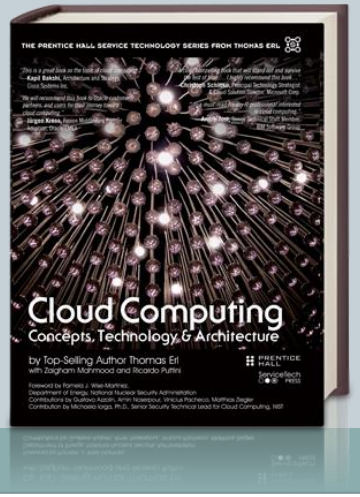
Cloud Computing

Concept, Technology & Architecture

Chapter 05
Cloud-Enabling Technology

Karthikeyan S
VIT AP



Contents

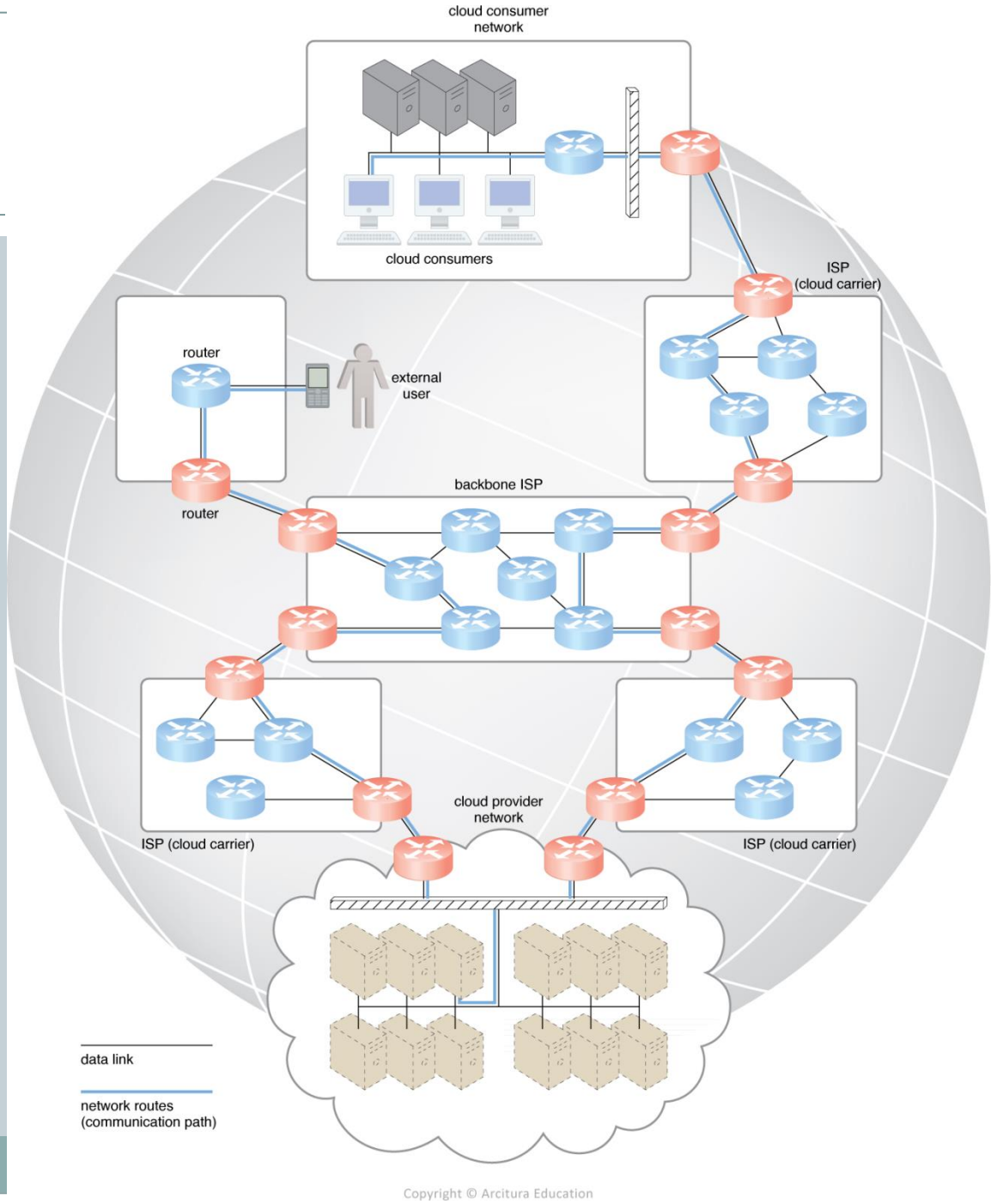
- Contemporary technologies that realize modern-day cloud computing platforms and innovations are discussed, particularly data centers, virtualization, and Web-based technologies.
  - 5.1 Broadband Networks and Internet Architecture
  - 5.2 Data Center Technology
  - 5.3 Virtualization Technology
  - 5.4 Web Technology
  - 5.5 Multitenant Technology
  - 5.6 Service Technology
  - 5.7 Case Study Example

5.1 Broadband Networks and Internet Architecture

- Internet Service Providers (ISPs) (Figure 5.1 & 5.2)
  - Connectionless Packet Switching (Datagram Networks)
  - Router-Based Interconnectivity (Figure 5.3 & 5.4)
- Technical and Business Considerations (Figure 5.5 & 5.6)
  - Connectivity issues
  - Network bandwidth and latency issues
  - Cloud carrier and cloud provider selection

Figure 5.1

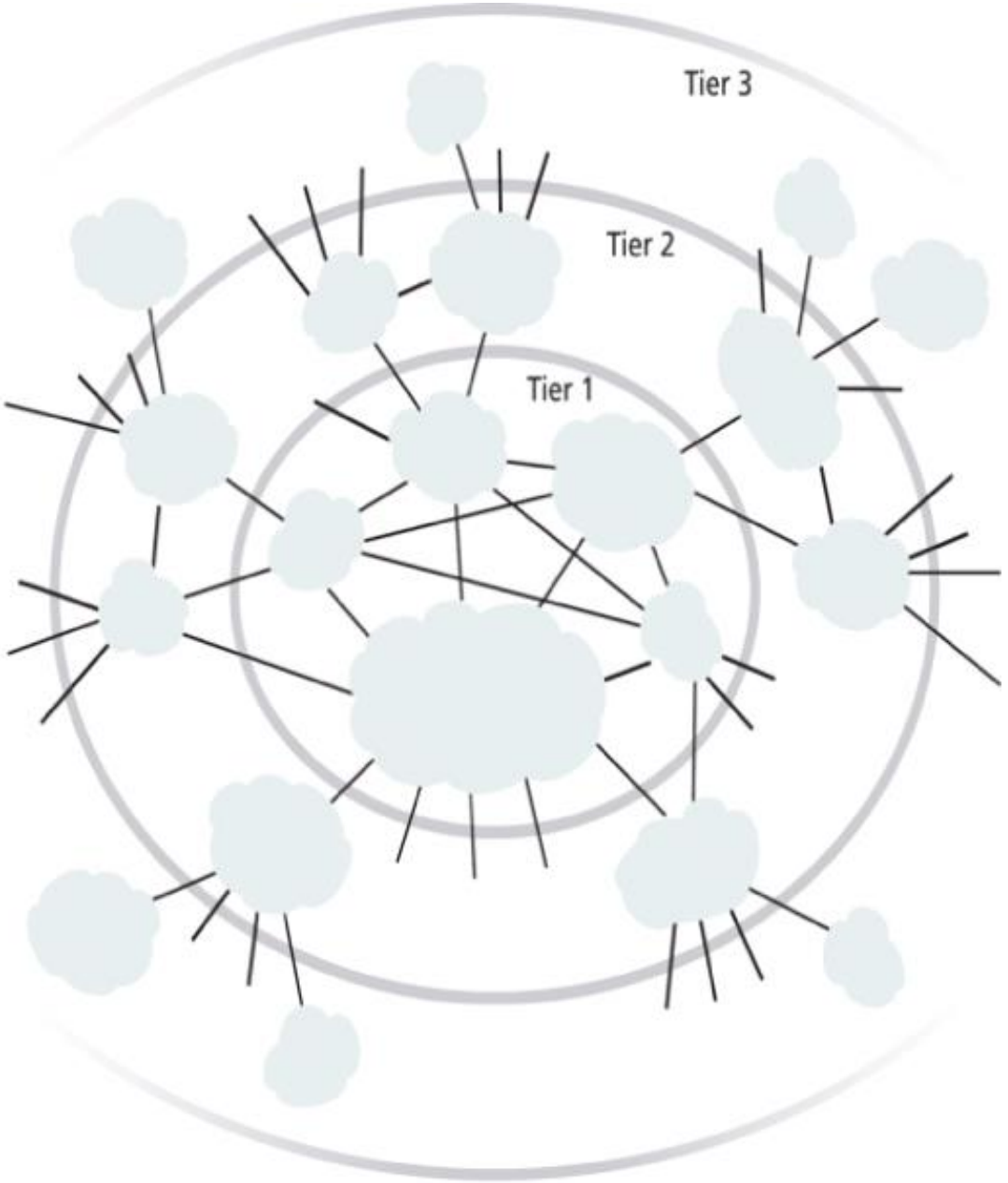
- *Figure 5.1 - Two messages travel over dynamic network routes in this ISP internetworking configuration.*



Copyright © Arcitura Education

Figure 5.2

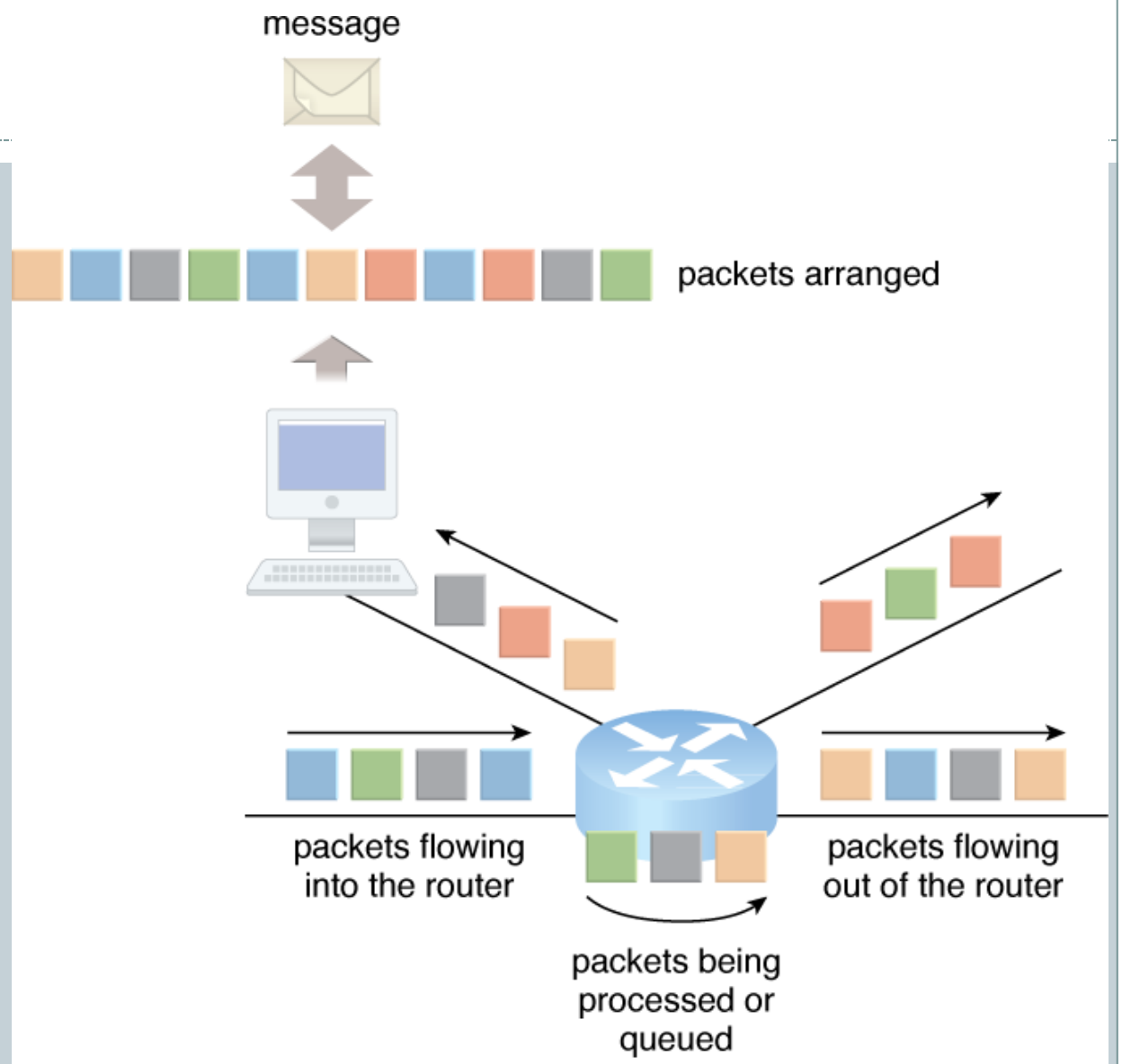
- *Figure 5.2 - An abstraction of the internetworking structure of the Internet.*



Copyright © Arcitura Education

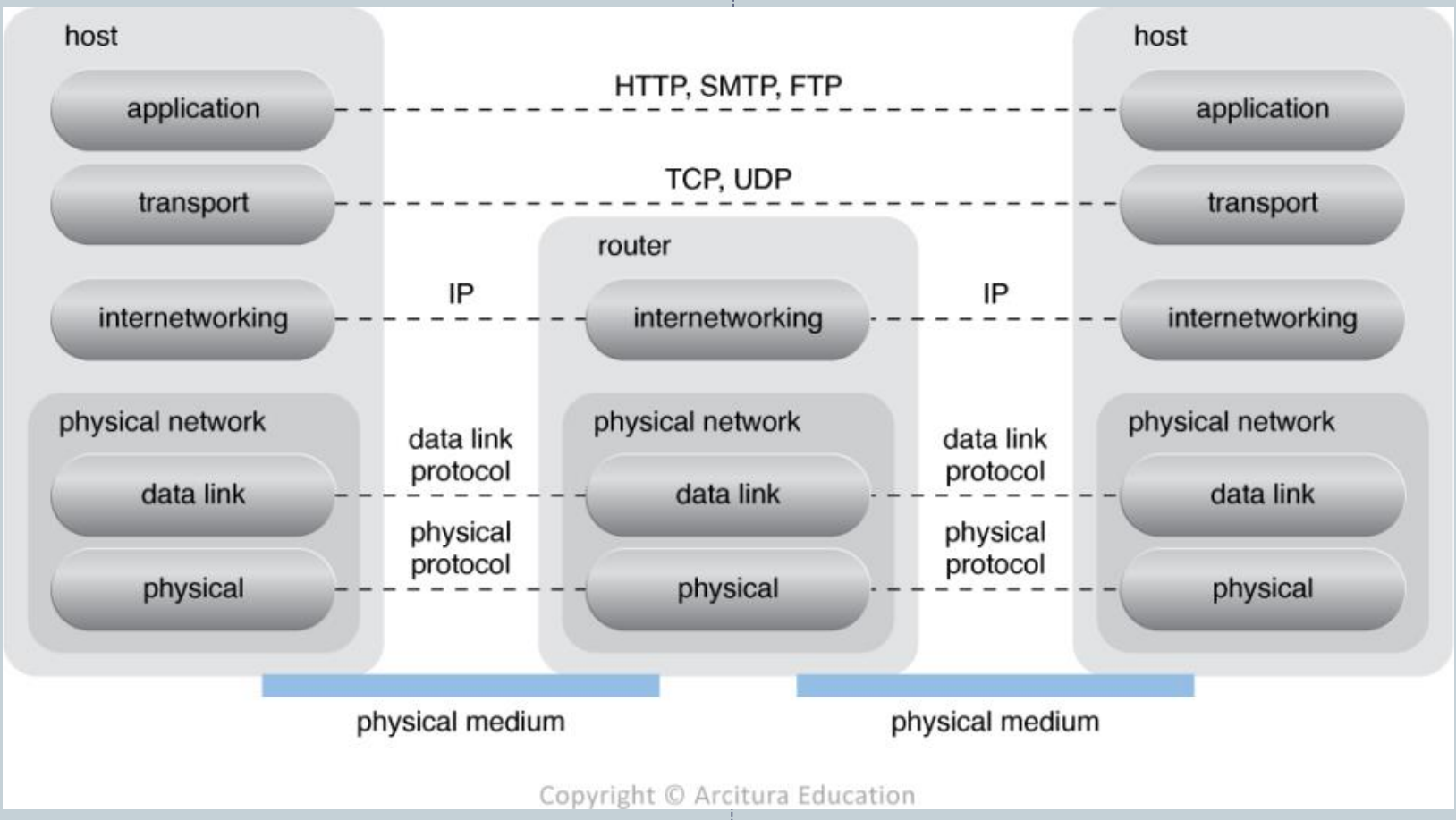
Figure 5.3

- *Figure 5.3 - Packets traveling through the Internet are directed by a router that arranges them into a message.*



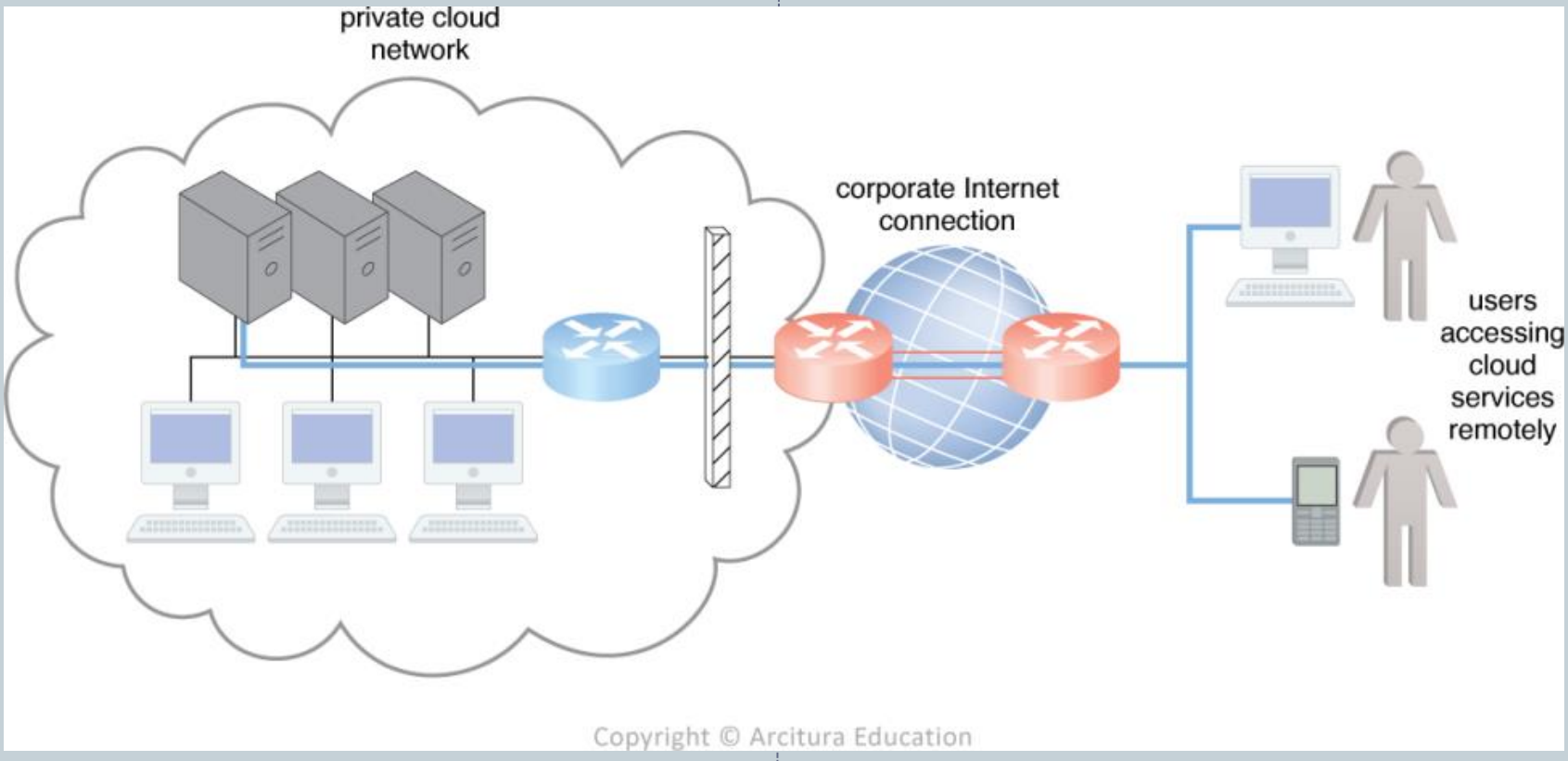
Copyright © Arcitura Education

Figure 5.4



- *Figure 5.4 - A generic view of the Internet reference model and protocol stack.*

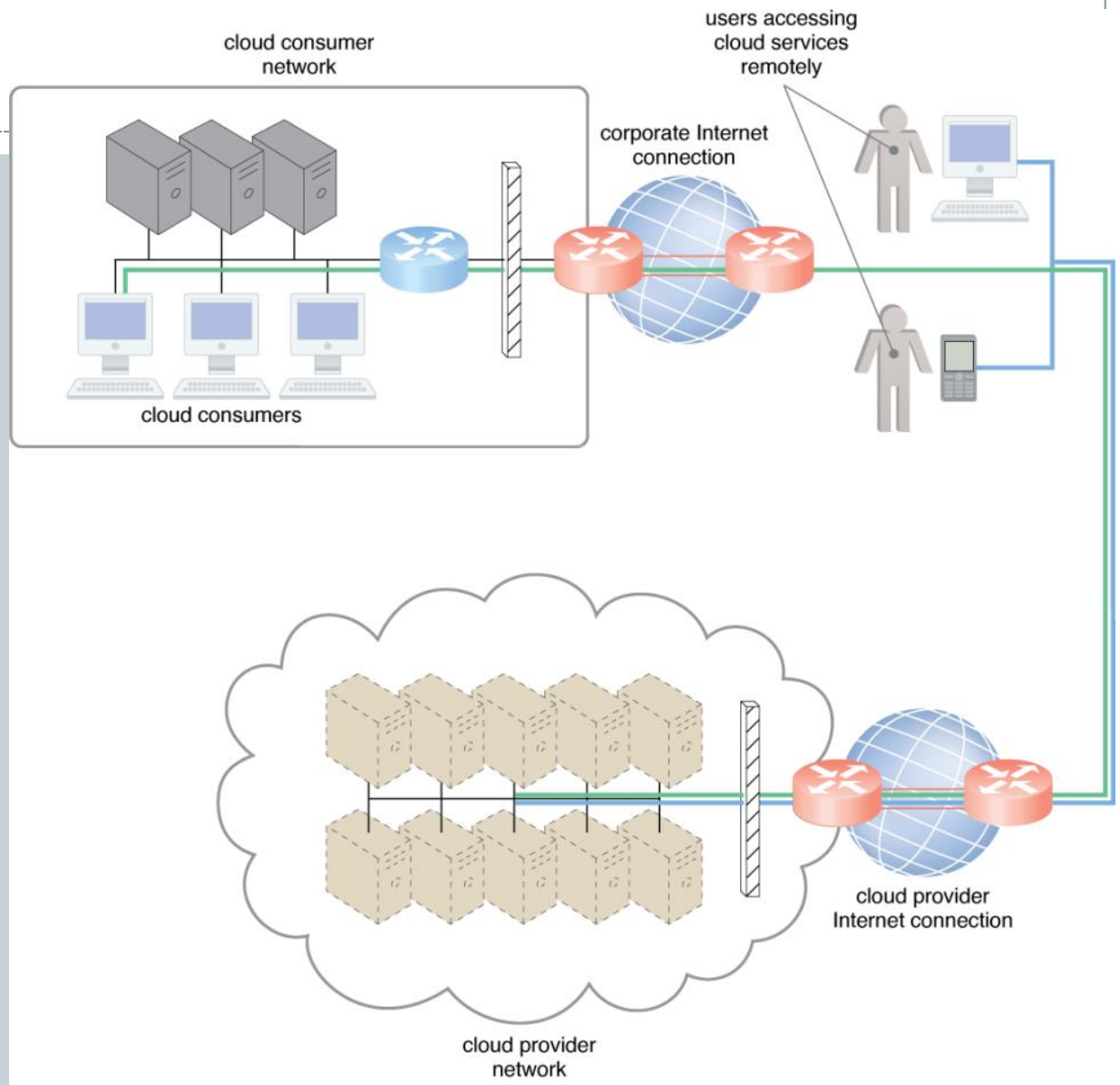
Figure 5.5



- *Figure 5.5 - The internetworking architecture of a private cloud. The physical IT resources that constitute the cloud are located and managed within the organization.*

Figure 5.6

- *Figure 5.6 - The internetworking architecture of an Internet-based cloud computing deployment model. The Internet is the connecting agent between non-proximate cloud consumers, roaming end-users, and the cloud provider's network.*



Copyright © Arcitura Education

A comparison of on-premise and cloud-based internetworking

On-Premise IT Resources	Cloud-Based IT Resources
internal end-user devices access corporate IT services through the **corporate** network	internal end-user devices access corporate IT services through an **Internet** connection
internal users access corporate IT services through the corporate Internet connection while roaming in external networks	internal users access corporate IT services while roaming in external networks through the cloud provider's Internet connection
external users access corporate IT services through the **corporate Internet connection**	external users access corporate IT services through the **cloud provider's Internet connection**

Summary of Broadband Networks and Internet

- Cloud consumers and cloud providers typically use the **Internet** to communicate, which is based on a decentralized provisioning and management model and is not controlled by any centralized entities.
- The main components of internetworking architecture are connectionless packet switching and router-based interconnectivity, which use network routers and switches.
- Networks bandwidth and latency are characteristics that influences QoS, which is heavily impacted by network congestion.

5.2 Data Center Technology (1/2)

- Grouping IT resources in close proximity with one another allows for power saving, higher efficiency in sharing resources, and improve accessibility for IT personnel. Following issues are concerned:

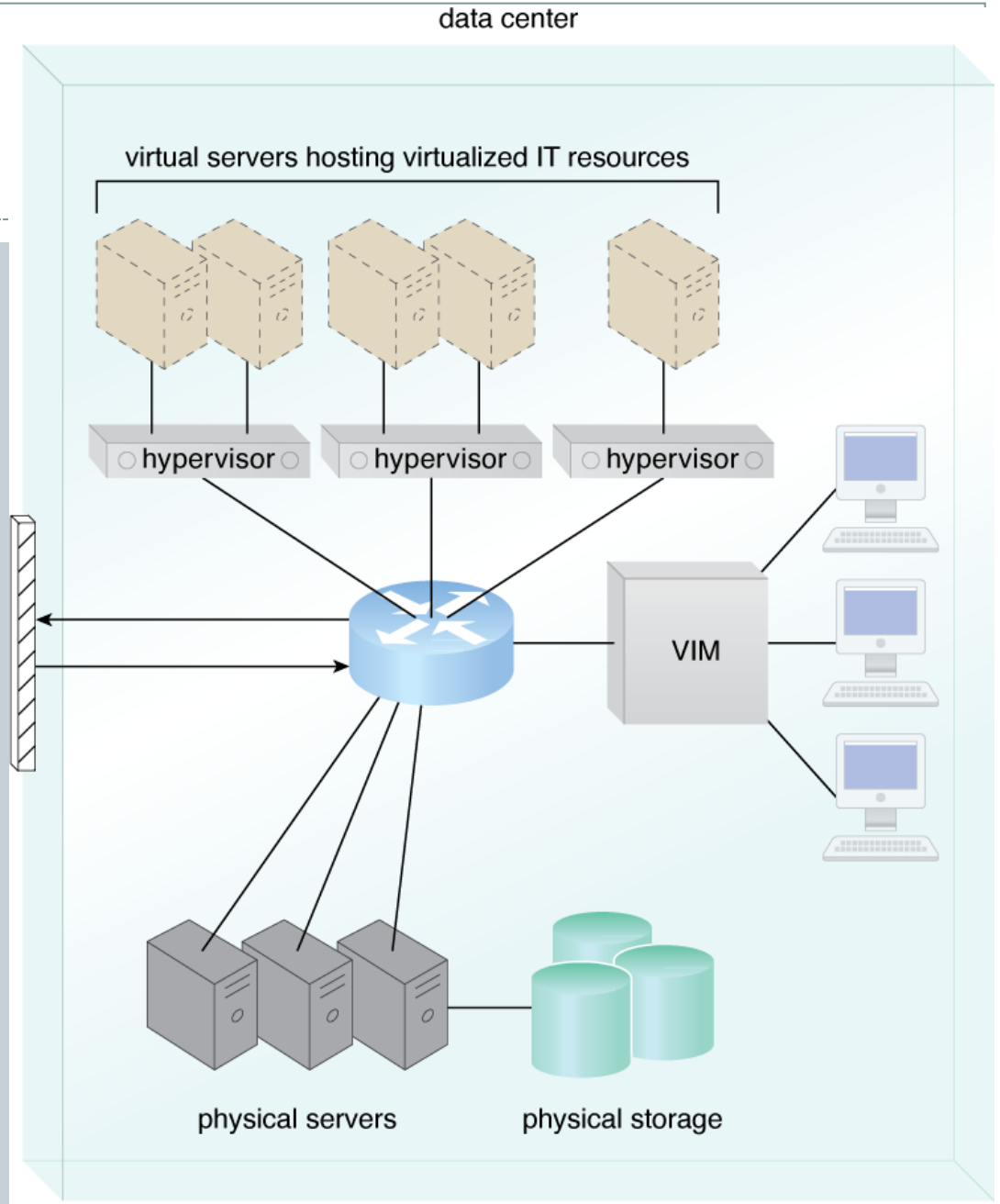
1. Virtualization (Figure 5.7)
2. Standardization and Modularity (enable economy of scale)
3. Automation (self-configuration, recovery)
4. Remote Operation and Management
5. High Availability (through redundancy)

5.2 Data Center Technology (2/2)

6. Security-Aware Design, Operation, and Management (outsourcing resources)
7. Facilities (power, cabling, cooling, fire protection,…)
8. Computing Hardware (standardized commodity servers)
9. Storage Hardware (array, hot-swapping, storage virtualization, fast data replication, SAN, NAS,…)
10. Network Hardware
    1) Carrier and External Networks Interconnection
    2) Web-Tier Load Balancing and Acceleration
    3) LAN Fabric
    4) ANS Fabric
    5) NAS Gateways

Figure 5.7

- *Figure 5.7 - The common components of a data center working together to provide virtualized IT resources supported by physical IT resources.*



Copyright © Arcitura Education

Summary Data Center Technology (1/2)

- A data center is a specialized IT infrastructure that houses centralized IT resources, such as servers, databases, and software systems.
- Data center IT hardware is typically comprises of standardized commodity servers of increased computing power and storage capacity, while storage system technologies include disk arrays and storage virtualization. Technologies used to increase storage capacity include DAS, SAN, and NAS.

Summary of Data Center Technology (2/2)

- Computing hardware technologies include rack-mounted server arrays and multi-core CPU architectures, while specialized high-capacity network hardware and technology, such as content-aware routing, LAN and SAN fabrics, and NAS gateways, are used to improve network connectivity.

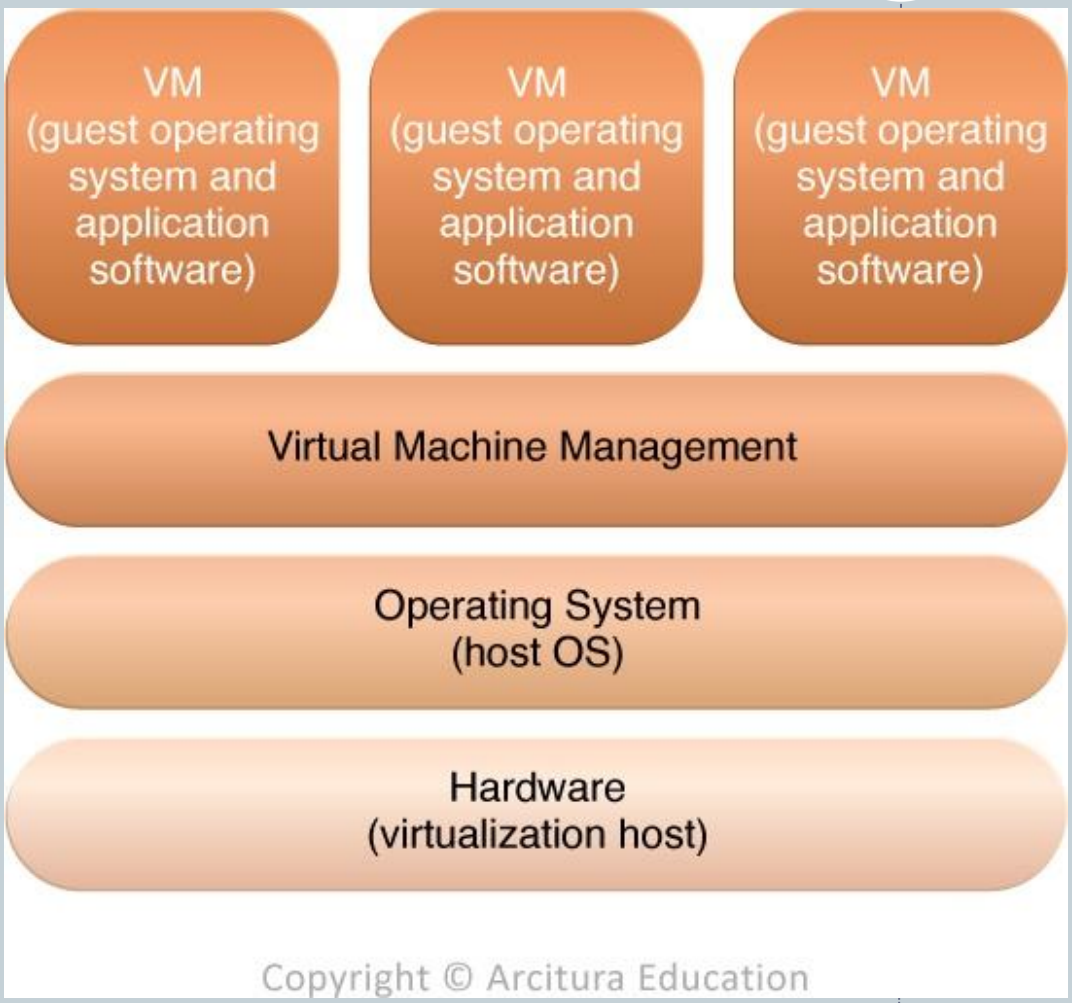
5.3 Virtualization Technology (1/2)

- Most types of IT resources can be virtualized: servers, storage, network, power.
- Hardware Independence
- Server Consolidation
  - Different virtual servers share one physical server
- Resource Replication
  - Virtual disk images can be accessible using simple file operations, such as copy, move, and paste by the host's OS for replication purpose

5.3 Virtualization Technology (2/2)

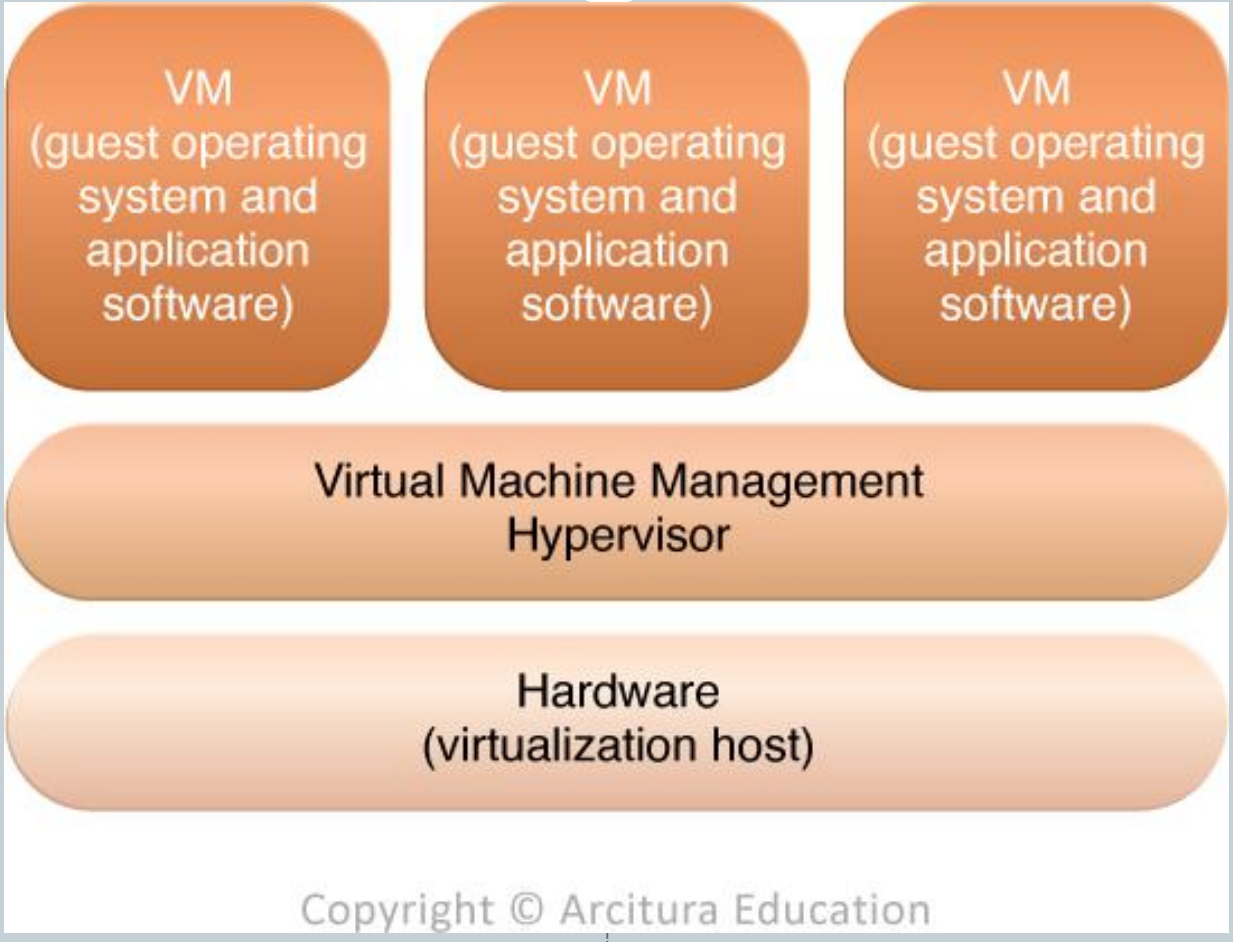
- Operating System-Based Virtualization (Figure 5.8)
- Hardware-Based Virtualization (Figure 5.9)
- Virtualization Management
  - Virtualization infrastructure management (VIM) collectively manage virtual IT resources running on a centralized module.
- Other Considerations
  - Performance overhead
  - Special hardware compatibility
  - Portability (Open Virtualization Format OVF)

Figure 5.8



- *Figure 5.8 - The different logical layers of operating system-based virtualization, in which the VM is first installed into a full host operating system and subsequently used to generate virtual machines.*

Figure 5.9



- *Figure 5.9 - The different logical layers of hardware-based virtualization, which does not require another host operating system.*

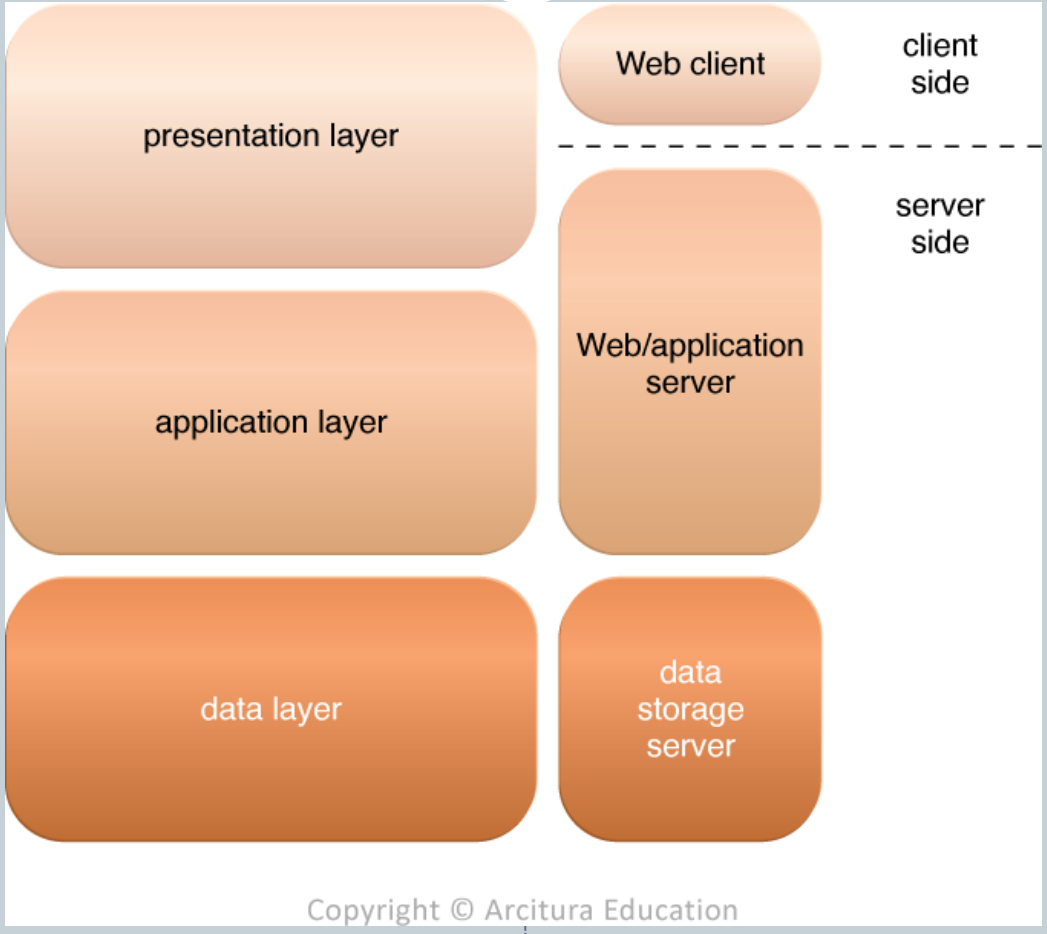
Summary of Virtualization Technology

- Server virtualization is the process of abstracting IT hardware into virtual servers using virtualization software.
- Virtualization provides hardware independence, server consolidation, and resource replication, and further supports resource pooling and elastic scalability.
- Virtual servers are realized through either operating system-based or hardware-based virtualization.

5.4 Web Technology

- Basic Web Technology
  - Uniform Resource Locator (URL)
  - Hypertext Transfer Protocol (HTTP)
  - Markup Language (HTMP, XML)
- Web Applications (Figure 5.10)
  - Presentation layer (user interface)
  - Application layer (application logic in application server)
  - Data layer (data store in data server)

Figure 5.10



- *Figure 5.10 - The three basic architectural tiers of Web applications.*

Summary of Web Service

- Web technology is very commonly for cloud service implementations and for front-ends used to remotely manage cloud-based IT resources.
  - For instance, typical PaaS offerings have separate instances of the Web server, application server, and data server.
- Fundamental technologies of Web architecture include the URL, HTTP, HTML, and XML.

5.5 Multitenant Technology

- Multitenant – a single instance of an IT resource serves multiple consumers (tenants).
- Multitenant application architecture is often significantly more complex than that of single-tenant applications.
- Multi-tenant applications need to support the sharing of various artifacts by multiple users (including portals, data schemas, middleware, and databases), while maintaining security levels that segregate individual tenant operational environments.

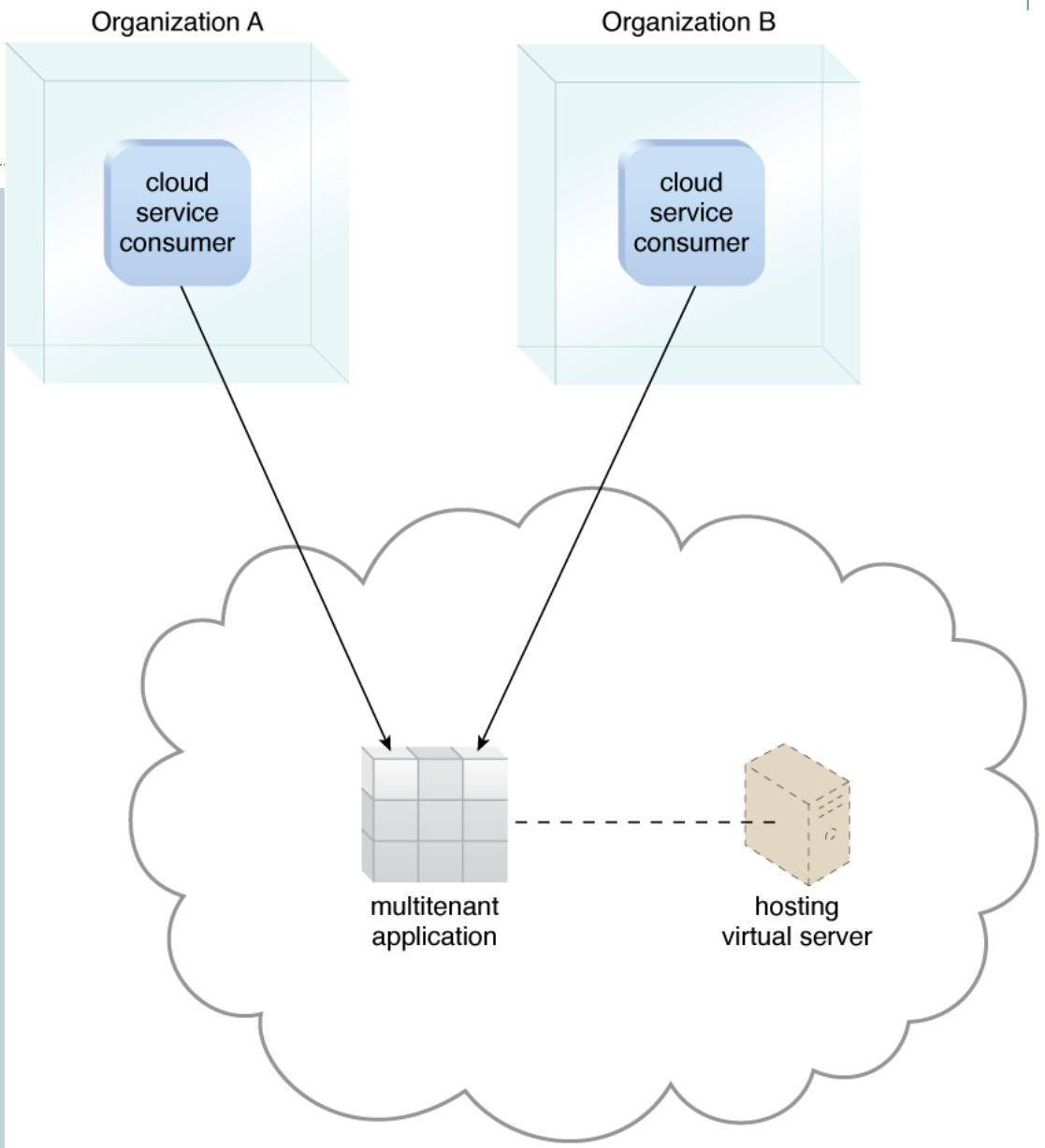
5.5 Characteristics of Multitenant

- Usage isolation
- Data security
- Recovery
- Application upgrades
- Scalability
- Metered usage
- Data tier isolation

- Multitenancy is sometimes mistaken for virtualization because the concept of multiple tenants is similar to the concept of virtualized instances.

Figure 5.11

- *Figure 5.11 - A multitenant application that is serving multiple cloud service consumers simultaneously.*



Copyright © Arcitura Education

Multitenancy VS. Virtualization

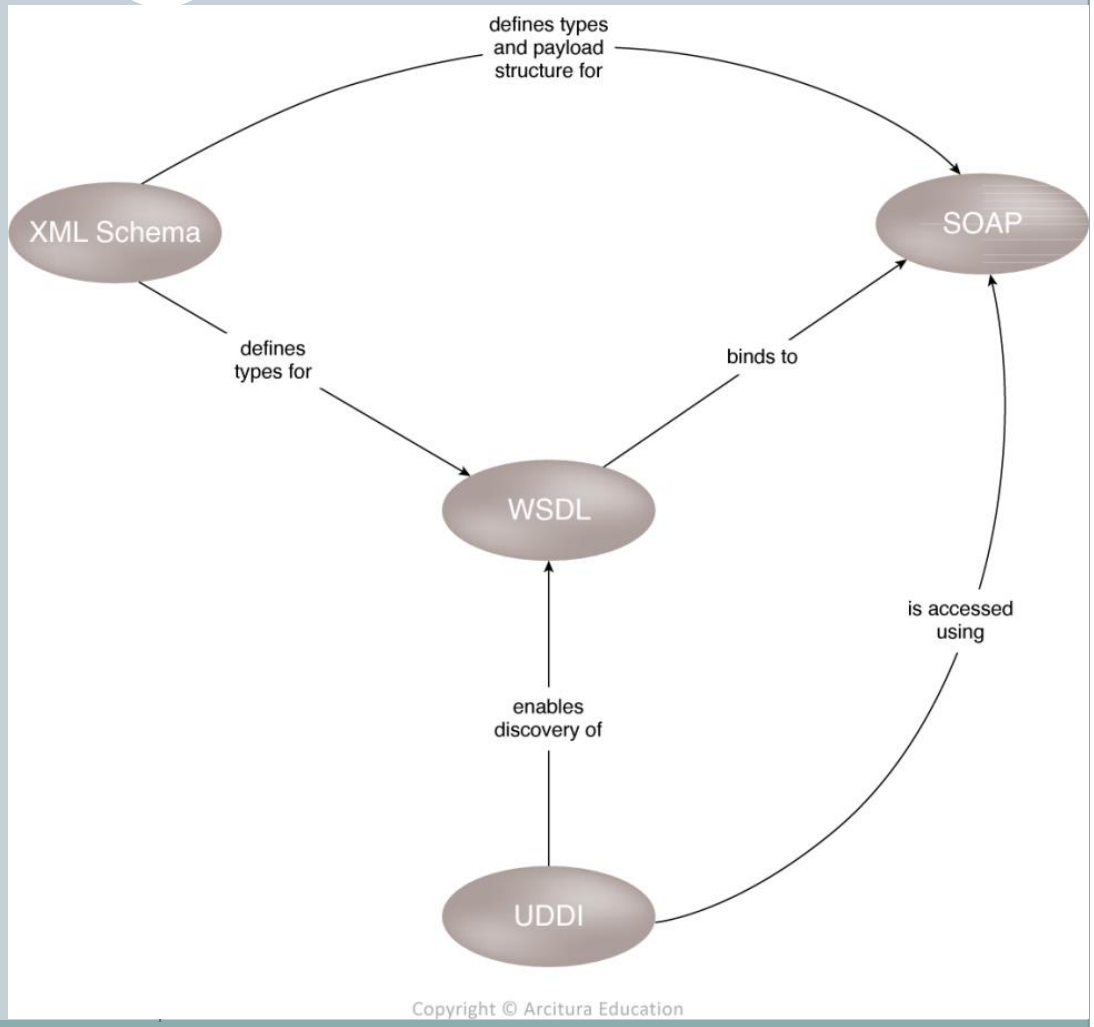
- The differences lie in what is multiplied within a physical server acting as a host:
  - With virtualization:
    - Multiple virtual copies of the server environment can be hosted by a single physical serve. Each copy can be provided to different users, can be configured independently, and can contain its own operating system and applications.
  - With multitenancy:
    - A physical or virtual server hosting an application is designed to allow usage by multiple different users. Each user feels as though they have exclusive usage of the application.

5.6 Service Technology

- Along with XML, the core technologies behind Web services are represented by the following industry standards:
  - Web Service Description Language (WSDL)
  - XML Schema Definition Language (XML Schema)
  - SOAP (Simple Object Access Protocol)
  - Universal Description, Discovery, and Integration (UDDI)
- Note that: These 4 technologies collectively form the first generation of Web service technology. The 2nd generation (WS-*) addresses additional features, such as security, reliability, transactions, routing, and business process automation.

Figure 5.12

- *Figure 5.12 - An overview of how first-generation Web service technologies commonly relate to each other*



Copyright © Arcitura Education

REST Service and Service Agents

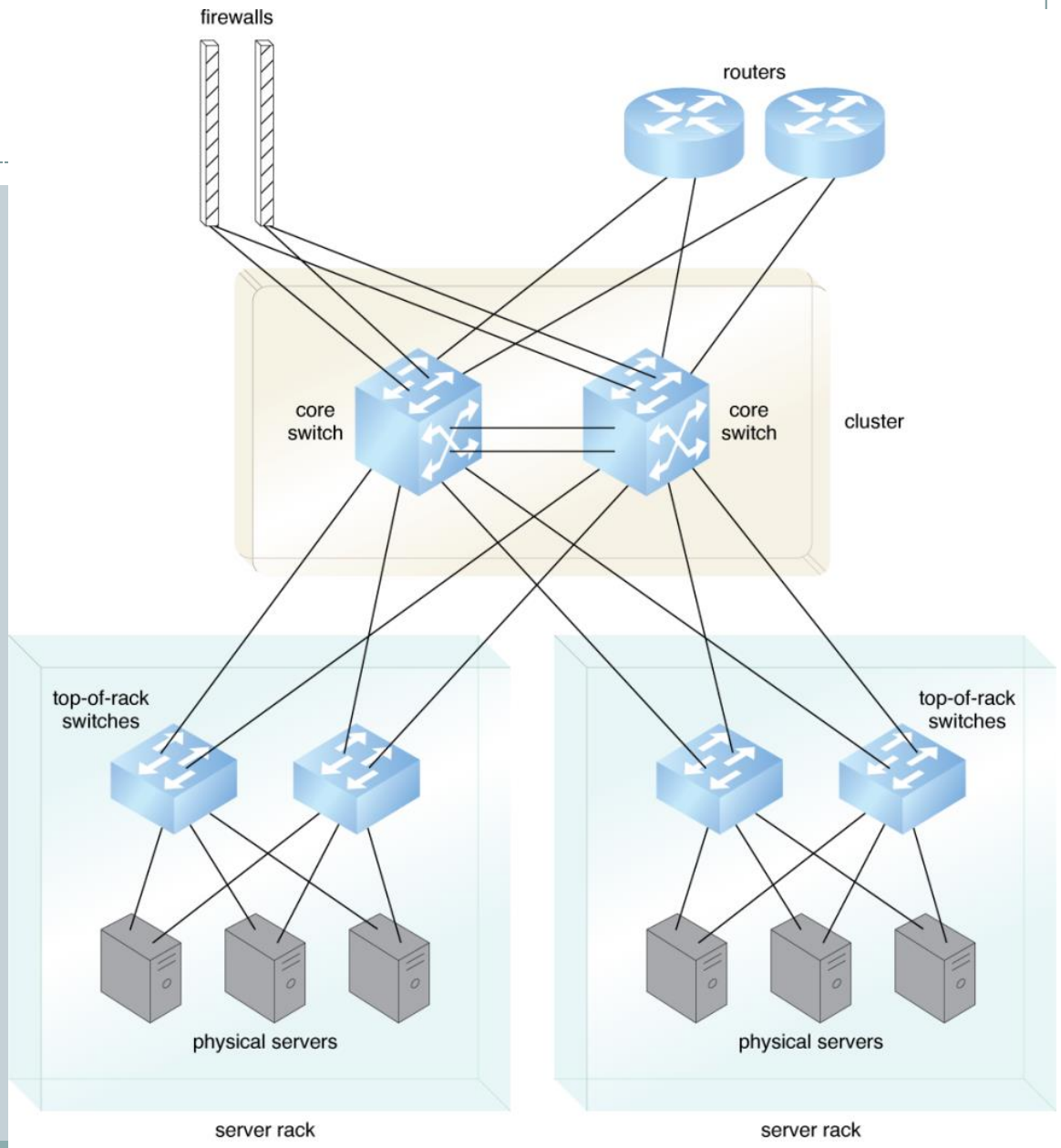
- REST services are designed according to a set of constraints that shape the service architecture to emulate the properties of the WWW.
- Service agents are event-driven programs designed to intercept messages at runtime, either active agent or passive agent.
- Falling under the umbrella of service technology is the large of middle platform. Two main categories are the enterprise service bus (ESB) and the orchestration platform.

Summary of Service Technology

- Web-based services such as Web services and REST services rely on non-proprietary communications and technical interface definitions to establish standardized communications frameworks based on Web technology.
- Service agents provide event-driven runtime processing that can be applied to numerous functional areas within clouds.
- Service middleware, such as ESBs and orchestration platforms, can be deployed on clouds.

Figure 5.13

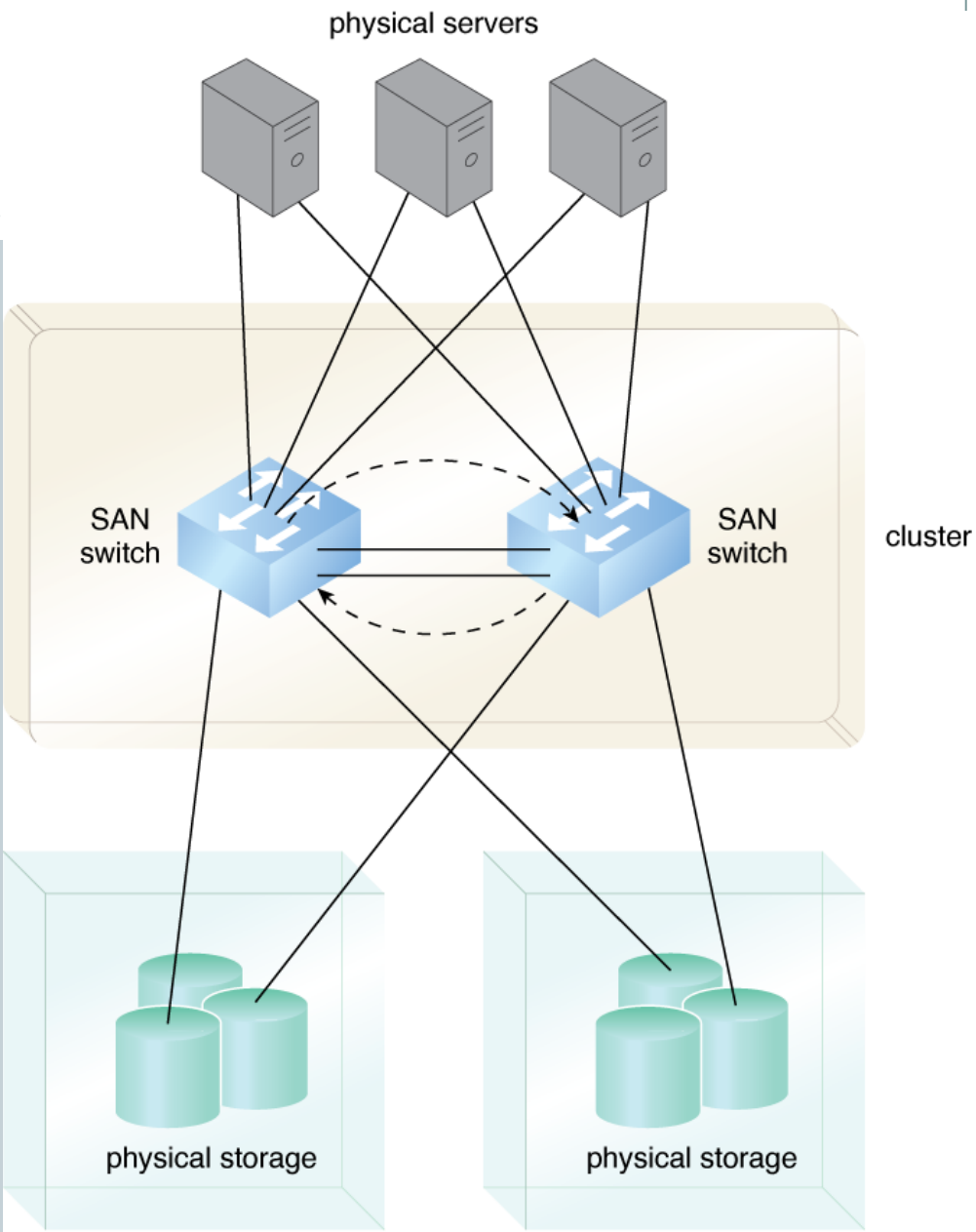
- *Figure 5.13 - A view of the server network connections inside the DTGOV data center.*



Copyright © Arcitura Education

Figure 5.14

- *Figure 5.14 - A view of the storage system network connections inside the DTGOV data center.*



Copyright © Arcitura Education