RNP – Rede Nacional de Ensino e Pesquisa

PORTUGUÊS

Request for Information (RFI) – Roteadores para Funções de Core, Peering, Agregação, Acesso, Metro, Datacenter e CPE.

A RNP (Rede Nacional de Ensino e Pesquisa) é uma organização social privada e sem fins lucrativos vinculada ao Ministério da Ciência, Tecnologia e Inovação (MCTI). É responsável por operar e desenvolver a infraestrutura de rede acadêmica nacional avançada do Brasil, conhecida como Rede Ipê, conectando mais de 800 universidades, institutos de pesquisa e outras organizações educacionais em todo o país. A missão da RNP é promover o uso inovador da tecnologia da informação e comunicação (TIC) para apoiar a educação, a pesquisa e a inovação no Brasil. Ela atua como um facilitador chave para a colaboração científica e a troca de dados, tanto nacional quanto internacionalmente.

A infraestrutura principal da RNP, a Rede Ipê, é uma rede de alto desempenho análoga a uma infovia digital, fornecendo conectividade de Internet segura e confiável e permitindo a transmissão de grandes volumes de dados para fins de pesquisa e educação. É a espinha dorsal para a colaboração acadêmica nacional e internacional.

Reconhecendo as crescentes necessidades de "big science" e da pesquisa intensiva em dados, a RNP está desenvolvendo a Rede de e-Ciência, uma infraestrutura dedicada projetada especificamente para centros de pesquisa com requisitos avançados para processamento, análise, transmissão e armazenamento de conjuntos de dados massivos. Diferentemente da Rede Ipê, que é mais ampla, a Rede e-Ciência oferece políticas e serviços especializados e adaptados aos fluxos de dados científicos, atendendo principalmente Instituições de Ciência e Tecnologia (ICTs) que operam centros de supercomputação, laboratórios multiusuários e outras instalações de pesquisa. Ela oferece velocidades de pelo menos 100 Gb/s e atua como um canal de alta velocidade entre as instituições.

O Programa Conecta, uma iniciativa chave dentro do novo Programa de Aceleração do Crescimento (PAC) do governo brasileiro e liderado pelo MCTI, expande e aprimora significativamente as capacidades da RNP. Os objetivos do programa incluem:

- Expansão e modernização da Rede Ipê: Aumentando sua capacidade, estendendo seu alcance ao interior do país (interiorização), aprimorando sua segurança e garantindo sua escalabilidade. Isso envolve a implementação de 32 enlaces nacionais, 19 infovias estaduais e 79 novas redes metropolitanas, frequentemente por meio de parcerias com empresas de transmissão de energia e provedores de internet.
- Desenvolvimento da Rede e-Ciência: Construindo esta rede especializada segura e de alto desempenho para pesquisa intensiva em dados.
- Estabelecimento de Centros Nacionais de Dados (CNDs): Criando uma rede de data centers seguros e escaláveis por meio de parcerias com provedores privados para hospedar, processar e gerenciar com segurança grandes volumes de dados científicos e tecnológicos. Esses CNDs serão conectados diretamente à Rede Ipê e à Rede e-Ciência.

Deve ser enfatizado que a RNP apoia a experimentação com tráfego e protocolos de rede, mas não é fundamentalmente uma rede experimental. Para apoiar essas diversas capacidades e

projetos, a RNP requer uma rede multifuncional com hardware e software (sistema operacional) confiáveis e estáveis.

Por favor, leia atentamente os seguintes requisitos. O fornecedor e seu parceiro devem atender a esses requisitos antes de prosseguir.

- Os fornecedores de equipamentos (cujos produtos serão avaliados como sistemas integrados de hardware e software) devem participar de testes multivendor conduzidos por organizações neutras, como a EANTC e seu prestigiado relatório de interoperabilidade entre diferentes fabricantes (Multi-Vendor MPLS SDN Interoperability Test), que na edição de 2024 que contou com 14 diferentes fabricantes nas temáticas: MPLS, Segment Routing, SDN e sincronismo de tempo.

- Os fornecedores são obrigados a comprovar sua capacidade de implantar e suportar uma rede crítica de alto desempenho.

- Os fornecedores devem fornecer evidências de implantação para o equipamento proposto ou uma série/família de produtos comparável com chipset e software idênticos em um ambiente de rede similar.
- O fornecedor, tanto para hardware quanto para software, deve participar ativamente de organizações de padronização como OIF, IETF e IEEE. O fornecedor deve prover evidências de seu envolvimento e contribuições propostas, incluindo autoria ou co-autoria.
- O fornecedor deve fornecer casos de uso de provedores de serviços de Internet Tier 1 e Tier 2, empresas de *hyperscale*, NRENs (Redes Nacionais de Ensino e Pesquisa) de prestígio e outros, demonstrando implantações nas mesmas camadas ou funções de rede propostas para esta RFI.
- É desejável (não obrigatório) que o fornecedor esteja listado em algum relatório de análise conduzido por organização neutra, como o Gartner Magic Quadrant.
- É desejável (não obrigatório) que a empresa (apenas o fornecedor) seja listada publicamente no mercado de ações (bolsa de valores).
- O parceiro do fornecedor deve prover evidências de sua capacidade e experiência na implementação da solução proposta.
- O parceiro do fornecedor deve provar ser um representante oficial do fornecedor.
- Os fornecedores devem compartilhar com a RNP casos de uso em projetos grandes e críticos com seus modelos de produtos (ou séries de produtos).
- O fornecedor deve ter um laboratório capaz de simular topologias personalizadas para validar e garantir a precisão de todas as informações técnicas fornecidas, incluindo a interoperabilidade de produtos de vários fornecedores para testes.
- A aquisição de roteadores e switches é um processo de duas fases: esta Request for Information (RFI) e a subsequente Request for Proposal (RFP). Fabricantes ou seus parceiros que responderem a esta RFI de acordo com os termos da RNP podem receber pontuação adicional para a próxima fase (ainda a definir).

Roteadores e switches abrangidos nesta RFI

Esta RFI abrange os tipos de equipamentos listados abaixo. Os fabricantes e seus representantes devem responder a todas as perguntas para cada tipo de roteador e switch.

Atenção:

1. Por favor, consulte a Topologia de Rede de Referência em anexo, que fornece uma representação detalhada da implantação dos tipos de roteadores e switches solicitados dentro da arquitetura de rede da RNP, conforme descrito nesta RFI.
1. Para os casos em que portas 10G/25G são solicitadas: o equipamento deve ter portas 10G, mas a porta 25G é opcional.
2. Se o fornecedor suportar um recurso opcional, ele poderá receber uma pontuação adicional para este item durante a fase de RFP (ainda a definir).

Roteadores CORE

- Tipo 1: 12 x 100G e 12 x 400G
- Tipo 2: 12 x 100G e 6 x 400G

Responsabilidade: Conecta diretamente o backbone da rede. Responsável pelo trânsito de alta velocidade e baixa latência de todo o tráfego entre diferentes partes da rede e, potencialmente, para redes externas. Fornece a infraestrutura de encaminhamento principal.

Roteadores PEERING

- Tipo 1: 8 x 10G e 12 x 100G
- Tipo 2: 8 x 10G e 8 x 100G

Responsabilidade: Conectar a rede de Ensino e Pesquisa a redes externas (outras redes de ensino e pesquisa, ISPs comerciais, provedores de conteúdo). Responsável por impor políticas de segurança na fronteira da rede e trocar informações de roteamento.

Roteadores AGGREGATION (Multisserviço)

- Tipo 1: 16 x 100G com 4 x 400G
- Tipo 2: 8 x 10G/25G e 6 x 100G

Responsabilidade: Agregar tráfego de várias redes de acesso e fornecer serviços VPN L2/L3. Atua como uma ponte entre a camada de acesso e o core. Responsável por estabelecer sessões de trânsito BGP com os clientes. Onde ocorre a junção (stitching) de protocolos.

Roteadores UNIVERSAIS (PE/Acesso)

- Tipo 1: 48 x 10G/25G e 6 x 100G
- Tipo 2: 24 x 10G/25G e 4 x 100G

Responsabilidade: Conectar sites de clientes (universidades, laboratórios de pesquisa) à rede. Fornece serviços VPN L2/L3 para esses clientes. O principal ponto de demarcação de serviço.

Roteadores METRO

- Tipo 1: 8 x 10G/25G, 8 x 100G/400G portas combo
- Tipo 2: 12 x 10G/25G e 4 x 100G
- Tipo 3: 12 x 10G/25G
- Tipo 4: 6 x 10G/25G

Responsabilidade: Interconexão de alta velocidade de sites de Agregação Metro dentro de uma área metropolitana ou região. Forma uma espinha dorsal regional. Agregação de tráfego e transporte entre a rede regional e a espinha dorsal nacional.

DATACENTER

Switch Spine

- Tipo 1: 12 x 100G e 8 x 400G
- Tipo 2: 12 x 100G e 2 x 400G

Responsabilidade: Atuar como o núcleo de uma arquitetura spine-leaf com interconexão de alta velocidade, facilitando o fluxo de tráfego leste-oeste eficiente e suportando uma malha VXLAN/EVPN, fornecendo a conectividade subjacente entre todos os switches leaf.

Switch Leaf

- Tipo 3: 48 x 10/25G e 4 x 100G

Responsabilidade: Fornece alta densidade para conectividade de servidores dentro de data centers. Frequentemente parte de uma malha VXLAN/EVPN.

CPE

- Tipo 1: 8 x 10G (fibra); 8 x 1G (cobre)
- Tipo 2: 4 x 10G (fibra); 8 x 1G (cobre)

Responsabilidade: Conectar a rede interna do cliente à rede do provedor de serviços (através do Roteador de Acesso Universal).

A partir deste ponto, todo o texto seguirá em inglês, repetindo o que está acima em português e dando sequência ao documento da RFI. Vale ressaltar que todos os questionamentos e respostas no processo deverão ser realizados na língua inglesa devido a ampla participação de empresas internacionais.

From now on, all text will be presented in English, following the information previously given in Portuguese and proceeding with the questions. Due to the extensive participation of international companies, all questions and answers in this process must be in English.

ENGLISH

Request for Information (RFI) – Routers for Core, Peering, Aggregation, Access, Metro, Datacenter and CPE roles.

RNP (Rede Nacional de Ensino e Pesquisa), the Brazilian National Education and Research Network, is a private and non-profit social organization under the Ministry of Science, Technology, and Innovation (MCTI). It operates and develops Brazil's advanced national academic network infrastructure, known as the Ipê network, connecting over 800 universities, research institutes, and other educational organizations across the country. RNP's mission is to promote innovative use of information and communication technology (ICT) to support education, research, and innovation in Brazil. It acts as a key facilitator for scientific collaboration and data exchange, both nationally and internationally.

RNP's core infrastructure, the Ipê network, is a high-performance network analogous to a digital "highway," providing secure and reliable internet connectivity and enabling the transmission of large volumes of data for research and educational purposes. It is the backbone for national and international academic collaboration.

Recognizing the growing needs of "big science" and data-intensive research, RNP is developing the Rede e-Ciência, a dedicated infrastructure designed specifically for research centers with advanced requirements for processing, analyzing, transmitting, and storing massive datasets. Unlike the broader Ipê network, the Rede de e-Ciência offers specialized policies and services tailored to scientific data flows, primarily serving Science and Technology Institutions (ICTs) that operate supercomputing centers, multi-user laboratories, and other research facilities. It offers speeds of at least 100 Gb/s and acts as a high-speed "tunnel" between institutions.

The Programa Conecta, a key initiative within the Brazilian government's new Growth Acceleration Program (PAC) and spearheaded by MCTI, significantly expands and enhances RNP's capabilities. The program's goals include:

- Expanding and upgrading the Ipê network: Increasing its capacity, extending its reach into the interior of the country (interiorization), enhancing its security, and ensuring its scalability. This involves implementing 19 state-level "infovias" (information highways) and 79 new metropolitan networks, often through partnerships with energy transmission companies and internet providers.
- Developing the Rede e-Ciência: Building out this specialized high-performance network for data-intensive research.
- Establishing National Data Centers (CNDs): Creating a network of secure and scalable data centers through partnerships with private providers to host, process, and securely manage large volumes of scientific and technological data. These CNDs will be directly connected to both the Ipê network and Rede de e-Ciência.

It should be emphasized that RNP supports experimentation with network traffic and protocols, it is not fundamentally an experimental network. To support these diverse capabilities and projects, RNP requires a multi-purpose network with reliable hardware and software (operating system).

Please read the following requirements carefully. The vendor and its partner must meet these requirements before proceeding.

- Equipment vendors (whose products are evaluated as integrated hardware and software systems) must participate in interoperability tests conducted by neutral organizations, such as EANTC Multi-Vendor Interoperability Test Report in 2024 (preferred).
- Vendors are required to prove their capability to deploy and support a critical, high-performance network.
- Vendors must provide evidence of deployment for the proposed equipment or a comparable product series/family with identical chipset and software in a similar network environment.
- The vendor, for both hardware and software, must actively participate in standardization organizations such as OIF, IETF, and IEEE. The vendor must provide evidence of its engagement and proposed contributions, including co-authorship.
- The vendor must provide use cases from Tier 1 and Tier 2 Internet service providers, hyperscale companies, prestigious NRENs, and others, demonstrating deployments in the same network layers or functions proposed for this RFI.

- It is desirable (not mandatory) that the vendor is listed in some analysis report conducted by neutral organization, such as Gartner Magic Quadrant.
- It is desirable (not mandatory) that the company (vendor only) is listed public (stocks).
- The vendor's partner must provide evidence of their ability and experience implementing the proposed solution.
- The vendor's partner must prove to be an official representative of the vendor.
- Vendors should share with RNP use cases in big and critical projects with their product models (or product series).
- The vendor must have a laboratory capable of simulating custom topologies to validate and ensure the accuracy of all provided technical information, including multi-vendor product interoperability for testing.
- The acquisition of routers and switches is a two-phase process: this Request for Information (RFI) and the subsequent Request for Proposal (RFP). Manufacturers or partners that respond to this RFI in accordance with RNP's terms may receive additional scoring for this item during the next phase.

Routers and switches covered in this RFI

This RFI covers the equipment types listed below. Manufacturers and their representatives must respond to all questions for every type of router and switch.

Notes:

1. Please refer to the attached Network Reference Topology, which provides a detailed representation of the deployment of the requested router and switch types within the RNP network architecture, as outlined in this RFI.
2. For cases where 10G/25G ports are requested: the equipment must have 10G ports, but the 25G port is optional.
3. If vendor fully supports an optional feature, it may receive additional scoring for this item during the RFP phase.

CORE Routers

- **Type 1:** 12 x 100G and 12 x 400G
- **Type 2:** 12 x 100G and 6 x 400G

Service Responsability: The backbone of the network. Responsible for high-speed, low-latency transit of all traffic between different parts of the network and, potentially, to external networks. Provides the core forwarding infrastructure.

PEERING Routers

- **Type 1:** 8 x 10G and 12 x 100G
- **Type 2:** 8 x 10G and 8 x 100G

Service Responsability: Connect the R&E network to external networks (other R&E networks, commercial ISPs, content providers). Responsible for enforcing security policies at the network boundary and exchanging routing information.

AGGREGATION Routers (Multi-Service)

- **Type 1:** 16 x 100G com 4 x 400G
- **Type 2:** 8 x 10G/25G and 6 x 100G

Service Responsability: Aggregate traffic from multiple access networks and provide L2/L3 VPN services. Acts as a bridge between the access layer and the core. Responsible for establishing BGP transit sessions with costumers. Where protocols stitching takes place.

UNIVERSAL Routers (PE/Access)

- **Type 1:** 48 x 10G/25G and 6 x 100G
- **Type 2:** 24 x 10G/25G and 4 x 100G

Service Responsability: Connect customer sites (universities, research labs) to the network. Provide L2/L3 VPN services to those customers. The primary point of service demarcation.

METRO Routers

- **Type 1:** 8 x 10G/25G, 8 x 100G/400G combo ports
- **Type 2:** 12 x 10G/25G and 4 x 100G ports
- **Type 3:** 12 x 10G/25G ports
- **Type 4:** 6 x 10G/25G

Service Responsability: High-speed interconnection of Metro Aggregation sites within a metropolitan area or region. Forms a regional backbone. Traffic aggregation and transport between the regional network and the national backbone.

DATACENTER

Spine switch

- **Type 1:** 12 x 100G and 8 x 400G
- **Type 2:** 12 x 100G and 2 x 400G

Service Responsability: Act as the core of a spine-leaf architecture with high-speed interconnection facilitating efficient east-west traffic flow and supporting a VXLAN/EVPN fabric by providing the underlay connectivity between all leaf switches.

Leaf switch

- **Type 3:** 48 x 10/25G and 4 x 100G

Service Responsability: Provide high-density server connectivity within data centers. Often part of a VXLAN/EVPN fabric.

CPE

- **Type 1:** 8 x 10G (fiber); 8 x 1G (cooper)
- **Type 2:** 4 x 10G (fiber); 8 x 1G (cooper)

Service Responsability: Connect the customer's internal network to the service provider's network (via the Universal Access Router).

Questions

Important Notes:

- **Unless explicitly stated, provide answers to all questions for every router/switch type listed in this RFI.**
- **All applicable standards (IEEE, IETF, OIF, etc.) must be listed for every question, highlighting those that guarantee interoperability with third-party vendors.**

ARCHITECTURE

- How is the pipeline: fixed or flexible?

- How many CPU cycles are required to process a packet (through its entire lifecycle) from input interface to the output interface considering many features enabled, like packet mirror, packet filtering, VLAN translation, QoS marking, etc (consider the worst case).
- Buffering design: per port, per group of port (NPU), IN and OUT, OUT Only
    - Comment about the design decision of buffering IN and OUT or OUT only.
- Maximum frame size: 9k, 16k, other? Specify the maximum value. Provide the information for both jumbo frame and packet frame.
- How filter scalability is handled when the same filter is applied to more than one physical and/or logical interface? Explain the design approach that helps reduce the resource utilization/memory utilization in this case.
- List all groups of features, in a multidimensional view, that impact other functionalities, meaning these features share resources and may affect each other when used simultaneously.
- List all features with dedicated memory area that are independent of other features, which means they do not impact resource utilization from other features if used at the same time.

PERFORMANCE

- Should inform the rate of routes installed, in both RIB and FIB, per second for 3 million IPv4 routes and 1 million IPv6 routes - evidence must be provided. If the FIB capacity of the router is below what specified above, a 3:1 ratio of IPv4 routes to IPv6 routes must be used at maximum capacity to provide the information requested.

- The maximum route scalability of both RIB and FIB is still valid when non-default routing-table is used to carrier Internet service (for example a full routing table in a VRF or an EVPN Type 5)? In other words, is it possible to run anything (e.g. multiple full routing) in non-default routing instances like VRF or EVPN Type 5 (L3)? If it's possible, is the performance the same as the main routing table with all the capabilities?
- What are the possible approaches to realizing the stitching between network slicing and SRv6 services?

NETWORK ISOLATION AND VIRTUALIZATION

Flexible Ethernet

- What Flex-E version is supported? Version 2.1 or newer is desirable.
- What are the use cases supported?
- What is the Flex-E mode supported? Unaware, Aware, Sub-rate?
- Is the calendar switching supported?
- Does it require any software license?
- List all interfaces/linecards/standalone routers the supports Flex-E.

Network Slicing

- Describe the technology supported to provide network slicing feature with guaranteed bandwidth and low jitter in a TDM style (or like a deterministic network).
- Inform all licenses needed, if they exist.
- Additional features to look at are bi-directional path (or symmetrical path) with end-to-end protection and restoration with bandwidth guarantee.

SECURITY

General

Describe the unique technical differentiators of your solution, particularly in the following areas:

- Security hardening
- Anomaly detection and network visibility
- Filtering capabilities for the control and data planes
- Scalability mechanisms

BGP Flowspec

- Are there any plans to support the draft of payload match *(draft-khare-idr-bgp-flowspec-payload-match)* or an alternative to that proposition?
- Is it possible to set a rate limit using pps (packets) instead of bps (bits)?

Payload filtering (special case of ACLs)

- Is it supported? How does it work and what are the limitations/caveats? Provide information about scalability and performance impact.
- Provide 8 real use cases (examples) of this kind of filtering to mitigate DDoS attacks showing why it could not be safely done using traditional L3-L4 filters.
- Is it possible to match a domain or URL in a DNS request message inside a packet?

Management plane protection:

- List all relevant hardening features available and applications.
- Comment about secure boot process, if available.
- Is there a password reset protection from console port? If yes, is it enabled by default? How does the recovery password process work in this case?

MONITORING

Packet mirroring:

- Information regarding maximum size, sampling, filtered by ACL/firewall-filters for selective mirroring.
- Is there any limitation in the packet sampling performance or is it line-rate when all ports are enabled at the same time? Please, provide the values in Mpps and Tbps and describe the architecture to ensure how the port mirroring works avoiding concurrent performance and impact.

Flow monitoring:

- What is the most granular sampling rate supported considering the router operating at full capacity?
- What is the scaling in Mfps (million flows per second) with no penalty in performance? And with penaltie performance?
- What are the formats supported (IPFIX, IPFIX 315, sFlow)?
    - For each format, it must inform if the processing is hardware or software based.
    - What is the impact on the NPU/ASIC?
    - What is the impact on CPU and memory (control plane)?

Telemetry

- Inform the export format of the telemetry available:

    - Proprietary
    - gRPC
    - gNMI
    - Model Driven Telemetry
- Provide details of what is supported in each format and the refresh interval rate (realtime, every X seconds).
- It's highly desirable that all monitoring metrics are available via telemetry, avoiding the dependence on SNMP. Specify the limitations, if they exist, when it comes to gathering monitoring metrics from telemetry compared to SNMP.
- Is telemetry managed by the CPU or ASIC? Explain the architecture.

Services

- What is the vendor recommendation for VRF and EVPN L3 interconnection?
- Since RNP currently runs RSVP-TE, what are the recommended migration strategies to Segment Routing? SR-MPLS or SRv6? Please justify the choice based on protocol maturity, software stability, adoption rates, and advantages for multi-domain deployments, with and without a controller, including any exclusive use cases.

AUTOMATION AND ORCHESTRATION

- Inform what kind of resources can be managed by:
    - Openconfig
    - Restconf
    - Netconf
- Detail the granularity of the schemas, and their purpose, specifying whether they are used for configuration or monitoring.
- If the vendor has Python support for on-box scripting tools, specify what kind of script is supported: event (triggered), on-demand, etc.
- If the device has support to run container applications, detail the topology and what kind of application can be executed. If applicable, what are the hardware, networking, performance limitations?
- List the libraries and the projects maintained by the vendor regarding automation projects e.g.:

- Ansible
- Digital twin
- Router virtualization (including third-party images)
- Containerization

POWER EFFICIENCY

Inform if the company has energy efficiency certificates for its equipment, such as the "80 Plus program".

QoS

- What is the maximum number of queues supported per interface?
- What is the maximum queue depth (in bytes, packets, or milliseconds)?
- Is the queue depth configurable?
- What is congestion management used (Tail Drop, RED, WRED)?
- How is QoS handled in EVPN environments (both MPLS and VXLAN encapsulation)?
- List all supported Queuing Disciplines supported.
- Is it possible to monitor queue depths, drop rates, latency, and throughput for individual queues and classes?
- What tools are available for troubleshooting QoS issues (e.g., debug commands, packet captures)?
- Provide recommended best practices for configuring QoS in a high-performance research and education network (NREN).

EVPN

General

- Vendors must provide comprehensive details regarding their EVPN development and their level of participation in IETF EVPN related proposal.

Layer 2

- What are the supported encapsulations for all types of layers 2 EVPN.
- How are leaf and root roles defined and configured?
- How is traffic forwarding restricted between leaf sites?

- How does E-Tree interact with other EVPN features (e.g. IRB)?
- How are EVPN route types used in an E-Tree context? Are there any additional route types or attributes used?
- What is the maximum number of leaf sites per E-Tree instance.
- What is the maximum number of root sites per E-Tree instance.
- How is unknown unicast flooding handled? Is it restricted to the root PEs?
- How is MAC address learning handled in an E-LAN and E-Tree environment? Is it different from E-LAN?
- What is the maximum MAC address table size per E-LAN and E-Tree instance?
- What is the maximum number of MAC addresses supported per EVI (EVPN Instance)?
- How are MAC addresses learned (control plane via BGP, data plane)?
- How is MAC address withdrawal handled?
- What is the maximum number of EVIs supported?
- How is Designated Forwarder (DF) election handled?
- How are broadcast and multicast handled? (Ingress replication, PIM/mLDP integration).
- Provide details regarding all-active and single-active multihoming implementation.
- Provide details regarding convergence process and timers for multihomed scenarios.
- Forwarding performance (throughput, latency) for unicast, BUM traffic.
- How are IP prefixes advertised and filtered within the EVPN control plane (using route type 2 or route type 5)?
- Maximum number of IP prefixes supported in the EVPN IRB context.
- Maximum number of ARP/ND entries.
- Forwarding performance for inter-VNI routing.
- Is it possible to apply traffic engineering to EVPN services to direct traffic along specific paths based on defined constraints? If yes, what protocols are supported (RSVP-TE, SR-TE, SRv6)?

Below, some of the key aspects of EVPN to take into consideration. These requirements must be implemented by vendors. Add more items to the proposal if needed.

- **E-LINE (VPWS):** single homed, multi homed, active-active and single-active (inform all the configurations possible and the recommended solution). FXC (flexible cross connect). Supports both ES (Ethernet Segment) and vES (virtual ES as VLANs).

- **E-LAN (M2M):** single homed, multi homed, active-active and single-active (inform all the configurations possible and the recommended solution).
- **E-TREE (P2M):** Load balancing modes: all-active (per flow), single-active (per vlan), port-active (per port)

Layer 3

Vendors must detail the supported EVPN Layer 3 features and provide recommended solutions for common deployment scenarios, including those listed below. Additional relevant features may be included as necessary.

- IRB and Anycast GW
- Asymmetric IRB (inform if RT5, RT2 or both)
- Symmetric IRB interface-less
- Symmetric IRB interface-full unnumbered
- Symmetric IRB interface-full numbered

SEGMENT ROUTING

- When migrating a network currently running RSVP-TE, which Segment Routing solution is recommended: SRv6 or SR-MPLS? What are the main reasons for this recommendation?
- Is it possible to apply traffic engineering over EVPN Layer 2 and Layer 3 services using either SR-MPLS or SRv6 as underlay? For example: for a given EVPN VPWS service between two points, apply the desired constraints based in the Flex-Algo?

SEGMENT ROUTING IPv6 (SRv6)

- What IGP is recommended in the scenario of SRv6, IS-IS or OSPF? Provide an explanation for the option chosen.
- How many constraints are supported on traffic engineering and what are these constraints?
- Support for TI-LFA (Topology-Independent Loop-Free Alternate) with SRv6.
- Specify support for TI-LFA with both IS-IS and OSPFv3.
- Provide measured convergence times using TI-LFA.
- Explain how TI-LFA is configured and managed.
- How does the router handle interworking between SRv6 and RSVP domains?

- Maximum number of SIDs in an SRv6 TE policy (SRH depth) in real world scenarios (multidimensional memory allocation).
- Performance impact of large SRHs. How does the router handle IPv6 extension header processing?
- How many SR policies can be configured?
- How many locators and functions can be configured?
- What is label depth supported?

ROUTING/MPLS

BGP

- How is memory allocated for the BGP table (static, dynamic)? What are the implications if the table grows beyond the allocated/reserved memory?
- Are there separate tables for different address families (e.g., IPv4 unicast, IPv6 unicast, VPNv4, VPNv6)? Describe how routing tables architecture is implemented.
- Provide measured convergence times for various scenarios:
    - Full BGP table download
    - Loss of a BGP peer (single peer, multiple peers)
    - Addition/removal of a prefix
    - Changes in BGP attributes (e.g., MED, AS_PATH)
    - Convergence time with BGP PIC (Prefix-Independent Convergence) Edge and Core
    - Specify the testing methodology used to determine convergence times (e.g., number of prefixes, network topology).
- How does convergence time scale with the number of BGP routes?
- How does the router handle BGP route flap damping? Provide details regarding configuration parameters.
- What mechanisms are in place to prevent BGP session flapping?
- Describe how invalid routes are handled with RPKI (e.g., rejected, marked with a specific community).

RSVP

- What is the maximum number of RSVP-TE tunnels supported?

IS-IS

- Provide measured SPF calculation times for various network sizes (number of nodes and links). Specify the testing methodology (e.g., topology used, types of changes simulated).
- How does SPF calculation time scale with network size?
- Overload bit handling: How does the router react when receiving an LSP with the overload bit set? Does it support setting the overload bit?
- Provide measured convergence times for various scenarios:
    - Link failure

    - Router failure
    - Addition/removal of a link/router
    - Changes in link metrics
- How does convergence time scale with network size?
- What are the mechanisms for IS-IS fast convergence implemented by vendor?
- What is the maximum number of supported areas?
- What is the maximum number of adjacencies/neighbors?
- Maximum number of IS-IS LSPs (Link-State PDUs) that can be stored in the LSDB (Link-State Database). This directly impacts the size of the network the router can handle.
- IS-IS micro loop avoidance mechanisms.

OSPF

- Provide measured SPF calculation times for various network sizes (number of nodes and links). Specify the testing methodology (e.g., topology used, types of changes simulated).
- How does SPF calculation time scale with network size?
- Provide measured convergence times for various scenarios:
    - Link failure
    - Router failure
    - Addition/removal of a link/router
    - Changes in link metrics
- How does convergence time scale with network size?
- What are the mechanisms for OSPF fast convergence implemented by vendor?
- What is the maximum number of supported areas?
- What is the maximum number of adjacencies/neighbors?
- Maximum number of LSAs (Link-State Advertisements) that can be stored in the LSDB (Link-State Database).
- LSA flooding rate (LSAs/second).
- LSA refresh interval and maximum.
- LSA age (configurable parameters).

VRF

- What is the maximum number of VRFs (Virtual Routing and Forwarding instances) supported.

LDP

- Provide information regarding supported loop detection mechanisms.
- What is the range of MPLS labels available for LDP allocation?
- What are the LDP modes supported: downstream unsolicited, downstream on demand or both?

LSP

- LSP generation and flooding rate (LSPs/second).
- LSP refresh interval and maximum LSP lifetime (configurable parameters).

LICENSE MODEL

For each device type required in RFI, provide the following information:

- Are there any scale licenses (FIB, VRF, Flows, physical ports, etc.). List all, if exist.
- How is the router licensed in terms of capacity? Is it per physical port or by total capacity configured/enabled? (e.g., a QSFP-DD will not necessarily consume 400G. It could depend on the configuration and/or transceiver used).
- Is there any specific license to use coherent transceivers (QSFP28 and QSFP-DD, both native and third-party)?
- Are there any feature licenses (SRv6, MPLS, MACsec, etc.). List all, if exist.
- Type of license: Perpetual/permanent vs subscription. RNP's budget is aligned with perpetual/permanent model (lowest OPEX).

SOFTWARE QUALITY PROCESS

Provide detailed information of software quality process in terms of:

- How many OSs and what names are used by the vendor on all router and switch families? (e.g.: Junos, Junos EVO / IOS, IOSXR / SROS, SR-Linux, etc.)
- Tests on not yet released versions.
- Tests on released versions.
- Continuous tests.
- Regression tests (models, architectures).
- Are the tests aimed for the new features only or are all features continuous tested at each software release?
- What are the latest software version release and the recommended stable for use in terms of EVPN, MPLS and Segment Routing.
- What security features are built into the OS (e.g., secure boot, code signing, vulnerability scanning)?

- Does the OS utilize any open-source components? If so, which ones, and how are they maintained and patched?
- Add any key differentiator. Why is this operating system better than the competitor?
- Is there any process running to enhance the quality of the operating system?
- What is the percentage of software developer's vs software testers in the company workforce?

SOFTWARE RELEASES

Explain the software release process:

- How many major and minor releases per year? What is expected in each type of software release?
- Is there a specific version to bug fixes? Is it released periodically or on demand? Is it depending on active contract support to be available?
- How are software versions managed (major releases, minor releases, maintenance releases)?
- Is the first GA (general available) version recommended for use in a production network? If it is not recommended, it must be explained the reasons for that.
- Is there a web portal available to customers with bug and CVE information per software release?

TECHNICAL CERTIFICATIONS

- The proponent, if not the vendor itself, must provide proof to RNP of their authorized partnership with the vendor.
- The proponent, if not the vendor itself, must provide proof to RNP that is qualified by vendor for this project.
- RNP requests press releases from the proponent and vendor detailing their involvement in similar RNP projects.

WARRANTY

- Is a lifetime warranty available on any of the products in the RFI?
- What is the period of the default warranty of the products in the proposal? 3 months, 12 months (RNP understanding of the default period), 24 months?

- During the warranty period, is it possible to download new software versions? If yes, is there any limitation? Is it must be related to an open case (eg. bug fix) or it could be just asked (or downloaded) without any reason informed?
- Are software upgrades free independent of an active contract or is it dependent on an active contract?

TAC – TECHNICAL ASSISTANCE CENTER

- Will first-tier technical support be provided directly by the vendor or by a certified partner?
- Specify the languages in which the TAC provides support: English, Portuguese, or a combination of both.
    - If English, in what country is running the TAC for Brazil?
- RMA must be provided using spare parts in Brazil. What is the SLA for delivery considering each state capital (provide a list of cities)?
- Is the option of 30 days available?
    - What are the logistic options for defective equipment return? Inform them if RNP must return the item or if there is a possibility for the vendor or its partner to collect the item and deliver it to the "repair center". RNP CNPJ numbers are only for the office addresses. RNP PoPs are located at Universities, Research Organizations of commercial sites not related to RNP's CNPJ.
- Is the option of "software only support" available (no hardware repair/replacement)?
- Regarding Next Business Day service in Brazil, what SLA is offered? Specifically, is it next-day shipping, next-day delivery, or a combination? Are there any location-based restrictions?
- What are the options for opening a technical case? Confirm all possibilities available:
    - Phone call: international or Brazilian number?
    - E-mail (confirm if it has an auto reply for the opening message)
    - Web
    - API (especially important for future automation). If available, describe the solution and if it uses an open API (e.g. REST) or a proprietary one
- Can a case be immediately escalated to the highest priority during a catastrophic event?

TECHNICAL PROPOSAL

The manufacturer is required to prepare a comprehensive technical proposal that addresses all specified requirements, utilizing the provided reference architecture as a basis. This proposal must include diagrams that clarify and support the written content.

Additionally, RNP invites each vendor to submit a second technical proposal outlining their vision for a national education and research network. This network should be secure, high-performance, and scalable to 400G, offering internet services, Layer 3 VPN, and Layer 2 VPN capabilities (both point-to-point and point-to-multipoint). These proposals may deviate from RNP's initial reference architecture. This request aims to stimulate internal discussion and potentially inform improvements or revisions to the network architecture prior to the final Request for Proposal (RFP).

Each manufacturer will be allocated a 3-hour slot for presenting their technical proposals. If multiple partners are offering solutions from the same manufacturer, the vendor must designate a single, official representative to RNP. Only this designated representative will be permitted to present the technical proposals to RNP.

INTEROPERABILITY TESTS

Please be advised that, in the upcoming RFP process, RNP intends to conduct interoperability testing with the leading proponents in each equipment category. This testing may include interaction with other selected vendors' equipment and RNP's current infrastructure.

MUTI-VENDOR IP CONTROLLER INTEGRATION (DESIRABLE - OPTIONAL)

From a router's perspective, please enumerate all features required to support key use cases for an IP controller. If possible, provide a general list of communication features with the IP controller (PCE and/or NETCONF), and then separate lists of features for each use case. Given the current network's reliance on RSVP-TE and the anticipated transition to SRv6 with new equipment, please consider this in your response.

COMMERCIAL PROPOSAL

- If subscription and permanent license exist, provide a TCO analysis comparison for 5 years (“subscription” vs “perpetual + support NBD”).
- Please provide the most competitive quotation possible to enable RNP to evaluate equipment categories, quantity estimates and target prices. This will allow RNP's team to understand the price range and project viability based on the selected options. It is highly desirable to receive the price per item.