Cybersecurity Assessment & Recommendations for OmniCommerce Solutions

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Executive Summary

OmniCommerce Solutions is undergoing a major transformation that targets enhancing their competitiveness in the global market as well as expanding the e-commerce presence to a wider customer base. This transformation aims at ensuring efficient compliant operations and security in alignment with the company's goals and future growth. The report focuses on strategic srameworks and governance where comparisons have been drawn between different frameworks, the most efficient suitable and adaptable framework has been recommended along with which compliance support is also advised. Implementing governance rules such as CISO, Security Auditor, and Compliance Officer, there by ensuring strong leadership roles segregation and adherence to security policies. Further identity access and authentication controls have been developed by streamlining identity and access management strategy that focuses on joiners movers and levers with defined roles for requesters managers system owners and provisioners. In addition to that, insights have been given into secure onboarding transfers promotions and off-boarding processes that are advised to be automated and with regular entitlement reviews to ensure security compliance and efficiency. Architectural security models and best practices have been provided. Zero trust architecture principles have been recommended by emphasizing the least privilege access continuous verification and establishing publicly key infrastructure involving generation, provisioning, monitoring and revocation. Developing a data protection strategy and integrating secure practices into secure software development life cycle based on NIST SP 800-218 and OWASP guidelines has been issued to ensure security by design until deployment. Finally Cloud security rules and responsibilities have been defined - SaaS, PaaS, and IaaS models, emphasizing alignment with ISO 27017 and FedRAMP standards and Role based Access Control mechanisms have been provided to ensure secure and scalable operations.

Introduction

Omni commerce Solutions is a scalable e-commerce platform that is transforming the digital landscape and currently expanding into market competitiveness. The company's digital strategy includes eficient cyber security operational efficiency and growth through Federal Contracting and international markets. The organization must aim to launch a scalable custom built e-commerce platform with secure payment methods in compliance with PCI DSS to protect customer transactions along with Federal contracts to achieve compliance of the cmmc and FedRAMP To ensurecontrolled unclassified information is handled appropriately. Organization should focuse on to developing a platform that supports international customer base making it convenient for regional payment methods and transactions as well as easy access to services thereby the organization must thrive to achieve compliance with regional specific standards such as the general data protection regulation for their international customer. Omni-commerce solution can facilitate enhanced user experiences by streamlining their marketing and optimizing the product recommendations by using Salesforce CRM and data analytics at the same time ensuring compliance with the California consumer Privacy Act (CCPA).   Further, developments in the IT infrastructure of the organization to achieve cloud efficiency will result in cost-effectiveness scalability and support for international operations at the same time ensuring compliance with ISO and IEC 27017 for cloud specific security is essential. Prioritizing secure personalized and data driven experience across digital platforms will ensure that the digital initiatives by the organization expands market reach builds customer trust and achieves operational success .

Strategic Frameworks and Governance

Cybersecurity Framework Selection

ISO -27001 Framework

The ISO-27001 is a versatile and comprehensive framework that provides certification to any company that decides to incorporate this framework into its Information Security Management System and program this fosters trust among stakeholders by promoting commitment to protecting sensitive data. It is mainly beneficial for those companies that require regulation in their infosec management. Further, this framework is useful for companies seeking to demonstrate their commitment to robust information security practices. The ISO follows the CIA triad that is focused on confidentiality, integrity and availability which provides risk-based prioritization that establishes a systematic process to assess risks and identify vulnerabilities (IT Governance, 2016). This is helpful to select and prioritise the most important parts of the organisation and work for protection around these aspects. Further, this framework is also recognised globally. This allows for the global expansion of the company without hampering its growth.

NIST CSF 2.0 Framework

NIST CSF is capable of providing a very flexible approach for any company that incorporates it into its cyber security program. This framework addresses areas of data protection governance and risk management it helps organizations achieve compliance at the same time satisfying their requirements and maintaining their standards. It equips the company to effectively support the tactical and strategic objectives of the organisation for protecting the customer data, internal scaling strategies as well the online domain that the company is handling. According to the demands of the stakeholders and to suit changing business models the framework can be adapted to suit their needs. The NIST CSF comprises 6 elements Govern, Identify, Protect, Detect, Respond and Recover elements which help the company understand the threat and respond to prevent it from causing any more damage(Best Practices | NIST, 2016). These elements ensure round-the-clock monitoring for anomalies and detection, incident response planning and mitigating the damage as soon as an attack occurs by prioritizing the restoration of affected systems and the prompt undoing of any damage that has occurred as well as having an established backup and recovery plan for critical systems and data.. Implementing this framework incorporates a structured and effective cybersecurity program for the company.

Regulatory Alignment

The NIST Cybersecurity Framework (CSF) can support compliance with the California Consumer Privacy Act (CCPA) that emphasises on requirements for data protection and consumer privacy by aligning with data protection requirements, customer rights, and data handling practices. It can also facilitate compliance with the Payment Card Industry Data Security Standard (PCI-DSS) for securing payment card data, including encryption, access controls, and vulnerability management. Furthermore, the General Data Protection Regulation (GDPR) imposes strict data privacy rules for organizations handling the personal data of EU citizens, focusing on data minimisation, consent, and breach notification which is also complied with by NIST. Hence by mapping between the framework and these standards and regulations. NIST CSF 2.0 provides the means to develop a structured approach to cybersecurity and demonstrate the organization's ongoing maintenance of compliance with relevant regulations(NIST, 2017).

Below is a comparison table between ISO2700 AND NIST

Criteria	ISO 27001	NIST
Purpose	Provides a framework for security management in the information	Provides a framework for managing cyber risks.

	system domain.	
Global standard	Used across the globs for industries that are mostly in the information technology sector	Mostly adopted in the US for any organisation that wants to deal with cyber risk
Certification	Certification is provided by accreditation	No certification
Risk Management	Based on the CIA triad	Based on the cyber risk and trying to improve an existing system in place
Target Audience	Focus company that primarily works in an information technology setting	Any organisation that wants to improve its cyber security defence
Implementing	Set requirements that are specific to information systems	Flexible management to customise to their needs.
Update	Less frequent	Regular updation

Based on the above observation it is recommended that the NIST cyber security framework be adapted to Omni Commerce Solution because it provides a practical and adaptable solution to fulfill the needs of the e-commerce company. This framework provides a flexible structure that helps the organization mould itself and its cyber security objectives along with its business goals to meet regulatory requirements including CCPA, PCI-DSS, and GDPR. The framework's core functions—Govern, Identify, Protect, Detect, Respond, and

Recover—offer a comprehensive taxonomy to manage cybersecurity risks, controls, and operational continuity(Bowen et al., 2006). Besides this the NIST framework is adaptable and it can be manoeuvred to match the organization's requirements, it is scalable allowing the company to adjust itself with its expansion and growing business requirements. Overall it allows a reduction in the burden to comply with multiple standards therefore helping the company maintain trust and avoid penalties for non-compliance this framework's focus lies on continuous improvement ensuring that the organization remains steadfast in the dynamic e-commerce environment and is able to effectively ensure protection long-term success.

Governance, Oversight, and Segregation of Duties

To ensure strong governance within OmniCommerce Solutions it is essential that a government model is established in the company with key roles defined such as CISO who is responsible as security leadership then comes to the security auditor who will perform independent assessments at regular intervals of time and a compliance officer responsible for ensuring adherence to policies and complying to frameworks and standards this governance model should define clear responsibilities and reporting lines for each role. Segregation of Duties shoud be ensured by enforcing role-based accountability through the separation of critical tasks and regular audits must take place to identify any anomalies in the system. Strict policies outlining specific functions by implementing zero trust architecture through least privilege principle policy enforcement must be adapted. Regulatory alignment with standards like ISO 27001, SOX, and NIST frameworks to ensure effective security management and regulatory compliance must be compliant. The Organization must implement oversight mechanisms through periodic reviews by the auditors and use compliance dashboards for reporting and documenting security policies and security changes in the company along with regular audits it is important to also document any form of discrepancies between employees of the organization to ensure conflict prevention to resolve conflicts of interest and established procedures for escalating and resolving issues promptly

Identity, Access, and Authentication Controls

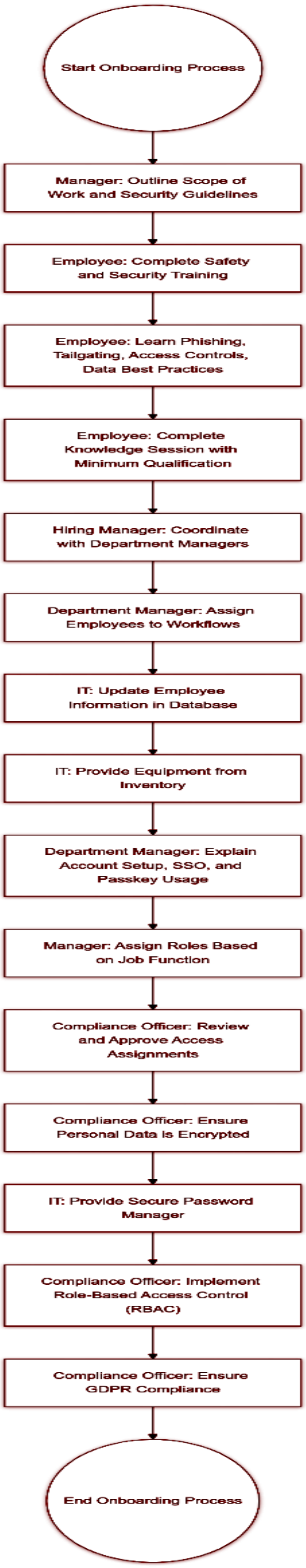
Objective

The Omnicommerce Solutions company targets itself to become a global organization, hence in view of that, there will be an increase in the employee strength and workforce that will be involved in the expansion of the company, therefore, onboarding, transfers, promotions, entitlement reviews as well as boarding needs to be well structured and streamlined to maintain efficiency without affecting the functioning of the company.

Onboarding

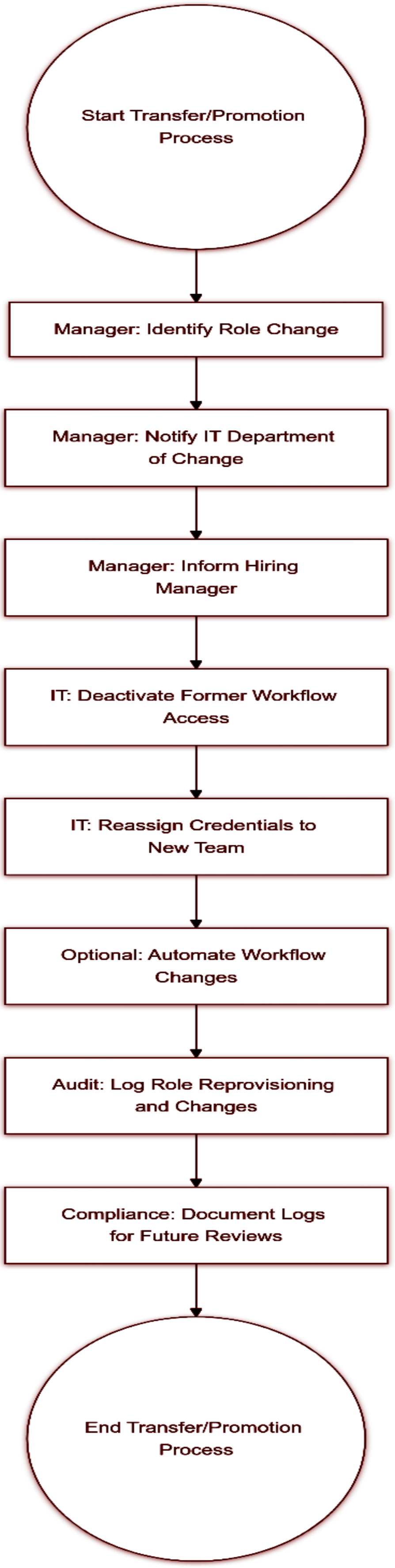
Onboarding should be initiated with a brief overlay of the scope of work that an employee would be performing and the security guidelines they would need to ensure are being complied with while on the job, employees would need to be put through safety training that would involve educating them on basic security guidelines and awareness creation such as handling phishing, tailgating turnstiles, switching badges, hampering across access controls as well as best practices while handling company data and password(Cloud, n.d.). After the training employees would be required to go through a knowledge session that would have a minimum qualification requirement to further advance through the onboarding stage. Once completed the hiring manager coordinates with each department manager who will be the provisoner, decides the placement of employees into each workflow, and then the workflow process and routine will be made aware to the employees. The IT team, which is considered the system owner, will be provided with employee information for updating the database, and equipment will be handed in from the inventory, further individual department managers can run through guidelines with their assigned employees regarding account and profile creation, educating the users on single sign-on, and passkey usage within company domain. Role assignment must be initiated by the manager to assign rules based on job function and access must be reviewed by the compliance officer and needs to be approved.

The compliance officer will need to ensure that all personal data is fully encrypted and ensure that the IT department provides the employees with a secure password manager, which is a tool that aids in creating managing, securely storing and sharing passwords in which admins will have complete visibility of employee password practices making it easier to enforce strong password creation and management (User Access Controls: 11 Best Practices for Businesses, 2024). Establishing role-based access control ensures the company is complying with the principle of least privilege and each employee has access only to the resources their job demands. Further, the Omni Commerce solution company is focusing on penetrating the global market which would require them to align themselves with the GDPR law, ensuring the rights of employees are protected in terms of guaranteeing individuals the right to manage the data and companies can only keep personal data as long as it is necessary for the purpose of which it is obtained and granted.


Start Onboarding Process
Manager: Outline Scope of Work and Security Guidelines
Employee: Complete Safety and Security Training
Employee: Learn Phishing, Tailgating, Access Controls, Data Best Practices
Employee: Complete Knowledge Session with Minimum Qualification
Hiring Manager: Coordinate with Department Managers
Department Manager: Assign Employees to Workflows
IT: Update Employee Information in Database
IT: Provide Equipment from Inventory
Department Manager: Explain Account Setup, SSO, and Passkey Usage
Manager: Assign Roles Based on Job Function
Compliance Officer: Review and Approve Access Assignments
Compliance Officer: Ensure Personal Data is Encrypted
IT: Provide Secure Password Manager
Compliance Officer: Implement Role-Based Access Control (RBAC)
Compliance Officer: Ensure GDPR Compliance
End Onboarding Process

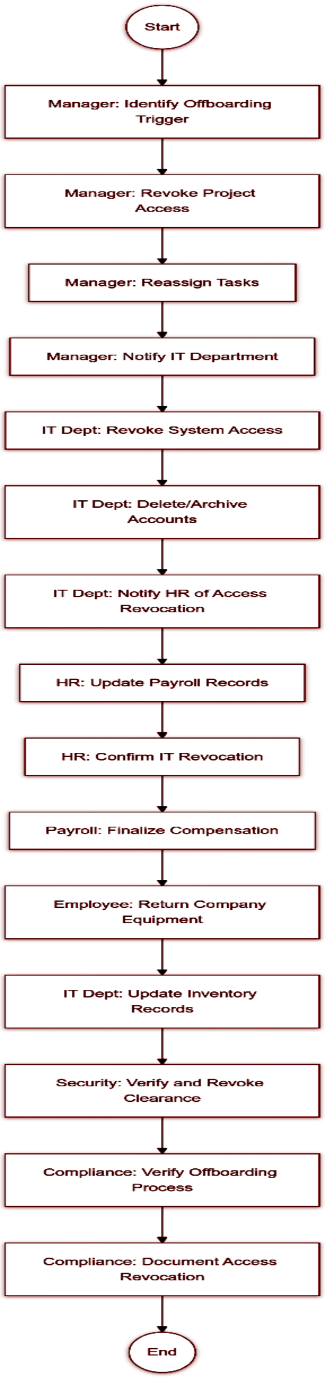
Transfers and Promotions

During transfers within the organisation, an employee changes their role based on the scope of work, the provisioner, that is, the manager would need to pass on the information and update the IT department on this change. The system owner, that is the IT department is required to deactivate any access the employee might have to his former workflow and must reassign the employee's credentials to the new team (OWinfreyATL, 2024). The hiring manager needs to be kept in the loop regarding all the changes. Role reprovisioning and logging changes need to be audited, logs have to be updated and documented for compliance and future reviews. Workflow changes could be automated as well.


Start Transfer/Promotion Process
Manager: Identify Role Change
Manager: Notify IT Department of Change
Manager: Inform Hiring Manager
IT: Deactivate Former Workflow Access
IT: Reassign Credentials to New Team
Optional: Automate Workflow Changes
Audit: Log Role Reprovisioning and Changes
Compliance: Document Logs for Future Reviews
End Transfer/Promotion Process

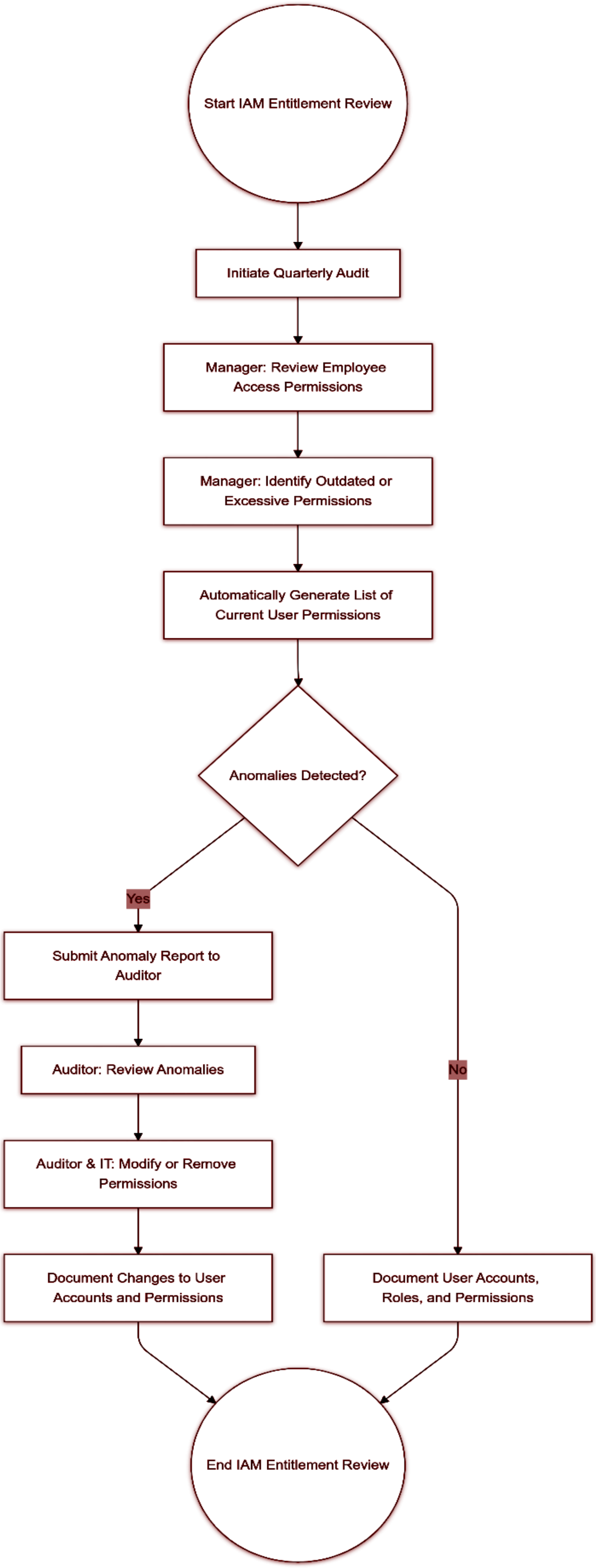
Offboarding

During Offboarding the manager must remove all access the employee has a promptly replace the employee in any ongoing project or any upcoming one. The IT department has to permanently revoke permissions and delete or archive accounts after a specified period of time and inform HR about offboarding. Payroll needs to be updated and on the last working day employee needs to hand over all equipment provided by the organization which needs to be updated into the inventory after transferring any necessary data email IDs or files relevant to the managers(What Is “User Account Offboarding”? n.d.). Security clearance must be verified and sanctioned. The compliance auditor would need to verify that all access is revoked along with information about their roles and access privileges and should be documented for future reviews.


Start
Manager: Identify Offboarding Trigger
Manager: Revoke Project Access
Manager: Reassign Tasks
Manager: Notify IT Department
IT Dept: Revoke System Access
IT Dept: Delete/Archive Accounts
IT Dept: Notify HR of Access Revocation
HR: Update Payroll Records
HR: Confirm IT Revocation
Payroll: Finalize Compensation
Employee: Return Company Equipment
IT Dept: Update Inventory Records
Security: Verify and Revoke Clearance
Compliance: Verify Offboarding Process
Compliance: Document Access Revocation
End

IAM Entitlement Reviews and Approvals

Companies can choose a specific timeline for example every quarter, they should conduct an audit to verify their security standards and protocols comply with company policies. Managers must review employee access identify outdated or excessive permissions and automatically generate a list of current user permissions. If any anomaly is found, submit requests to the auditor who in turn will work with the IT department to modify or remove unnecessary permissions, Finally, document details of all user accounts, along with information about their roles and access privileges(User Access Reviews: Process & Best Practices Checklist, n.d.).


Start IAM Entitlement Review
Initiate Quarterly Audit
Manager: Review Employee Access Permissions
Manager: Identify Outdated or Excessive Permissions
Automatically Generate List of Current User Permissions
Anomalies Detected?
Yes
Submit Anomaly Report to Auditor
Auditor: Review Anomalies
Auditor & IT: Modify or Remove Permissions
Document Changes to User Accounts and Permissions
No
Document User Accounts, Roles, and Permissions
End IAM Entitlement Review

Authentication Back-End

OmniCommerce Solutions is dynamic as an e-commerce platform hence to ensure that high standards of reliability, customer satisfaction and operational efficiency are maintained this platform focuses on enhancing and widening its expansion by leveraging technology for fast secure and user-friendly services in order to do so it is essential to adapt authentication mechanisms. Different authentication mechanisms will first be reviewed and the most suitable and adaptable mechanism will be suggested for the company's benefit to ensure customer data is safeguarded, building trust and enhancing the platform's overall security posture.

New Technology LAN Manager(NTLM)

NTLM is a challenge-response authentication Protocol that essentially is used to authenticate client messages and ensure integrity within. This protocol primarily verifies access and security of the systems through access provision channels. NTLM authentication is a protocol that consists of Windows Msv1_0.dll. Other NTLM authentication protocols include LAN Manager versions 1 and 2 and NTLM versions 1 and 2. NTLM protocols are embedded in applications. The caller sends parameters to NTLM, which then replies with an authentication method that the caller would use in its messages that are to be used for transmission(NTLM, 2023).

This protocol is essential for authenticating users and systems by verifying the server and domain controller. It ensures secure communication channels are utilized, with users aware of the passwords associated with their accounts. Whenever a new access token is required, the resource server must verify the identity of the computer or user. This involves contacting the domain authentication service on the domain controller associated with the computer's or user's domain account, if applicable.

Authentication is ensured in three major steps as follows:

NEGOTIATE_MSG: To begin the communication client sends the message
(Request) to the server to access the service. In this message, the client specifies its supported NTLM options to the server.

CHALLENGE_MSG (Server to Client): This message is sent by the server to the client to challenge the client to prove their identity. This message is generated by the server in response to the client's negotiated message.

AUTHENTICATE _MSG (Client to Server): This message is sent from client to server in response to the challenge given by the server.(Bhandari et al., 2014).

NTLM comes with its own set of strengths and weaknesses. NTLM's greatest strength lies in its connection-less authentication. A user can use the authentication without a connection to the domain controller this is extremely helpful in places that consist of limited network infrastructure. following this NTLM can also authenticate the identity of the server it is targeting without even having any background about the source this aspect is essentially helpful when it comes to diverse network configurations. Provides benefits by preventing the sharing of passwords over the network and also is beneficial because it provides service by integrating other protocols and aids in file sharing. Further, it is considered compatible with Linux and permits, Linux to use NTLM proxies through tools like CNTLM and NTLM Authorization Proxy Server (APS). NTLM allows users to access network resources such as shared folders or printers without repeated credential prompts; a convenience that comes with security trade-offs. This helps the integrity of communications and data within companies. It is a great way for companies that are small-scale working on expansions or startups whose majority workforce and revenue is dependent on online sales and for those companies who majorly run business as online storefronts. However, NTLMv1 hashes are always the same length and are not salted, making them easy to crack. NTLM only verifies one way that is it only consists of a one-way authentication feature which means the client can verify the identity of the server but the server cannot identify the identity of the client hence it lacks mutual authentication. NTLM's one-way authentication process allows attackers to impersonate a server and intercept or alter communications between the client and the server. Then there is another form of security risk called the NTLM relay attacks that occurs since attackers can intercept authentication traffic between a client and a server and redirect the user's credentials to a different server they control (Yoad Dvir, 2024). The use of weaker algorithms, such as MD4 and DES, makes NTLM hashes make way for further attacks, especially creating the vulnerability to brute-force attacks. Then there is another form of security risk called the NTLM relay attacks that occurs since attackers can intercept authentication traffic between a client and a server and redirect the user's credentials to a different server they control (Yoad Dvir, 2024)

KERBEROS

Kerberos is a computer network authentication protocol that uses trusted third-party and secret-key cryptography to verify user identities and authenticate client-server applications(Bhandari et al, 2014).

This application is developed to provide an authentication service and at the same time ensure integrity and confidentiality of the data that is exchanged between the client and the server. This application allows a processor to run itself on behalf of a user and prove the identity to the verifier without actually sending any real data across the network which might allow an attacker or an impersonator to take advantage. Kerberos ticket is issued by an authentication server and encrypted using the service key and the Kerberos ticket is used to distribute it to the verifier. The Kerberos ticket is a certificate issued by an authentication server and encrypted using the server key. Initially, a client presents its identity to the server using the ticket, which contains the principal, authenticator, and service principal. Issuing of tickets is provided by the Key Distribution Center (KDC). The KDC Stores the secret keys of clients and servers in the Database. These keys serve the client and server for the authenticity of the tickets they receive. It is important to note that a ticket's lifetime is limited, i.e., it eventually expires(Neuman & Ts'o, 1994). The ultimate strength of Kerberos lies in the keys used for encryption are never transmitted across the network, reducing the chance of interception. The interoperability feature supports different types of systems and platforms, including Windows, Unix, and Linux. (Hill, n.d.). the single sign-on capability helps users authenticate only once and gain access to various services thereby reducing the issue of password fatigue that leads users to adopt insecure practices due to an overload of passwords(Kerberos Authentication Protocol - Article, 2024). Kerberos allows employees the ease to remember only a single password allowing them to gain access to the company services the same time providing safety by ensuring the safe passage of data and facilitating viable communication between client and user. Kerberos also plays a critical role by preventing replay and man-in-the-middle attacks. It encrypts all authentication exchanges, ensuring secure communication and protecting against unauthorized access within the network. However, Kerberos was initially designed for use within a single domain so establishing cross-realm trust relationships between different administrative domains will be complex to set up and manage it is a challenge to integrate systems and services that do not support this application. Another issue is if KDC becomes compromised since Kerberos security depends heavily on KDC, the entire authentication system will get disrupted and cause issues in maintaining and streamlining uninterrupted workflow.

Roasting is a form of attack Kerberos is exposed to, where the attacker creates a duplicate of a Kerberos ticket-granting ticket (TGT) using credentials that have been compromised, with this fake TGT, the attacker can impersonate any user in the domain, second being Kerberoasting, the attacks work by leveraging the Kerberos authentication to perform a variety of tasks such as Scan Active Directory (AD) for users with a Service Principal Name (SPN), a unique identifier that helps to authenticate that user into a specific account. Post which the attacker can also move laterally within the network unchecked, request, extract tickets and decrypt them for password information and steal other critical data(Harmj0y – Harmj0y, 2014)

Lightweight Directory Access Protocol (LDAP)

The Lightweight Directory Access Protocol (LDAP) is a vendor-neutral software protocol that is used to look for information or devices within a network; it is a protocol that helps users find data about organisations, persons, etc. LDAP has two main goals: to store data in the LDAP directory and authenticate users to access the directory, it is designed to deliver fast READ performance. LDAP is majorly designed to build central authentication servers. These servers contain usernames and passwords for all the users within a network. Applications irrespective of their types and services can connect to the LDAP server to authenticate and authorise users.

Connecting an LDAP directory is required for completing a request, there is a certain process involved initially first by establishing a secure connection which is essential for a user and prior to which the user should have pre-installed the LDAP client on the device that they're using. Client is required that they establish a secure connection with LDAP directory by using services that are secure sockets layer or transport layer by submitting a query. The query submitted to an application for performing actions is accessed the client and sends the users distinguished name and password to the LDAP directory server for authentication after authenticating and authorizing the user the director decides and determines that the user has credible credentials and then identifies the user group that requires the permission and provides access for performing the functions. After the query is considered complete, the directory returns information to the user, providing the necessary service that was requested.

Hence ending the session, the user disconnects from the LDAP directory and the session ends(Lightweight Directory Access Protocol (LDAP), 2019). LDAP helps backup critical files when you install other security extensions along with using this protocol(What Is LDAP and How Does It Benefit Your Business? 2022). LDAP also verifies the identity of the person who is requesting information this method provides a foundational level of security and it also helps in eliminating a layer of access management and ensures that there is an enhancement in encryption security for the company's and organisation's safety. LDAP enables organisations to store, manage, and secure information about the organisation, its users, and assets–like usernames and passwords. This helps reduce the complexity of storage access by providing structural segmentation of information, and it can be extremely useful for corporations, and startups as they grow and acquire more user data and assets. LDAP also functions as an identity and access management (IAM) for ensuring the company's internal security solution that targets user authentication, supports Kerberos, single sign-on (SSO), Simple Authentication Security Layer (SASL), and Secure Sockets Layer (SSL)(What Is Lightweight Directory Access Protocol (LDAP) Authentication? 2022). However, The application isn't secure enough to be touching credentials and despite this flaw, The LDAP server cannot enforce the security of the authentication mechanism used to obtain the credentials. Further, an application using LDAP for authentication will forever be limited to usernames and passwords(link et al., 2018). Considering the weakness possessed by LDAP there is a major security risk called LDAP injection which is a type of attack where code is injected through a web application in order to access sensitive information in an LDAP directory. The injected code is said to consist of LDAP metacharacters that perform the function of modifying legitimate requests from LDAP clients to achieve malicious objectives. The repercussions resulting in this injection attack include data breach, user privilege escalation, or account hijacking. This attack is orchestrated by attackers when servers do not validate the legitimacy of LDAP client requests, which allows uninterrupted access to cyber attackers for liberal communication within the LDAP servers(What Is LDAP? How It Works, Uses and Security Risks in 2022 | UpGuard, n.d.)

In conclusion, considering the analysis drafted above, Kerberos and LDAP work together to create a foundationally strong system for managing authentication and directory services in OmniCommerce Solutions . Kerberos is a secure authentication tool that verifies users identities and keeps data safe during communication. By allowing users to log in with a single password, it makes access simple and secure, ensuring that sensitive information is protected. While, LDAP helps organize and manage directory information, such as user accounts, roles, and permissions. It provides an easy way to keep track of users and control access, making it simpler to handle a growing number of users and services. Incorporating both authentication methods together, Kerberos and LDAP provide a complete secure mechanism that combines secure user authentication with efficient directory management. This ensures the organisation is able to grow with the business, while offering a smooth experience for both users and administrators.

Architectural Security Models and Best Practices

Zero Trust Architecture (ZTA)

OmniCommerce Solutions company is focused on providing a commitment to safeguarding their data and information through advanced security. recognizing the growing complexity of cyber threats, OmniCommerce Solutions should incorporate the Zero Trust Architecture (ZTA) as a cornerstone of its cybersecurity strategy. Zero Trust operates on the principle of "never trust, always verify," ensuring that no user, device, or application is inherently trusted, whether inside or outside the organization's network.

Authentication is a positive approach towards security and is built into every step of access theatre internal or external(Qazi, 2022). Zero-Trust mandates strict authentication and authorization processes. Users and devices must be continuously verified through multifactor authentication (MFA), with access granted on a need-to-know basis. This limits the potential damage caused by compromised credentials or insider threats. (Gargan, 2024). Zero Trust is built on several key principles to enhance security. First, it assumes that threats can exist even within the organization, so no implicit trust is given to any internal region. Security policies are enforced at all times, including during asset migration, ensuring continuous compliance.

Further, the model assumes that local network connections are untrustworthy, even for remote users and devices, emphasizing the need for secure communication. Access controls are applied dynamically based on factors like device status, user roles, and potential risks, allowing flexibility without compromising security. Finally, advanced analytics, such as User and Entity Behavior Analytics (UEBA), help monitor and analyze behaviour patterns to detect unusual or suspicious activities, providing an additional layer of protection (Dhiman et al., 2024). As per the National Institute of Standards and Technology (NIST) report on Zero Trust Architecture, ZTA is not a single network architecture which can be achieved using just one technology et al. (2020). Rather, ZTA comprises various guiding principles that need to be strategically implemented to secure enterprise assets such as data, devices, users and other components of infrastructure. The key principles for achieving ZTA are authentication and access control, as these are the means by which the user's identity is established and privileges ascertained for the conduct of different operations involving protected resource(s). For implementing ZTA in a critical infrastructure context, a strong authentication scheme which identifies both users and devices is required (Syed et al., 2022).

Key principles of Zero Trust include:

Verify Explicitly: Authentication and authorization are required for every access request based on all available data points, such as user identity, location, device status, and the sensitivity of the resource being accessed.

Least-Privilege Access: Access is limited to only what is necessary for a user or device to perform its function, reducing exposure to sensitive resources.

Assume Breach: Zero Trust assumes that a breach has already occurred or could happen, so the security approach focuses on minimizing potential damage and lateral movement within the network.

Organizations adopt Zero Trust to protect against evolving threats, ensure compliance with regulations, and secure hybrid and remote work environments. Hence Zero Trust, not only enhances security but also supports a flexible and scalable infrastructure Architecture. Through this, the organisation protects its critical assets, enforces strict access controls, and leverages advanced analytics to detect and respond to threats in real-time. OmniCommerce Solutions will be able to maintain its resilience and integrity of organisational data and customer information through the highest standards of security.

Public Key Infrastructure (PKI) and Certificate Management

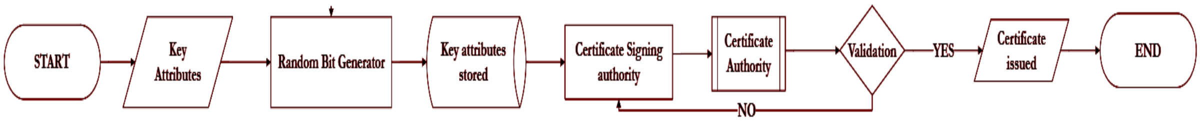
Key Generation

The key is created through key management by utilising a hardware security model process that involves generating the key for the output of a cryptographically secure random bit generator, another way to generate the key would be to derive it from another already existing key. Derivation of this new key could also be done from a password and key agreement performed by two entities using an approved key agreement scheme(Barker et al., 2020). According to the federal government, two admissible cryptographic keys have been identified, i.e., symmetric and asymmetric keys (Barker & Roginsky, 2018). The elliptic curve cryptography (ECC) is normally used for smaller key sizes and better performance.

Provisioning

Once a key has been created the database will store the key and its attributes. Attributes of the key may include name, date, activation size etc. Each key would have its strength usually measured in bits and is capable enough to protect throughout its lifetime.

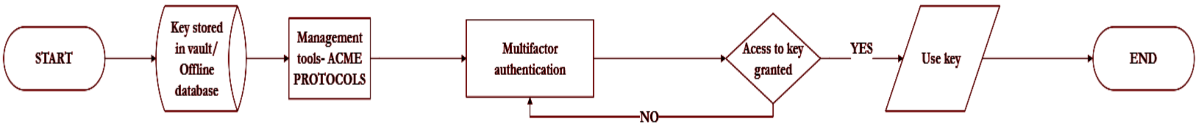
With the help of the generated key a CSR - Certificate Signing Request is generated as well - it is passed on to a Certificate Authority(CA), who then validates the resource for which the certificate was requested belongs to the owner, the CA finally provides a certificate, signed by them, which identifies the public key, and the resource it is authenticated for.



Monitoring

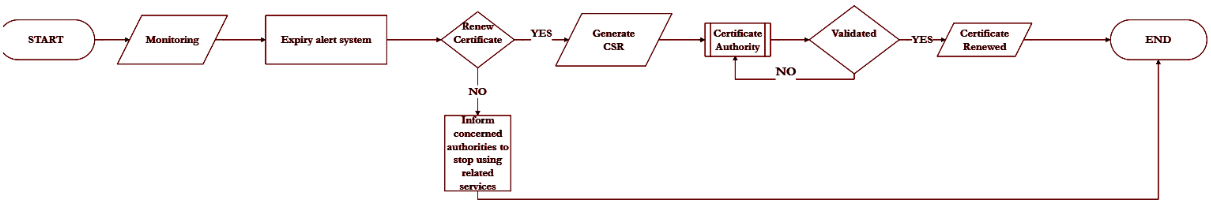
Once the key is generated and the certificate has been issued it is very crucial to ensure the safety of keys from unauthorised access, typically this process is considered key management (Furtak, 2020), in this regard we can adopt the hardware security module which is a device that protects keys in a tamper-resistant vault, separate from the network or Encrypt keys using Key Encryption Keys (KEKs) before storing them in offline devices or databases as well as utilising secure storage API'S. Security can also be implemented by ensuring that only authenticated and authorised users or machines use keys to encrypt or decrypt the data.

Key management would include multi-factor authentication (MFA) for key and certificate access to improve security and ensure a proper balance between key lifetime and strength. According to NIST SP 800-57 Part 1, the hash function may be used to provide security services. Robust hash functions like SHA-256 or SHA-3NIST protect to prevent data integrity loss. (Special Publications (SP) 800-56A, 800-56B, 800-56C and 800-108).


START
Key stored in vault/ Offline database
Management tools- ACME PROTOCOLS
Multifactor authentication
Acess to key granted
YES
NO
Use key
END

Management

Please need to be regularly managed and monitored for the expiration of the issued certificates to ensure that downtime is prevented. To ensure that the certificate has not expired administrators can enable an automated alert system through which they are notified nearing the date of expiry of the key. Through the ACME protocol, users can also automate certificate lifecycle management communications between the CA and the organisation's servers. Before a certificate expires, a renewal process may be initiated. The CA will issue a new certificate with the same public key. This process may be done by generating a new CSR that needs to be sent over to the CA for authenticating the ownership as done in the first round and once it is validated a new certificate is issued, mostly using the same public key unless it's a case where key renewal is also necessary.



Revocation

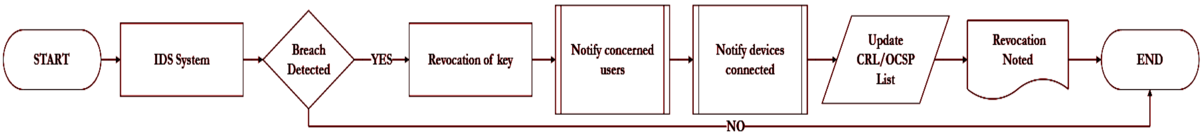
When a cryptographic key is either compromised or lost, it can be detected using an intrusion detection system. Once a key is revoked, its status is clearly communicated to the users. They are informed that the key can no longer be used for encrypting or decrypting messages or verifying digital signatures. Additionally, notifications are sent to any devices or applications linked to the certificate to ensure they stop using or associating with it immediately.

The Certificate Authority (CA) plays a crucial role in this process by updating the Certificate Revocation List (CRL). This list acts as a record of compromised or untrustworthy certificates, ensuring that everyone knows these certificates are no longer valid. The CRL helps maintain trust in secure communication by flagging certificates that should not be used.

An alternative to the CRL is the Online Certificate Status Protocol (OCSP). This protocol allows systems to check in real time whether a digital certificate is still valid or if it has been revoked. This entire process of managing revoked certificates and ensuring they are not used is commonly referred to as blacklist management.

Decommissioning

After a certificate has expired and is no longer needed for use or when a breach has occurred and the certificate was revoked, the key that was issued by the certificate authority needs to mandatorily be destroyed to mitigate any threats or risks this process is called decommissioning. After destroying the keys it is necessary to document the proof of deletion to comply with standards for compliance and auditing and important for meeting regulations set by PCI DSS and GDPR.



Alignment with Industry Best Practices

The above-mentioned cryptographic key lifecycle has been chalked out to ensure that it aligns and complies in terms of security and operational efficiency according to the NIST SP 800-57 (Guiding how organizations should manage cryptographic keys) and NIST SP 800-130 (Providing a Framework for Designing Cryptographic Key Management). It focuses on the safety and integrity of the key that is maintained by using hash functions as well as incorporating continuous monitoring of secure key storage and revocation procedures to ensure a physically secure environment for storing private keys and protecting them from unauthorized access and tampering. This lifecycle is also drafted keeping in mind that it can be utilised globally in compliance with the regulations laid down by the General Data Protection Regulation law.

Data and Software Security Measures

Business Operation 1: Customer and Employee Data Management

Employee Data	**Customer Data**
Contact	Contact
Residence	Residence
Social Security Number	Email
Tax Information	Login Password/Username
Bank Account details	Browsing preferences

Performance records	

	Data at Rest	**Data in Transit**	**Data in use**
Risk	Unauthorized access to stored personal data	Apply role-based access control (RBAC); monitor user activity	Unauthorized access to stored personal data
Control	Unauthorized access to stored personal data	Apply role-based access control (RBAC); monitor user activity	Apply role-based access control (RBAC); monitor user activity

Business Operation 2: Supply Chain Operations and Online Storefront

Supply Chain Data	**Customer Data**
Inventory levels	Transaction information
Production levels	Payment information
Order Status	Billing shipping information

Financial information	Item level data
Sales numbers	Contact information

	Data at Rest	**Data in Transit**	**Data in use**
Risk	Order information intercepted during transfers	Order information intercepted during transfers	Insider fraud or system manipulation
Control	Encrypt supply chain databases with AES-256	Apply TLS encryption and secure APIs	Use RBAC and audit logs for activity tracking

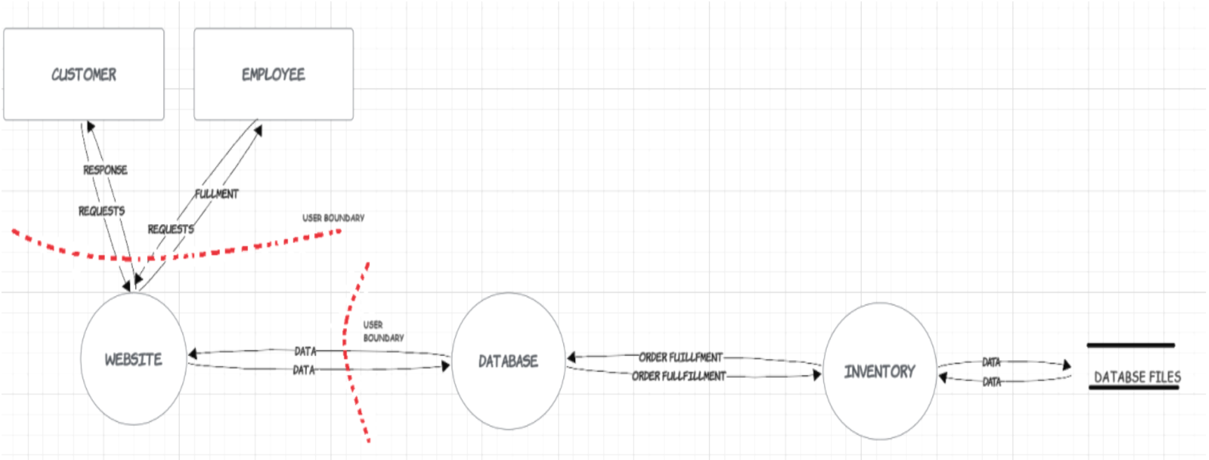
Business Operation 3: Marketing and Communication

Marketing	**Customer Communication**

Product	Customer feedback
Price	Customer service - Complaints/ Returns/ Refunds
Web analytics - visitors, sessions, clicks, engagements, downloads, purchases, form	Customer Tie Ups

	Data at Rest	**Data in Transit**	**Data in use**
Risk	Order information intercepted during transfers	Order information intercepted during transfers	Insider fraud or system manipulation
Control	Encrypt supply chain databases with AES-256	Apply TLS encryption and secure APIs	Use RBAC and audit logs for activity tracking

Since the entire business runs on an online platform, there is a crucial need to maintain the security and integrity of the company. The company has multiple business processes involved in ensuring its success, this paper will focus on and analyse one such process - Order Processing and Fulfilment(Order Fulfillment Process: Definition and 7 Key Steps, 2024). The process begins with retaining customer information in the company database followed by a secure payment gateway, and delivery logistics, and finally ends with ensuring customer satisfaction(Lisa Schwarz, 2020).



Trust Boundary	**STRIDE Category**	**Threat Identified**	**Weakness/Vulnerability**	**Mitigation Control**
Checkout page ↔ Customer details	Information Disclosure	Customer details exposed	Unencrypted data transmission, excessive access	Utilising end-to-end encryption, RBAC, Least privilege principle, Masking data

Checkout Page ↔ Payment Gateway	Spoofing	Attacker disguises to claim payment details	Secure payment gateways use authentication methods	(PCI DSS) compliance and implementing secure electronic transactions
Order Processing System ↔ Database	Tampering	The attacker tampers with order details and makes changes	Lack of encryption, absence of access control, database corruption	Constant monitoring of logs, RBAC, and Least privilege principle.
	Denial Of Service	The attacker prevents the processing of the order	Lack of security controls in server and database.	Monitor threats in real-time and limit network traffic
Order Processing System ↔ Warehouse System	Information Disclosure	Customer details exposed	Unencrypted data transmission, excessive access	Utilising end-to-end encryption, RBAC, Zero Trust principle

Order Management System ↔ Delivery	Spoofing	Impersonate delivery partner	Identify verification failure	User authentication systems, PCI DSS Compliance
	Elevation of Privilege	Leak customer addresses and delivery details	Lack of secure access controls	Masking data, RBAC, Least privilege principle
	Denial of Service (DoS)	Prevents delivery of products	Lack of security controls in server and database.	Monitor threats in real-time and limit network traffic
Customer Service Portal ↔ Customer Support	Customer fraud/ Repudiation	Customer denies receiving the product, raises fake complaints	Failure to document proper delivery and item information	Proper documentation, auditing, and customer query logs maintained

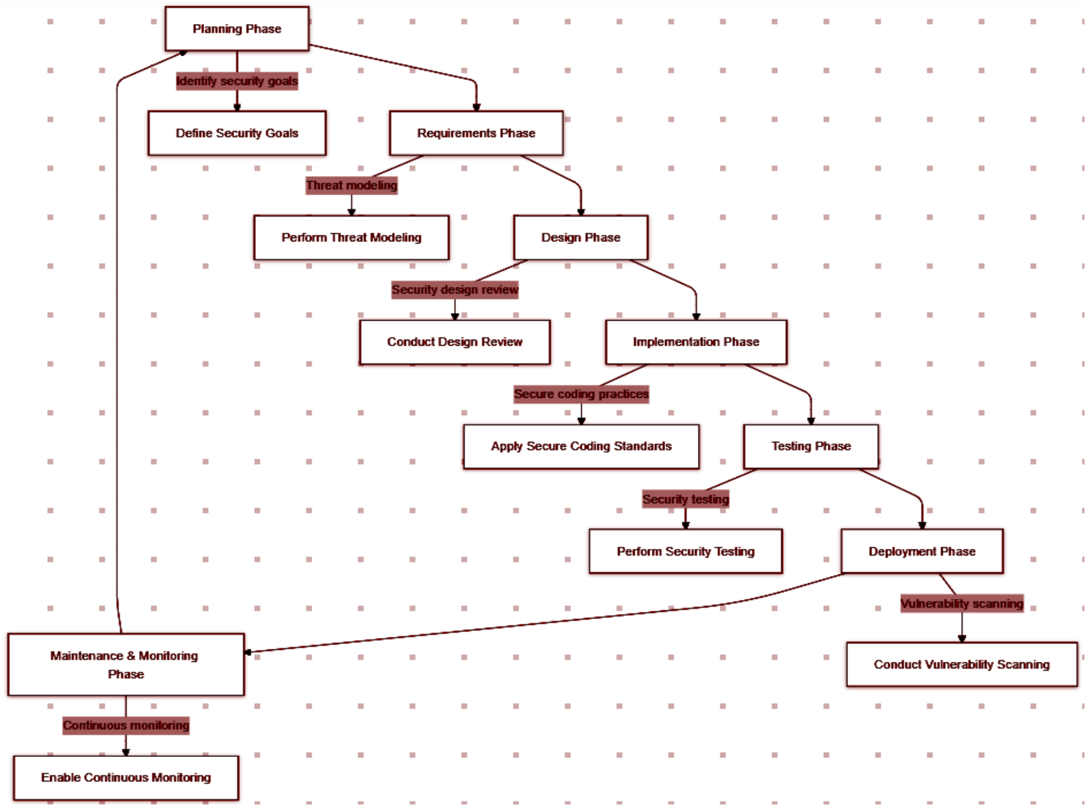
Compliance

In order to ensure OmniCommerce Solutions works efficiently and maintains standards of protection not only for themselves but also for their customers it is crucial to be compliant with standards such as PCI-DSS, NIST SP 800-57, and NIST SP 800-171.

For PCI-DSS compliance, role-based access control (RBAC) should be enforced. Multi-factor authentication may be utilized for accessing the system by employees that handle particularly cardholder data and access privileges should be audited by compliance officers at regular intervals of time.

For NIST SP 800-57 compliance Strict Key Management policy should be enforced with regard to its storage rotation and destruction access to the keys should be limited within the workforce principle of least privilege and zero trust should be ensured accessing monitoring should be implemented to detect unauthorized attempts and access should be promptly revoked when employees change rules or exit the company.

Secure Software Development Lifecycle (SSDLC)



Best Practices

Best practices for secure software development life cycle involves planning through which dell defined security goals and requirements and assigning roles and responsibilities must be incorporated. Additionally there is a requirement for conducting threat modeling to identify potential vulnerabilities and establishing security focused management. On the design aspect, there needs to be security design reviews by applying principles like least privilege defense in depth and zero trust architecture. At the implementation stage, compliance requirements must be established security testing tools can be utilized code reviews for security flaws need to be mandated and secure coding guidelines such as the OWASP, SANS CWE needs to be adapted.

Security Recommendations

In the security aspect, the organization can adapt and utilize tools such as intrusion detection system security information and event management solutions to monitor threats. Security assessments, regular penetration testing, security audits and immediate patch management along with updating vulnerability databases and ensuring automated scanning tools at all times ensures security and smooth efficient functioning of the organizations workforce.By integrating these best practices into each phase, the company can be rest assured that security is not an afterthought but a core component of the development lifecycle.

Cloud Security Management

Cloud Security Roles, Responsibilities, and Compliance

Cloud computing accesses IT infrastructure through a computer network facilitating the delivery of various computing resources over the Internet. Cloud Computing assets include devices and applications such as data storage, servers, data sets, systems management, and programming. Cloud Computing enables the delivery of resources like storage processing power and databases over the internet. This is an information technology service in which hardware and software are given to consumers on demand across a network without the use of a device or location(Singh, 2021). The National Institute of Standards and Technology (NIST) characterises cloud computing as "Cloud computing is a model for empowering helpful, on-request network admittance to a common pool of configurable computing assets that can be quickly provisioned and delivered with negligible administration exertion or service supplier connection"(Singh, 2021)

It is a set of network-enabled services that offer scalable, guaranteed, typically customised, relatively affordable services in an easy-to-use manner(Uzoma & Okhuoya, 2022).

They are of the following types as given below:

Private Cloud: Gives its services to a single client and remains available only to that particular client.

Public Cloud: This form of cloud is primarily used to provide public access whose ownership can't be claimed by a particular user.

Hybrid Cloud: This cloud type combines the facilities provided by a private cloud and a public cloud together.

Furthermore, cloud computing is classified on the basis of the services it provides:

Software as a Service(SaaS): Provides services to clients on a subscription basis.
clients. Licences are typically granted on a pay-as-you-go or on-request basis. To achieve economies of scale and optimisation, maintenance, and security, users of the applications of various cloud consumers are grouped on the SaaS cloud in a single logical environment. (Uzoma & Okhuoya, 2022)

Platform as a Service(PaaS): This cloud platform is developed in such a way that customers may pay money as and when they need the cloud service and use it according to their consumption. (IBM, 2023)

Infrastructure as a service (IaaS): Provides clients with computing and storage services such as processing, storage, and networks.

Data storage as service (DaaS): Provides the facility to users to access virtual desktops over the internet. The virtual environment could files, folders, operation systems and user preferences. (Uzoma & Okhuoya, 2022)

Five essential characteristics of cloud computing include its on-demand self-service, which provides users with computing capacities without external engagement. Cloud also possesses broad network access, which allows users to access any data from any location. Then comes resource pooling, which allows multiple users to utilise the same physical assets. Computer assets are pooled in the multitenant model to provide support to a large number of buyers(Singh, 2021).

Cloud Security Roles

Role	Responsibilities
Cloud administrator	Responsible for User access and configurations within the cloud.
System owner	Conducts regular security audits ensuring compliance.
Compliance officer	Ensuring regulations are complied with such as CCPA, GDPR, CMMC, FEDRamp and PCI-DSS
Cloud Security Auditor	Conducting regular Audits and ensuring prompt documentation

End-User	Follows security guidelines and policies; reports any suspicious activity.

Responsibilities

The National Security Agency (NSA) outlines 10 Risk Mitigation Strategies for improving cloud security. The first strategy is to "Uphold the Cloud Shared Responsibility Model." This strategy highlights the importance of understanding who is responsible for what in cloud environments, focusing on the division of responsibilities between the cloud service provider (CSP) and the customer. The CSP is responsible for managing the cloud infrastructure. This includes maintaining and securing the hardware, operating systems, networking components, and platform software. CSPs typically offer automated tools, software-defined services, and interfaces, making it easier for customers to operate within the cloud securely. However, cloud security isn't just the provider's job; it's a shared responsibility. Both the CSP and the customer must work together to keep their cloud environments safe and secure. Customers play a significant role in this shared model. They are responsible for protecting their data, controlling access permissions, and ensuring they are aware of the information they share with their CSP. Sometimes, CSPs may need access to customer data for specific purposes. In such cases, customers should always review and audit the type of data they authorize the CSP to access. This helps ensure that no sensitive information is inadvertently exposed. Further, customers who use multiple cloud environments (known as multi-cloud) should be cautious about managing permissions. Since each cloud provider might have different security protocols and rely on different third-party auditors for their safety measures, customers need to understand these variations. Proper oversight of permissions helps prevent security gaps and unauthorized access.

Finally, when deploying applications in the cloud, customers should follow the principles of “secure by design” and “secure by default.” This means ensuring that applications are built with strong security measures from the start and configured with default settings that prioritize security. By doing so, customers can reduce vulnerabilities and strengthen their overall cloud security posture. The NSA emphasizes that maintaining security in cloud environments is an ongoing effort that requires collaboration, vigilance, and careful management by both the cloud provider and the customer (NSA Releases Top Ten Cloud Security Mitigation Strategies, n.d.). To ensure the safety of the cloud customers could adopt certain measures starting with Incident response - Customer needs to be well prepared and must educate themselves with their CSP's incident response procedure and have a playbook ready in hand. They must actively hunt for intrusions in the cloud, every client or organisation must have a strong cyber defence equipped who would be in charge of looking for threats and vulnerabilities and initiate protection protocol upon review (NSA Releases Top Ten Cloud Security Mitigation Strategies, n.d.).

Compliance

SaaS (Software as a Service), PaaS (Platform as a Service) comply with ISO 27017 which provides guidelines for implementing information security controls specific to cloud environments. SaaS, PaaS, IaaS provides compliance in accordance to FedRAMP which focuses on a standardized security framework for federal agencies adopting cloud services, emphasizing the shared security responsibility model. Aligning with ISO 27017 and FedRAMP ensures clarity in responsibilities, reduces security gaps, and supports a secure and compliant cloud environment.

Summary & Recommendations

OmniCommerce Solutions (OCS) is undertaking a significant digital transformation to enhance its competitiveness in local markets and expand internationally, it is imperative that the organization builds a secure eCommerce platform. Keeping this in mind to support the transformation a comprehensive cyber security strategy has been recommended throughout the report with the focus on identity and access management, secure authentication, zero trust architecture, least privilege principles, public key infrastructure, data protection secure software development life cycle and cloud security management. Initially in the report comparisons between the ISO and the NIST framework has been drawn andconcluded that in terms of adaptability and scaling of the organization NIST framework is most suitable. Moving ahead, for the sake of strong governance and oversight support for compliance role based accountability and effective security management, a governance model with roles such as Chief Information Security Officer (CISO), Security Auditor, and other key stakeholders has been proposed. Well defined practices for enforcing segregation of duties, including regular audits and policy enforcement have been suggested. Further a high-level IAM strategy that includes identity lifecycle management and an entitlement review process has been drafted that needs to be incorporated into the organisation. A Zero Trust model highlighting key ZTA principles - least privilege access, continuous verification, and
network segmentation alongside which, a PKI and certificate management process for secure communication and data integrity has been explained for the organisation to adapt and implement. Enhanced data protection strategies, secure development practices have also been incorporated into the report. Lastly focus is drawn on defining cloud security roles, responsibilities, and practices for SaaS, PaaS, and IaaS models, with recommendation on least privilege access and compliance with standards such as ISO 27017 and FedRAMP has been ensured. The strategic implementation of these security measures will help mitigate risks, improve operational efficiency, and enable OCS to successfully expand their market base

both locally and internationally, while maintaining compliance with relevant data protection standards.

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