SDN: Software Defined Networking with Python

Course Overview

This comprehensive course outline for Software-Defined Networking (SDN) with Python bridges the gap between traditional network engineering and modern programmable infrastructure. It moves sequentially from foundational Python concepts to advanced multi-tenant data center orchestration

Course Description

This course bridges the gap between traditional network engineering and modern software-driven infrastructure. Students will master the principles of Software-Defined Networking (SDN) and learn to automate, manage, and secure modern networks using Python.Through a mix of theory and hands-on labs, participants will program open-source controllers, manipulate OpenFlow traffic rules, and interface with Restful Northbound APIs. The curriculum covers everything from setting up virtual network topologies in Mininet to deploying Advanced Traffic Engineering and Network Functions Virtualization (NFV). By the end of this course, students will be equipped to transition from manual CLI configuration to programmatic, centralized network orchestration.

Learning Curriculum

Module 1

Introduction to SDN & Network Programmability

Traditional vs. SDN Architectures: Control, data, and management plane separation.SDN Layers: Application layer, northbound APIs, central controllers, and southbound APIs.The Role of Python: Why Python drives network automation, script execution, and API management

Module 2

Python for Network Engineers (Quickstart)

Core Data Structures: Working with Python lists, dictionaries, tuples, and JSON parsing.Control Flow: Implementing logic using loops (for, while) and conditional statements (if-else).File Operations: Automating input/output tasks for network configuration scripts.Functions & Modules: Packaging structured, reusable code for efficient network managemen

Module 3

Network Simulation and Environments

Mininet Framework: Deploying virtual nodes, links, and customized topologies via Python.Linux Container Networking: Integrating Linux Docker containers with virtual networks.Open vSwitch (OVS): Configuring software-driven switches inside the emulation testbed

Module 4

Southbound APIs and OpenFlow Protocol

OpenFlow Mechanics: Inspecting flow tables, pipelines, match fields, and instructions.Southbound Interfaces: Comparing OpenFlow with alternative protocols like NETCONF and gNMI.Packet Processing Analysis: Writing custom rules to control traffic forwarding behavior dynamically

Module 5

Python-Based SDN Controllers

POX and Ryu Frameworks: Setting up open-source, component-based controllers in Python.Event-Driven Programming: Writing applications that respond to network events like link failures or host tracking.Custom Topology Discovery: Mapping out complex networks dynamically with Python code.

Module 6

Northbound APIs and REST Automation

REST & RESTCONF: Consuming northbound APIs via Python to query or push policies to controllers.YANG Data Modeling: Structuring configurations systematically for multi-vendor environments.Automation Tools Integration: Connecting Python scripts with frameworks like Netmiko, Napalm, and Ansible

Module 7

Advanced Traffic Engineering & Network Functions Virtualization (NFV)

Traffic Management: Writing dynamic optimization algorithms for load balancing and custom routing paths.NFV Basics: Virtualizing firewalls, routers, and load balancers to replace dedicated hardware.Network Slicing: Partitioning physical infrastructure into isolated, secure virtual network slices

Module 8

SDN Security and Verification

Network Security Policies: Automating real-time attack mitigation and ACL enforcement.Network Verification: Implementing static and dynamic validation rules to check network state correctness.Troubleshooting Tools: Debugging control loops and monitoring traffic with Python network analysis packages

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