CITY UNIVERSITY OF HONG KONG
Cloud Security Standard (For Central IT)

(Approved by the Information Strategy and Governance Committee in Jan 2024)

INTERNAL **Date of Issue: 2024-01-11**

Document Control

Document Owner	Classification	Publication Date
CSC	INTERNAL	2024-01-11

Revision History

Version	Date	Summary of Changes
1.0	2023-08-31	Initial Release
1.1	2024-01-11	Added 11.12.1 (f) – security vetting requirement

Distribution

Copy	Issued to	Location
Master	Internal	https://www.cityu.edu.hk/csc/information-security/information-security-policies-and-standards

Contents

1 Policy Statement

The City University of Hong Kong (“University”) must ensure the security when building private clouds and acquiring public cloud services from external cloud services providers.

2 Objective

The purpose of this document is to establish a security standard for adopting cloud services and to outline the fundamental security control requirements in a cloud environment.

3 Scope

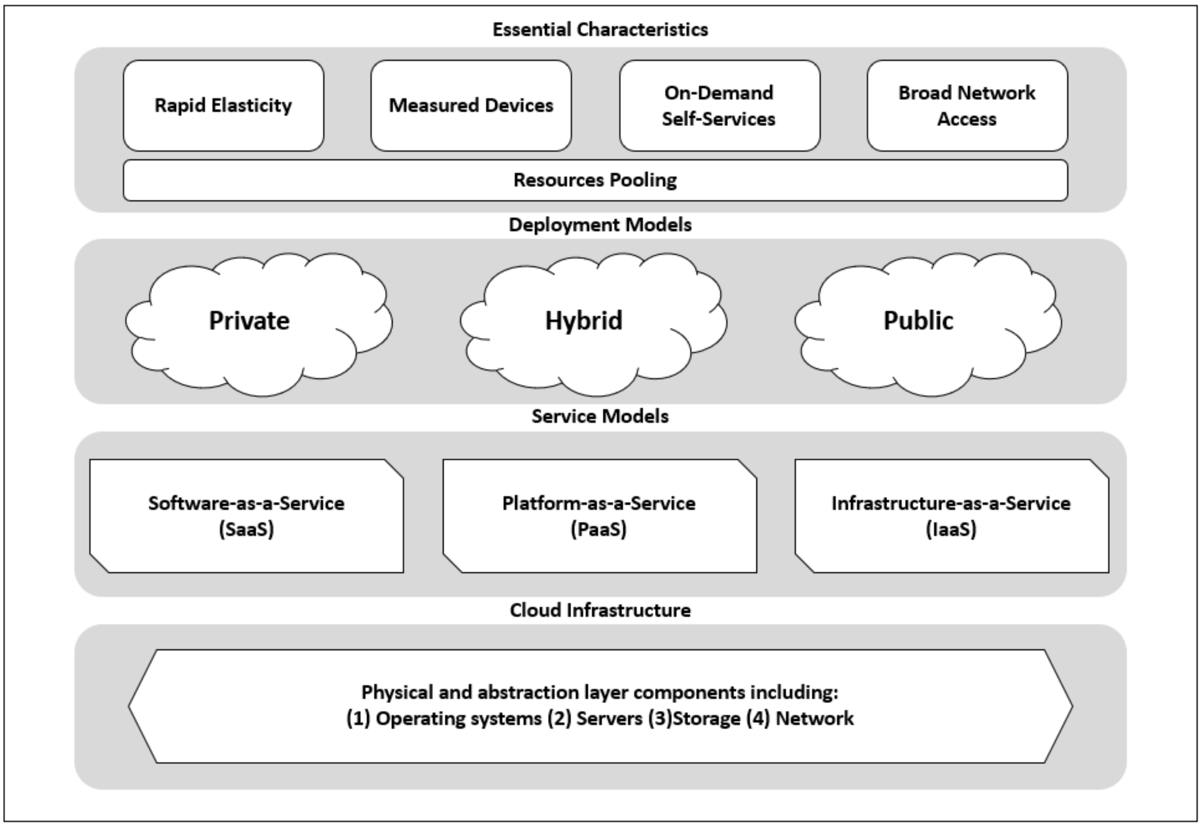
This standard applies to all cloud applications and cloud service adoptions at the University, including projects utilizing private or public clouds and any combination of Infrastructure-as-a-service, Platform-as-a-Service, and Software-as-a-Service cloud service models.

4 Terms and Definitions

Throughout the document, Cloud Service Provider (CSP) generally refers to a vendor or third party providing public cloud services to the University. This may include the underlying platform provider (e.g., AWS, Azure), the multi-cloud managed service provider (or cloud service broker), the system integrator supporting the cloud project, or the vendor supplying the SaaS application. The actual responsible party may vary depending on each project's arrangement.

5 Cloud Computing Model

As defined by National Institute of Standards and Technology (NIST), cloud computing is a model that enables ubiquitous, convenient and on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud computing infrastructure can be categorized into three service models and three deployment models, as illustrated in the diagram below.



Essential Characteristics
Rapid Elasticity
Measured Devices
On-Demand Self-Services
Broad Network Access
Resources Pooling
Deployment Models
Private
Hybrid
Public
Service Models
Software-as-a-Service (SaaS)
Platform-as-a-Service (PaaS)
Infrastructure-as-a-Service (IaaS)
Cloud Infrastructure
Physical and abstraction layer components including:
(1) Operating systems (2) Servers (3)Storage (4) Network

6 Cloud Service Models

There are three typical types of cloud service models, outlined as follows:

(a) Infrastructure-as-a-Service (IaaS):

IaaS is a service delivery model in which the basic computing infrastructure, including servers, software, and network equipment, is provided as an on-demand service. This allows for the establishment of a platform to develop and execute applications.

(b) Platform-as-a-Service (PaaS):

PaaS is a service delivery model in which the computing platform is provided as an on-demand service, enabling applications to be developed and deployed. Its main purpose is to reduce the cost and complexity of purchasing, housing, and managing the underlying hardware and software components of the platform, including any necessary programming and database development tools.

(c) Software-as-a-Service (SaaS):

SaaS is a service delivery model in which one or more applications and the computational resources required to run them are provided for use on-demand as a turnkey service.

7 Deployment Models

There are three typical types of cloud deployment models, outlined as follows:

(a) Private Cloud: A private cloud is provisioned for the exclusive use of a single organization comprising multiple user departments. It may be owned, managed, and operated, or any combination of them, by the organization itself or external service providers. The infrastructure may be hosted within the organization's data center or externally.

(b) Public Cloud:

A public cloud is provisioned for public use. It supports multi-tenancy and may be owned, managed, and operated, or any combination of them, by an external CSP. The infrastructure is hosted at the CSP's premises.

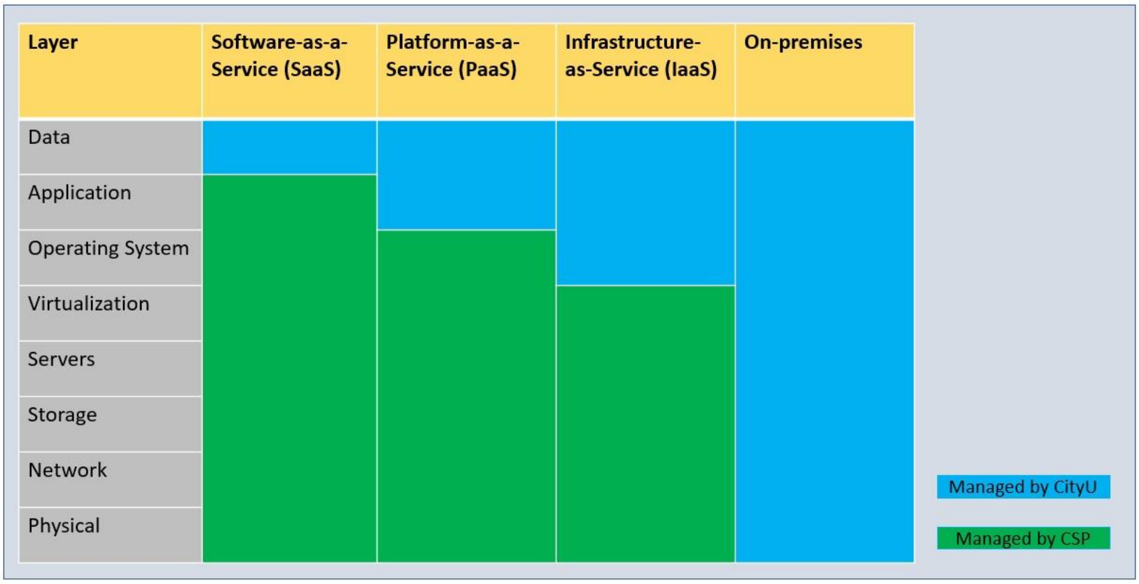
(c) Hybrid Cloud:

A hybrid cloud consists of more than one distinct cloud infrastructure (e.g., private and public) that may be provisioned by different CSPs. This model enables data and application portability.

8 Shared Responsibility Model

Adopting cloud services adheres to a shared responsibility model, which means that cloud users assume some responsibilities for security when moving applications, data, and workloads to the cloud environment, while the CSP takes on other responsibilities simultaneously. However, the shared responsibility varies by the CSP and cloud service models, and it is essential to define the boundary between the cloud users' responsibilities and those of the CSP to reduce the risk of introducing security control weaknesses or security loopholes into the cloud environment.

The table below provides a high-level overview of the shared responsibilities between the University and the CSP:



Layer	Software-as-a-Service (SaaS)	Platform-as-a-Service (PaaS)	Infrastructure-as-Service (IaaS)	On-premises
Data	🟦	🟦	🟦	🟦
Application	🟩	🟦	🟦	🟦
Operating System	🟩	🟩	🟦	🟦
Virtualization	🟩	🟩	🟩	🟦
Servers	🟩	🟩	🟩	🟦
Storage	🟩	🟩	🟩	🟦
Network	🟩	🟩	🟩	🟦
Physical	🟩	🟩	🟩	🟦

🟦 Managed by CityU

🟩 Managed by CSP

Cloud User's Share of Responsibilities:

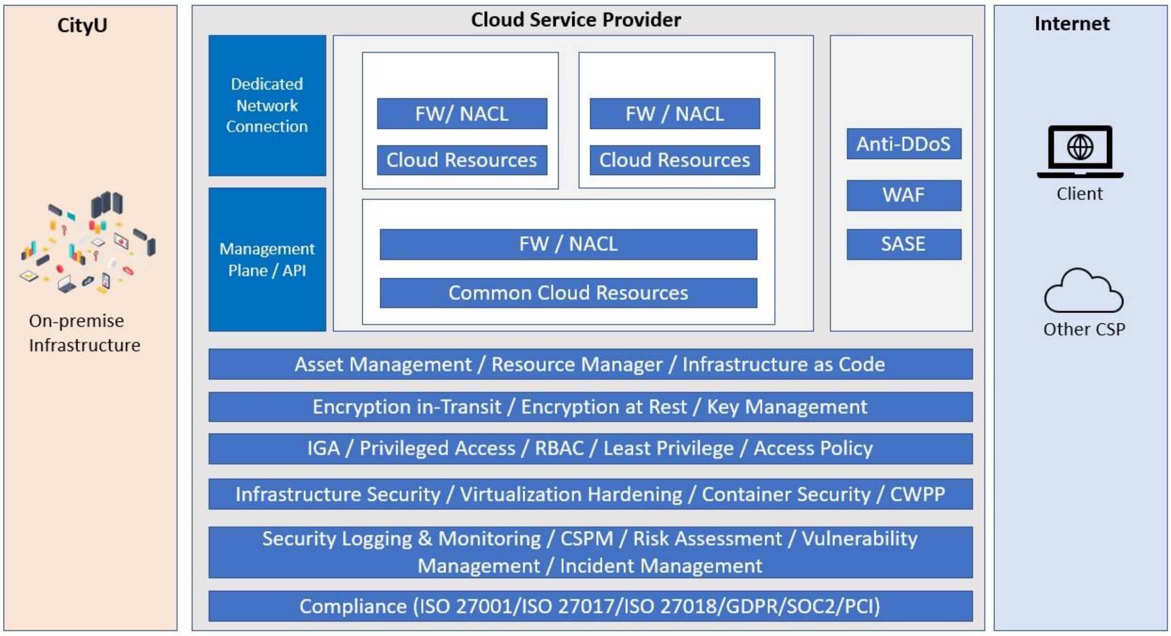
When using a server-based IaaS, serverless infrastructure, or a PaaS cloud service model, cloud users are responsible for several key tasks, including:

a) Managing information and data, and controlling how and when data is used;
b) Securing application code repositories from malicious intrusion or misuse, including application build testing throughout the development and integration process;
c) Maintaining all aspects of identity and access management, including but not limited to:
    i. Authentication and authorization mechanisms;
    ii. Single sign-on ("SSO");
    iii. Multifactor authentication ("MFA");
    iv. Access keys;
    v. Certificates;
    vi. User creation and access provisioning processes;
    vii. Password Management.
d) Maintaining platform and resources configurations, including but not limited to:
    i. Operating system and application patching;
    ii. Operating system and application hardening;
    iii. Change and configuration management for IaaS instances.

CSP's Share of Responsibilities:
Regardless of the cloud service models, the CSP is responsible for several key tasks, including:

a) Controlling the provisioning of physical resources via virtualization;
b) Ensuring network segmentation and customer isolation among multiple tenants in the shared pool of virtual resources;
c) Protecting hardware, including physical hosts, network, and data center through various software and physical means; and
d) Ensuring rapid failover and high-availability disaster recovery mechanisms.

9 Cloud Security Architecture


CityU
On-premise Infrastructure
Cloud Service Provider
Dedicated Network Connection
Management Plane / API
FW/ NACL
Cloud Resources
FW / NACL
Cloud Resources
FW / NACL
Common Cloud Resources
Anti-DDoS
WAF
SASE
Asset Management / Resource Manager / Infrastructure as Code
Encryption in-Transit / Encryption at Rest / Key Management
IGA / Privileged Access / RBAC / Least Privilege / Access Policy
Infrastructure Security / Virtualization Hardening / Container Security / CWPP
Security Logging & Monitoring / CSPM / Risk Assessment / Vulnerability Management / Incident Management
Compliance (ISO 27001/ISO 27017/ISO 27018/GDPR/SOC2/PCI)
Internet
Client
Other CSP

The above diagram illustrates the cloud security architecture and below components are recommended to be adopted:

a) Secure Access Service Edge (SASE)

SASE is an emerging offering that combines comprehensive WAN capabilities with network security functions such as Secure Web Gateway (SWG), Cloud Access Security Brokers (CASB), Firewall-as-a-Service (FWaaS), and Zero Trust Network Access (ZTNA) to support the dynamic secure access needs of digital enterprises. SASE capabilities are delivered as a service based on the identity of the entity, real-time context, enterprise security/compliance policies, and continuous assessment of risk/trust throughout the sessions. Identities of entities can be associated with people, groups of people (branch offices), devices, applications, services, Internet of Things (IoT) systems, or edge computing locations.

b) Cloud Access Security Brokers (CASBs)

CASBs are on-premises or cloud-based security policy enforcement points placed between cloud service consumers and cloud service providers to combine and interject enterprise security policies as the cloud-based resources are accessed. CASBs act as a security policy enforcement gateway to ensure that users' actions are authorized and compliant with the organisation’s policies. CASBs consolidate multiple types of security policy enforcement, such as authentication, single sign-on, authorization, credential mapping, device profiling, encryption, tokenization, logging, alerting, malware detection/prevention, and more.

c) Cloud Workload Protection Platforms (CWPPs)

CWPPs are designed for workload-specific protection. Workloads exist in varying states, and CWPP unifies management across multiple CSPs and all types of workloads, from API to business application to virtual machines. CWPPs reduce cloud protection complexity, provide a consistent view of all cloud environments, and boost portability. The market for CWPPs is defined by workload-centric security protection solutions, which are typically agent-based. They address the unique requirements of server workload protection in modern hybrid data center architectures that span on-premises, physical and virtual machines (VMs), and multiple public cloud infrastructure as a service (IaaS) environments. Ideally, they also support container-based application architectures.

d) Cloud Security Posture Management (CSPM)

CSPM is a continuous process of cloud security improvement and adaptation to reduce the likelihood of a successful attack. It is a group of security products and services that monitor a wide variety of cloud environment issues. CSPM is used for continuous compliance monitoring, configuration drift prevention, and security operation center investigations. Example use cases include compliance monitoring, DevOps integration, incident response, risk assessment, and risk visualization. CSPM aims to satisfy the growing need of organizations to correctly configure public cloud IaaS and PaaS services and address cloud risks.

10 Cloud Security Principles

The Cloud Security Principles require that:

a) Different security control requirements should be considered depending on the following factors:
   i. Data involved
   ii. The cloud service model (e.g. IaaS, PaaS, SaaS or combinations)
   iii. Business use cases (e.g. target users, operation models, etc.)
b) Zero-trust, layered security, and defense-in-depth principles be adopted.
c) Equivalent or stronger security controls or processes in the cloud environment compared to on-premise be implemented.
d) Security control objectives should be vendor-neutral and can be achieved by native cloud security services or third-party solutions.
e) Automation be considered as far as practically possible.
f) Data Privacy Principles be referenced for any information related to Personally Identifiable Information (PII) managed and stored in the private and public cloud environment.

11 Security Requirements for Provisioning of Cloud Services

11.1 Data Security

11.1.1 Cloud Asset Inventory

a) Central IT should maintain an up-to-date registry that records all cloud services used by the University.

b) Central IT should identify and maintain an up-to-date inventory list that documents all IT assets pertaining to each cloud service adopted. The IT assets should include the following, where applicable:
   i. Business information;
   ii. Virtualized hardware;
   iii. Virtualized storage;
   iv. Software

c) Central IT may establish an approved list of cloud services to govern what services can be used in the production environment.

11.1.2 Cloud Data Classification

a) System owners shall identify and classify all data stored and business applications hosted in the cloud environment.

b) System owners shall ensure appropriate security controls have been implemented for each classification in the cloud environment.

11.1.3 Data Ownership

System owners shall define the ownership of the following data and communicate with the CSP prior to service adoption:

a) Content data and metadata in the public cloud environment;

b) Virtual machine image(s);

c) IT users' account information.

11.1.4 Data Privacy

a) System owners shall create and maintain an up-to-date inventory of data store/process for each cloud service. Privacy impact assessment (PIA) should be conducted prior to deployment of the respective cloud services. A PIA is typically designed to accomplish three main objectives:
   i. Ensure conformance with applicable legal, regulatory, and policy requirements for privacy.
   ii. Identify and evaluate the risks of privacy breaches or other incidents and effects.
   iii. Identify appropriate privacy controls to mitigate unacceptable risks.

b) System owners shall prevent data migration, particularly CONFIDENTIAL and RESTRICTED data, to the cloud without prior approval.

c) System owners shall observe data protection and privacy legislation, including but not limited to the Personal Data (Privacy) Ordinance (PDPO) (Cap. 486) and its Amendments, particularly the Data Protection Principle 4 (on security of personal data). If the data will be processed/stored in EU, UK, or the Mainland, the CSP shall also comply with EU/UK General Data Protection Regulation (GDPR) and the Mainland Personal Information Protection Law (PIPL). They shall also observe the University's Code of Practice on Personal Data (Privacy) Issues.

d) System owners shall ensure that the CSP supports secure data destruction for disposal at the expiry or termination of service or upon request of the University.

e) System owners should require the CSP to disclose the locations/jurisdictions where the data will be stored, so that this information may be made known to the data subjects.

f) System owners should choose a CSP that allows them to choose or specify locations/jurisdictions where there is adequate legal protection to personal data.

g) System owners shall make users aware of the transborder arrangement with regard to how their personal data is protected.

11.1.5 Data Loss Prevention

a) System owners should implement a data loss prevention solution for all CONFIDENTIAL data (e.g., EID, HKID, patent-pending, unpublished research information and identifiable research subject data) stored and processed in the public cloud to detect and prevent potential data leakage.

b) System owners should enforce data de-identification (e.g. tokenization[1], anonymisation[2] and randomisation[3]) to prevent data subjects' identities from being revealed with the processed results while business purposes are being fulfilled.

Notes:

1 Data tokenisation involves replacing sensitive data elements with substitutes without extrinsic meanings, usually referred to as tokens. These tokens can be mapped back to sensitive data afterwards.

2 Data anonymisation is the process of turning data into a form such that the identification of individuals is not likely to succeed.

3 Data randomisation adds noise to a data field. It does not preserve data truthfulness at the record level but reduces the risk of singling out identifying attributes. Generally the values are modified so that their new values differ from their true values in a random way.

11.2 Physical and Environmental Security

11.2.1 Security Controls of Data Centers

System owners shall request and review relevant certifications and/or audit reports (e.g., ISO27001, SOC2) that demonstrate compliance with international best practices on the data centers' physical and environmental security controls. This includes, but is not limited to, the following:

a) Video surveillance system;
b) Door access system;
c) Reception desk;
d) Security patrols;
e) Perimeter intruder detection systems;
f) Locked environment for IT equipment, servers and network devices;
g) Uninterruptible power supply ("UPS");
h) Air conditioning and ventilation;
i) Fire suppression system;
j) Water damage and flood control System.

11.3 Identity and Access Management

11.3.1 Cloud User Access Management

a) System owners should implement an approval process for provisioning user access to cloud applications, infrastructure, and backend systems.

b) System owners shall enforce a password policy by following the "Password Management and Multi-Factor Authentication Policy" as far as possible for all user accounts in the cloud environment.

c) System owners shall enable multi-factor authentication (MFA) for cloud applications that process/store CONFIDENTIAL level or above data.

d) System owners should clearly define personnel roles and responsibilities, and assign user access rights to cloud applications, infrastructure, and backend systems, including virtualized hardware and storage, according to a pre-defined role-based user access matrix.

e) System owners should follow the principles of least privilege and separation of duties when assigning data access rights and access privileges of information systems to cloud users.

f) System owners shall manage and securely keep user login credentials for accessing the cloud application's production environment to prevent unauthorized access and change of cloud application programs and configuration files.

g) System owners should assign permission to user roles or groups instead of to individual user accounts.

h) System owners should gain access to service accounts through user roles instead of individual user accounts.

i) System owners should regularly review user access rights to cloud applications, infrastructure, and backend systems (e.g., annually) or upon change of personnel, and disable all logical access and credentials upon contract termination.

j) System owners should review and disable inactive user accounts where appropriate.

k) System owners shall not write credentials (e.g., password) in code when using APIs, CLI, or SDKs to access cloud resources, but shall adopt centralized management services instead.

l) System owners may adopt cloud-based access rights review tools to trace all access-level alterations and account activities to detect abnormal or suspicious activities and misconfigurations of access rights in public cloud applications, infrastructure, and backend systems.

m) System owners may consider using Identity and Access Management (IAM) system to manage user account provisioning, authentication, and authorization in the cloud using open standards such as OpenID.

n) System owners may adopt identity federation service for accounts and applications to facilitate the interconnection of disparate identity repositories.

o) System owners should leverage industry standards (e.g., SAML) for implementing secure single sign-on solutions for passing identities and attributes, as well as enforcing authorization policies.

p) System owners should use an access key if they need to make API calls or use Cloud CLI or tools for Windows PowerShell.

q) System owners should not generate access keys for users who only need to access the management console.

r) System owners should rotate access keys on a regular basis (e.g., annually).

s) System owners should avoid generating access keys for the root account as it may allow full access to all resources for the cloud services.

t) System should disable access keys that have not been used for a certain period (e.g., 90 days).

11.3.2 Privileged Account Management on Cloud

a) System owners shall enable multi-factor authentication for privileged user accounts. Alternative security controls (e.g., PAM) shall be implemented if MFA cannot be enabled to prevent unauthorized privileged user account access.

b) System owners shall not allow sharing of privileged user accounts, and must strictly enforce accountability of privileged users.

11.3.3 Restriction on Privileged Utility Program

PaaS Only:

a) System owners should ensure that the CSP's practice on privileged utility programs provided (i.e., programs that are run as an administrator in Windows, as root or via su/sudo in Linux) running in the public cloud environment complies with ISO27001 certification to ensure security controls on the use of the programs accessing cloud service are in place.

b) System owners should perform system hardening to remove or restrict the use of privileged utility program(s) capable of potentially overriding system and application controls, and disable all unnecessary application(s) running in the cloud environment.

11.4 Cryptography

11.4.1 Data Encryption

System owners shall implement appropriate encryption controls to ensure that all CONFIDENTIAL or above data stored in the cloud environment is encrypted.

11.4.2 Cryptographic Key Management

IaaS or PaaS Only:

a) System owners should identify the cryptographic keys used for each cloud service.

b) When Bring-Your-Own-Key (BYOK) has been adopted for a public cloud service, the CSP shall not be permitted to access the University's encryption keys for cryptographic operations.

c) System owners should assign designated personnel as key custodians responsible for managing the encryption keys, including key generation, storage, backup, transfer, and destruction.

d) System owners should ensure that no single user has sole access to the encryption keys stored in all cloud key management servers.

e) System owners should rotate encryption keys stored in the cloud key management servers on a regular basis (e.g., annually).

f) System owners should enable logging and auditing functions in the public cloud services to automatically log all user activities performed in the cloud key management servers.

g) System owners should back up the encryption keys in the cloud key management servers at least annually and regularly delete expired keys.

h) System owners should define processes for the key management lifecycle, including how keys are created, stored, backed up, recovered, rotated, and deleted.

i) To avoid the risk of compromising any cloud platforms, cryptographic keys should not be reused across different cloud platforms, especially under a hybrid cloud scenario.

11.5 Security Monitoring and Reporting

11.5.1 Security Incident Management

a) System owners shall follow the "Information Security Incident Management Standard" for handling security incidents directly related to the University systems deployed in the public cloud environment.

b) System owners should regularly review the existing incident management procedure to incorporate potential changes caused by changes in public cloud service(s) and CSP(s).

c) System owners shall define the roles and responsibilities of each stakeholder in the University and CSP to ensure all relevant stakeholders are aware of their action(s) to be taken during the incident response process for public cloud services.

d) System owners shall maintain a list of contact points for incident response, which contains at least a point of contact from the CSP for incident reporting, and distribute the list to all relevant stakeholders in the University and the CSP to maintain effective communication during the incident response process.

e) System owners should regularly review alerts and findings from the security monitoring and detection service provided by CSP, and remediate any identified issues in a timely manner.

f) System owners may centrally manage security event notifications by security service with analysis and threat intelligence capabilities provided by CSP.

g) System owners may leverage automatic event-driven response capabilities to reduce the time-to-value between detective and responsive mechanisms.

11.5.2 Incident Reporting

CSP shall provide an incident report with all relevant information to the University for investigation within a reasonable time upon confirmation of an incident occurring in the CSP's public cloud environment that has impacted the University's service. The incident report should include the following information:

i. Date and time of the incident identified;
ii. Description of the incident;
iii. Initial findings;
iv. Systems affected;
v. Physical location of the affected systems;
vi. Impact;
vii. Root cause;
viii. Action plan for remediation (short-term/long-term);
ix. Current system remediation status;
x. Cost incurred (if any).

11.6 Operations Security

11.6.1 Data Backup

a) System owners should clearly define and agree upon the responsibilities for performing backups related to the adopted cloud services with CSPs.

b) If the CSP is responsible for backups, system owners should request and review their backup capability specifications to ensure they meet the University’s backup requirements. The specifications should include, but are not limited to:

i. Scope and schedule of backups;

ii. Backup methods and data formats (if relevant);

iii. Retention period for backup data.

c) For critical systems, system owners should obtain at least one offline regular backup copy of operational data to ensure the possibility of recovery to the most up-to-date state.

d) System owners should perform regular backup recovery tests to confirm the proper functioning of recovery procedures, their up-to-date status, and their ability to meet the Recovery Time Objective (RTO) and Recovery Point Objective (RPO).

e) System owners should store backups, log copies, access records, and other relevant information securely for legal and compliance purposes.

f) System owners may utilize built-in backup capabilities and automated processes with policies in storage services.

11.6.2 Vulnerability Management

a) The University should conduct regular security assessments (e.g., vulnerability scanning, penetration testing) for the University-managed systems hosted in the public cloud environment.

b) System owners should follow the "Network and Platform Security Standard" to fix identified security vulnerabilities in the cloud environment within defined timeframes, adopting a risk-based approach.

c) System owners should establish an agreement with CSPs regarding the feasibility of conducting security assessments (e.g., vulnerability scanning, penetration testing) in the public cloud environment, as well as the responsibilities and arrangements for security assessments (e.g., assessment approach, frequency).

d) System owners should scan any binary files before uploading them to non-compute resources (e.g., storage) in the cloud environment.

11.6.3 Change and Configuration Management

a) System owners should assess, authorize, and test changes to cloud applications/platforms before implementing them in the production environment to avoid undesired impacts on the University's services/operations.

b) System owners should configure systems and applications hosted in the cloud environment according to regulatory requirements and the CSP's recommended security practices.

c) System owners should continuously monitor for any unauthorized changes to the configurations of all systems and applications hosted in the cloud environment.

d) System owners should develop a set of standardized configuration templates (i.e., Infrastructure as Code) to standardize and automate the provisioning, management, and deployment of infrastructure components in the cloud environment (e.g., servers, operating systems, database connections and storage.).

11.7 Security Audit and Monitoring

11.7.1 Audit Log Management

a) System owners should define and agree upon the allocation of responsibilities and requirements for audit logging in cloud applications, infrastructure, and backend systems with CSPs.

b) System owners should enable system auditing and logging for all cloud applications, infrastructure, and backend system components, including but not limited to:
   i. Network;
   ii. Operating system;
   iii. Container;
   iv. Application;
   v. Function calls;
   vi. Virtual instances.

c) System owners should define the retention period for audit logs for all adopted cloud applications, infrastructure, and backend system components.

d) System owners shall strictly control access to audit logs and ensure they are tamper-resistant to prevent unauthorized modification.

11.7.2 Audit Log Review and Analysis

a) System owners should continuously perform log reviews using correlation tools to analyze any abnormal activities occurring in the cloud applications, infrastructure, and backend systems within the cloud environment.

b) System owners should configure and enable alert notifications for analysis and remediation.

c) If a CSP performs log review and analysis functions, system owners should request a regular log review report (e.g., monthly) from the CSP, including but not limited to the following items:
   i. System faults;
   ii. System performance;
   iii. Malicious activities;
   iv. Event summary and trend analysis.

11.8 System Acquisitions and Development

11.8.1 Secure Development of Cloud Applications

a) System owners shall follow the "Information System Acquisition, Development, and Maintenance Standard" during the development of applications in the cloud platform.

b) System owners should apply a secure software development lifecycle to cloud applications and address security threats throughout the development process with proactive checks, including:
   i. Conducting threat modeling during the design process to identify and mitigate potential security issues early;
   ii. Following development best practices and secure coding standards (e.g. security code review, de-identification of personal data, data input validation and output encoding requirements) for preventing web application vulnerabilities; and
   iii. Using various tools (e.g. code scanning and analysis tools, testing tools and code obfuscation tools) for testing, verification and code protection before deployment.

11.9 Network Communications Security

11.9.1 Protection for data transmission

a) System owners shall follow the "Network and Platform Security Standard" and implement strong communication channel encryption protocols for data transmission involving sensitive information.

b) System owners shall implement secure protocols such as TLS, Virtual Private Network (VPN), or dedicated connections for end-to-end data transmission between the cloud and the University's network.

IaaS or PaaS Only:

c) System owners shall follow the "Logical Access Control Security Standard" to define and implement network-level access controls (e.g., deny public access to internal cloud services by default, do not open management ports such as TCP port 22 and 3389 directly to the public network, but allow managed remote access service provided by the CSP).

11.9.2 Network Attack Monitoring and Protection

IaaS or PaaS Only:

System owners should implement network security monitoring and protection measures to continuously detect and immediately respond to network-based attacks on the University's network, including the virtual network. These measures should include, but not be limited to:

i. Network Firewall;
ii. Web Application Firewall;
iii. Anti-DDoS;
iv. Network Traffic Information;
v. Log Monitoring Tool.

11.10 Infrastructure Security

11.10.1 Virtual Network Segmentation

a) System owners should create security zones to isolate virtual instances based on the following criteria:
   i. Implementation phase (i.e. development, testing and production environment);
   ii. Data classification;
   iii. Architecture layer;
   iv. Criticality of the cloud systems/applications.

b) System owners should implement network access controls at both container and platform levels to control network traffic between nodes and master nodes, as well as between master nodes and external nodes.

11.10.2 Virtualization Security

IaaS or PaaS Only:

a) System owners shall perform hardening to remove and/or disable all unnecessary configurations, services, and ports on system components, covering at least the following:
   i. Host and Guest OS;
   ii. Container images;
   iii. Hypervisors;
   iv. Container orchestration stack and control plane.

b) System owners should perform periodic vulnerability scanning for the host and guest OS/image used for virtualization.

c) System owners should enable logging for all privileged accounts' activities in virtual instances and hypervisors to trace unauthorized access to virtual instances' images or snapshots.

d) System owners may adopt Cloud Workload Protection Platforms ("CWPP") or runtime defense solutions to secure the University's workloads in the public cloud environment.

e) System owners should implement hypervisor-based, network-based, and host-based protection solutions for each VM or a cluster of related VMs, if appropriate.

f) System owners must handle VM images and snapshots with care, as they may contain captured CONFIDENTIAL data on the system at the time the image/snapshot was taken. They must also wipe VM image copies and snapshots when no longer needed.

g) When deleting a VM from a physical server or moving it to another physical server, system administrators shall ensure no data is left behind on the disk that may make data recovery possible.

h) System owners should clear VMs using secure deletion solutions.

IaaS Only:

i) System owners should make use of resilience capabilities (e.g. VM clustering on host machines) to prevent single point of failure in the virtual network.

j) System owners should plan and regularly review the use of virtualized resources (e.g., CPU utilization, disk space, bandwidth) to avoid potential resource contention.

k) System owners shall perform regular patching for dormant virtual instances managed by the University.

11.10.3 Container Security

IaaS or PaaS Only

a) Define a standardized process for securely managing centralized container images and repositories in the cloud environment to:

   i. Perform periodic container image scanning to identify potential security vulnerabilities;

   ii. Rebuild container images for security patching;

   iii. Perform hardening on container images and pertinent configuration files according to the defined configuration baseline;

   iv. Use base images from trusted sources only, update base images frequently and select base images from minimalistic technologies like Alpine Linux and Windows Nano Server to reduce attack surface areas.

IaaS Only

b) System owners shall perform hardening on the host infrastructure in the cloud environment according to the defined configuration baseline (e.g., Pod Security Policy). The hardening should address the following:

   i. Define and assign access permissions to container image repositories, clusters, and namespace resources based on the principle of least privilege and role-based access control;

   ii. Define and limit resources available to the container;

   iii. Ensure the implementation of appropriate task segregation and security isolation, including system, process, network, and storage.

11.11 Third Party Management

11.11.1 Contractual Requirements

a) The agreement of terms and conditions of cloud services between the University and the CSP shall include at least the following:
   i. A list of services and support tasks that will be provided by the CSP;
   ii. An agreement on handing confidential information; and
   iii. Actions and penalty clauses applicable in the event of security breach caused/performed by the CSP, as well as their failure to comply with the agreed service level; especially their obligation to notify the University of any data breaches that occur within a reasonable timeframe after they become aware of the breach.
   iv. Security requirements/checklist for the adopted cloud services.

b) If there is a sub-contracting arrangement, system owners should obtain formal contractual assurance from the CSP that the same level of protection and compliance controls are equally applicable to their sub-contractors.

c) The Service Level Agreement (SLA) between the University and CSP shall include confidentiality and non-disclosure clauses that explicitly state that all cloud user data would be safely and securely removed from the CSP when the cloud service is terminated.

d) System owners should regularly review and evaluate the CSP's performance against the SLA, and address any non-conformance.

e) System owners should regularly check with the CSP for any notices of changes in the common statements of Service Level Agreement as the CSP may reserve the rights to update some terms in the SLA with limited advance notice.

11.11.2 Exit Management

a) System owners shall formulate an exit plan with the CSP during contract establishment for the provisioning of cloud services to define procedures to retrieve data and virtual instances out of the CSP and securely remove the data and virtual instances from the CSP's environment.

b) In the event of termination or change of CSP, system owners should implement at least the following measures:
   i. Prepare a formal handover document that covers a checklist of the assets to be handed over and is signed-off by both the University and the CSP.
   ii. Modify the implemented authentication and authorization controls (e.g., passwords, credential information for authentication, etc.) to terminate CSP's access rights to the University's application data and information.
   iii. Include in the exit plan how to retrieve data and the virtual environments out of the CSP and how to clean up data and the virtual environments.
   iv. Ensure the legal notice clearly states that all data or configuration settings stored in the CSP's system, including the backup data, are permanently removed.

11.11.3 Business Continuity Planning (BCP)

a) System owners should follow the "Business Continuity Management Standard" to conduct a business impact analysis and assess how changes in cloud service adoption may impact the cloud environment's systems or data.

b) System owners should develop a Business Continuity Plan (BCP) for the adopted cloud services, which includes, at a minimum, the following scenarios:
   i. Loss of the CSP’s public cloud services;
   ii. Loss of third-party dependent capabilities.

c) System owners should conduct regular BCP drill tests to ensure that all relevant stakeholders, including the CSP, understand the BCP procedures and that the BCP functions properly.

11.11.4 Disaster Recovery (DR)

a) System owners should define and agree on the disaster recovery arrangements with the CSP, including:
   i. Recovery Point Objective (“RPO”) and Recovery Time Objective (“RTO”);
   ii. Restoration priorities;
   iii. Location of the disaster recovery site(s);
   iv. Roles and responsibilities of the recovery teams;
   v. Lines of communications during the DR arrangements.

b) System owners should ensure the CSP's practice of disaster recovery complies with ISO27001 certification by performing regular drill tests (e.g., annually) and having test reports in place that cover the exercise scope, final outcomes, and recommendations.

11.12 Compliance

11.12.1 Compliance with Applicable Standards and Regulatory Requirements

a) System owners should conduct a security assessment or engage an independent third-party assessor to conduct a security assessment on the adopted cloud applications, infrastructure, and backend systems against the requirements outlined in this document, regulations, and industry best practices on a regular basis (e.g., annually).

b) System owners should ensure the CSP regularly conducts third-party audits and/or security assessments against its information security policies, regulatory requirements, and industry best practices at a mutually agreed frequency (e.g., annually).

c) System owners should discuss with the CSP the applicable criteria for audit and service level measurement and agree with them on the extent of the University's access to the CSP's environment for audit and compliance verification.

d) System owners shall request and review the CSP's third-party audit reports or compliance certificates (e.g., ISO 27001, ISO 27018, SOC2 Type 1 and Type II report) to verify its level of compliance with globally recognized industry security standards.

e) System owners shall ensure the CSP is CSA STAR Level 2 (attestation) compliant or completes the CSA STAR Level 1 Self-Assessment. The Consensus Assessments Initiative Questionnaire created by the Cloud Security Alliance can be used as a reference set of questions for assessing a CSP.

f) System owners shall obtain security vetting from Information Security Unit (ISU) of CSC if the cloud services being utilized will store or process information categorized as CONFIDENTIAL or RESTRICTED. System owner shall make sure cloud services provider to comply Standard Security Requirements set out in Appendix A during provision the cloud services.

IaaS or PaaS Only:

g) System owners should enable the CSP's security compliance checking service to perform a high-level check on the cloud platform's configurations against the recommended settings.

12 Appendix

12.1 Appendix A: Standard Security Requirements for Cloud Service Tender Preparation

The following standard clauses set out the mandatory security requirements that shall be included in a Tender for the provision of Cloud Services.

1) Cloud Service Provider (CSP) shall comply with the data protection and privacy legislation in Hong Kong, including the Personal Data (Privacy) Ordinance (PDPO) and its Amendments. If data is processed/stored in EU, UK or Mainland China, the CSP shall also comply with their corresponding data protection regulations :
    a. EU General Data Protection Regulation (GDPR)
    b. UK General Data Protection Regulation (GDPR)
    c. Personal Information Protection Law (PIPL) of the Mainland
2) CSP shall disclose to the University the locations/jurisdictions where the data will be stored.
3) CSP shall support secure data destruction for disposal at the expiry or termination of service or upon request of the University.
4) The proposed Cloud System/Application shall support Multi-Factor Authentication (MFA) for systems or applications that may process or store confidential data. If MFA is not supported, the CSP must provide compensating security controls (e.g. strong password and regular password change) to protect cloud user accounts.
5) The proposed Cloud System/Application shall support MFA for privileged user accounts. Alternative security controls shall be provided (e.g. PAM) if MFA is not supported to prevent unauthorized privileged user account access.
6) The proposed Cloud System/Application shall support encryption for both data-at-rest and data-in-transit to protect confidential data.
7) CSP shall provide a list of contact points for security incident response and inform the University when the list changes.
8) CSP shall provide an incident report and provide information to the University for investigation within reasonable time upon the confirmation of security incidents in the CSP’s cloud environment that have impacted the University’s service. The incident report should include the following information:
    a. Date and time of the incident identified;
    b. Description of the incident;
    c. Initial findings;
    d. Systems affected;
    e. Physical location of the affected systems;
    f. Impact;

g. Root cause;
h. Action plan for remediation (short-term/long-term);
i. Current system remediation status;
j. Cost incurred (if any).

9) The proposed Cloud System/Application shall only allow authorized persons from the University to access the audit logs, and all audit logs must be tamper-resistant to prevent unauthorized modification.
10) CSP shall support secured connections (e.g. TLS, VPN or dedicated connections) to protect end-to-end data transmission between the proposed Cloud System/Application and the University.
11) The proposed Cloud System/Application shall be hardened so that all unnecessary configurations, services and ports on its system components are removed or disabled.
12) CSP shall handle VM images and snapshots with care as they may contain capture of CONFIDENTIAL data on the system at the time the image/snapshot was taken.
13) CSP shall notify the University at least one month in advance of any significant changes (e.g. service upgrade, cease offering a particular service) in the proposed Cloud System/Application.
14) CSP shall ensure that the same level of protection and compliance controls apply to their sub-contractors.
15) CSP shall provide the procedures to retrieve the University's data/virtual instances and securely remove the data and virtual instances from the CSP's environment when the cloud service is terminated.
16) CSP shall comply with the following security standards and provide the latest certificates/audit reports for the University to review whenever the certificates/audit reports have been renewed.
    a. ISO 27001
    b. SOC2 Type 1 and Type II
    c. ISO 27018
    d. CSA STAR Level 2 or Level 1

12.2 Appendix B: Checklist

The following checklist can help cloud service subscribers to check if they comply with this Cloud Security Standard.

Item	Description	Reference	Checked (Yes,No,N/A)
1	Ensure Cloud Service Provider (CSP) comply with applicable data protection laws and regulations	11.1.4	
2	Confirm with CSP the locations/jurisdictions where the data will be stored	11.1.4	
3	Ensure CSP supports secure data destruction for disposal at the expiry or termination of service or upon request of the University	11.1.4	
4	The password policy for the user accounts in the cloud environment shall follow the University's prevailing password policy as far as possible	11.3.1	
5	Ensure Multi-Factor Authentication (MFA) has been enabled for cloud applications that process/store confidential data	11.3.1	
6	Ensure Multi-Factor Authentication (MFA) or equivalent security control has been enabled for privileged user accounts.	11.3.2	
7	Ensure privileged user accounts shall not be shared and the accountability of privileged users shall be strictly enforced.	11.3.2	
8	Ensure appropriate encryption controls have been implemented to ensure that all confidential data processed/stored in the cloud environment is encrypted	11.4.1	
9	Get a list of contact points from CSP for security incident response and ensure CSP will inform the University when the list changes	11.5.1	
10	Ensure CSP will provide an incident report and provide information to the University for investigation within reasonable time upon the confirmation of security incidents occurring in the CSP's cloud environment which have impacted the University's service	11.5.2	
11	Ensure the access to audit logs shall be strictly controlled and all audit logs are tamper-resistant to prevent unauthorized modification	11.7.1	
12	Ensure secure protocols, such as TLS, Virtual Private Network (VPN) or dedicated connections has been implemented for end-to-end data transmission between the Cloud and the University	11.9.1	
13	Ensure network-level access controls has been implemented to prevent unauthorized access	11.9.1	
14	Ensure hardening has been performed to remove or disable all unnecessary configurations, services and ports on cloud system components	11.10.2	
15	Ensure the VM images and snapshots will be handled with care as they may contain capture of CONFIDENTIAL data on the system at the time the image/snapshot was taken	11.10.2	
16	Ensure the same level of protection and compliance controls apply to CSP's sub-contractors	11.11.1	

17	Ensure CSP has provided the procedures to retrieve the University's data/virtual instances and securely remove the data and virtual instances from the CSP's environment when the cloud service is terminated	11.10.2	
18	Ensure CSP complies with relevant industry standards and provides the latest certificates/audit reports for the University to review whenever the certificates/audit reports have been renewed	11.12.1	

12.3 Appendix C: Reference

This Standard is prepared with reference to the following documents :

- Information Security Policies (ISMS-ISPS-001)
- Network and Platform Security Standard (ISMS-ISPS-010)
- Information System Acquisition, Development and Maintenance Standard (ISMS-ISPS-012)
- Logical Access Control Security Standard (ISMS-ISPS-011)
- Information Security Incident Management Standard (ISMS-ISPS-014)
- Business Continuity Management Standard (ISMS-ISPS-015)
- Password Management and Multi-factor Authentication Policy
- Practice Guide for Cloud Computing Security [ISPG-SM04], the Government of Hong Kong Special Administrative Region;
- Information technology – Security techniques – Information security management systems – Requirements, ISO/IEC 27001:2022, dated 25 October 2022;
- Guidelines on Security and Privacy in Public Cloud Computing, NIST Special Publication 800-144
- Application Container Security Guide, NIST Special Publication 800-190
- Cloud Controls Matrix, Cloud Security Alliance (CSA)
- "Privacy Risks of Cloud Computing" -- Privacy Commissioner's article contribution at Hong Kong Lawyer (December 2019)
- Cloud computing (Information leaflet, July 2015), PCPD