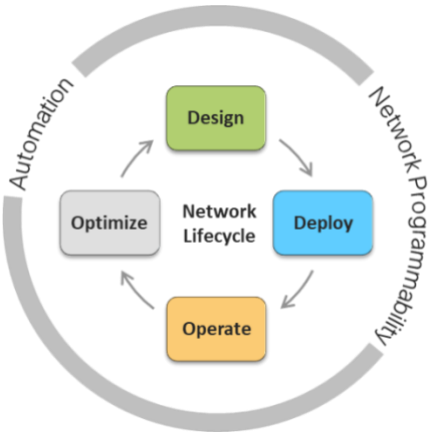
# CCIE Service Provider (v5.1) Lab Exam Topics – Practical Exam

The Cisco CCIE Service Provider Infrastructure v5.1 Lab Exam is an eight-hour, hands-on lab exam that requires a candidate to plan, design, implement, operate, and optimize dual stack solutions (IPv4 and IPv6) of complex service provider networks.




Candidates are expected to program and automate the network within their exam, as per exam topics below.

The following topics are general guidelines for the content likely to be included on the exam. Your knowledge, skills and abilities on these topics will be tested throughout the entire network lifecycle, unless explicitly specified otherwise within this document.

The exam is closed book and no outside reference materials are allowed.

**25%** **1.0 Core Routing**

- 1.1 Interior Gateway Protocol
  - 1.1.a IS-IS
  - 1.1.b OSPFv2 and OSPFv3
  - 1.1.c Optimize IGP scale and performance
- 1.2 Border Gateway Protocol
  - 1.2.a IBGP, EBGP, and MP-BGP
  - 1.2.b BGP route policy enforcement
  - 1.2.c BGP path attribute
  - 1.2.d BGP scale and performance
  - 1.2.e BGP labeled unicast and linked state
- 1.3 Multicast
  - 1.3.a Design PIM (PIM-SM, PIM-SSM, and BIDIR-PIM)
  - 1.3.b Design RP (Auto-RP, BSR, static, anycast RP, and MSDP)
  - 1.3.c Design IGMP and MLD
  - 1.3.d MLDP
  - 1.3.e Tree-SID
- 1.4 Multiprotocol Label Switching
  - 1.4.a MPLS forwarding and control plane mechanisms
  - 1.4.b LDP
  - 1.4.c LDP scale and performance

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- 1.5 MPLS traffic engineering
  - 1.5.a IS-IS and OSPF extensions
  - 1.5.b RSVP-TE
  - 1.5.c MPLS TE policy enforcement
  - 1.5.d PMLS LSP attributes
  - 1.5.e Optimize MPLS TE scale and performance

- 1.6 Segment routing
  - 1.6.a IS-IS segment rouging control plane for IPv4 and IPv6
  - 1.6.b OSPFv2 and OSPFv3 segment routing control plane
  - 1.6.c BGP SR
  - 1.6.d SR (SRGB and max label depth)
  - 1.6.e SR-TE
  - 1.6.f LDP and SR interworking, segment routing mapping server
  - 1.6.g PCE and PCEP technology
  - 1.6.h Flexible algorithm
  - 1.6.i SRv6 locator
  - 1.6.j SRv6 micro-segment (uSID)
  - 1.6.k SRv6 encapsulation functions
  - 1.6.l SRv6 interworking gateway

**25% 2.0 Architectures and Services**

- 2.1 Mobile infrastructure architecture
  - 2.1.a Design 5G vRAN and ORAN transport
  - 2.1.b Design 5G converged packet transport architecture
  - 2.1.c Design clocking and synchronization
  - 2.1.d Design multi-access edge computing (MEC)
  - 2.1.e Design transport network slicing
  - 2.1.f Design telco hybrid and multi-cloud

- 2.2 Optical architecture
  - 2.2.a Design routed optical network (RON)

- 2.3 Large-scale MPLS architecture
  - 2.3.a Unified MPLS
  - 2.3.b Multi-domain segment routing with SR-PCE
  - 2.3.c SLA based on IGP/TE metrics and disjoint paths

- 2.4 Carrier Ethernet
  - 2.4.a E-Line, E-LAN, and E-TREE
  - 2.4.b VPWS, VPLS, and H-VPLS
  - 2.4.c EVPN (single-homed and multi-homed)
    - 2.4.c.i EVPN-VPWS
    - 2.4.c.ii EVPN ELAN
    - 2.4.c.iii EVPN-IRB
  - 2.4.d L2VPN service auto steering into segment routing policy

2.5 L3VPN
- 2.5.a L3VPN
- 2.5.b PE-CE routing protocols (OSPF and BGP)
- 2.5.c Loop prevention techniques in multi-homed environments
- 2.5.d Inter-AS L3VPN
- 2.5.e Shared services, for example: extranet and internet access
- 2.5.f L3VPN service auto steering into segment routing policy

2.6 Internet service
- 2.6.a IPv4 translation mechanism, such as: NAT44, CGNAT
- 2.6.b IPv4 translation mechanism, such as: NAT64, MAP-T
- 2.6.c Internet peering route and transit policy enforcement

2.7 Multicast VPN
- 2.7.a NG mVPN (profile 0,3,6,7, 11, 12, 13, 14, 27, 28, and 29)

2.8 Quality of service for core, distribution, and access
- 2.8.a Classification and marking
- 2.8.b Congestion management and scheduling
- 2.8.c Congestion avoidance
- 2.8.d MPLS QoS models (pipe, short pipe, and uniform)
- 2.8.e MPLS TE QoS (MAM, RDM and PBTS)

**10% 3.0 Access Connectivity**

3.1 BNG connectivity
- 3.1.a Design cloud-native BNG
- 3.1.b Design control and user plane separation

3.2 Layer 2 connectivity
- 3.2.a IEEE 802.1ad (Q-in-Q) and ITU G.8032
- 3.2.b Spanning Tree Access Gateway (MST-AG and PVST-AG)
- 3.2.c Design and operate MC-LAG

**10% 4.0 High Availability and Fast Convergence**

4.1 High availability
- 4.1.a (SSO/NSF, NSR, and GR)

4.2 Routing/fast convergence
- 4.2.a IGP convergence
- 4.2.b LDP convergence
- 4.2.c BGP Prefix Independent Convergence (BGP-PIC)
- 4.2.d BFD
- 4.2.e LFA-FRR (LFA, remote LFA, and TI-LFA)
- 4.2.f MPLS TE FRR

**10% 5.0 Security**

5.1 Control plane security
- 5.1.a Control lane protection techniques (LPTS and CoPP)

5.1.b Routing protocol and LDP authentication and security
5.1.c BGP prefix-based and attribute-based filtering
5.1.d BGP-RPKI (origin AS validation)

5.2 Management plane security
5.2.a Implement and troubleshoot device management (MPP, SSH, and VTY)
5.2.b Implement and troubleshoot logging and SNMP security
5.2.c Implement and troubleshoot AAA

5.3 Infrastructure security
5.3.a ACL compression and object groups
5.3.b uRPF
5.3.c RTBH and router hardening
5.3.d BGP Flowspec
5.3.e TLS and mTLS certificates using gRPC and gNMI
5.3.f Design MACsec

**20% 6.0 Assurance and Automation**

6.1 Network assurance
6.1.a Syslog and logging functions
6.1.b SNMP traps and RMON
6.1.c NetFlow and IPFIX
6.1.d Segment routing performance monitoring
6.1.e IP performance monitoring (TWAMP)
6.1.f Y.1731 performance monitoring and Y.1564

6.2 Network automation
6.2.a Design, deploy, and optimize NSO service packages (Yang models, template based, Python-based, fastmap, reactive fastmap, CLI NEDs, NETCONF NEDs, and NSO northbound integration using RESTCONF)
6.2.b Design and deploy model-driven telemetry templates on XR devices (Yang models, gRPC, gNMI, GPB, and device configuration and collection architecture)
6.2.c Deploy and optimize Ansible playbook and Python scripts that interact with NSO, IOS XE, and IOS XR devices
6.2.d IOS XR application hosting using native and container-based applications
6.2.e Secure ZTP

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