreover, it supports low-latency monitoring and control loops as well as the scalability and reusability of xApps. Therefore, xApps written in other platforms can seamlessly be integrated with Amarisoft RAN.

Q6: What are the overhead costs associated with extra O-RAN, AI-RAN and O-Cloud stacks?

A: **O-RAN stack:** The RIC stack is ultra-lean and it additional computing overhead is minimal with a small memory and networking footprint.

O-Cloud: the additional computing overhead is minimal. We run Amarisoft natively in containers (no VM layer), so there's no per-packet tax on the user plane. The extra O-Cloud elements (SMO, manager, cloud-native license server and observability) are lightweight microservices posing only small computing overhead.

AI-RAN: if the on-perm local computing is required, then the compute nodes must be equipped with the right GPU (estimated additional cost is between 5K$-15K$). Otherwise, the additional computing overhead is minimal as APIs will be used.

Q7: What are the benefits of could-native deployment for Amarisoft?

A: Cloud-native deployment enables dynamic and agile deployment at scale, automated configuration, support for large-scale networks, and seamless integration with other services (e.g., O-RAN x/rApp ecosystems).

Q8: What are the contact emails?

A: sales@amarisoft.com and sales@bubbleran.com

7 Change History

7.1 Version 2026-01

Amarisoft AI-RAN integration

Amarisoft UE Simbox Series 2024-12-13

Amarisoft TRX_IP support

Amarisoft Proxy-E2 Agent and O-RAN enhancement

Amarisoft Websocket API enhancement

7.2 Version 2025-01

Amarisoft NW Series 2024-12-13

Amarisoft NTN

Amarisoft Proxy-E2 Agent and O-RAN enhancement

Amarisoft Websocket API enhancement

7.3 Version 2024-01

Amarisoft NW Series 2023-12-15

Amarisoft Proxy-E2 Agent and O-RAN integration

Amarisoft Websocket API integration

7.4 Version 2023-01

Amarisoft NW Series 2022-12-16

Amarisoft FR1 and FR2

Amarisoft FLS support on shared cloud infrastructure

Amarisoft SDR 50 and 100 support

Amarisoft UHD support

Amarisoft utilities

8 License

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- Amarisoft software is © 2012–2026 Amarisoft.

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9 Terminology

RAN	Radio Access Network
CN	Core Network
IMS	IP Multimedia Subsystem
UE	User Equipment
O-RAN	Open RAN Access Network
AI-RAN	Artificiel Intelligence Radio Access Network
SMO	Service Management and Orchestration
RIC	RAN Intelligent Controller
Non-RT RIC	Non-Real-Time RIC
Near-RT RIC	Near-Real-Time RIC
E2	E2 Interface (Near-RT RIC to RAN Agent)
A1	A1 Interface (Non-RT-RIC to Near-RT RIC)
R1	R1 interface (rApps)
RF	RAN Function
E2SM	E2 Service Model
xApp	eXternal App (Near-RT RIC)
rApp	RAN Application (Non-RT RIC)
CU	3GPP Central Unit
DU	3GPP Distributed Unit
O-RU	O-RAN Radio Unit
E2E	End-to-End
AI-for-RAN	Artificial Intelligence for Radio Access Network
AI-on-RAN	Artificial Intelligence on Radio Access Network
AI-and-RAN	Artificial Intelligence and Radio Access Network
A2A	Agent-to-Agent Protocol
MCP	Model Context Protocol
SDK	Software Development Kit
CDK	Container Development Kit
BAT	BubbleRAN Agentic ToolKit
BRC	BubbleRAN Command Line Interface
SMO-Sphere	BubbleRAN SMO-Sphere Product
RIC-Sphere	BubbleRAN RIC-Sphere Product

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