2.2 Grid Families

Grid technology demands new distributed computing models, software/middleware support, network protocols, and hardware infrastructures. National grid projects are followed by industrial grid plat-form development by IBM, Microsoft, Sun, HP, Dell, Cisco, EMC, Platform Computing, and others. New grid service providers (GSPs) and new grid applications have emerged rapidly, similar to the growth of Internet and web services in the past two decades.

In Table 1.4, grid systems are classified in essentially two categories: computational or data grids and P2P grids.

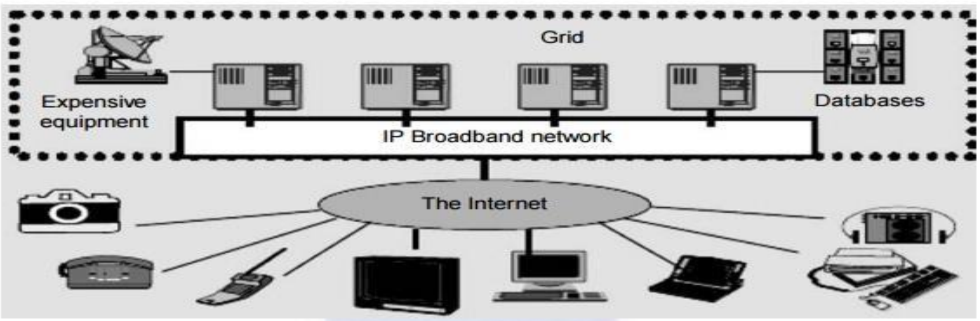


FIGURE 1.16
Computational grid or data grid providing computing utility, data, and information services through resource sharing and cooperation among participating organizations.

Table 1.4 Two Grid Computing Infrastructures and Representative Systems

Design Issues	Computational and Data Grids	P2P Grids
Grid Applications Reported	Distributed supercomputing, National Grid initiatives, etc.	Open grid with P2P flexibility, all resources from client machines
Representative Systems	TeraGrid built in US, ChinaGrid in China, and the e-Science grid built in UK	JXTA, FightAid@home, SETI@home
Development Lessons Learned	Restricted user groups, middleware bugs, protocols to acquire resources	Unreliable user-contributed resources, limited to a few apps

3. Peer-to-Peer Network Families

An example of a well-established distributed system is the client-server architecture. In this scenario, client machines (PCs and workstations) are connected to a central server for compute, e-mail, file access, and database applications. The P2P architecture offers a distributed model of networked systems. First, a P2P network is client-oriented instead of server-oriented. In this section, P2P systems are introduced at the physical level and overlay networks at the logical level.

3.1 P2P Systems

In a P2P system, every node acts as both a client and a server, providing part of the system resources. Peer machines are simply client computers connected to the Internet. All client machines act autonomously to join or leave the system freely. This implies that no master-slave relationship exists among the peers. No central coordination or central database is needed. In other words, no peer machine has a global view of the entire P2P system. The system is self-organizing with distributed control.

Figure 1.17 shows the architecture of a P2P network at two abstraction levels. Initially, the peers are totally unrelated. Each peer machine joins or leaves the P2P network voluntarily. Only the participating peers form the physical network at any time. Unlike the cluster or grid, a P2P network does not use a dedicated interconnection network. The physical network is simply an ad hoc network formed at various Internet domains randomly using the TCP/IP and NAI protocols. Thus, the physical network varies in size and topology dynamically due to the free membership in the P2P network.

3.2 Overlay Networks

Data items or files are distributed in the participating peers. Based on communication or file-sharing needs, the peer IDs form an overlay network at the logical level. This overlay is a virtual network

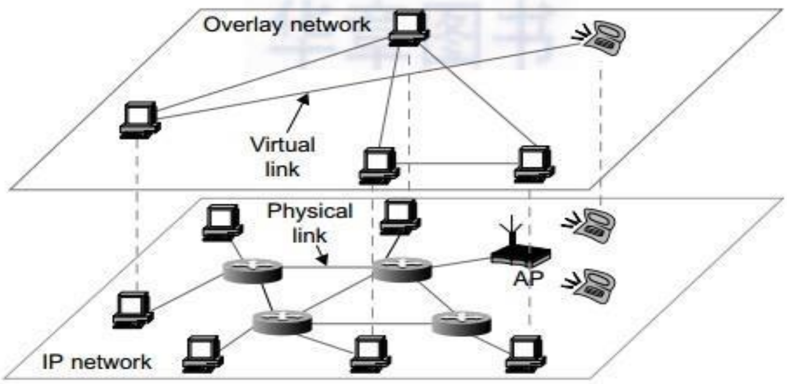


FIGURE 1.17

The structure of a P2P system by mapping a physical IP network to an overlay network built with virtual links.

formed by mapping each physical machine with its ID, logically, through a virtual mapping as shown in Figure 1.17. When a new peer joins the system, its peer ID is added as a node in the overlay network. When an existing peer leaves the system, its peer ID is removed from the overlay network automatically. Therefore, it is the P2P overlay network that characterizes the logical connectivity among the peers.

There are two types of overlay networks: unstructured and structured. An unstructured overlay network is characterized by a random graph. There is no fixed route to send messages or files among the nodes. Often, flooding is applied to send a query to all nodes in an unstructured overlay, thus resulting in heavy network traffic and nondeterministic search results. Structured overlay net-works follow certain connectivity topology and rules for inserting and removing nodes (peer IDs) from the overlay graph. Routing mechanisms are developed to take advantage of the structured overlays.

3.3 P2P Application Families

Based on application, P2P networks are classified into four groups, as shown in Table 1.5. The first family is for distributed file sharing of digital contents (music, videos, etc.) on the P2P network. This includes many popular P2P networks such as Gnutella, Napster, and BitTorrent, among others. Collaboration P2P networks include MSN or Skype chatting, instant messaging, and collaborative design, among others.

3.4 P2P Computing Challenges

P2P computing faces three types of heterogeneity problems in hardware, software, and network requirements. There are too many hardware models and architectures to select from; incompatibility exists between software and the OS; and different network connections and protocols

Table 1.5 Major Categories of P2P Network Families [46]

System Features	Distributed File Sharing	Collaborative Platform	Distributed P2P Computing	P2P Platform
Attractive Applications	Content distribution of MP3 music, video, open software, etc.	Instant messaging, collaborative design and gaming	Scientific exploration and social networking	Open networks for public resources
Operational Problems	Loose security and serious online copyright violations	Lack of trust, disturbed by spam, privacy, and peer collusion	Security holes, selfish partners, and peer collusion	Lack of standards or protection protocols
Example Systems	Gnutella, Napster, eMule, BitTorrent, Aimster, KaZaA, etc.	ICQ, AIM, Groove, Magi, Multiplayer Games, Skype, etc.	SETI@home, Geonome@home, etc.	JXTA, .NET, FightingAid@home, etc.

make it too complex to apply in real applications. We need system scalability as the workload increases. System scaling is directly related to performance and bandwidth. P2P networks do have these properties. Data location is also important to affect collective performance. Data locality, network proximity, and interoperability are three design objectives in distributed P2P applications.

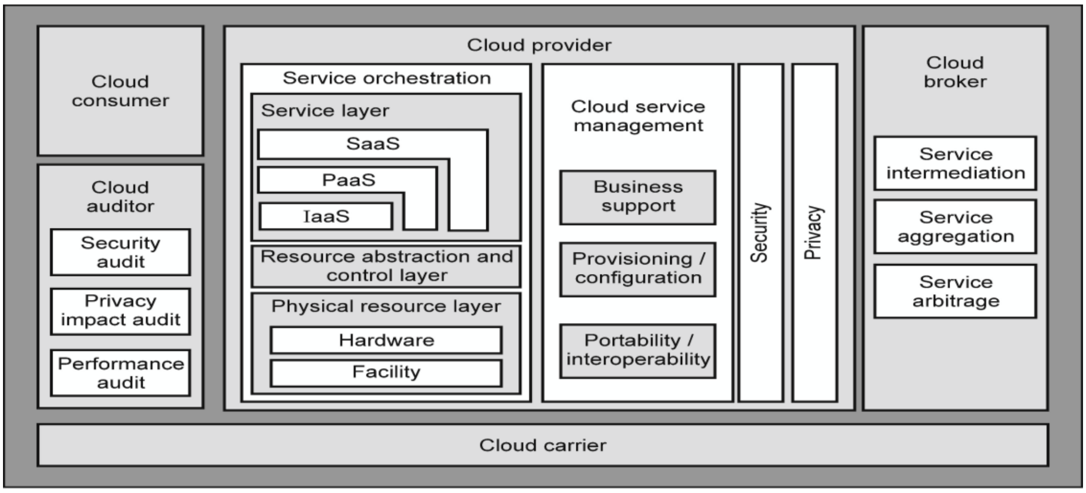
3. **Internet clouds :**The idea is to move desktop computing to a service-oriented platform using server clusters and huge databases at data centers. Cloud computing leverages its low cost and simplicity to benefit both users and providers. Machine virtualization has enabled such cost-effectiveness. Cloud computing intends to satisfy many user Virtualized resources from data centers to form an Internet cloud, provisioned with hardware, software, storage, network, and services for paid users to run their applications.

NIST Cloud Computing Reference Architecture

4. Explain about the NIST Cloud Computing reference architecture. (May-2022)

The reference architecture model given by the National Institute of Standards and Technology (NIST). The model offers approaches for secure cloud adoption while contributing to cloud computing guidelines and standards.

The NIST team works closely with leading IT vendors, developers of standards, industries and other governmental agencies and industries at a global level to support effective cloud computing security standards and their further development. It is important to note that this NIST cloud reference architecture does not belong to any specific vendor products, services or some reference implementation, nor does it prevent further innovation in cloud technology.



Conceptual cloud reference model showing different actors and entities

Cloud reference architecture includes five major actors :

- Cloud consumer
- Cloud provider
- Cloud auditor
- Cloud broker
- Cloud carrier

Each actor is an organization or entity plays an important role in a transaction or a process, or performs some important task in cloud computing. The interactions between these actors are illustrated in Fig. 1.3.

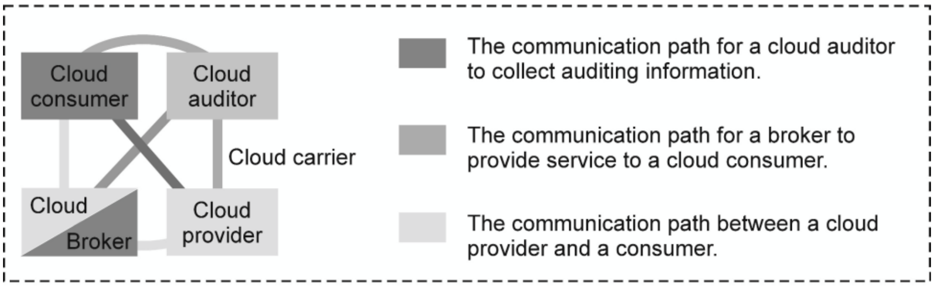


Fig. 1.3: Interactions between different actors in a cloud

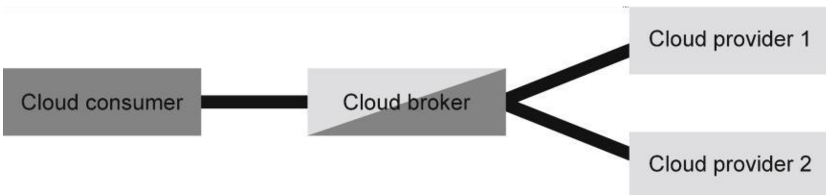
Now, understand that a cloud consumer can request cloud services directly from a CSP or from a cloud broker. The cloud auditor independently audits and then contacts other actors to gather information. We will now discuss the role of each actor in detail.

Cloud Consumer

A cloud consumer is the most important stakeholder. The cloud service is built to support a cloud consumer. The cloud consumer uses the services from a CSP or person or asks an organization that maintains a business relationship. The consumer then verifies the service catalogue from the cloud provider and requests an appropriate service or sets up service contracts for using the service. The cloud consumer is billed for the service used.

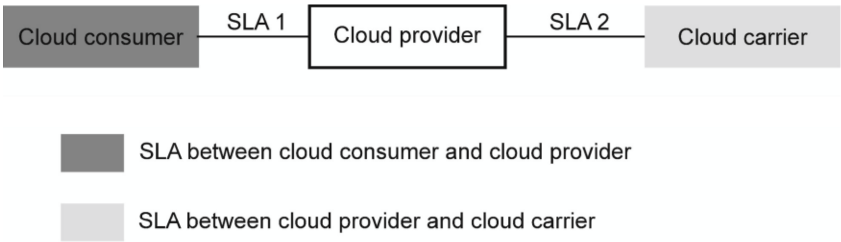
Some typical usage scenarios include :

Example 1 : Cloud consumer requests the service from the broker instead of directly contacting the CSP. The cloud broker can then create a new service by combining multiple services or by enhancing an existing service. Here, the actual cloud provider is not visible to the cloud consumer. The consumer only interacts with the broker. This is illustrated.



Cloud broker interacting with cloud consumer

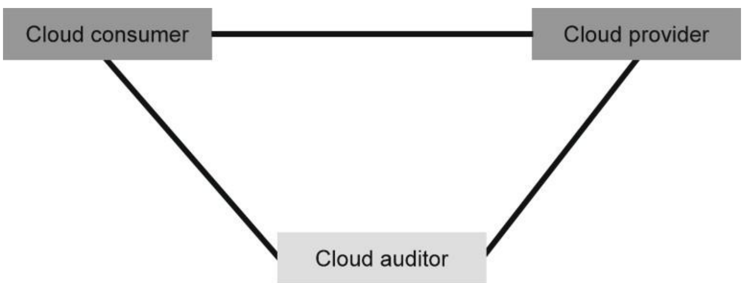
Example 2 : In this scenario, the cloud carrier provides for connectivity and transports cloud services to consumers. This is illustrated in Fig. 1.5.



Scenario for cloud carrier

In Fig. 1.2.4, the cloud provider participates by arranging two SLAs. One SLA is with the cloud provider (SLA2) and the second SLA is with the consumer (SLA1). Here, the cloud provider will have an arrangement (SLA) with the cloud carrier to have secured, encrypted connections. This ensures that the services are available for the consumer at a consistent level to fulfil service requests. Here, the provider can specify the requirements, such as flexibility, capability and functionalities in SLA2 to fulfil essential service requirements in SLA1.

Example 3 : In this usage scenario, the cloud auditor conducts independent evaluations for a cloud service. The evaluations will relate to operations and security of cloud service implementation. Here the cloud auditor interacts with both the cloud provider and consumer, as shown in Fig. 1.6.



Usage scenario involving a cloud auditor