TRANSITION TO HYBRID SDN ENVIRONMENT WITH NFV INTEGRATION

HYBRID SDN HIGH LEVEL DESIGN DOCUMENT

BY

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Abstract

The transition from traditional networking infrastructures to Hybrid Software-Defined Networking (SDN) environments, integrated with Network Function Virtualization (NFV), is revolutionizing modern network architectures. This high-level design document outlines the strategic migration of ABC's network to a hybrid SDN model, leveraging Cisco Application Centric Infrastructure (ACI) and Cisco DNA Center for enhanced programmability, centralized control, and automation. The proposed solution aims to improve scalability, flexibility, and operational efficiency by integrating virtualized network functions, reducing reliance on legacy hardware-based services, and implementing a policy-driven automation framework. The document details the methodology, design principles, and risk mitigation strategies necessary for a seamless deployment. A phased approach, including Green Field Implementation, Migration, Testing, and Deployment, ensures minimal service disruptions while maximizing network performance. The study also highlights potential constraints, such as legacy system dependencies and compatibility issues, and proposes mitigation measures to optimize transition success. By adopting Cisco's SDN and NFV technologies, ABC will benefit from enhanced traffic optimization, improved security enforcement, and intelligent network management. This transformation will facilitate a dynamic, software-controlled networking environment, ensuring business continuity, scalability, and future growth readiness.

Keywords:

Hybrid SDN, Network Function Virtualization (NFV), Cisco ACI, Cisco DNA Center, Software-Defined Networking (SDN), Network Automation, Policy-Driven Networking

1. INTRODUCTION

1.1 PURPOSE

This document outlines the high-level design for ABC's transition from a traditional network architecture to a Cisco Software-Defined Networking (SDN) environment integrated with Network Function Virtualization (NFV). The solution leverages Cisco Application Central Infrastructure (ACI) and Cisco DNA Center for enhanced programmability, automation, and centralized control (Kreutz, D, et al. 2015).

1.2 INTENDED AUDIENCE

This document is intended for the following:

- ABC Network, Cloud and Security Team
- Vendors Network and Cloud Engineers
- Other concerned teams with the deployment as confirmed by ABC

1.3 PROJECT OBJECTIVE

ABC is looking to transition from their existing traditional infrastructure to a hybrid SDN environment to achieve the following.

1. Enhance scalability through a leaf-spine architecture
2. Replace traditional hardware-based services with virtualized functions using NFV.
3. Deploy centralized management using Cisco APIC and DNA Center.

1.4 SCOPE

The Scope of the project will be limited to the following:

1. Streamline network management with policy-driven automation.
2. Modernize ABC's existing network infrastructure to enhance performance and manageability using Cisco SDN technologies.
3. Facilitate seamless integration between traditional networking components and Cisco SDN components.

1.5 METHOD OF APPROACH

Vendor will provide the technical and management leadership, assisted by staff of ABC to deliver the scope described in this document. Project activities will be coordinated by the Vendor Project Manager assigned to this project (**McKeown, N. et al, 2008**).

The Network refresh solution will be delivered in the following phases

Phase 1: Green Field Implementation, Testing and Validation

Phase2:Full deployment and migration of legacy services to Cisco SDN environment

DESIGN AND IMPLEMENTATION PRINCIPLE

This section captures and provides a high level of the different principles and design approaches that were taken into consideration before the designs were proposed.

1.6 Design Principles

The proposed solution was designed with the following guidelines:

- The solution will be designed and delivered collaboratively, leveraging maximum benefit from both the customer and the vendor.
- The solution will be designed within the context of the system, not in isolation, by focusing on the optimization of the system, rather than on individual components.
- The solution design will be flexible and agile, easy to modify in response to changing business requirements.
- Future growth of the organization will be considered during design to ensure scalability.

1.7 Assumptions and Constraints

This section discusses the assumptions and the limiting factors that were key major decision factors during proposing a solution design.

1.7.1 Assumptions

The following assumptions were made during the solution design:

1. All required hardware and software licenses for Cisco SDN and NFV components are available prior to the commencement of the project.
2. The existing network infrastructure supports the integration of Cisco Nexus switches and other SDN technologies.
3. Adequate training will be provided to the operational team for managing the new Cisco SDN environment.

1.7.2 Constraints

The following were the limiting factors faced while designing the solution.

1. No Visibility into the different segments of ABC Network, Solution design is based on conceptual information of commonly used Network segments in Enterprise networks.
2. Legacy system dependencies might limit the pace of migration to SDN.
3. Compatibility issues with older devices may necessitate additional configuration efforts.

1.8 Risks

Below is a non-exhaustive list of possible risks that can occur during deployment with their probability and impact levels.

S/N	Risk Description	Probability	Impact	Response
1	Unavailability of allocated resources	Low	High	ABC to provide required manpower
2	Compatibility Issue	Low	High	Validate integration during pilot phase.
3	Service Downtime	Low	High	Perform migration during non-peak hours.

1.9 Delivery Approach

The tasks required to deliver this deployment has been grouped into different phases (Design, Build, Testing, Implementation phases). Tasks in the different phases are not arranged in a particular order. Please find below a list of high-level tasks required to deliver this implementation.

Phase	Tasks
Design	▪ Identify best migration approach from Information gathering ▪ Conduct design workshops ▪ Develop a detailed LLD based on this HLD ▪ Simulate network configurations to validate design choices ▪ Document all operational processes, including failover and disaster recovery procedures.
Build	▪ Install Cisco Nexus switches and APIC controllers ▪ Deploy the NFVI platform and set up hypervisors for hosting VNFs ▪ Configure DNA Center for centralized management and policy enforcement ▪ Establish initial connectivity and integrate existing network systems.

Phase	Tasks
Implementation	▪ Deploy and configure VNFs, including firewalls, load balancers, and NAT services. ▪ Migrate services and policies to the SDN environment ▪ Implement redundancy and high-availability configurations. ▪ Conduct initial performance tests to verify functionality.
Testing	▪ Perform end-to-end testing of SDN and NFV components ▪ Validate service integration between legacy and SDN systems. ▪ Test failover and disaster recovery processes
Deployment and Handover	▪ Gradually roll out the new network environment, ensuring minimal disruption ▪ Provide detailed documentation and training to the operational team ▪ Conduct post-deployment monitoring and address outstanding issues.

2. DESIGN AND ARCHITECTURE

This section discusses the high-level design of the cisco SDN solutions in ABC Network

The Cisco ISE servers will be deployed at the Datacenter and DR sites respectively.

The design is shown by two different topologies.

1. Physical Topology
2. Logical Topology

The Physical Topology shows the physical connectivity of devices in the solution and depicts physical cabling overview of the solution.

The Logical Topology shows the Traffic flows from device to device in the network.

2.1 FBN Cisco ISE Physical Topology

The proposed Physical topology for the ISE servers is depicted below

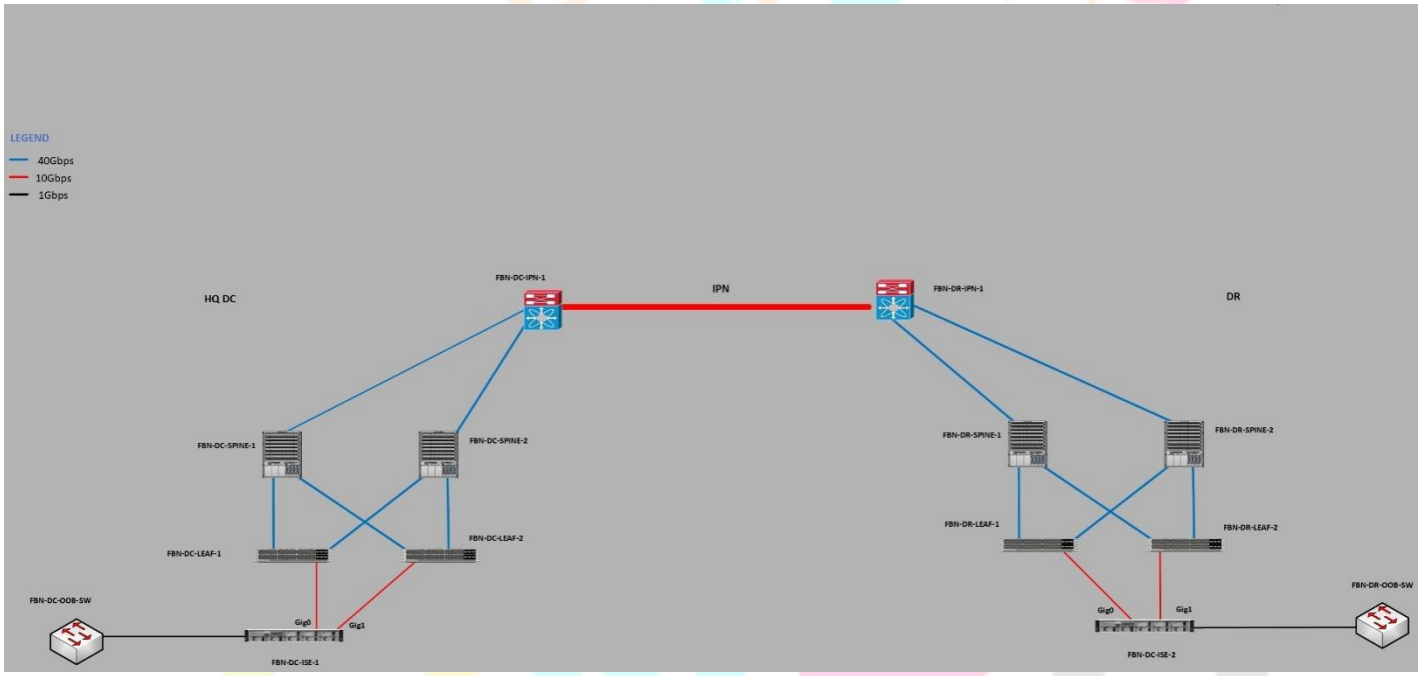

Figure 1: FBN Cisco ISE servers Physical connectivity

2.2 Proposed High Level Network Overview

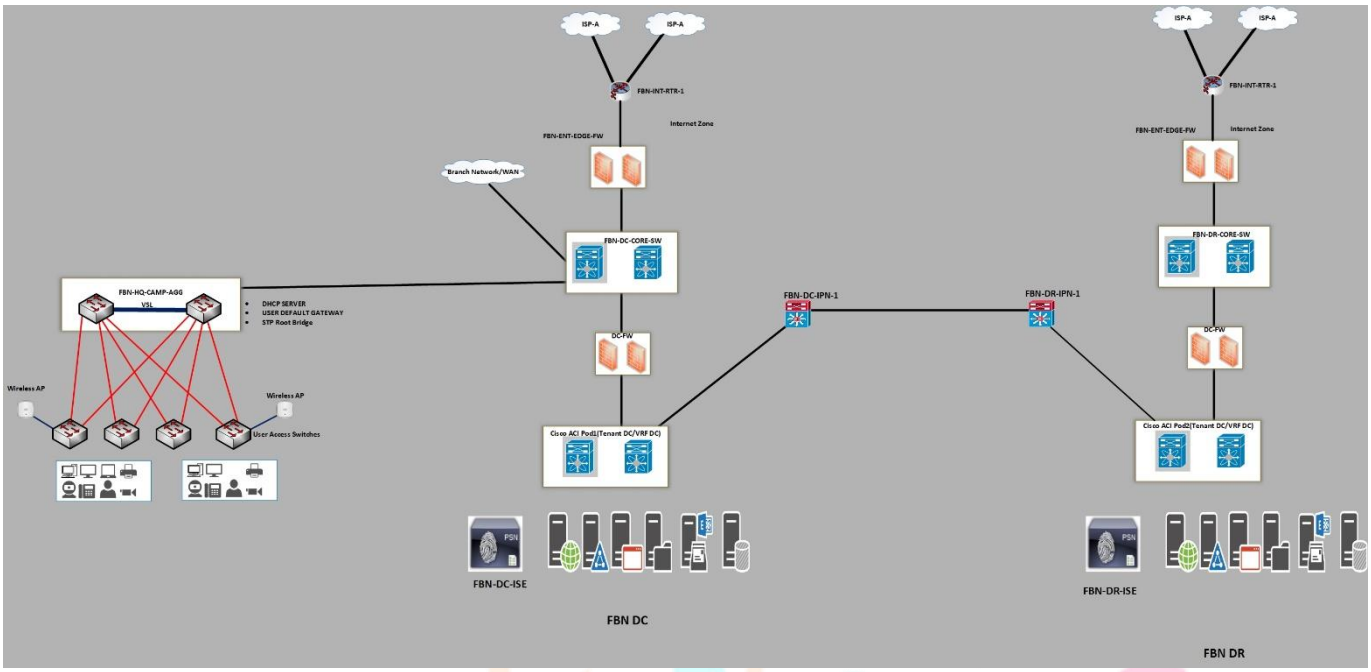

Figure 3: Logical topology of FBN Cisco ISE deployment

The figure above shows the logical setup of the Cisco ISE infrastructure in First Bank Enterprise network

The ISE servers will be deployed at the datacenter subnet (EPG) of the enterprise network. Enterprise Network devices administration traffic will transverse through the datacenter firewall and as such required firewall rules will be implemented on the DC firewall

Both ISE servers will be deployed on the same Datacenter EPG across both DC and DR (ACI Multipod).

2.3 Traffic Flows

In other to fully understand the cisco SDN setup, it is important to identify the various traffic flows that exists in this deployment

The Identified traffic flows in ABC Cisco SDN deployment with NFV integration are as follows

- Ingress Trafficthrough edge devices, with SDN controller dynamically adjusting forwarding based on policies.
- Intermediate devices forward based on SDN control, possibly passing through virtualized network functions.
- SDN controllers will optimize traffic flow in real-time based on network conditions and service requirements.
- Virtualized security, optimization, real-time network monitoring and other network services traffic.

3. SOLUTION SPECIFICS

This section describes the Cisco SDN solution, components and specifics as related toABCEnterprise Network.

3.1 Cisco ISE

- **Cisco APIC –**Acts as the central control point for the Application Centric Infrastructure (ACI), enabling policy-driven automation and network programmability.
- **Cisco DNA Center –** Provides intent-based networking capabilities for campus and branch networks, including device onboarding, policy application, and AI-driven insights.
- **Cisco NSO –** Facilitates service automation and orchestration, ensuring seamless integration between physical and virtual network components.
- **Cisco Nexus Switches –** Delivers high-performance networking through a leaf-spine topology, enabling low latency and high throughput.
- **Cisco NFVI –** Hosts virtual network functions (VNFs), ensuring flexible deployment of services like firewalls, load balancers, and intrusion detection systems.
- **Cisco ESC –** Manages the lifecycle of VNFs, from deployment to scaling and terminations, ensuring operational efficiency.

3.2 Software version and Licenses

The software version for the Cisco SDN deployment will be based on the recommended release by cisco on the official site.

Below is the software version of the Cisco SDN and the patch version to be installed for the deployment.

S/N	Component	Software Version	Release date
1	Cisco APIC	-	-
2	Cisco DNAC	-	-
3	Cisco Nexus Switches	-	-
4	Cisco NFVI	-	-

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4. APPENDIX

This section provides additional information that provides more clarity to the design document.

4.1 Terminologies & Abbreviations

Acronym	Description
SDN	Software Defined Networking
ACI	Application Centric Infrastructure
APIC	Application Policy Infrastructure Controller
DNAC	Digital Network Architecture Center
NFVI	Network Functions Virtualization Infrastructure
VNF	Virtual Network Function
NAT	Network Address Translation
ESC	Elastic Services Controller
LAN	Local Area Network