



RESEARCH ABOUT BUILDING AN SECURED ENTERPRISE NETWORK

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Abstract :

This report presents a detailed analysis of server operating system selection and network service architecture for NOSS2027, a dual-site enterprise network connecting Swansea and London. It evaluates Windows Server 2025 and Debian Linux across administration, licensing, update management, and security posture, then assesses ten core infrastructure services: Dynamic Host Configuration Protocol (DHCP), Domain Name System (DNS), directory services, file sharing, web services, remote access, routing, virtual private networking (VPN), public key infrastructure (PKI), and monitoring. The work draws on peer-reviewed studies published between 2022 and 2026 and acknowledges that independent empirical evaluation of Windows Server 2025 remains limited. The recommended architecture is a mixed-platform deployment: Windows Server hosts identity and user-facing services, while Debian delivers lightweight, scriptable infrastructure services, all underpinned by a least-privilege security baseline

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I. INTRODUCTION

Modern enterprise networks must provide consistent, secure, and resilient access to resources across geographically distributed sites, while adapting to evolving security threats and organisational growth. NOSS2027 operates from two principal locations — Swansea and London — where the wide-area link connecting them represents both a critical communications channel and a potential single point of failure. Traditional perimeter-centric security models are increasingly recognised as insufficient; Zero Trust frameworks, which operate on the principle "never trust, always verify," are now the emerging standard for network design [1]. Simultaneously, operational challenges such as delayed patch deployment continue to expose organisations to preventable risk [2]. Authentication practices are also evolving, with stronger multi-factor controls and revised password policies reshaping how identity is managed [3]. This report sets out the functional and non-functional requirements for the NOSS2027 network, compares two leading server operating systems — Windows Server 2025 and Debian Linux — across operational and security dimensions, evaluates the suitability of core network services within this dual-site context, and presents a final deployment architecture and security baseline. The design priorities of resilience, maintainability, and scalability alongside evidence-based security practices.

II. ENTERPRISE NETWORK REQUIREMENTS AND GROWTH PROJECTIONS

A. Functional and Site-Specific Requirements NOSS2027 requires unified identity, name resolution, automated IP addressing, and controlled file access across both sites, with the inter-site wide-area link treated as the weakest component in the infrastructure. The simulated environment comprises two distinct subnets: one hosting Windows Server for identity and core user services, and a second running Debian Linux administered exclusively via the command line. Windows workstations at both sites will be joined to a central domain, ensuring consistent policy application and single sign-on capability. Immediate functional priorities include.

- Centralised authentication and access control;
- Automated address allocation and name resolution;
- Departmental file storage with role-based permissions;
- Internal web portal services;
- Encrypted connectivity between sites;
- Centralised event logging and anomaly detection.

B. Scalability and Future Growth

Enterprise networks rarely remain static, and design decisions must accommodate expansion without costly reconfiguration. As user numbers increase, authentication load, address lease demand, and permission complexity all rise proportionally — manual configuration approaches become unmanageable beyond small deployment sizes. Beyond sheer scale, the network must also support changing work patterns, including hybrid and fully remote working, where implicit trust in internal network location is no longer a valid security assumption [1]. Zero Trust principles — continuous verification, resource segmentation, and automated policy enforcement — are therefore integrated into the design from the outset rather than added as an afterthought.

C. Resilience and Maintainability.

Service resilience requires that operations continue if one site or the inter-site link becomes unavailable. The minimum implementation includes a secondary domain controller located in London, replicated name resolution services, and documented recovery procedures. Virtualisation makes redundant deployments technically and financially feasible; however, hypervisor selection requires careful consideration. Hyper-V delivers marginally better performance for Windows-based virtual machines, while Proxmox Virtual Environment is more readily configured as a clustered solution for Linux workloads [4]. Because measurable performance differences are narrow, selection should be guided by staff expertise and long-term operational familiarity rather than minor throughput variations.

Maintainability is frequently underprioritised in network design but directly influences long-term security and reliability. A systematic review of 72 empirical studies identified 14 sociotechnical barriers to effective patch management, including cross-team coordination difficulties, tool incompatibilities, and reluctance to apply updates that may disrupt service availability [2]. Standardised role definitions, scripted server builds, and repeatable deployment procedures reduce reliance on individual administrator expertise and create an auditable record of system configuration.

III SERVER OPERATING SYSTEM COMPARATIVE ANALYSIS.

A. Administrative Philosophy and Management Model

Windows Server 2025 and Debian Linux differ less in technical capability than in underlying administrative design. Windows Server 2025 is a recent release, meaning independent peer-reviewed evaluation of its security and operational characteristics remains limited; vendor claims are therefore treated as working hypotheses to be validated during practical implementation.

Windows Server centres on Active Directory, Group Policy, and role-based administration, delivered through graphical consoles and PowerShell automation. This model enables consistent configuration to be applied across large numbers of devices from a single point of control. Active Directory has become the de-facto enterprise identity platform in Windows-centric environments, with organisations commonly relying on it to centralise authentication and access policy [3].

Debian, by contrast, stores all system and service configuration in human-readable text files managed through the package manager and service control utilities. This approach offers complete auditability of system state and straightforward scriptability but requires administrative discipline or additional configuration management tools — such as Ansible — to ensure consistency across multiple servers. In a mixed-platform environment, domain-joined Windows clients receive uniform security baselines via Group Policy, while Debian servers are hardened through documented, version-controlled build scripts.

B. Licensing and Resource Footprint.

Licensing represents the most distinct practical difference between the two platforms. Windows Server 2025 requires licensing based on processor core count for the server itself, plus separate Client Access Licenses for each user or device connecting to services. Costs scale directly with deployment size, making Windows-centric designs progressively more expensive as the network grows. Debian carries no upfront licence fees; total cost of ownership is instead determined by administrative labour and any purchased commercial support agreements. For headless infrastructure roles — routing, firewalling, logging — Debian also operates with significantly lower memory and processor overhead than a full Windows Server deployment, leaving more system resources available for core service delivery.

C. Update Management and Operational Disruption.

The two platforms follow fundamentally different updated cadences and restart requirements. Windows updates are released on a scheduled monthly cycle, with major updates typically requiring a full system to restart that interrupts service availability. Debian delivers security patches through its package management system; most service updates can be applied without system reboot, with only kernel and critical system library updates necessitating a restart. Because downtime avoidance and patch testing complexity are among the most significant barriers to timely vulnerability remediation [2], reduced operational disruption constitutes a material advantage for infrastructure roles.

D. Security Posture and Risk Profile

Overall security posture depends more on configuration quality and operational discipline than on operating system brand. Active Directory centralises identity management, creating a single authoritative source for user and device information — but also concentrating on risk. A compromised domain controller can grant attackers access to resources across the entire network, and evidence indicates that many organisations lack the monitoring infrastructure required to detect such compromises [3]. PowerShell provides powerful automation and auditing capability on Windows; Bash, Secure Shell (SSH), and configuration management tools offer equivalent functionality on Debian. Administrators consistently weigh security risks against availability concerns when deciding whether to apply updates, creating a natural tension that can delay critical remediation [5]. Automation addresses this by handling routine tasks uniformly and predictably, while reserving high-impact decisions for human review.

E. Platform Suitability and Allocation.

Compatibility and native integration strongly support a mixed-platform architecture where each system is deployed for the workloads to which it is best suited. Windows clients integrate natively with Active Directory, Group Policy, Internet Information Services (IIS), and Server Message Block (SMB) file sharing. Debian excels as a lightweight router, VPN endpoint, log aggregator, and caching resolver. The recommended allocation is therefore:

- Windows Server 2025: Identity services, user authentication, file access, internal web services;
- Debian Linux: Inter-site routing, firewall protection, encrypted connectivity, backup, centralised logging.

IV. NETWORK SERVICES ARCHITECTURE.

A. DHCP — Dynamic Host Configuration Protocol

DHCP eliminates manual IP address configuration and enables site-specific address scopes, gateway settings, and lease duration policies. The protocol is operationally essential but trust-dependent: clients accept the first address offer received, meaning an untrusted or compromised DHCP server can redirect traffic or exhaust available addresses [6]. Address starvation attacks can disrupt service entirely if unmitigated [7].

Implementation: An Active Directory-authorised DHCP server operates on Windows Server, with separate address scopes for Swansea and London. DHCP relay agents forward requests across the inter-site link without deploying duplicate servers. Authorisation and port-level security prevent unapproved devices from offering addresses on the network.

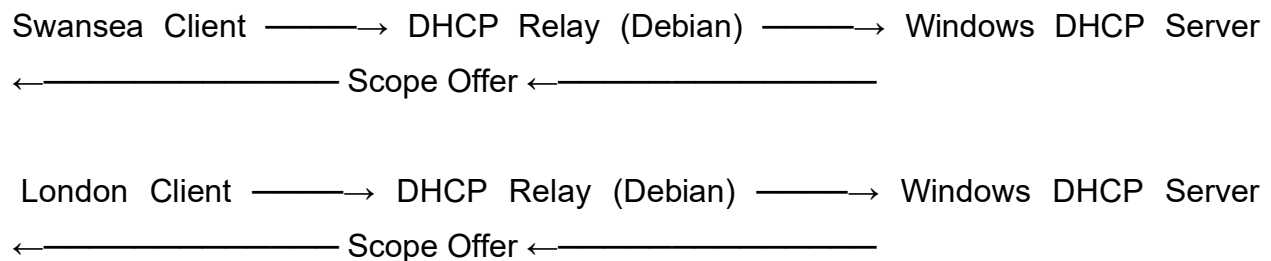


Fig. 1. DHCP relay and scope allocation flow — separate address pools assigned per site through a central authorised server.

B. DNS — Domain Name System.

DNS provides the naming foundation upon which Active Directory, file sharing, and web access depend; a DNS failure manifests as service failure across all dependent systems. The design uses Active Directory-integrated primary zones hosted on Windows Server, with a secondary caching resolver on Debian to provide redundancy and separate internal and external resolution paths.

DNS over HTTPS (DoH) enhances user privacy but complicates network-level threat detection and filtering, as encrypted queries cannot be inspected for known malicious destinations [8]. Real-world protocol abuse is well documented [9], so NOSS2027 will enforce internal resolution via trusted servers and explicitly document any policy allowing clients to use external encrypted resolvers.

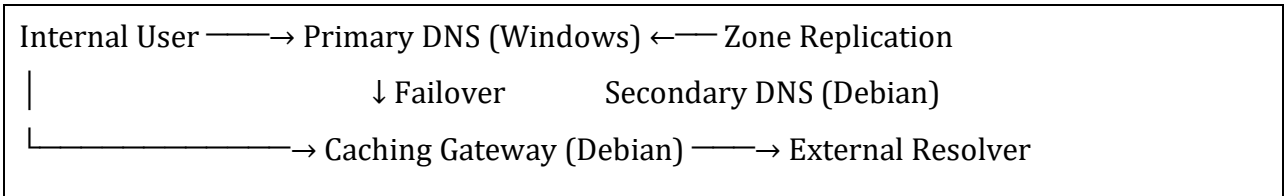


Fig. 2. DNS resolution and redundancy architecture — Active Directory-integrated primary with independent Debian secondary and forwarder.

C. Directory Services

Active Directory Domain Services provides a single authoritative store for user accounts, devices, security groups, and policy, enabling Kerberos-based single sign-on across both sites. Because directory compromise affects every connected resource, a secondary domain controller is deployed in London to maintain availability if the primary link or site

fails. Regular replication ensures consistency between sites, and time synchronisation is enforced to preserve Kerberos ticket validity.

D. File Sharing

SMB file sharing with NTFS access control lists is implemented on Windows Server, with permissions managed through Active Directory security groups. This aligns file access policy with central identity management and simplifies permission auditing. Samba provides cross-platform compatibility where needed, but primary shares remain centralised on Windows for consistency. Debian servers host replicated backup copies to support recovery. Shares are restricted to internal subnets and segmented by departmental groups to limit lateral exposure.

E. Web Services and IIS

Internet Information Services on Windows Server provides an internal intranet portal with native Windows authentication and certificate integration, reducing additional configuration overhead. The trade-off is a larger attack surface and dependency on Windows update cycles; this is mitigated through server hardening, service minimisation, and certificate-only encrypted connections.

F. Remote Access and RDS

Remote Desktop Services (RDS) centralises application delivery and data storage, ensuring sensitive information remains within the corporate network even when accessed remotely. Direct exposure to the internet carries significant risk, as publicly accessible endpoints are targeted systematically for credential guessing. All remote access is

therefore routed through a VPN or authentication gateway with multi-factor verification enabled, consistent with Zero Trust principles of identity-centric access [1].

G. Routing and Firewalling

Inter-site routing is implemented on Debian using IP forwarding and nftables packet filtering to create a transparent, scriptable policy. Rules are stored in version-controlled configuration files, enabling audit, review, and rapid reversion if required. This static model suits the two-site design; expansion to additional locations would require dynamic routing protocols or software-defined networking overlays to support automated failover.

Swansea Subnet — [Default-Deny nftables Firewall] — London Subnet
Only: DNS, Kerberos, LDAP, SMB, DHCP Relay, VPN permitted

Fig. 3. Inter-site firewall policy — default-deny principle with explicitly permitted service ports only.

H. Virtual Private Networking

WireGuard is selected as the primary VPN protocol for both site-to-site encrypted connectivity and remote user access. Comparative testing in virtualised environments demonstrates WireGuard delivering approximately 210 Mbps throughput compared with 110 Mbps for OpenVPN, alongside lower packet loss [10]. On high-bandwidth links,

WireGuard remains the highest-performing software-based option [11]. OpenVPN is retained as a fallback for high-latency connections where it may perform more reliably [10]. All VPN endpoints run on Debian to isolate encrypted traffic processing from identity services.

I. Certificates and PKI

Active Directory Certificate Services provides an internal public key infrastructure (PKI) trusted natively by all domain-joined devices. Production-grade deployments typically use a two-tier hierarchy with an offline root certificate authority to mitigate risks from rogue intermediate authorities and delayed revocation [12]. For this simulated environment, a single issuing authority is used with limitations documented. Certificates are deployed to secure web, directory, and VPN sessions, ensuring both traffic encryption and endpoint identity verification.

J. Logging and Monitoring

Centralised logging enables post-incident analysis and early detection of suspicious activity. Windows event logs and Debian rsyslog entries are forwarded to a dedicated Debian log collector, where they are stored and correlated. Alerting is configured for failed authentication attempts, account lockouts, and unexpected DHCP address patterns. Cross-source correlation is essential because evidence of attack may appear in fragmented form across multiple systems [13].

V. INFORMATION SECURITY AND OPERATIONAL BASELINE.

A. Identity and Authentication

Identity management forms the foundation of security design. Kerberos authentication is used for all domain-joined resources; Debian servers accept only SSH key-based

authentication, with password authentication disabled entirely. Multi-factor authentication will be implemented for all administrative accounts and remote users, reflecting industry adoption growth from 22.2% in 2019 to 51.2% in 2023 [3].

Password policy departs from traditional calendar-based expiry in Favor of evidence-driven resets triggered only when compromise is suspected. Guidance now recommends combining minimum length requirements, complexity rules, and blocklists of known compromised passwords rather than relying on forced rotation [14]. Many public services still fail to block the most common weak passwords, making proactive filtering essential [15].

B. Least Privilege and Access Control

Least privilege principles dictate that users and services receive only the permissions necessary to fulfil their intended function. Standard and administrative accounts are kept separate; domain-administrator credentials are never used for routine workstation logons. Access is granted through role-aligned security groups rather than assigned directly to individual accounts, simplifying auditing and offboarding. Network segmentation ensures that a compromise in one area cannot easily spread, aligning with Zero Trust recommendations [1].

C. Patching and Change Management

Patch management follows a test-then-deploy workflow with system snapshots taken before changes are applied. Industry data indicates that the average response time to patch critical vulnerabilities exceeds 72 hours, and approximately 15 % of organisations leave critical vulnerabilities unpatched after 30 days [2]. The deployment process prioritises stability and repeatability: updates are applied to a staging environment first,

validated, and then rolled out systematically. Additional operational controls include verified backups, formal change records, and strict separation between laboratory and production data.

VI. CONCLUSION AND FINAL RECOMMENDATION

The evidence supports a deliberately mixed-platform architecture that allocates services to the environment where they deliver the greatest benefit, as summarised in Table I.

TABLE I: SERVICE ALLOCATION AND JUSTIFICATION.

Role / Service	Platform Selected	Rationale
Active Directory, DNS, DHCP	Windows Server 2025	Native integration, Group Policy, identity consistency
SMB File Services, IIS Intranet	Windows Server 2025	Windows client compatibility, permission alignment
Routing, Firewall (nftables)	Debian	Scriptable, low overhead, version-controlled policy
VPN Endpoint (WireGuard)	Debian	Performance, protocol support, traffic isolation
Centralised Logging	Debian	Lightweight, efficient log processing
Backup Storage	Debian	Separation from primary services, resource efficiency

Resilience is addressed through redundant domain controllers in separate locations, replicated DNS, and pre-tested recovery snapshots. Security is anchored on strong

authentication, least-privilege segmentation, default-deny firewall rules, and continuous monitoring.

A key limitation is acknowledged: the analysis draws on established technology studies rather than independent long-term evaluation of Windows Server 2025 specifically. Every architectural assumption will therefore be validated, tested, and documented during the practical implementation phase.

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