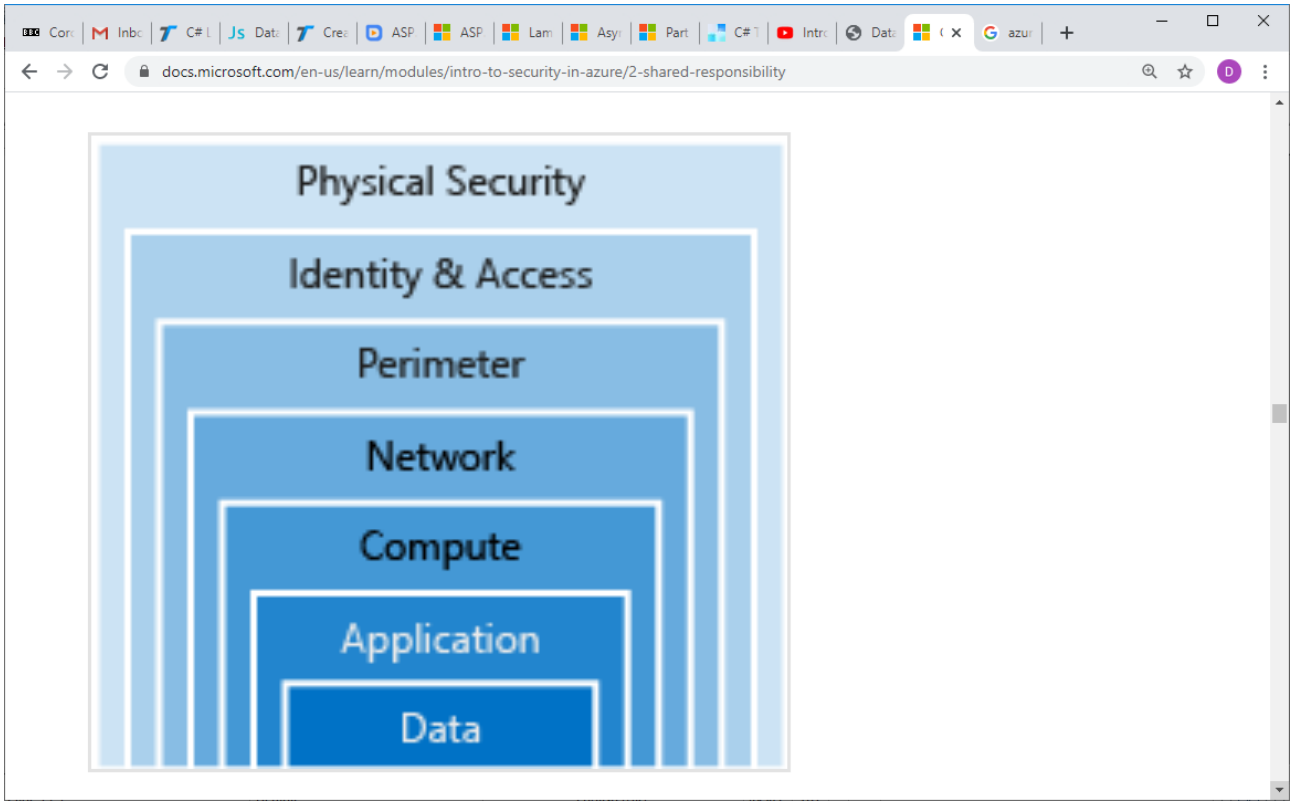
AZ-900 Revision Chapter – 3: Understand Security, Provacy, Compliance and Trust

Cloud security is a shared responsibility

Regardless of the deployment type, you always retain responsibility for the following items:

- Data
- Endpoints
- Accounts
- Access management



Data

In almost all cases, attackers are after data:

- Stored in a database
- Stored on disk inside virtual machines
- Stored on a SaaS application such as Office 365
- Stored in cloud storage

It's the responsibility of those storing and controlling access to data to ensure that it's properly secured. Often, there are regulatory requirements that dictate the controls and processes that must be in place to ensure the confidentiality, integrity, and availability of the data.

Application

- Ensure applications are secure and free of vulnerabilities.
- Store sensitive application secrets in a secure storage medium.

- Make security a design requirement for all application development.

Integrating security into the application development life cycle will help reduce the number of vulnerabilities introduced in code. We encourage all development teams to ensure their applications are secure by default, and that they're making security requirements non-negotiable.

Compute

- Secure access to virtual machines.
- Implement endpoint protection and keep systems patched and current.

Malware, unpatched systems, and improperly secured systems open your environment to attacks. The focus in this layer is on making sure your compute resources are secure, and that you have the proper controls in place to minimize security issues.

Networking

- Limit communication between resources.
- Deny by default.
- Restrict inbound internet access and limit outbound, where appropriate.
- Implement secure connectivity to on-premises networks.

At this layer, the focus is on limiting the network connectivity across all your resources to allow only what is required. By limiting this communication, you reduce the risk of lateral movement throughout your network.

Perimeter

- Use distributed denial of service (DDoS) protection to filter large-scale attacks before they can cause a denial of service for end users.
- Use perimeter firewalls to identify and alert on malicious attacks against your network.

At the network perimeter, it's about protecting from network-based attacks against your resources. Identifying these attacks, eliminating their impact, and alerting you when they happen are important ways to keep your network secure.

Identity and access

- Control access to infrastructure and change control.
- Use single sign-on and multi-factor authentication.
- Audit events and changes.

The identity and access layer is all about ensuring identities are secure, access granted is only what is needed, and changes are logged.

Physical security

- Physical building security and controlling access to computing hardware within the data center is the first line of defense.

With physical security, the intent is to provide physical safeguards against access to assets. These safeguards ensure that other layers can't be bypassed, and loss or theft is handled appropriately.

Get tips from Azure Security Center

- 10 minutes

A great place to start when examining the security of your Azure-based solutions is **Azure Security Center**. Security Center is a monitoring service that provides threat protection across all of your services both in Azure, and on-premises.

Azure Security Center is available in two tiers:

1. Free. Available as part of your Azure subscription, this tier is limited to assessments and recommendations of Azure resources only.
2. Standard. This tier provides a full suite of security-related services including continuous monitoring, threat detection, just-in-time access control for ports, and more. Azure Security Center is $15 per node per month.

You can reduce the chances of a significant security event by configuring a security policy, and then implementing the recommendations provided by Azure Security Center.

- A security policy defines the set of controls that are recommended for resources within that specified subscription or resource group. In Security Center, you define policies according to your company's security requirements.
- Security Center analyzes the security state of your Azure resources. When Security Center identifies potential security vulnerabilities, it creates recommendations based on the controls set in the security policy. The recommendations guide you through the process of configuring the needed security controls. For example, if you have workloads that do not require the Azure SQL Database Transparent Data Encryption (TDE) policy, turn off the policy at the subscription level and enable it only in the resources groups where SQL TDE is required.

Authentication and authorization

Authentication is the process of establishing the identity of a person or service looking to access a resource. It involves the act of challenging a party for legitimate credentials, and provides the basis for creating a security principal for identity and access control use. It establishes if they are who they say they are.

- Authorization is the process of establishing what level of access an authenticated person or service has. It specifies what data they're allowed to access and what they can do with it.

What is Azure Active Directory?

Authentication. This includes verifying identity to access applications and resources, and providing functionality such as self-service password reset, multi-factor authentication (MFA), a custom banned password list, and smart lockout services.

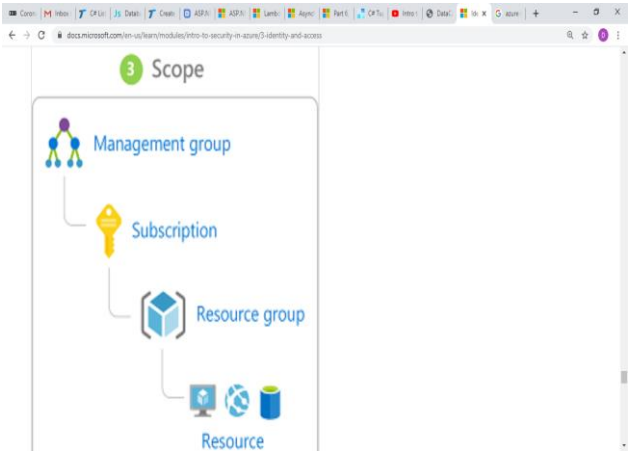
- **Single-Sign-On (SSO).** SSO enables users to remember only one ID and one password to access multiple applications. A single identity is tied to a user, simplifying the

security model. As users change roles or leave an organization, access modifications are tied to that identity, greatly reducing the effort needed to change or disable accounts.

- **Application management.** You can manage your cloud and on-premises apps using Azure AD Application Proxy, SSO, the My apps portal (also referred to as Access panel), and SaaS apps.
- **Business to business (B2B) identity services.** Manage your guest users and external partners while maintaining control over your own corporate data
- **Business-to-Customer (B2C) identity services.** Customize and control how users sign up, sign in, and manage their profiles when using your apps with services.
- **Device Management.** Manage how your cloud or on-premises devices access your corporate data.

Role-based access control

Roles are sets of permissions, like "Read-only" or "Contributor", that users can be granted to access an Azure service instance.
Identities are mapped to roles directly or through group membership. Separating security principals, access permissions, and resources provides simple access management and fine-grained control. Administrators are able to ensure the minimum necessary permissions are granted.
Roles can be granted at the individual service instance level, but they also flow down the Azure Resource Manager hierarchy.
Here's a diagram that shows this relationship. Roles assigned at a higher scope, like an entire subscription, are inherited by child scopes, like service instances.



Privileged Identity Management

In addition to managing Azure resource access with role-based access control (RBAC), a comprehensive approach to infrastructure protection should consider including the ongoing auditing of role members as their organization changes and evolves. Azure AD Privileged Identity Management (PIM) is an additional, paid-for offering that provides oversight of role assignments, self-service, and just-in-time role activation and Azure AD and Azure resource access reviews.

Symmetric encryption uses the same key to encrypt and decrypt the data. Consider a desktop password manager application. You enter your passwords and they are encrypted with your own personal key (your key is often derived from your master password). When the data needs to be retrieved, the same key is used, and the data is decrypted.

Asymmetric encryption uses a public key and private key pair. Either key can encrypt but a single key can't decrypt its own encrypted data. To decrypt, you need the paired key. Asymmetric encryption is used for things like Transport Layer Security (TLS) (used in HTTPS) and data signing.
Both symmetric and asymmetric encryption play a role in properly securing your data. Encryption is typically approached in two ways:

1. Encryption at rest
2. Encryption in transit

Data at rest is the data that has been stored on a physical medium. This data could be stored on the disk of a server, data stored in a database, or data stored in a storage account. Regardless of the storage mechanism, encryption of data at rest ensures that the stored data is unreadable without the keys and secrets needed to decrypt it. If an attacker was to obtain a hard drive with encrypted data and did not have access to the encryption keys, the attacker would not compromise the data without great difficulty.

Data in transit is the data actively moving from one location to another, such as across the internet or through a private network. Secure transfer can be handled by several different layers. It could be done by encrypting the data at the application layer prior to sending it over a network. HTTPS is an example of application layer in transit encryption.

You can also set up a secure channel, like a virtual private network (VPN), at a network layer, to transmit data between two systems.
Encrypting data in transit protects the data from outside observers and provides a mechanism to transmit data while limiting risk of exposure.

Azure Storage Service Encryption for data at rest helps you protect your data to meet your organizational security and compliance commitments. With this feature, the Azure storage platform automatically encrypts your data before persisting it to Azure Managed Disks, Azure Blob storage, Azure Files, or Azure Queue storage, and decrypts the data before retrieval.

Azure Disk Encryption is a capability that helps you encrypt your Windows and Linux IaaS virtual machine disks. Azure Disk Encryption leverages the industry-standard BitLocker feature of Windows and the dm-crypt feature of Linux to provide volume encryption for the OS and data disks. The solution is integrated with Azure Key Vault to help you control and manage the disk encryption keys and secrets (and you can use managed service identities for accessing Key Vault).

Transparent data encryption (TDE) helps protect Azure SQL Database and Azure Data Warehouse against the threat of malicious activity. It performs real-time encryption and decryption of the database, associated backups, and transaction log files at rest without requiring changes to the application. By default, TDE is enabled for all newly deployed Azure SQL Database instances.

We've seen that the encryption services all use keys to encrypt and decrypt data, so how do we ensure that the keys themselves are secure? Corporations may also have passwords, connection strings, or other sensitive pieces of information that they need to securely store. In Azure, we can use **Azure Key Vault** to protect our secrets.

Azure Key Vault is a centralized cloud service for storing your application secrets. Key Vault helps you control your applications' secrets by keeping them in a single, central location and by providing secure access, permissions control, and access logging capabilities. It is useful for a variety of scenarios:

- Secrets management. You can use Key Vault to securely store and tightly control access to tokens, passwords, certificates, Application Programming Interface (API) keys, and other secrets.
- Key management. You also can use Key Vault as a key management solution. Key Vault makes it easier to create and control the encryption keys used to encrypt your data.
- Certificate management. Key Vault lets you provision, manage, and deploy your public and private Secure Sockets Layer/ Transport Layer Security (SSL/ TLS) certificates for your Azure, and internally connected, resources more easily.
- Store secrets backed by hardware security modules (HSMs). The secrets and keys can be protected either by software, or by FIPS 140-2 Level 2 validated HSMs.

The benefits of using Key Vault include:

- Centralized application secrets. Centralizing storage for application secrets allows you to control their distribution, and reduces the chances that secrets may be accidentally leaked.
- Securely stored secrets and keys. Azure uses industry-standard algorithms, key lengths, and HSMs, and access requires proper authentication and authorization.

- Monitor access and use. Using Key Vault, you can monitor and control access to company secrets.
- Simplified administration of application secrets. Key Vault makes it easier to enroll and renew certificates from public Certificate Authorities (CAs). You can also scale up and replicate content within regions, and use standard certificate management tools.
- Integrate with other Azure services. You can integrate Key Vault with storage accounts, container registries, event hubs, and many more Azure services.

Because Azure AD identities can be granted access to use Azure Key Vault secrets, applications with managed service identities enabled can automatically and seamlessly acquire the secrets they need.

Azure certificates

As mentioned previously, Transport Layer Security (TLS) is the basis for encryption of website data in transit. TLS uses certificates to encrypt and decrypt data. However, these certificates have a lifecycle that requires administrator management. A common security problem with websites is having expired TLS certificates that open security vulnerabilities.

Certificates used in Azure are **x.509 v3** and can be signed by a trusted certificate authority, or they can be self-signed. A self-signed certificate is signed by its own creator; therefore, it is not trusted by default. Most browsers can ignore this problem.

Service certificates

Service certificates are attached to cloud services and enable secure communication to and from the service. For example, if you deploy a web site, you would want to supply a certificate that can authenticate an exposed HTTPS endpoint. Service certificates, which are defined in your service definition, are automatically deployed to the VM that is running an instance of your role.
You can upload service certificates to Azure either using the Azure portal or by using the classic deployment model. Service certificates are associated with a specific cloud service. They are assigned to a deployment in the service definition file.
You can manage service certificates separately from your services, and you can have different people managing them. For example, a developer could upload a service package that refers to a certificate that an IT manager has previously uploaded to Azure.

Management certificates

Management certificates allow you to authenticate with the classic deployment model. Many programs and tools (such as Visual Studio or the Azure SDK) use these certificates to automate configuration and deployment of various Azure services. However, these types of certificates are not related to cloud services.

Using Azure Key Vault with certificates

You can store your certificates in Azure Key Vault - much like any other secret. However, Key Vault provides additional features above and beyond the typical certificate management.

- You can create certificates in Key Vault, or import existing certificates
- You can securely store and manage certificates without interaction with private key material.
- You can create a policy that directs Key Vault to manage the life cycle of a certificate.
- You can provide contact information for notification about life-cycle events of expiration and renewal of certificate.
- You can automatically renew certificates with selected issuers - Key Vault partner x509 certificate providers / certificate authorities.

Protect your network : **A layered approach to network security**

What is a Firewall?

A firewall is a service that grants server access based on the originating IP address of each request. You create firewall rules that specify ranges of IP addresses. Only clients from these granted IP addresses will be allowed to access the server. Firewall rules, generally speaking, also include specific network protocol and port information.
To provide inbound protection at the perimeter, you have several choices.

- **Azure Firewall** is a managed, cloud-based, network security service that protects your Azure Virtual Network resources. It is a fully stateful firewall as a service with built-in high availability and unrestricted cloud scalability. Azure Firewall provides inbound protection for non-HTTP/S protocols. Examples of non-HTTP/S protocols include: Remote Desktop Protocol (RDP), Secure Shell (SSH), and File Transfer Protocol (FTP). It also provides outbound, network-level protection for all ports and protocols, and application-level protection for outbound HTTP/S.
- **Azure Application Gateway** is a load balancer that includes a Web Application Firewall (WAF) that provides protection from common, known vulnerabilities in websites. It is designed to protect HTTP traffic.
- **Network virtual appliances (NVAs)** are ideal options for non-HTTP services or advanced configurations, and are similar to hardware firewall appliances.

When you combine **Azure DDoS Protection** with application design best practices, you help provide defense against DDoS attacks. DDoS Protection leverages the scale and elasticity of Microsoft's global network to bring DDoS mitigation capacity to every Azure region. The Azure DDoS Protection service protects your Azure applications by monitoring traffic at the Azure network edge before it can impact your service's availability. Within a few minutes of attack detection, you are notified using Azure Monitor metrics.

Azure DDoS Protection provides the following service tiers:

- **Basic** - The Basic service tier is automatically enabled as part of the Azure platform. Always-on traffic monitoring and real-time mitigation of common network-level attacks provide the same defenses that Microsoft's online services use. Azure's global network is used to distribute and mitigate attack traffic across regions.
- **Standard** - The Standard service tier provides additional mitigation capabilities that are tuned specifically to Microsoft Azure Virtual Network resources. DDoS Protection Standard is simple to enable and requires no application changes. Protection policies are tuned through dedicated traffic monitoring and machine learning algorithms. Policies are applied to public IP addresses associated with resources deployed in virtual networks, such as Azure Load Balancer and Application Gateway. DDoS standard protection can mitigate the following types of attacks:
- Volumetric attacks. The attackers goal is to flood the network layer with a substantial amount of seemingly legitimate traffic.
- Protocol attacks. These attacks render a target inaccessible, by exploiting a weakness in the layer 3 and layer 4 protocol stack.
- Resource (application) layer attacks. These attacks target web application packets to disrupt the transmission of data between hosts.

Controlling the traffic inside your virtual network

Virtual network security

Once inside a virtual network (VNet), it's crucial that you limit communication between resources to only what is required.

For communication between virtual machines, *Network Security Groups* (NSGs) are a critical piece to restrict unnecessary communication.

Network Security Groups allow you to filter network traffic to and from Azure resources in an Azure virtual network. An NSG can contain multiple inbound and outbound security rules that enable you to filter traffic to and from resources by source and destination IP address, port, and protocol. They provide a list of allowed and denied communication to and from network interfaces and subnets, and are fully customizable.

You can completely remove public internet access to your services by restricting access to service endpoints. With service endpoints, Azure service access can be limited to your virtual network.

Network integration

Virtual private network (VPN) connections are a common way of establishing secure communication channels between networks. Connections between Azure Virtual Network and an on-premises VPN device are a great way to provide secure communication between your network and your VNet on Azure.

To provide a dedicated, private connection between your network and Azure, you can use Azure ExpressRoute. ExpressRoute lets you extend your on-premises networks into the Microsoft cloud over a private connection facilitated by a connectivity provider. With ExpressRoute, you can establish connections to Microsoft cloud services, such as Microsoft

Azure, Office 365, and Dynamics 365. ExpressRoute connections improve the security of your on-premises communication by sending this traffic over the private circuit instead of over the public internet. You don't need to allow access to these services for your end users over the public internet, and you can send this traffic through appliances for further traffic inspection.

Protect your shared documents

Microsoft Azure Information Protection (sometimes referred to as AIP) is a cloud-based solution that helps organizations classify and optionally protect documents and emails by applying labels.
Labels can be applied automatically based on rules and conditions. Labels can also be applied manually. You can also guide users to choose recommended labels with a combination of automatic and manual steps.
After your content is classified, you can track and control how the content is used. For example, you can:

- Analyze data flows to gain insight into your business
- Detect risky behaviors and take corrective measures
- Track access to documents
- Prevent data leakage or misuse of confidential information

Azure Advanced Threat Protection

- 5 minutes

Azure Advanced Threat Protection (Azure ATP) is a cloud-based security solution that identifies, detects, and helps you investigate advanced threats, compromised identities, and malicious insider actions directed at your organization.
Azure ATP is capable of detecting known malicious attacks and techniques, security issues, and risks against your network.

Azure ATP components

Azure ATP consists of several components.

Azure ATP portal

Azure ATP has its own portal, through which you can monitor and respond to suspicious activity. The Azure ATP portal allows you to create your Azure ATP instance, and view the data received from Azure ATP sensors. You can also use the portal to monitor, manage, and investigate threats in your network environment. You can sign in to the Azure ATP portal at https://portal.atp.azure.com . Your user accounts must be assigned to an Azure AD security group that has access to the Azure ATP portal to be able to sign in.

Azure ATP sensor
Azure ATP sensors are installed directly on your domain controllers. The sensor monitors domain controller traffic without requiring a dedicated server or configuring port mirroring.

Azure ATP cloud service

Azure ATP cloud service runs on Azure infrastructure and is currently deployed in the United States, Europe, and Asia. Azure ATP cloud service is connected to Microsoft's intelligent security graph.

Purchasing Azure Advanced Threat Protection

Azure ATP is available as part of the Enterprise Mobility + Security E5 suite (EMS E5) and as a standalone license. You can acquire a license directly from the Enterprise Mobility + Security Pricing Options page or through the Cloud Solution Provider (CSP) licensing model. It is not available to purchase via the Azure portal.

Understand Security Considerations for Application Lifecycle Management Solutions
- 8 minutes

The **Microsoft Security Development Lifecycle (SDL)** introduces security and privacy considerations throughout all phases of the development process. It helps developers build highly secure software, address security compliance requirements, and reduce development costs. The guidance, best practices, tools, and processes in the SDL are practices used internally at Microsoft to build more secure products and services.

Provide training
Security is everyone's job.

Define security requirements
Security and privacy is a fundamental aspect of developing highly secure applications and systems.
actors that influence security requirements include, but are not limited to:
- Legal and industry requirements
- Internal standards and coding practices
- Review of previous incidents
- Known threats

Define metrics and compliance reporting
It's essential for an organization to define the minimum acceptable levels of security quality, and to hold engineering teams accountable to meeting that criteria.
Perform threat modeling
Threat modeling should be used in environments where there is a meaningful security risk.

Establish design requirements
The SDL is typically thought of as assurance activities that help engineers implement more secure features, meaning the features are well engineered for security
Define and use cryptography standards
With the rise of mobile and cloud computing, it's important to ensure all data - including security-sensitive information and management and control data - are protected from unintended disclosure or alteration when it's being transmitted or stored
Manage security risks from using third-party components
The vast majority of software projects today are built using third-party components (both commercial and open source).
Use approved tools
Define and publish a list of approved tools and their associated security checks, such as compiler/linker options and warnings.
Perform Static Analysis Security Testing
Analyzing source code prior to compilation provides a highly scalable method of security code review, and helps ensure that secure coding policies are being followed
Perform Dynamic Analysis Security Testing
Performing run-time verification of your fully compiled or packaged software checks functionality that is only apparent when all components are integrated and running.
Perform penetration testing
Penetration testing is a security analysis of a software system that is performed by skilled security professionals who simulate the actions of a hacker.
Establish a standard incident response process
Preparing an incident response plan is crucial for addressing new threats that can emerge over time, and your plan should be created in coordination with your organization's dedicated Product Security Incident Response Team (PSIRT).