

MX-PDK

Spec V1.2

A Flexible Multi-x 4G/5G Platform Development Kit



1. General Description & Features

The MX-PDK platform is an integrated turnkey HW-SW solution on x86 processing units, allowing 4G LTE and 5G NR networking for most types of user equipment. It combines OpenAirInterface, SRSRAN, Open5GS, and optionally additional 3rd party stacks such as Amarisoft industrial stack on the top of the same MX-PDK platform. It acts as a 3GPP compliant monolithic and disaggregated eNodeB, aNodeB/CU/DU, EPC, 5GC, IMS for both Non-standalone mode (NSA) and mode (SA) Standalone deployment in frequency range 1 and 2 (FR1, FR2), featuring **Cloud-Native Multi-Vendor Open RAN.**

BubbleRAN MX-PDK is designed for R&D, test, measurements, PoC/MVP to validate business applications and use-cases, and show case innovations in the area of 4G and 5G. It also provides a built-in Cloud-Native Open RAN studio, compliant with the O-RAN specification, allowing to learn, develop, integrate, and test an end-to-end 4G/5G Open RAN with xApps/rApps and UEs in the loop. The SMO comes with a set of user interfaces, including CLI, APIs, and GUI. Users are able to design, mix-and-match, and deploy a desired network, collect user and network data, analyze and evaluate the results.

MX-PDK Features: simple to use and (re-)configure, cloud-native automation, 3GPP and OpenRAN compliant, Standardized interfaces, customizable, open documentation and resources.

Multi-X Dimensions: vendor, version, frequency, SDR/RF, runtime, OS, deployment.

O-RAN Stack: E2 Agent, Near-RT-RIC, Non-RT-RIC, SMO, xApps, rApps.

Environment: Bare-metal (Binary Archives, Snap), single-node container (Docker, Podman), any K8S distribution (Kubeadm, OpenShift, Rancher), and public cloud (Google Cloud).

The BubbleRAN MX-PDK hardware platform is composed of (1) a compute node (typically i9 or Xeon or AMD) under **Ubuntu or RHEL low latency kernel**, (2) a radio frontend, SDR such as USRP, LimeSDR, AmariSDR. or COTS eCPRI RRH (vendor AW2S); or 7.2-compliant RU (vendor Lite-on), and (3) 4G/5G Quectel UE, SIM cards, and accessories.





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2. Software Stack

The software stack of the BubbleRAN is shown below. It includes multi-vendor 3GPP and O-RAN compliant software stacks running on the top of the same Multi-x hardware platform. The components are:

- MX-RAN:
 - Amarisoft: 4G eNB, 5G gNB for FR1 and FR2;
 - OAI: 4G eNB, 5G gNB/CU/DU for Frequency Range 1; 4G and 5G soft UE.
 - srsRAN: 4G eNB; 5G gNB;
- MX-CN:
 - Amarisoft 4GC, 5GC, IMS;
 - OAI 4GC and 5GC;
 - Open5GS: 4GC/5GC;
- Artifact Registry Hub: serving archives, packages, images, models, Operator bundles, and configurations;
- **MX-Operator:** 4G/5G full Life-cycle management, CI/CD, DevOps user interface; Supports deployment on-premises or on Google Cloud.
- **MX-RIC (Optional):** Both near-RT-RIC and Non-RT -RIC for 4G/5G for OAI, srsRAN, and Amarisoft. It includes the O-RAN KPM and custom monitoring service models. RAN control (RC) and Cell configuration and Control (coming soon);
- **rApps/xApps (Optional):** an ecosystem of RAN xApps and rApps supporting monitoring, slicing, traffic control, scheduling, and mobility management;



MAIN FEATURES

- 1. 3GPP and O-RAN standard compliant
- 2. Open Documentation for developers & users (<u>https://bubbleran.com/docs/</u>)
- 3. Single pane-of-glass UI for vendors, operators, and developers (CLI, GUI, API)
- 4. Logging, events, alarms, and measurements
- 5. End-to-end data networking with COTS UEs and Application in the loop
- 6. Built-in Open RAN studio with reusable xApps and rApps
- 7. Easy and agile declarative configuration and life-cycle management at scale (Level 1 level 5)
- 8. Custom sub-6GHz frequency with the SDR cards (PCI-E or USRP families)
- Multi-vendor 4G/5G OpenRAN combining open-source and commercial 4G and 5G stacks



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3. Hardware

3.1. PC SPEC: STANDARD, BOOSTED, EXTREME PROFILES

Features	Value	
Format HxLxW	Workstation: 417,9 mm (16,45") 176,5 mm (6,94"), 518,3 mm RACK: 42,8 mm (1,68"), 482 mm (18,98"), 589,1 mm (23,19")	
Number of PCIe SDR Cards	4 (depending on the configuration)	
Weight	Workstation: 15Kg RACK: 12 kg	
CPU	Typical: i9/Ryzen (16C) or Epyc/Xeon (16-64 Core)	
RAM	Typical: 32GB	
DISK	Typical: SSD 500GB Intensive RW	
Ethernet	Typical: 2x10/35Gb SPFs, 3x1Gb	
USB3/4	2 distinct ports	
PCI-e Gen 3/4	4 slots (Gen 3)	
Power supply voltage Input:	100 - 240V AC	
Output	19.5V/9.23A	
Power Consumption	Typical: 550W (Intel i9 or AMD Ryzen Workstation) – 1100- 1800W (Epyc RACK Or Intel Xeon)	
Operating System	Ubuntu, RHEL (optimized Bios)	

3.2. PCI-E SDR SPEC

Features	Value	
Power Supply	12 V DC input	
RF coverage	500MHz – 6.0 GHz (up/down convertor for FR2)	
RF Bandwidth	200KHz – 100 MHz	
Range	30 meter (with No PF)	
Operation Mode	FDD and TDD	
МІМО	2x2 or 4x4	

Note: USRP and LimeSDR product specifications are not added here, please refer to their respective website. Example of USRP:

- Networked series: https://www.ettus.com/product-categories/usrp-networked-series/
- X series: https://www.ettus.com/product-categories/usrp-x-series/
- Bus series: https://www.ettus.com/product-categories/usrp-bus-series/







4. Multi-X Radio Access Network (RAN)

4.1. ENB AND NG-ENB SPEC

Features	Value
3GPP Release	16
Frequency bands	All bands. TDD and FDD
Bandwidth	Amarisoft: 1.4, 3, 5, 10, 15 and 20 OAI: 5, 10, and 20 MHz srsRAN: 1.4, 3, 5, 10, 15 and 20 MHz
Number of Component Carrier	Amarisoft: 3xDL and 3xUL
Transmission Mode	Amarisoft: 1 (single antenna) to 10 (MIMO 4x4) OAI & srsRAN: 1 to 4
Modulation and Coding Scheme	Amarisoft: Up to 1024QAM in DL and 256QAM in UL OAI: Up to 64QAM in DL and 16QAM in UL srsRAN: Up to 256QAM in DL and 16QAM in UL
AS Integrity and Encryption	Snow3G and AES
Handover	Amari: S1, X2, Intra ng-eNodeB, NG, Xn and EPS to 5GS handover support
eNodeB Network Interfaces	Amarisoft/OAI:S1AP and GTP-U, X2AP between eNodeBs, NGAP and GTP-U to 5GC, XnAP between ng-eNodeBs

4.2. GNB SPEC

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Features	Value		
3GPP Release	16		
Frequency Bands	Amarisoft: FDD/TDD FR1 and FR2 OAI & SRS: TDD FR1		
Bandwidth	Up to 100MHz		
МІМО	2x2 and 4x4		
Subcarrier Spacing	Amarisoft: Data subcarrier spacing: 15, 30,60, 120 KHz, SSB subcarrier spacing: 15, 30, 120 or 240 KHz OAI & srsRAN: Data and SSB subcarrier spacing: 15,30 KHz		
Modulation and Coding Scheme	Amarisoft: Up to 256QAM in DL and UL OAI & srsRAN: Up to 256QAM in DL and 64QAM in UL		
Supported Modes NSA, SA	Amarisoft: NSA and SA OAI & srsRAN: SA		
Handover	Amarisoft: Intra gNodeB, NG, Xn and 5GS to EPS HO		
Deployment Scenario	Amarisoft: Monolithic OAI & & srsRAN: Monolithic, Disaggregated (CU, DU)		
Use-case	eMBB		
eNodeB Network Interfaces	NG interface (NGAP and GTP-U) to 5GC XnAP between aNodeBs 5		
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5. Multi-X Core Network (CN)

5.1. 4GC SPEC

Features	Value
3GPP Release	16
Network elements	Amarisoft: MME, SGW, PGW, HSS, ePDG, PCRF OAI: MME, SP-GW, HSS Open5GS: MME, HSS, S-GW, and P-GW
AS integrity and encryption	Snow3G and AES
IP version	IPv4, IPv6
QoS	Amarisoft: LTE QCI, TFT, and Dedicated Bearer OAI & Open5GS: TFT and dedicated bearer
Handover	Amarisoft: Intra-MME and and EPS 5GS IRAT handover support OAI & Open5GS: S1
Network	Amarisoft: S1AP, GTP-U, RX to IMS, S6A, S13 OAI & Open5GS: S1AP, GTP-U, S6A.

5.2. 5GC SPEC

Features	Value
3GPP Release	16
Network elements	Amarisoft: All-in-one (AMF, AUSF, SMF, UPF, UDM) OAI & Open5GS: AMF, SMF, AUSF, UDM, UPF, NRF, NSSF
AS integrity and encryption	Snow3G and AES
IP version	Amarisoft: IPv4, IPv6, and unstructured PDUs support OAI & Open5GS: IPv4, IPv6
QoS	Amarisoft: Configurable QFI
PDU Session	Multi PDU sessions support
Handover	Amarisoft: intra-AMF and 5GS to EPS IRAT support
Slicing	Multiple Slice (shared or dedicated NF)
Network	Amarisoft: NG, Rx to IMS, N12 to AUSF, N8 to UDM, N17 to 5G-EIR, N50 to CBC OAI & Open5GS: NG



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6. Multi-X RIC and Operator

6.1. MX-RIC SPEC

Features	Value
O-RAN Spec	E2 V1.x, v2.x
Service Models	ORAN: KPM, RAN Control (coming soon) Custom: Monitoring, Slicing, Traffic Control
Multi-Vendor	Yes: OAI, srsRAN, Amarisoft
NearRT and Non-RT RIC	Yes. AI API supported.
Service Models	KPM V2.0, RAN Control (RC), CCC (Coming Soon)
xApps, rApps	Data collections, performance monitoring, RAN stats, RAN slicing, RAN reconfiguration. SLA-Policy.
xApp Language	C, C++, Python, Go, Java.
01	Yes (depends on the 4G/5G vendor support)

6.2. MX-OPERATOR

Features	Value	
Level 1 life cycle operation	Resource detection and discovery (day 0), deploy (day 1), and test (day 2)	
Level 2 life cycle operation	Release and upgrade (day 2)	
Level 3 life cycle operation	Full lifecycle control, including provisioning (day 0), configuration (day 1), and reconfiguration (day 2)	
Level 4 life cycle operation	Deep insight with full observability, including monitoring, log processing, metrics, and alarms	
Multi-X	Multi-vendor, multi-version, multi-container, multi-OS, multi- node, multi-RAT, multi-RF	
Security	Isolation, Signed Artifacts, Unprivileged, Rootless (coming soon), Access Control (coming soon), RBAC	
User Interface	API and CLI, GUI, and Dashboard.	
Image registry	BubbleRAN hub (hub.bubbleran.com)	
Networking	Flannel, Calico (BGP, eBPF, IPVS) over Ethernet/Fiber, Multus	
Storage	Host storage, Rook and Ceph (coming soon)	
CI/CD	Consistent artifact generation, integration, validation, security, CDK, Jenkins, Argo and Flux (coming soon)	
Infrastructure	K8s distribution on Kubeadm, MicroK8s, Openshift, cloud-init, hardware resource detection and automation	
Container runtime	Docker, Containerd, Podman, CRI-O, Snap, LXD (coming soon), Kata Containers (coming soon)	



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7

7. Building Blocks

BubbleRAN features multi-vendor 4G/5G RAN, CN, and IMS stacks as well as SDR, RRH, and O-RAN compliant RU options with both Open-Source and Industrial grade 4G/5G stacks, as shown in the figure below. They can be deployed in a bare-metal, container, a Kubernetes cluster in a private or public cloud fully operated by the MX-Operator, a.k.a. SMO in O-RAN terminology.



As detailed in the figure below, the MX-PDK product is composed of three main layers including (1) host telco-optimized infrastructure and a multi-vendor support, (2) cloud-native resources and security, and (3) telco software operators, applications and services designed to deliver high performances and reliability, security, observability, and fault tolerancy.

PTP-Synchronized	Cost & Energy Optimizer	xApps & rApps	Hub Artifact Registry	Grafana Visualization	Events & Alarms
Edge Services & Apps	Network Operator	Odin NonRT-RIC	MANO/SMO	Promscale DB	Logs & Metrics
Accelerator & Device Plugin	Terminal Operator	FlexRIC RT+NearRT-RIC	3GPP Slicing	Prometheus	CLI, API, Dashboard
Telco Opti	mizations	Open RAN	& Open CN	Obser	vability
Multus + Any CNI	Calico Network Policy	Local Storage	Optimized BIOS	Seccomp	Admission Webhooks
BGP + No encapsulation	NFT & eBPF & IPVS	Ceph Distributed Storage	NUMA & CPU Pinning	AppArmor	RBAC & CV
IPv4 + IPv6 Dual Stack	DNS with Scoping	PVC + Any CSI	Telco Pod Scheduler	SELinux	Policy Agent
Networking and	d Service Mesh	Storage	Compute	Security and	d Compliance
Kubeadm	CentOS	Ubuntu Snapd & LXD	AW2S RRH	Open5GS	srsRAN
Openshift	RHEL	Podman & CRI-O	Lime SDR	nVidia Aerial	OpenAirInterface
Microk8s	Ubuntu	Docker & containerd	NI USRP	0-RAN 7.2 RU	Amarisoft
Kubernetes	Linux Distrib.	Runtime		Telco Vendors	







8. License Model of the Software Stack

8.1. OPEN-SOURCE

Software	License	link
OAI 4G MME	3-Clause BSD License	https://opensource.org/licenses/BSD-3-Clause
OAI 5G/4G RAN, CN, nearRT RIC	OAI Public License 1.1 (FRAND-clause)	https://openairinterface.org/legal/oai-public-license/
xApps and rApps	3-Clause BSD License	https://opensource.org/licenses/BSD-3-Clause
srsRAN	GNU GPL	https://github.com/srsran/srsRAN/blob/master/LICENSE
Open5GS	GNU AGPL V3	https://github.com/open5gs/open5gs
Kubernetes	Apache License 2.0	https://www.apache.org/licenses/LICENSE-2.0

8.2. PROPRIETARY CLOSED-SOURCE

Software	Component	License
Amarisoft	All	Amarisoft and BubbleRAN Terms and Conditions
BubbleRAN	O-RAN stack	BubbleRAN Terms and Conditions

8.3. OPEN-SOURCE

Software	Component	License
BubbleRAN	xApps, rApps, Datasets, Training materials, Documentation	BubbleRAN Terms and Conditions





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We are helping organizations to seamlessly build, customize, and operate their private 4G/5G infrastructure by consolidating open RAN and cloud-native architectures with a green MANO/SMO offering more than 10x efficiency and delivery cycle with lower carbon footprint for a wide range of R&D and enterprise use-cases from the lab to the production environment.



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