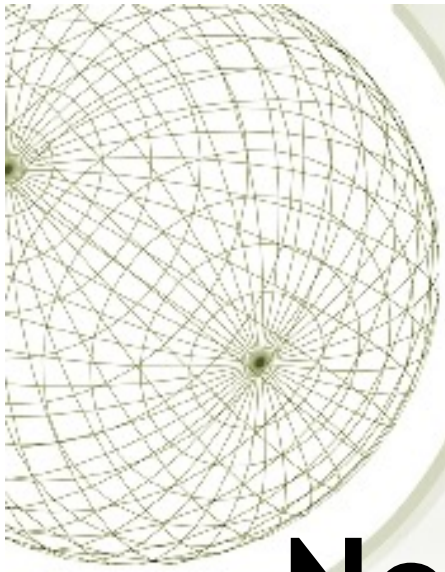

Network Access Control and Cloud Security

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Network Access Control (NAC)

- An umbrella term for managing access to a network
- Authenticates users logging into the network and determines what data they can access and actions they can perform
- Also examines the health of the user's computer or mobile device

NAC systems deal with three categories of components:

Access requester (AR)

- Node that is attempting to access the network and may be any device that is managed by the NAC system, including workstations, servers, printers, cameras, and other IP-enabled devices
- Also referred to as ***supplicants***, or **clients**

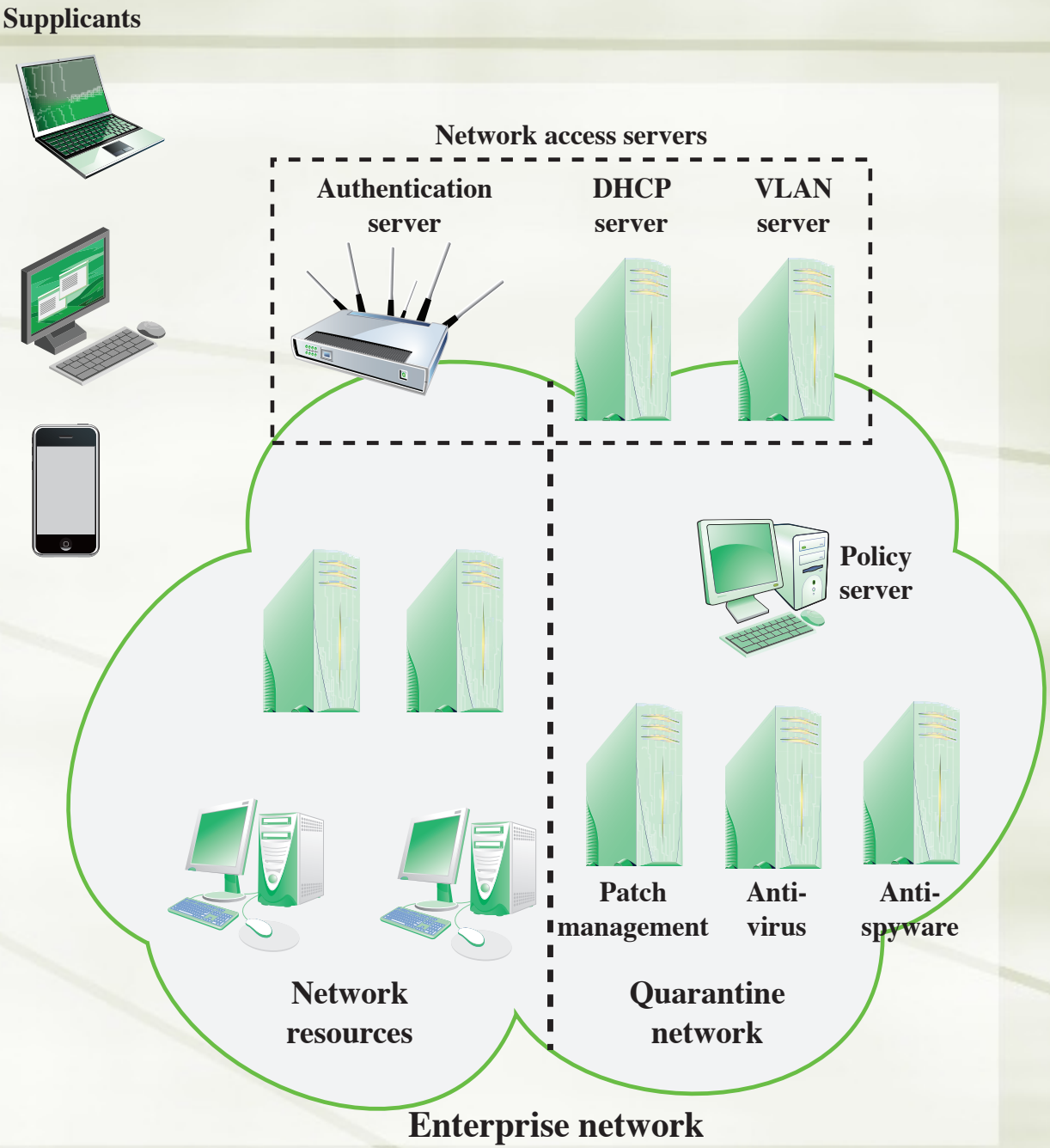
Network access server (NAS)

- Functions as an access control point for users in remote locations connecting to an enterprise's internal network
- Also called a *media gateway, remote access server (RAS), or policy server*
- May include its own authentication services or rely on a separate authentication service from the policy server

Policy server

- Determines what access should be granted
- Often relies on backend systems

Network Access Control Context



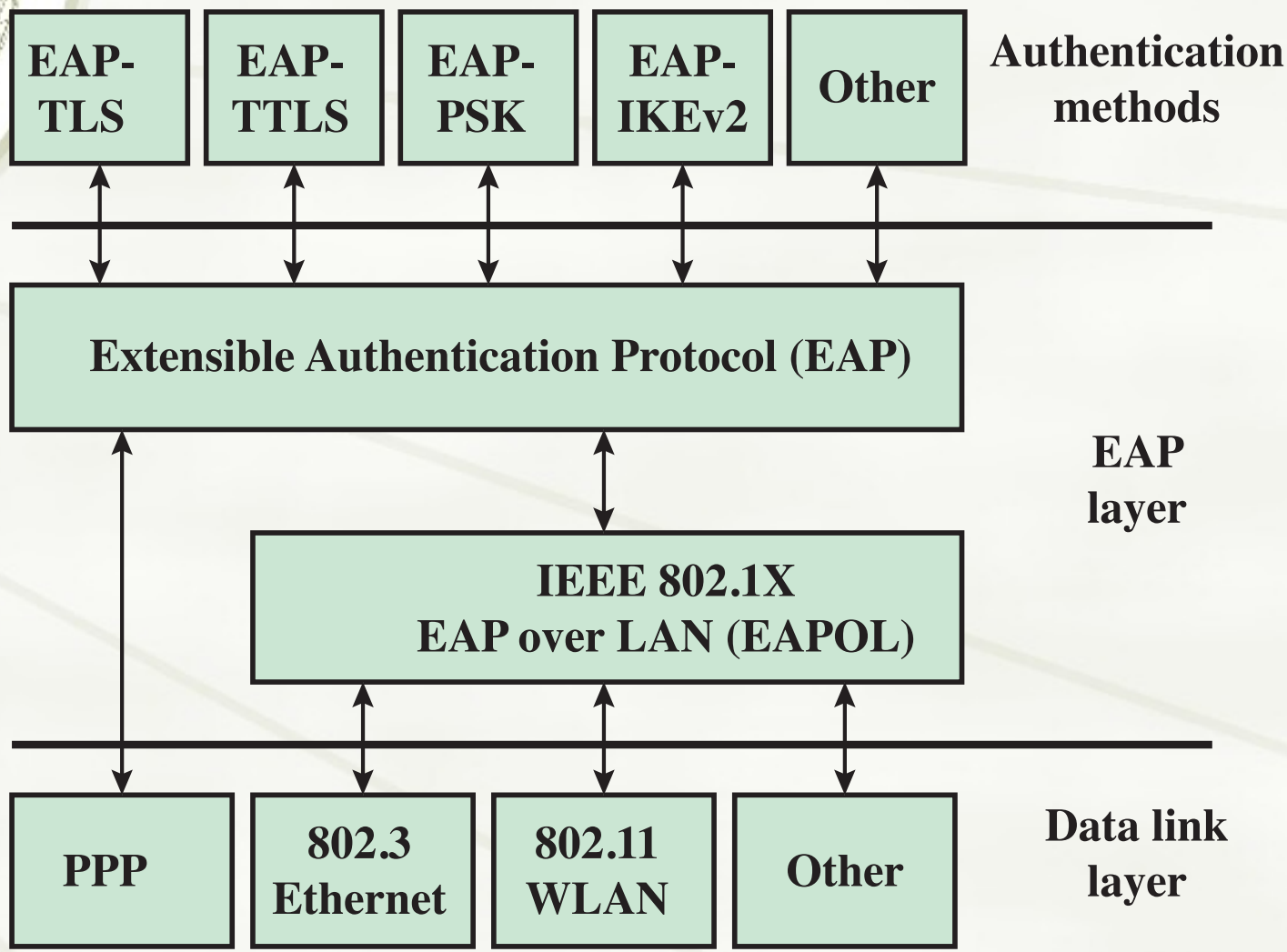
Network Access Enforcement Methods

- The actions that are applied to ARs to regulate access to the enterprise network
  - Many vendors support multiple enforcement methods simultaneously, allowing the customer to tailor the configuration by using one or a combination of methods

Common NAC enforcement methods:

- IEEE 802.1X
- Virtual local area networks (VLANs)
- Firewall
- DHCP management

EAP Layered Context



Authentication Methods

- EAP provides a generic transport service for the exchange of authentication information between a client system and an authentication server
- The basic EAP transport service is extended by using a specific authentication protocol that is installed in both the EAP client and the authentication server

Commonly supported EAP methods:

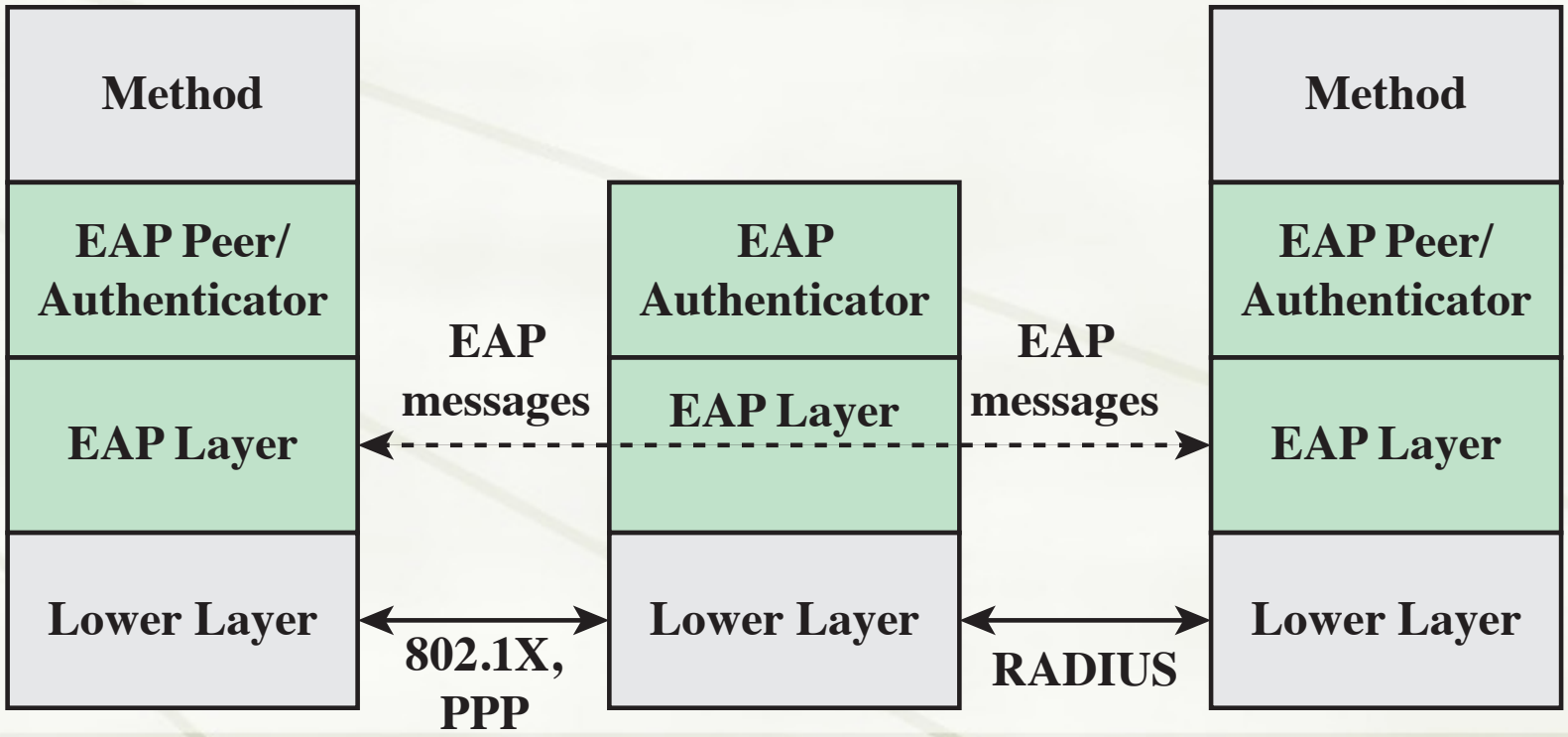
- EAP Transport Layer Security
- EAP Tunneled TLS
- EAP Generalized Pre-Shared Key
- EAP-IKEv2

EAP Protocol Exchanges

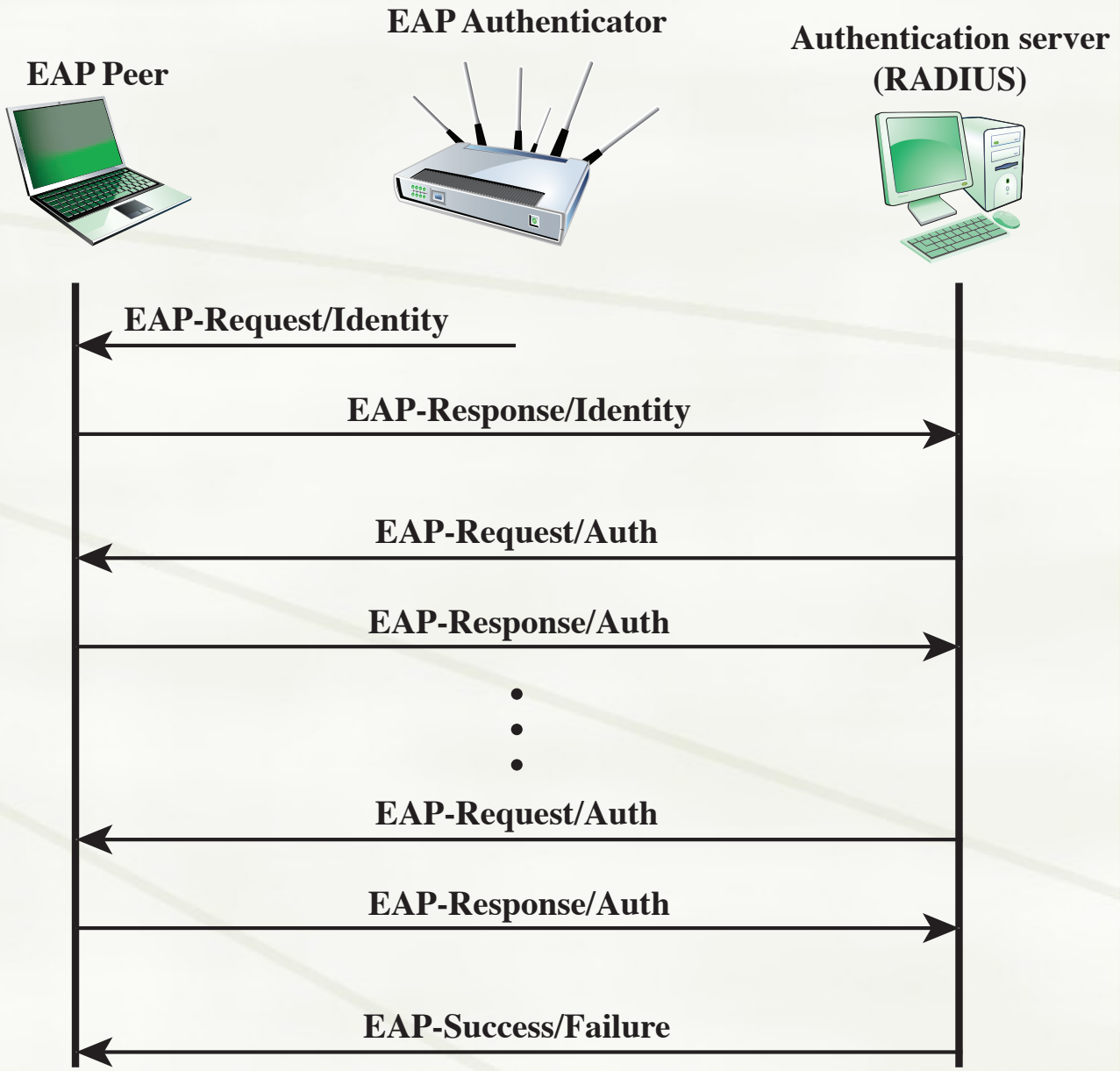
EAP Peer

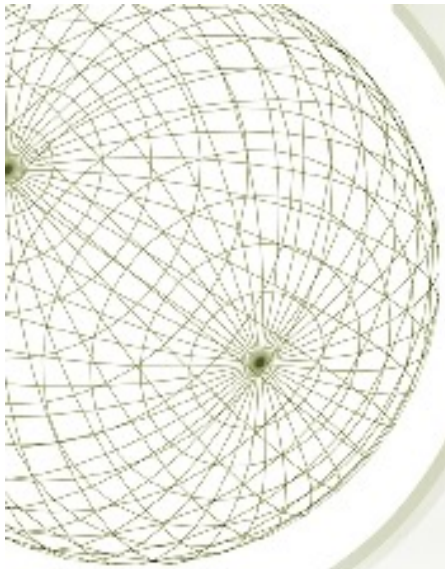
EAP Authenticator

Authentication server (RADIUS)



EAP Message Flow in Pass-Through Mode





Terminology Related to IEEE 802.1X

Authenticator
An entity at one end of a point-to-point LAN segment that facilities authentication of the entity to the other end of the link.

Authentication exchange
The two-party conversation between systems performing an authentication process.

Authentication process
The cryptographic operations and supporting data frames that perform the actual authentication.

Authentication server (AS)
An entity that provides an authentication service to an authenticator. This service determines, from the credentials provided by supplicant, whether the supplicant is authorized to access the services provided by the system in which the authenticator resides.

Authentication transport
The datagram session that actively transfers the authentication exchange between two systems.

Bridge port
A port of an IEEE 802.1D or 802.1Q bridge.

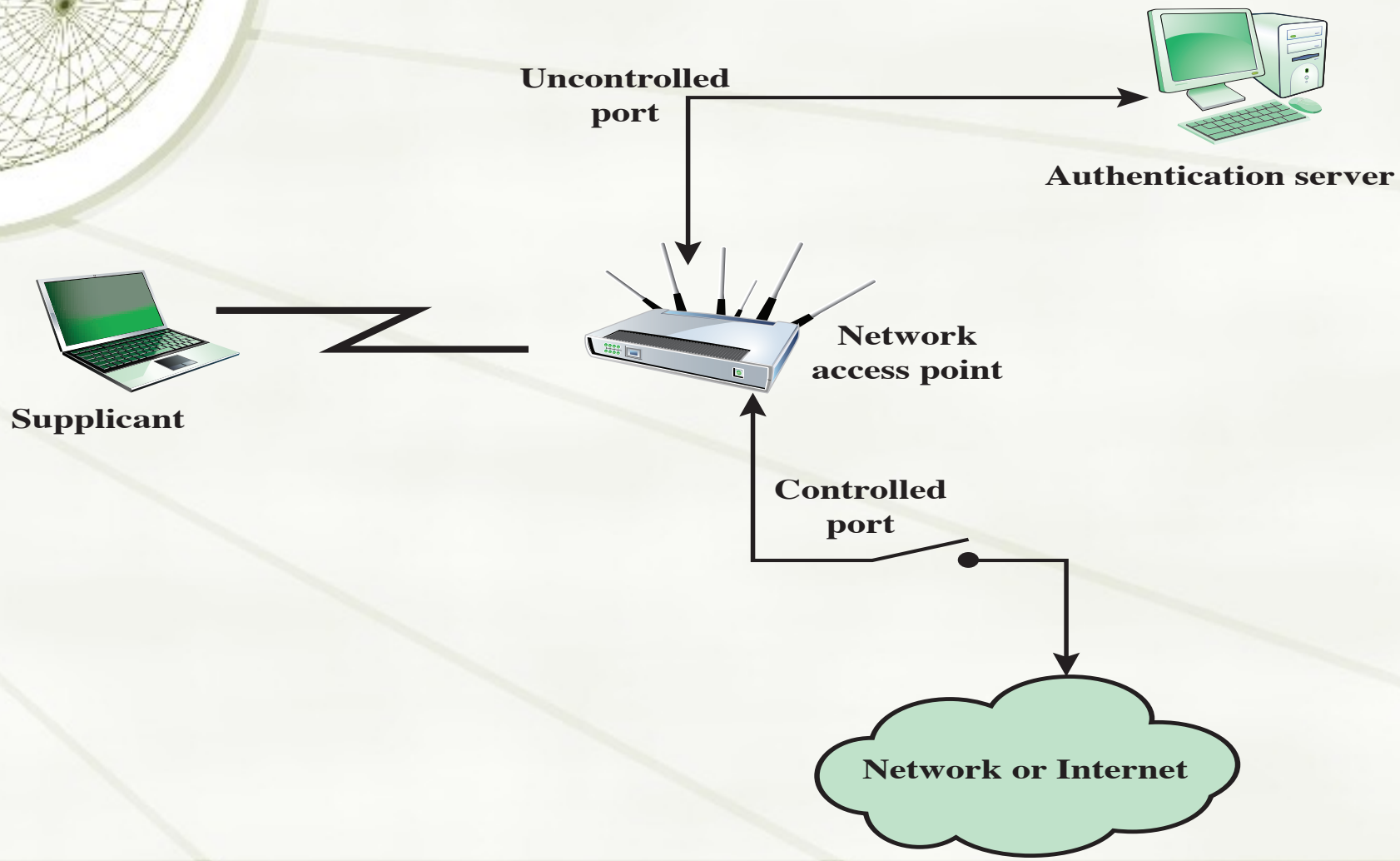
Edge port
A bridge port attached to a LAN that has no other bridges attached to it.

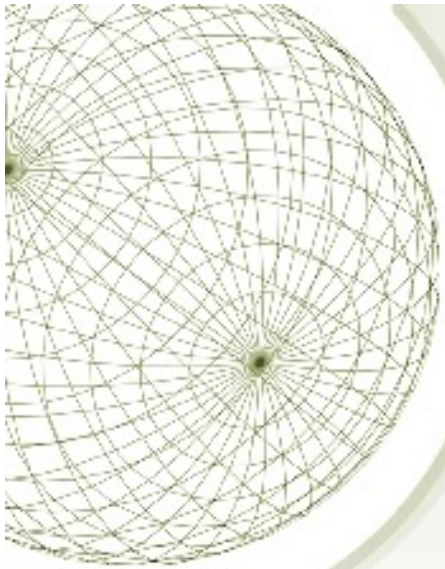
Network access port
A point of attachment of a system to a LAN. It can be a physical port, such as a single LAN MAC attached to a physical LAN segment, or a logical port, for example, an IEEE 802.11 association between a station and an access point.

Port access entity (PAE)
The protocol entity associated with a port. It can support the protocol functionality associated with the authenticator, the supplicant, or both.

Supplicant
An entity at one end of a point-to-point LAN segment that seeks to be authenticated by an authenticator attached to the other end of that link.

802.1X Access Control

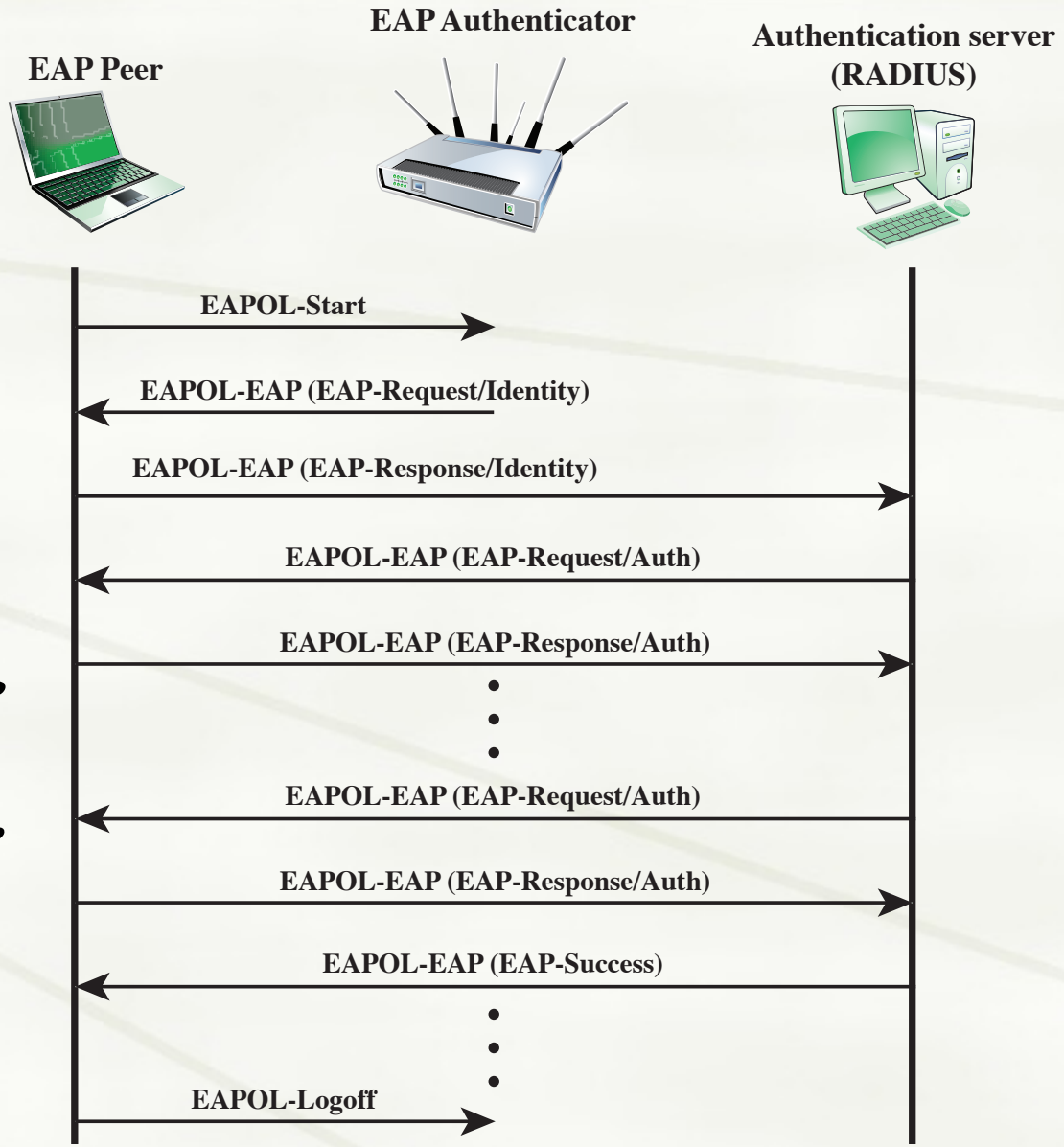




Common EAPOL Frame Types

Frame Type	Definition
EAPOL-EAP	Contains an encapsulated EAP packet.
EAPOL-Start	A supplicant can issue this packet instead of waiting for a challenge from the authenticator.
EAPOL-Logoff	Used to return the state of the port to unauthorized when the supplicant if finished using the network.
EAPOL-Key	Used to exchange cryptographic keying information.

Example Timing Diagram for IEEE 802.1X

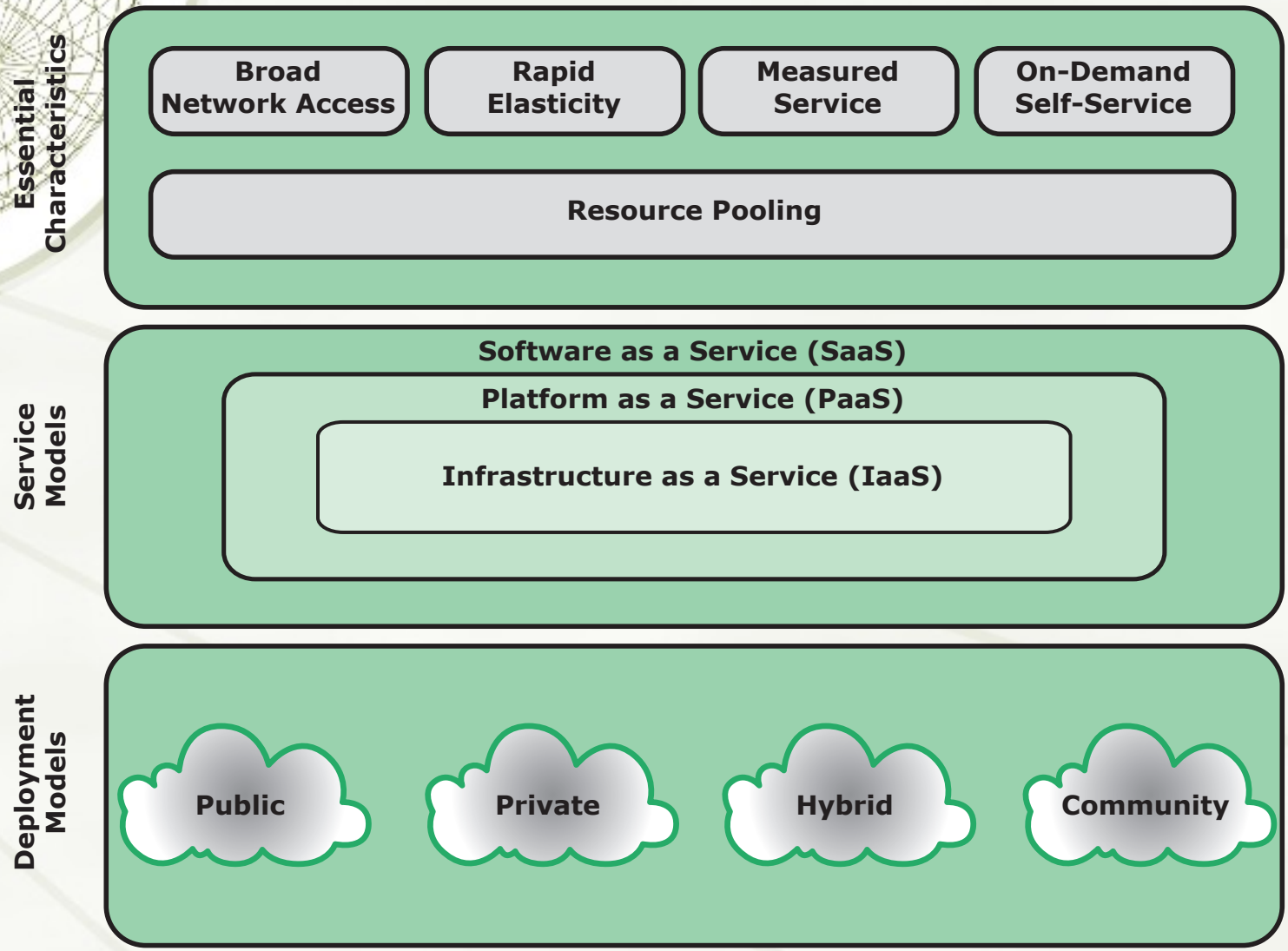


Cloud Computing

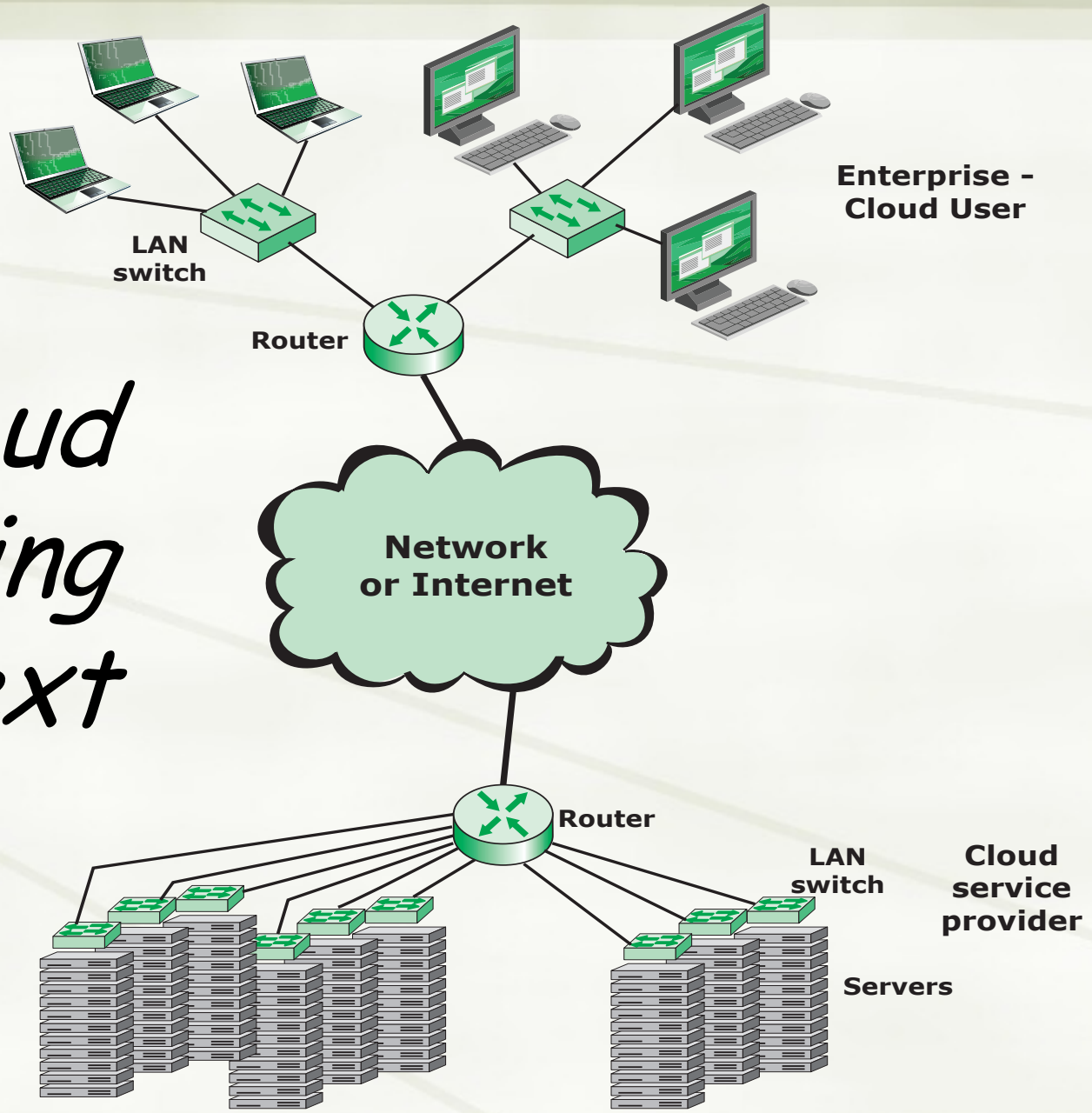
- NIST defines cloud computing, in NIST SP-800-145 (The NIST Definition of Cloud Computing), as follows:

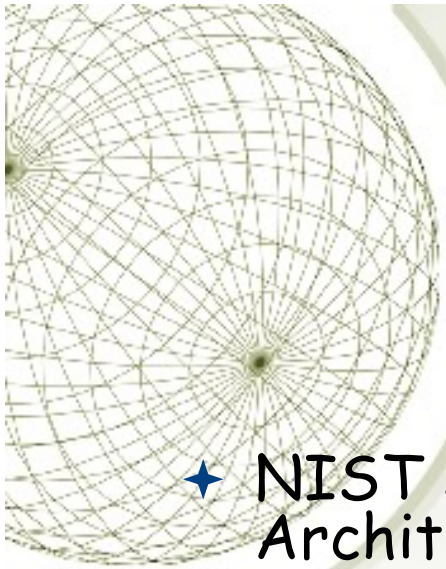
"A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models."

Cloud Computing Elements



Cloud Computing Context



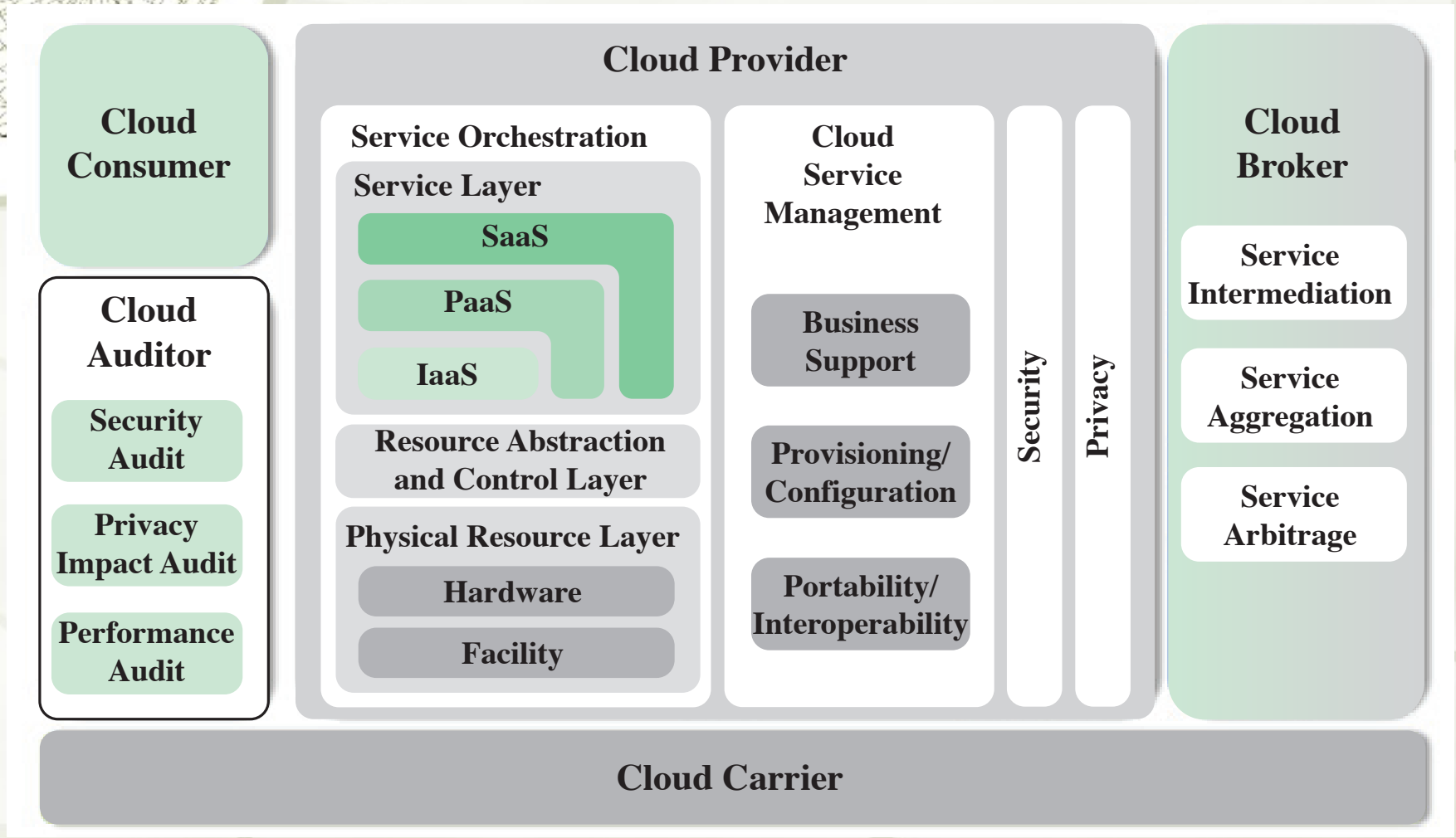


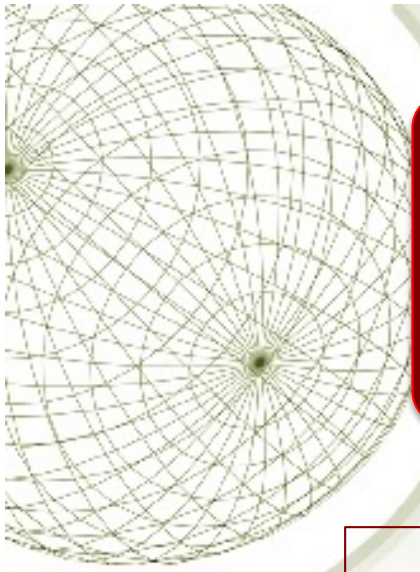
NIST Cloud Computing Reference Architecture

- NIST SP 500-292 (NIST Cloud Computing Reference Architecture) establishes a reference architecture, described as follows:

"The NIST cloud computing reference architecture focuses on the requirements of "what" cloud services provide, not a "how to" design solution and implementation. The reference architecture is intended to facilitate the understanding of the operational intricacies in cloud computing. It does not represent the system architecture of a specific cloud computing system; instead it is a tool for describing, discussing, and developing a system-specific architecture using a common framework of reference."

NIST Cloud Computing Reference Architecture





Cloud Provider

Cloud provider (CP)

Can provide one or more of the cloud services to meet IT and business requirements of cloud consumers

For each of the three service models (SaaS, PaaS, IaaS), the CP provides the storage and processing facilities needed to support that service model, together with a cloud interface for cloud service consumers

For SaaS, the CP deploys, configures, maintains, and updates the operation of the software applications on a cloud infrastructure so that the services are provisioned at the expected service levels to cloud consumers

For PaaS, the CP manages the computing infrastructure for the platform and runs the cloud software that provides the components of the platform, such as runtime software execution stack, databases, and other middleware components

For IaaS, the CP acquires the physical computing resources underlying the service, including the servers, networks, storage, and hosting infrastructure

Roles and Responsibilities

Cloud carrier

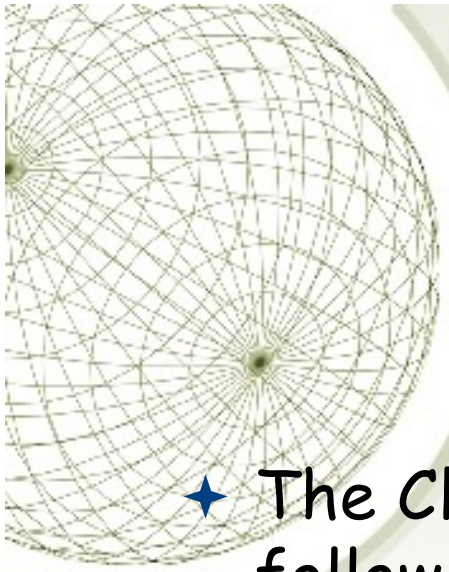
- A networking facility that provides connectivity and transport of cloud services between cloud consumers and CPs

Cloud auditor

- An independent entity that can assure that the CP conforms to a set of standards

Cloud broker

- Useful when cloud services are too complex for a cloud consumer to easily manage
- Three areas of support can be offered by a cloud broker:
  - Service intermediation
    - Value-added services such as identity management, performance reporting, and enhanced security
  - Service aggregation
    - The broker combines multiple cloud services to meet consumer needs not specifically addressed by a single CP, or to optimize performance or minimize cost
  - Service arbitrage
    - A broker has the flexibility to choose services from multiple agencies



Cloud Security Risks and Countermeasures

- The Cloud Security Alliance lists in 2010 the following as the top cloud specific security threats, together with suggested

Abuse and nefarious use of cloud computing

- Countermeasures: stricter initial registration and validation processes; enhanced credit card fraud monitoring and coordination; comprehensive introspection of customer network traffic; monitoring public blacklists for one's own network blocks

Malicious insiders

- Countermeasures: enforce strict supply chain management and conduct a comprehensive supplier assessment; specify human resource requirements as part of legal contract; require transparency into overall information security and management practices, as well as compliance reporting; determine security breach notification processes

Risks and Countermeasures (continued)

Insecure interfaces and APIs

- Countermeasures: analyzing the security model of CP interfaces; ensuring that strong authentication and access controls are implemented in concert with encryption machines; understanding the dependency chain associated with the API

Shared technology issues

- Countermeasures: implement security best practices for installation/configuration; monitor environment for unauthorized changes/activity; promote strong authentication and access control for administrative access and operations; enforce SLAs for patching and vulnerability remediation; conduct vulnerability scanning and configuration audits

Data loss or leakage

- Countermeasures: implement strong API access control; encrypt and protect integrity of data in transit; analyze data protection at both design and run time; implement strong key generation, storage and management, and destruction practices

Risks and Countermeasures (continued)

Account or service hijacking

- Countermeasures: prohibit the sharing of account credentials between users and services; leverage strong two-factor authentication techniques where possible; employ proactive monitoring to detect unauthorized activity; understand CP security policies and SLAs

Unknown risk profile

- Countermeasures: disclosure of applicable logs and data; partial/full disclosure of infrastructure details; monitoring and alerting on necessary information

Revised 2016 Cloud Computing Top Threats

(in falling order of severity)

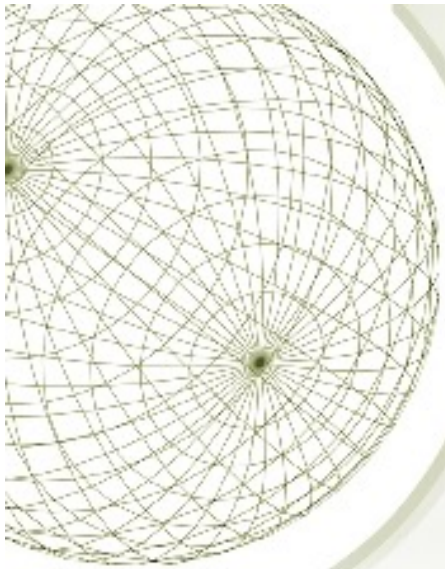
1. Data Breaches
2. Insufficient Identity, Credential and Access Management
3. Insecure Interfaces and APIs
4. System Vulnerabilities
5. Account Hijacking
6. Malicious Insiders
7. Advanced Persistent Threats
8. Data Loss
9. Insufficient Due Diligence
10. Abuse and Nefarious Use of Cloud Services
11. Denial of Service
12. Shared Technology Issues

Source: Cloud Security Alliance, "The Treacherous 12 – Cloud Computing Top Threats in 2016, February 2016.

#1 - Data Breaches

- A data breach is an incident in which sensitive, protected or confidential information is released, viewed, stolen or used by an individual who is not authorized to do so. A data breach may be the primary objective of a targeted attack or may simply be the result of human error, application vulnerabilities or poor security practices. A data breach may involve any kind of information that was not intended for public release including, but not limited to, personal health information, financial information, personally identifiable information (PII), trade secrets and intellectual property.

Källa: Cloud Security Alliance, ”The Treacherous 12 – Cloud Computing Top Threats in 2016, February 2016.



NIST Guidelines on Security and Privacy Issues and Recommendations

Governance

Extend organizational practices pertaining to the policies, procedures, and standards used for application development and service provisioning in the cloud, as well as the design, implementation, testing, use, and monitoring of deployed or engaged services.

Put in place audit mechanisms and tools to ensure organizational practices are followed throughout the system lifecycle.

Compliance

Understand the various types of laws and regulations that impose security and privacy obligations on the organization and potentially impact cloud computing initiatives, particularly those involving data location, privacy and security controls, records management, and electronic discovery requirements.

Review and assess the cloud provider's offerings with respect to the organizational requirements to be met and ensure that the contract terms adequately meet the requirements. Ensure that the cloud provider's electronic discovery capabilities and processes do not compromise the privacy or security of data and applications.

Trust

Ensure that service arrangements have sufficient means to allow visibility into the security and privacy controls and processes employed by the cloud provider, and their performance over time.

Establish clear, exclusive ownership rights over data.

Institute a risk management program that is flexible enough to adapt to the constantly evolving and shifting risk landscape for the lifecycle of the system.

Continuously monitor the security state of the information system to support ongoing risk management decisions.

Architecture

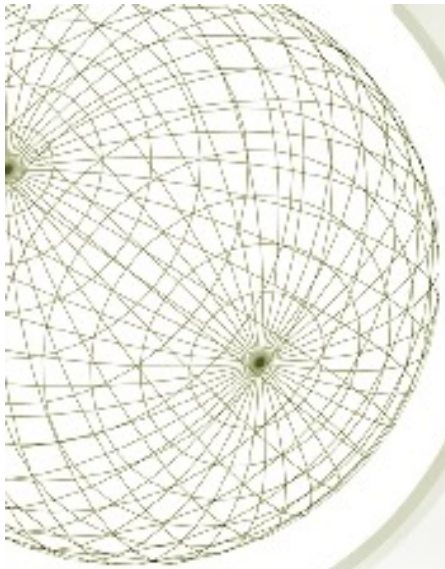
Understand the underlying technologies that the cloud provider uses to provision services, including the implications that the technical controls involved have on the security and privacy of the system, over the full system lifecycle and across all system components.

Identity and access management

Ensure that adequate safeguards are in place to secure authentication, authorization, and other identity and access management functions, and are suitable for the organization.

Software isolation

Understand virtualization and other logical isolation techniques that the cloud provider employs in its multi-tenant software architecture, and assess the risks involved for the organization.



NIST Guidelines on Security and Privacy Issues and Recommendations

Data protection

Evaluate the suitability of the cloud provider's data management solutions for the organizational data concerned and the ability to control access to data, to secure data while at rest, in transit, and in use, and to sanitize data.

Take into consideration the risk of collating organizational data with those of other organizations whose threat profiles are high or whose data collectively represent significant concentrated value.

Fully understand and weigh the risks involved in cryptographic key management with the facilities available in the cloud environment and the processes established by the cloud provider.

Availability

Understand the contract provisions and procedures for availability, data backup and recovery, and disaster recovery, and ensure that they meet the organization's continuity and contingency planning requirements.

Ensure that during an intermediate or prolonged disruption or a serious disaster, critical operations can be immediately resumed, and that all operations can be eventually reinstituted in a timely and organized manner.

Incident response

Understand the contract provisions and procedures for incident response and ensure that they meet the requirements of the organization.

Ensure that the cloud provider has a transparent response process in place and sufficient mechanisms to share information during and after an incident.

Ensure that the organization can respond to incidents in a coordinated fashion with the cloud provider in accordance with their respective roles and responsibilities for the computing environment.

Focus on: Data Protection in the Cloud

- The threat of data compromise increases in the cloud
- Database environments used in cloud computing can vary significantly

Multi-instance model

- Provides a unique DBMS running on a virtual machine instance for each cloud subscriber
- This gives the subscriber complete control over role definition, user authorization, and other administrative tasks related to security

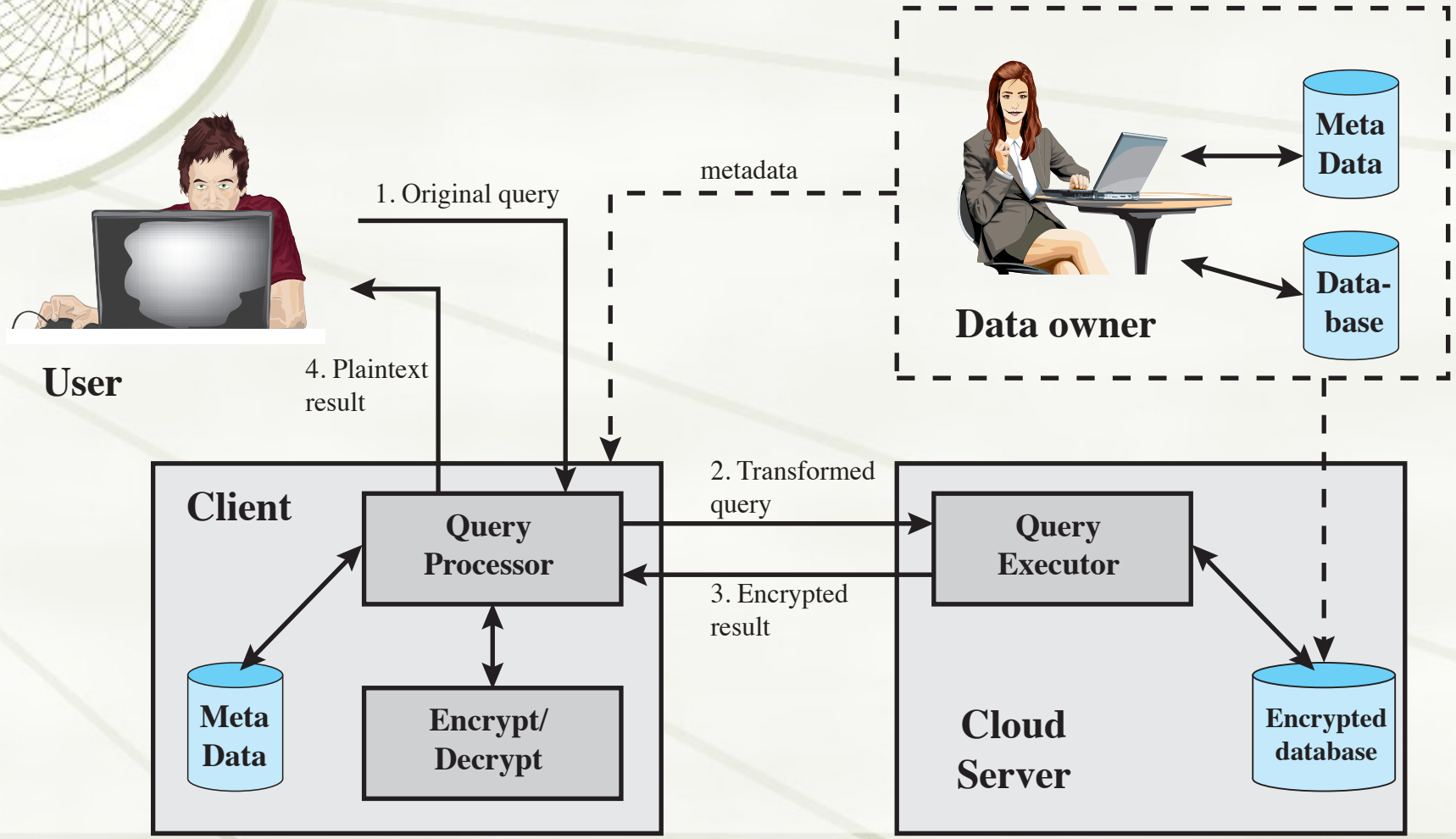
Multi-tenant model

- Provides a predefined environment for the cloud subscriber that is shared with other tenants, typically through tagging data with a subscriber identifier
- Tagging gives the appearance of exclusive use of the instance, but relies on the CP to establish and maintain a sound secure database environment

Data Protection in the Cloud

- Data must be secured while at rest, in transit, and in use, and access to the data must be controlled
- The client can employ encryption to protect data in transit, though this involves key management responsibilities for the CP
- For data at rest the ideal security measure is for the client to encrypt the database and only store encrypted data in the cloud, with the CP having no access to the encryption key
- A straightforward solution to the security problem in this context is to encrypt the entire database and not provide the encryption/decryption keys to the service provider
  - The user has little ability to access individual data items based on searches or indexing on key parameters
  - The user would have to download entire tables from the database, decrypt the tables, and work with the results
  - To provide more flexibility it must be possible to work with the database in its encrypted form (Homomorphic encryption)

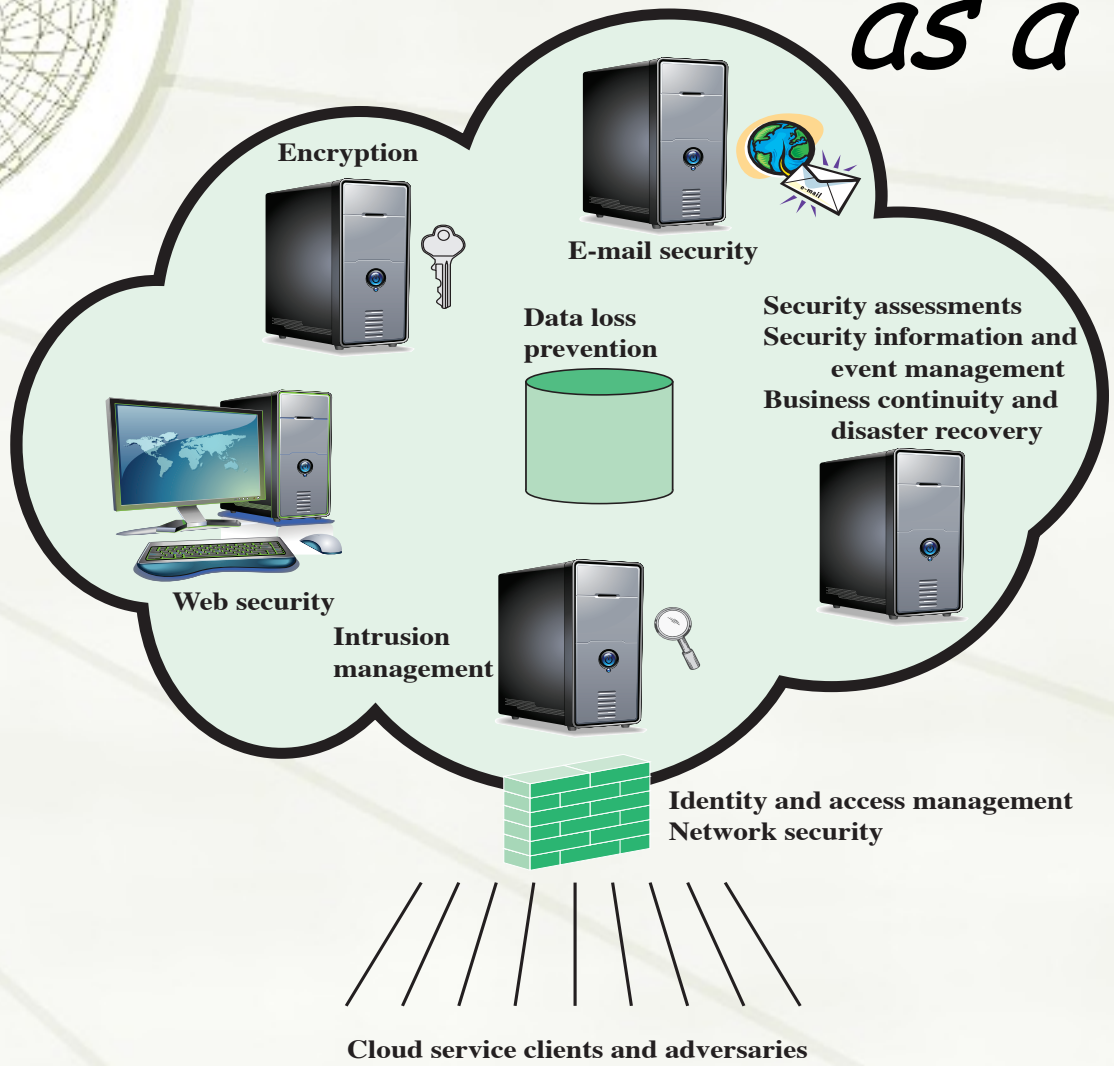
An Encryption Scheme for a Cloud-Based Database

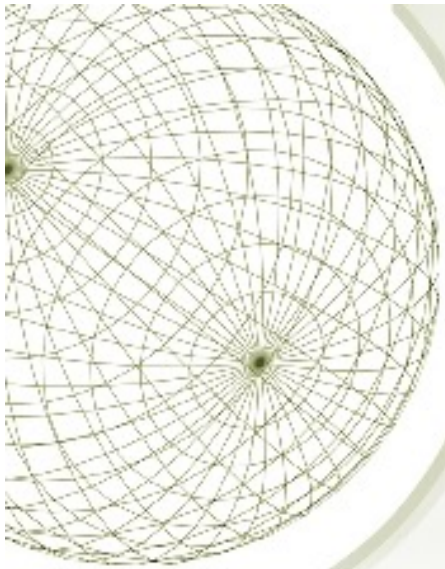


Cloud Security as a Service (SecaaS)

- The Cloud Security Alliance defines SecaaS as the provision of security applications and services via the cloud either to cloud-based infrastructure and software or from the cloud to the customers' on-premise systems
- The Cloud Security Alliance has identified the following SecaaS categories of service:
  - Identity and access management
  - Data loss prevention
  - Web security
  - E-mail security
  - Security assessments
  - Intrusion management
  - Security information and event management
  - Encryption
  - Business continuity and disaster recovery
  - Network security

Elements of Cloud Security as a Service





Is there time for a Kahoot?