[Unit 4: Security in Cloud Computing]

Cloud Computing (CSC-458)

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Cloud Security Challenges:

Software as a Service Security:

The seven security issues which one should discuss with a cloud-computing vendor:

1. **Privileged user access** —inquire about who has specialized access to data, and about the hiring and management of such administrators.
2. **Regulatory compliance**—make sure that the vendor is willing to undergo external audits and/or security certifications.
3. **Data location**—does the provider allow for any control over the location of data?
4. **Data segregation** —make sure that encryption is available at all stages, and that these encryption schemes were designed and tested by experienced professionals.
5. **Recovery** —Find out what will happen to data in the case of a disaster. Do they offer complete restoration? If so, how long would that take?
6. **Investigative support** —Does the vendor have the ability to investigate any inappropriate or illegal activity?
7. **Long-term viability** —What will happen to data if the company goes out of business? How will data be returned, and in what format?

To address the security issues listed above, SaaS providers will need to incorporate and enhance security practices used by the managed service providers and develop new ones as the cloud computing environment evolves. The baseline security practices for the SaaS environment as currently formulated are discussed in the following sections.

- Security Management (People): One of the most important actions for a security team is to develop a formal charter for the security organization and program. This will foster a shared vision among the team of what security leadership is driving toward and expects, and will also foster “ownership” in the success of the collective team. The charter should be aligned with the strategic plan of the organization or company the security team works for. Lack of clearly defined roles and responsibilities, and agreement on expectations, can result in a general feeling of loss and confusion among the security team about what is expected of them, how their skills and experienced can be leveraged, and meeting their

performance goals. Morale among the team and pride in the team is lowered, and security suffers as a result.

- **Security Governance:** A security steering committee should be developed whose objective is to focus on providing guidance about security initiatives and alignment with business and IT strategies. A charter for the security team is typically one of the first deliverables from the steering committee. This charter must clearly define the roles and responsibilities of the security team and other groups involved in performing information security functions. Lack of a formalized strategy can lead to an unsustainable operating model and security level as it evolves. In addition, lack of attention to security governance can result in key needs of the business not being met, including but not limited to, risk management, security monitoring, application security, and sales support. Lack of proper governance and management of duties can also result in potential security risks being left unaddressed and opportunities to improve the business being missed because the security team is not focused on the key security functions and activities that are critical to the business.

- **Risk Management:** Effective risk management entails identification of technology assets; identification of data and its links to business processes, applications, and data stores; and assignment of ownership and custodial responsibilities. Actions should also include maintaining a repository of information assets. Owners have authority and accountability for information assets including protection requirements, and custodians implement confidentiality, integrity, availability, and privacy controls. A formal risk assessment process should be created that allocates security resources linked to business continuity.

- **Risk Assessment:** Security risk assessment is critical to helping the information security organization make informed decisions when balancing the dueling priorities of business utility and protection of assets. Lack of attention to completing formalized risk assessments can contribute to an increase in information security audit findings, can jeopardize certification goals, and can lead to inefficient and ineffective selection of security controls

that may not adequately mitigate information security risks to an acceptable level. A formal information security risk management process should proactively assess information security risks as well as plan and manage them on a periodic or as-needed basis. More detailed and technical security risk assessments in the form of threat modeling should also be applied to applications and infrastructure. Doing so can help the product management and engineering groups to be more proactive in designing and testing the security of applications and systems and to collaborate more closely with the internal security team. Threat modeling requires both IT and business process knowledge, as well as technical knowledge of how the applications or systems under review work.

- **Security Monitoring and Incident Response:** Centralized security information management systems should be used to provide notification of security vulnerabilities and to monitor systems continuously through automated technologies to identify potential issues. They should be integrated with network and other systems monitoring processes (e.g., security information management, security event management, security information and event management, and security operations centers that use these systems for dedicated 24/7/365 monitoring). Management of periodic, independent third-party security testing should also be included. Many of the security threats and issues in SaaS center around application and data layers, so the types and sophistication of threats and attacks for a SaaS organization require a different approach to security monitoring than traditional infrastructure and perimeter monitoring. The organization may thus need to expand its security monitoring capabilities to include application- and data-level activities. This may also require subject-matter experts in applications security and the unique aspects of maintaining privacy in the cloud. Without this capability and expertise, a company may be unable to detect and prevent security threats and attacks to its customer data and service stability.

- **Third-Party Risk Management:** As SaaS moves into cloud computing for the storage and processing of customer data, there is a higher expectation that the SaaS will effectively manage the security risks with third parties. Lack of a third-party risk management program may result in damage to the provider's reputation, revenue losses, and legal

actions should the provider be found not to have performed due diligence on its third-party vendors.

Security Architecture Design:

A security architecture framework should be established with consideration of processes (enterprise authentication and authorization, access control, confidentiality, integrity, non-repudiation, security management, etc.), operational procedures, technology specifications, people and organizational management, and security program compliance and reporting. A security architecture document should be developed that defines security and privacy principles to meet business objectives. Documentation is required for management controls and metrics specific to asset classification and control, physical security, system access controls, network and computer management, application development and maintenance, business continuity, and compliance. A design and implementation program should also be integrated with the formal system development life cycle to include a business case, requirements definition, design, and implementation plans. Technology and design methods should be included, as well as the security processes necessary to provide the following services across all technology layers:

1. Authentication
2. Authorization
3. Availability
4. Confidentiality
5. Integrity
6. Accountability
7. Privacy

The creation of a secure architecture provides the engineers, data center operations personnel, and network operations personnel a common blueprint to design, build, and test the security of the applications and systems. Design reviews of new changes can be better

assessed against this architecture to assure that they conform to the principles described in the architecture, allowing for more consistent and effective design reviews.

Vulnerability Assessment:

Vulnerability assessment classifies network assets to more efficiently prioritize vulnerability-mitigation programs, such as patching and system upgrading. It measures the effectiveness of risk mitigation by setting goals of reduced vulnerability exposure and faster mitigation. Vulnerability management should be integrated with discovery, patch management, and upgrade management processes to close vulnerabilities before they can be exploited.

Data Privacy:

A risk assessment and gap analysis of controls and procedures must be conducted. Based on this data, formal privacy processes and initiatives must be defined, managed, and sustained. As with security, privacy controls and protection must an element of the secure architecture design. Depending on the size of the organization and the scale of operations, either an individual or a team should be assigned and given responsibility for maintaining privacy. A member of the security team who is responsible for privacy or a corporate security compliance team should collaborate with the company legal team to address data privacy issues and concerns. As with security, a privacy steering committee should also be created to help make decisions related to data privacy. Typically, the security compliance team, if one even exists, will not have formalized training on data privacy, which will limit the ability of the organization to address adequately the data privacy issues they currently face and will be continually challenged on in the future. The answer is to hire a consultant in this area, hire a privacy expert, or have one of your existing team members trained properly. This will ensure that your organization is prepared to meet the data privacy demands of its customers and regulators.

For example, customer contractual requirements/agreements for data privacy must be adhered to, accurate inventories of customer data, where it is stored, who can access it, and how it is used must be known, and, though often overlooked, Request for Interest/Request

for Proposal questions regarding privacy must answered accurately. This requires special skills, training, and experience that do not typically exist within a security team. As companies move away from a service model under which they do not store customer data to one under which they do store customer data, the data privacy concerns of customers increase exponentially. This new service model pushes companies into the cloud computing space, where many companies do not have sufficient experience in dealing with customer privacy concerns, permanence of customer data throughout its globally distributed systems, cross-border data sharing, and compliance with regulatory or lawful intercept requirements.

Data Security:

The ultimate challenge in cloud computing is data-level security, and sensitive data is the domain of the enterprise, not the cloud computing provider. Security will need to move to the data level so that enterprises can be sure their data is protected wherever it goes. For example, with data-level security, the enterprise can specify that this data is not allowed to go outside of the United States. It can also force encryption of certain types of data, and permit only specified users to access the data. It can provide compliance with the Payment Card Industry Data Security Standard (PCI DSS). True unified end-to-end security in the cloud will likely requires an ecosystem of partners.

Application Security:

Application security is one of the critical success factors for a world-class SaaS company. This is where the security features and requirements are defined and application security test results are reviewed. Application security processes, secure coding guidelines, training, and testing scripts and tools are typically a collaborative effort between the security and the development teams. Although product engineering will likely focus on the application layer, the security design of the application itself, and the infrastructure layers interacting with the application, the security team should provide the security requirements for the product development engineers to implement. This should be a collaborative effort between the security and product development team. External penetration testers are used for application source code reviews, and attack and penetration tests provide an objective

review of the security of the application as well as assurance to customers that attack and penetration tests are performed regularly. Fragmented and undefined collaboration on application security can result in lower-quality design, coding efforts, and testing results.

Virtual Machine Security:

In the cloud environment, physical servers are consolidated to multiple virtual machine instances on virtualized servers. Not only can data center security teams replicate typical security controls for the data center at large to secure the virtual machines, they can also advise their customers on how to prepare these machines for migration to a cloud environment when appropriate.

Firewalls, intrusion detection and prevention, integrity monitoring, and log inspection can all be deployed as software on virtual machines to increase protection and maintain compliance integrity of servers and applications as virtual resources move from on-premises to public cloud environments. By deploying this traditional line of defense to the virtual machine itself, you can enable critical applications and data to be moved to the cloud securely. To facilitate the centralized management of a server firewall policy, the security software loaded onto a virtual machine should include a bidirectional stateful firewall that enables virtual machine isolation and location awareness, thereby enabling a tightened policy and the flexibility to move the virtual machine from on-premises to cloud resources. Integrity monitoring and log inspection software must be applied at the virtual machine level.

This approach to virtual machine security, which connects the machine back to the mother ship, has some advantages in that the security software can be put into a single software agent that provides for consistent control and management throughout the cloud while integrating seamlessly back into existing security infrastructure investments, providing economies of scale, deployment, and cost savings for both the service provider and the enterprise.