Distributed Computing

Computer Engg
Semester – 6th

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Distributed Computing

- Field of **computer** science that studies **distributed systems**
- A **distributed system** is a model in which **components** located on networked computers communicate and coordinate their actions by passing messages.
- The **components** interact with each other in order to achieve a common goal.


Cloud
Computing

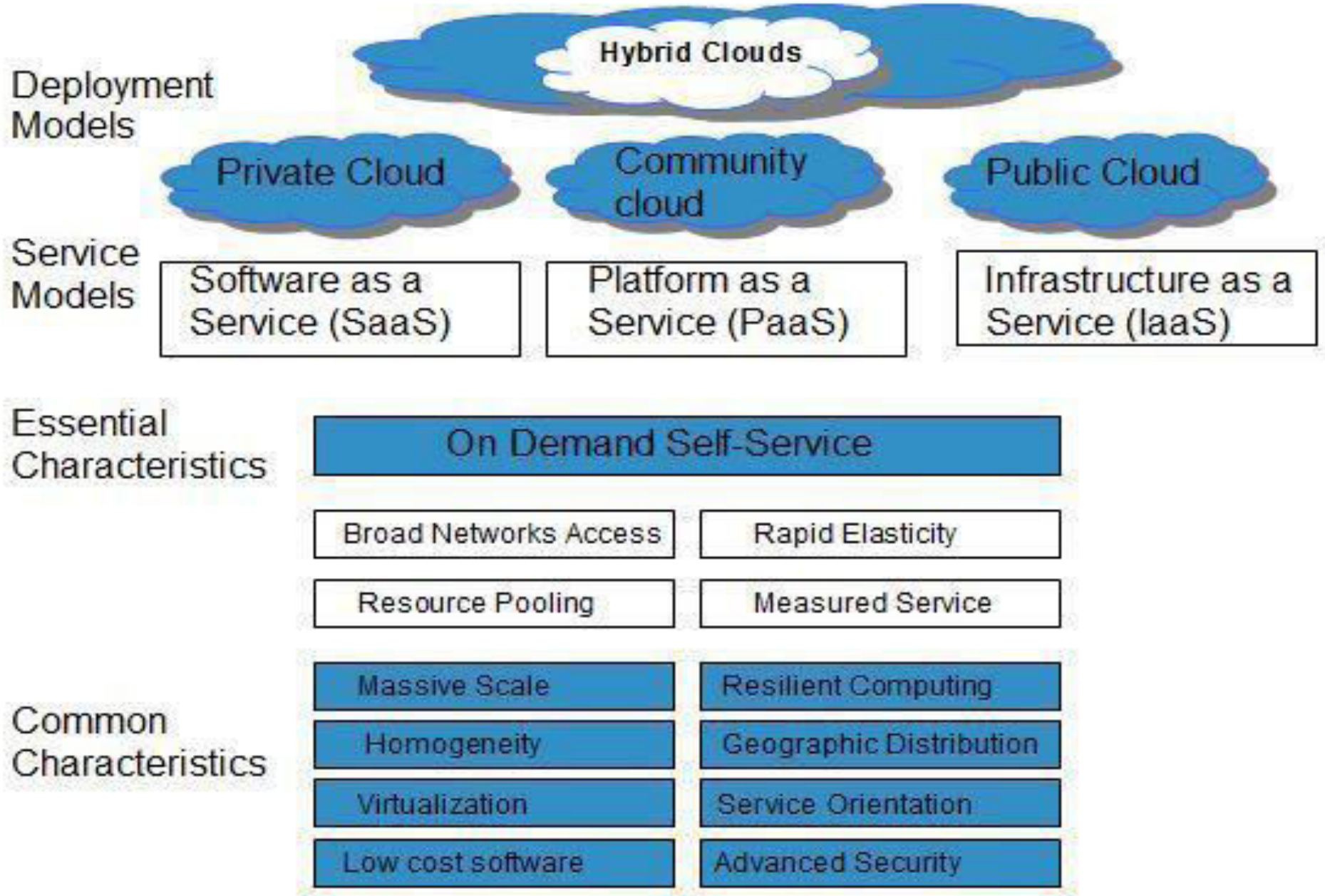
Cloud Computing

- Cloud Computing can be defined as delivering computing power (CPU, RAM, Network Speeds , Storage OS software) as a service over a network (usually on the internet) rather than physically having the computing resources at the customer location.
- Cloud computing means ***on demand delivery of IT resources via*** **the internet with pay-as-you-go pricing.**
- It provides a solution of IT infrastructure in low cost.

Overview

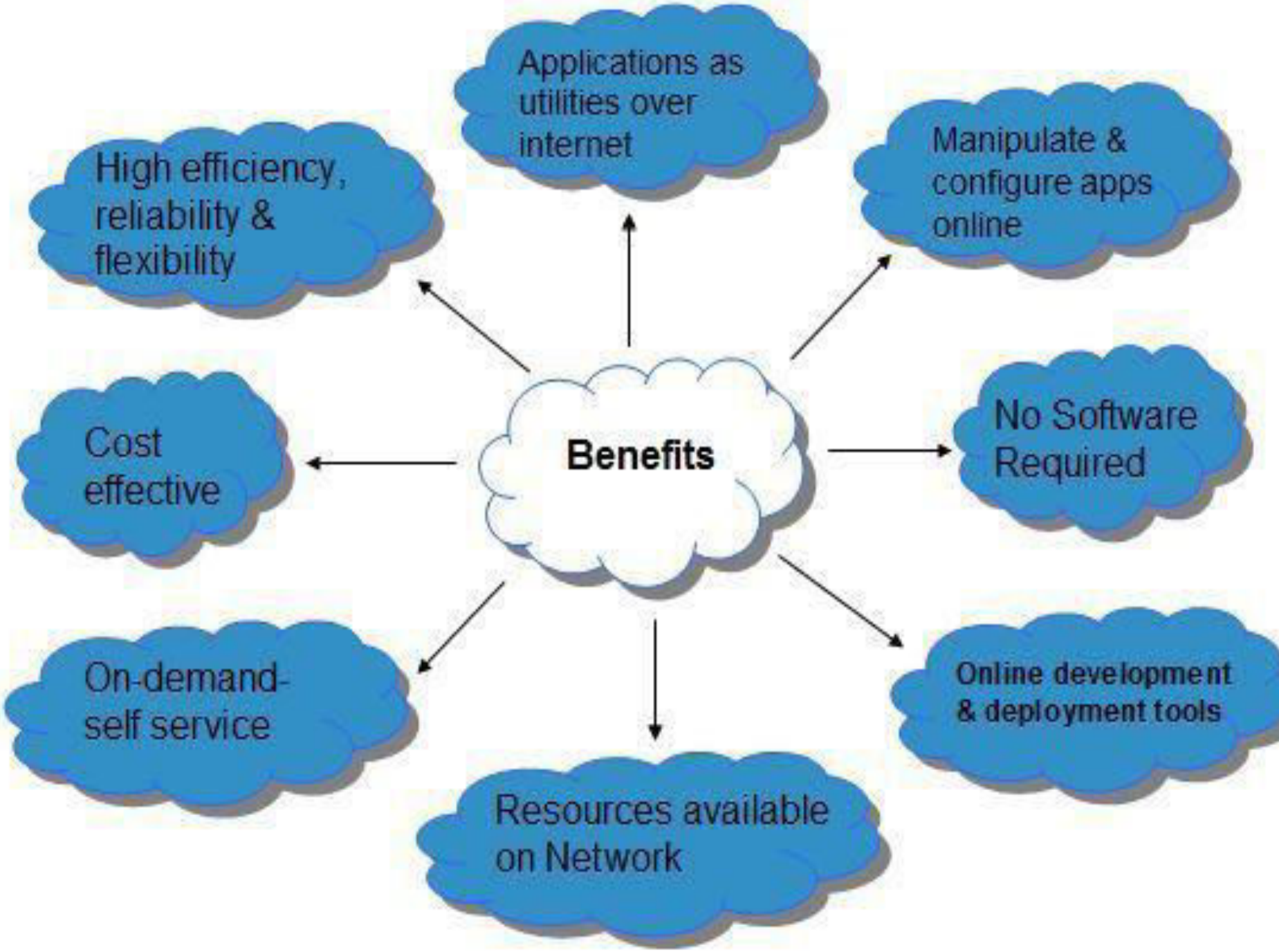
- **Cloud computing** refers to applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards.
- It brings the user access to data, applications and storage that are not stored on their **computer**.
- For a very simple **cloud** computing **overview**, it can be understood as a delivery system that delivers computing the same way a power grid delivers electricity.

Charcteristics of Cloud Ccomputing



Characteristics

- On demand Self Services
- Deployment Models
- Service Models
- Broad Network Access
- Resource Pooling
- Rapid Elasticity
- Measured Service(pay-per-use mode)
- Multi-tenacity
- High Scalability
- High Availability and Reliability
- Low cost
- Location Independence
- Agility


Applications as utilities over internet
High efficiency, reliability & flexibility
Manipulate & configure apps online
Cost effective
Benefits
No Software Required
On-demand-self service
Online development & deployment tools
Resources available on Network

Advantages

- Reduced cost
- Increased Storage
- Flexibility
- Cost Efficient
- Backup and Recovery
- Automatic Software Integration
- Quick Deployment
- Increased Data Safety
- Improved Performance
- Scalability

Challenges

- Data Protection(Security)
- Data Recovery and Availability
- Management Capabilities
- Regulatory and Compliance Restrictions
- Technical Issues
- Security Issues
- Prone to Attack
- High speed Internet Required
- Requires Constant Internet Connection

Applications

- Infrastructure as a Service
- Platform as a Service
- Private cloud
- Hybrid cloud
- Test and Development
- Bid Data Analytics
- File Storage
- Disaster Recovery
- Backup

Cloud Computing Models

- Cloud computing has two types of models :-
  - **Service Models**
  - **Deployment Models**

Software as a Service

- SaaS is a software distribution model in which applications are hosted by a cloud service provider and made available to customers over internet.
- SaaS is also known as "On-Demand Software".
- In SaaS, software and associated data are centrally hosted on the cloud server.
- SaaS is accessed by users using a thin client via a web browser.

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Disadvantages of SaaS

- Security
- Latency issue
- Total Dependency on Internet
- Switching between SaaS vendors is difficult

Advantages of SaaS

- SaaS is easy to buy
- Less hardware required for SaaS
- Low Maintenance required No special software or hardware versions required
- for SaaS

Platform as a Service

- PaaS cloud computing platform is a developer programming platform
- created for the programmer to develop, test, run and manage the applications.
- A developer is able to write the application as well as deploy it directly into this layer easily.
- PaaS extend and abstract the IaaS layer by removing the hassle of managing the individual virtual machine.

Advantages of PaaS

- Simplified Development
- Lower risk
- Prebuilt business functionality
- Instant community
- Scalability

Disadvantages of PaaS

- Vendor lock-in
- Data Privacy
- Integration with the rest of the systems applications

Infrastructure as a Service

- IaaS is one of the layers of cloud computing platform wherein the customer organization outsources its IT infrastructure such as servers, networking, processing, storage, virtual machines and other resources.
- Customers access these resources over internet i.e. cloud computing platform, on a pay-per-use model.
- IaaS cloud computing platform layer eliminates the need for every organization to maintain the IT infrastructure.

Advantages of IaaS

- You can dynamically choose a CPU, memory and storage configuration as per your needs.
- You easily access the vast computing power available on IaaS cloud platform.
- You can eliminate the need of investment in rarely used IT hardware.
- IT infrastructure will be handled by the IaaS cloud computing platform vendors.

Disadvantages of IaaS

- There is a risk of IaaS cloud computing platform vendor by gaining the access to the organization's data.But it can be avoided by opting for private cloud.
- IaaS cloud computing platform model is dependent on internet availability.
- It is also dependent on the availability of virtualization services.
- IaaS cloud computing platform can limit the user privacy and customization options.

Public Cloud

- Public cloud allows the accessibility of systems and services easily to general public.
- It is constructed with a view to offer unlimited storage space and increased bandwidth via Internet to all Businesses.
- They are owned, hosted and operated by third-party service providers.
- It is based on “pay-as-you-go” model.
- Eg: Amazon, IBM, Microsoft, Google, Rackspace etc.

Advantages Of Public Cloud

- Pay for what we use
- Reliable
- Flexible
- Location Independent
- High Scalability
- Freedom of Self-Service

Disadvantages Of Public Cloud

- Low Security
- Less Customizable
- Lack of Investment
- Slow speed

Private Cloud

- The Private cloud allows the accessibility of systems and services within the organization.
- Private cloud is operated only within a particular organization.
- It can be managed and hosted internally or by third party.
- Users are charged on basis of per Gigabytes usage along with bandwidth transfer fees.
- E.g. Amazon VPC, IBM SmartCloud Foundation and Microsoft Private Cloud.

Advantages Of Private Cloud

- High Security and Privacy
- More Control
- Data Sovereignty Concerns
- Greater Customization
- FUD(Fear, Uncertainty and Doubt)

Disadvantages Of Private Cloud

- Higher Cost
- Restriction
- Less Scalability
- Onsite Maintenance
- Capacity Ceiling

Hybrid Cloud

- The Hybrid cloud is the mixture of public and private cloud.
- Non-critical activities are performed by public cloud while critical activities are performed by private cloud.
- It has advantages of both private and public cloud, offer flexibility, control and security of multiple deployment models.
- IT organizations use hybrid clouds to employ cloud bursting for scaling across clouds.

Advantages of Hybrid Cloud

- Scalable
- Flexible and Secure
- Cost Effective
- Optimal Utilization

Disadvantages Of Hybrid Cloud

- Networking Issues
- Security Compliance

Community Cloud

- The cloud infrastructure is shared between the organizations having similar interests and requirements.
- It can be managed and hosted internally or by a third party.
- This model is built when the organizations are ready to share the benefits of cloud service.

Advantages Of Community Cloud

- Security
- Highly Scalable
- Common Practices

Disadvantages Of Community Cloud

- Risk of Data
- Difficult in combining organization
- Highly Scalable
- Common Practices

Grid Computing

Introduction

- The term Grid comes from an analogy to the Electric Grid.
  - Pervasive access to power.
  - Similarly, Grid will provide pervasive, consistent, and inexpensive access to advanced computational resources.
- Grid computing is all about achieving greater performance and throughput by pooling resources on a local, national, or international level.

GRID Computing

- Grids are about large-scale resource sharing.
  - Spanning administrative boundaries.
    - Central processors, storage, network bandwidth, databases, applications, sensors and so on
- Problem solving in dynamic, multi-institutional environment.
- Organizing geographically distributed computing resources
  - So that they can be flexibly and dynamically allocated and accessed
- Providing such capabilities, where Sharing is highly controlled, clear definitions of exactly what is shared, who is allowed to share, and the conditions under which sharing occurs.

Elements of Grid Computing

- Resource sharing
  - Computers, data, storage, sensors, networks, …
  - Sharing always conditional: issues of trust, policy, negotiation, payment, …
- Coordinated problem solving
  - Beyond client-server: distributed data analysis, computation, collaboration, …
- Dynamic, multi-institutional *virtual organizations*
  - Community overlays on classic org structures
  - Large or small, static or dynamic

Virtual Organizations

- A set of individuals and/or institutions defined by a set of sharing rules
- The sharing is highly controlled, with resource providers and consumers defining clearly and carefully just what is shared

An example: the set of application service providers, storage service providers, cycle providers and consultants engaged by a car manufacturer to plan for a new factory

Another example: industrial consortium building a new aircraft

More Formal Definition of Grids

- A grid is a system that:
  - Coordinates resource sharing in a de-centralized manner (i.e., different VOs).
  - Uses standard, open, general purpose protocols and interfaces.
  - Delivers non-trivial qualities of service.
    - Guaranteed bandwidth for application.
    - Guaranteed CPU cycles.
    - Guaranteed latency.

Computational Grid Applications

- Biomedical research
- Industrial research
- Engineering research
- Studies in Physics and Chemistry

Grid Computing Software Infrastructure

Open Grid Services Architecture

- Developed by the Global Grid Forum to define a common, standard, and open architectures for Grid-based applications.
  - Provides a standard approach to all services on the Grid.
    - VO Management Service.
    - Resource discovery and management service:
    - Job management service.
    - Security services.
    - Data management services.
- Built on top of and extends the Web Services architecture, protocols, and interfaces.

A stateless Web Service invocation

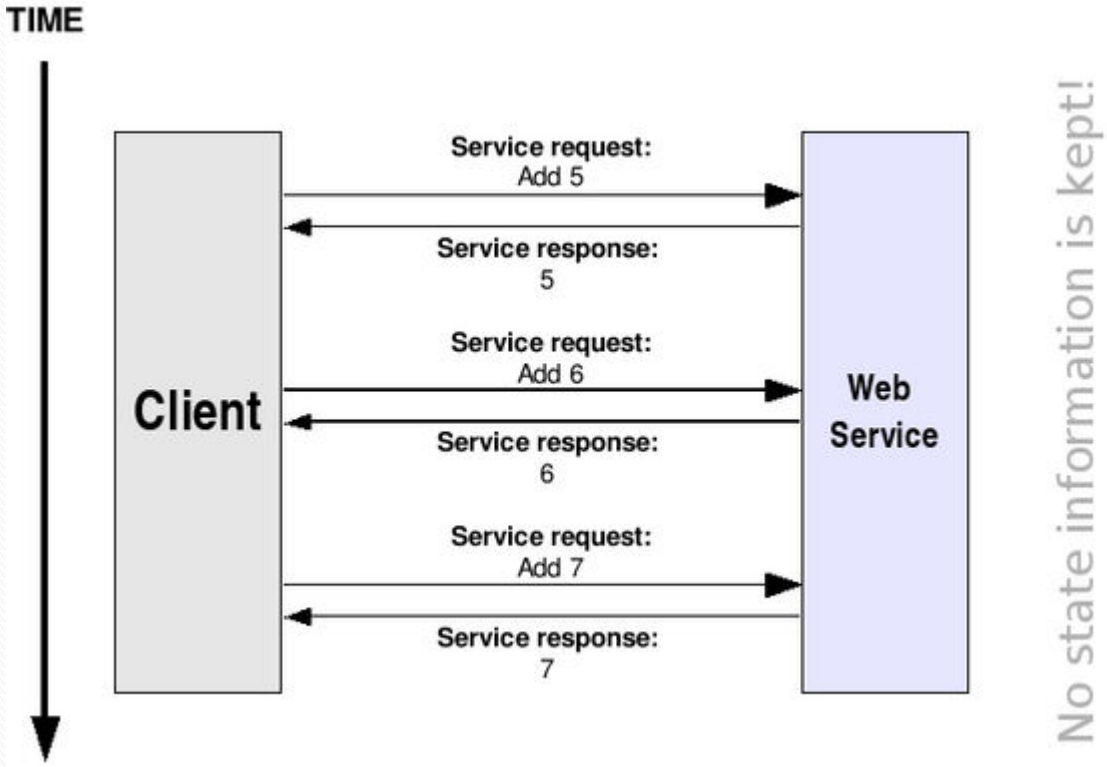
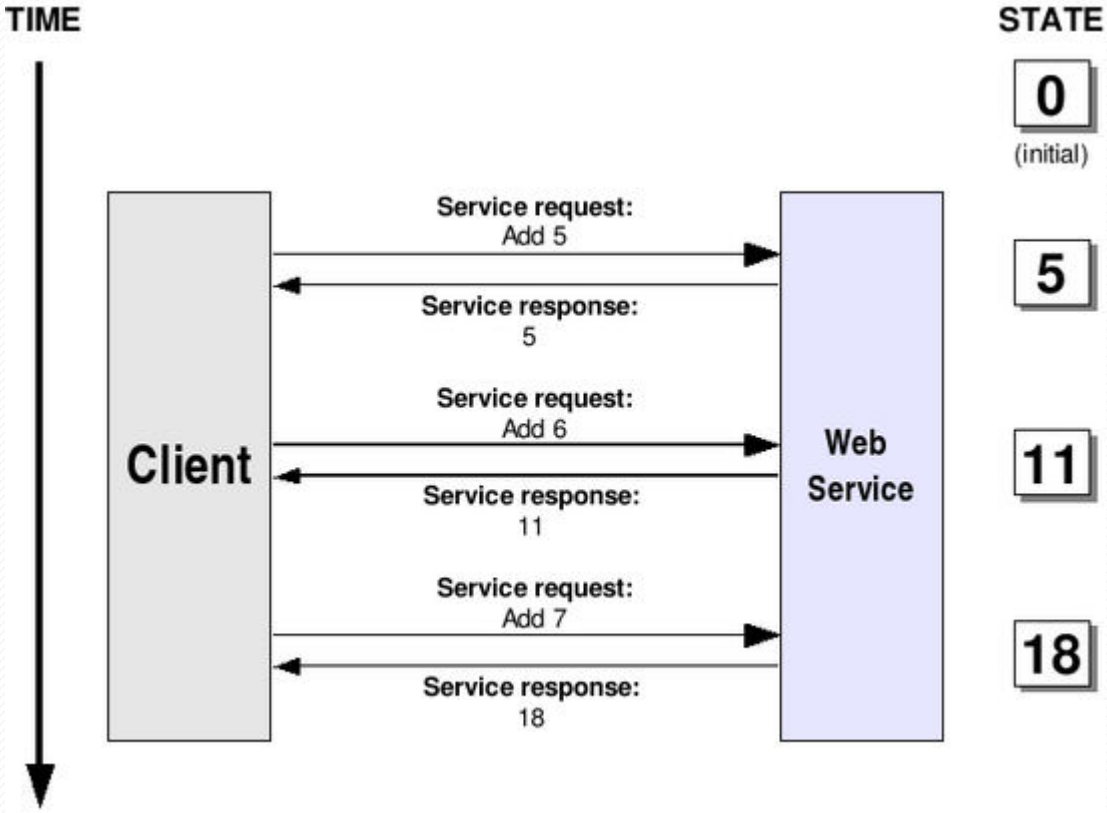


Figure 1.11. A stateful Web Service invocation



Standards Bodies

The primary standards-setting body is[1]:

- Global Grid Forum (GGF)
  - Started in 1998
  - More than 40 organizations involved and growing …

Others:

- W3C consortium (Worlds Wide Web Consortium)
  - Working on standardization of web-related technologies such as XML
  - See http://www.w3.org
- OASIS (Organization for the Advancement of Structured Information Standards)
- IETF, DMTF

Globus Project

- Open source software toolkit developed for grid computing.
- Roots in I-way experiment.
- Work started in 1996.
- Four versions developed to present time.
- Reference implementations of grid computing standards.
- Defacto standard for grid computing.

Globus Version 4

- A “toolkit” of services and packages for creating the basic grid computing infrastructure
- Higher level tools added to this infrastructure
- Version 4 is web-services based
- Some non-web services code exists from earlier versions (legacy) or where not appropriate (for efficiency, etc.).

Thanks