SE 4455 – Cloud Computing

Introduction to Cloud Computing

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What is Cloud Computing

Cloud Computing Enablers

- Business drivers
  - Capacity planning
  - Cost reduction
  - Organizational agility
- Technology drivers
  - Computing clusters
  - Grid computing
  - Virtualization

Estimating IT Cost

- Key activity when deciding cloud vs in-house

- Capital expenditure (cap-ex)
  - One-time expense
  - Physical building, power and cooling

- Operational expenditure (op-ex)
 - Recurring expense

Operational Expenditure (op-ex)

- IT personnel
- Maintenance personnel
- Expenses during upgrade (testing and deployment)
- Utility expenses
- Security and access control
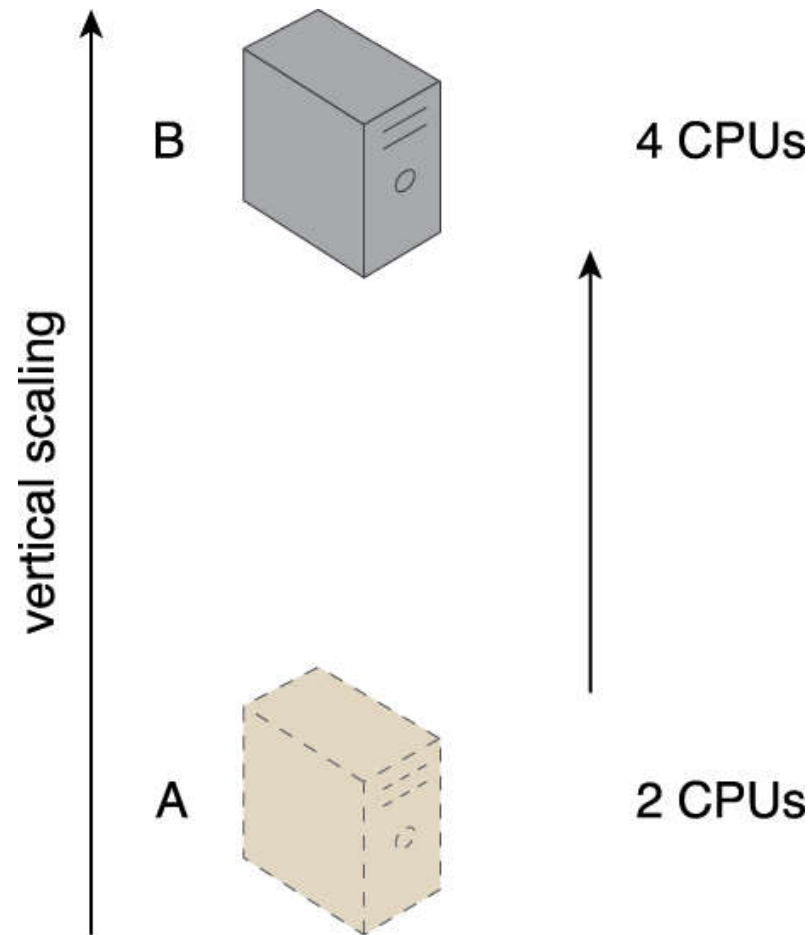- Administrative and accounting personnel

Terminology

- On-premise
- Cloud consumers
- Cloud providers
- Horizontal scaling (scaling out/in)
- Vertical scaling (scaling up/down)
- Cloud service
- SLA (service-level agreement)
- Trust boundary

Horizontal Scaling
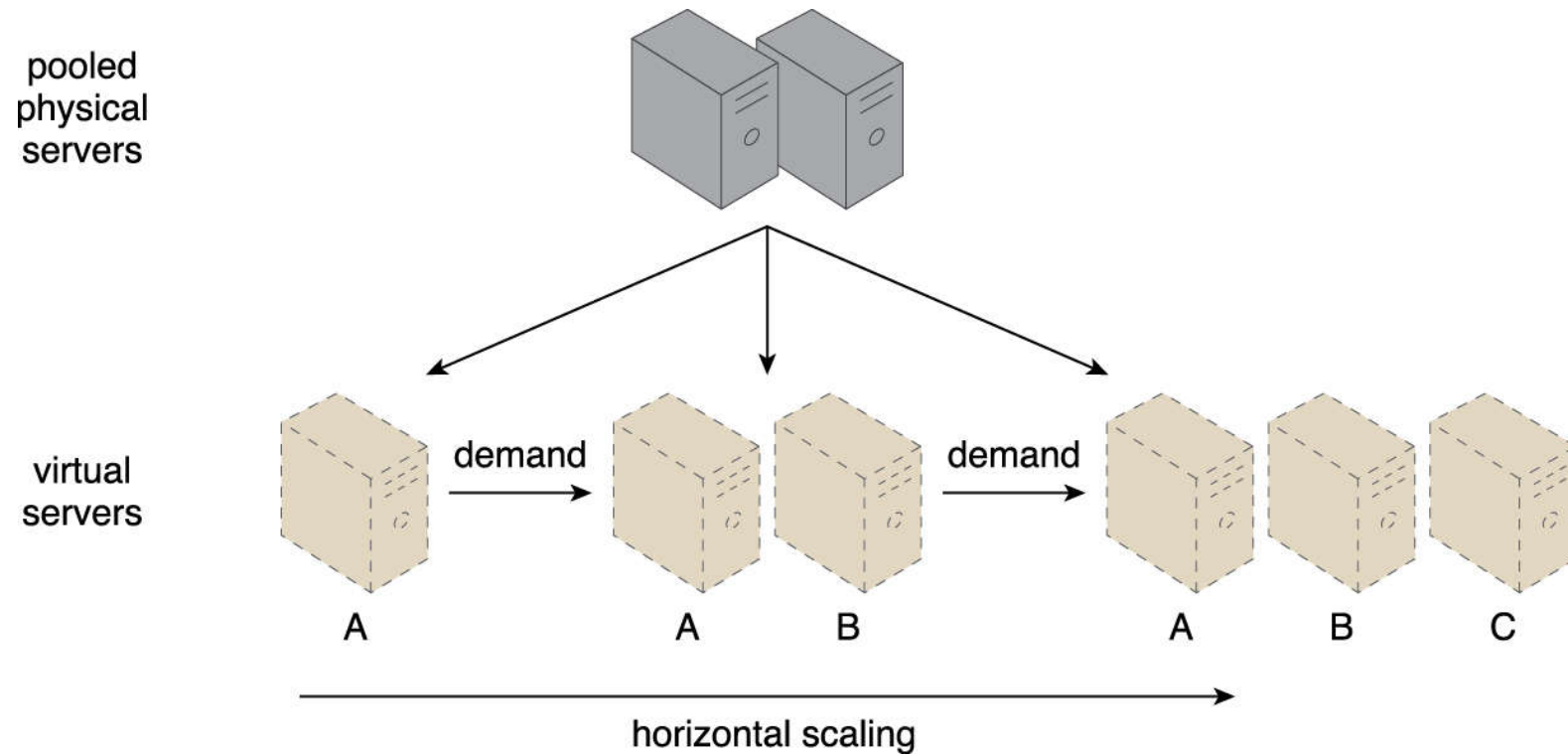
Vertical Scaling
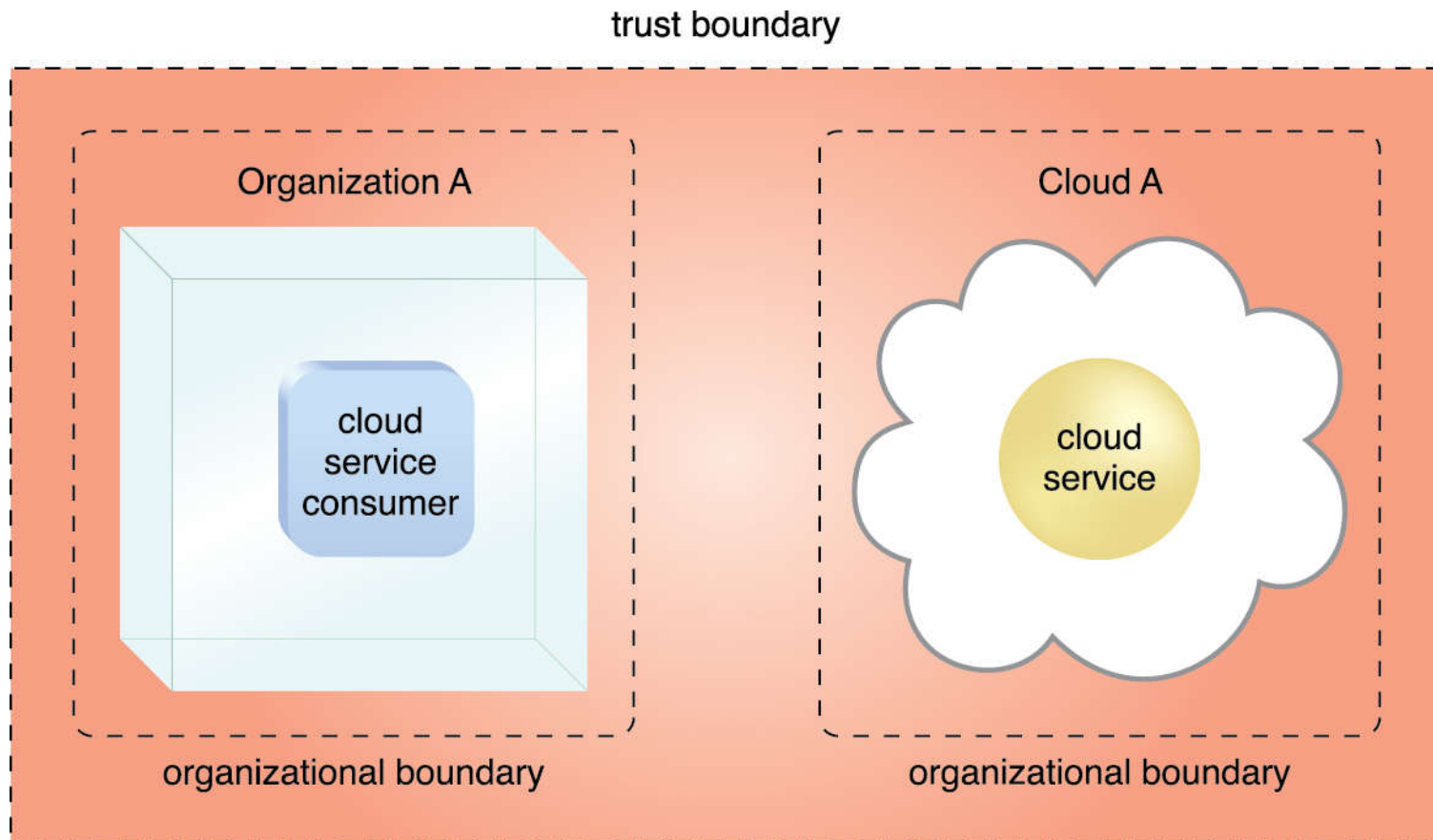
Horizontal vs Vertical Scaling

- Horizontal Scaling
  - E.g. Increasing/decreasing number of servers
  - Less Expensive (commodity)
  - Always instantly available
  - Resource replication and automated scaling
- Vertical Scaling
  - E.g. Increasing/decreasing quality of servers
  - More expensive (specialized)
  - May not be instantly available
  - Additional setup is normally needed

Trust Boundary

trust boundary

Organization A

Cloud A

cloud service consumer

cloud service

organizational boundary

organizational boundary

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Benefits of Cloud Computing

- Reduced capital investment
- Proportional costs
- Increased scalability
- Increased availability and reliability

Challenges of Cloud Computing

- Increased security vulnerabilities
- Reduced control
- Limited options for switching providers
- Multi-regional compliance and legal issues

Cloud Computing Attributes

- On-demand usage
- Ubiquitous access
- Multi-tenancy and resource pooling
- Elasticity
- Measured usage
- Resiliency

On Demand Usage

- **For cloud consumer**
  - Self-provisioning IT resources
  - Ability to automate provisioning based on need
- **For cloud provider**
  - Providing tools and interfaces for self-provisioning
  - Providing tools to automate provisioning and configuration
 - Load balancing and automatic migration
  - Failover

Ubiquitous Access

- Providing device and location independence
- Supporting necessary transport protocols
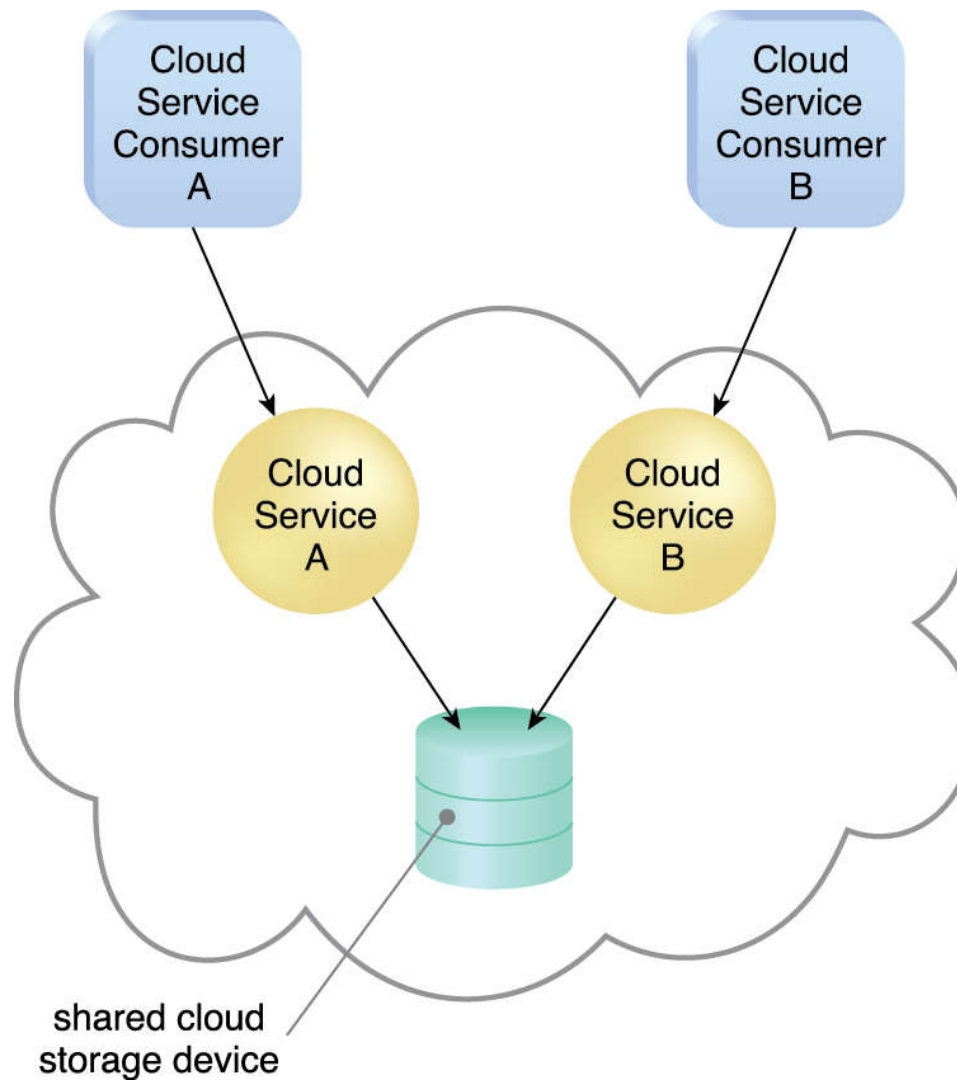- Providing security services

Multi-tenancy and Resource Pooling

- Ability of software to support multiple users within one instance

- Ability to pool large scale IT resources to serve multiple cloud consumers

Single Tenancy

Multi-Tenancy

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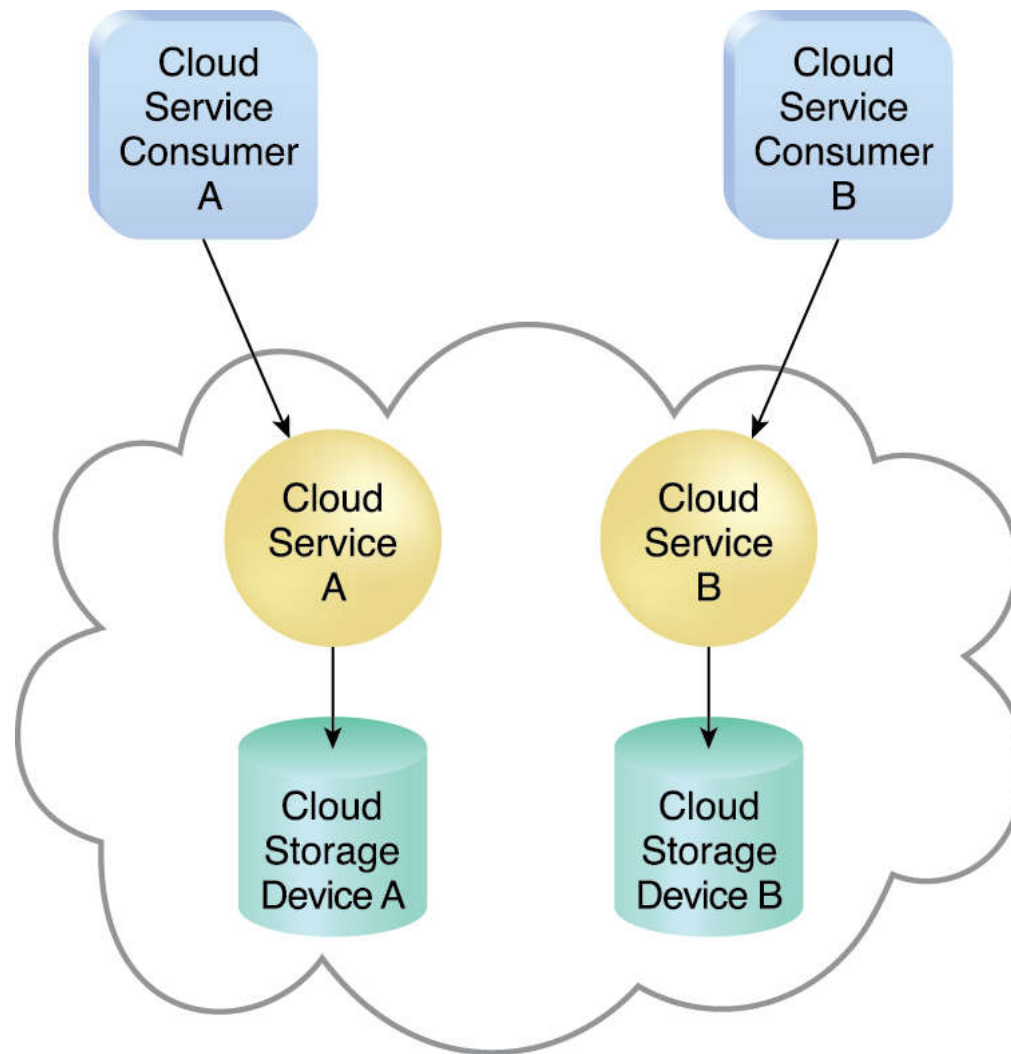
Elasticity

- Automated ability to transparently scale
  - In response to run-time conditions
  - Or pre-determined by consumer or provider
- Often a core justification for adoption
- Closely associated with reduced investment and proportional cost

Measured Usage

- Ability to measure usage of various resources
- Keep track of usage by consumers (billing)
- Monitoring usage patterns
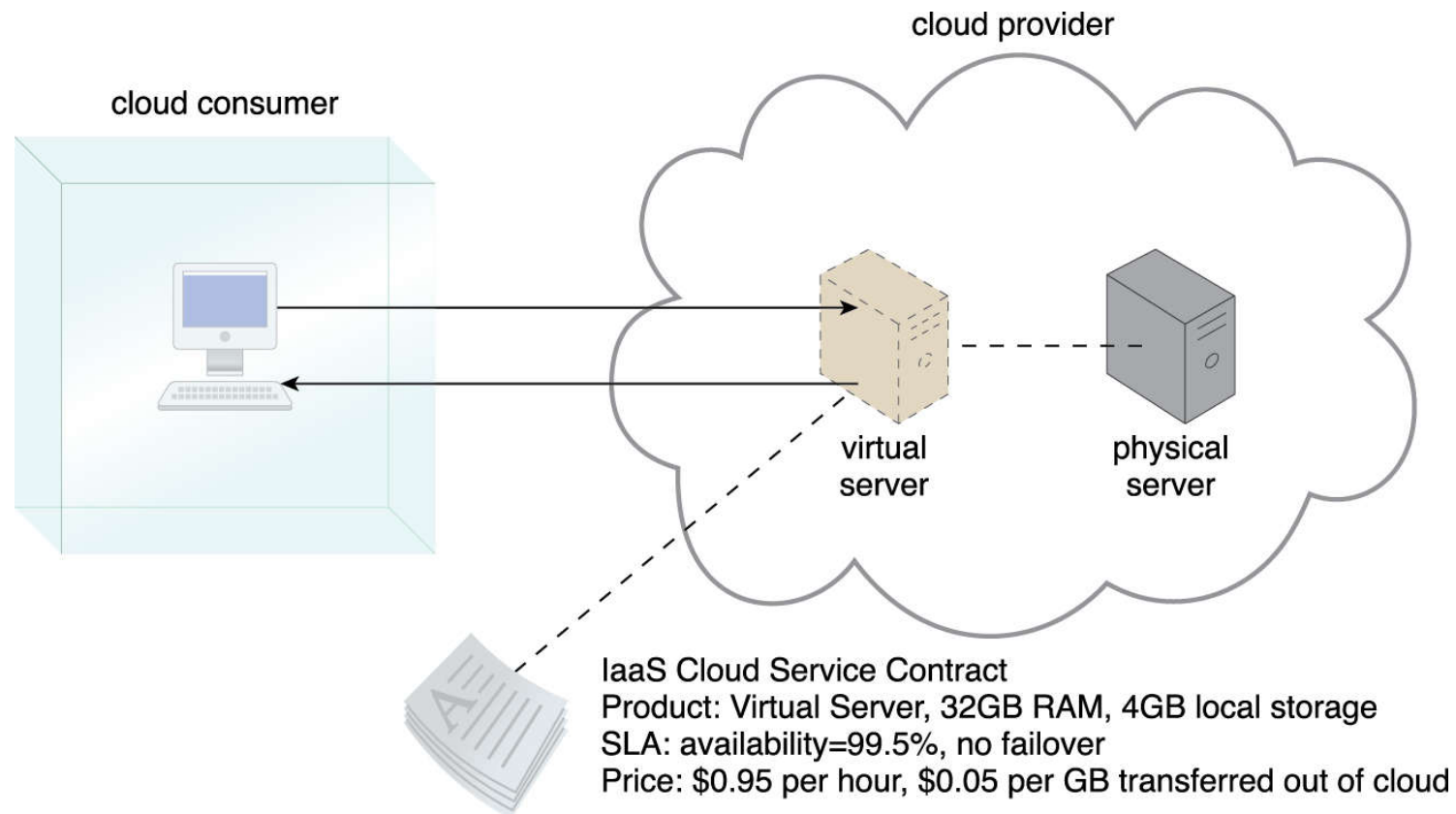- Providing usage reports and statistics

Resiliency

- Form of failover
- Ability to provide and consume redundant implementations of IT resources
- Redundancy across geographic locations for consumer by a provider
- Redundancy across providers by consumer

Cloud Delivery Models

- Primary models
  - Infrastructure-as-a-Service (IaaS)
  - Platform-as-a-Service (PaaS)
  - Software-as-a-Service (SaaS)
- Specialized models
  - Storage-as-a-Service
  - Database-as-a-Service
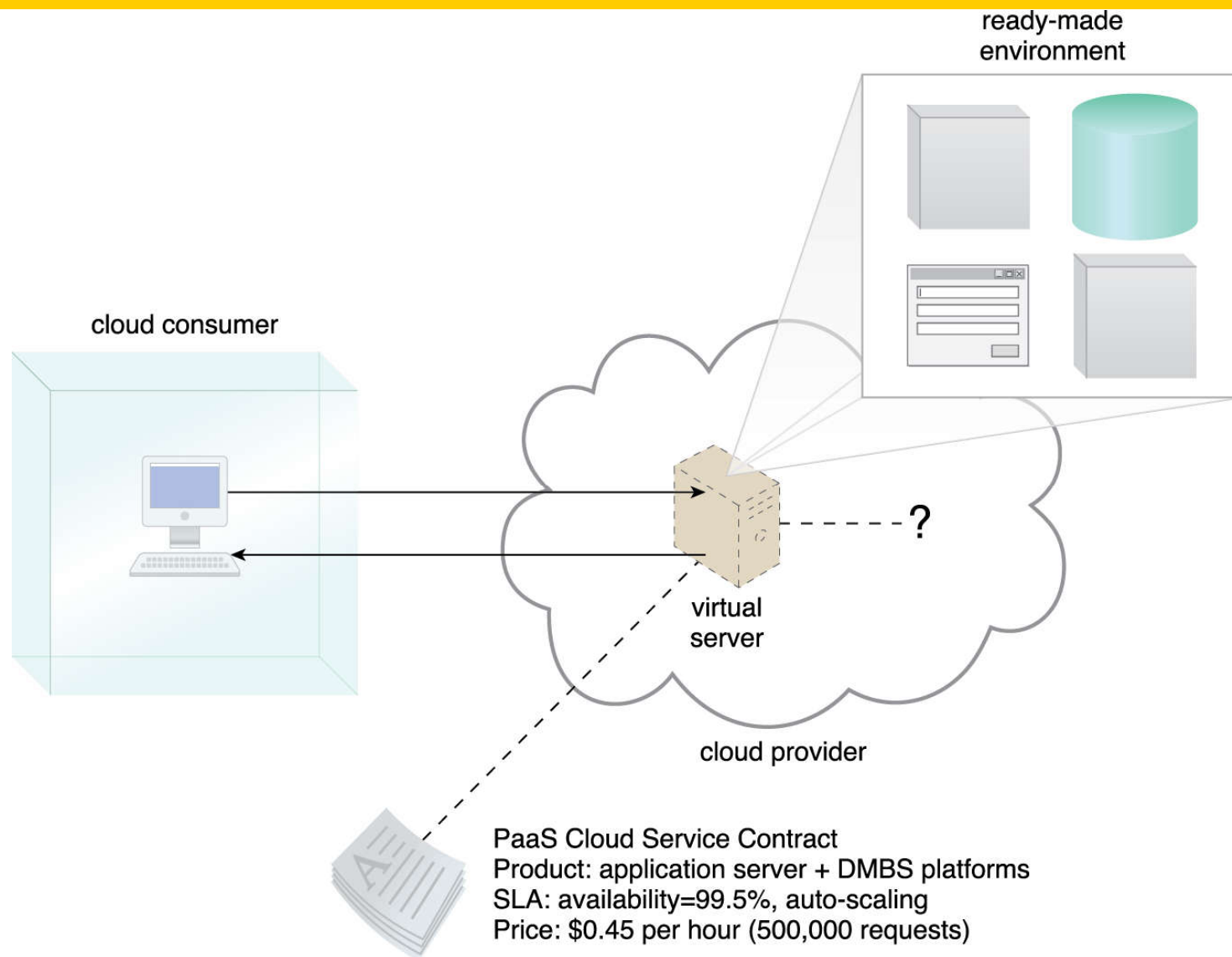 - Security-as-a-Service

Infrastructure-as-a-Service (IaaS)

cloud provider

cloud consumer

virtual server

physical server

IaaS Cloud Service Contract
Product: Virtual Server, 32GB RAM, 4GB local storage
SLA: availability=99.5%, no failover
Price: $0.95 per hour, $0.05 per GB transferred out of cloud

Infrastructure-as-a-Service (IaaS)

- Provides raw IT resources
  - E.g. virtual servers
  - Include hardware, network connectivity (intranet and internet) and OS
- Configuration, deploying necessary software and administration are handled by the cloud consumer
- Provides high level of control over the resources

Platform-as-a-Service (PaaS)

ready-made
environment

cloud consumer

virtual
server

?

cloud provider

PaaS Cloud Service Contract
Product: application server + DMBS platforms
SLA: availability=99.5%, auto-scaling
Price: $0.45 per hour (500,000 requests)

Platform-as-a-Service (PaaS)

- Provides a pre-defined, ready-to-use environment
- Choice is typically limited
- No administrative burden of deploying and maintenance
- Lower level of control

Software-as-a-Service (SaaS)

SaaS Cloud Service Contract
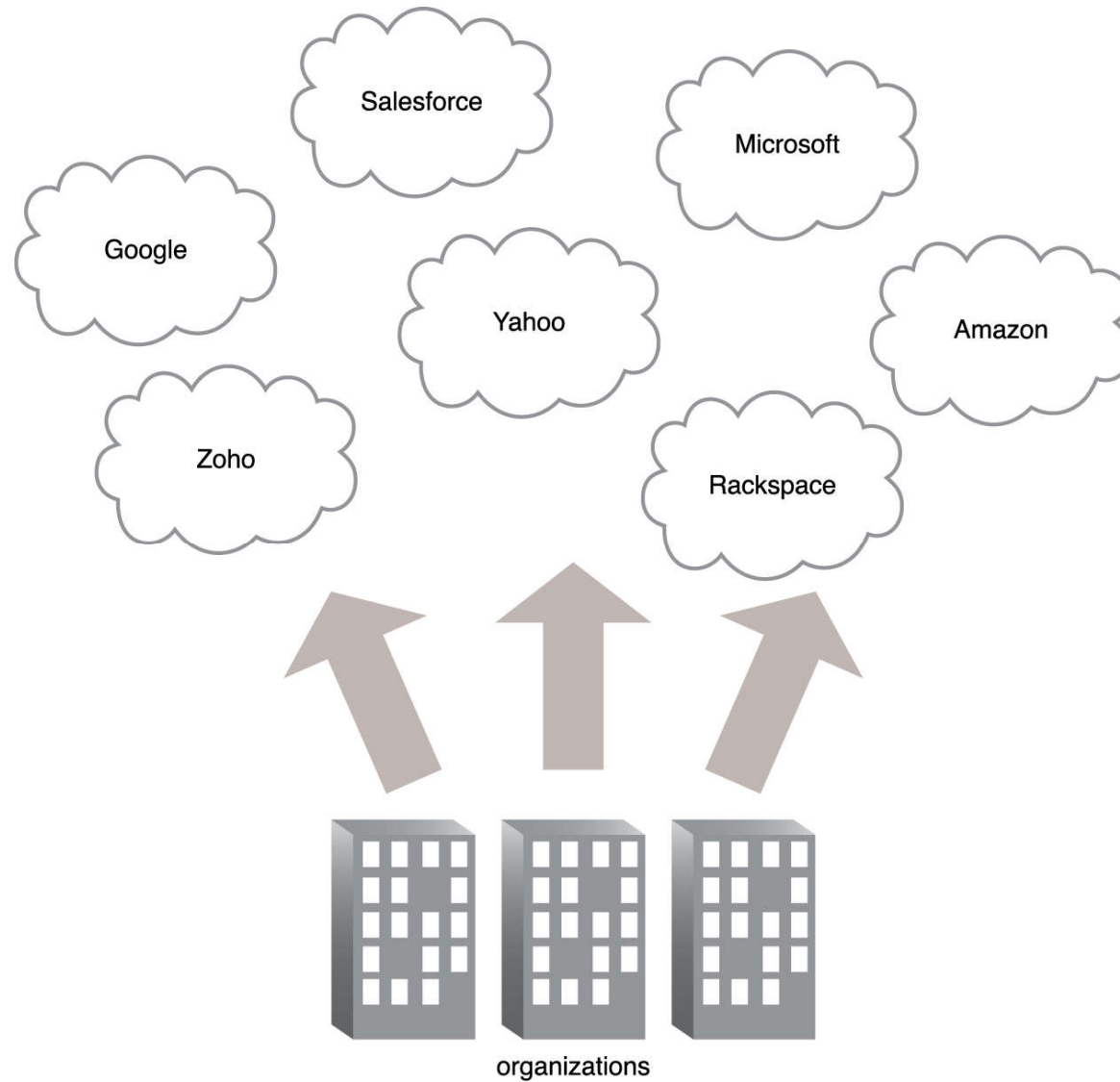SLA: response time=0.5ms
Price: $0.05 per 100 requests
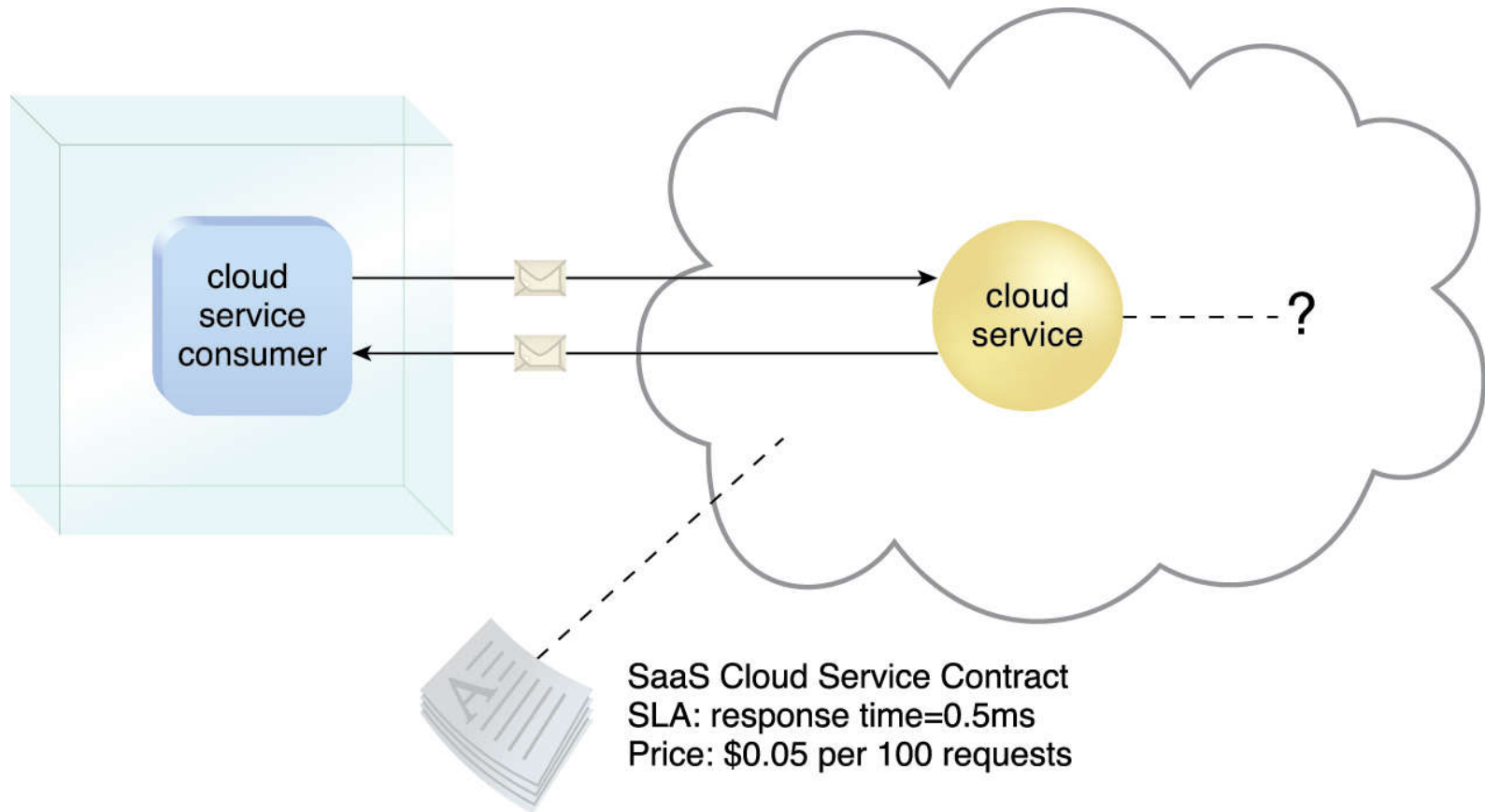
Software-as-a-Service (SaaS)

- Provides a specific software
- Choice is typically limited
- No administrative burden of deploying and maintenance
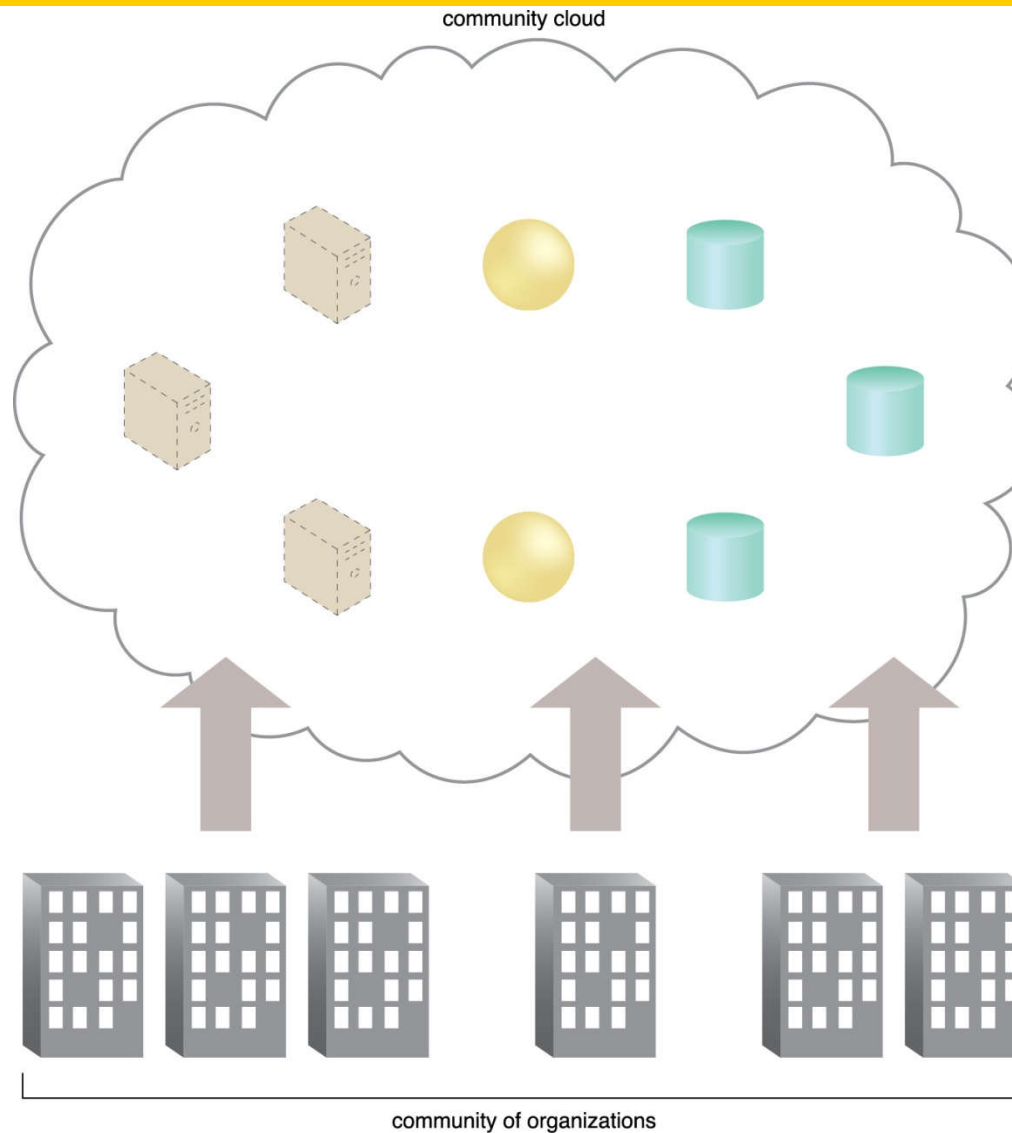- Lowest level of control

Cloud Deployment Models

- Public cloud
- Community cloud
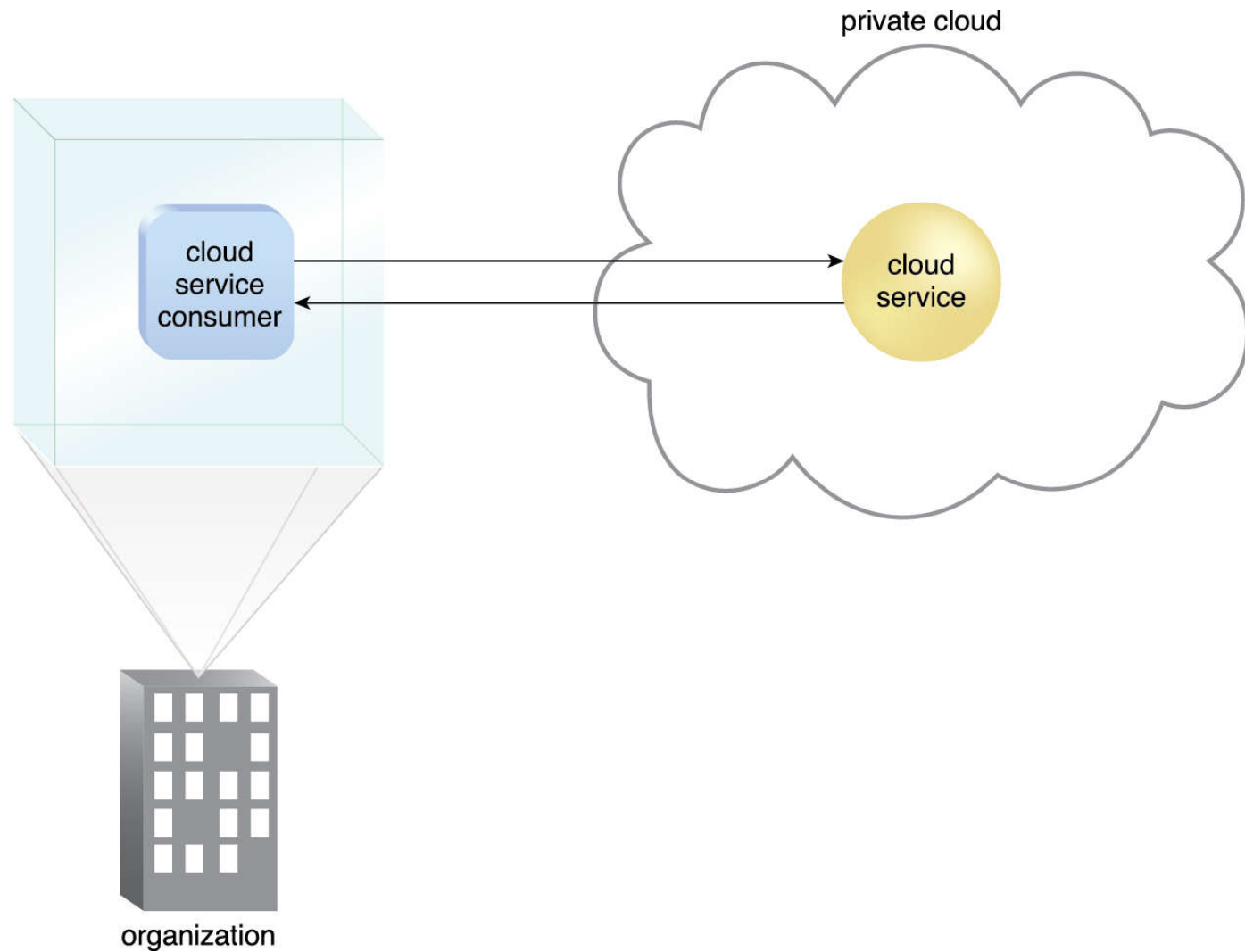- Private cloud
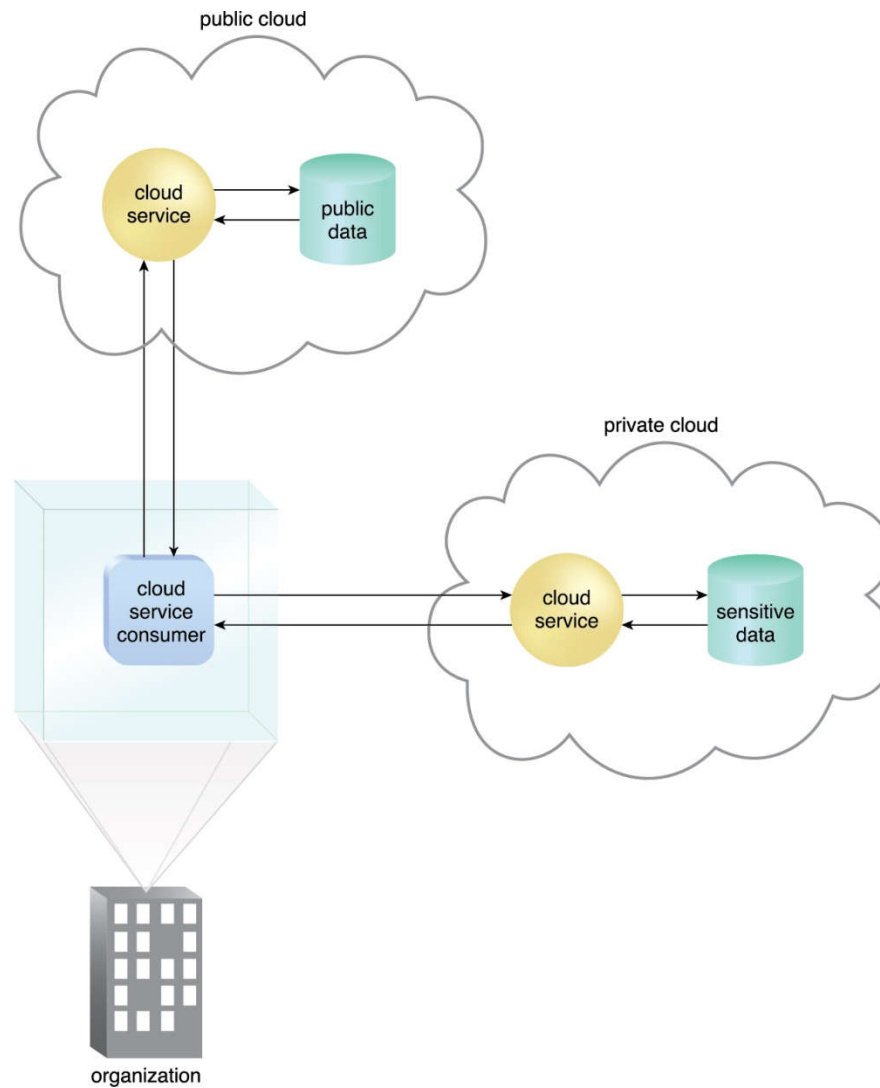- Hybrid cloud

Public Cloud

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Community Cloud

community cloud

community of organizations

Private Cloud

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Hybrid Cloud

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Summary

- What is cloud computing
- What drove cloud computing
- Cloud computing terminology
- Benefits and challenges
- Attributes of cloud computing
- Cloud delivery models
- Cloud deployment models