

## **UNIT-4**

# **Role of data, information, knowledge and collaboration**

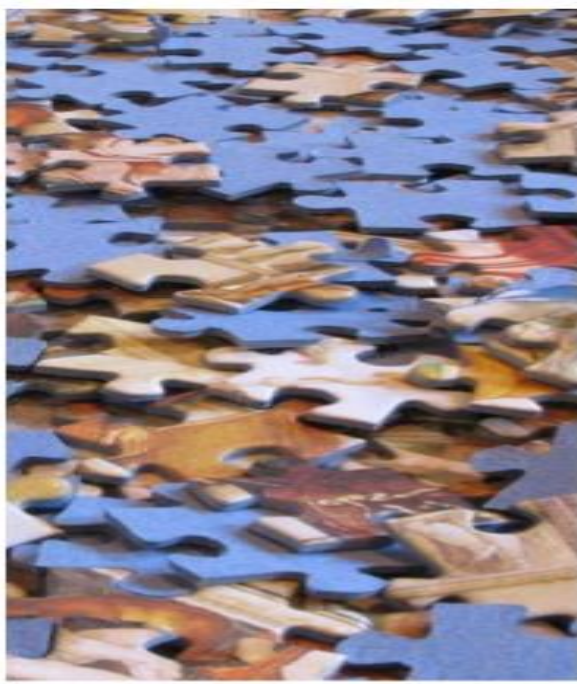
# What is data?

The concept of data as it is used in the syllabus is commonly referred to as ‘raw’ data – a collection of text, numbers and symbols with no meaning. Data therefore has to be processed, or provided with a context, before it can have meaning.

Example :

- 3, 6, 9, 12
- cat, dog, rabbit
- 161.2, 175.3, 166.4, 164.7, 169.3

These are meaningless sets of data. They could be the first four answers in the 3 x table, a list of household pets and the heights of 15-year-old students but without a context we don't know.



## Data can be

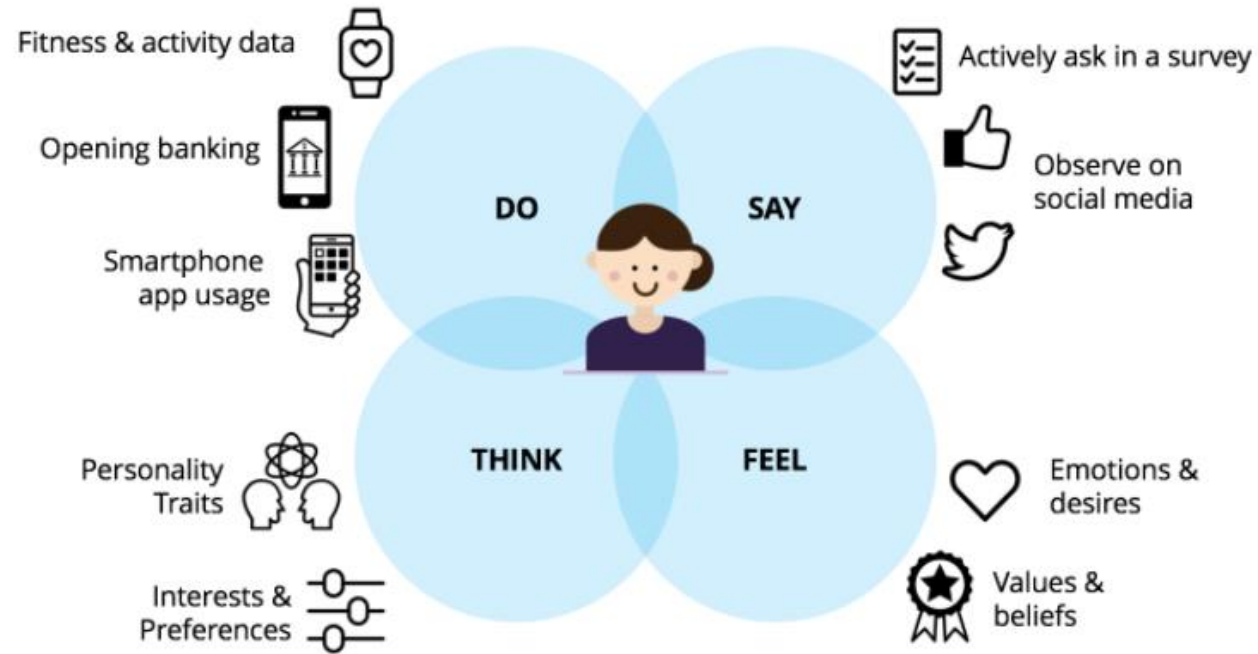
- **Observational:** Captured in real-time, typically outside the lab
  - **Examples:** Sensor readings, survey results, images, audio, video
- **Experimental:** Typically generated in the lab or under controlled conditions
  - **Examples:** test results
- **Simulation:** Machine generated from test models
  - **Examples:** climate models, economic models
- **Derived / Compiled:** Generated from existing datasets
  - **Examples:** text and data mining, compiled database, 3D models

## Data can be

- **Text:** field or laboratory notes, survey responses
- **Numeric:** tables, counts, measurements
- **Audiovisual:** images, sound recordings, video
- **Models, computer code, geospatial data**
- **Discipline-specific:** FITS in astronomy, CIF in chemistry
- **Instrument-specific:** equipment outputs



# Sources of Data



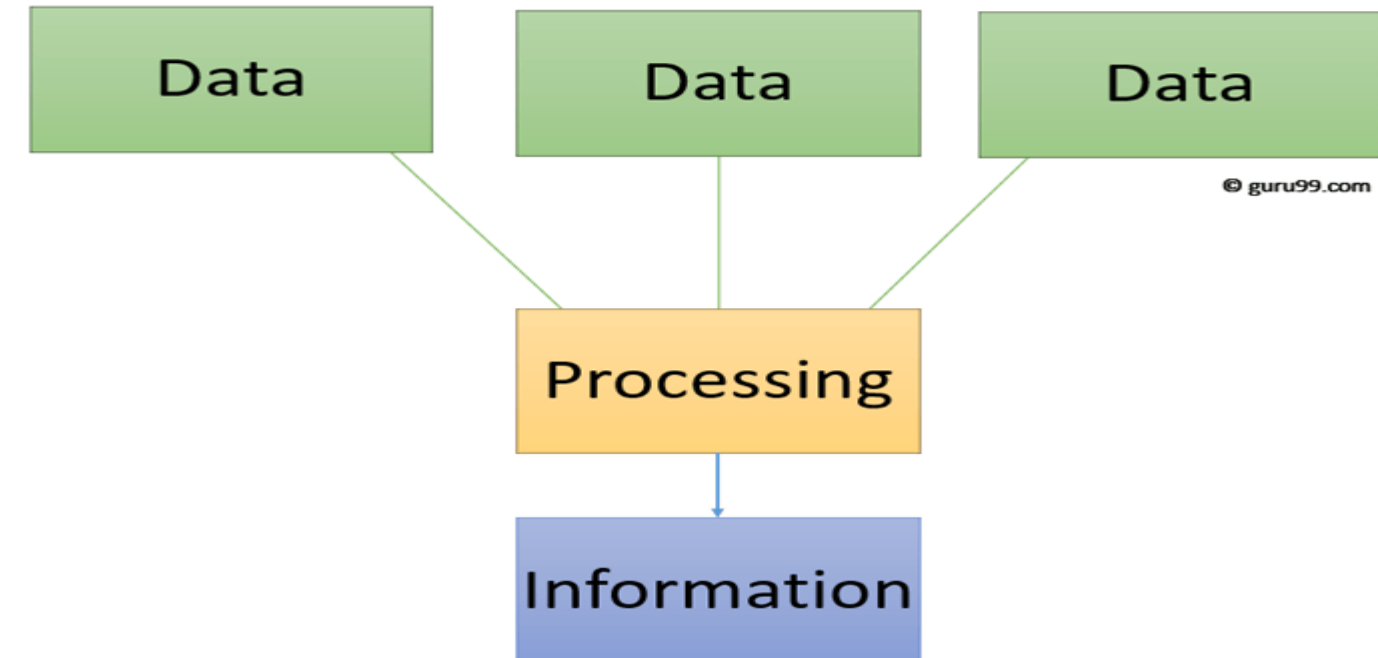
# What is information?

It is important that students learn the concept of what 'information' is as used in information technology.

Information is the result of processing data. Information is data that has meaning.

This results in facts, which enables the processed data to be used in context and have meaning.

## When does data become information?



# Information:

In IT, symbols, characters, images, or numbers are data. These are the inputs an IT system needs to process in order to produce a meaningful interpretation. In other words, data in a meaningful form becomes information. Information can be about facts, things, concepts, or anything relevant to the topic concerned. It may provide answers to questions like who, which, when, why, what, and how.

If we put Information into an equation it would look like this:

$$\text{Data} + \text{Meaning} = \text{Information}$$

Example

**Data :**

- 3, 6, 9, 12
- cat, dog, rabbit
- 161.2, 175.3, 166.4, 164.7, 169.3

**Information :**

Only when we assign a context or meaning does the data become information.

- 3, 6, 9 and 12 are the first four answers in the 3 x table → **about 3 table**
- cat, dog, rabbit, is a list of household pets → **PETS**
- 161.2, 175.3, 166.4, 164.7, 169.3 are the heights of **15-year-old students**

Example : 2

The data **P952BR** could have several meanings.

It could possibly be:

- **a product code**
- **a postal / ZIP code**
- **a car registration number.**

For the data to become information, it needs to be given meaning. Information is useful because it means something.

### EXAMPLE

Data	Context	Meaning
P952BR	A product code	A product code for a can of noodles.
@bbcclick	A Twitter handle	The Twitter address for the BBC's weekly technology show, <i>Click</i> , which is worth watching on BBC World News and BBC2 to keep up to date with technology.
359	Price in Pakistani rupees	The price of a mobile phone cover.

## **Definitions:**

**Data** are recorded (captured and stored) symbols and signal readings.

- Symbols include words (text and/or verbal), numbers, diagrams, and images (still &/or video), which are the building blocks of communication.
- Signals include sensor and/or sensory readings of light, sound, smell, taste, and touch.

**Information** is a message that contains relevant meaning, implication, or input for decision and/or action. Information comes from both current (communication) and historical (processed data or 'reconstructed picture') sources. In essence, the purpose of information is to aid in making decisions and/or solving problems or realizing an opportunity.

**Knowledge** is the (1) cognition or recognition (know-what), (2) capacity to act (know-how), and (3) understanding (know-why) that resides or is contained within the mind or in the brain. The purpose of knowledge is to better our lives. In the context of business, the purpose of knowledge is to create or increase value for the enterprise and all its stakeholders. In short, the ultimate purpose of knowledge is for value creation.



## **KEY DIFFERENCE **Data and Information** :**

- Data is a raw and unorganized fact that is required to be processed to make it meaningful whereas Information is a set of data that is processed in a meaningful way according to the given requirement.
- Data does not have any specific purpose whereas Information carries a meaning that has been assigned by interpreting data.
- Data alone has no significance while Information is significant by itself.
- Data never depends on Information while Information is dependent on Data.
- Data can be structured, tabular data, graph, data tree whereas Information is language, ideas, and thoughts based on the given data.

## Knowledge:

**Knowledge** is **information** that has been retained with an understanding about the significance of that **information**.

If we put Knowledge into an equation it would look like this:

$$\text{Information} + \text{application or use} = \text{Knowledge}$$

### Example

Looking at the examples given for **data**:

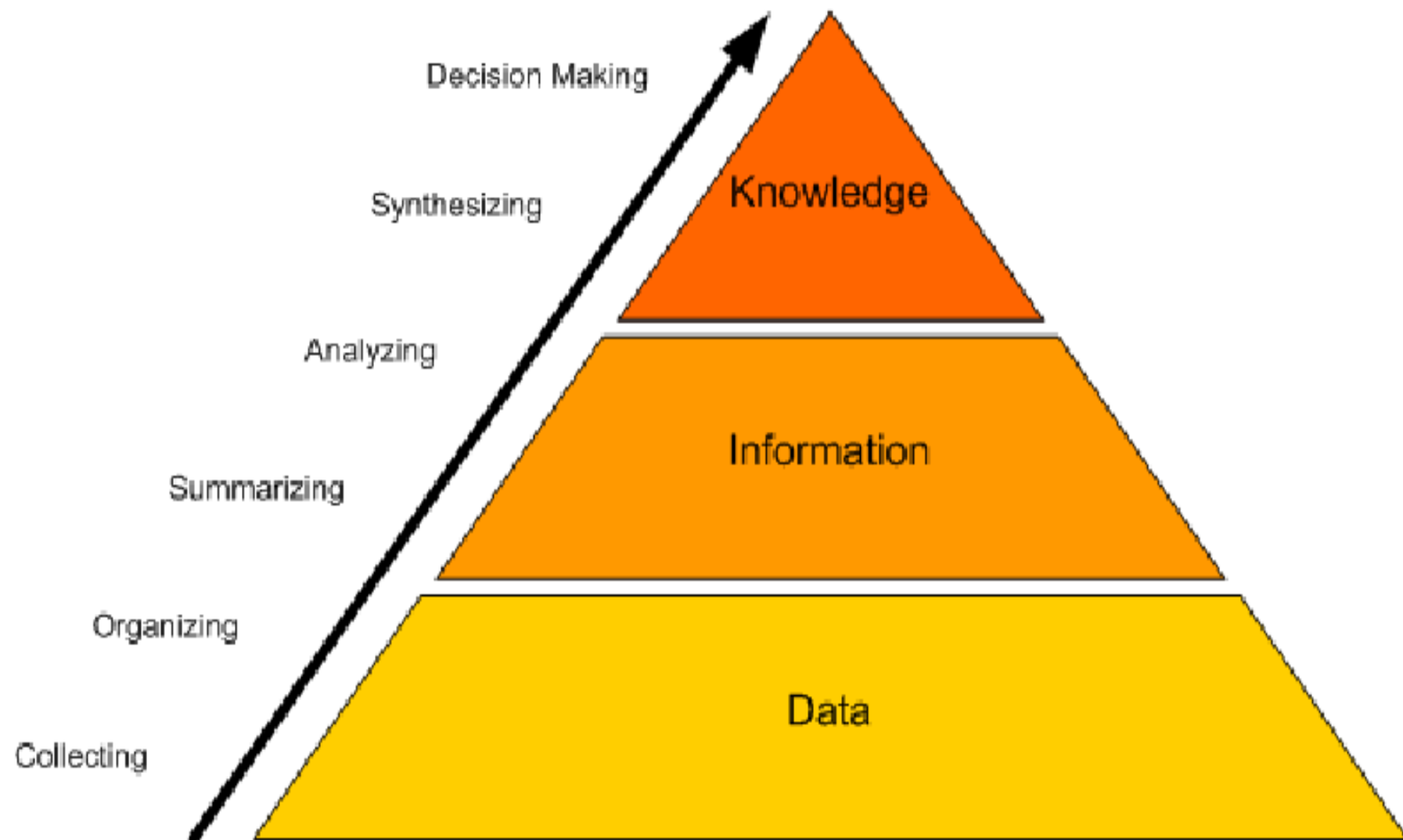
- 3, 6, 9, 12
- cat, dog, rabbit
- 161.2, 175.3, 166.4, 164.7, 169.3

when we assign a context or meaning that the data become information.

- **3, 6, 9 and 12 are the first four answers in the 3 x table**
- **cat, dog, rabbit is a list of household pets**
- **161.2, 175.3, 166.4, 164.7, 169.3 are the heights of the five tallest 15-year-old students in a class.**

If we now apply this information to gain further knowledge we could say that:

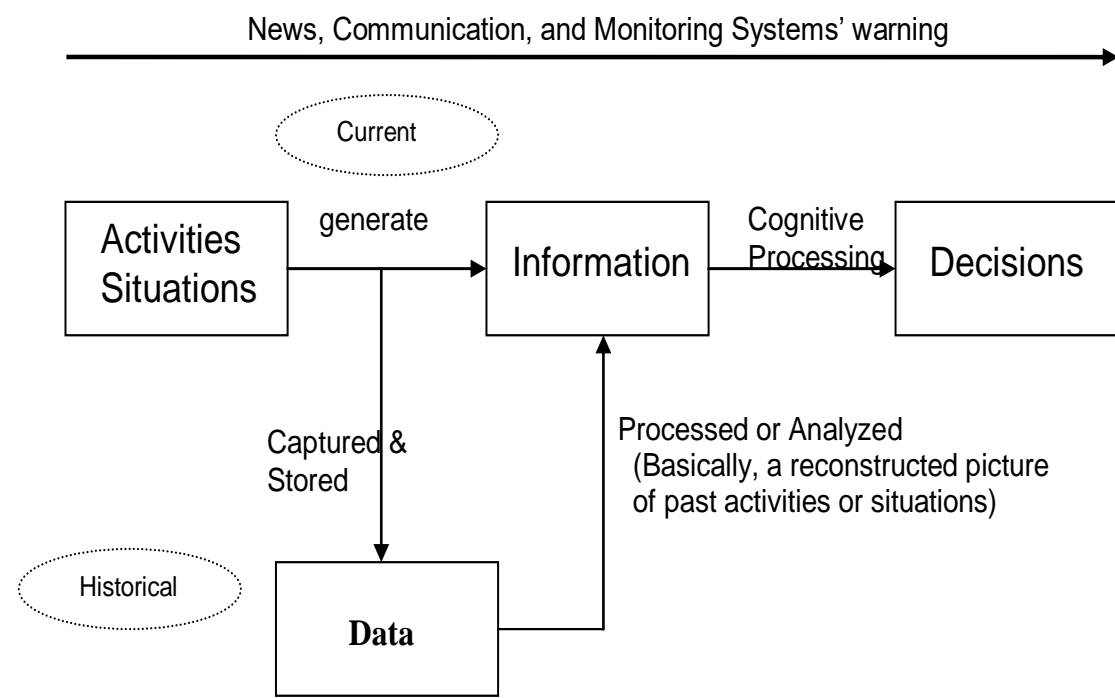
- **4, 8, 12 and 16 are the first four answers in the 4 x table (because the 3 x table starts at three and goes up in threes the 4 x table must start at four and go up in fours)**
- **The tallest student is 175.3cm.**
- **A lion is not a household pet as it is not in the list and it lives in the wild**



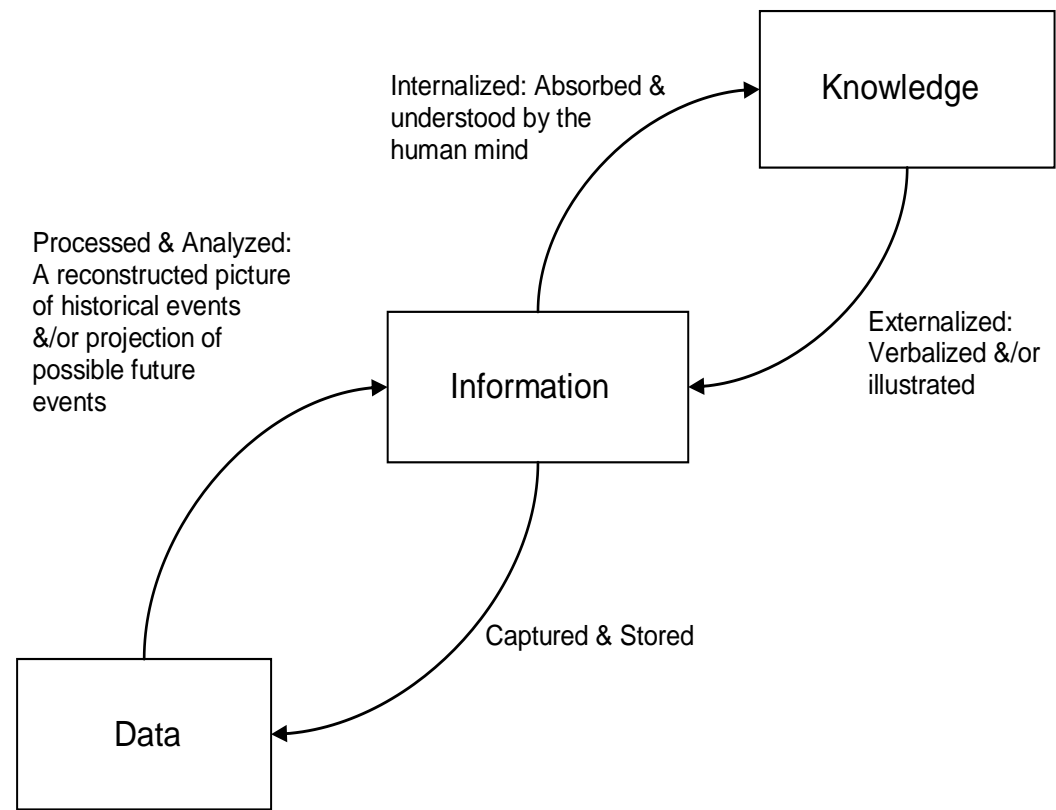
Finck, 2005)

**Figure 1: DIK Model**

# Formation of Information and Data



# Relationships Amongst Knowledge, Information, And Data



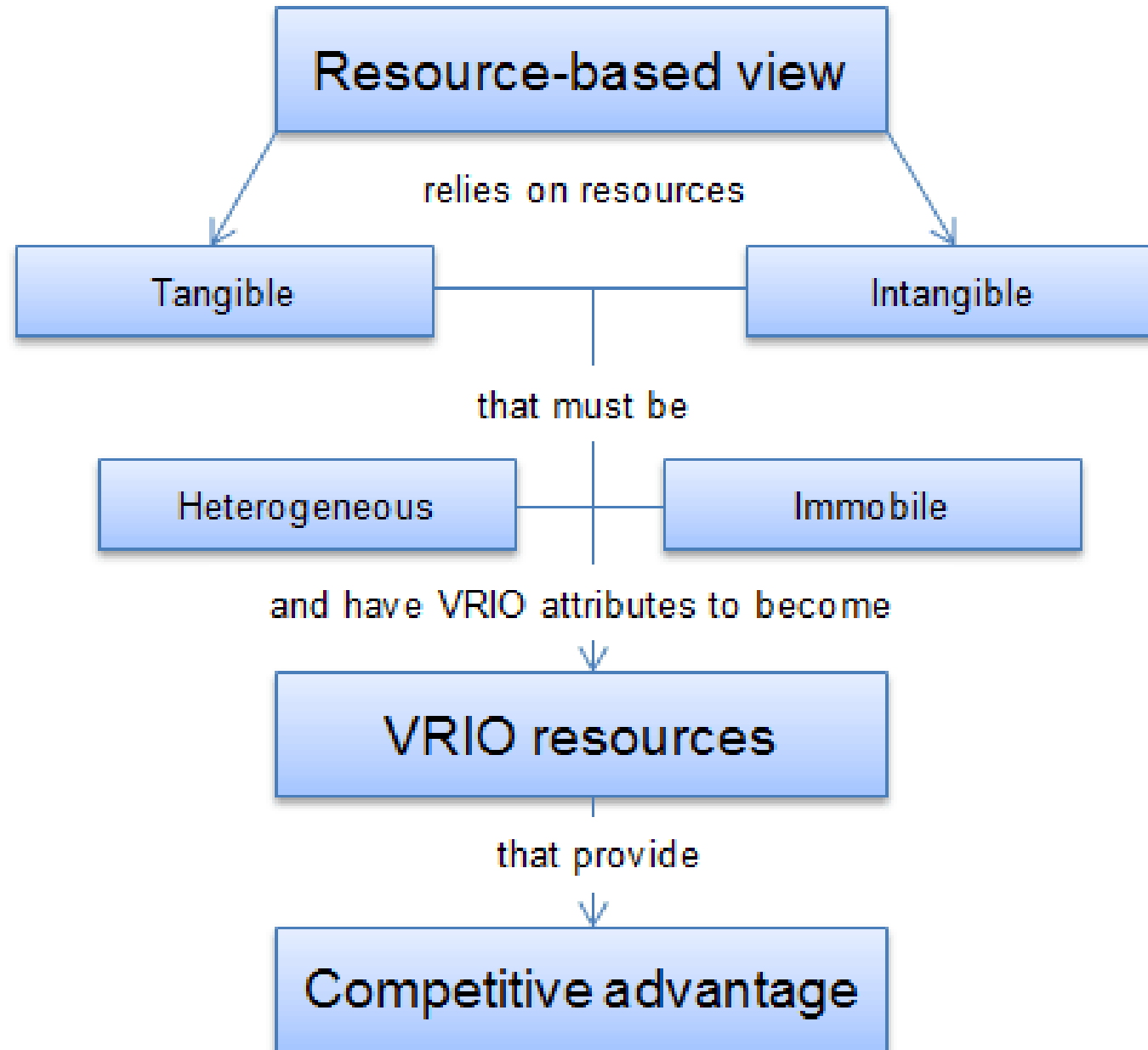
# Resource-based view of a firm

## What is Resource-based View Strategy (RBV)?

The **resource-based view or RBV** is a strategy(a carefully developed plan) formulated by organizations to understand the elements of the business for a long-term competitive advantage. This theory emerged during the 1980s-1990s from the major works of **B Wernerfelt, Hamel, Prahalad**, and others.

The resource-based view (RBV) is a model that sees resources as key to superior firm performance. If a resource exhibits VRIO(**value, rarity, imitability, and organization**) attributes, the resource enables the firm to gain and sustain competitive advantage.

They stated that- 'to have an edge over the competition, the organization should look into the potential of the company's internal resource pool rather than seeking the external competitive environment'.



In RBV model, resources are given the major role in helping companies to achieve higher organizational performance. There are two types of resources: **tangible and intangible**.

**Tangible assets** are physical things. Land, buildings, machinery, equipment and capital – all these assets are tangible. Physical resources can easily be bought in the market so they confer little advantage to the companies in the long run because rivals can soon acquire the identical assets.

**Intangible assets** are everything else that has no physical presence but can still be owned by the company. Brand reputation, trademarks, intellectual property are all intangible assets. Unlike physical resources, brand reputation is built over a long time and is something that other companies cannot buy from the market. Intangible resources usually stay within a company and are the main source of sustainable competitive advantage.

**Heterogeneous:** The first assumption is that skills, capabilities and other resources that organizations possess differ from one company to another. If organizations would have the same amount and mix of resources, they could not employ different strategies to outcompete each other. What one company would do, the other could simply follow and no competitive advantage could be achieved. This is the scenario of perfect competition, yet real world markets are far from perfectly competitive and some companies, which are exposed to the same external and competitive forces (same external conditions), are able to implement different strategies and outperform each other. Therefore, RBV assumes that companies achieve competitive advantage by using their different bundles of resources.

### **Example**

The competition between Apple Inc. and Samsung Electronics is a good example of how two companies that operate in the same industry and thus, are exposed to the same external forces, can achieve different organizational performance due to the difference in resources. Apple competes with Samsung in tablets and smartphones markets, where Apple sells its products at much higher prices and, as a result, reaps higher profit margins. **Why Samsung does not follow the same strategy?** Simply because Samsung does not have the same brand reputation or is capable to design user-friendly products like Apple does. (**heterogeneous resources**)

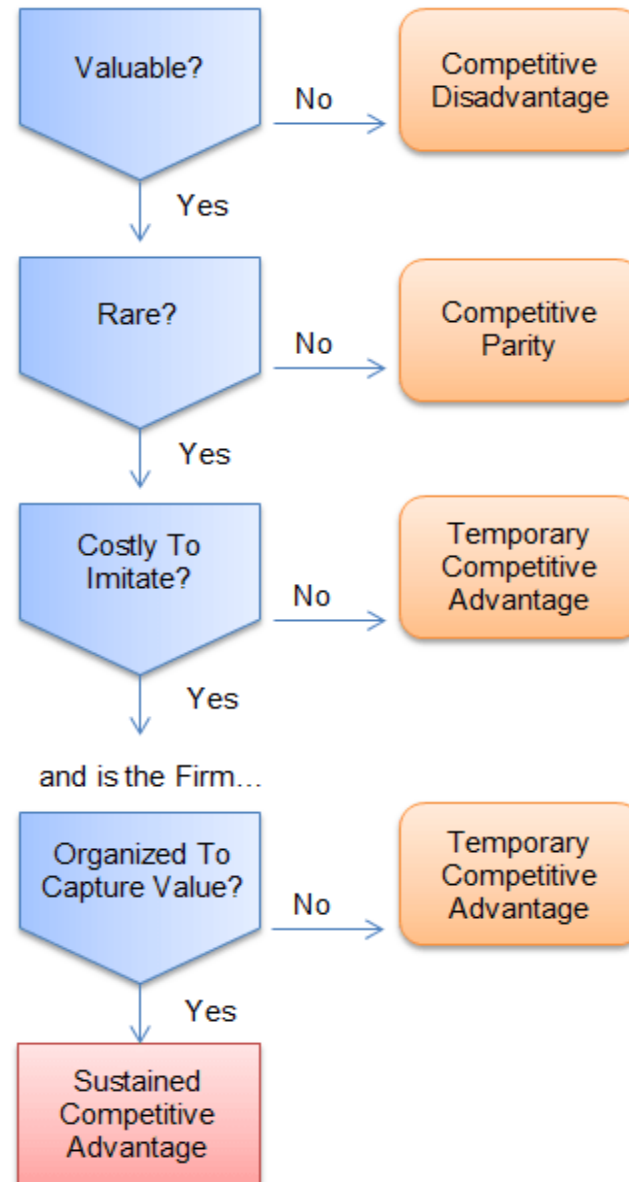
**Immobile:** The second assumption of RBV is that resources are not mobile and do not move from company to company, at least in short-run. Due to this immobility, companies cannot replicate rivals' resources and implement the same strategies. Intangible resources, such as brand equity, processes, knowledge or intellectual property are usually immobile.



# VRIO framework

VRIO is a four-part business analysis framework used to determine a business' competitive potential.

The dimensions (value, rarity, imitability, and organization) are evaluated by asking: Is the Resource or Capability...



A VRIO analysis is a framework that allows companies to assess their Competitive advantages.

This framework defines how solid a Competitive Advantage is based on different questions.

These questions can be directed to:

- A Business unit.
- A Service offered.
- A particular Product.

1. **Value**: How valuable is a Product, Service or a Business activity.
  - Is it profitable?
2. **Rarity**: How Common is a Product, Service or Business activity.
  - Is the market saturated?
3. **Imitability**: How difficult is a Product, Service or Business activity to be copied.
  - Is it easy to copy?
4. **Organization**: How well economically exploited is a Product, Service or Business activity, by the Organization.
  - Is the company “squeezing” all its economic potential?

Depending on the answer to these questions, a Company can have a:

- Non sustainable Business.**
- Sustainable Business model.**
- Profitable Business model.**
- Long term Profitable Business model.**
- Business with a Competitive Advantage.**

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✗				Non sustainable Business
✓	✗			Sustainable Business model
✓	✓	✗		Profitable Business model
✓	✓	✓	✗	Long term Profitable Business model
✓	✓	✓	✓	Business with Competitive Advantage



An example of a non-valuable product?

- Typewriters.

*VRIO framework of a Typewriter company.*

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✗				Non sustainable Business



Barber shops, Pubs, little restaurants... are perfect examples of **Valuable but not Rare Businesses**.

- They are Valuable since **you can make a living from it**.

As you can see in the VRIO framework, they are simply Sustainable companies.

*VRIO framework of a Barber Shop.*

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✓	✗			Sustainable Business model



**Fidget Spinners:** a rotating piece of plastic that moves and holds with your fingers.

- Simple, but everybody went crazy for them.

But, what happened to the person that invented it? Did she became rich?

In fact, **the person who invented the first Fidget Spinner** (Catherine Hettinger – According to Wikipedia) **didn't make a single dollar with it.**

What happened?

Possible plagiarism and/or misappropriations aside, **the problem was that this Toy is extremely easy to copy.**

Everybody made money with it, but **no company could “monopolize” its success.**

*VRIO framework of a Fidget Spinner.*

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✓	✓	✗		Profitable Business model

### A Gold Mine in your backyard - VRIO example



*VRIO framework of a Gold mine in your backyard.*

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✓	✓	✓	✗	Long term Profitable Business model



Because **Coca-Cola is not just the canned “sweet black liquid”**. It is much more.

“Coca-Cola” is the second most understood word in the world.

- Just after “OK”.

**Its Value is not in the taste, but in the Brand:** how it is perceived by customers.

**Is Coca-Cola Rare?**

- Well, there are numerous cola drinks.
- But **there is not a single beverage company that is associated with “happiness”, “friendship”, “good moments”... like Coca-Cola.**

**Is Coca-Cola Easy to Imitate?**

- Coca-Cola has invested billions of dollars in Marketing for decades.
  - You can see it in movies, advertisements, TV...
- It is **almost impossible to copy its Brand perception.**

**Is Coca-Cola economically Exploiting its products successfully?**

- We don't need to answer this question.
  - We can't imagine the margin that Coca-Cola obtains for each can sold.

*VRIO framework of Coca-Cola:*

Valuable?	Rare?	Difficult to Imitate?	Exploited?	Competitive Advantage
✓	✓	✓	✓	Business with Competitive Advantage

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## Summarizing

If you have a defined Product, Service or Business activity, you should develop a VRIO analysis.

It allows you to assess whether you have a solid Competitive Advantage or a simple Business that can be easily copied.

The VRIO framework analyzes:

- The Value of your product.
- How Rare your product is.
- How easy to Imitate it is.
- If you are Exploiting it economically or not.

If developed properly, a VRIO analysis will tell you what you need to improve, what you should keep doing and .... when to retreat.



**Value:** Resources are valuable if they help organizations to increase the value offered to the customers. This is done by increasing differentiation or/and decreasing the costs of the production. The resources that cannot meet this condition, lead to competitive disadvantage.

**Rarity:** Resources that can only be acquired by one or few companies are considered rare. When more than few companies have the same resource or capability, it results in competitive parity.

**Imitability:** A company that has valuable and rare resource can achieve at least temporary competitive advantage. However, the resource must also be costly to imitate or to substitute for a rival, if a company wants to achieve sustained competitive advantage.

**Organization:** The resources itself do not confer any advantage for a company if it's not organized to capture the value from them. Only the firm that is capable to exploit the valuable, rare and imitable resources can achieve sustained competitive advantage.

#### LIMITATIONS:

- Difficult to implement
- Difficult to adapt to service organizations
- Truly comparable activities may be difficult to identify
- Information may be difficult to obtain

More information/Reference about VRIO : <https://strategicmanagementinsight.com/topics/resource-based-view.html>  
<https://strategicmanagementinsight.com/tools/vrio.html>  
<https://www.businessballs.com/strategy-innovation/resource-based-view/>

## •Cross-functional usage of resources

In a matrix organization, the resource-based strategy model facilitates **enterprise-wide visibility** of the workforce and its expertise. It helps in allocating appropriate resources from different departments and form a cross-functional team to execute the project. It **reduces hiring cycle costs** and also helps to leverage the diversified workforce. Besides, employees are also given multi-faceted projects to work on enhancing their professional portfolio.

# **Data as a new resource for organizations**

## **WHY IS DATA SO IMPORTANT TO ORGANIZATIONS TODAY?**

Data is recognized as a resource that organizations can utilize for competitive advantage. The more data that a company has, the more capacity it has to leverage the data to beat its competitors. As such, data is highly sought after.

With so much data and information around us, many people are being empowered to make decisions on their own. Initially, decision-making was confined to an elite group of professionals. Today, everyone has access to information enabling them to can make decisions pertaining to their lives, businesses and future. This is a direct effect of the dissemination of data.

Business stakeholders understand the value of data. Therefore, they all search for more and more of it. Thanks to this overload of data on organizations, the systems that are in place today are unable to satisfy the need. As such, special database technologies have been developed to hold big data.

# BENEFITS OF USING BIG DATA FOR COMPANIES AND ORGANIZATIONS

Not only does big data provide more, actionable information to modern companies, it also offers a number of benefits including:

## Creating new business solutions:

By collecting billions of packets of data, a company can leverage them to create solutions that improve overall performance. It can collect information on products, customers, resources and competition. This data can be further repackaged to create solutions that improve customer relations or help it to utilize its resources better.

## Save costs, improve efficiency and comply with modern regulations

The database services that are used to manage big data can help a company save costs and improve the efficiency of business processes. There are many legacy systems that are used by companies to manage day-to-day activities. They are costly to maintain and are slower than the latest data management technologies. By adopting the use of big data, companies can get rid of the inconsistencies associated with legacy systems and embrace the new, open-source big data technologies available today. This results in faster performance and more efficient business performance. Moreover, adopting big data technologies assists a company to comply with current IT regulations.

## Enjoy a new resource for competitive advantage

Companies are constantly searching for sources of competitive advantage. Big data offers an effective source that they can use. It allows a company to have significant sources of information for business decisions and them be more proactive, to changes in their environment. By adapting quickly , organizations are able to stay at the forefront of their industry.

For example, a company can use big data about current demographics to [respond faster to the demands of their consumers](#).

We're currently surrounded by big data. People and corporations are constantly sending and receiving data to one another from various platforms. And the Internet is a conduit for this data. By tapping into this mesh of big data, organizations can leverage it to promote growth and improve profits.

## EFFECTS OF BIG DATA

Big data affects the interaction patterns between colleagues at companies. Today, business people and Information Technology (IT) professionals cooperate to solve business challenges using big data.

This information helps employees make reliable decisions in their day-to-day work. As a result, they are able to fulfill the following:

- 1.Create deep engagement with customers
- 2.Create operations that are optimized
- 3.Eliminate threats and fraud in their organizations
- 4.Find and capitalize on new sources of revenue for the company

There is a continued and pressing need for more innovation in business organizations today. As such, big data is required even more than before.

Few example, how data is capturing google and Facebook.

### Things you create or provide to us



When you create a Google Account, you provide us with personal information that includes your name and a password. You can also choose to add a phone number or payment information to your account. Even if you aren't signed in to a Google Account, you might choose to provide us with information — like an email address to receive updates about our services.

We also collect the content you create, upload, or receive from others when using our services. This includes things like email you write and receive, photos and videos you save, docs and spreadsheets you create, and comments you make on YouTube videos.

### Information we collect as you use our services



We collect information about your activity in our services, which we use to do things like recommend a YouTube video you might like. The activity information we collect may include:

- Terms you search for
- Videos you watch
- [Views and interactions with content and ads](#)
- Voice and audio information when you use audio features
- Purchase activity
- People with whom you communicate or share content
- Activity on third-party sites and apps that use our services
- Chrome browsing history you've [synced with your Google Account](#)

If you use our [services to make and receive calls or send and receive messages](#), we may collect telephony log information like your phone number, calling-party number, receiving-party number, forwarding numbers, time and date

## Your location information



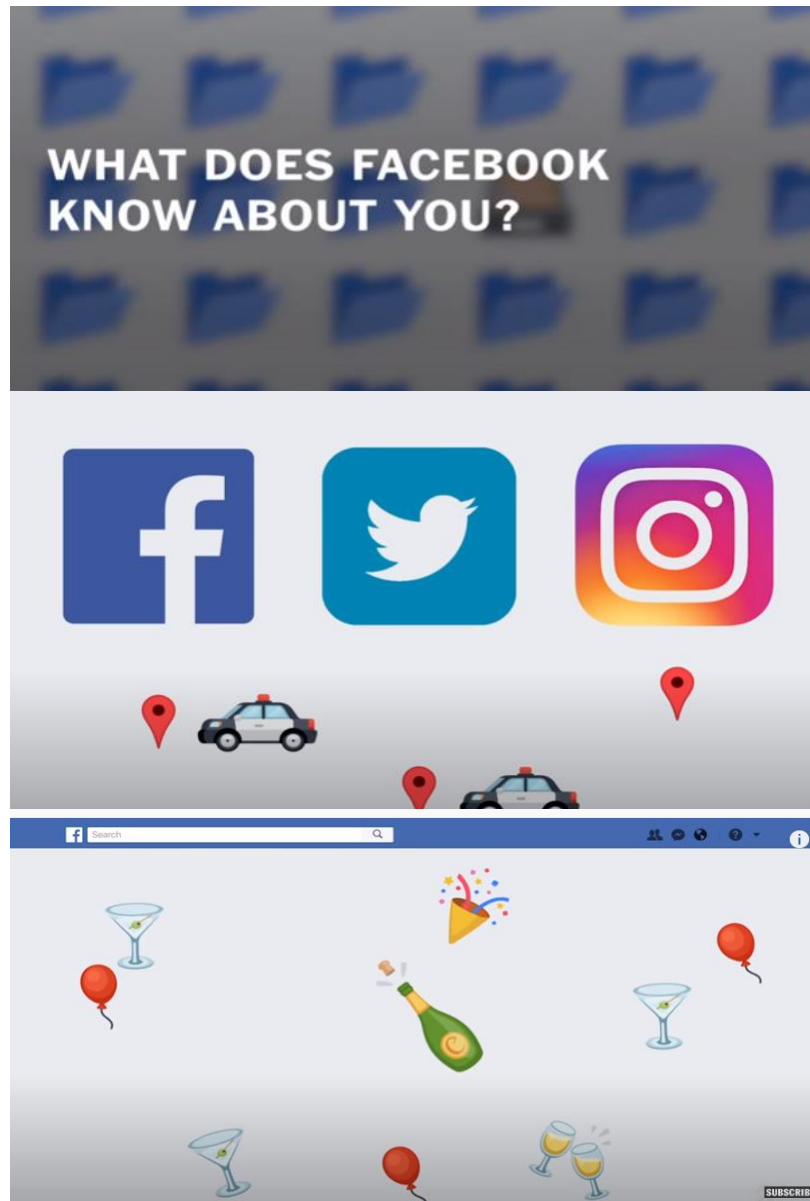
We collect information about your location when you use our services, which helps us offer features like driving directions for your weekend getaway or showtimes for movies playing near you.

Your location can be determined with varying degrees of accuracy by:

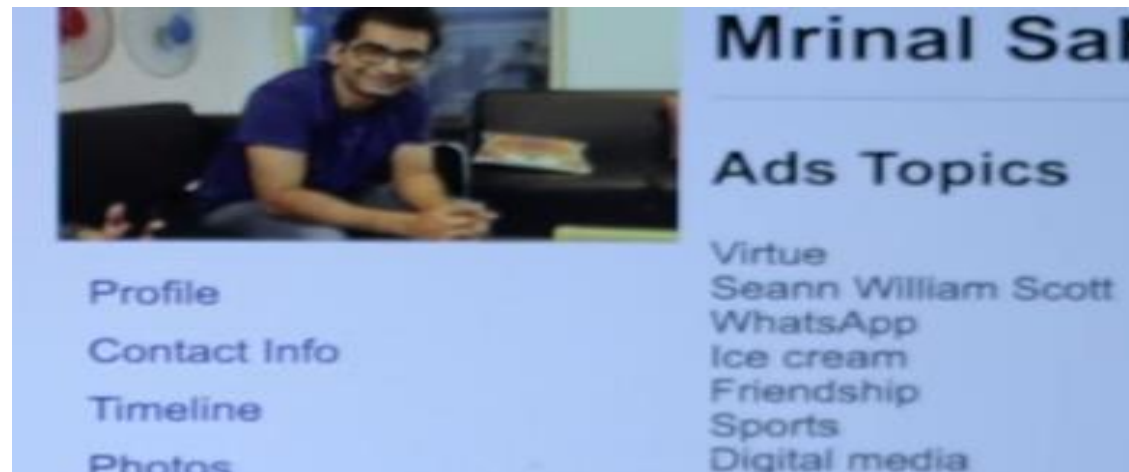
- GPS
- [IP address](#)
- [Sensor data from your device](#)
- [Information about things near your device](#), such as Wi-Fi access points, cell towers, and Bluetooth-enabled devices

The types of location data we collect depend in part on your device and account settings. For example, you can [turn your Android device's location on or off](#) using the device's settings app. You can also turn on [Location History](#) if you want to create a private map of where you go with your signed-in devices.





- Facebook ,features(Birth days, Check-ins, Events, photos, friends) are captures our data, as per that ads, recommendations will suggested to the user.



# Properties of Data as a Resource

- Intangibility
- Consumability
- Shareability
- Copyability
- Transportability
- Nonfungibility
- Fragility
- Versatility
- Valuation
- Depreciability
- Source
- Renewability
- Storage
- Implications for Management
- Supply Management
- Access
- Security
- Quality
- Usage Management
- Underlying Issues
- Prescriptions

More information use this reference:

<https://sloanreview.mit.edu/article/data-as-a-resource-properties-implications-and-prescriptions/>

## Harnessing and sharing knowledge in organizations

Knowledge sharing defined as “the process of transferring knowledge from a person to another in organization . It is a process to accumulate shared knowledge among members”. It also defined as a kind of social interaction among people. Knowledge, unlike information and is locked in the human mind and part of human identity. Knowledge sharing is about “how people share and use what they know” .

In addition, knowledge sharing asserted as a social system that supports collaboration and integration which is normally facilitated by technology . Other researchers agreed that knowledge sharing is to be associated with “appropriate mix” of technological channels for optimizing knowledge exchanges.

Creating and exchanging knowledge are intangible activities that can neither be supervised nor imposed . They happen only when people cooperate voluntarily. This exchange of knowledge can lead to the creation of new knowledge, which can be an important source of competitive advantage.

He said that people will not share their knowledge as they think their knowledge is valuable and important. Thus, knowledge sharing practice are motivated and executed mainly at the individual levels. Even in the absence of strong organizational norms of knowledge sharing, employees may tend to share knowledge according to their personal benefits and cost . At the end, knowledge sharing practices can help organizations becomes more profitable and undefeated.

WHY DON'T PEOPLE SHARE As mentioned earlier, knowledge sharing needs to communicate with face-to-face and collaboration with workgroup. One of the challenges of knowledge management is that of getting people to share their knowledge. In some organizations, sharing is caring and natural

There are questions why don't people share knowledge:

- “Not invented here” syndrome People have pride in not having to seek advice from others and in waiting to discover new ways for themselves.
- Not realizing how useful particular knowledge is to others An individual may have knowledge used in one situation but unaware that other people at other times and places might face similar situations.
- Lack of trust If people share some of their experience, will they used it out of context, mis-apply it and then blame each other or pass it off as their own without giving any acknowledgement or recognition to them as source.
- Lack of time Lack of time is also the major reason given by employees in many organizations. There is pressure on productivity on deadlines, and it's general rule that the more knowledgeable they are, the more people waiting to collar for the next task.
- Secret Information and knowledge There is not all information and knowledge can be share within community and society. In organization, there are or maybe have top secret information which cannot be share. This classified “Top Secret” information and knowledge which keep in organizations have a high values. Only trusted individuals or people know the secret information and knowledge to protect organizations or country.

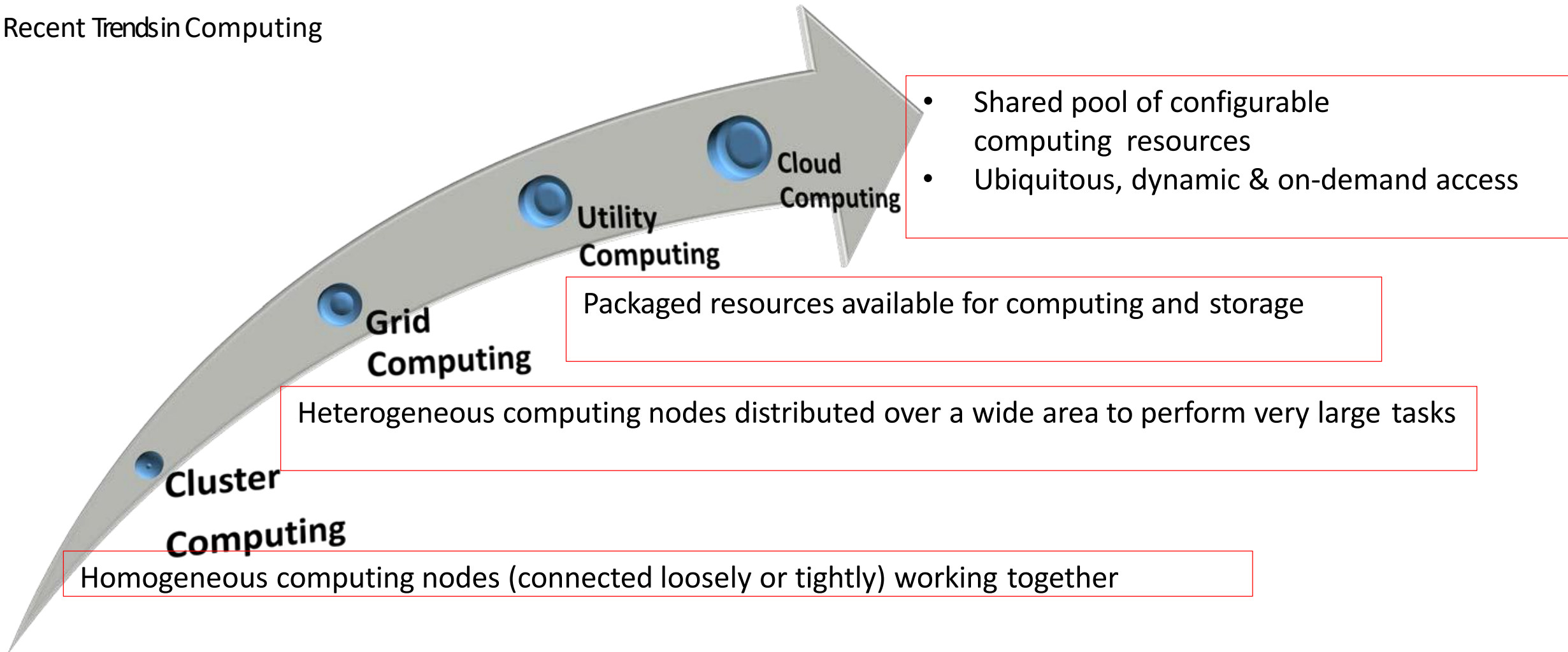
## ADVANTAGES OF KNOWLEDGE SHARING PRACTICE IN ORGANIZATION

- There are some advantages of embedding knowledge sharing practices in organizations.
- Sharing is Caring Embedding knowledge sharing practice can be regarded as a public good because people who do not pay or contribute to the organization or community also can share knowledge. Multiple people also can access and shared knowledge at the same time.
- Innovative and Creative Knowledge sharing practices can make people in organization innovative and creative to created things. Meetings, discussion and forum are the best platform to share the knowledge and idea among groups. The people in the groups can easily exchange and share knowledge to make their tasks work. It is generally understood that knowledge sharing is an antecedent to many more knowledge management activities.
- c) Knowledge is Power When knowledge sharing among people or employees in organization becomes stronger, it shows that knowledge also becomes more powerful in organization. Individual or person who shares their tacit knowledge through conversation becomes more innovative and creative in their work. This tacit knowledge exists and it communicated through conversations in community of practices or networks of practices. Such “know how”, “know who”, “know where” knowledge promises to be more important.
- d) Attitude One of advantages of embedding knowledge sharing practice in organization is attitude. Attitude has been shown to be a critical factor because one’s knowledge about how to solve organizational problems could influence one’s trade value.
- e) People also may consider sharing their knowledge in an organization if they believe this will be personally important and valuable for them.
- f) Changing Culture change is never easy and takes time. In those firms environment, effective knowledge sharing deals with cultural change of the people, process transformation, and technological management systems. Nevertheless, involvement from people or individual in organization could be some of the best knowledge sharing cultures is where everybody believes their knowledge is respected, valued and used to inform decision. Knowledge sharing practice could make people and individual become valuable.

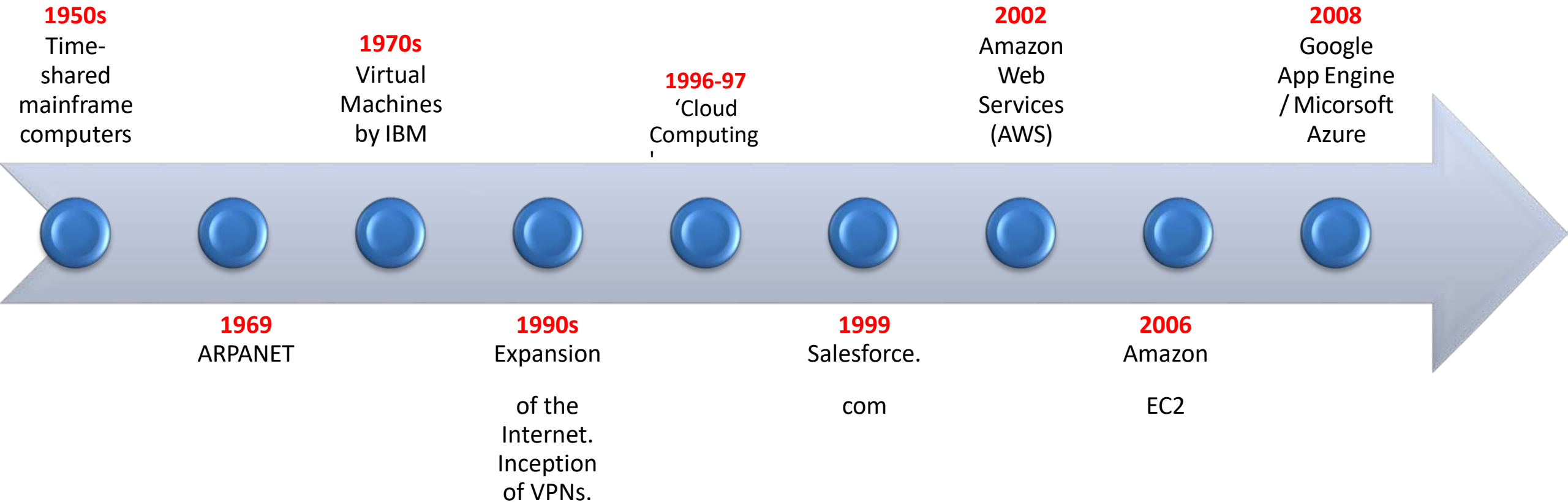
Finally, knowledge sharing practice in organization is very important and beneficial to be implemented. It helps organizations in many ways such as information updating, innovations, creations and others. Therefore, by understanding the concepts and advantages could facilitate knowledge sharing and help managers, information and knowledge professionals to support knowledge sharing practices. Due to this importance, it is expected that organizations to take advantage of the new transformation of information handling skills for their employees to turn into knowledge management capabilities.

# Cloud computing

Recent Trends in Computing



# Evolution of Cloud Computing





# Cloud Computing

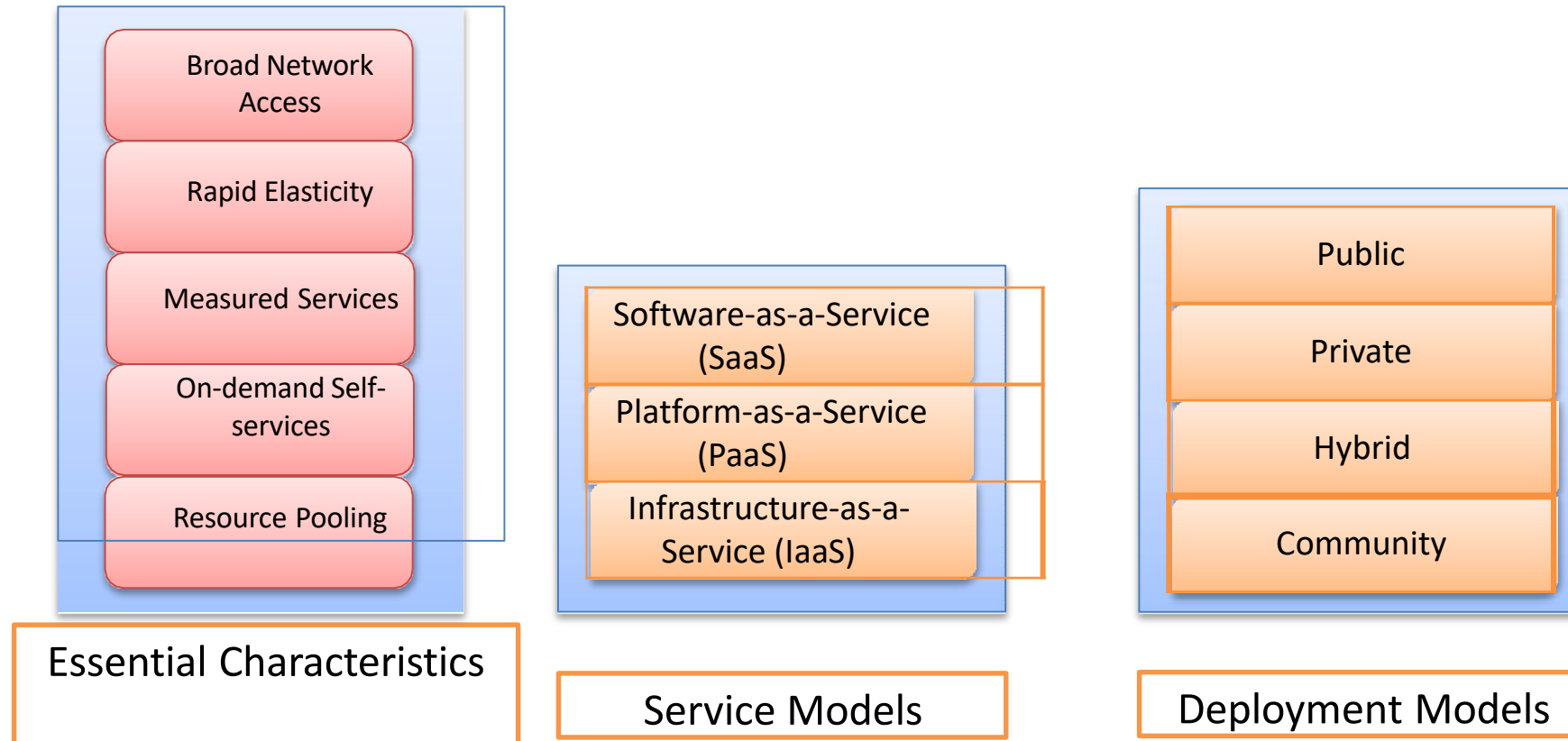
*“Cloud computing is a model for enabling **convenient**, **on-demand** network access to a **shared** pool of **configurable** computing resources (e.g., network infrastructures, servers, storage, applications, etc.)” – NIST*

Source: P Mell & T Grance, “A NIST Notional Definition of Cloud Computing”, version 15, 2009.

- It can be envisioned as step on from Utility Computing
- It provides **high level generalization (abstraction)** of computation and storage model
- It can be **rapidly allocated** and **released** with low management effort
- It has some essential **characteristics, service models, and deployment models**
- It provides on-demand services, that can be accessed from any place and at anytime

Source: Rajkumar Buyya, “Mastering Cloud Computing: Foundations and Applications Programming”, Tata McGraw-Hill Education, 2013

# NIST Visual Model of Cloud Computing



Source: NIST

# Essential Characteristics

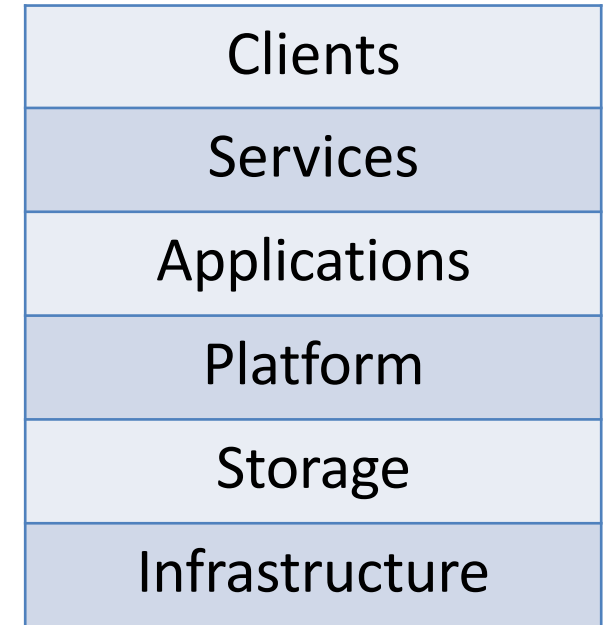
- ✓ **Broad network access**
  - Cloud resources should be available over the network
  - Should support standard mechanisms for information retrieval using traditional interfaces
  - Supported clients: heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs)
- ✓ **Rapid elasticity**
  - Cloud resource allocation should be rapid, elastic and automatic
  - Dynamic allocation/release facility for scale-out and scale-in
  - Consumers should feel infinite resources
  - Facility for add/remove of quantity should be there
- ✓ **Measured service**
  - Resource usage should be recorded and monitored
  - Facility to dynamically control and optimize the resource usage
  - This facility should be transparent between the service provider and consumer.
- ✓ **On-demand self-service**
  - Provide server time and network storage to users automatically
  - This facility should be available as a self-service
- ✓ **Resource pooling**
  - Automatically pool the whole available resources
  - Serve multiple end-users using a multi-tenant model
  - Resources should be allocated according to user's demand

# Business Advantages

- ✓ Nearly zero cost for upfront infrastructure investment
- ✓ Real-time Infrastructure availability
- ✓ More efficient resource utilization
- ✓ Usage-based costing
- ✓ Reduced time to market

# Components of Cloud Computing

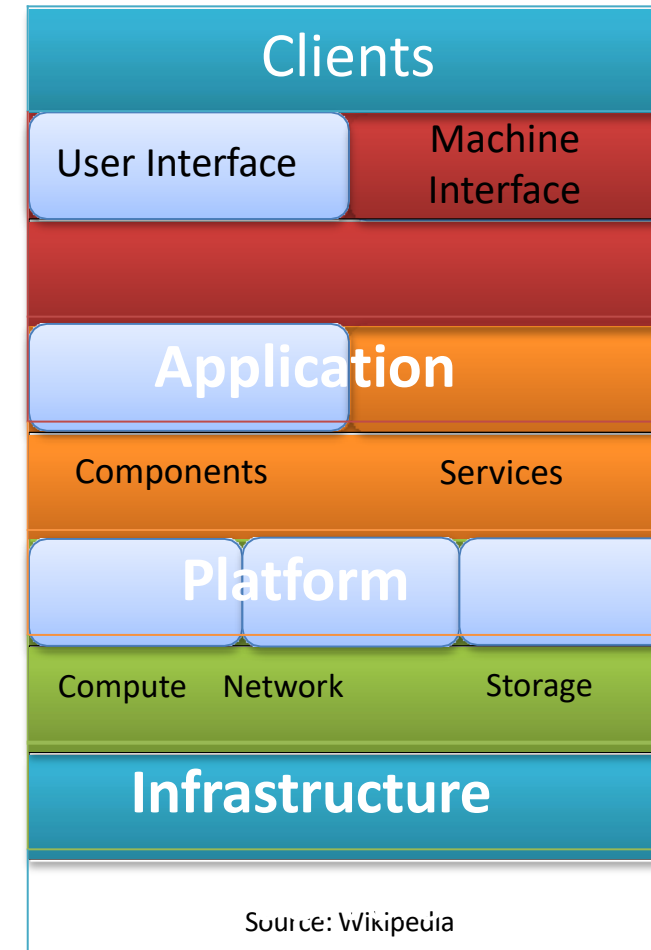
- ✓ **Clients /end-users:** Thick, Thin, Mobile
- ✓ **Services:** Products & solutions (Identity, Mapping, Search, etc.)
- ✓ **Applications:** Web apps, SaaS, etc.
- ✓ **Platform:** Apps/Web hosting using PaaS
- ✓ **Storage:** Database, Data-Storage-as-a-Service (DSaaS)
- ✓ **Infrastructure:** Virtualization, IaaS, EC2



Source: Wikipedia

# Service Models

- ✓ Software-as-a-Service (SaaS)
- ✓ Platform-as-a-Service (PaaS)
- ✓ Infrastructure-as-a-Service (IaaS)



# Software- as- a-Service(SaaS)

- ✓ Facility to execute service provider's applications at user's end
- ✓ Applications are available as 'services'
- ✓ Services can be accessed via different types of client devices (e.g. web browser, app)
- ✓ End-users do not possess the control of the cloud infrastructure

***Examples: Google Apps, Salesforce, Learn.com.***

## Platform-as-a-Service (PaaS)

- ✓ Facility for the consumer to execute *consumer-created* or *acquired applications* onto cloud infrastructure
- ✓ Support for deployment of such applications
- ✓ The user does not control the cloud infrastructure
- ✓ User can control the deployed applications using given configurations

***Examples: Windows Azure, Google App Engine***

# Platform-as-a-Service (PaaS)

Source: P Mell & T Grance, "A NIST Notional Definition of Cloud Computing", version 15, 2009.



# Infrastructure-as-a-Service (IaaS)

- ✓ Facility to access computing resources such as network, storage, and operating system
- ✓ User can deploy, execute and control any software (*Operating systems* and *other applications*)
- ✓ In some case, the user can control selected networking components (e.g., host firewalls).

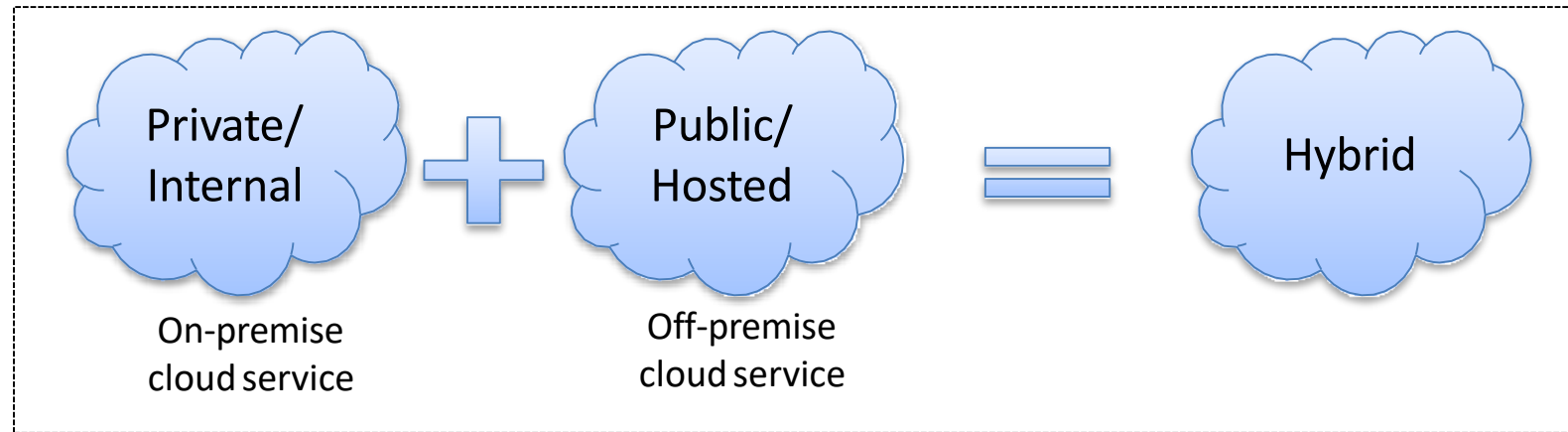
***Examples: Amazon EC2, GoGrid, iland, Rackspace Cloud Servers.***

Source: P Mell & T Grance, "A NIST Notional Definition of Cloud Computing", version 15, 2009.

# Deployment Models

- ✓ Public cloud
- ✓ Private cloud
- ✓ Hybrid cloud
- ✓ Others:

- Community cloud
- Distributed cloud
- Multi-cloud
- Inter-cloud



Source: [https://en.wikipedia.org/wiki/Cloud\\_computing](https://en.wikipedia.org/wiki/Cloud_computing)

# Private Cloud

- ✓ Cloud set-up functioned only for a single organization
- ✓ Typically managed by the organization itself (on-premises) or a third party (off-premises)
- ✓ Advantages:
  - Total control over the system and data
  - Minimum security concerns
- ✓ Disadvantages:
  - Regular maintenance

## Public Cloud

- ✓ Cloud set-up for the use of any person or industry
- ✓ Typically owned by an organization who offers the cloud service.
- ✓ Examples: Amazon Web Service (AWS), Google Compute Engine, Microsoft Azure
- ✓ Advantages:
  - Easy to set-up at low cost, as provider covers the hardware, application and bandwidth costs.
  - Scalability to meet needs.
  - Pay-per-use ensures that from user's perspective no resources wasted.

# Public Cloud vs Private Cloud

	Public Cloud	Private Cloud
Virtualized resources	Publicly shared	Privately shared
Customer types	Multiple	Limited
Connectivity	Over Internet	Over Internet/private network
Security	Low	High

Source: Christian Baun and Marcel Kunze, "A Taxonomy Study on Cloud Computing Systems and Technologies", Cloud Computing - Methodology, Systems, and Applications, L Wang et al. (Eds), CRC Press, 2012

# Hybrid Cloud

- ✓ Cloud set-up constructed by two or more unique cloud set-up (private, community, or public)
- ✓ Pooled together by standardized tools
- ✓ Supports data and application portability (e.g., facility for load-balancing between clouds)
- ✓ Provides multiple deployment models
- ✓ **Community cloud**
  - Shared set-up between several organizations having common concerns (security, compliance, jurisdiction, etc.)
  - Managed by internally or by third party
- ✓ **Distributed Cloud**
  - Collection of scattered set of computing devices in different locations, however, connected to a single network
  - Two types – *Public-resource Computing* and *Volunteer Cloud*.
- ✓ **Multi-cloud**
  - Multiple cloud computing services offered via single heterogeneous architecture
  - Increases fault-tolerance and flexibility
- ✓ **Inter-cloud**
  - Unified global '*cloud of clouds*' based on the Internet
  - Supports interoperability between cloud service providers

# General Characteristics

- ✓ Improved **agility** in resource provisioning.
- ✓ **Ubiquitous** – independent of device or location
- ✓ **Multitenancy** – sharing of resources and costs across a large pool of users
- ✓ Dynamic load balancing
- ✓ Highly **reliable** and **scalable**
- ✓ Low cost and low maintenance
- ✓ Improved security and access control

# Comparison of Different Deployment Models

	On-premise	Off-premise
Dedicated Access	Private cloud	Hosted private cloud
Shared Access	Community cloud	Public cloud

Source: Christian Baun and Marcel Kunze, "A Taxonomy Study on Cloud Computing Systems and Technologies", Cloud Computing - Methodology, Systems, and Applications, L Wang et al. (Eds), CRC Press, 2012

# Cloud Computing Architecture

