Review

1. The Cloud Controls Matrix is a list of cloud security controls mapped by domain and aligned to various regulatory frameworks.
2. The CCM is an excellent tool for evaluating your cloud security controls and is useful to both cloud providers and consumers.
3. The Consensus Assessment Initiative Questionnaire is a standard set of security questions for cloud providers. It allows cloud consumers to directly compare providers and allows providers to reduce the need to respond to non-standard RFPs.
4. The Cloud Security Alliance Guidance (which this training is based on) tells you how to implement your controls, while the CCM tells you which controls to implement.
5. The STAR and StarWatch tool serve as central repositories and methods for cloud provider security documentation, including the CAIQ.

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Module Content

Content in this module comes from the following domains in CSA's Security Guidance:

- **DOMAIN 5** // Information Governance
- **DOMAIN 6** // Management Plane and Business Continuity
- **DOMAIN 11** // Data Security

Covers the following subject areas:

- Cloud data architectures
- Data security and encryption
- CASB and Data Loss Prevention
- Data governance

Click on the module to the right to view the course objectives.

DOWNLOAD THE LATEST VERSION OF THE CSA SECURITY GUIDANCE.

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Module Structure

Unit 1 // Module Intro

Unit 2 // Cloud Data Storage and Data Moving to the Cloud

Unit 3 // Access Controls and Entitlements

Unit 4 // Encryption for IaaS

Unit 5 // Encryption for PaaS and SaaS

Unit 6 // Encryption key management

Unit 7 // Other Data Security Options

Unit 8 // Data Security Lifecycle

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Objectives

Understand the different cloud storage models

Define security issues for data in the cloud

Assess the role and effectiveness of access controls.

Learn different cloud encryption models.

Understand additional data security options

Introduce data security lifecycle.

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Cloud Data Storage Is Different

- All data is eventually stored on a physical device, but cloud platforms use multiple types of data storage virtualization to abstract and build storage pools.
- These are not necessarily off-the-shelf technologies that map to traditional data storage virtualization, like SAN/NAS, that are well known.
- This storage may be expressed/exposed like traditional storage but under the hood is quite different.
- Just like SDN
- Security focuses on access controls, encryption, and proper configuration.

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Major Cloud Data Storage Types

APPLICATION / PLATFORM
- Everything from a content delivery network to a SaaS application that includes file storage as a feature.

DATABASE
- Includes relational and non-relational.
- Not merely a DB running on an instance.

OBJECT
- Resilient file storage via API
- Not normal filesystems. Closer to a "database for files."

VOLUME
- Essentially, virtual hard drives for VMs/Instances.

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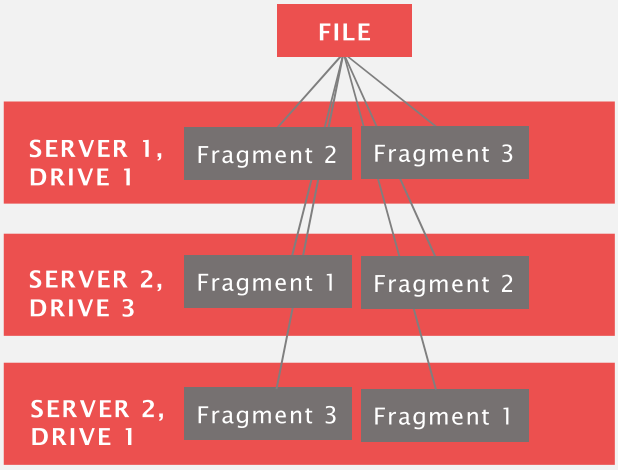
Data Dispersion (Bit-Splitting)



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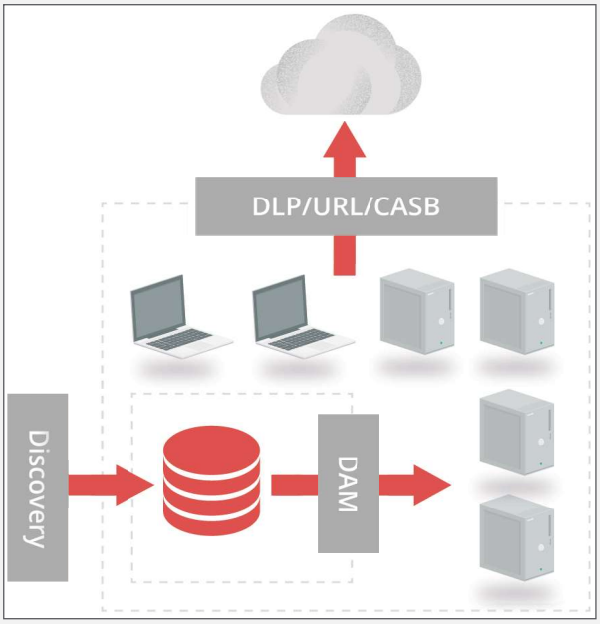
Manage Data Migrating To The Cloud



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Cloud Access Security Brokers (CASB)

Also known as Cloud Security Gateways

DISCOVER | MONITOR | PROTECT

Inline (Local)

Inline (Cloud)

Via API

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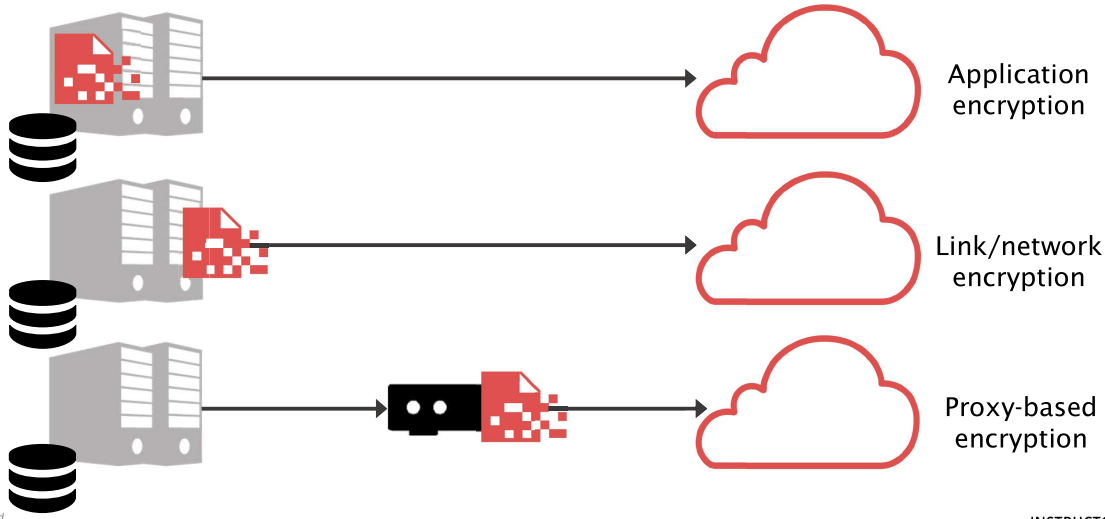
Protecting Data As It Moves



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Review

- Cloud data storage types include object, volume, database and application.
- Cloud providers store data in a multitenant and resilient way
- Migration control tools: CASB, DLP, URL filtering and DAM
- Data in motion can be encrypted client side, on the network, and/or proxy based

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Access Controls and Entitlements

Module 4 // Unit 3

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Access Controls

- Always your first data security control
- Granularity and implementation vary massively between platforms, services, and technologies
- The finer-grained the access controls the better for security, but the harder for manageability
- As with many things they may look the same on the surface but will likely be very different in practice
- It's critical to create platform-specific entitlement matrices

Management plane

Public & internal sharing controls

Application-level controls

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Building An Entitlement Matrix

ENTITLEMENT	SUPER-ADMIN	SERVICE-ADMIN	STORAGE-ADMIN	DEV	SECURITY-AUDIT	SECURITY-ADMIN
VOLUME DESCRIBE	X	X		X	X	X
OBJECT DESCRIBE	X		X	X	X	X
VOLUME MODIFY	X	X		X		X
READ LOGS	X				X	X

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Review

1. Access controls are the most fundamental security control, even in cloud computing.
2. There is massive variability of available access controls between cloud providers, and cloud storage may offer new categories of controls, such as sharing, beyond those in more-traditional storage.
3. An entitlement matrix is the documentation of authorizations. It defines who should be allowed to not only access data, but what they should be allowed to do with it.

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Encryption for IaaS

Module 4 // Unit 4

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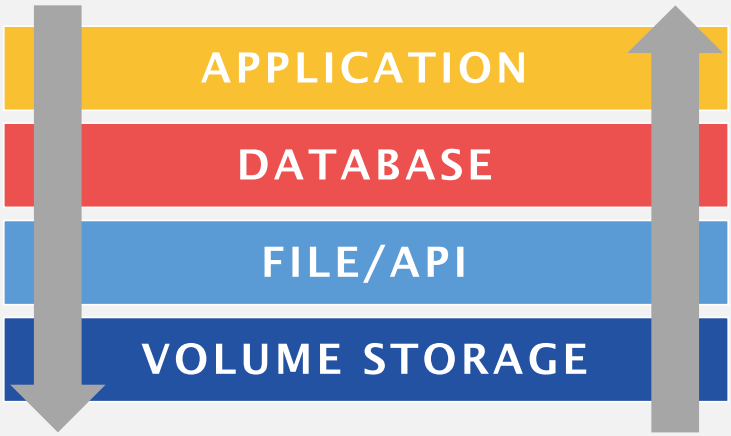
Cloud Data Encryption Layers



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Cloud Encryption System Matrix

Who owns the components? Where are they? How are they connected?

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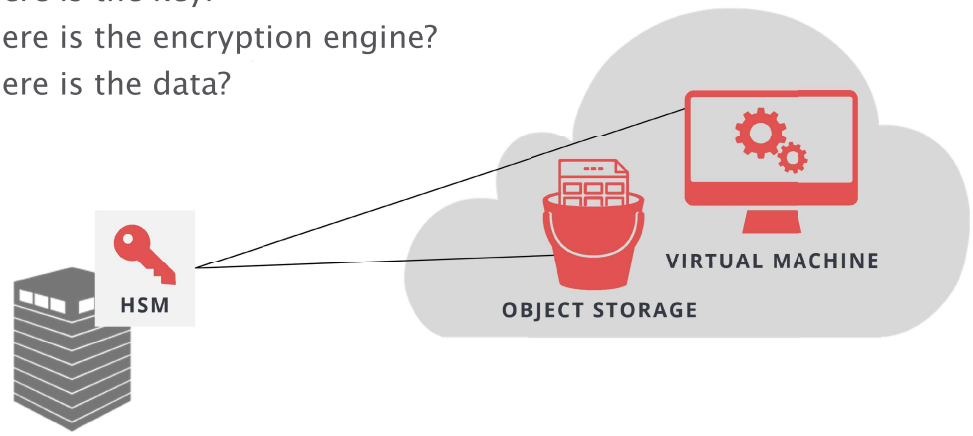
Cloud Encryption System Matrix

- Where is the key?
- Where is the encryption engine?
- Where is the data?



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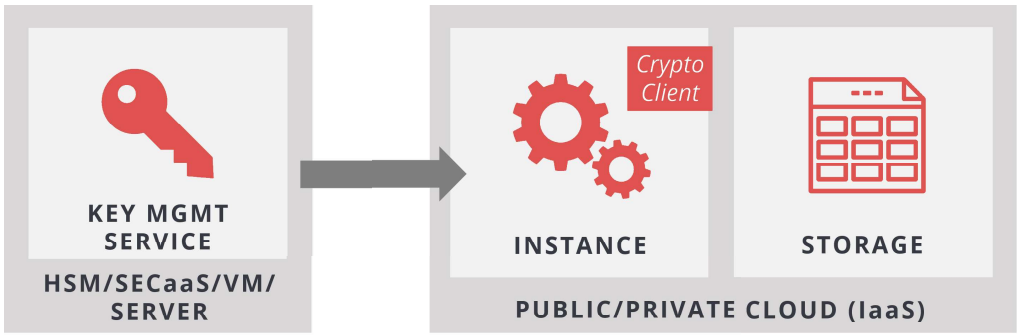
Volume Storage Encryption



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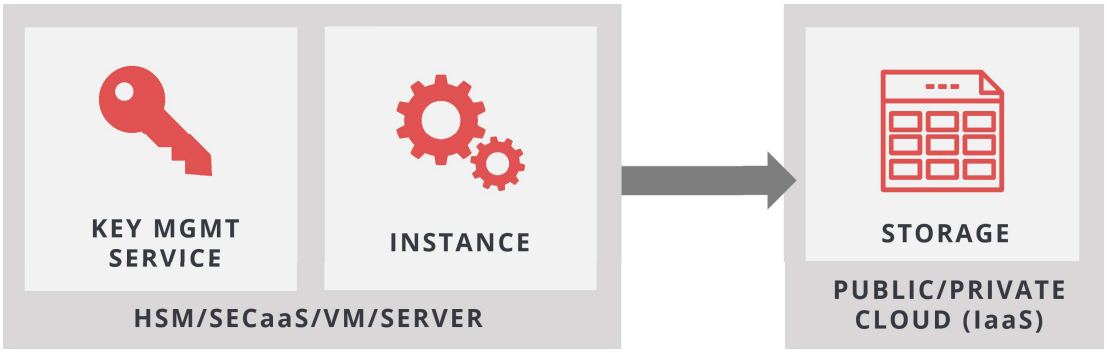
Instance-Managed



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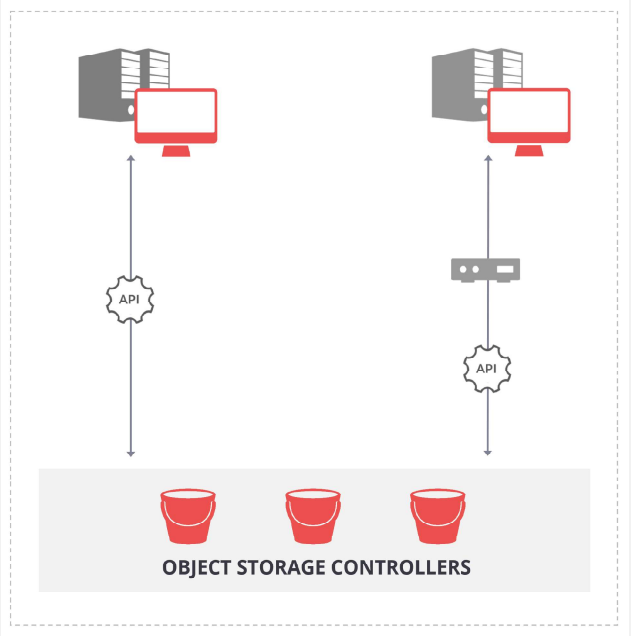
Object Storage

CLIENT-SIDE

SERVER-SIDE

PROXY



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Review

1. There are multiple layers where you can encrypt, each with benefits and complications. Encrypting higher in the application stack is often best for discreet data, while lower-level encryption, like volume, is better for bulk data.
2. Encryption systems are composed of the data, the encryption engine, and the key management, Where you place these determines the architecture and affects the security of the system.
3. Whenever possible, you want to separate the encryption key from the data and the encryption engine.
4. For object storage encryption, you can encrypt the data on the client site, the server side (using multiple techniques), or even through storage proxies (which we frequently see used for site backups).

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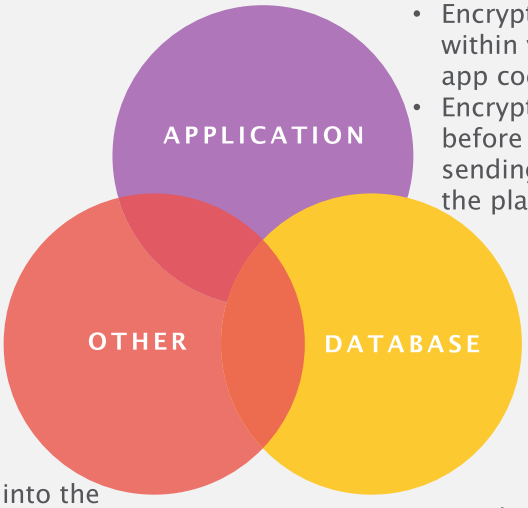
ENCRYPTING PaaS

- When you control the code, you can always encrypt there, which is also more portable.
- Volatile memory and swap files may be issues; understand your platform specifics.
- If you are the provider, use per-customer keys as much as possible.



- Encrypt within your app code
- Encrypt before sending to the platform

- Integrated into the provider's platform
- May include customer-managed key options

- Transparent Database Encryption (TDE)
- Field-Level

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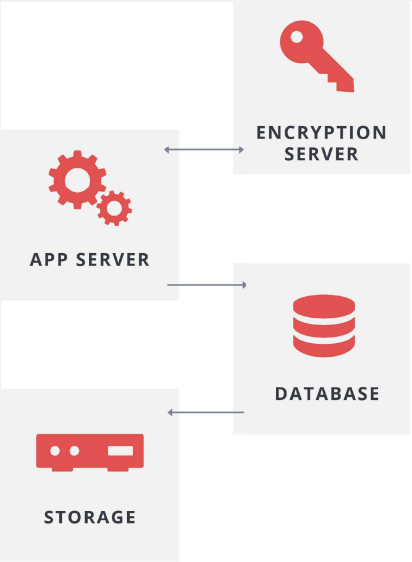
Example // Application Encryption Architecture

- Where is the key?
- Where is the data?
- Where is the encryption engine?



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SaaS Encryption

Provider Managed

- Provider-managed may offer customer managed keys (we will discuss in a moment)

Customer Managed

- Proxy encryption requires an external tool or service
  - You re-route SaaS traffic to the proxy before it is sent to your SaaS provider
  - This encryption typically breaks SaaS applications, often dramatically reducing capabilities

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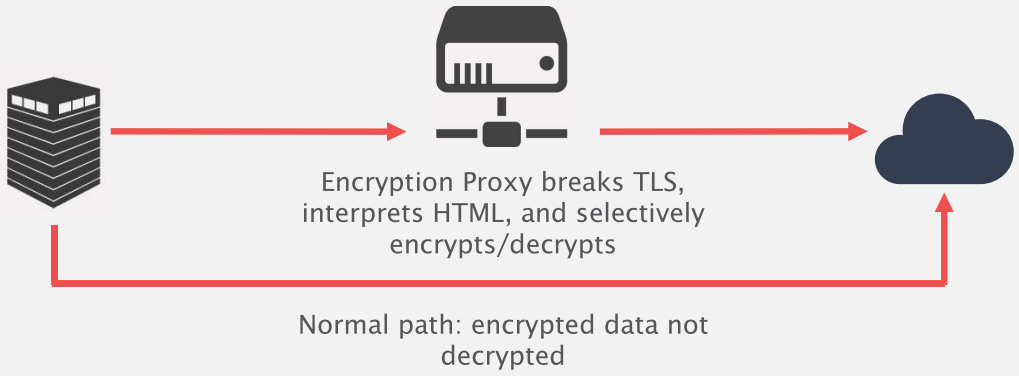
PROXY ENCRYPTION FOR SaaS



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Review

1. Platform as a Service (PaaS) encryption will depend almost completely on the kind of platform and options supported by your provider. For workloads though, you can nearly always program your own encryption at the application layer.
2. When encrypting in your application, you can handle the encryption in your own code or hand it off to an external encryption server or service.
3. For Software as a Service you only have two options – rely on your provider's supported encryption or use a third-party encryption proxy that sits as a man in the middle.
4. SaaS encryption proxies may introduce new security concerns due to requiring you to break any network encryption to the cloud provider. They may also break application functionality. However, there are still valid use cases, albeit limited.

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Cloud Key Management Options

HSM / APPLIANCE

VIRTUAL APPLIANCE / SOFTWARE

CLOUD PROVIDER SERVICE

HYBRID

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Provider Key Management & BYOK

- Some providers build encryption into their platform. By default they typically manage keys for you.
  - E.g., The checkbox to encrypt an S3 bucket, or the default encryption on Box/Dropbox.
- Some providers now allow you to manage your own keys. "Bring your own key" (we also call these customer managed keys).
  - To varying degrees of security. Some are fully under your control, others the provider can technically get to, but they provide separation of duties.

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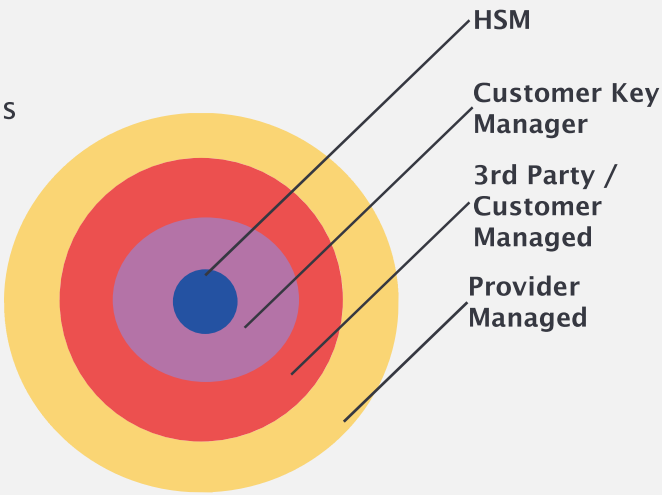
Cloud Key Management Options

- The customer owns the keys, but the provider may manage
- This isn't necessarily insecure it all depends on the provider's security controls
- Providers should be very transparent about these
- Keys always exposed at some level, but typically data encryption keys, not master keys
- Often good option for SaaS and PaaS



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Review

1. Proper key management is essential to effective encryption.
2. HSMs and physical appliances may be offered by your cloud provider, or you can look at deploying software or virtual appliances in the cloud, connecting to existing hardware over a hybrid connection, or even leverage new options like a key management service from your cloud provider or a third party.
3. Providers offer a range of key management options, from the provider completely managing the keys, to allowing you to manage your own keys in their environment or even provide keys as needed.
4. Bring Your Own Key will work differently on different providers and services, with varying levels of relative security.
5. Once you know the risk you are trying to prevent, you can evaluate the technical options in your provider and platform of choice. Remember, not all data needs the same level of security, so you don't always need to default to the most secure option.

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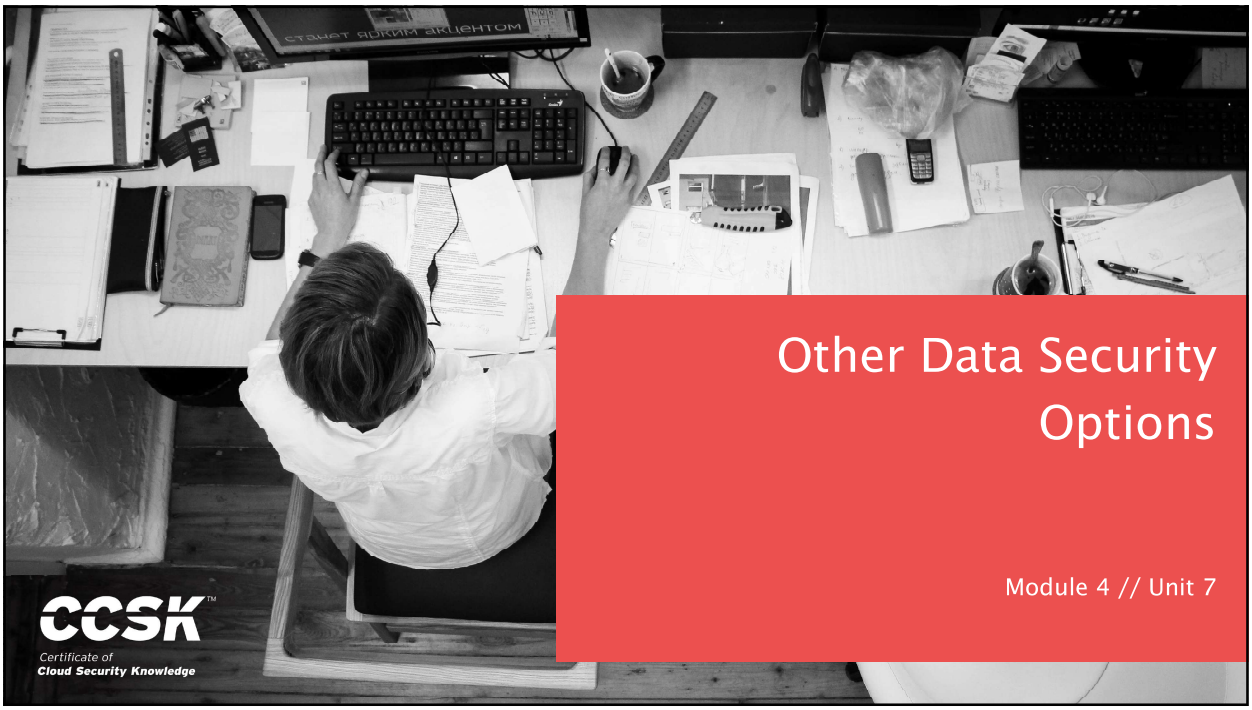

Other Data Security Options

Module 4 // Unit 7

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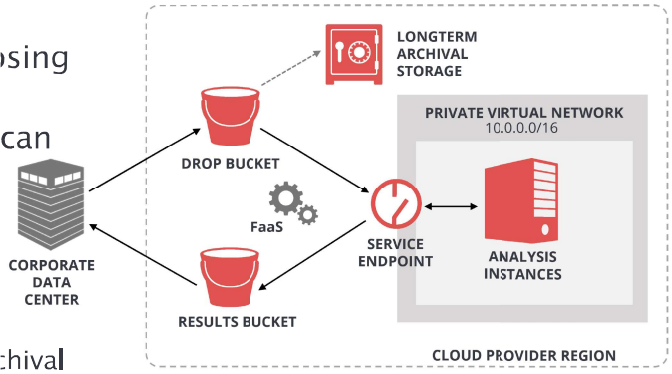
Data Security Architecture

- This example shows using a private network for data processing without ever exposing servers to the internet
- Good architectural decisions can optimize security
- Performance advantages:
  - No servers running
  - No instances
  - No virtual machines
  - You only pay for batch jobs, archival storage & object storage
- There's no network attack path



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More Than Encryption

Auditing/Monitoring/Alerting

- Collect at the provider / metastructure and the data storage level when possible

Provider Specific Controls

- Various providers and platforms have their own data security controls that may not fit our categories

Data Loss Prevention

- Typically a SaaS (and maybe PaaS) priority, don't see much in IaaS
- CASB often best bet, and may integrate with dedicated DLP tools
- Cloud providers sometimes offer basic DLP in the platform (mostly file collaboration products)

ERM/Digital Rights Management

- Full DRM not often seen and not a cloud-specific issue. Will break most SaaS
- Providers may offer DRM-like capabilities (e.g., user + device + content restrictions)

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Data Masking // Dynamic & Test Data Generation

Masking Tool

PRODUCTION

ID	LAST	FIRST	CREDIT CARD PAN
1	Smith	John	1234-5678-9101-1234
2	Doe	Jane	2345-8654-8646-4567

DEV / TEST

ID	LAST	FIRST	CREDIT CARD PAN
1	Jones	John	1234-6824-9854-1234
2	Smith	Jane	2345-8346-1623-4567

Test Data Generation Shown

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Review

1. Integrating PaaS and other new cloud architectural options into applications and data storage may allow cloud consumers to shift more security burden onto cloud providers and reduce the stack's attack surface.
2. Good activity monitoring and alerting are important to cloud data security, and providers may also support a variety of additional security controls.
3. Data Loss Prevention tends to be more useful for SaaS and may be integrated into CASB tools.
4. Traditional DRM/ERM isn't necessarily useful for cloud, but some SaaS/PaaS services may have "DRM-like" capabilities such as sharing or view controls that provide similar protections.
5. Data masking is critical for test data generation and to ensure production data is not exposed in development environments.

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Data Security Lifecycle

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How to Use the Lifecycle

- The Data Security Lifecycle is a tool to help you model your security controls.
- Don't get too granular or it will be too complex to model. Focus on the big picture.
- Use the lifecycle to determine where data flows.
- Then use it to map how data *can* be used, and how it *should* be used.
- When you can do something that shouldn't be allowed, that's where you need to insert a security control.

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Locations & Access

- The simple data security lifecycle does not address location or how data is accessed
- External use reliant on different controls
- Internal and external access usually have different security policies
- You have *multiple* data security lifecycles

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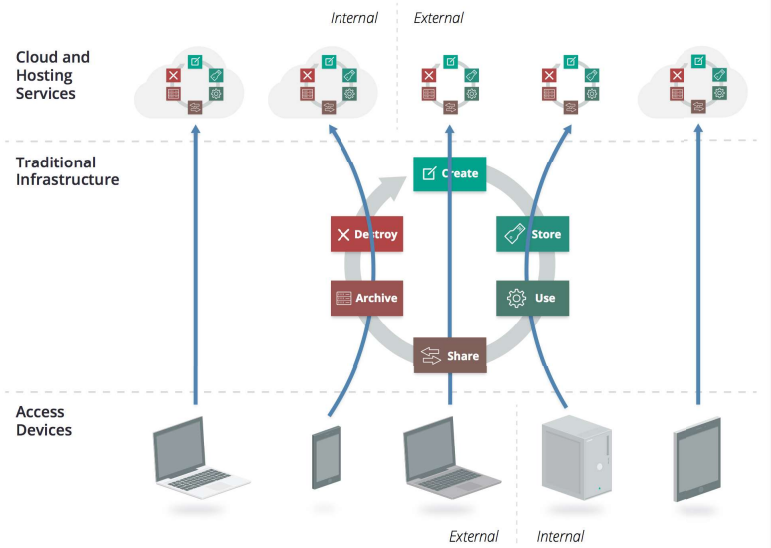
Locations & Access



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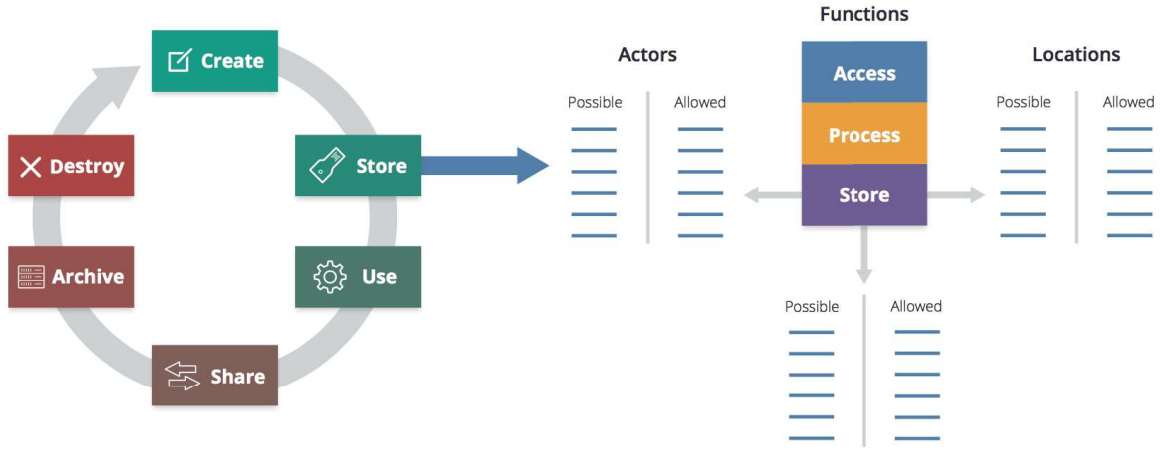
Mapping The Lifecycle To Functions



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Functions Possible in Each Data Lifecycle Phase

	Create	Store	Use	Share	Archive	Destroy
Read	X	X	X	X	X	X
Process	X		X			
Store		X			X	

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Mapping Controls

Function		Action		Location	
Possible	Allowed	Possible	Allowed	Possible	Allowed
		RW	R		
		RWE	E		
		E			

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Recommendations

- Understand the specific capabilities of the cloud platform you are using.
- Don't dismiss cloud provider data security. In many cases it is more secure than building your own and comes at a lower cost.
- Create an entitlement matrix for determining access controls. Enforcement will vary based on cloud provider capabilities.
- Consider CASB to monitor data flowing into SaaS. It may still be helpful for some PaaS and IaaS but rely more on existing policies and data repository security for those types of large migrations.
- Use the appropriate encryption option based on the threat model for your data, business, and technical requirements.

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Recommendations

- Consider use of provider-managed encryption and storage options. Where possible, use a customer-managed key.
- Leverage architecture to improve data security. Don't rely completely on access controls and encryption.
- Ensure both API and data-level monitoring are in place, and that logs meet compliance and lifecycle policy requirements
- Standards exist to help establish good security and the proper use of encryption and key management techniques and processes. Specifically, NIST SP-800-57, ANSI X9.69 and X9.73.

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Review

1. The Data Security Lifecycle is a tool to help us visualize how our data is used and exposed and can be helpful in determining where to place security controls.
2. The lifecycle itself consists of 6 phases from creation to destruction, but practically speaking data will bounce between all the phases as it is used. However, each phase has a distinct set of potential associated security issues and controls.
3. Data will move between various locations, and be accessed using a variety of devices, users, and services. Mapping these can be useful in designing security controls.
4. Depending on the location, phase, etc., the data will have a set of potential actors, functions, and locations. Our application risk assessment will tell us what we want to allow (e.g. through an entitlement matrix.
5. Mapping these against each other will tell us what additional security controls, such as access controls, we need.

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