

ABSTRACT

Continuous Integration and Continuous Deployment (CI/CD) have become a foundational practice in modern software engineering by accelerating release cycles and improving collaboration efficiency. However, maintaining secure and manageable connectivity between distributed developers and internal CI/CD infrastructures remains a critical challenge. Virtual Private Network (VPN) technologies are commonly employed to address this issue, yet differences in architectural approaches, configuration models, and operational abstraction levels introduce varying degrees of complexity that may influence CI/CD integration effectiveness. This study conducts a comparative experimental analysis of three VPN approaches: router-based VPN (L2TP/IPSec), modern kernel-level VPN (WireGuard), and zero-configuration VPN (Tailscale) to examine their suitability for CI/CD environments from an implementation and integration perspective. The evaluation is performed through controlled scenario-based simulations that replicate CI/CD workflows and developer access patterns. The analysis focuses on four key parameters: configuration complexity, required technical expertise, multi-client configuration behavior, and adaptability to network topology changes. The results demonstrate that router-based L2TP/IPSec VPNs provide strong control at the network layer but introduce higher configuration complexity and greater dependency on static topology management, which can affect CI/CD integration agility. WireGuard reduces configuration overhead through a streamlined peer-based model while maintaining manual control over network policies, positioning it as an intermediate approach. In contrast, Tailscale abstracts network configuration through identity-based access and automated routing, enabling more adaptive integration with dynamic CI/CD workflows and collaborative development environments. This study concludes that VPN selection plays a strategic role in shaping CI/CD integration efficiency rather than serving solely as a networking decision. The findings highlight that no single VPN approach is universally optimal; instead, effectiveness depends on alignment between VPN architecture and organizational operational characteristics. The insights provided offer a practical reference for organizations seeking to design secure, manageable, and scalable VPN infrastructures that support modern DevOps and CI/CD practices.

Keywords : *Comparative Analysis; DevOps Workflow; Configuration Efficiency; Virtual Private Network (VPN); Continuous Integration and Continuous Deployment (CI/CD).*