# Service Layer-API



# Get to Know Service Layer API

A service layer API is a model-driven network communication protocol that

- uses Google-defined remote procedure call (gRPC) to enable programmatic control of network devices,
- provides direct access to network infrastructure layers for high performance, and
- supports multiple programming languages for integration with various clients, controllers, and protocols.

### Benefits

Service layer APIs provide direct access to the Network Infrastructure Layer (Service-Adaptation Layer), resulting in:

- High Performance: Access bypasses intermediary network-state databases, enabling faster operations than typical management APIs. For example, batch updates go directly to the Label Switching Data Base (LSDB) and Routing Information Base (RIB) over gRPC.
- Flexibility: Developers can bring custom protocols or controllers in a variety of languages (C++, Python, Go, etc.) using gRPC.
- Offloading of Low-Level Tasks: IOS XR infrastructure handles conflict resolution, transactional notifications, and data plane abstraction, allowing you to focus on higher-layer protocols and logic.

### Components of Service Layer API

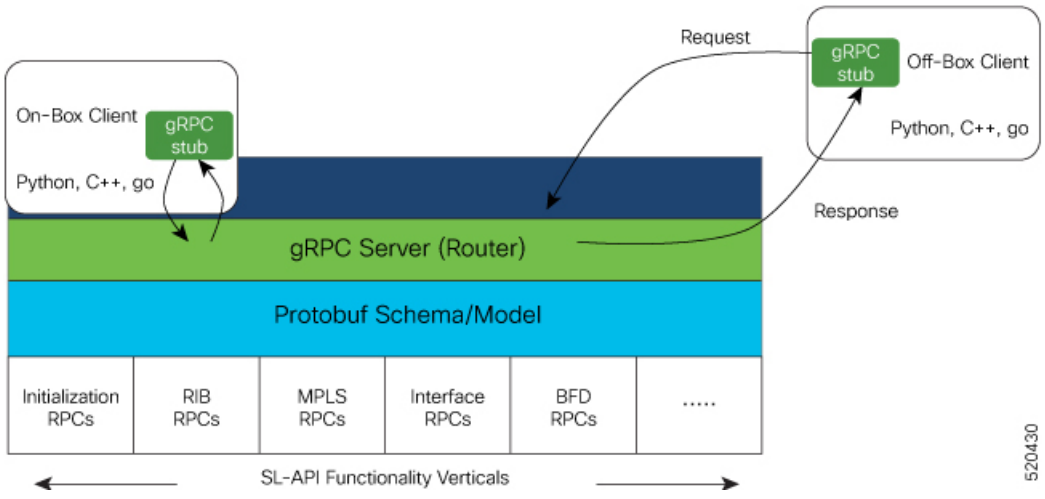
- Functionality Verticals/Domains: These categorize API capabilities. Supported verticals include:
  - Initialization (event notifications, heartbeats)
  - Route (RIB) manipulation (IPv4, IPv6)
  - MPLS (label allocation and mapping)
  - Interface (state event subscription)
  - BFD (session management and notifications)
  - Policy-Based Routing (PBR)

- Protobuf schema/model: APIs are defined using gRPC and Google Protocol Buffers (GPB) for model-driven communication.
- gRPC: Handles serialization and encoding/decoding requests/responses between clients and routers, with bindings generated for various languages.
- Service layer gRPC clients: Can run on-box (agents in containers) or off-box (controllers or open-source tools).
- gRPC authentication modes: Secure communication between clients and servers using different methods.
- The following table lists the authentication type and configuration requirements:

***Table 1: Types of Authentication with Configuration***

| Type | Authentication Method | Authorization Method | Configuration Requirement | Requirement From Client |
|---|---|---|---|---|
| Metadata with TLS | username, password | username | **grpc** | username, password, and CA |
| Metadata without TLS | username, password | username | **grpc no-tls** | username, password |
| Metadata with Mutual TLS | username, password | username | **grpc tls-mutual** | username, password, client certificate, client key, and CA |
| Certificate based Authentication | client certificate's common name field | username from client certificate's common name field | **grpc tls-mutual** and **grpc certificate authentication** | client certificate, client key, and CA |

***Figure 1: Components of Service Layer API***



### Bring your controller

To bring your controller on IOS XR, first, enable the service layer on the router and then write your Service Layer Client API.

1. Enable the service layer, on page 3
2. Write Your Service Layer Client API.

# Enable the service layer

Enable the service layer for gRPC, allowing for efficient service communication and enhanced network operations.

Enabling the service layer activates network functions related to gRPC and gNMI/gRIBI protocols. It is required for programmatic configuration, monitoring, and service integration.

- You can use this task when enabling service integration and programmatic control on your router.

Perform these steps to enable the service layer on your router.

### Before you begin

- Ensure you have access to the router CLI.
- Confirm that you have administrative privileges.
- Identify the preferred gRPC port for your deployment.

### Procedure

**Step 1** Enable the service layer.

**Example:**

```
Router# configure
Router(config)# grpc
Router(config-grpc)# port 57777
Router(config-grpc)# service-layer
Router(config-grpc)# no-tls
Router(config-grpc)# commit
```

The default gNMI service port is 9339. Valid gNMI service port values range from 57344 to 57999. The default gRIBI service port is 9340. Valid gRIBI service port values range from 57344 to 57999.

The service layer is enabled.

**Step 2** Verify that the service layer is operational.

**Example:**

```
Router# show running-config grpc
Mon Nov  4 04:19:14.044 UTC
```

```
grpc
port 57777
no-tls
service-layer
!
```

The running configuration displays the service layer settings.

**Step 3** Verify the gRPC state.

**Example:**

```
Router# show service-layer state
Mon Feb 24 04:18:40.055 UTC
------------service layer state----------
config on:                    YES
standby connected :           NO
idt done:                     NO
blocked on ndt:               NO
connected to RIB for IPv4:    YES
connected to RIB for IPv6:    YES
Initialization state:         estab sync
pending requests:             0
BFD Connection:               UP
MPLS Connection:              UP
Interface Connection:         UP
Objects accepted:             NO
interface registered:         NO
bfd registered for IPv4:      NO
bfd registered for IPv6:      NO
```

Service layer and related protocol connections are displayed.

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The service layer is enabled and operational, allowing the router to communicate using gRPC and related services.

### What to do next

- If needed, verify integration with network management systems or initiate application communications using the configured service layer.

# Write Your Service Layer Client API

he Service Layer API enables you to design and implement clients tailored to specific business requirements. Developing a Service Layer API client involves understanding how to import the generated client bindings, establish communication channels, register with the gRPC server, and utilize remote procedure calls (RPCs) for various functionality verticals.

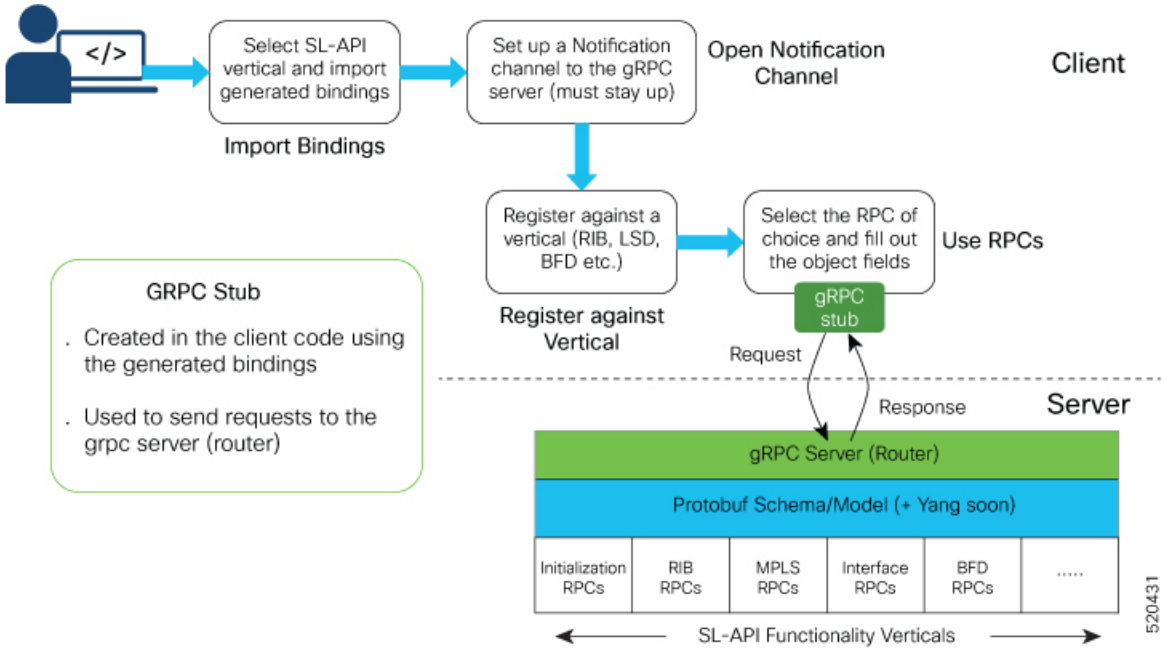
Key aspects of developing a Service Layer API client include:

- Importing Bindings: After generating the necessary bindings from provided specifications, you must import these into your codebase to enable interaction with the API.
- Opening Notification Channels: Initialization requires creating a notification channel, which allows your client to register with the gRPC server running on the router.

- Registering with Functionality Verticals: The registration RPC must be used to declare the specific vertical (set of functionality) your client will work with. Any attempts to make calls without prior registration will be rejected by the system.
- Using RPCs: After registration, you can select and use available RPCs by populating the relevant object fields in the gRPC stub.

The diagram below illustrates the typical workflow when developing a Service Layer API client:

***Figure 2: Service Layer API Workflow***




**Note** Removing VRF or interface configurations referenced by SL-API objects is not supported and may impact network traffic. Before making such changes, ensure that Service Layer API clients have rerouted traffic and updated routing information.

# Intra-AFI RIB route prioritization

Intra-AFI RIB route prioritization is an architectural enhancement that

- maps SL-API route priorities to the internal RIB Bulk Content Downloader (BCDL) priority queues for ordered processing,
- ensures critical controller-programmed route updates received via SL-API are processed and programmed into the forwarding plane ahead of lower-priority updates,
- improves convergence time during link failures and control-plane contention, and
- allows SL-API clients to assign explicit route priorities.

*Table 2: Feature History Table*

| Feature Name | Release Information | Feature Description |
|---|---|---|
| Intra-AFI RIB route prioritization | Release 26.1.1 | Introduced in this release on: Fixed Systems (8200 [ASIC: Q200, P100], 8700 [ASIC: P100]); Centralized Systems (8600 [ASIC:Q200]); Modular Systems (8800 [LC ASIC: Q200, P100])<br><br>Intra-AFI RIB route prioritization improves routing visibility and convergence for controller-programmed route updates received through SL-API. The feature allows controllers to assign priorities to routes so that the router processes and programs critical updates into the forwarding plane before lower-priority routing updates. |

### Intra-AFI route processing enhancements

The feature prioritizes controller-programmed route updates received via SL-API during the RIB to FIB download process, ensuring that time-sensitive controller operations program the forwarding plane before lower-priority routing updates. The solution extends the existing Label Switching Database (LSD) prioritization model to the RIB.

The following enhancement is introduced:

- Route priority mapping in RIB

  The router allows the controller-programmed route updates via SL-API, to assign explicit priorities to route updates. The RIB maps these priorities to internal BCDL queues and programs the FIB based on priority.

### Benefits of intra-AFI route prioritization

The benefits of intra-AFI route prioritization include:

- The router prioritizes critical controller-programmed route updates via SL-API, reducing convergence delays during link failures and topology changes.
- The router processes controller-programmed route updates via SL-API based on priority, preventing important updates from being delayed during control-plane contention.
- Controllers can assign priorities to routes and program time-sensitive route updates via SL-API into the FIB ahead of lower-priority updates.

# SL-API priority routing model

The SL-API priority model is a routing update category that allows SL-API clients to assign priority levels to route updates so that the router programs critical routes before lower-priority updates.

During route programming, the controller assigns priorities and passes them to the RIB through SL-API. The RIB honors these priorities when processing route update operations.

The feature defines four distinct priority levels to ensure ordered and predictable route programming.

***Table 3: SL-API priority mapping***

| SL-API priority | RIB queue |
|---|---|
| Critical | BCDL0 |
| High | BCDL1 |
| Medium | BCDL2 |
| Low | BCDL3 |

# Verify intra-AFI route prioritization

Follow the steps to verify the intra-AFI route prioritization.

### Procedure

Run the **show service-layer route <ipv4|ipv6> detail** command to verify the SL-API RIB priority.

**Example:**

The highlighted lines in the show output confirm that the priority assigned by the controller via SL-API is correctly recognized and applied in the RIB.

```
Router# show service-layer route ipv4 100.2.1.2/32 detail
Output received:
Sun Jan 25 08:41:51.177 UTC

VRF: default, Client 0

100.2.1.2/32, tag: 0, distance: 2, metric: 3824949353, priority: critical
    path: 1, 102.1.4.4 via Bundle-Ether1402
        remote labels: 24001, 17000,
        load metric: 11, path flags: 0
        id: 0, protected bitmap: 0x0
        ref count: 1
    path: 2, 103.1.4.4 via Bundle-Ether1403
        remote labels: 24001, 17000,
        load metric: 11, path flags: 0
        id: 0, protected bitmap: 0x0
        ref count: 1
    path: 3, 104.1.4.4 via Bundle-Ether1404
        remote labels: 24001, 17000,
        load metric: 10, path flags: 0
        id: 0, protected bitmap: 0x0
```

```
        ref count: 1
  Update TimeStamp: Jan 25 08:41:27.072483
  Client:0, Session:31, Operation ID:2065, Operation Result: 0x0
  RIB:Programmed, FIB:Unavailable, Ack Type:Rib, FIB Version:0
  Ack Cadence:Continuous, Ack PermitGate/Status: ALL/Open
Network 100.2.1.2/32: RIB priority = 'rib_priority_slapi_critical (5) svd type rib_svd_type_local',
 SL priority = 'critical'
Network 100.2.1.2/32: Priority match confirmed - SL priority 'critical' found in RIB priority
```

### Example:

```
Router# show service-layer route ipv6 2002::6402:101/128 detail
Sun Jan 25 08:41:52.675 UTC

VRF: default, Client 0

2002::6402:101/128, tag: 0, distance: 2, metric: 4189176100, priority: critical
    path: 1, ::ffff:102.1.4.4 via Bundle-Ether1402
        remote labels: 24500, 16062,
        load metric: 11, path flags: 0
        id: 0, protected bitmap: 0x0
        ref count: 1
    path: 2, ::ffff:103.1.4.4 via Bundle-Ether1403
        remote labels: 24500, 16062,
        load metric: 11, path flags: 0
        id: 0, protected bitmap: 0x0
        ref count: 1
    path: 3, ::ffff:104.1.4.4 via Bundle-Ether1404
        remote labels: 24500, 16062,
        load metric: 10, path flags: 0
        id: 0, protected bitmap: 0x0
        ref count: 1
  Update TimeStamp: Jan 25 08:41:27.207009
  Client:0, Session:32, Operation ID:2667, Operation Result: 0x0
  RIB:Programmed, FIB:Unavailable, Ack Type:Rib, FIB Version:0
  Ack Cadence:Continuous, Ack PermitGate/Status: ALL/Open
Network 2002::6402:101/128: RIB priority = 'rib_priority_slapi_critical (5) svd type
rib_svd_type_local', SL priority = 'critical'
Network 2002::6402:101/128: Priority match confirmed - SL priority 'critical' found in RIB priority
```