Securing Cloud Applications & Users

Module 5

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Module Content

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

- Domain 10 // Application Security
- Domain 12 // Identity Entitlement and Access Management
- Domain 14 // Related Technologies

Covers the following subject areas:

- SSDLC
- Immutable
- DevOps
- IAM

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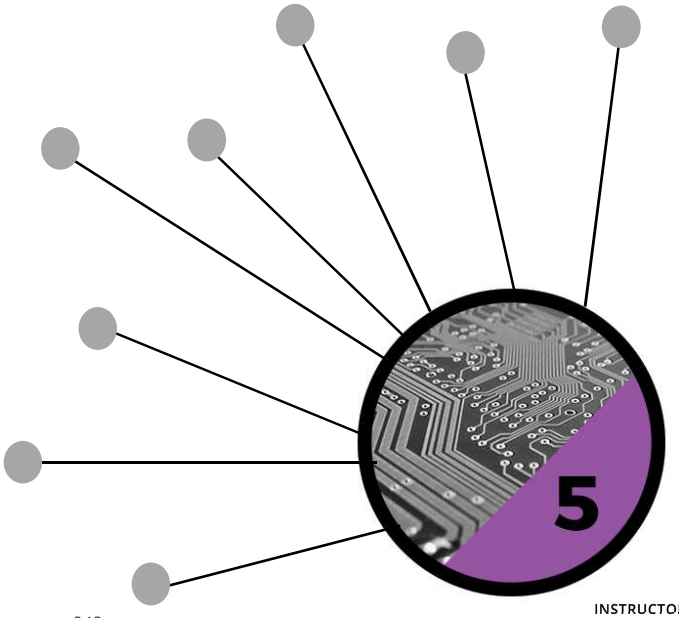
Module Structure

Unit 1 // Module Intro
Unit 2 // SSDLC
Unit 3 // Testing and Assessment
Unit 4 // DevOps and Immutable
Unit 5 // Secure Operations and Architecture
Unit 6 // IAM definitions
Unit 7 // IAM Standards
Unit 8 // IAM in practice



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Objectives

Discover how application security differs in cloud computing.

Review secure software development basics and how those change in the cloud.

Leverage cloud capabilities for more secure cloud applications.

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How Cloud Changes AppSec

Opportunities

- Higher baseline security
- Responsiveness / agility
- Isolated environments
- Independent VMs for microservices
- Elasticity
- DevOps
- Unified interface

Challenges

- Limited visibility
- Increased application scope
- Changing threat models
- Reduced transparency

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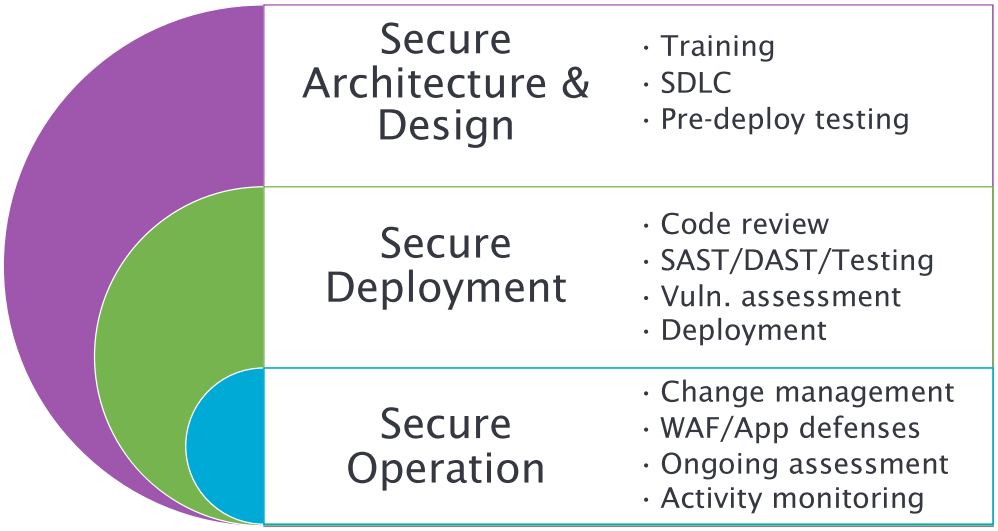
Application Security Phases



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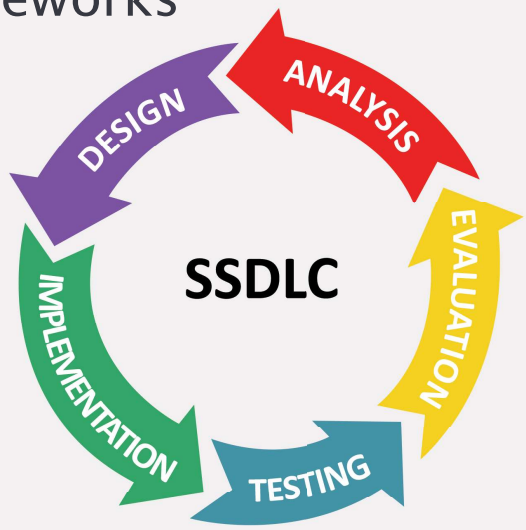
SSDLC Frameworks & Guidance



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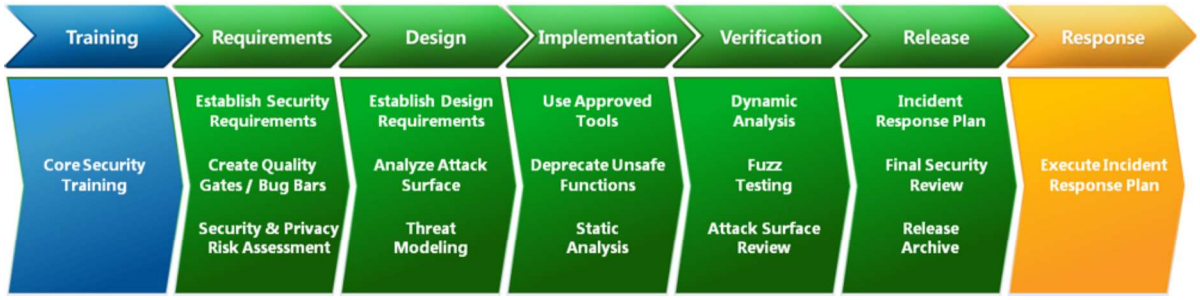
SSDLC Frameworks & Guidance

Microsoft's Security Development Lifecycle



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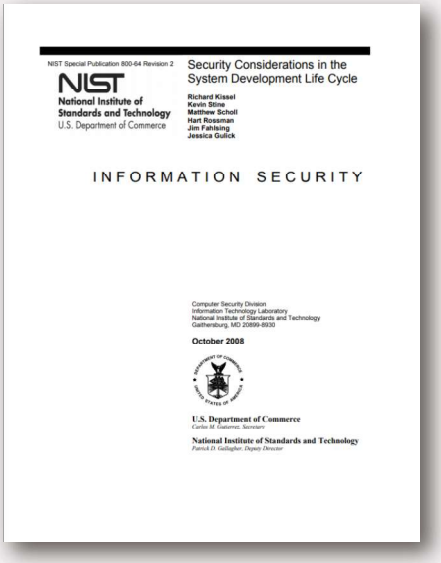
SSDLC Frameworks & Guidance

NIST 800-64


NIST Special Publication 800-64 Revision 2

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Security Considerations in the System Development Life Cycle

Richard Kissel
Kevin Stine
Matthew Scholl
Hart Rossman
Jim Fahlsing
Jessica Gulick

INFORMATION SECURITY

Computer Security Division
Information Technology Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8930

October 2008

U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

National Institute of Standards and Technology
Patrick D. Gallagher, Deputy Director

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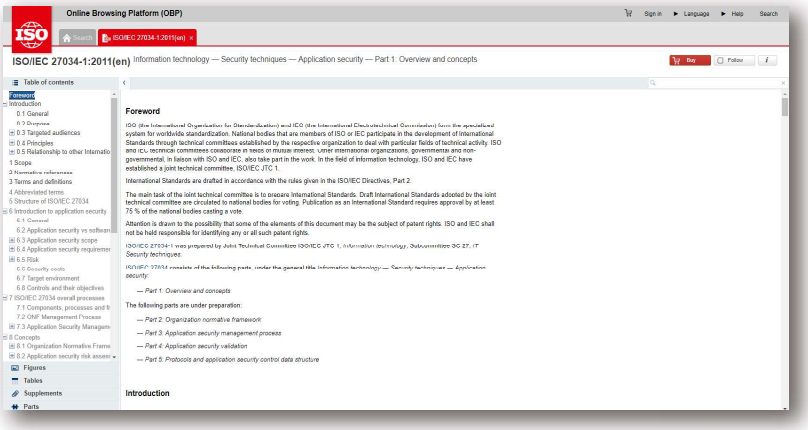
SSDLC Frameworks & Guidance

ISO/IEC 27034



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SSDLC Frameworks & Guidance

- Other organizations, including OWASP and a variety of application security vendors, also publish their own lifecycle and security activities guidance.

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Cloud Impact On SSDLC

- More reliance on cloud provider under shared responsibilities model
- Large changes to visibility and control
- Highly variable differences between providers and platforms
- Management plane/metastructure now within scope of application security
- New architectural options, especially with PaaS
- DevOps // Not cloud-specific, but highly correlated

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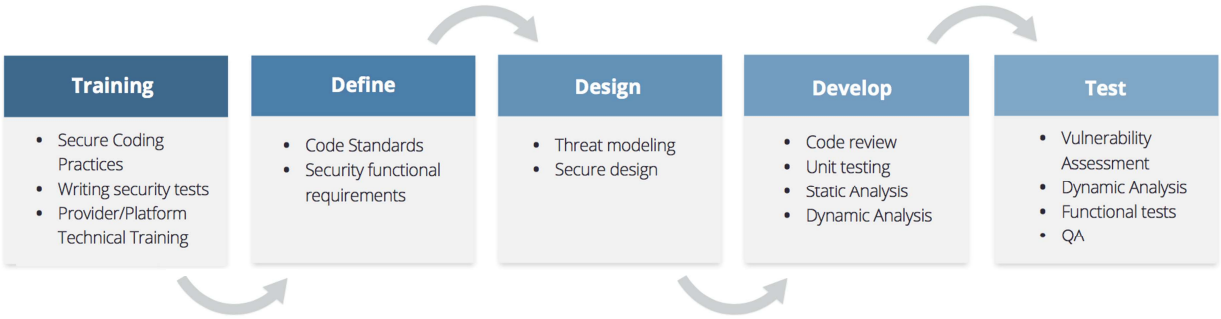
Secure Design & Development



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Threat Modeling Example

THREAT	DESCRIPTION	EXAMPLE
Spoofing	Assume identity of client, server or request/response	Phishing attack to fool user into sending credentials to fake site
Tampering	Alter contents of request of response	Message or data integrity compromised to change parameters or values
Repudiation	Dispute legitimate transaction	Illegitimately claiming a transaction was not completed
Information Disclosure	Unauthorized release of data	Unencrypted message sniffed off the network
Denial of Service	Service not available to authorized users	System flooded by requests until web server fails
Elevation of Privilege	Bypass authorization system	Attacker changes group membership

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Example Mapping Threat Model To Countermeasures

THREAT	SECURITY SERVICE
Spoofing	Authentication
Tampering	Digital signature, Hash
Repudiation	Audit logging
Information Disclosure	Encryption
Denial of Service	Availability
Elevation of Privilege	Authorization

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Review

1. The secure software development lifecycle (SSDLC) is a structured process for ensuring security needs are met throughout application development processes.
2. There are multiple frameworks, such as those from Microsoft and OWASP.
3. Cloud will impact each phase of the lifecycle, from training all the way into operations. Changes in visibility and more reliance on the shared responsibilities model are constant threads.
4. When modeling application threats for cloud deployments, some risk will be greater and some less. Threat modeling is a great way to evaluate these differences.

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SSDLC Testing & Assessment

Module 5 // Unit 3

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Note: Testing is not isolated to secure development or secure deployment, these phases overlap and there aren't walls between them.

We merely break them out as a way to structure the discussion

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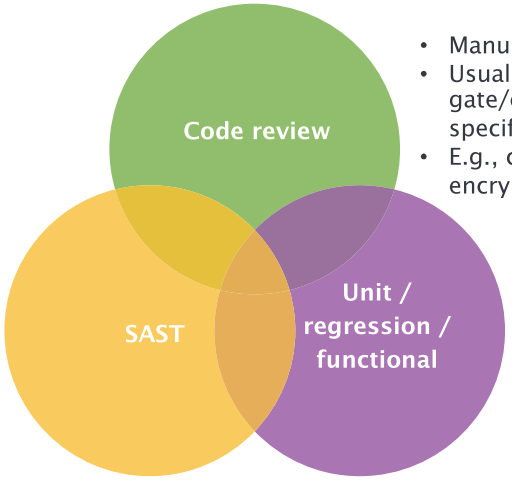
Secure Development & Testing

- Cloud doesn't change the kind of testing, but does change some of what is tested
- E.g., need to account for cloud API calls, environment, PaaS integration



- Manual
- Usually implemented at gate/checkpoint for only specific functionality
- E.g., cloud auth and encryption

- Static Application Security Testing
- Add checks for cloud credentials and API calls

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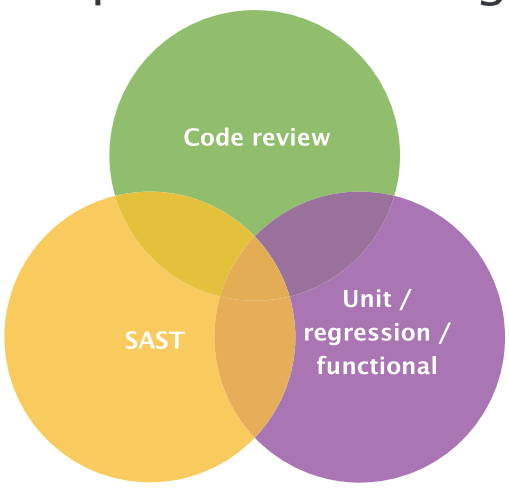
Secure Development & Testing

- In IaaS, you have substantial restrictions to test the cloud infrastructure, but you are free to test the app, database, etc. In PaaS you are free to test your app code and all the rest is restricted. In SaaS you would need to rely on 3rd-party testing done on behalf of the providers
- In IaaS you are generally free to test without permission at the app level, but not in PaaS/SaaS



- Standards of dev testing
- Should be used to test for security capabilities / functions

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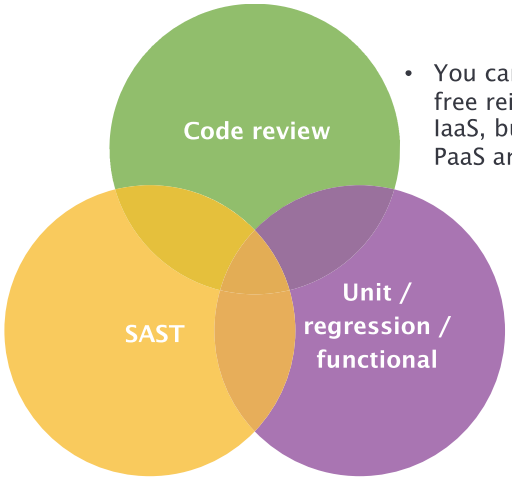
Secure Deployment & Testing

- Use tools and companies with cloud-specific features and experience; tools and background don't translate from traditional to cloud as well in these areas



- You can expect mostly free reign to fuzz in IaaS, but not same level PaaS and SaaS

- Often requires close coordination with Cloud provider (depending on scope)

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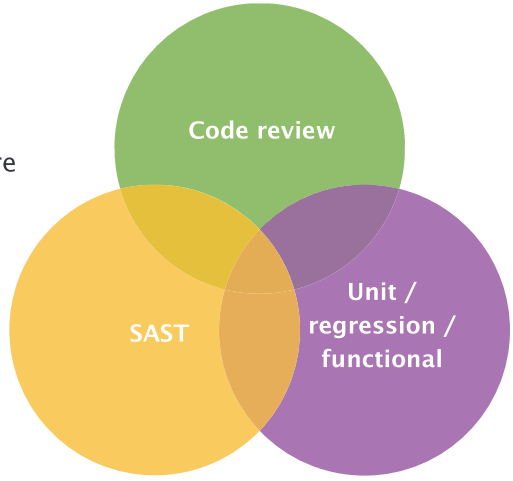
Secure Deployment & Testing

- Include developers and cloud admins within scope of penetration tests since they are often the weak link
- For multitenant apps, allow pen testers authorized access to try and break isolation



- Must define what level in the stack the scan targets
- External scans may require cloud provider permission

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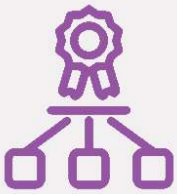
Vulnerability Assessment In The Cloud

Test Images In The Pipeline

Use A Host-based Agent



Traditional Network Assessment (With Permission)

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Review

1. Secure software development involves a range of security testing. All of these are impacted by cloud computing.
2. With static analysis you should place a greater emphasis on looking for stored cloud credentials, as well as the proper configuration of API usage.
3. Dynamic analysis and vulnerability assessment may require permission from your cloud provider.
4. New vulnerability analysis options, such as scanning in a deployment pipeline or using host-based agents, are often better used for cloud.
5. Assessing the configuration of the cloud environment should now be within scope for an application security assessment.

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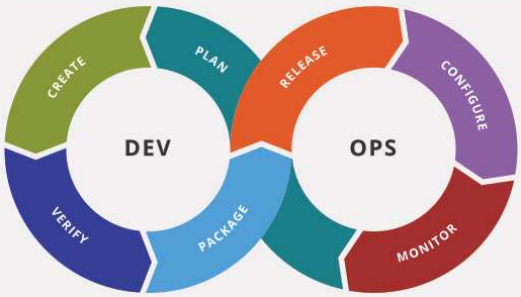
DevOps

Security Benefits:

- Greater standardization
- Automated testing
- Improved auditing
- Leverage automation techniques to improve security operations



No single definition, but typically refers to changing culture and process around continuous integration / delivery and automation.

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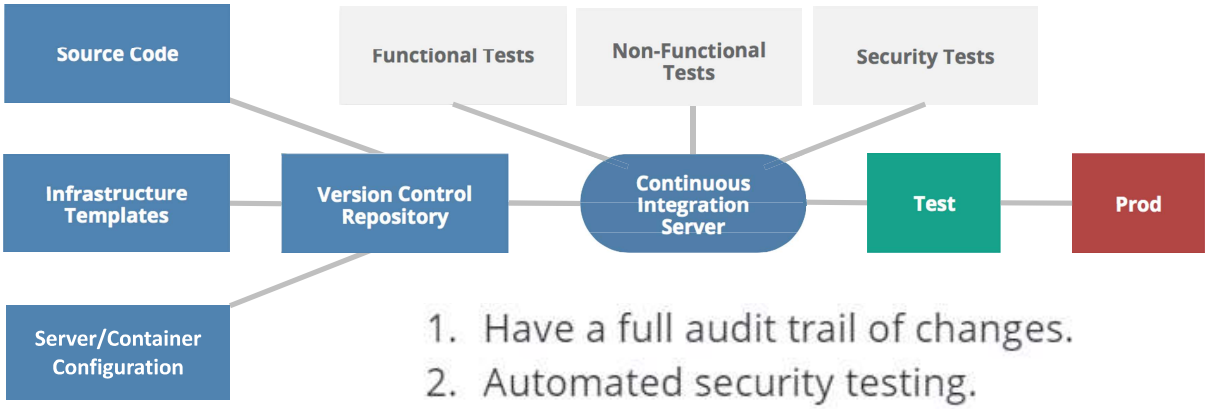
DevOps & Continuous Integration



1. Have a full audit trail of changes.
2. Automated security testing.

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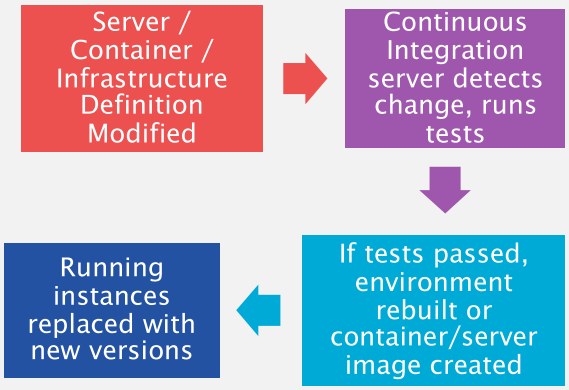
Immutable & Infrastructure As Code

- Infrastructure stack, virtual machines (instances), and containers all defined in templates in version control
- Environments and servers/containers rebuilt based on updated configurations
- Changes never made manually in production since the next approved change would overwrite
- Entire environment fully consistent, easy to rebuild / roll-back
- Can remove ability to log into production E.g., disable SSH on instances
- Massive security benefits- consistency, control, auditability



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Review

1. There are many definitions of DevOps, but a key defining characteristic is the use of continuous integration and/or continuous delivery (CI/CD).
2. Continuous integration pipelines support consistency and integrated security testing.
3. DevOps also supports immutable deployments, where instead of updating things or making manual changes we replaced them from a known good definition.
4. This supports security through consistency and allowing us to even remove the need to log into production assets.
5. There is a lot more to DevOps, but integrated security testing, consistency due to use of CI/CD, and immutable are some of the key security benefits.

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Secure Operations

- Lock down the management plane very tightly for production
- Actively monitor for changes at both cloud and app stack levels
- Don't neglect ongoing testing
- Cloud configuration is now within scope of change management
- WAF: Must auto scale, be embedded in the workload, or be cloud-hosted (filter traffic before it hits your application)
- RASP (Realtime Application Security Protection) an emerging option
  - RASP, one variant resembles a WAF inside the application

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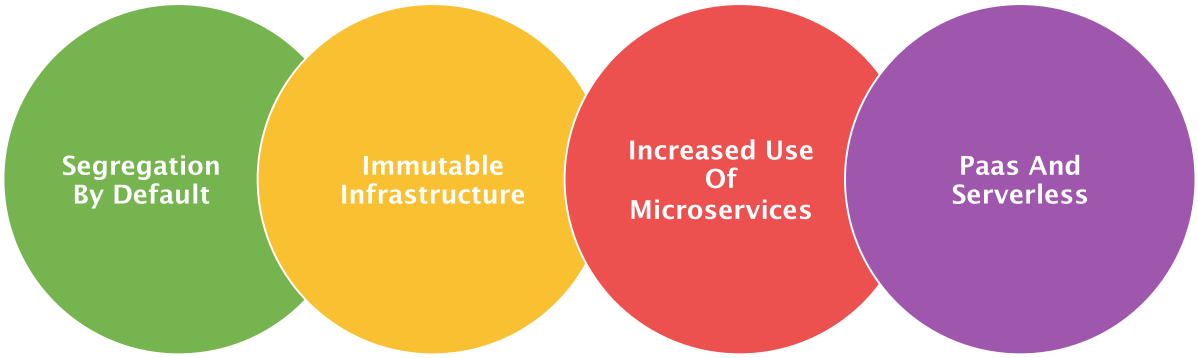
How Cloud Impacts Application Design & Architecture



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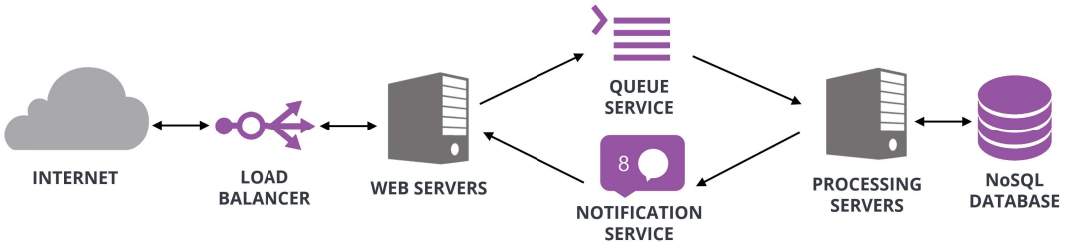
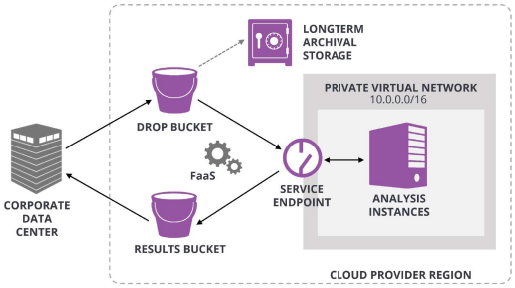
PAAS/Serverless & Security



- Provider takes on more security responsibilities
- Communicating via API on provider's platform reduces network attack paths
- Enables *software defined security* (security automated with APIs and code)
- May enable *event-driven security* (events in the cloud trigger execution of security code)



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Application Security Recommendations

- Understand the security capabilities of your cloud providers. Not merely their baseline, but the various platforms and services.
- Build security into the initial design process. Cloud deployments are more often greenfield, creating new opportunities to engage security early.
- Even if you don't have a formal SDLC, consider moving to continuous deployment and automating security into the deployment pipeline.
- Threat modeling, SAST, and DAST (with fuzzing) should all be integrated. Testing should be configured to work in the cloud environment, but also to test for concerns specific to cloud platforms, such as stored API credentials.

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Application Security Recommendations

- Understand the new architectural options and requirements in the cloud. Update your security policies and standards to support them, and don't merely attempt to enforce existing standards on an entirely different computing model.
- Integrate security testing into the deployment process.
- Use software-defined security to automate security controls.
- Use event-driven security, when available, to automate detection and remediation of security issues.
- Use different cloud environments to better segregate management plane access and provide developers the freedom they need to configure development environments, while also locking down production environments.

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Review

1. Secure operations is all about keeping your application secure once it is deployed into production.
2. When using cloud, the management plane is now a concern and the cloud configuration is now within scope for change management.
3. WAF will need to be adjusted to account for the different deployment options, like autoscaling, used in cloud.
4. New cloud architectural options, such as serverless and micro services may offer security benefits and are increasingly common.
5. Serverless puts more responsibility onto the cloud provider, leveraging the shared responsibilities model to reduce the customer's attack surface and scope of security operations.

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Identity & Access Management Definitions

Module 5 // Unit 6

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Intro To CSA Identity Terms

ENTITY	• Discrete types that will have *Identity*; these are to Users, Devices, Code, Organizations and Agents
IDENTITY	• The unique expression of an entity within a given namespace.
IDENTIFIER	• The means by which an *Identity* can asserted, usually using crypto tokens for digital identities
ATTRIBUTES	• Facets of an *identity* (e.g., org. unit or IP address)
PERSONA	• Expression of an *identity* with attributes that indicates context. E.g., a developer logged into a given project

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Intro To CSA Identity Terms (Cont'd)

AUTHORITAT SOURCE	ROLE	• Has multiple meanings. Typically used to indicate a persona or subset. E.g., "developer" vs. "admin"
AUTHENTICA	AUTHENTICATION	• The process of confirming an identity. *Authn*
MULTIFACTO AUTHENTICA	MULTIFACTOR AUTHENTICATION	• Use of multiple factors in authentication (e.g., username + password + *token*)
AUTHORIZAT	ACCESS CONTROL	• Restricting access to a resource, Access management is the corresponding process
ENTITLEMENT	AUTHORITATIVE SOURCE	• The "root" source for an identity, such as a directory server

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Intro To CSA Identity Terms (Cont'd)

ACCESS CO	AUTHORIZATION	• Allowing an identity access. *Authz*
FEDERATED MANAGEME	ENTITLEMENT	• Mapping an identity to an authorization
IDENTITY P	FEDERATED IDENTITY MANAGEMENT	• The process of asserting an identity across different systems
RELYING PA	IDENTITY PROVIDER	• The trusted source of the identity in federation
ROLE	RELYING PARTY	• The system that relies on an identity assertion from an identity provider

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Review

1. It is important to understand the foundational terminology for identity and access management (IAM).
2. At the heart is an entity, which is a person, device, or other "thing" that will be given access.
3. An identity is the expression of that entity within a namespace, such as an email address or username for a given system.
4. Entities prove their identity by providing identifiers during authentication.
5. After being authenticated, users may be granted access to objects or actions. This is called an authorization, and an entitlement is a specific approval.
6. Federated identity is critical for cloud computing because it allows us to manage identities across different systems.

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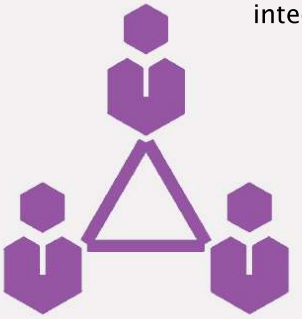
How IAM Is Different For Cloud

Management plane/metastructure integration



IAM now always spans organizational boundaries

Greater use of Federation to manage

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IAM Standards For Cloud

Most Common			Less Common	
SAML	OAUTH	OPENID	XACML	SCIM

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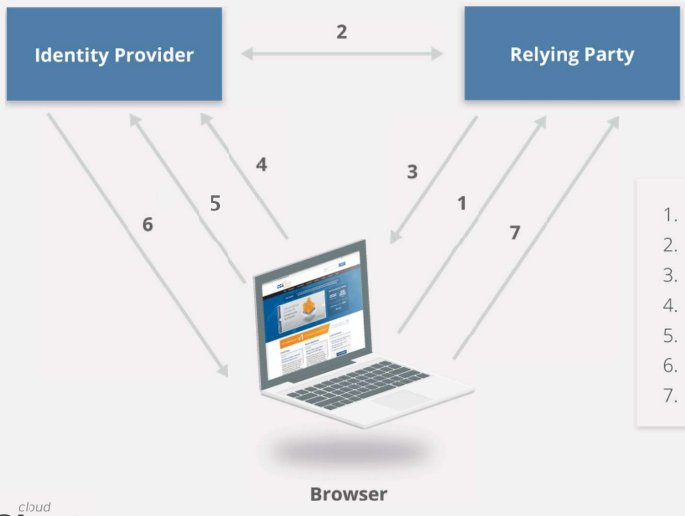
OPENID EXAMPLE



1. User sends their OpenID URL
2. IP and RP set shared secret
3. Browser redirected to get token from provider
4. Request to IP for token for site
5. Login if needed
6. Token returned to browser
7. Token handed to requesting site

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Review

1. IAM for cloud computing relies on federated identity due to the requirement to manage authentication and authorization between the cloud consumer and the cloud provider.
2. The most widely supported and used federation standard for connecting enterprises with their cloud providers SAML.
3. Oauth and OpenID are web-centric federation standards often used by both consumers and organizations.
4. Federation involves multi-step cryptographically supported processes to connect an Identity Provider (the source for the identity) and the Relying Party (most often the cloud provider, where authorizations occur).
5. Typically the identity provider handles authentication, then the relying party handles authorization (enforcing what someone can actually do).

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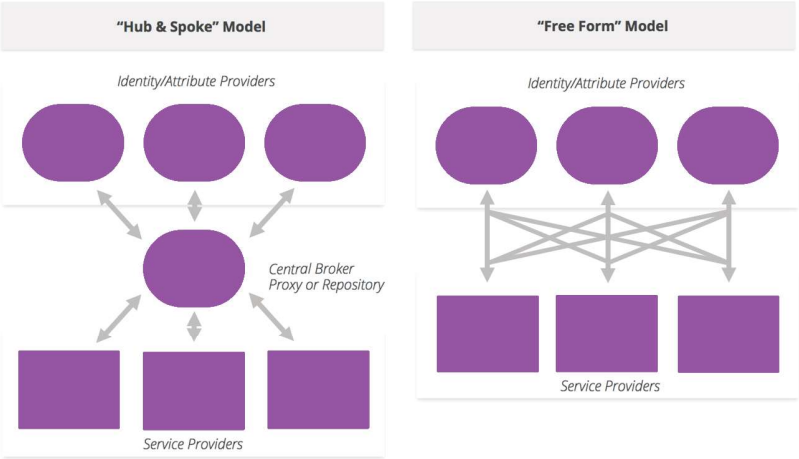
Managing Users & Identities For Cloud

- Cloud providers need to support internal identities and federation
- Cloud consumers need to determine where to manage identities and how to integrate with providers
- Generally, consumers should own the identity and federate to the provider (as much as possible)



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Additional Identity Decisions

- How to manage identities for systems/code/devices/services
  - Defining the identity provisioning process and how to integrate with cloud.
  - Often a good time to review and update your process
- Provisioning and supporting various cloud providers/platforms
  - Mapping attributes
  - Enabling monitoring/logging
  - Building entitlement matrices
  - Documenting break/fix for federation outages
  - IR for account takeovers and other IAM incidents
- Deprovisioning

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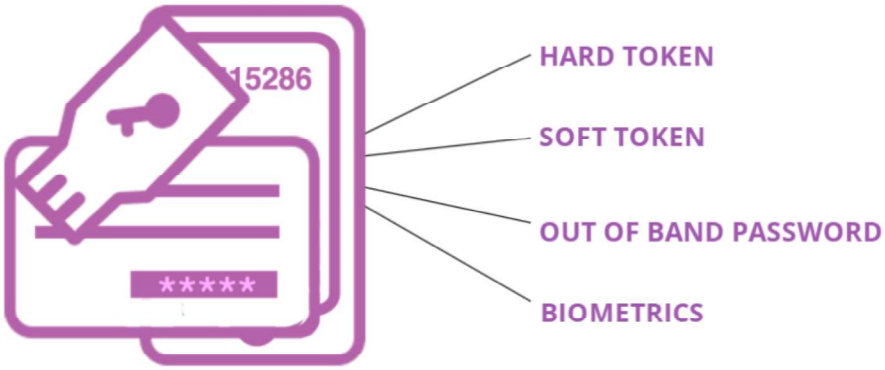
Authentication: MFA Is Mandatory



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Moving From RBAC To ABAC

RBAC
- Role Based Access Controls
- Very familiar
- Decisions based on assigned role in that context

ABAC
- Attribute Based Access Controls
- Decision based on more attributes than just role
- Far more granular and flexible
- Best model for cloud

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Sample Cloud Entitlement Matrix

Entitlement	Super-Admin	Service-1 Admin	Service-2 Admin	Dev	Security-Audit	Security-Admin
Service 1 List	X	X		X	X	X
Service 2 List	X		X	X	X	X
Service 1 Modify Network	X	X		X		X
Service 2 Modify Security Rule	X	X				X
Read Audit Logs	X				X	X

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Identity Management Recommendations

- Organizations should develop a comprehensive and formalized plan and processes for managing identities and authorizations with cloud services.
- When connecting to external cloud providers, use federation, if possible, to extend existing identity management. Try to minimize silos of identities in cloud providers that are not tied to internal identities.
- Consider the use of identity brokers where appropriate.
- Cloud consumers are responsible for maintaining the identity provider and defining identities and attributes.
- These should be based on an authoritative source.
- Distributed organizations should consider using cloud-hosted directory servers when on-premises options either aren't available or do not meet requirements.

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Identity Management Recommendations

- Cloud consumers should prefer MFA for all external cloud accounts and send MFA status as an attribute when using federated authentication.
- Privileged identities should always use MFA.
- Develop an entitlement matrix for each cloud provider and project, with an emphasis on access to the metastructure and/or management plane.
- Translate entitlement matrices into technical policies when supported by the cloud provider or platform.
- Prefer ABAC over RBAC for cloud computing.
- Cloud providers should offer both hosted identities and federation using open standards.
- There are no magic protocols: pick your use cases and constraints first and find the right protocol second.

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Review

1. Due to the complexity of managing multiple directory servers and cloud providers, a hub and spoke model using a federated identity broker is often preferred.
2. Because of the broad network access supported by cloud providers, multi factor authentication is critical to help reduce the chances of account takeovers.
3. Many cloud providers are now supporting attribute based access controls, which support greater granularity in entitlements than traditional role-based access controls.
4. Building an entitlement matrix can help document authorizations for your cloud providers different services and help with assessments and audits.

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