Delivering Cloud-Native 4G/5G Technology and its DevOps Multi-vendor Platform

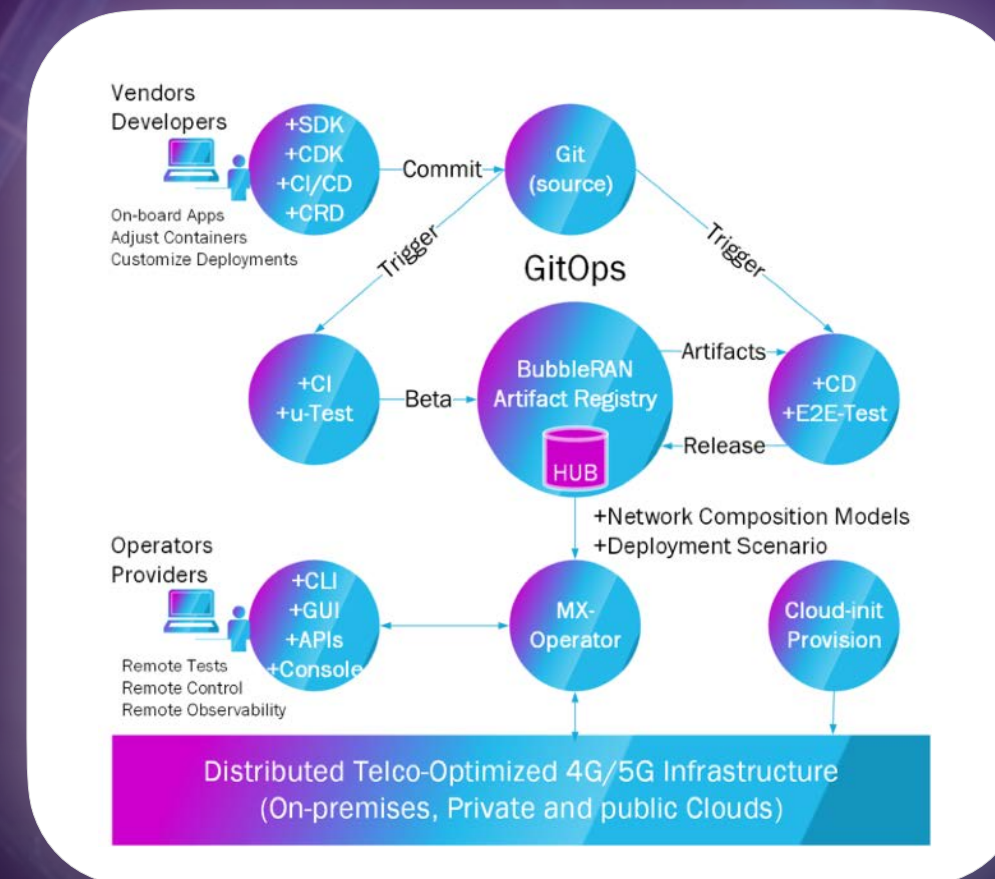## BubbleRAN DevOps Technology & Releases

Why BubbleRAN?

We are helping organisations to seamlessly build, customise, 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.
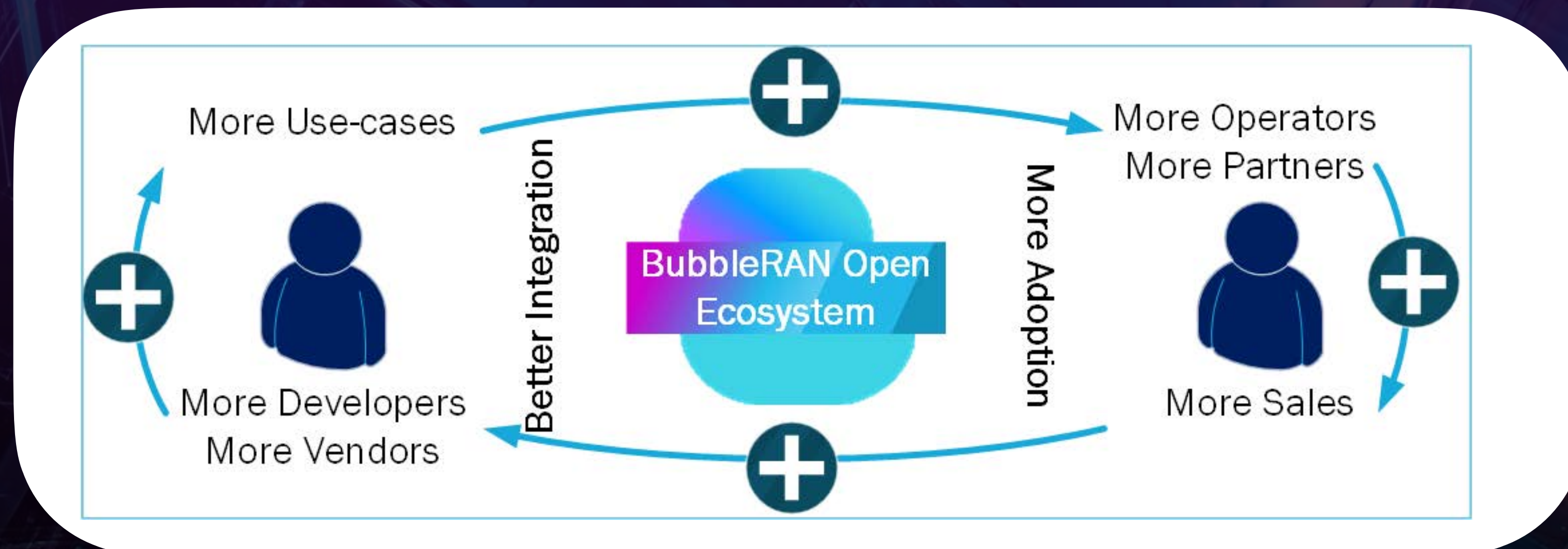
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Benefits of BubbleRAN Solutions
Emergent Open Ecosystem

1. OpenRAN/O-RAN

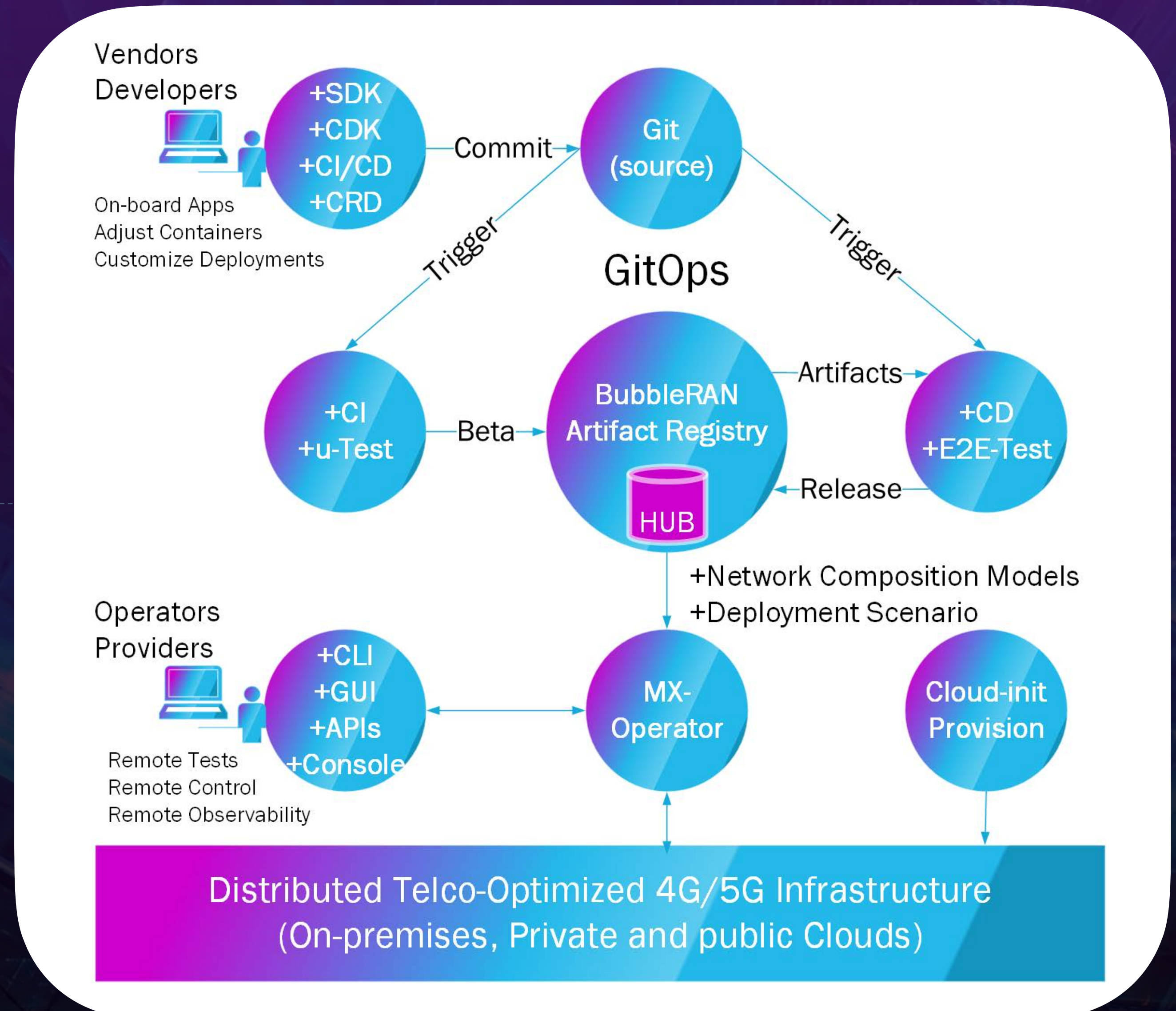2. Cloud-Native E2E 4G/5G (RAN,CN,IMS)

3. Green MANO/SMO

1. Automation/CI/CD/CO DevOps

2. Self-service processes

3. Open Ecosystem and Hub

BubbleRAN 4G/5G DevOps Technology

1. Packaging
2. Testing
3. Distribution

1. Provisioning
2. Automation
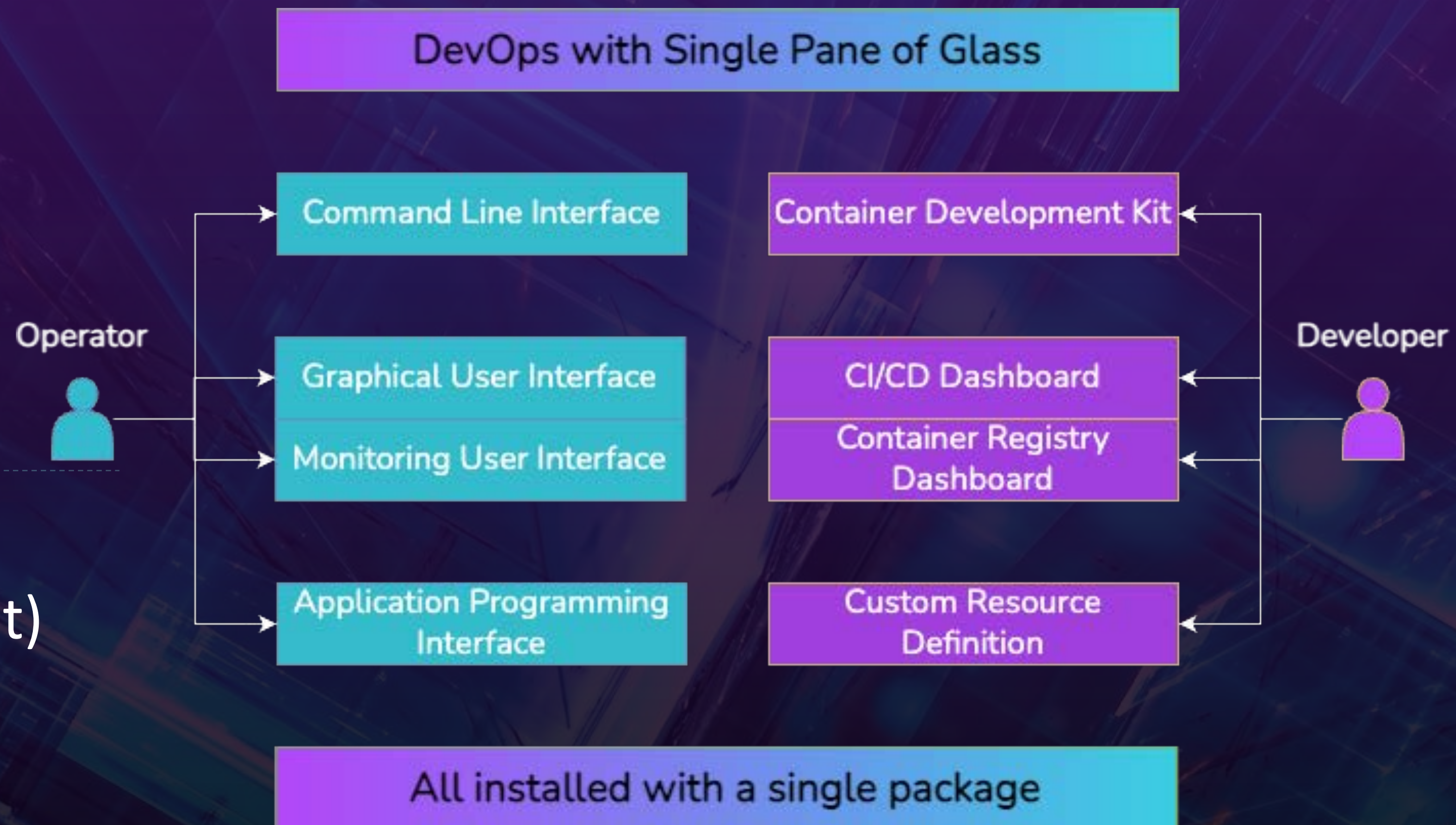3. Control
4. Observability
5. Testing

Vendors
Developers

+SDK
+CDK
+CI/CD
+CRD

On-board Apps
Adjust Containers
Customize Deployments

Commit

Git
(source)

GitOps

Trigger

Trigger

+CI
+u-Test

Beta

BubbleRAN
Artifact Registry

HUB

Artifacts

+CD
+E2E-Test

Release

+Network Composition Models
+Deployment Scenario

Operators
Providers

+CLI
+GUI
+APIs
+Console

Remote Tests
Remote Control
Remote Observability

MX-
Operator

Cloud-init
Provision

Distributed Telco-Optimized 4G/5G Infrastructure
(On-premises, Private and public Clouds)

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BubbleRAN Single Pane of Glass

Operator user interface:
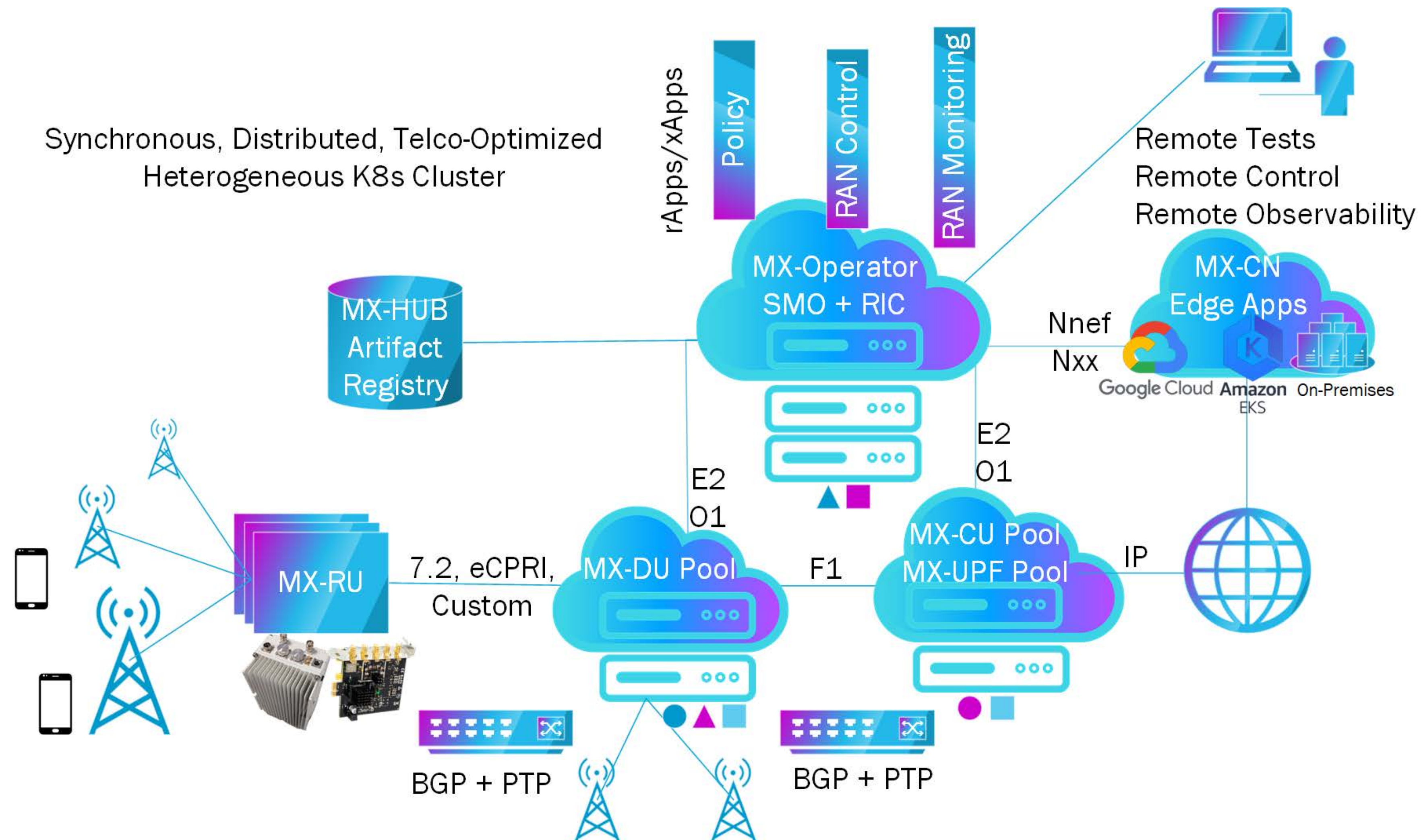
+ CLI

+ GUI

+ Monitoring, Alarms, Events

+ APIs

Developer user interface :

+ CDK (Container Development Kit)

+ CI/CD Dashboard

+ Artifact Registry

+ CRD (Custom Resource Definitions)

DevOps with Single Pane of Glass

Operator

Command Line Interface

Graphical User Interface

Monitoring User Interface

Application Programming Interface

Container Development Kit

CI/CD Dashboard

Container Registry Dashboard

Custom Resource Definition

Developer

All installed with a single package

Deployment Models
From Bare-metal to public and private Cloud

Synchronous, Distributed, Telco-Optimized Heterogeneous K8s Cluster

rApps/xApps

Policy

RAN Control

RAN Monitoring

Remote Tests
Remote Control
Remote Observability

MX-Operator
SMO + RIC

MX-HUB
Artifact
Registry

MX-CN
Edge Apps

Nnef
Nxx

Google Cloud · Amazon EKS · On-Premises

E2
O1

E2
O1

MX-CU Pool
MX-UPF Pool

IP

MX-RU

7.2, eCPRI,
Custom

MX-DU Pool

F1

BGP + PTP

BGP + PTP

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BubbleRAN S 4G/5G Technology
Software-based, Cloud-Native, and Green
[Public or Private Cloud]

Multi-X RAN	Multi-X CN	Multi-X Operator	Multi-X RIC
- 3GPP-compliant (R16)	- 3GPP-compliant (R16)	- D0/D1/D2 Ops	- O-RAN Compliant
- Software-based	- IMS, Telco Apps	- Cloud-Native Intelligent	- Plugin Service Models
- FR1/FR2, MIMO	- Software-based	- Closed-loop Observability	- rApps/xApp and APIs
- OpenRAN	- Network Slicing	- Isolation and Security	- Cloud-Native
- Cloud-Native CU/DU	- Cloud Native	- Green MANO/SMO	- RAN Intelligence

Multi-x includes Multi-vendor, Multi-version, Multi-RAT, Multi-Frequency, Multi-RF, Multi-cloud, Multi-OS, Multi-deployment.
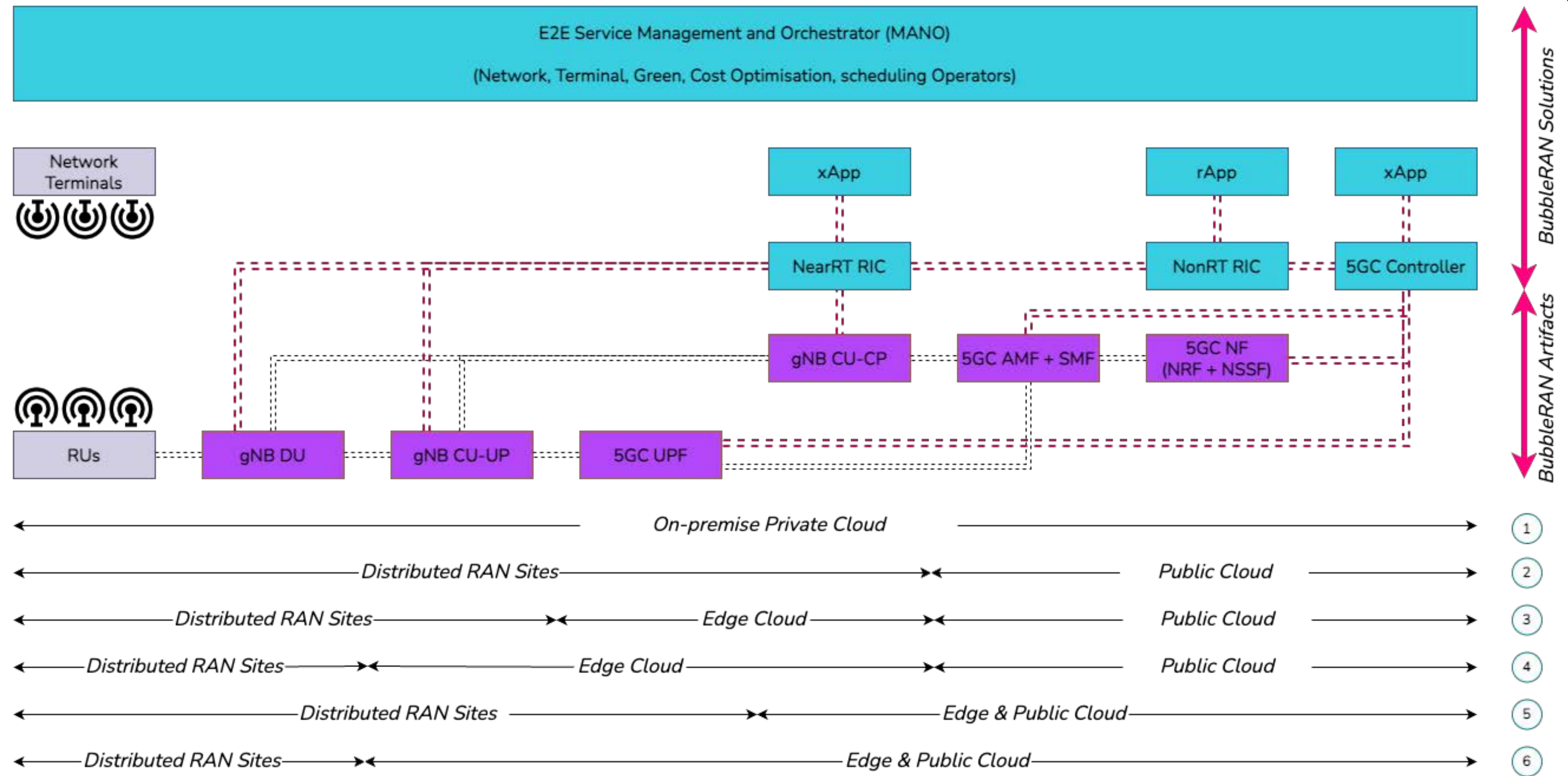
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BubbleRAN Technology Building Blocks
Software-based, Cloud-Native, and Green

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 Optimizations		**Open RAN & Open CN**		**Observability**	
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
Cloud Native Networking and Service Mesh		**Cloud Native Storage**	**Cloud Native Compute**	**Security and 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	O-RAN 7.2 RU	Amarisoft
Kubernetes Distribution	**Host Linux Distribution**	**Container Runtime**	**Telco Vendors**		

*On-demand Telco Vendors: O-RAN O-CU, O-DU, Radisys, Intel FlexRAN, Altran.
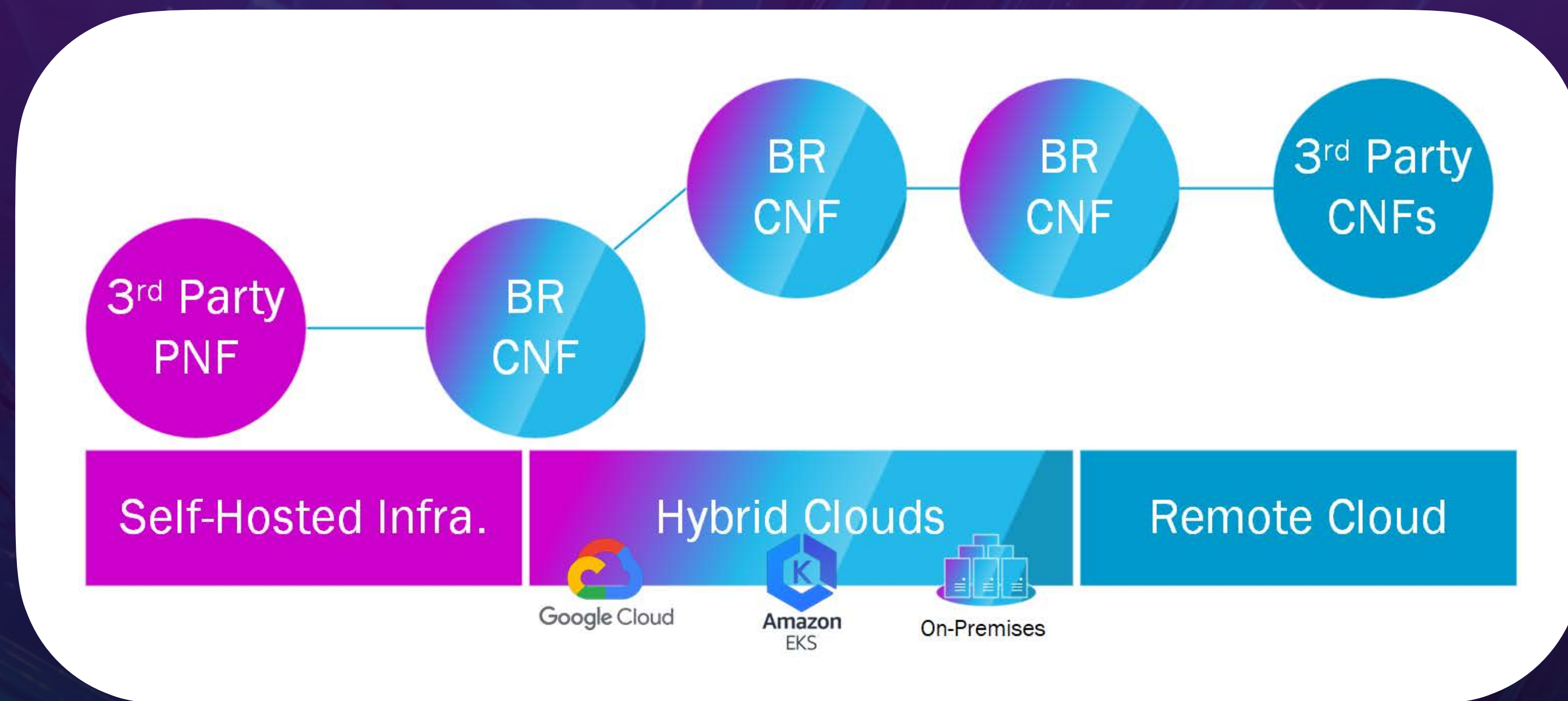
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BubbleRAN Cloud Deployment Options

BubbleRAN Integration Options

Opt for a gradual upgrade and slow adoption

+ Seamlessly integrate your PNF and VNF with the BubbleRAN CDK

+ Leverage your self-hosted infrastructure or remote cloud

BubbleRAN Emergent Open Ecosystem

PNF: Physical Network Function
VNF: Virtual Network Function
CNF: Cloud-Native Network Function
Hybrid clouds: public or private or on-permises cloud

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BubbleRAN Customisation Options

Opt for BubbleRAN network function customisation as a service

+ Customize across three dimensions
- ▷ Deployment models
- ▷ Network Functions
- ▷ Tuning and configuration parameters

+ Leave the packaging and on-boarding for the last steps
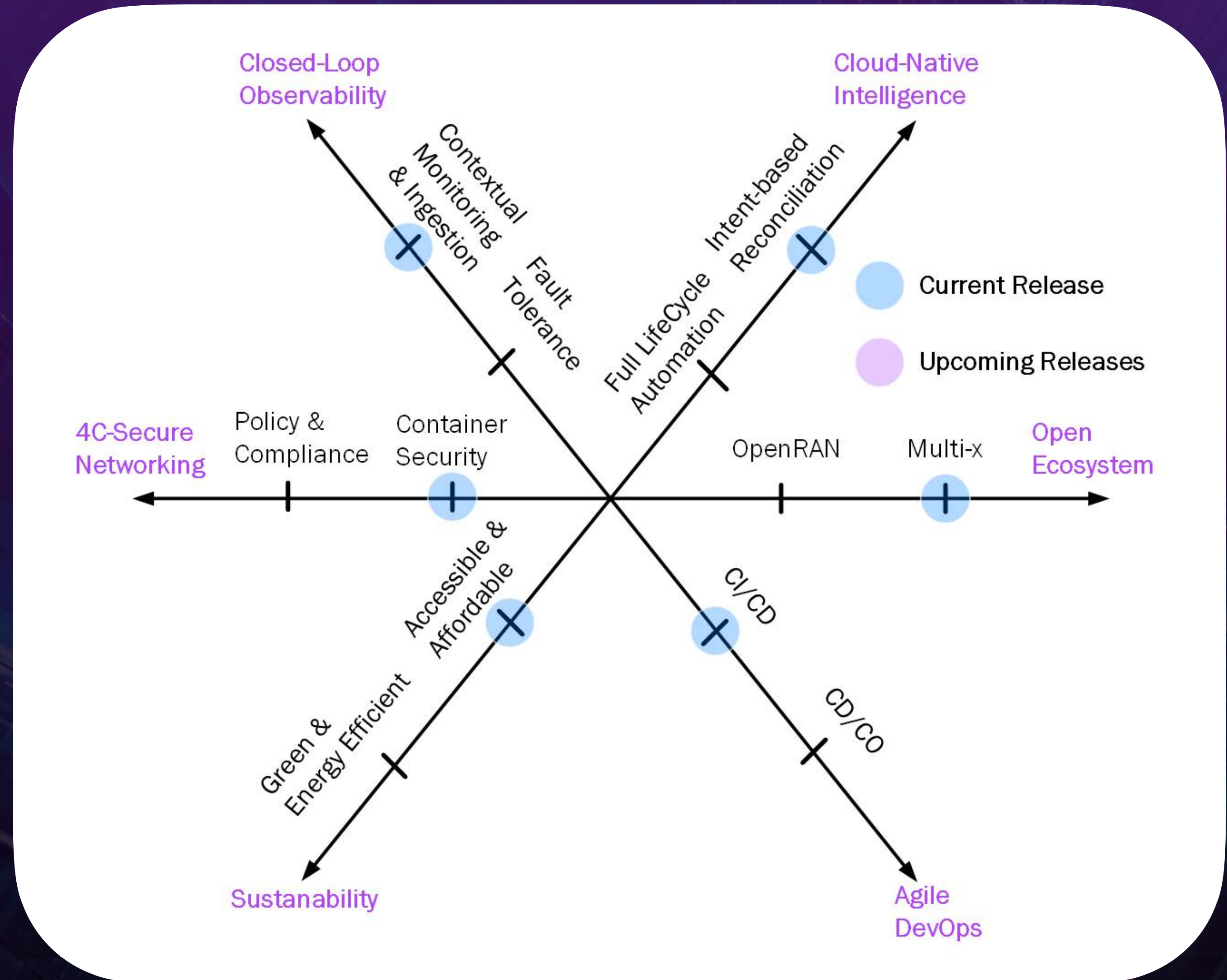- ▷ Assisted transition using BubbleRAN CDK

CDK: Container Development Kit
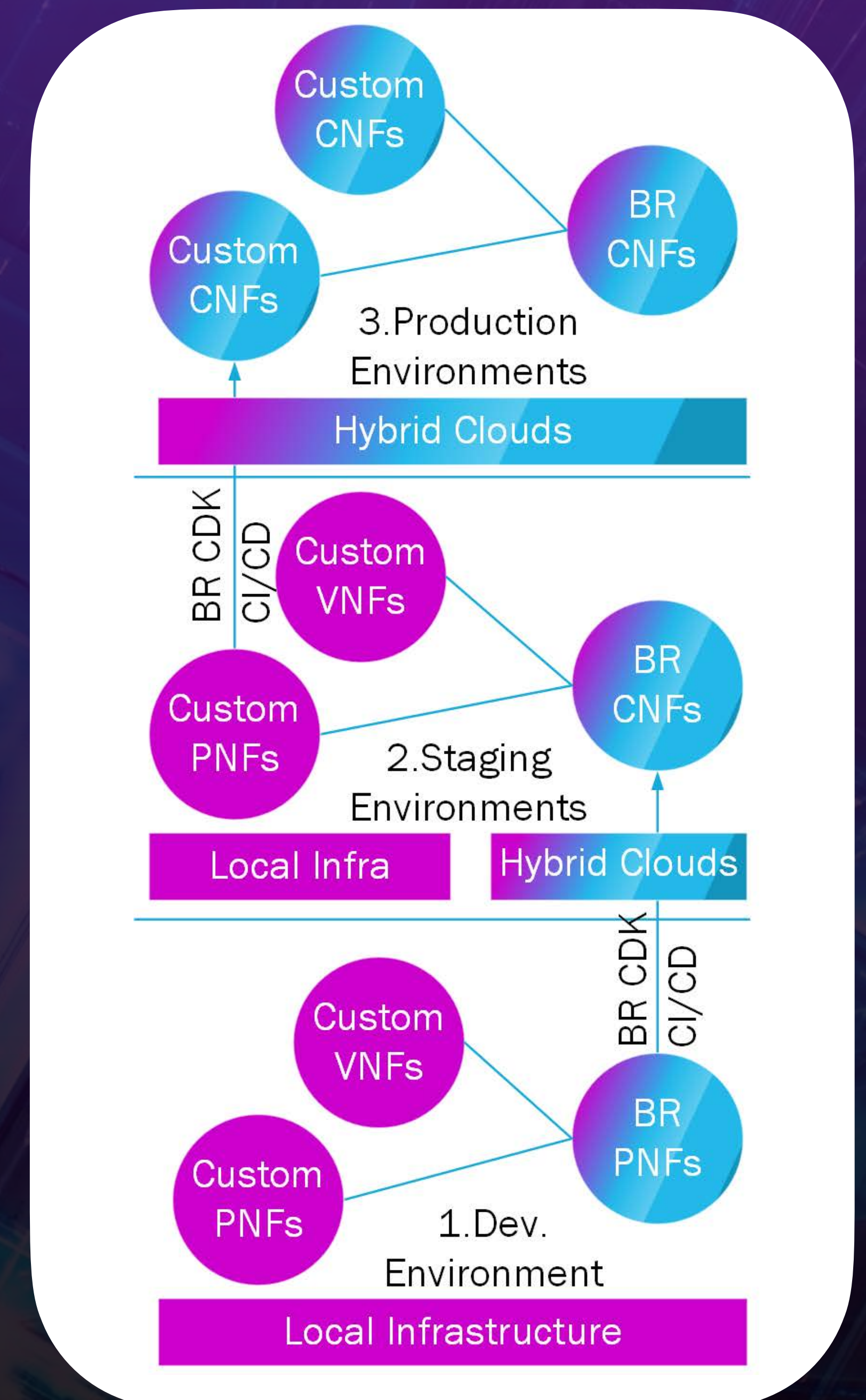
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BubbleRAN Current Release

Cloud-Native OpenRAN

Release Cycle: 3-months with Automated Updates

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BubbleRAN Multi-X Product Family

1. R&D, PoC, Validation, Test, MVP
    1. Industrial and Open-source 4G/5G stacks (RAN, CN, IMS)
    2. Cloud-Native, OpenRAN, Slicing, MANO/SMO, RIC
    3. DevOps Environments

1. **MX-PDK**

2. Private5G Deployment, Trials, and Production (CBRS, NTT)
    1. Industrial-grade 4G/5G stack (RAN, CN, IMS)
    2. Green MANO/SMO, and RAN Intelligent Controller (RIC)
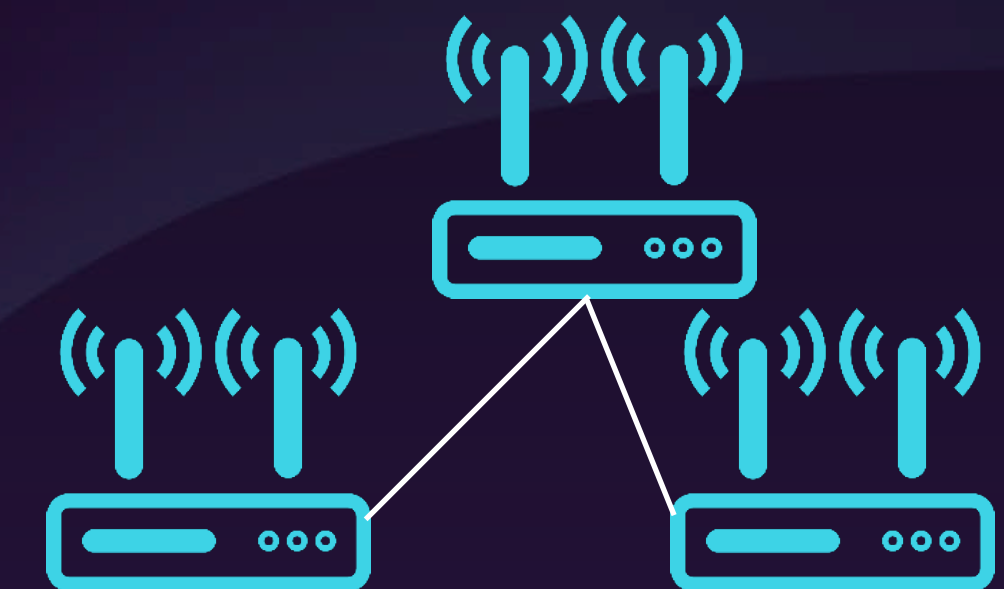   3. Operated and Managed Network and Terminals

2. **MX-PRO**

3. Network in a Box (NIB) w/wo BH
    1. All-in-one, portable, embeddable NIB
    2. Routing, control, and Management
    3. Meshing (coming soon)

3. **MX-HUB**

What are the dimensions of Multi-X ? Multi-vendor, Multi-version, Multi-RAT, Multi-Frequency, Multi-RF, Multi-cloud, Multi-OS, Multi-deployment.

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