



Testbed OpenRAN Brasil

Ambiente Físico e Lógico

META 2

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Ecosistema de Infraestrutura do Testbed

Especificação de Domínios



Domínio Cloud e Edge

SERVIDOR TIPO I

Servidor OpenRAN Tipo I

- Tamanho: 1U ou 2U
- CPU: 2 x 16 cores 32 threads 2,4Ghz+, Intel Silver ou Gold
- Memória: 4 x 32GB com possibilidade de expansão - Total: 128GB
- Discos: 2 x 480GB SSD, hot-pluggable
- GPU: Slot para GPU / FPGA PCI-E 16x com conector de energia PCI-E
- Interfaces 1GbE: 4 x 1GbE - Intel ou Broadcom com Suporte a PXE e SR-IOV
- Network Card 40GbE+: 2 x 40GbE ou 4 x 40GbE - Intel com Suporte a QSFP+, LAGG, PDPK, SR-IOV, DAC e AOC
- SFP:
 - Cabo DAC - QSFP+ to QSFP+, 40GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
- Mgmt: Redfish (ou IPMI), suporte a SNMP
- UEFI: UEFI secure boot enabled
- Kit para instalação em Rack

OpenRAN Server Type I - Itens 1 e 2	
Description	QTY
X12 Ultra 2U, 6x 2.5 Hybrid, X12DPU-6, 219ULTS-R1K62P	1
Intel Xeon Silver 4314 Processor 16-Core 2.4GHz 24MB Cache (135W)	2
32GB DDR4 1.2V 3200 ECC REG	4
Samsung PM883,480GB,SATA 6Gb/s,V4 TLC VNAND,2,5",7mm	2
2U Ultra Riser, 2 PCIe4.0 x16 and 1 PCIe3.0 x8 -- AOC-2UR668G4	1
Ultra I/O bracket for SC829U, 219U (Square Opening)	1
2x 40GbE QSFP+ Intel XL710, Gen3 x8 LP -- AOC-S40G-I2Q	1
4x GbE RJ45 Intel i350-AM4, Gen3 x4 LP -- AOC-SGP-I4	1
2U LHS WIO Riser card with two PCI-E 4.0 x16 slots,HF,RoHS	1
GPU,2x4F/CPU to 2x4F/CPU,P4.2, 30CM,16AWG, 10A/pin, -40~105C	1
PWYCB,GPU,2x4F/CPU to two (2x3F+2x1F)/PCIe,P4.2, 20CM,16/20A	1
1U Passive CPU VC HS for X12 ICX/CPX	2
Plastic X12 Air Shroud for SC219UL left GPU,RoHS	1
Plastic X12 Air Shroud for SC219UL right GPU,RoHS	1
Dummy memory DIMM spacer (set) for DDR3, DDR4,RoHS	16
5M QSFP to QSFP Ethernet/InfiniBand QDR 26AWG	2
5M 10GbE SFP+ to SFP+, Passive, Pull release	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

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Domínio Cloud e Edge

SERVIDOR TIPO II

Servidor OpenRAN Tipo II

- Tamanho: 1U ou 2U
- CPU: 2 x Xeon Gold 6348 28 cores (2 socket)
- Memória: 6 x 32GB com possibilidade de expansão - Total: 192GB
- Discos: 2 x 480GB SSD, hot-pluggable
- GPU: Slot para GPU / FPGA PCI-E 16x com conector de energia PCI-E
- Interfaces 1GbE: 4 x 1GbE - Intel ou Broadcom com Suporte a PXE e SR-IOV
- Network Card 10GbE: Intel Ethernet Converged Network Adapter X710DA4FH (Fortville) Quad port 10 GbE.
- Network Card 40GbE+: 2 x 40GbE ou 4 x 40GbE - Intel suporte a QSFP+, LAGG, DDPK, SR-IOV, DAC e AOC
- SFP:
 - Cabo DAC - SFP+ to SFP+, 10GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
 - Cabo DAC - QSFP+ to QSFP+, 40GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
- Mgmt: Redfish (ou IPMI), suporte a SNMP
- UEFI: UEFI secure boot enabled
- Crypto Card Accelerator: Intel QuickAssist Adapter 8970
 - Referência:
<https://www.cdw.com/product/intel-quickassist-adapter-8970-cryptographic-accelerator/5101079>
- FPGA Cards: FPGA Intel PAC N3000
 - 10 Gbps, 25 Gbps (up to 100 GbE) with Dual Intel Ethernet Converged Network Adapter XL710
 - Intel FPGA PAC N3000 accelerates network traffic for up to 100 Gbps to support low-latency, high-bandwidth 5G applications.
 - Referência:
 - <https://www.intel.com/content/www/us/en/products/sku/193920/intel-fpga-pac-n3000/specifications.html>

OpenRAN Server Type II - Itens 3 e 4	
Description	QTY
X12 Ultra 2U, 6x 2.5 Hybrid, X12DPU-6, 219ULTS-R1K62P	1
Intel Xeon Gold 6348 Processor 28-Core 2.6GHz 42MB Cache (235W)	2
32GB DDR4 1.2V 3200 ECC REG	8
Samsung PM883,480GB,SATA 6Gb/s,V4 TLC VNAND,2.5",7mm	2
2U Ultra Riser, 2 PCIe4.0 x16 and 1 PCIe3.0 x8 -- AOC-2UR668G4	1
Ultra I/O bracket for SC829U, 219U (Square Opening)	1
2x 40GbE QSFP+ Intel XL710, Gen3 x8 LP -- AOC-S40G-I2Q	1
4x GbE RJ45 Intel i350-AM4, Gen3 x4 LP -- AOC-SGP-I4	1
[NR]Intel IQA89701G1P5QuickAssist100Gbps hardwareaccelerator□	1
4x 10GbE SFP+ Intel XL710-BM1, Gen3 x8 LP -- AOC-STG-I4S	1
2U LHS WIO Riser card with two PCI-E 4.0 x16 slots,HF,RoHS	1
NR]IntelVACC100G1P5 PCIeGen3x16vRAN AcceleratorACC100 Adapt□	1
1U Passive CPU VC HS for X12 ICX/CPX	2
Plastic X12 Air Shroud for SC219UL left GPU,RoHS	1
Plastic X12 Air Shroud for SC219UL right GPU,RoHS	1
Dummy memory DIMM spacer (set) for DDR3, DDR4,RoHS	12
5M QSFP to QSFP Ethernet/InfiniBand QDR 26AWG	2
5M 10GbE SFP+ to SFP+, Passive, Pull release	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

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Domínio Cloud e Edge

SERVIDOR TIPO IV

Servidor OpenRAN Tipo IV

- CPU: **Xeon Gold 6212U (Single Socket)**
- Memória: **4x 32GB com possibilidade de expansão - Total: 128**
- Discos: **2 x 480GB SSD, hot-pluggable**
- Interfaces 1GbE: **4 x 1GbE - Referência: Intel ou Broadcom 1GbE BASE-T**
- **Suporte a PXE e SR-IOV**
- Network Card 10GbE: **Intel Ethernet Converged Network Adapter X710DA4FH (Fortville) Quad port 10 GbE SFP+**
- SFP:
 - Cabo DAC - SFP+ to SFP+, 10GbE, Copper Twinax Direct Attach Cable, 5 Meter: **2 unidades**
- Mgmt: **Redfish (ou IPMI), suporte a SNMP**
- UEFI: **UEFI secure boot enabled**

OpenRAN Server Type IV - Item 7	
Description	QTY
IMM, 2x 2.5 HDD, 1x M.2 M-Key 22110/2280, 2x FHFL PCIe x16, AC Red	1
Intel Xeon Gold 6312U Processor 24-Core 2.4GHz 36MB Cache (185W)	1
32GB DDR4 1.2V 3200 ECC REG	4
Samsung PM883,480GB,SATA 6Gb/s,V4 TLC VNAND,2.5",7mm	2
2x GbE RJ45 Intel i350-AM2, Gen3 x4 LP -- AOC-SGP-I2	1
4x 10GbE SFP+ Intel XL710-BM1, Gen3 x8 LP -- AOC-STG-I4S	1
5M 10GbE SFP+ to SFP+, Passive, Pull release	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

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SERVIDOR TIPO III

Servidor OpenRAN Tipo III

- Tamanho: 1U ou 2U
- CPU: 2 x Xeon Gold 6348 28 cores (2 socket)
- Memória: 6 x 32GB com possibilidade de expansão - Total: 192GB
- Discos: 2 x 480GB SSD, hot-pluggable
- GPU: Slot para GPU / FPGA PCI-E 16x com conector de energia PCI-E
- Interfaces 1GbE: 4 x 1GbE - Intel ou Broadcom com Suporte a PXE e SR-IOV
- Network Card 10GbE: Intel Ethernet Converged Network Adapter X710DA4FH (Fortville) Quad port 10 GbE SFP+.
- Network Card 40GbE: 2 x 40GbE ou 4 x 40GbE - Intel suporte a QSFP+, LAGG, DPDK, SR-IOV, DAC e AOC
- SFP:
 - Cabo DAC - SFP+ to SFP+, 10GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
 - Cabo DAC - QSFP+ to QSFP+, 40GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
- Mgmt: Redfish (ou IPMI), suporte a SNMP
- UEFI: UEFI secure boot enabled

OpenRAN Server Type III - Itens 5 e 6	
Description	QTY
X12 Ultra 2U, 6x 2.5 Hybrid, X12DPU-6, 219ULTS-R1K62P	1
Intel Xeon Gold 6348 Processor 28-Core 2.6GHz 42MB Cache (235W)	2
32GB DDR4 1.2V 3200 ECC REG	8
Samsung PM883,480GB,SATA 6Gb/s,V4 TLC VNAND,2.5",7mm	2
2U Ultra Riser, 2 PCIe4.0 x16 and 1 PCIe3.0 x8 -- AOC-2UR668G4	1
Ultra I/O bracket for SC829U, 219U (Square Opening)	1
2x 40GbE QSFP+ Intel XL710, Gen3 x8 LP -- AOC-S40G-I2Q	1
4x GbE RJ45 Intel i350-AM4, Gen3 x4 LP -- AOC-SGP-I4	1
4x 10GbE SFP+ Intel XL710-BM1, Gen3 x8 LP -- AOC-STG-I4S	1
2U LHS WIO Riser card with two PCI-E 4.0 x16 slots,HF,RoHS	1
GPU,2x4F/CPU to 2x4F/CPU,P4.2, 30CM,16AWG, 10A/pin, -40~105C	1
PWYCB,GPU,2x4F/CPU to two (2x3F+2x1F)/PCIe,P4.2, 20CM,16/20A	1
1U Passive CPU VC HS for X12 ICX/CPX	2
Plastic X12 Air Shroud for SC219UL left GPU,RoHS	1
Plastic X12 Air Shroud for SC219UL right GPU,RoHS	1
Dummy memory DIMM spacer (set) for DDR3, DDR4,RoHS	12
5M QSFP to QSFP Ethernet/InfiniBand QDR 26AWG	2
5M 10GbE SFP+ to SFP+, Passive, Pull release	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

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SERVIDOR TIPO V

Servidor OpenRAN Tipo V

- Tamanho: 1U ou 2U
- CPU: 2 x 16 cores 32 threads 2,4Ghz+, Intel Silver ou Gold
- Memória: 6 x 32GB com possibilidade de expansão - Total: 192GB
- Discos:
 - 2 x 240GB SSD
 - 2 x 1TB SSD, hot-pluggable*, Storage
- GPU: Slot para GPU / FPGA PCI-E 16x com conector de energia PCI-E
- Interfaces 1GbE: 4 x 1GbE - Intel ou Broadcom com Suporte a PXE e SR-IOV
- Network Card 40GbE: 2 x 40GbE ou 4 x 40GbE - Intel suporte a QSFP+, LAGG, DPDK, SR-IOV, DAC e AOC
- SFP:
 - Cabo DAC - QSFP+ to QSFP+, 40GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
- Mgmt: Redfish (ou IPMI), suporte a SNMP
- UEFI: UEFI secure boot enabled

OpenRAN Server Type V - Itens 8 e 9	
Description	QTY
X12 Ultra 2U, 6x 2.5 Hybrid, X12DPU-6, 219ULTS-R1K62P	1
Intel Xeon Silver 4314 Processor 16-Core 2.4GHz 24MB Cache (135W)	2
32GB DDR4 1.2V 3200 ECC REG	8
Samsung PM883 240GB SATA 6Gb/s V4 TLC 2.5" 7mm (1.3 DWPD)	2
Samsung PM883,960GB,SATA 6Gb/s,V4 TLC VNAND,2.5",7mm	2
2U Ultra Riser, 2 PCIe4.0 x16 and 1 PCIe3.0 x8 -- AOC-2UR668G4	1
Ultra I/O bracket for SC829U, 219U (Square Opening)	1
2x 40GbE QSFP+ Intel XL710, Gen3 x8 LP -- AOC-S40G-I2Q	1
4x GbE RJ45 Intel i350-AM4, Gen3 x4 LP -- AOC-SGP-I4	1
2U LHS WIO Riser card with two PCI-E 4.0 x16 slots,HF,RoHS	1
GPU,2x4F/CPU to 2x4F/CPU,P4.2, 30CM,16AWG, 10A/pin, -40~105C	1
PWYCB,GPU,2x4F/CPU to two (2x3F+2x1F)/PCIe,P4.2, 20CM,16/20A	1
1U Passive CPU VC HS for X12 ICX/CPX	2
Plastic X12 Air Shroud for SC219UL left GPU,RoHS	1
Plastic X12 Air Shroud for SC219UL right GPU,RoHS	1
Dummy memory DIMM spacer (set) for DDR3, DDR4,RoHS	12
5M QSFP to QSFP Ethernet/InfiniBand QDR 26AWG	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

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SERVIDOR TIPO V

Servidor OpenRAN Tipo V

- Tamanho: 1U ou 2U
- CPU: 2 x 16 cores 32 threads 2,4Ghz+, Intel Silver ou Gold
- Memória: 6 x 32GB com possibilidade de expansão - Total: 192GB
- Discos:
 - 2 x 240GB SSD
 - 2 x 1TB SSD, hot-pluggable*, Storage
- GPU: Slot para GPU / FPGA PCI-E 16x com conector de energia PCI-E
- Interfaces 1GbE: 4 x 1GbE - Intel ou Broadcom com Suporte a PXE e SR-IOV
- Network Card 40GbE: 2 x 40GbE ou 4 x 40GbE - Intel suporte a QSFP+, LAGG, DPDK, SR-IOV, DAC e AOC
- SFP:
 - Cabo DAC - QSFP+ to QSFP+, 40GbE, Copper Twinax Direct Attach Cable, 5 Meter: 2 unidades
- Mgmt: Redfish (ou IPMI), suporte a SNMP
- UEFI: UEFI secure boot enabled

OpenRAN Server Type V - Itens 8 e 9	
Description	QTY
X12 Ultra 2U, 6x 2.5 Hybrid, X12DPU-6, 219ULTS-R1K62P	1
Intel Xeon Silver 4314 Processor 16-Core 2.4GHz 24MB Cache (135W)	2
32GB DDR4 1.2V 3200 ECC REG	8
Samsung PM883 240GB SATA 6Gb/s V4 TLC 2.5" 7mm (1.3 DWPD)	2
Samsung PM883,960GB,SATA 6Gb/s,V4 TLC VNAND,2.5",7mm	2
2U Ultra Riser, 2 PCIe4.0 x16 and 1 PCIe3.0 x8 -- AOC-2UR668G4	1
Ultra I/O bracket for SC829U, 219U (Square Opening)	1
2x 40GbE QSFP+ Intel XL710, Gen3 x8 LP -- AOC-S40G-I2Q	1
4x GbE RJ45 Intel i350-AM4, Gen3 x4 LP -- AOC-SGP-I4	1
2U LHS WIO Riser card with two PCI-E 4.0 x16 slots,HF,RoHS	1
GPU,2x4F/CPU to 2x4F/CPU,P4.2, 30CM,16AWG, 10A/pin, -40~105C	1
PWYCB,GPU,2x4F/CPU to two (2x3F+2x1F)/PCIe,P4.2, 20CM,16/20A	1
1U Passive CPU VC HS for X12 ICX/CPX	2
Plastic X12 Air Shroud for SC219UL left GPU,RoHS	1
Plastic X12 Air Shroud for SC219UL right GPU,RoHS	1
Dummy memory DIMM spacer (set) for DDR3, DDR4,RoHS	12
5M QSFP to QSFP Ethernet/InfiniBand QDR 26AWG	2
PWCD,US,IEC60320 C14 TO C13,6FT,14AWG,RoHS	2

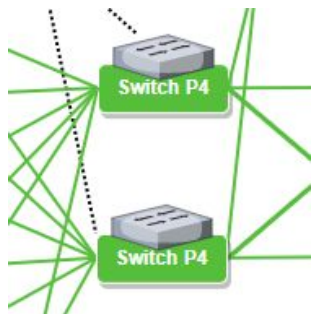
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Especificação de Domínios



Domínio Pacote



P4 Programmable Pipeline

32 x 100G QSFP28 switch ports with Tofino 32Q

Real-time Telemetry

User Plan Function

Dual e Quad P4 Pipelines

DCS800

6.4T PROGRAMMABLE DATA CENTER SWITCH

Wedge 100BF-32X
32 x 100G QSFP28 switch ports with Tofino 32D
Programmable Tofino switches for data centers



Network Packet Broker



Broadband Network Gateway



Real-time Telemetry



L4 Server Load Balancer



P4 Programmable Pipeline



OpenBMC



Edge-core
NETWORKS

DCS810

25.6T P4 PROGRAMMABLE DATA CENTER SWITCH

AS9516-32D
32 x 400G QSFP-DD switch ports with Tofino 2
Programmable leaf or spine switch for large scale data centers



Network Packet Broker



Broadband Network Gateway



Real-time Telemetry



L4 Server Load Balancer



P4 Programmable Pipeline



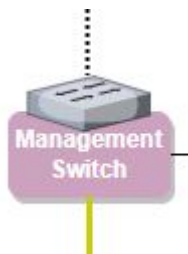
OpenBMC



[Solution Brochure](#) [Click to see 400G Programmable solutions](#)



Gerenciamento



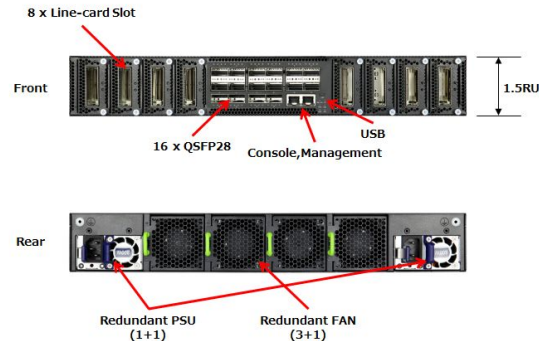
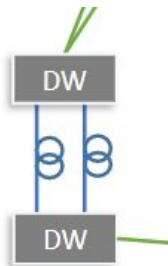
S9600-72XC Front and Rear Views



ufiSpace



Domínio WDM



AS7716-24SC

Edge-core
NETWORKS

Especificação de Domínios



Domínio FTTX

OLT



OLT Combo (GPON e XGS-PON)

- Tamanho: 1U
- Quantidade de Portas:
 - 2 portas QSFP28
 - 16 portas Any-PON (GPON ou XGS-PON)
 - Portas combo (Suporte a GPON e XGS-PON)
- Certificado: VOLTHA 2.9 (Certification Program)
 - https://docs.voltha.org/master/release_notes/voltha_2.9.html
- Transceivers:
 - Transceiver QSFP28: 01 unidade(s)
 - Transceiver XGS-PON para OLT Combo: 01 unidade(s)
 - Transceiver GPON para OLT Combo: 01 unidade(s)

OLT XGS-PON

- Tamanho: 1U
- Quantidade de Portas:
 - 4 portas QSFP28
 - 16 portas XGS-PON
- Certificado: VOLTHA 2.9 (Certification Program)
 - https://docs.voltha.org/master/release_notes/voltha_2.9.html
- Transceivers:
 - Transceiver QSFP28: 01 unidade(s)
 - Transceiver XGS-PON para OLT XGS-PON: 01 unidade(s)

Edge-core
NETWORKS



XGS- PON ASXVOLT16



GPON RTL1600X

RadisyS

ONT



XG-99XS

CIG



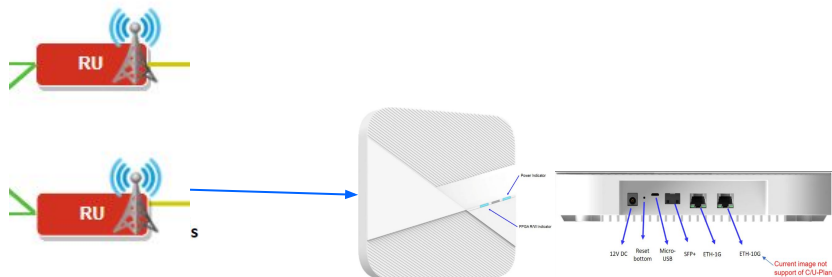
PM4264

RadisyS

Especificação de Domínios



Domínio RAN



Foxconn Indoor RRU RPQN-7801E

Small Cell Open Ran

- SFP: 1 x Suporte SFP 10G
- Porta: 1 x porta Gigabit
- Frequência: 3.3GHz ~ 3.8GHz
- Duplex: TDD
- Banda 3GPP: n78
- Antena: MIMO 4x4
- Ganho antena: >= 4dBi
- Potência: >= 24dBm
- BW: 10 Mhz ~ 100 Mhz
- O-RAN: C-Plane / U-Plane / S-Plane / M-Plane
- 3GPP: 3GPP Release 16
- Grau de proteção: IP3X
- Montagem: Kit de montagem em parede / Teto
- Cabeça de rádio para Small Open RAN: Foxconn Sub6 - Intel Arria10 based Indoor 4x4 MIMO RRH (with power adapter)

ID Outlook

Highlight

Radio	5G NR TDD
MSR	Band n78/n79
FPGA	Intel Arria10
Throughput	up to 1.6Gbps
Dimension	260mm×242mm×76.5mm (L×W×H)
Weight	< 4.5Kg
Power	< 60W

Technical Specification	
Hardware Configuration	
Fronthaul interface	O-RAN option 7.2 over 10Gbps RJ45/SFP+
Internal Antenna	5G NR*4
Power Supplier	12V DC/5A input and PoE++
Memory	DDR4 8Gb, microSD
External interface	1Gbps RJ45, microUSB, Power Jack
3GPP R15	
Frequency	7800 (3.3-3.6GHz)
	7801 (3.7-3.8GHz)
	7901 (4.8-4.9GHz)
chBW	100 MHz
Capacity	1.6 Gbps
Tx/Rx Paths	4T4R; 4 data streams
Max Output Power	24dBm (per RF connector)
Antenna Gain	~ 5dBi
Synchronization	
Frequency Stability	±0.1ppm
Frequency Synchronization	PTP(IEEE1588v2)
Network Features	
	SSH, IPv4
Environmental	
Ingress protection	Class IP30
Working temperature	0°C~+40°C
Mounting	Wall-mount, Ceiling-mount





Domínio Sincronização (FrontHaul)



Falcon-RX

- IEEE 1588-2008 (PTP) Grand Master e Boundary Clock
- Interfaces:
 - 2x IEEE 1588-2008 (PTP) 100Base-TX, 1000Base-T
 - 1000Base-X with Synchronous Ethernet (electrical RJ45 & optical SFP)
- Gerenciamento remoto



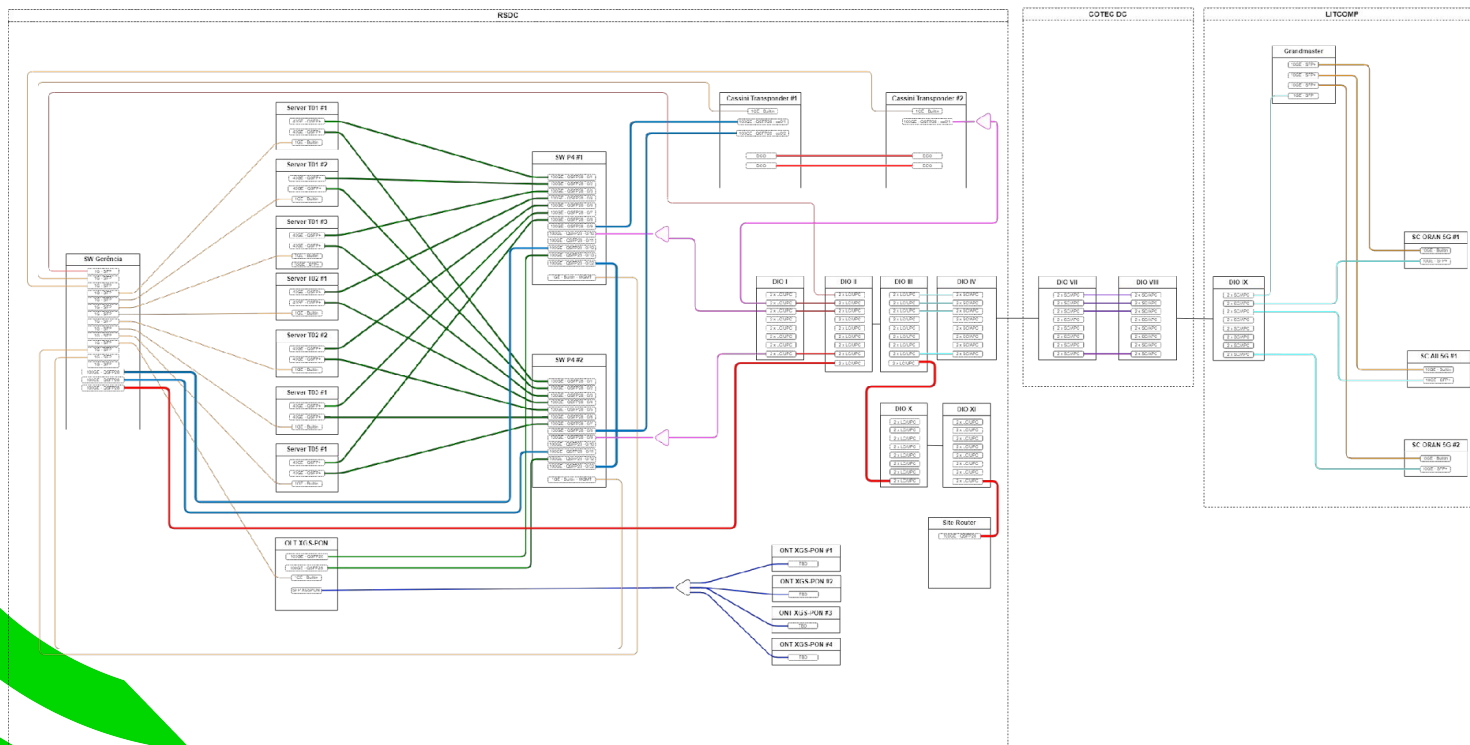


Conectividade Física

Conectividade Física



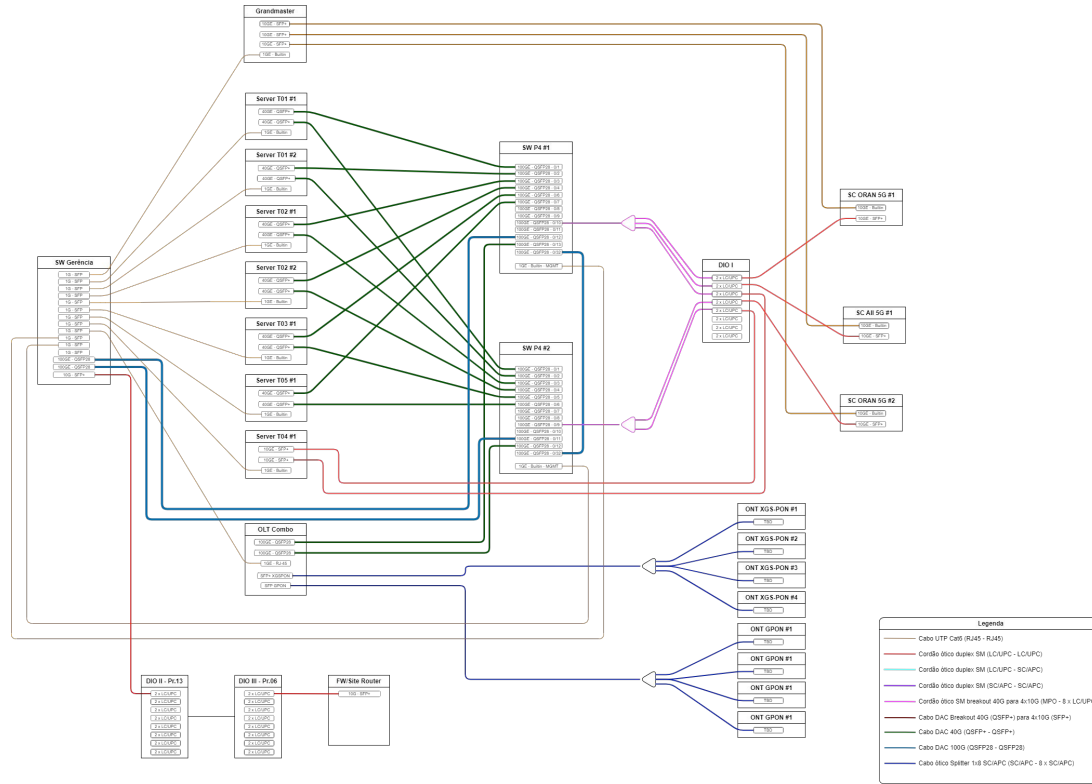
- Planta de Conectividade Física (PoP-RJ)



Conectividade Física



- Planta de Conectividade Física (CPQD)



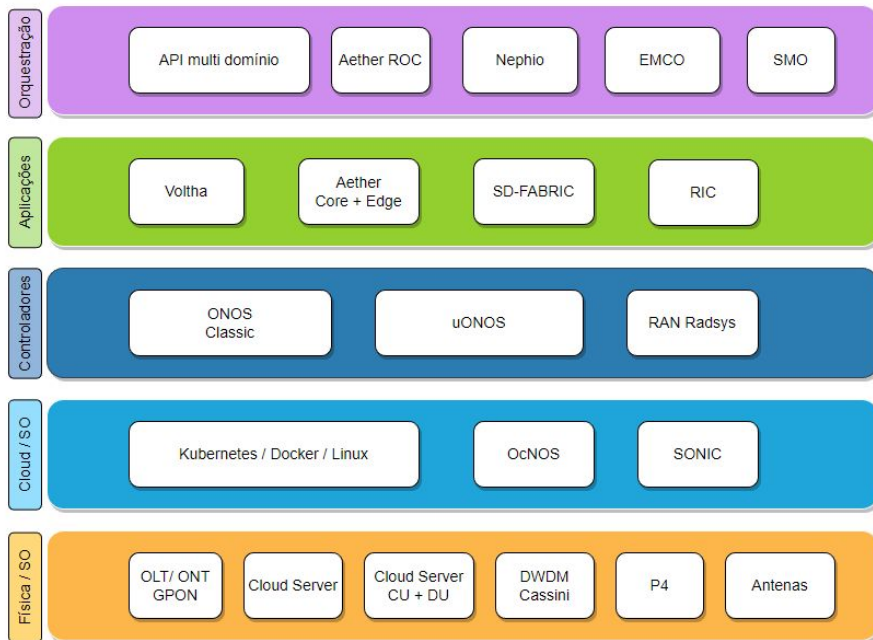


Conectividade Lógica

Conectividade Lógica



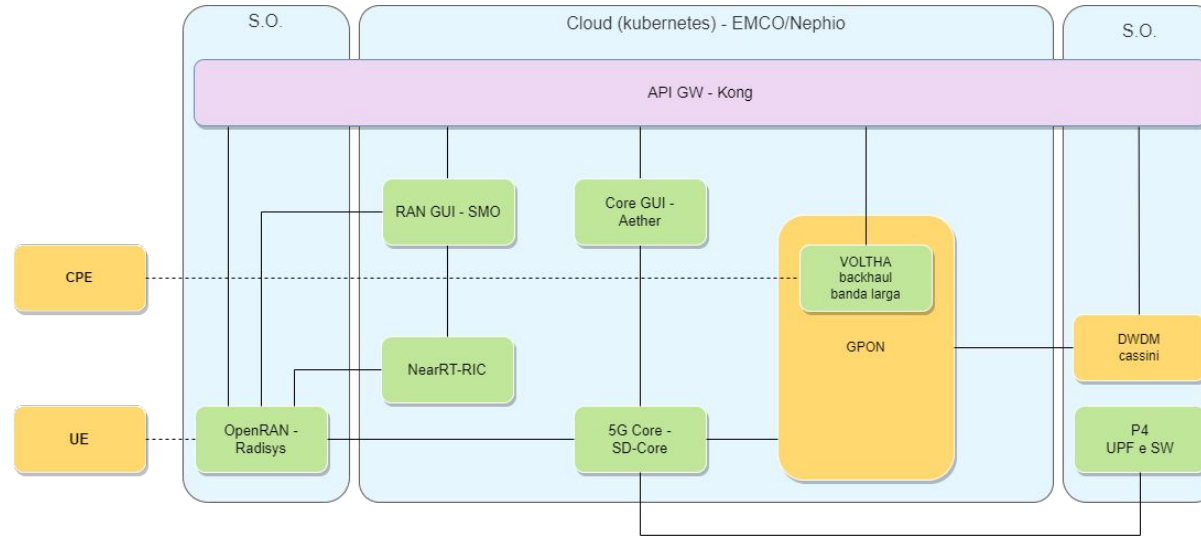
- Conectividade de softwares de controle de camadas superiores



Conectividade Lógica



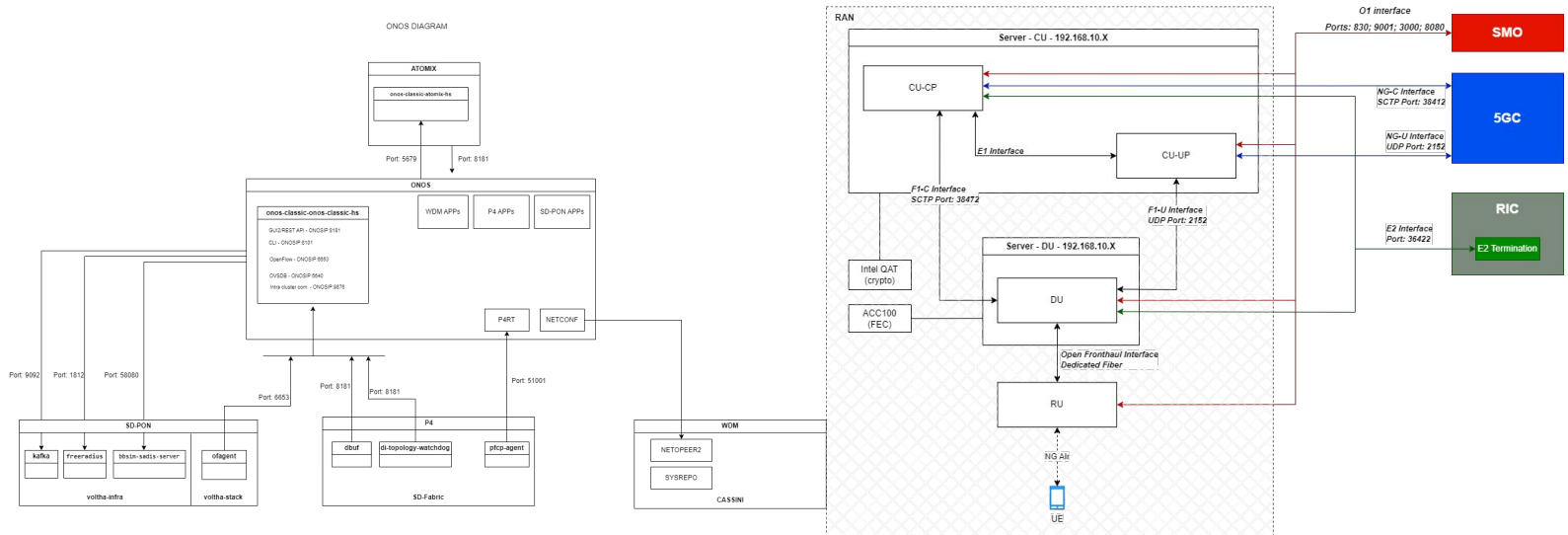
- Conectividade de softwares de controle de camadas superiores



Conectividade Lógica



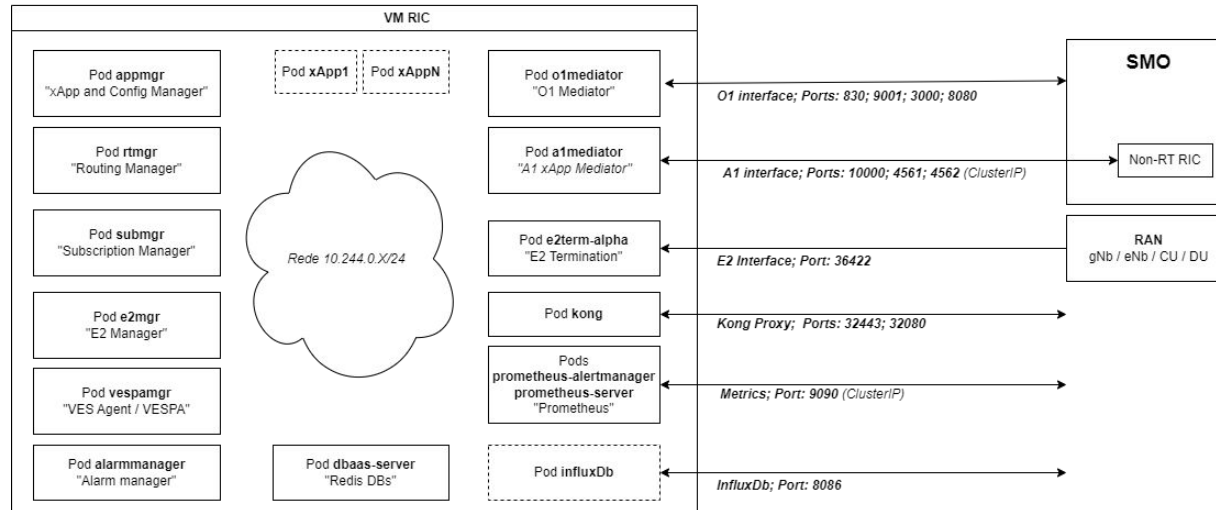
- Design e Planejamento de Conectividade, Endereçamento e Portas Lógicas:



Conectividade Lógica



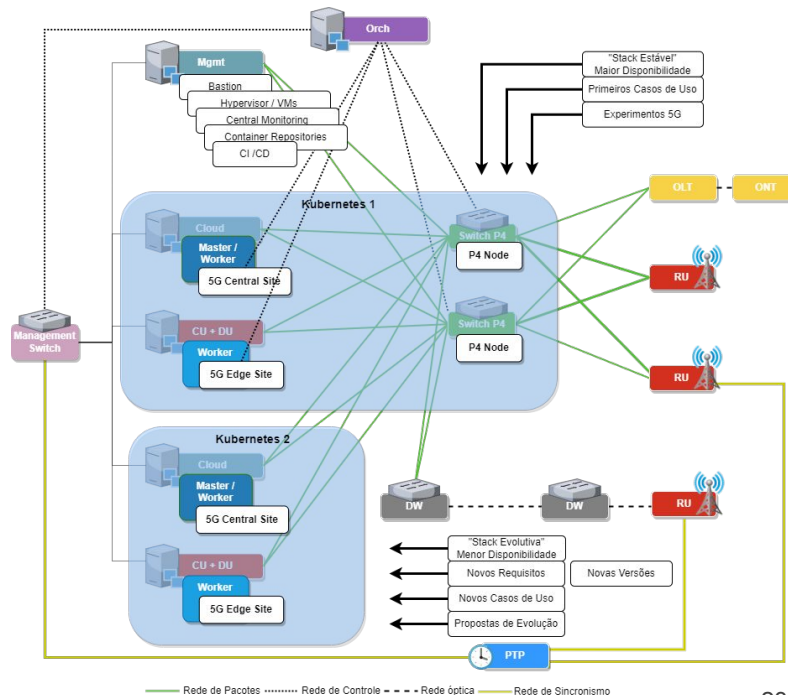
- Design e Planejamento de Conectividade, Endereçamento e Portas Lógicas:



Conectividade Lógica



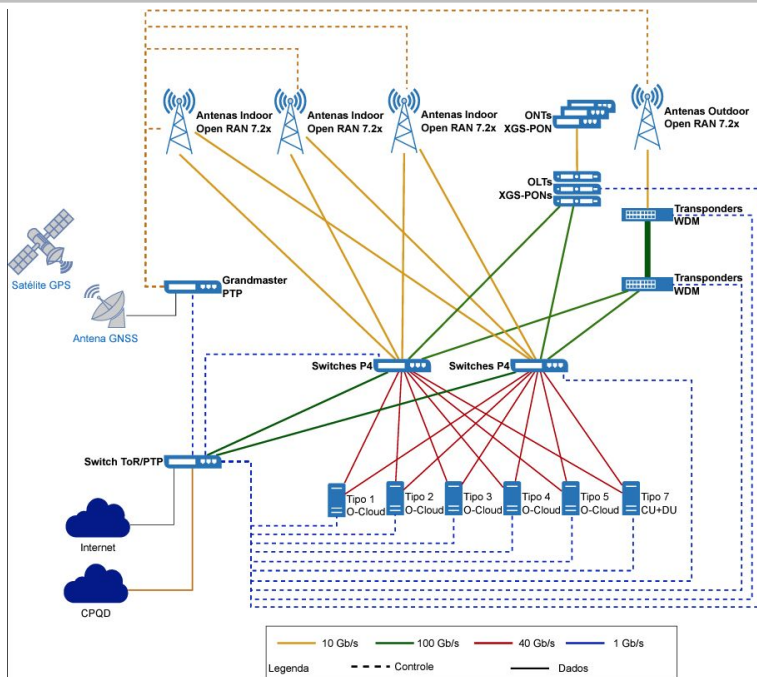
- Design e planejamento de recurso de nuvem e edge:



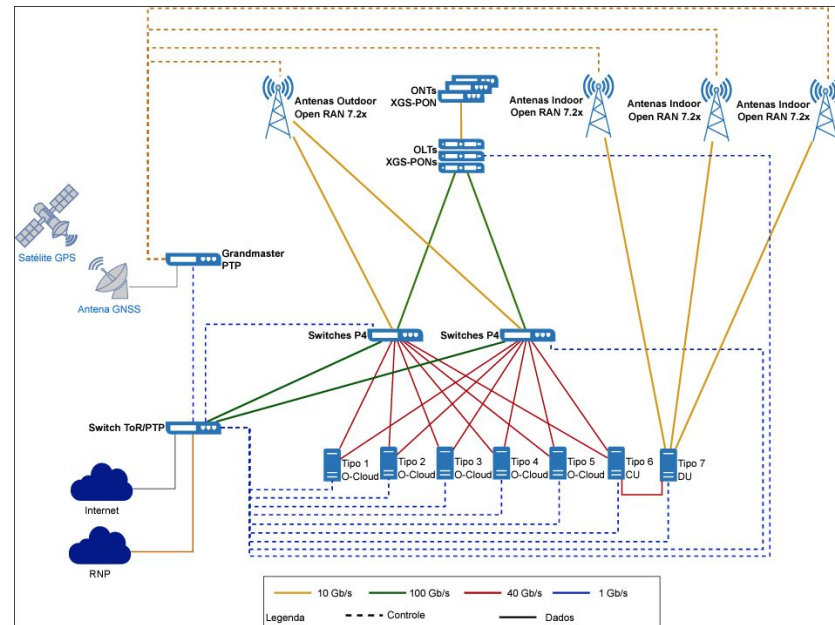


Testbed OpenRAN V1.0

Testbed OpenRAN Ver 1.0



CBPF - PoP-RJ (RNP)



CPQD - CPS



- Emulação de Topologia via Switch P4
 - Enlaces Virtuais (atraso e perda de pacote, customizáveis)
- Gerador de tráfego
 - Granalidade 10, 25 e 40 Gbps
- Domínio FTTH
 - OLT XGS-PON (2.5/10 Gbps)
 - ONT XGS-PON (2.5/10Gbps)
- Orquestração de experimento

Obrigado!