OpenRAN@Brasil - Boosting RD&I in Telecom

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Agenda

- Who are we?
  - RNP
  - Speaker
- What is Open RAN?
  - From RAN to Open RAN
- The OpenRAN@Brasil Program
  - Objective
  - Phases
  - Activities
- What is next?
- Final Remarks

Who are we?

- Rede Nacional de Ensino e Pesquisa (RNP)
  - Brazilian Network for Education and Research
  - Helped to bring the Internet to Brazil in 1992
  - Today, our network reaches all states of the country, offering our secure and high-capacity services
  - Interconnected to other education and research networks in Latin America, North America, Africa, Europe, Asia and Oceania through terrestrial and submarine optical fiber cables

800
connected organizations

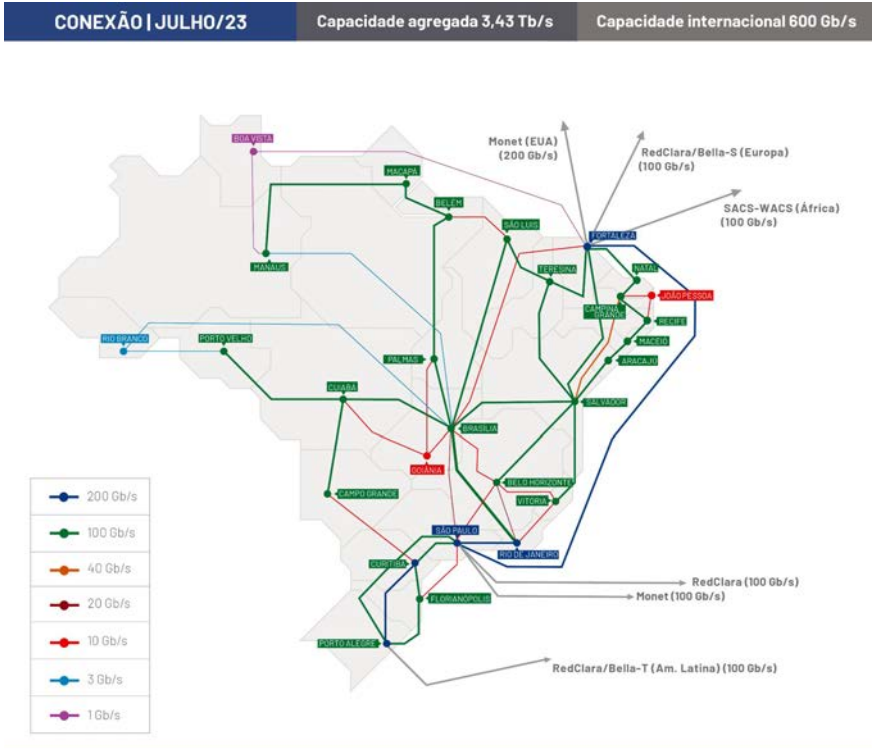
+4 million
users

50
community connections

+100 Gbps
connections

Who are we?

- Ipê network
  - Brazilian academic network
  - Quality internet access
  - Support to the transmission of large volumes of data for scientific projects and development of new technologies
- https://www.rnp.br/sistema-rnp/rede-ipe



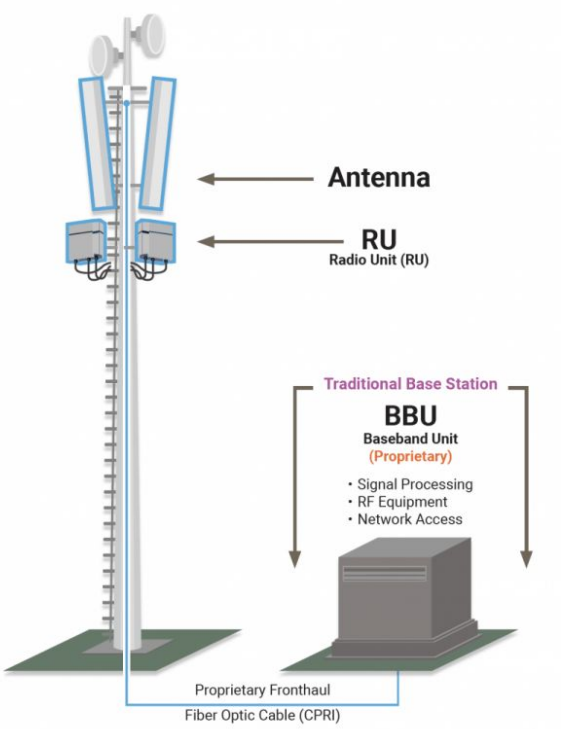
Introduction

- About Me
  - R&D Coordination at RNP
  - Ph.D. in Computer Science (2019)
  - Master Degree in Computer Science (2014)
  - Computer Engineering Degree (2011)
  - Red Belt in Eagle Claw Kung Fu
  - Benny's guardian

- lbondan.wordpress.com

What is Open RAN?

- RAN (Radio Access Network)
  - Radio element of cellular networks
  - Users' entry point to the network
  - In general, composed of three elements
    - Antenna
    - Radio Unit (RU)
    - Baseband Unit (BBU)



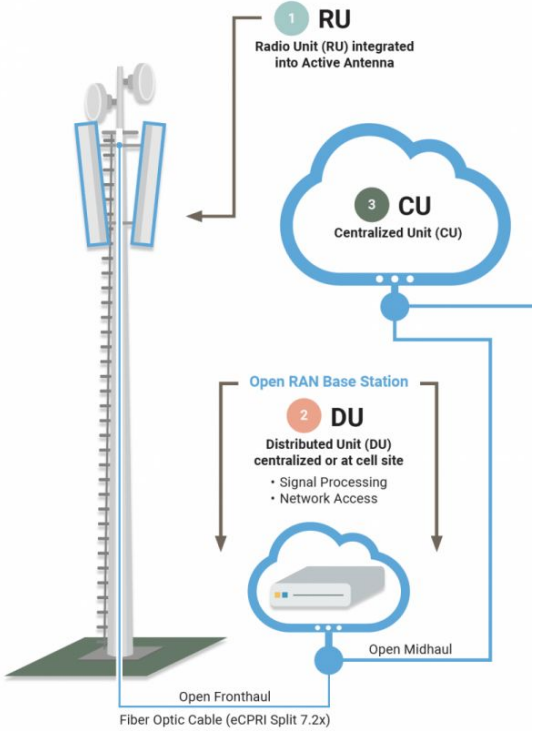
Source: https://www.mavenir.com/wp-content/uploads/2020/11/Open-RAN-Infographic-FINAL.pdf

What is Open RAN?

- Traditional Operator Networks
  - Proprietary, pre-defined radio, hardware and software
  - Closed and embedded interfaces
  - Single vendor
    - Makes the network operator a "hostage" of the vendor
    - Performance reduction when matching cells from different vendors
    - Barrier for innovation

What is Open RAN?

- Open RAN
  - Three main elements
    - Radio Unit (RU)
    - Distributed Unit (DU)
    - Centralized Unit (CU)
  - Programmable, software-defined operation
    - DU and CU run as virtualized software functions on vendor-neutral hardware
  - Open interfaces
    - Opening and standardizing interfaces can make networks deployment more modular
  - Multivendor
  - "Disaggregated RAN"
    - Network agility and flexibility
    - Increased innovation
    - Cost savings



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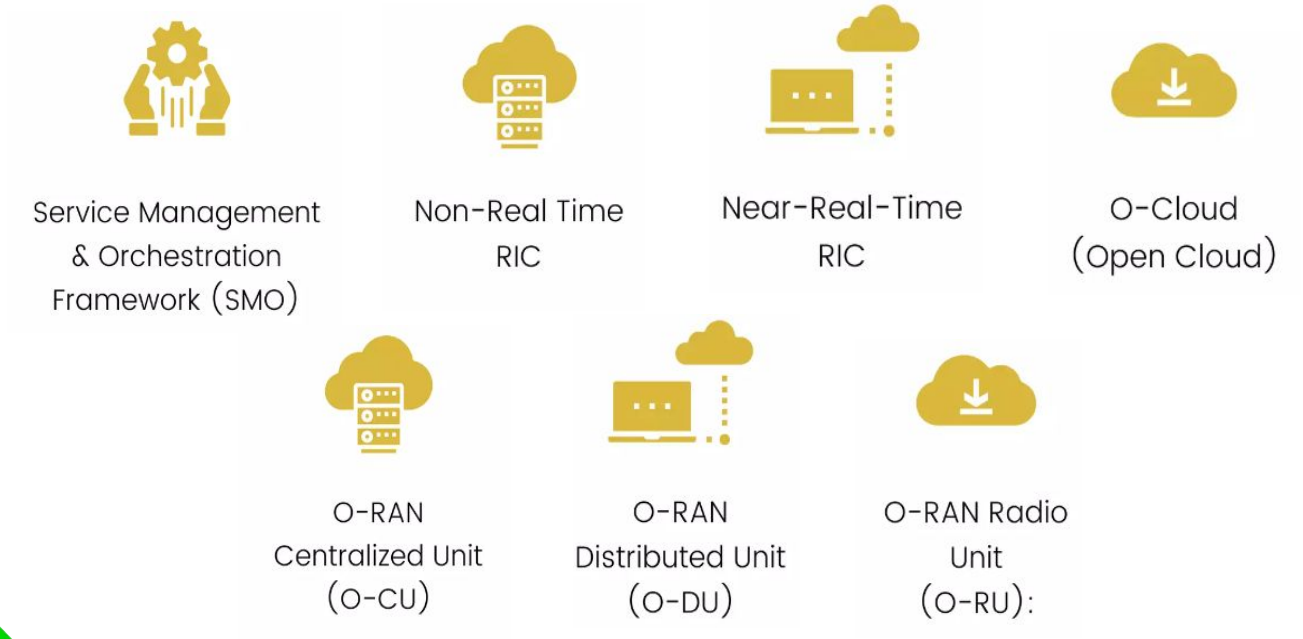
What is Open RAN?

- Open RAN main components



Open RAN Initiatives

- O-RAN Alliance
  - Founded by AT&T, China Mobile, Deutsche Telekom, NTT DOCOMO and Orange
  - Architecture for open, intelligent, virtualized and fully interoperable RAN
- Telecom Infra Project (TIP)
  - A Meta initiative
  - Non profit organization focused on advance global connectivity
- Open Network Foundation
  - Proposed the Software-Defined RAN (SD-RAN)
    - 3GPP compliant
    - Consistent with the O-RAN architecture

Source: https://www.mavenir.com/wp-content/uploads/2020/11/Open-RAN-Infographic-FINAL.pdf

The OpenRAN@Brasil Program

- **Aspiration:** to accelerate the development of an open network ecosystem from research, development, innovation and workforce training in technologies and applications related to 5G and beyond
  - Stimulating interaction between actors from industry, academia and government
  - Demand-driven (mainly service providers and users)
  - Promoting application scenarios (public and private networks)
  - Promoting collaborative development models (mainly open source, but not limited to)
  - Promoting the innovation ecosystem through the experimentation and demonstration space
  - Promoting workforce training

The OpenRAN@Brasil Program

- Cornerstones
  - Research, develop, deploy and validate innovative solutions for intelligent management and control of open and disaggregated networks in different technological domains
  - **Build and make available** experimentation infrastructures in different technological domains that adopt openness and disaggregation
  - **Train** professionals and **engage** academia/industry

OpenRAN@Brasil - Glosary

RAN	Radio Access Network
RIC	RAN Intelligent Controller
PON	Passive Optical Network
G-PON	Gigabit PON
XGS-PON	10 Gigabit Symmetrical PON
SD-	Software-Defined <something>
SMO	Service Management and Orchestration
O-	Open <something>
DWDM	Dense wavelength-division multiplexing

OpenRAN@Brasil - Phases

Phase 1

R&D on management, control and automation layers

- Service Management and Orchestration (SMO)
- RAN Intelligent Controller (RIC)
- SDN, P4 and DWDM in the transport layer
- SD-PON in the Fronthaul
- CLOUD/EDGE computing orchestration

Testbed building

- 2 sites
  - Campinas (CPQD)
  - Rio de Janeiro (RNP)
- Composed of open and disaggregated domains (packet, optical and wireless)

Academia and startup open calls

Status: running
Duration: 36 months

Phase 2

P&D on Hardware

- Development of own Radio Unit (RU)
- Motivation:
  - Most expensive part of the architecture
  - Few vendors

R&D in Software

- RIC xApps/rApps

P&D in Cybersecurity

Status: running
Duration: 30 months

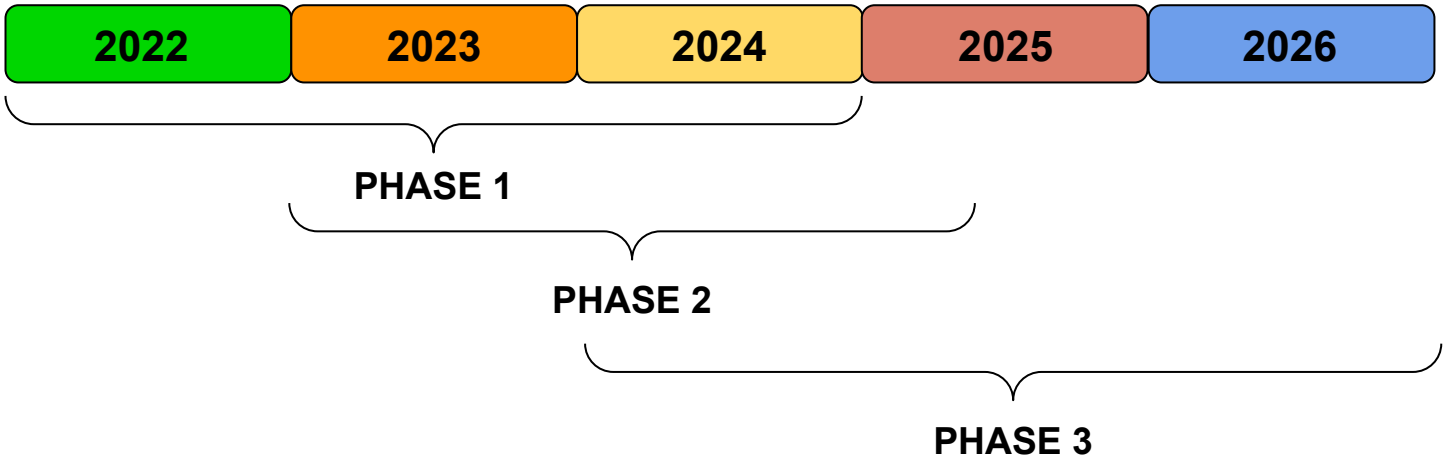
Phase 3

Testbed expansion

- At least one site in each region in Brazil
- Relevant market verticals

Status: under analysis
Duration: 36 months

OpenRAN@Brasil - Phases



Budget

- Total Budget (all phases)
  - ~102M BRL (~21M USD)

Biden-Harris Administration Launches $1.5 Billion Innovation Fund to Develop a More Competitive and Diverse Telecommunications Supply Chain

FOR IMMEDIATE RELEASE
April 12, 2023

- Average income (annual)
  - USA: 55,680 USD
  - Brazil: 7,076 USD

Sources:
https://www.ntia.gov/press-release/2023/biden-harris-administration-launches-15-billion-innovation-fund-develop-more
https://take-profit.org/en/statistics/wages/

OpenRAN@Brasil - Partners

“If you want to go fast, go alone, if you want to go far, go together”.

African Proverb

OpenRAN@Brasil - Partners

- Execution
  - RNP (Phases 1 and 2)
  - CPQD (Phases 1 and 2)
  - Eldorado (Phase 2)
  - INATEL (Phase 2)

OpenRAN@Brasil - Partners

- Research
  - Phase 1
    - UFF, UFPA, UFRGS, UNICAMP, UFRJ
  - Phase 2
    - UFPA, UFCG, UNISINOS, UFG

Phase 1

- Objective:
  - R&D to build an open, programmable infrastructure (testbed)
    - Disaggregated equipments
    - Offered to different communities (academia, industry and service providers)
  - Foster RD&I in open RAN
    - Working groups
    - Startup
  - Train specialized workforce in different open RAN technologies
- Budget: ~32M BRL (~6.5M USD)

Phase 1 - Testbed

- Testbed characteristics
  - Open hardware
  - Open software
    - Developed by international communities/initiatives
  - Paradigms:
    - Softwarization, Virtualization and disaggregation
  - Multiple technological domains orchestration and control
    - Packet, optical and wireless

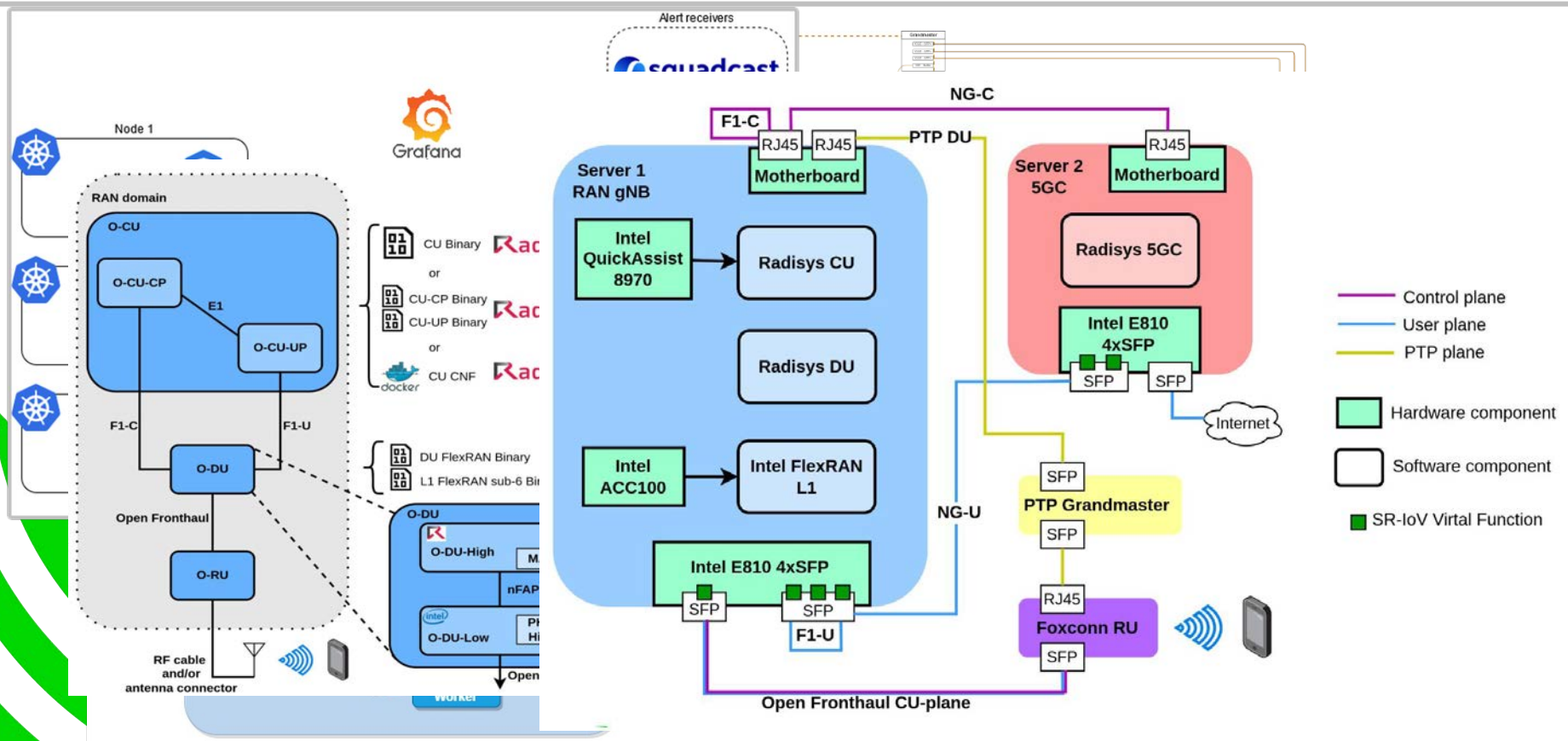
Phase 1 - Testbed

- Testbed offers
  - 5G Open RAN
  - Optical access via PON
  - Packet transport networks
  - Optical networks
  - Could/edge computing to support control and orchestration software
  - Data processing for 5G O-RAN antennas
  - RIC, CU and DU

Phase 1 - Testbed

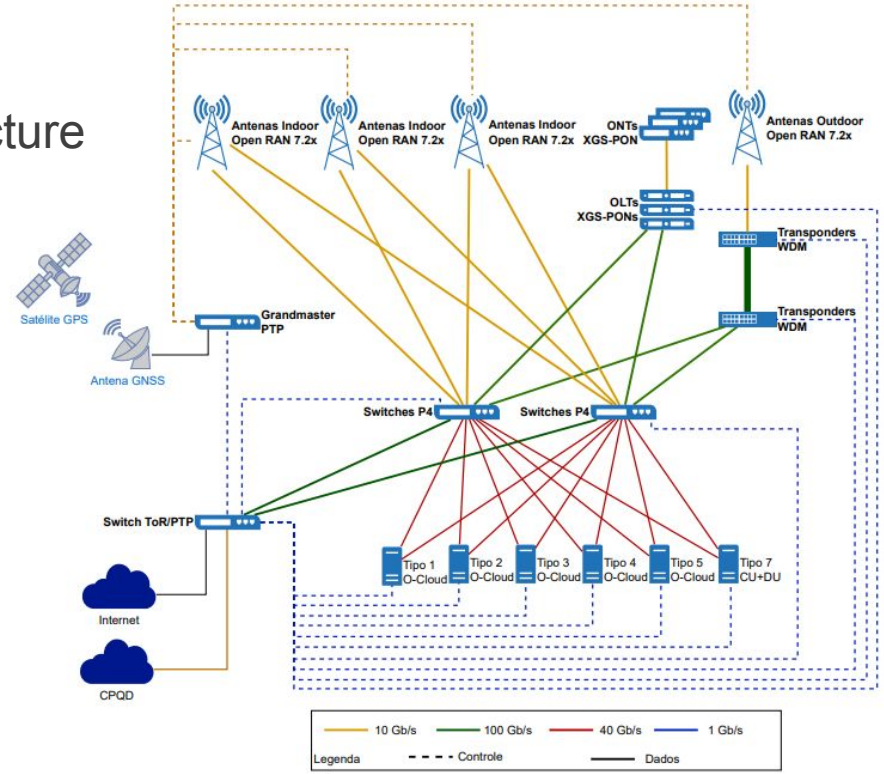
- Sites
  - Two sites deployed in Phase 1
    - CPQD - Campinas, SP
    - RNP - Rio de Janeiro, RJ
  - Both located in the southeast
    - Geographical distance: 397 km (~246.7 miles)
    - Road distance: 493.1 km (~306.4 miles)
  - Connected by a 10 Gbps link

Phase 1 - Testbed



Phase 1 - Testbed

- Standard site configuration
  - O-RAN Alliance Split 7.2X architecture
    - O-RU disaggregated from O-DU
  - Computing
    - 6 to 7 servers
  - O-RAN antennas
    - 3 indoor 5G O-RAN antennas
  - Packet domain
    - Leaf-spine topology
    - P4 switches
  - Optical domain
    - PON (XGS-PON and GPON)
    - DWDM



Phase 1 - Servers

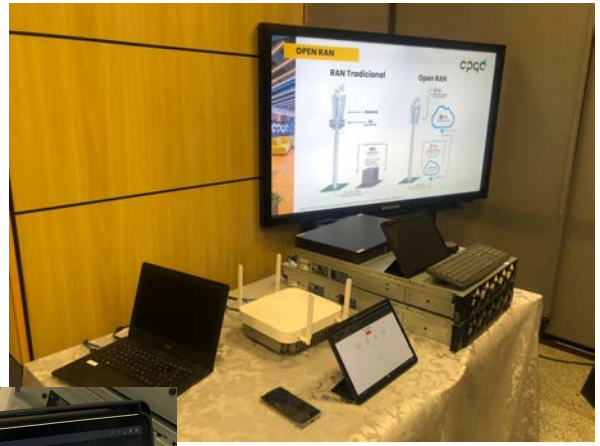
Server Type	Function	Site
Cloud Controller	Control and orchestrate cloud infrastructure	RNP; CPQD;
Application Server	Host and execute testbed applications	RNP; CPQD;
Storage Server	Store and manage testbed data and resources	RNP; CPQD;
Edge Server	Prodive edge services and local processing	RNP; CPQD;
Management Server	Manage and monitor testbed infrastructure	RNP; CPQD;

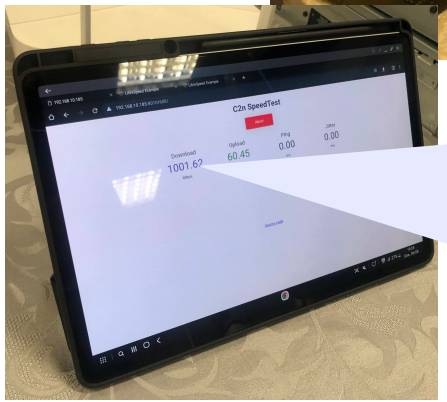
Phase 1 - Testbed Status

- Testbed project is concluded
- First round of acquisitions concluded
  - Antennas, RU, DU, switches, servers…
- Second round of acquisitions started
  - Smartphones, tablets, VR/AR devices…
- Third round of acquisitions on the works
  - Bring more capabilities to the testbed

Phase 1 - Testbed Status

- First demonstration in May 2023
  - WRNP 2023
  - Available at: https://eduplay.rnp.br/portal/video/185000
  - Achieved 800Mbps
- Second demonstration in Aug 2023
  - Open Networks seminar with Japan at ANATEL (Brazil)
  - Achieved ~1Gbps





Phase 1 - Open Call for Working Groups

- Objective:
  - Foster R&D in technologies related to open RAN, adding/improving testbed functionalities
- Budget: ~152k BRL (~31k USD) for each project
  - Release date: February 28, 2023
  - Notification of Acceptance: August 8, 2023
- 6 gorking groups selected
  - Duration: 1 year
    - Start: November 1, 2023
    - End: October 31, 2024

Phase 1 - Open Call for Working Groups

Working Group Name	Topic
GT ORAN-QOS	QoS for open RAN
Plateou	Slicing orchestration
OIRAN	High availability, low power orchestration
GT-FAIR-5G	5G security
GT-AGIR	Intent-based management for open RAN
IQoS	Smart Management for QoS

Phase 1 - Open Call for Startups

- Objective:
  - Deployment of client applications from different verticals
  - Demonstrate the flexibility, adaptability and intelligence of the testbed
- Based on the Lean Startup methodology
- Budget: 396k BRL (~81k USD)

Phase 2

- Objectives:
  - R&D of a 5G O-RAN Alliance compliant Radio Unit (O-RU)
  - R&D of smart SDN applications for the Open RAN domain (xApps/rApps)
  - Open RAN cybersecurity risk analysis
- Budget: ~30M BRL (~6,17M USD)

Phase 2 - RU

- Hardware
  - DC/DC Converter
  - Baseband Processing
  - Power Amplifier (N78 e N40)
  - Mechanical filters
  - Mechanic
- Programmability
  - Fronthaul interface
  - Synchronization (radio synch)
  - Low-PHY
- O-RU management software
  - NETCONF protocol/YANG models

xApps and rApps

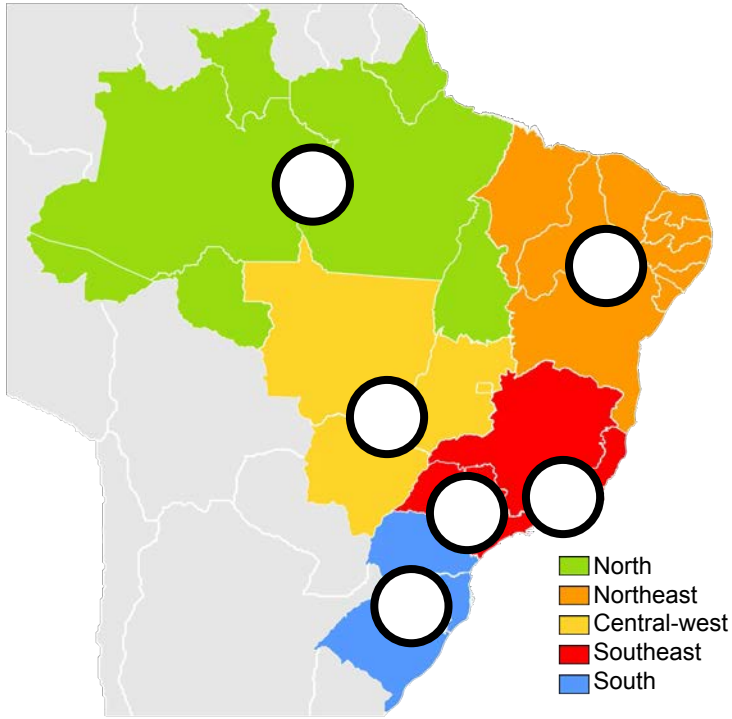
- What are they?
  - Network automation tools
  - Provide essential control and management features and functionality
- Differences
  - xApp
    - Hosted on the near RT RIC
    - Optimize radio spectrum efficiency
  - rApp
    - Operates from within the RIC's SMO framework
    - Non-real time network automation

Phase 2 - xApps and rApps

- First four xApps selected to development
  - RIC distribution
  - Energy consumption
  - Network slicing
  - Self-organizing RAN
- Development environment
  - Different RICs being explored
    - Open Network Foundation: SD-RAN
    - O-RAN Alliance: SC
    - Open Air Interface: FlexRIC
  - ns-3 (ns-oran)
  - colosseum
- Systematic literature overview regarding security risks

Phase 3

- Objectives:
  - Expand the testbed infrastructure to every region in Brazil
    - North, Northeast, Central-west, South
  - R&D on applications only possible in Open RAN infrastructures
- Budget: ~40M BRL (~8,23M USD)



Phase 3 - Open Calls

- Testbed expansion
  - Selecting proposals from Institutes of Science and Technology
- R&D on applications
  - Focus on application/use cases in:
    - Industry
    - Agriculture
    - Health
    - Education
    - Cities
    - Gaming

What is next?

- Testbed release
  - September/October 2023
  - Incremental release
    - v1.0: 5G open RAN network capabilities
    - v2.0: Smart orchestration capabilities
    - V3.0: New capabilities (under investigation)
      - GPUs for packet acceleration
      - Wi-Fi capabilities

What is next?

- Working groups start
  - November 1, 2023
- Startup selection process
  - Ongoing
  - Startup start: Q1, 2024

What is next?

- Incorporate additional Partners
  - New ICTs want to be part of the program
  - Build a community of open RAN research in Brazil
  - Put together different infrastructures
    - Private and open radio stacks
  - Test interoperability
  - Knowledge Exchange

Final Remarks

- Open RAN stimulates competition in the communication industry
  - Open RAN adoption can open the market for new hardware/software vendors, stimulating competition in the communication industry
  - Cost reduction for operators
  - Interoperability between different components allows the adoption of more suitable solutions for specific scenarios
  - Better service quality and more accessible services
  - Single vendor dependency reduction

Final Remarks

- Open RAN facilitates connectivity expansion in remote and rural areas
  - Bring high-quality connectivity to remote and rural areas with limited infrastructures
  - Digital inclusion
  - Reduction in social inequality through equal access to communication and internet services

Final Remarks

- Open RAN can boost advances in innovative applications
  - Flexibility and interoperability facilitate the appearance of new services and business models
    - New apps/services for advanced scenarios (smart cities, industrial automation, digital health, …)
  - Driving digital transformation in various sectors
    - Health, agriculture, education, among others…

Final Remarks

- The OpenRAN@Brasil Program has the potential to revolutionize communications networks in the country
  - Fostering innovation
  - Reducing costs
  - Strengthening national industry
  - Expanding connectivity
  - Promoting global colaboration

Final Remarks

- Provisioning of a modern and flexible communication infrastructure
  - Able to quickly adapt to ever-evolving demands

Final Remarks

- Strengthening the national technology industry
  - Encouraging collaboration between companies, universities and research institutes
  - The Program's open platform allows the development of customized solutions
  - Fostering innovation in the areas related to open RAN
  - Creating business opportunities, exporting technology and preparing qualified workforce

Final Remarks

- Global collaboration and knowledge exchange
  - OpenRAN@Brasil benefits from global collaboration with international organizations
    - ONF, Linux Foundation, OAI, etc.
  - Promotes knowledge exchange and best practices
  - Extends the reach of the project, increasing its international relevance
  - Attract investment and technical support from international organizations

Final Remarks

Open RAN offers a promising view of a more open, including and efficient future.

OpenRAN@Brasil is "surfing this wave".

Thanks!

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www.openranbrasil.org

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