INTRO 4.0

CLOUD COMPUTING

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INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

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THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

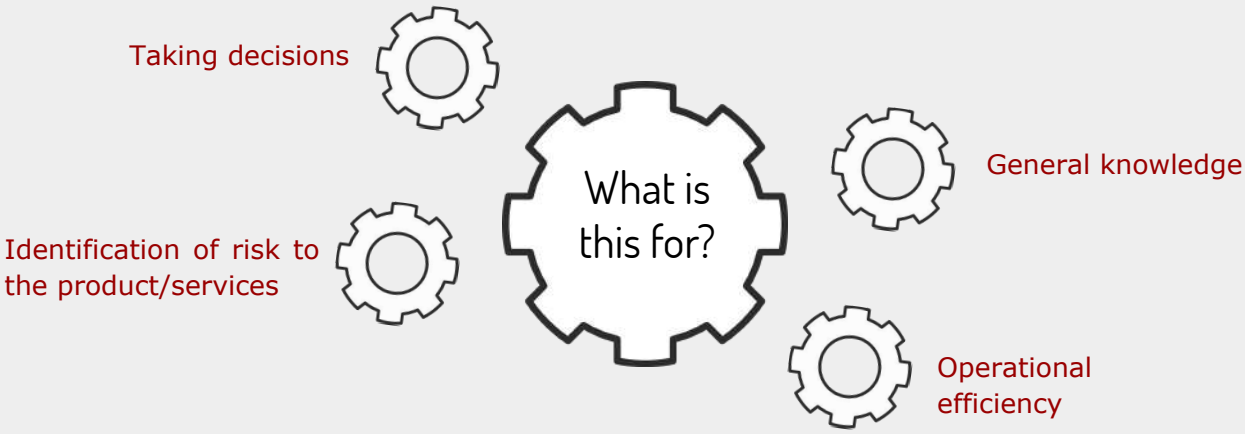
- Increase general knowledge of the Cloud Computing.
- Show and improve basic skills.
- Identify Cloud Computing benefits.
- Have a trained and skilled workforce.
- To help the organization to create new opportunities.

INTRODUCTION

CLOUD COMPUTING the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

Specific Learning Objectives

- Understand Cloud Computing
- Identify the most useful tools
- Recognize and improve most value skills
- Monitor organizational challenges and good practices
- Increase company resources and benefits
- Detect advantages and disadvantage
- Perform useful strategies
- Set practical uses
- Provide useful information about courses and certificates



WHAT IS IT?

Whether you are using it to run applications that share photos to millions of mobile users or to support business critical operations, a cloud services platform provides rapid access to flexible and low cost IT resources. With Cloud Computing, you don't need to make large upfront investments in hardware and spend a lot of time on the heavy lifting of managing that hardware. Instead, you can provision exactly the right type and size of computing resources you need to power your newest idea or operate your IT department. You can access as many resources as you need, almost instantly, and only pay for what you use.

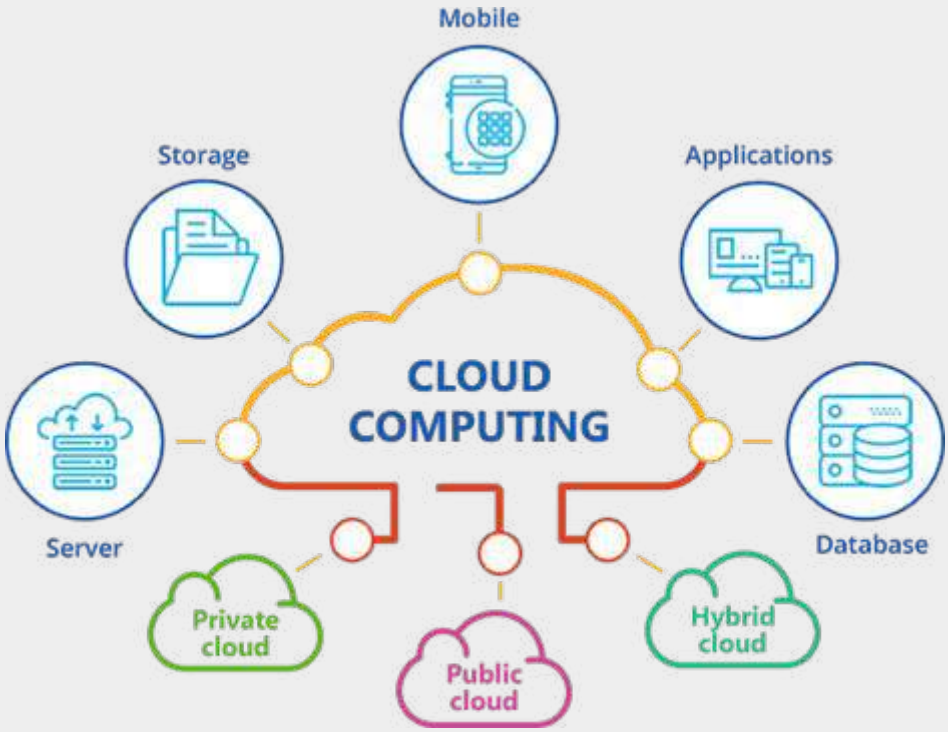


Figure 1. General view. Source: www.kcsitglobal.com

With the cloud, you can easily deploy your application in multiple physical locations around the world with just a few clicks. This means you can provide a lower latency and better experience for your customers simply and at minimal cost.

WHAT IS IT?

Essentially, Cloud Computing is a kind of outsourcing of computer programs. Using Cloud Computing, users are able to access software and applications from wherever they are; the computer programs are being hosted by an outside party and reside in the cloud. This means that users do not have to worry about things such as storage and power, they can simply enjoy the end result.

Traditional business applications have always been very complicated and expensive. The amount and variety of hardware and software required to run them are daunting. You need a whole team of experts to install, configure, test, run, secure, and update them

When you multiply this effort across dozens or hundreds of apps, it's easy to see why the biggest companies with the best IT departments aren't getting the apps they need. Small and midsize businesses don't stand a chance.

60's

- MIT develop technology allowing for a "computer to be used by two or more people, simultaneously."
- The concept began with ARPANET in 1969, which was the precursor to what we know today as the internet.

90's

- The advancement of the internet being connected to huge numbers of personal computers
- Salesforce became a popular example of using Cloud Computing successfully. They used it to pioneer the idea of using the Internet to deliver software programs to the end users.

XXI

- Amazon launched Amazon Web Services, which offers online services to other websites, or clients.
- Google launched the Google Docs services.
- Expansion of PaaS, SaaS and IaaS

WHAT IS THIS FOR?

With Cloud Computing, you eliminate the fact of storing your own data, because you're not managing hardware and software — that becomes the responsibility of an experienced vendor. The shared infrastructure means it works like a utility: You only pay for what you need, upgrades are automatic, and scaling up or down is easy.

Cloud-based apps can be up and running in days or weeks, and they cost less. With a cloud app, you just open a browser, log in, customize the app, and start using it.

Businesses are running all kinds of apps in the cloud, like customer relationship management (CRM), HR, accounting, and much more. Some of the world's largest companies moved their applications to the cloud after rigorously testing the security and reliability of our infrastructure.

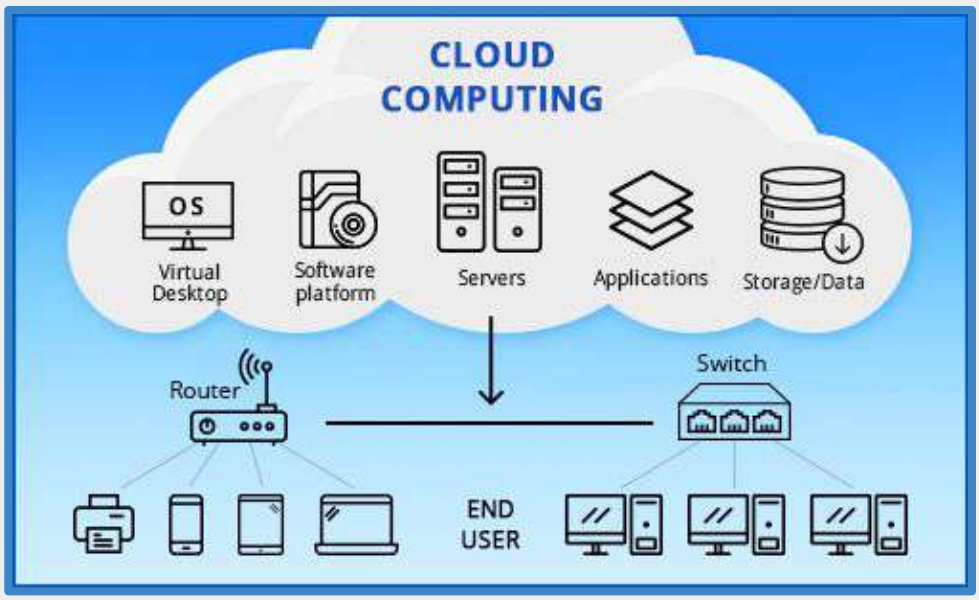


Figure 2. Cloud Computing solutions. Source: www.thinkitsolutions.com

As Cloud Computing grows in popularity, thousands of companies are simply rebranding their non-cloud products and services as "Cloud Computing".

Companies that provide Cloud Computing services actually host data centers with multiple servers interconnected to each other, and utilize special virtualization software to create a large computing and storage resource that can be divided into virtual resources which are rented to users and clients as a service.

WHAT IS THIS FOR?

Here are a few examples of what's possible today with cloud services from a cloud provider:

Create new apps and services

Quickly build, deploy, and scale applications—web, mobile, and **API**—on any platform. Access the resources you need to help meet performance, security, and compliance requirements.

Application Programming Interface (API)

An API is a software intermediary that allows two applications to talk to each other. In other words, an API is the messenger that delivers your request to the provider that you're requesting it from and then delivers the response back to you

Test and build applications

Reduce application development cost and time by using cloud infrastructures that can easily be scaled up or down.

Store, back up, and recover data

Protect your data more cost-efficiently—and at massive scale—by transferring your data over the Internet to an offsite cloud storage system that's accessible from any location and any device.

Analyze data

Unify your data across teams, divisions, and locations in the cloud. Then use cloud services, such as machine learning and artificial intelligence, to uncover insights for more informed decisions.

Stream audio and video

Connect with your audience anywhere, anytime, on any device with high-definition video and audio with global distribution.

Embed intelligence

Use intelligent models to help engage customers and provide valuable insights from the data captured.

WHAT IS THIS FOR?

Modes of Cloud Computing

Not all clouds are the same and not one type of Cloud Computing is right for everyone. Several different models, types, and services have evolved to help offer the right solution for your needs.

First, you need to determine the type of cloud deployment, or Cloud Computing architecture, that your cloud services will be implemented on. There are three different ways to deploy cloud services: on a public cloud, private cloud, or hybrid cloud.

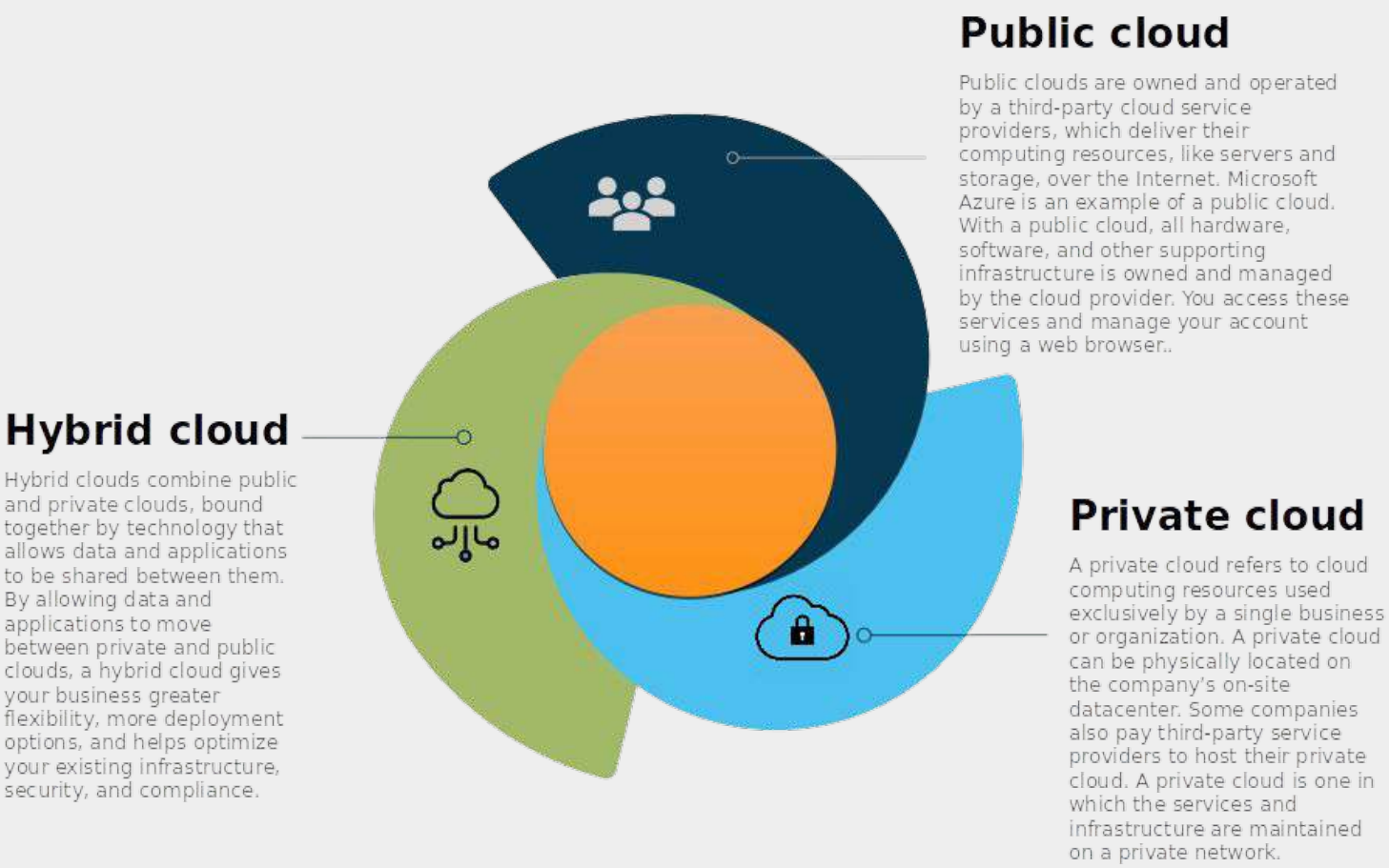


Figure 3. Modes. Source: Self made

WHAT IS THIS FOR?

Types of Cloud Computing

SOFTWARE AS A SERVICE (SAAS)

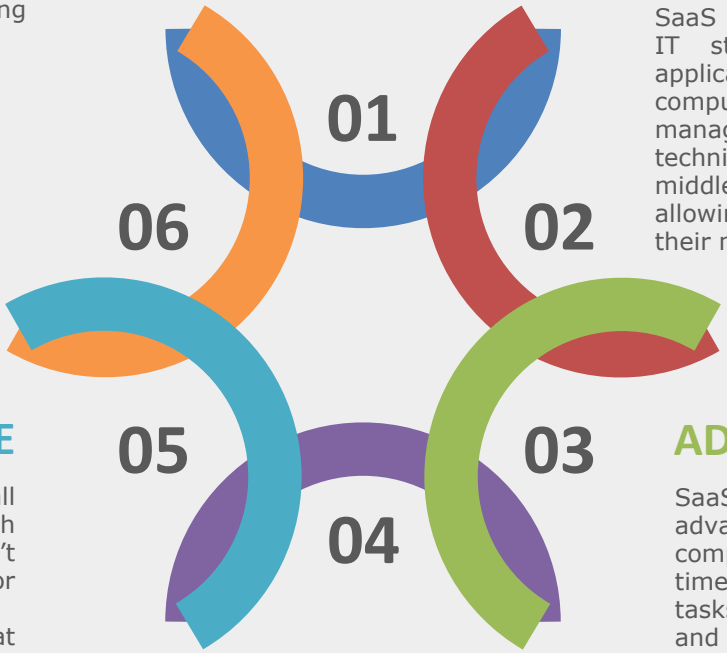
also known as cloud application services, represents the most commonly utilized option for businesses in the cloud market. SaaS utilizes the internet to deliver applications, which are managed by a third-party vendor, to it's users. A majority of SaaS applications are run directly through the web browser, and do not require any downloads or installations on the client side.

EXAMPLES

Google Apps, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting

DELIVERY

Due to its web delivery model, SaaS eliminates the need to have IT staff download and install applications on each individual computer. With SaaS, vendors manage all of the potential technical issues, such as data, middleware, servers, and storage, allowing businesses to streamline their maintenance and support..



WHEN TO USE

- If you are a startup or small company that needs to launch ecommerce quickly and don't have time for server issues or software
- For short-term projects that require collaboration
- If you use applications that aren't in-demand very often, such as tax software
- For applications that need both web and mobile access

ADVANTAGES

SaaS provides numerous advantages to employees and companies by greatly reducing the time and money spent on tedious tasks such as installing, managing, and upgrading software. This frees up plenty of time for technical staff to spend on more pressing matters and issues within the organization..

CHARACTERISTICS

- Managed from a central location
- Hosted on a remote server
- Accessible over the internet
- Users not responsible for hardware or software updates

Figure 4. SAAS. Source: Self made

WHAT IS THIS FOR?

PLATFORM AS A SERVICE (PAAS)

Cloud platform services, or Platform as a Service (PaaS), provide cloud components to certain software while being used mainly for applications. PaaS delivers a framework for developers that they can build upon and use to create customized applications. All servers, storage, and networking can be managed by the enterprise or a third-party provider while the developers can maintain management of the applications.

EXAMPLES

AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift

DELIVERY

The delivery model of PaaS is similar to SaaS, except instead of delivering the software over the internet, PaaS provides a platform for software creation. This platform is delivered over the web, and gives developers the freedom to concentrate on building the software while still not having to worry about operating systems, software updates, storage, or infrastructure.
PaaS allows businesses to design and create applications that are built into the PaaS with special software components. These applications, or middleware, are scalable and highly available as they take on certain cloud characteristics.

WHEN TO USE

There are many situations where utilizing PaaS is beneficial or even necessary. If there are multiple developers working on the same development project, or if other vendors must be included as well, PaaS can provide great speed and flexibility to the entire process. PaaS is also beneficial if you wish to be able to create your own customized applications. This cloud service also can greatly reduce costs and it can simplify some challenges that come up if you are rapidly developing or deploying an app.

ADVANTAGES

- Makes the development and deployment of apps simple and cost-effective
- Scalable
- Highly available
- Gives developers the ability to create customized apps without the headache of maintaining the software
- Greatly reduces the amount of coding
- Automates business policy
- Allows easy migration to the hybrid model

CHARACTERISTICS

- It is built on virtualization technology, meaning resources can easily be scaled up or down as your business changes
- Provides a variety of services to assist with the development, testing, and deployment of apps
- Numerous users can access the same development application
- Web services and databases are integrated

Figure 5. PAAS. Source: Self made

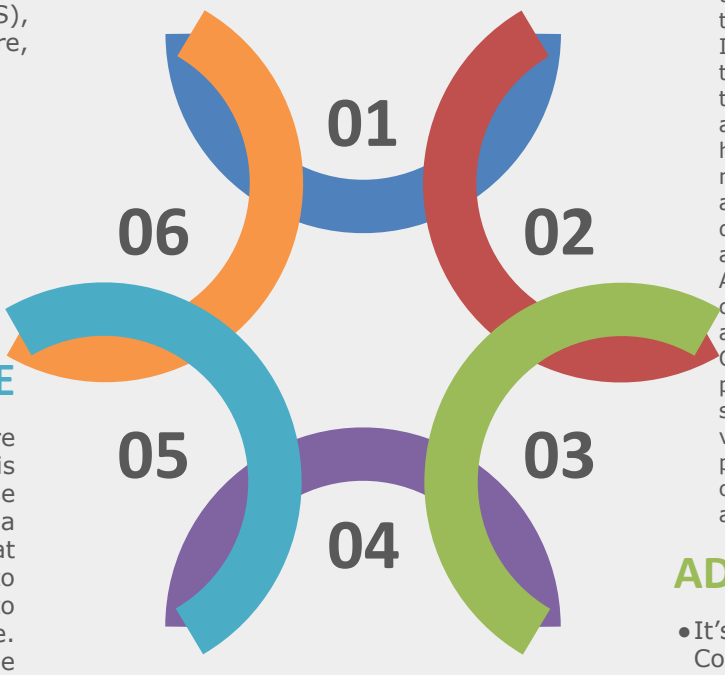
WHAT IS THIS FOR?

INFRASTRUCTURE AS A SERVICE (IAAS)

Cloud infrastructure services, known as Infrastructure as a Service (IaaS), are made of highly scalable and automated compute resources. IaaS is fully self-service for accessing and monitoring things like computers, networking, storage, and other services, and it allows businesses to purchase resources on-demand and as-needed instead of having to buy hardware outright.

EXAMPLES

ADigitalOcean, Linode, Rackspace, Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE)



DELIVERY

IaaS delivers Cloud Computing infrastructure, including things such as servers, network, operating systems, and storage, through virtualization technology. These cloud servers are typically provided to the organization through a dashboard or an API, and IaaS clients have complete control over the entire infrastructure. IaaS provides the same technologies and capabilities as a traditional data center without having to physically maintain or manage all of it. IaaS clients can still access their servers and storage directly, but it is all outsourced through a "virtual data center" in the cloud.

As opposed to SaaS or PaaS, IaaS clients are responsible for managing aspects such as applications, runtime, OSes, middleware, and data. However, providers of the IaaS manage the servers, hard drives, networking, virtualization, and storage. Some providers even offer more services outside of the virtualization layer, such as databases or message queuing.

WHEN TO USE

Just as with SaaS and PaaS, there are specific situations when it is the most advantageous to use IaaS. If you are a startup or a small company, IaaS is a great option because you don't have to spend the time or money trying to create hardware and software. IaaS is also beneficial for large organizations that wish to have complete control over their applications and infrastructures, but are looking to only purchase what is actually consumed or needed. For rapidly growing companies, IaaS can be a good option since you don't have to commit to a specific hardware or software as your needs change and evolve. It also helps if you are unsure what demands a new application will require as there is a lot of flexibility to scale up or down as needed.

CHARACTERISTICS

- Resources are available as a service
- The cost varies depending on consumption
- Services are highly scalable
- Typically includes multiple users on a single piece of hardware
- Provides complete control of the infrastructure to organizations
- Dynamic and flexible

ADVANTAGES

- It's the most flexible Cloud Computing model
- Easily allows for automated deployment of storage, networking, servers, and processing power
- Hardware can be purchased based on consumption
- Gives clients complete control of their infrastructure
- Resources can be purchased as-needed
- Is highly scalable

Figure 6. IAAS. Source: Self made

WHAT IS THIS FOR?

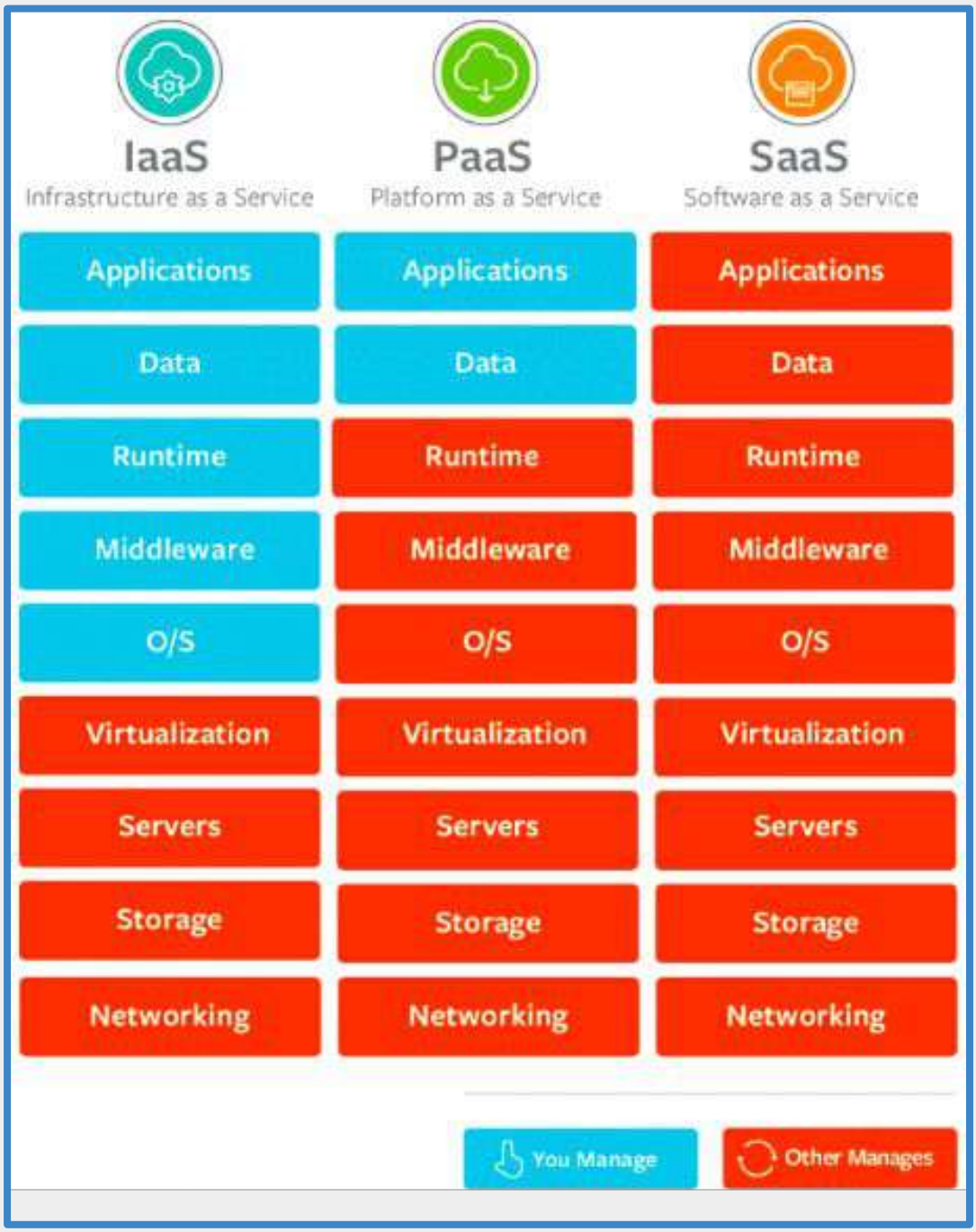


Figure 7. Key Differences. Source: www.bmc.com

WHAT IS THIS FOR?

TOP 8
CLOUD COMPUTING SKILLS FOR WORKERS

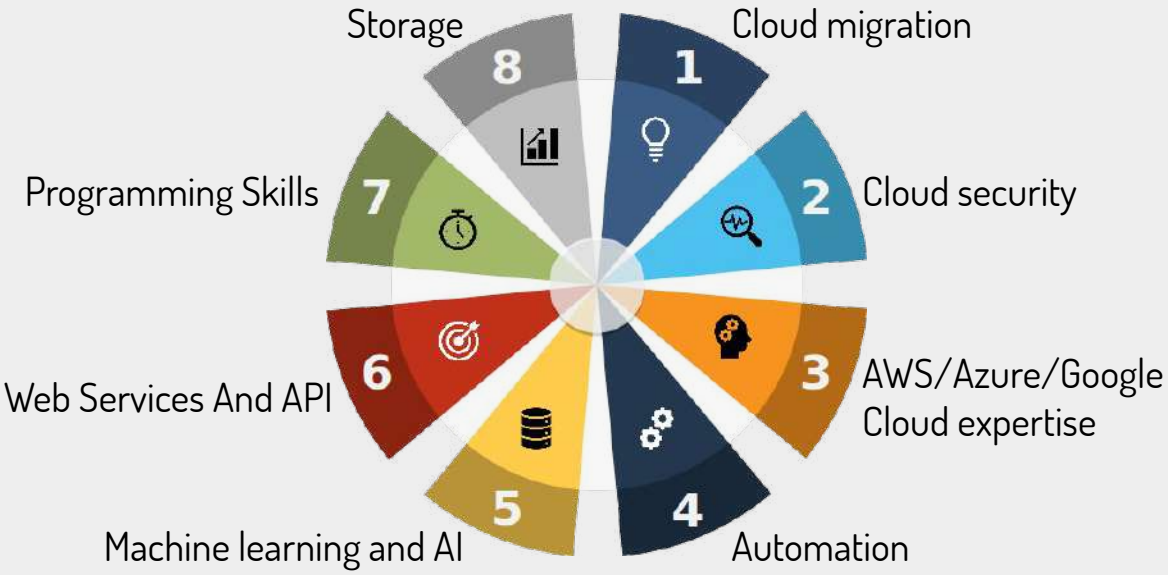


Figure 8. Top 8 Cloud Computing skills for workers. Source: Self made

Cloud migration: A huge hurdle for businesses adopting a cloud solution is migrating all their data to the cloud. Businesses need to transfer enormous amounts of data from one infrastructure to another without losing any of it. IT teams should be familiar with what their cloud infrastructure looks like and where all the data is supposed to go.Enterprise Companies that are struggling to measure resources to meet demand along with targeting to save time on basic tasks like database backup or maintenance will help from moving to the cloud.

Cloud security: In the early days, many companies were concerned about hosting their data in the cloud. But today, as cloud security has improved, there is more confidence in cloud data being safe and secure. Cloud security is a shared responsibility between the cloud providers and the businesses using them. This brings about the need for cloud professionals with specialization in cloud security skills. Cloud providers and organizations have a significant need for professionals who understand cloud security and can leverage the cloud security tools.

WHAT IS THIS FOR?

The CISSP or Certified Information Systems Security Professional is known as one of the most sought after certification in the Cloud Computing world. This credential is given by the International Information System Security Certification Consortium, Inc., and the exam covers knowledge in areas like identity and access management, asset security, and software development security.

AWS/Azure/Google Cloud expertise: The top three cloud providers on the market are AWS, Azure, and Google Cloud. Most businesses are using at least one of these cloud services, so being familiar with them is a big benefit. Ideally, a cloud professional would know each of these services inside out. Amazon, Microsoft, and Google all offer certifications that show IT managers you know how to operate in each environment.

Automation: There are plenty of tasks in the cloud space that can be automated. IT workers need to be able to set up these automated tasks and ensure that they work properly. This requires knowledge of how the cloud network is laid out, as well as how to program tasks in it. IT teams can draw from several parts of the cloud architecture to automate tasks across the entire cloud spectrum. There are three popular tools "Jenkins, Terraform, and Chef". They are all standard tools that permit automation diagonally numerous platforms. They also permit professionals targeting to raise their profitability. These tools should also contemplate in addition to the skills to their knowledge path.

Machine learning and AI: Machine Learning (ML) and Artificial Intelligence (AI) are the additional Cloud Computing skills, recommended for a bright cloud career. Machine learning is a field of computer science or an application of artificial intelligence (AI) that shares systems the skill to automatically learn and progress from knowledge without being clearly programmed. Machine learning concentrates on the expansion of computer programs that can access data using statistical techniques and use it for themselves.
Whereas Artificial Intelligence, sometimes called Machine Intelligence, is an intelligence established by technologies, in divergence to the natural intellect displayed by humans and other animals. It is simply defined as the theory and development of computer systems able to achieve tasks normally requiring human intelligence, such as speech recognition, decision-making, visual perception and translation between languages

WHAT IS THIS FOR?

Web Services And API: The underlying foundation is very important to any architecture. Cloud architectures are heavily based on APIs and Web Services because Web services provide developers with methods of integrating Web applications over the Internet. XML, SOAP, WSDL and UDDI open standards are used to tag data, transfer data, describe and list services available. Plus you need API to get the required integration done.
Thus having experience of working on websites, and related knowledge would help you have a strong core in developing Cloud Architectures.

Programming Skills: Cloud Computing is said to add a new dimension to the world of development. Now the developers have the ability to build, deploy, and manage applications quickly which scale to unlock the full capabilities of the cloud.
In the last couple of years, we have seen programming languages like Perl, Python, and Ruby rise to prominence in the cloud ecosystem. Traditional languages like PHP, Java, and .NET continue to be popular.
Python is a good starting point if you are looking to build your cloud programming skills. It is a high-level language and is easy to learn.

Storage: Cloud storage can be defined as "Storing data online on the Cloud" So company's data is stored and accessed from multiple distributed and connected resources. Some of the benefits of Cloud Storage are:

- Greater accessibility
- Reliability
- Quick Deployment
- Strong Protection
- Data Backup and Archival
- Disaster Recovery
- Cost OptimisatioN

The fact that data is centric to Cloud Computing. It is important one understands where to store and how to store it. This is because the measures taken to achieve what is mentioned above may vary based on the type and volume of data an organistaion wants to store and use. Hence understanding and learning how Cloud Storges work, would be a good idea making it an important cloud engineer skill.

WHAT IS THIS FOR?

MOST VALUED SKILLS:

1. Teamwork
2. Problem solving
3. Strategic Understanding
4. Management And Business
5. Negotiation

Cloud professionals need business skills in addition to technology skills. Among them are:

- Managing personnel
- Communication
- Negotiation

The additional demands fall under two categories.

- Internal — within the organization
- External — vendors and other service providers

The professional must fully comprehend cloud security and its implications for online data and applications. They must take extra care to ensure the security of all online operations.

Cloud Computing makes customization of data for each business possible. Analysts, who can remodel data and tailor it into formats specified by each department in an organization, are a highly prized asset.

WHAT IS THIS FOR?

Prerequisites for Learning Cloud Computing

If you are willing to learn Cloud Computing then there are some prerequisites you should know before learning Cloud Computing such as you should have basic knowledge of operating systems for example. There are few assumptions about learning Cloud Computing.

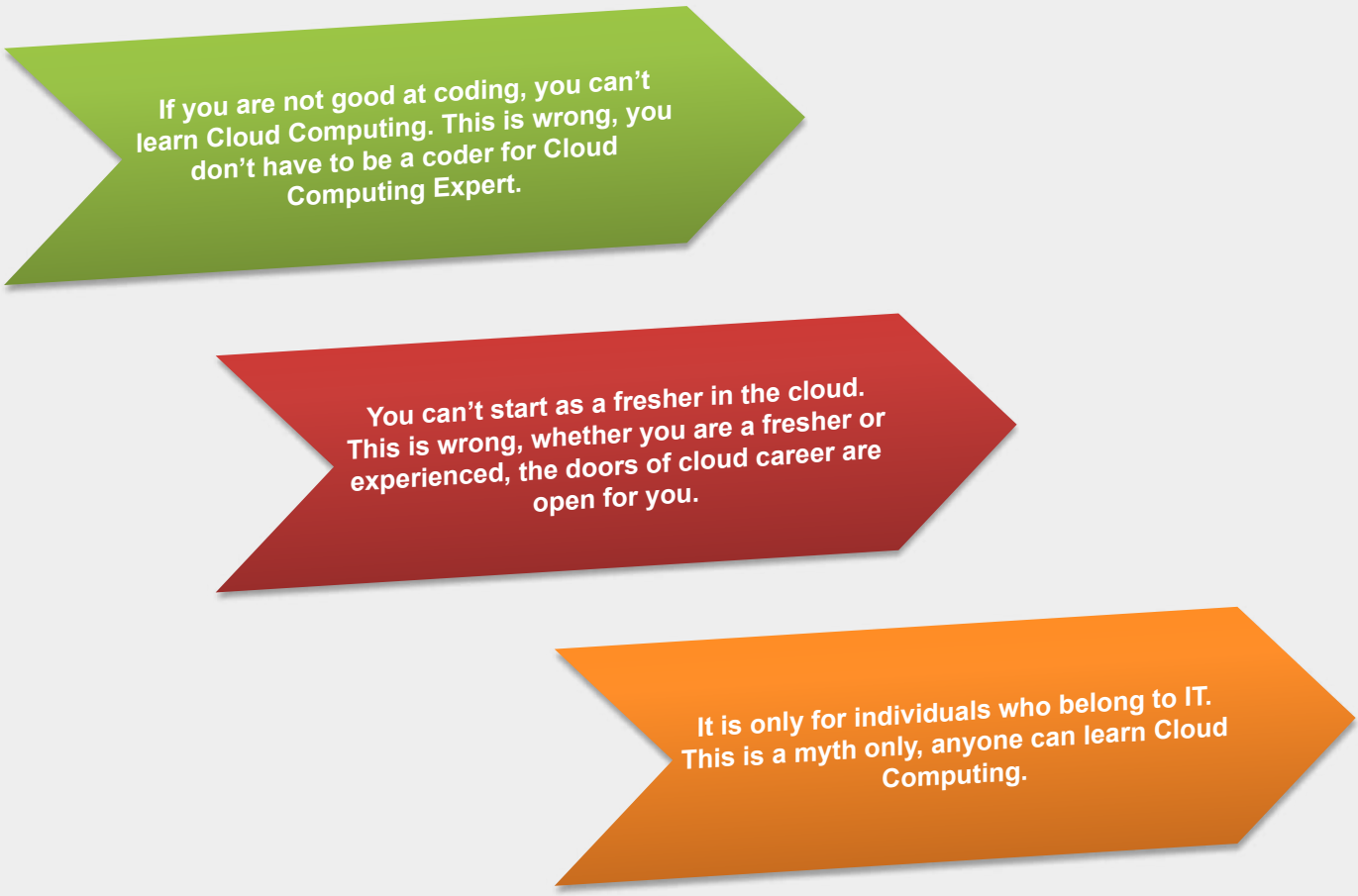


Figure 9. Prerequisites for Learning Cloud Computing Source: Self made

WHAT IS THIS FOR?

How to Start Career in Cloud Computing?

If you are willing to start a career in Cloud Computing you should know about basic steps that can make you a Cloud Computing Expert along with the certifications available for a bright Cloud Computing career.Basic factors that will help you to achieve in Cloud Computing career are:

Strong Foundation in Cloud Computing Concepts

Strong foundation in Cloud Computing concepts can help you achieve the top cloud job positions like Cloud Architect, Cloud Consultant, Cloud Software Engineer, Cloud Software Application Engineer, and Cloud Security Expert.

Practical Knowledge

If you have hands-on experience and good practical knowledge, then you will be in more demand in the industry.

Latest Technology

Cloud Computing technology is continuously updating. So keep updating yourself with the latest technology to start a career in the cloud.

Certifications

There are a number of Cloud Computing Certifications that can make a difference in your profile. AWS Certifications, Microsoft Azure Certifications, Google Cloud Certifications, Alibaba Cloud Certifications, VMware Certifications, Cloud Security Certifications are the top Cloud Computing certifications to boost the Cloud Computing career.

GOOD PRACTICES

Any enterprise considering a move to the cloud must understand that the perceived benefits can be short-lived without a plan that places Cloud Computing in the context of its overall business strategy and affects security, performance, and connectivity.

In particular, large organizations will need to be able to integrate Cloud Computing into existing IT systems and applications. Very few organizations are ready or willing to start from scratch and most will not move all of their business processes fully to the cloud at once. This makes it essential to plan for the integration challenges ahead.

Figure 10

In fact, there may be business processes and applications that never move off-premise. This means we may always need to connect on-premise to on-premise, as well as on-premise to cloud, and cloud-to-cloud, adding more complexity to integration than ever before. With enterprise IT increasingly freed from ongoing infrastructure management to focus on new areas for innovation, business integration demands simplification. With this in mind, let's look more closely at how we advise our own customers considering the cloud.

GOOD PRACTICES

Figure 11 . Good practices for your company. Source: Self made

Avoid upfront costs

One reason businesses turn to Cloud Computing and software-as-a-service (SaaS) is to mitigate risk. With a pay-as-you-go model, you can simply turn the system off if it is not working for you, and you only pay for what you use. Be sure not to jeopardize return on investment with expensive software licenses -- your integration solution, like every other part of your Cloud Computing investment, should use a flexible subscription model, too.

Get serious about autonomy

Integration of on-premise applications has traditionally required a team of IT specialists who have a deep understanding of underlying application frameworks and processes. SaaS applications are designed to be managed by business users-non-domain experts who will need to quickly and easily connect data with other enterprise systems. Cloud integration should complement the model by minimizing development, implementation, and maintenance resources, allowing users to focus on their core business.

GOOD PRACTICES

Address security concerns

According to analysts, nearly 75 percent of CIO and IT executives cite security as their number one concern when it comes to Cloud Computing. Because integrated Cloud Computing involves moving sensitive data between the cloud and on-premise networks, guaranteeing security is vital. When vetting an integration solution, determine which standards are supported for securing the data in transit. Keep in mind that as enterprises move more processes to the cloud, the volume of sensitive data flowing to and from the cloud increases.

Ensure performance and availability of the data

Today, popular Cloud Computing services provide levels of availability and performance that outperform internal infrastructure, in many cases 99.9 percent uptime or better. When designing a cloud strategy, identify integration requirements for each system (real-time, near real-time, batch), and determine the number of simultaneous requests to be handled, and specify all special architecture requirements. Success depends on ensuring information will not be lost if the cloud or on-premise source goes down. (Yes, even the cloud needs a backup plan.)

Maximize connectivity options

Cloud Computing has become a loose definition for services on the Web: everything from SaaS and platform-as-a-service (PaaS), to Web-based utility and storage solutions, and emerging Web 2.0 properties such as Google Docs, LinkedIn, and Twitter. According to research1 from Saugatuck Technology, by the end of 2010, one-quarter of business process improvement initiatives will include integration of information from enterprise social computing solutions.

GOOD PRACTICES

Connectivity requirements will continue to evolve beyond standard enterprise applications, legacy systems, and databases, to modern Web service and Web 2.0 APIs.

Learn from the mistakes of those who came before you

Early adopters took a standalone approach to Cloud Computing. The services were readily available, easy to consume, and economical. Implementation challenges were few. However, for enterprises where traditional IT infrastructure often serves core business operations, the "detached" cloud might deliver only short-term value and potentially require future re-implementation or migration. Although a standalone approach risks creating silo-ed applications, an integrated cloud strategy will deliver long-term results.

Create a strategy and a set of (realistic) goals upfront

Some businesses are jumping in without articulating a long-term cloud strategy and how it relates to their overall business. As with any project, establish realistic goals and priorities, a clear budget and deadline, as well as a shared understanding of what resources are available for implementation and maintenance. Although Cloud Computing promises significant **ROI** (productivity gains of 50 percent or more) keeping complexity and cost to a minimum requires planning and strategy.

Return on Investmen (ROI)

is a performance measure used to evaluate the efficiency of an investment or compare the efficiency of a number of different investments. ROI tries to directly measure the amount of return on a particular investment, relative to the investment's cost.

GOOD PRACTICES

Netflix's business is growing rapidly and experiences very uneven demand (highly skewed toward evenings, when, by some accounts, its video streaming service represents 29 percent of all Internet traffic). In this kind of environment, Netflix didn't want to experience service interruptions due to its inability to build data centers fast enough to handle the huge number of customers. This implies that each service must deliver high availability and be failure-resistant. When Netflix found that it was outpacing its traditional data center's capabilities, it turned to the cloud for help with scalability in order to meet spikes in demand and lulls in activity. They successfully migrated all of its databases to the cloud in 2016. As a result, the streaming giant can now produce more content, onboard more customers and easily handle sharp increases in usage spikes (typically when new episodes of a show are made available). The company can also add or reduce storage amounts in real-time based on its current viewers.

Some leading providers:

KAMATERA EXPRESS

phoenixNAP GLOBAL IT SERVICES

Dropbox

amazon web services™

Microsoft Azure

IBM Cloud

ORACLE CLOUD

Google Cloud Platform

salesforce

vmware ESXi

verizon

BENEFITS FOR THE COMPANY

Cloud Computing capabilities:

Cloud Computing is a hot topic these days and it promises to be a fundamental transition in the evolution of IT. Every organization is under pressure to do less with more and there is an incredible pressure to maximize the ROI (Return on Investment). Measurable benefits such as lower costs, greater agility and better resource utilization helps one to focus on what is important for your Business.

Features like security, scalability, cost-efficiency, automated backups, and recovery form the basis of why the cloud is so great.However, there are more subtle benefits that are often overlooked, yet can be a real game changer for your business.

- SHORT-TERM
  - Reduction of vendor lock-in
  - Improved means to deal with data and communication
  - Better understanding of cloud capabilities and programmability of cloud services
  - Useable management of trust, privacy and confidentiality
  - Adequate market regulatory frameworks and viable business models
  - An affordable, international mobile data service

- MID-TERM
  - Reduced costs
  - Increased security
  - Performance & reliability, programmability
  - Overcoming heterogeneity
  - Standards / Interoperability / Orchestration

- LONG-TERM
  - Flexibility, heterogeneity, distribution (new techniques for interoperation)
  - Performance & reliability, adaptability (new programming and executing paradigms, new devices)
  - Common agreement on the legal framework, including data protection etc.
  - Common contractual terminology
  - Full connectivity (new data management mechanisms)

BENEFITS FOR THE COMPANY

Some benefits of migrating to a cloud-based infrastructure

Minimal launch time (Performance)

The biggest Cloud Computing services run on a worldwide network of secure datacenters, which are regularly upgraded to the latest generation of fast and efficient computing hardware. This offers several benefits over a single corporate datacenter, including reduced network latency for applications and greater economies of scale. Rather than taking hours—if not days—to launch or update, cloud applications are typically up and running in seconds or minutes, and easy to learn.

Reliability

Cloud computing makes data backup, disaster recovery, and business continuity easier and less expensive because data can be mirrored at multiple redundant sites on the cloud provider's network.

Greater scalability

Users can effortlessly scale their compute or storage capacity up or down depending on what's needed, keeping your infrastructure simple and efficient.

Immediate global workforce

Enable your team to access information through the Cloud anywhere, anytime, and on any mobile device — so long as they have an internet connection.

Reduce or eliminate infrastructure maintenance

Cloud systems can automatically sync with the main server to get the latest updates and patches, which drastically cuts back on time spent doing administrative task

Intelligent automation

Self-provisioning tools give users the ability to spend more time responding to customer and business needs, and less time tinkering with manual intervention.

Low startup and capital costs

Maintain easy access to vital information with minimal upfront investment. With the Cloud model, simply pay as you go and based on how much storage space you are using.

BENEFITS FOR THE COMPANY

Security & confidentiality

The primary concern with Cloud Computing is security. Serious companies need to ensure that private data in the Cloud stays confidential. Using one of two SharePoint cloud hosting platforms, the consultants at Innovative Architects will make sure your migration to the Cloud is quick, easy, but above all, secure.

Cost

Cloud Computing eliminates the capital expense of buying hardware and software and setting up and running on-site datacenters—the racks of servers, the round-the-clock electricity for power and cooling, and the IT experts for managing the infrastructure. It adds up fast.

Big data

In addition to helping store data, cloud computing services give you the ability to sift through vast amounts of unstructured data to find meaningful business intelligence—a must-have tool for making informed decisions about your organization's future goals.

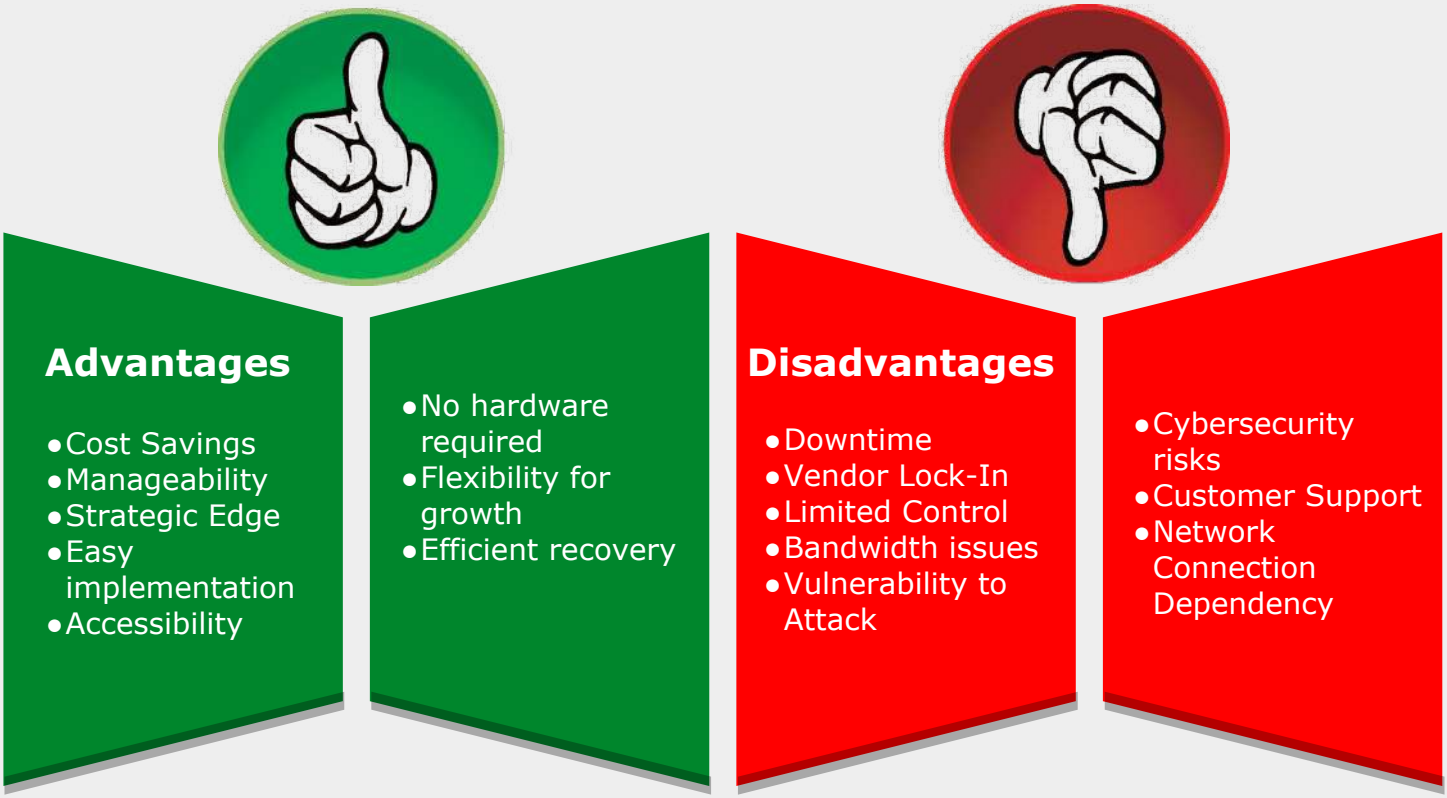


Figure 13. Advantages and Disadvantages of Cloud Computing. Source: Self made

FUTURE APPLICATIONS

Emerging cloud technologies and services:

Cloud providers are competitive, and they constantly expand their services to differentiate themselves. This has led public IaaS providers to offer far more than common compute and storage instances.

For example, serverless, or event-driven computing is a cloud service that executes specific functions, such as image processing and database updates. Traditional cloud deployments require users to establish a compute instance and load code into that instance. Then, the user decides how long to run and pay for that instance.

With serverless computing, developers simply create code, and the cloud provider loads and executes that code in response to real-world events, so users don't have to worry about the server or instance aspect of the cloud deployment. Users only pay for the number of transactions that the function executes. AWS Lambda, Google Cloud Functions and Azure Functions are examples of serverless computing services.

Public Cloud Computing also lends itself well to big data processing, which demands enormous compute resources for relatively short durations. Cloud providers have responded with big data services, including Google BigQuery for large-scale data warehousing and Microsoft Azure Data Lake Analytics for processing huge data sets.

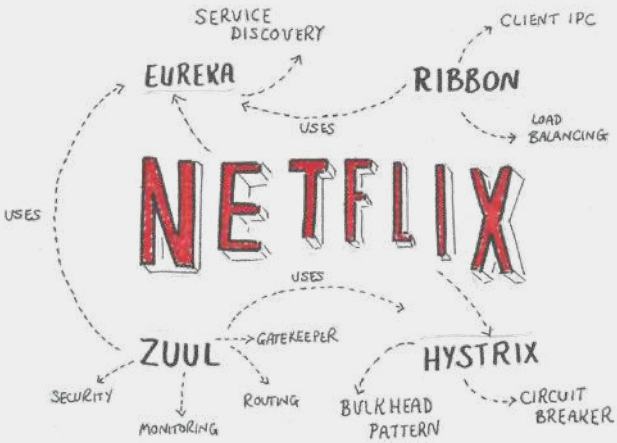
Another crop of emerging cloud technologies and services relates to artificial intelligence (AI) and machine learning. These technologies build machine understanding, enable systems to mimic human understanding and respond to changes in data to benefit the business. Amazon Machine Learning, Amazon Lex, Amazon Polly, Google Cloud Machine Learning Engine and Google Cloud Speech API are examples of these services.

FUTURE APPLICATIONS

Practical Uses of Cloud Computing:

The uses of Cloud Computing are not just limited to personal emails or storage, rather these scalable solutions have become the medium of choice for development, testing and deployment of software as well. The examples of Cloud Computing are everywhere from the messaging apps to audio and video streaming services.

Scalable Usage: Cloud Computing offers scalable resources through various subscription models. This means that you will only need to pay for the computing resources you use. This helps in managing spikes in demands without the need to permanently invest in computer hardware.



Netflix, for instance, leverages this potential of cloud computing to its advantage. Due to its on-demand streaming service, it faces large surges in server load at peak times. The move to migrate from in-house data centres to cloud allowed the company to significantly expand its customer base without having to invest in setup and maintenance of costly infrastructure.

Chatbots: The expanded computing power and capacity of the cloud enables us to store information about user preferences. This can be used to provide customized solutions, messages and products based on the behaviour and preferences of users.

Siri, **Alexa**, **Cortana** and **Google Assistant** all are cloud-based natural-language intelligent bots. These chatbots leverage the computing capabilities of the cloud to provide personalized context-relevant customer experiences

FUTURE APPLICATIONS

Communication: The cloud allows users to enjoy network-based access to communication tools like emails and calendars. Most of the messaging and calling apps like **Skype** and **WhatsApp** are also based on cloud infrastructure. All your messages and information are stored on the service provider's hardware rather than on your personal device. This allows you access your information from anywhere via the internet.

Productivity: Office tools like **Microsoft Office 365** and **Google Docs** use Cloud Computing, allowing you to use your most-productive tools over the internet. You can work on your documents, presentations and spreadsheets - from anywhere, at any time. With your data stored in the cloud, you don't need to bother about data loss in case your device is stolen, lost or damaged. Cloud also helps in sharing of documents and enables different individuals to work on the same document at the same time at you will get different results. All this is made possible using big data.

Business Process: Many business management applications like customer relationship management (CRM) and enterprise resource planning (ERP) are also based on a cloud service provider. **Salesforce**, **Hubspot**, **Marketo** etc. are popular examples of this model. This method is cost-effective and efficient for both the service provider and customers. It ensures hassle free management, maintenance and security of your organization's critical business resources and allows you to access these applications conveniently via a web browser.

FUTURE APPLICATIONS

Backup and recovery: When you choose cloud for data storage the responsibility of your information also lies with your service provider. This saves you from the capital outlay for building infrastructure and maintenance. Your cloud service provider is responsible for securing data and meeting legal and compliance requirements. The cloud also provides more flexibility in the sense that you can enjoy large storage and on-demand backups. Recovery is also performed faster in the cloud because the data is stored over a network of physical servers rather than at one on-site data centre. **Dropbox**, **Google Drive** and **Amazon S3** are popular examples of cloud backup solutions.

Application development: Whether you are developing an application for web or mobile or even games, cloud platforms prove to be a reliable solution. Using cloud, you can easily create scalable cross-platform experiences for your users. These platforms include many pre-coded tools and libraries like directory services, search and security. This can speed up and simplify the development process. **Amazon Lumberyard** is a popular mobile game development tool used in the cloud.

Test and development: The cloud can provide an environment to cut expenses and launch your apps in the market faster. Rather than setting up physical environments developers can use the cloud to set up and dismantle test and development environments. This saves the technical team from securing budgets and spending critical project time and resources. These dev-test environments can also be scaled up or down based on requirements. **LoadStorm** and **BlazeMeter** are popular testing tools..

FUTURE APPLICATIONS

Big data analytics: Cloud Computing enables data scientists to tap into any organizational data to analyze it for patterns and insights, find correlations make predictions, forecast future crisis and help in data backed decision making. Cloud services make mining massive amounts of data possible by providing higher processing power and sophisticated tools. There are many open source big data tools that are based on the cloud for instance **Hadoop**, **Cassandra**, **HPCC** etc. Without the cloud, it won't be very difficult to collect and analyze data in real time, especially for small companies.

Social Networking: Social Media is the most popular and often overlooked application of cloud computing. **Facebook**, **LinkedIn**, **MySpace**, **Twitter**, and many other social networking sites use cloud computing. Social networking sites are designed to find people you already know or would like to know. In course of finding people, we end up sharing a lot of personal information. Of course, if you're sharing information on social media then you are not only sharing it with friends but also with the makers of the platform. This means that the platform will require a powerful hosting solution to manage and store data in real-time - making use of cloud critical.

FUTURE APPLICATIONS

TRENDS:

Businesses nowadays are seeking innovative ways to grow and accomplish their business goals. With the help of Cloud Computing, this business will keep on growing in the future. Cloud Computing is powerful and expansive and will continue to grow in the future. Some trends for the next year will be:

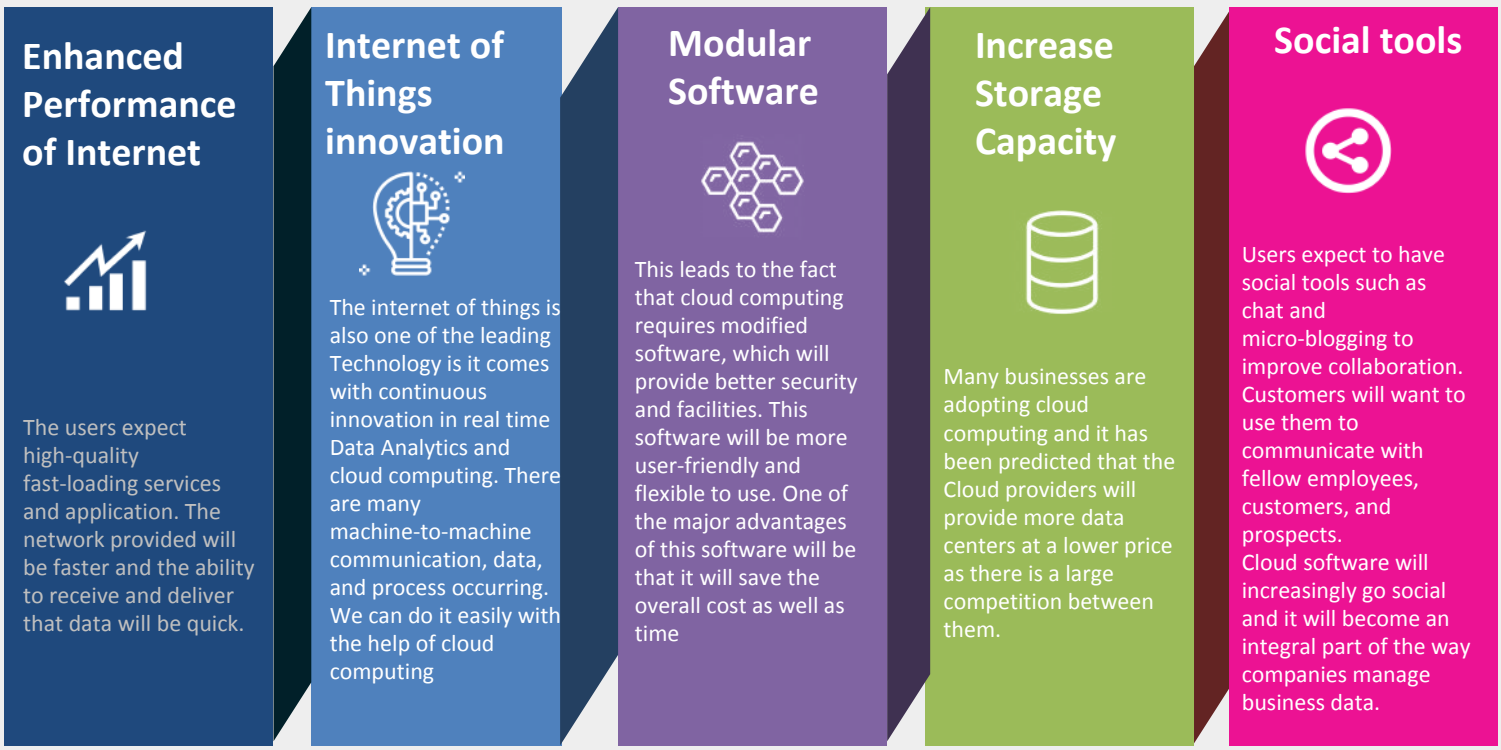


Figure 14. Cloud Computing Trends.
Source: Self made

Given the vital role that IT plays in today's business environment, cloud computing is also fundamentally changing the way that companies operate. Tens of thousands of companies of all sizes in a broad range of industries are utilizing cloud-based software, platforms, and even infrastructure to streamline processes, lower IT complexity, gain better visibility, and reduce costs.

ADVANCED CONTENT

Nature and Features:

Cloud Computing in simplified terms can be understood as the storing, processing and use of data on remotely located computers accessed over the internet. This means that users can command almost unlimited computing power on demand, that they do not have to make major capital investments to fulfil their needs and that they can get to their data from anywhere with an internet connection. Cloud Computing has the potential to slash users' IT expenditure and to enable many new services to be developed. Using the cloud, even the smallest firms can reach out to ever larger markets while governments can make their services more attractive and efficient even while reining in spending.

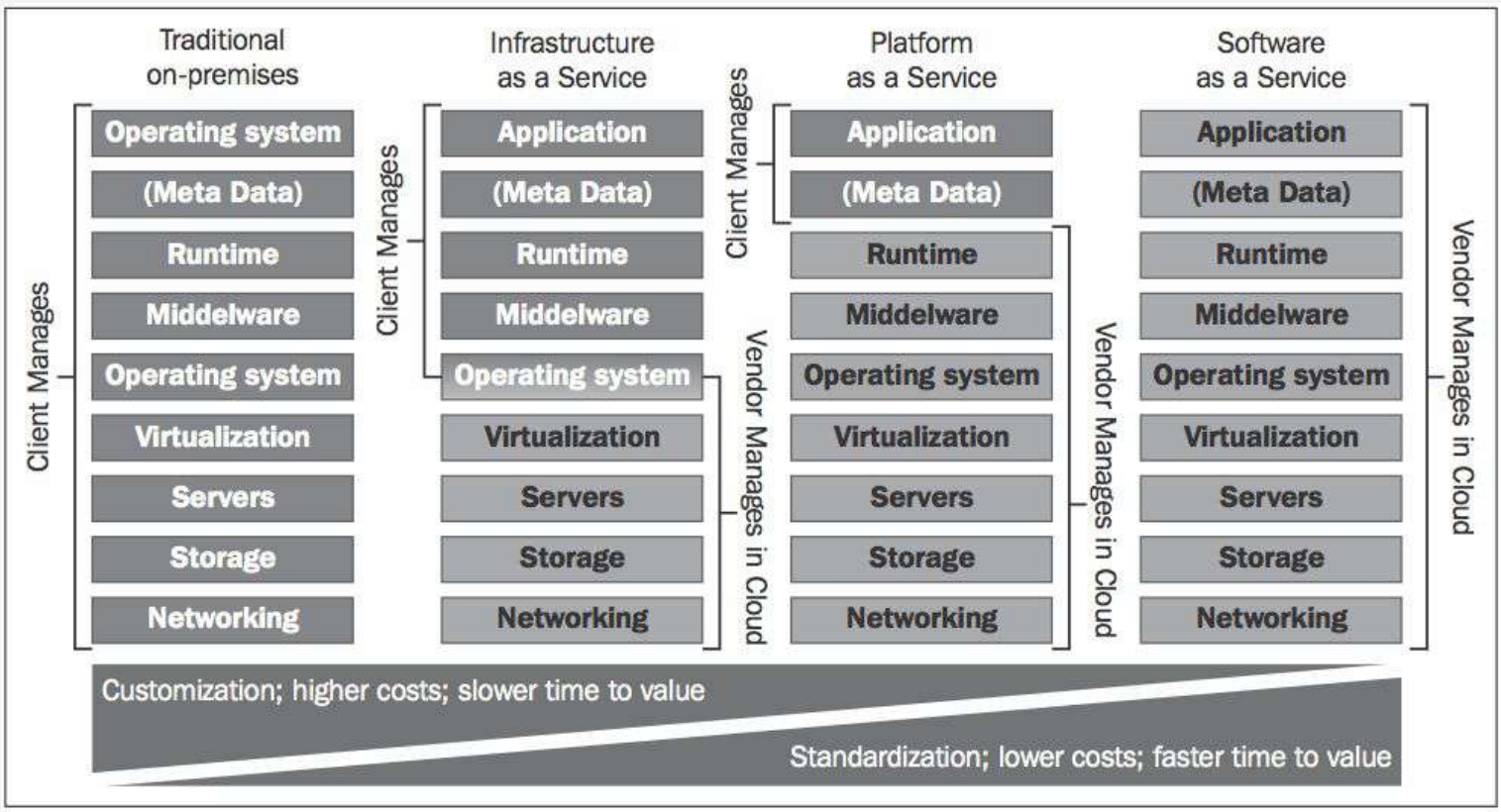


Figure 15. Nature of Cloud Computing.
Source: www.ibm.com

ADVANCED CONTENT

1. Hardware (computers, storage devices) is owned by the Cloud Computing provider, not by the user who interacts with it via the internet
2. Cloud providers often move their users' workloads around (e.g. from one computer to another or from one data centre to another) to optimise the use of available hardware
3. Organisations and individuals can access their content, and use their software when and where they need it, e.g. on desktop computers, laptops, tablets and smartphones
4. The remote hardware stores and processes data and makes it available, e.g. through applications (so that a company could use its cloud-based computing in just the same way as consumers already today use their webmail accounts)
5. The use of hardware is dynamically optimised across a network of computers, so that the exact location of data or processes, as well as the information which piece of hardware is actually serving a particular user at a given moment, does not in principle have to concern the user, even though it may have an important bearing on the applicable legal environment.
6. A cloud set-up consists of layers: hardware, middleware or platform, and application software. Standardisation is important especially at the middle layer because it enables developers to address a wide range of potential customers and gives users choice
7. Users normally pay by usage, avoiding the large upfront and fixed costs necessary to set up and operate sophisticated computing equipment
8. At the same time, users can very easily modify the amount of hardware they use (e.g. bring new storage capacity online in a matter of seconds with a few mouse clicks)

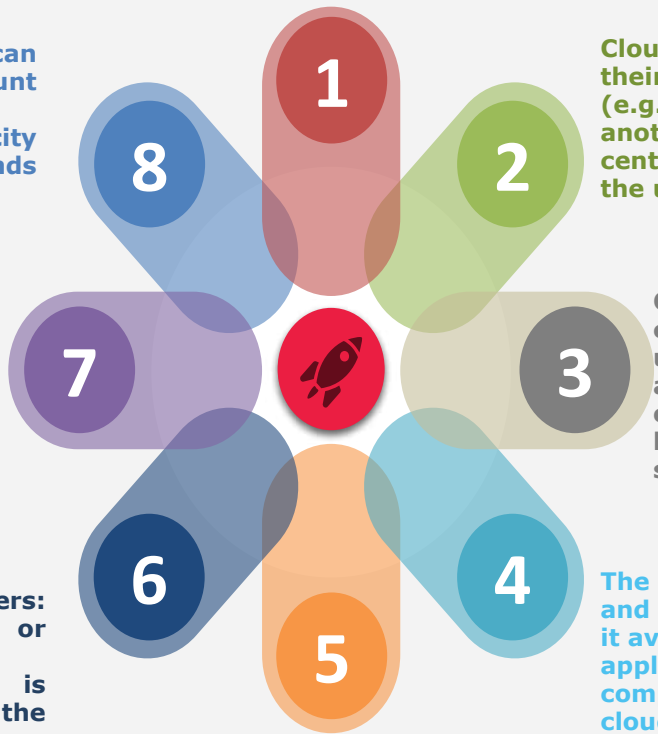


Figure 16. Cloud computing features.
Source: Self made

ADVANCED CONTENT

Creating a strategy

Before investing the money for Cloud Computing & deploying cloud applications companies must necessarily consider the requirements, strategically plan them for business needs and consider:

- Client accessing facility
- Budget requirement
- Type of deployment - private, public, community or hybrid
- Privacy and Data security
- Data backup requirement
- Data export requirement
- Requirement of training

The three main phases are:

1 Strategy Phase

Here, companies discuss about the problems that customers might encounter. There are two steps of examining this phase:

- Value proposition of Cloud technology: It involves IT management simplifications, maintaining cost reduction, low-cost outsourcing, high QoS (quality of service) outsourcing & innovation in the business model.
- Strategy planning of Cloud technology: Based on analysis of value proposition, the strategy is established; and the strategy documentation is made according to the problems the customer might encounter while using cloud technology.

ADVANCED CONTENT

2 Planning Phase

Here the problem analysis & risk analysis for switching to cloud technology is checked to ensure whether the customer is satisfied in meeting their business goals or not. The steps for planning are:

- Development of Business Architecture
- Development of IT Architecture
- QOS development requirement
- Development of Transformation plan

3 Deployment Phase

Deployment Phase pivots its strategies based on the above two phases of planning and involves the following steps:

- Selecting appropriate providers of Cloud: This selection is made based on SLA (Service Level Agreement), which defines the level of service the cloud-provider will provide.
- Maintaining the Technical Service: The provider must ensure the proper maintenance of services by providing the best Quality of Service to their users.

ADVANCED CONTENT

Factors to Consider Before Investing

1 Availability

As soon as all your business-critical data get stored in the cloud storage, it becomes essential to check whether the data is available or not, whether the data is secured or there are loopholes that might become the reason of the downfall of an organization's business. Therefore, as a user you should stay focus & check this aspect with the service provider before signing the deal.

2 Compliance

Even though it seems that all data gets stored in the cloud storage, but data resides on multiple servers; these servers are located in different nations of the globe. Though it has an advantage for data availability, users must concern about the legality issue; the issue in the sense - users need to check whether there will be any discrimination or restriction for a particular type of data to store beyond national boundaries.

3 Compatibility

Users must check the compatibility of IT infrastructure of his/her organization before investing money in Cloud. Though cloud technology is providing users with the optimum possible benefits, as a vendor users must also harvest and extract the maximum usage of cloud. Moreover, it has to keep in mind that the employees of the organization must cope-up with the infrastructure of the cloud technology. the toil.

4 Monitoring

As you put your data on cloud storage, the cloud service provider takes the responsibility and control of your data. For this reason, monitoring becomes an issue. Since complete monitoring of data is possible, so users should make sure that proper monitoring of data is allowed by the providers based on user requirement.

ADVANCED CONTENT

SOME CLOUD COMPUTING TOOLS:

Cloudability

It aggregates expenditures into reports, helps identify opportunities for reducing costs, offers budget alerts and recommendations via SMS and email, and provides APIs for connecting cloud billing and usage data to any business or financial system.

Cloudyn

These tools are designed to help corporate IT from over-buying Amazon cloud resources. Cloudyn's suite of services gives users a dashboard showing detailed information on all of their virtual machine instances, databases, and storage

AtomSphere

Is a cloud-based software Platform as a Service used by customers who want to integrate their various cloud-based applications with each other and with on-premise apps

EnStratius

Provides cross-platform cloud infrastructure management for public, private, and hybrid clouds that can be closely aligned with an enterprise's governance and security requirements.

Informatica

Cloud integration tools that include enhancements that address data security issues in the cloud and help enterprise IT manage data integration issues in hybrid cloud deployments

MuleSoft

Delivered as a packaged integration experience, CloudHub and Mule ESB are built on open source technology to provide quick, reliable application integration without vendor lock-in.

Opscode

Chef is an open source Ruby-based configuration management product served up by Opscode under the Apache license,focuses on provisioning, configuring and integrating cloud resources.

PuppetLabs

Is an IT automation software that gives system administrators the power to easily automate repetitive tasks, quickly deploy critical applications, and proactively manage infrastructure changes, on-premise or in the cloud

RightScale

Its platform lets organizations easily deploy and manage business-critical applications across public, private and hybrid clouds. RightScale provides configuration, monitoring, automation and governance of Cloud Computing infrastructure and applications.

DXC-Agility

Provides a single, integrated control point for governance, compliance and security across an enterprise's cloud applications and cloud environments.

Figure 17. Some B tools.
Source: Self made

EDUCATION

Test your knowledge of **Cloud Computing** with this quiz:

Self-assessment tool:

https://searchcloudcomputing.techtarget.com/quiz/Quiz-Cloud-computing-basics

Degrees/Masters

- Cloud Computing MSc, PGDip - University of Leicester
- Online Cloud Computing Architecture Master's Degree - University of Maryland University College
- BSc (Hons) Cloud Computing - University of Wolverhampton
- Master of Technology in Cloud Computing - K L University

MOOC's

- Cloud Computing Concepts, Part 1 - Coursera
- Cloud Computing Concepts: Part 2 - Coursera
- Cloud Computing Security - edX
- SAP Cloud Platform Essentials - openSAP

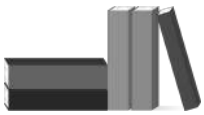
EDUCATION

External manuals & tutorials for more information

- Practical Guide to Cloud Computing Version 3.0, by Cloud Standards Customer Council
- Cloud Services For Dummies, IBM Limited Edition, by J. Hurwitz, M.Kaufman, and Dr. F. Halper
- Cloud Computing Tutorial for Beginners
- Cloud Computing Bible, by B. Sosinsky

Certifications

- Google Certified Professional Cloud Architect
- Project Management Professional (PMP)
- AWS Certified Solutions Architect – Associate
- Microsoft Certified Solutions Expert (MCSE): Server Infrastructure



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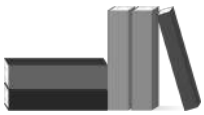

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SELF APPRAISAL

- After having read this text have I a clear idea of what Cloud Computing is?
- What tools am I used to?

- Do I know the benefits that Cloud Computing can bring to my company?
- Can I recognize the advantages and disadvantages of its implementation for my company?

INTRO 4.0

NETWORK COMMUNICATION

EuroProfis

edit value
apoio à gestão

@nced
ASOCIACIÓN NACIONAL DE CENTROS DE e-LEARNING Y DISTANCIA

bit schulungscenter
member of bit group

Co-funded by the Erasmus+ Programme of the European Union

Associate partner:

udima
UNIVERSIDAD A DISTANCIA DE MADRID

INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

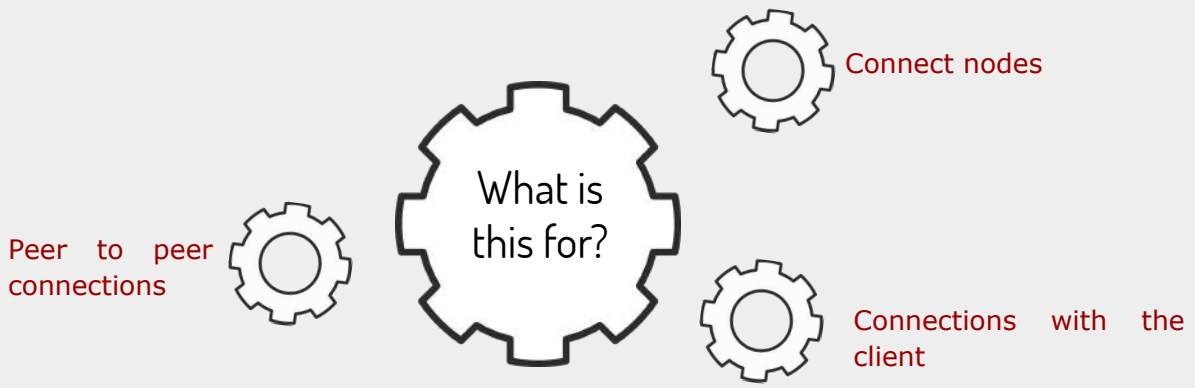
- Understand the fundamentals of Network Communication
- Identify the different types of Network
- Know the importance of IoT
- Estimate the benefits that Network Communication can have for companies
- Recognize future applications

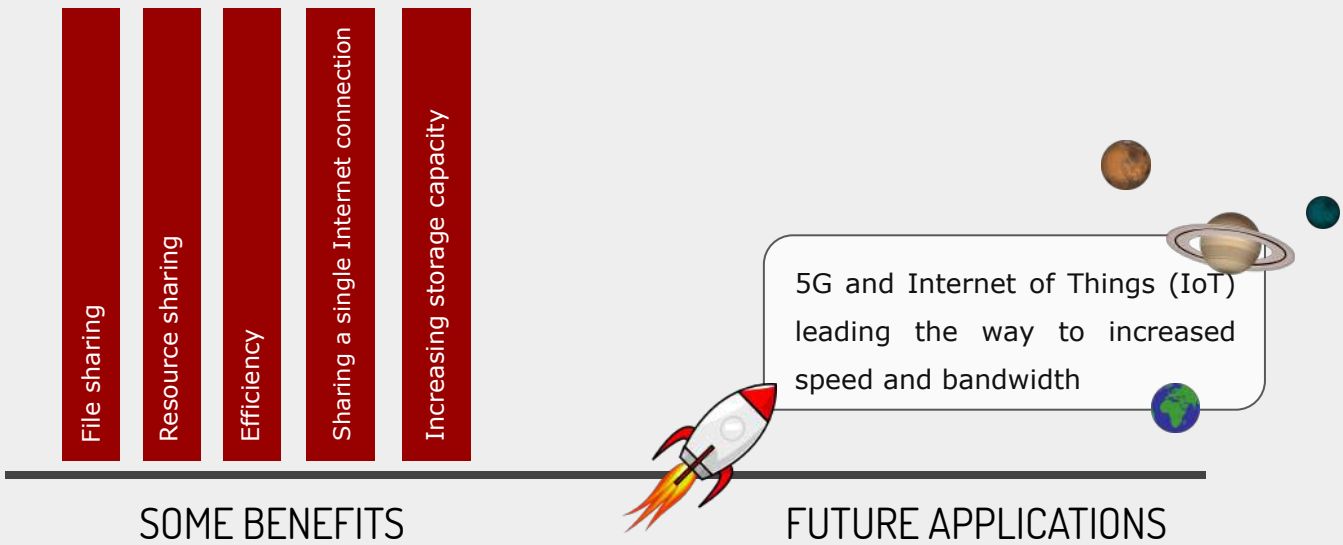
INTRODUCTION

Network Communication is a network of a group of devices comprising hardware and software connected together.

Learning Objectives

- Understand the fundamentals of Network Communication
- Identify the different types of Network
- Know the importance of IoT
- Estimate the benefits that Network Communication can have for companies
- Recognize future applications

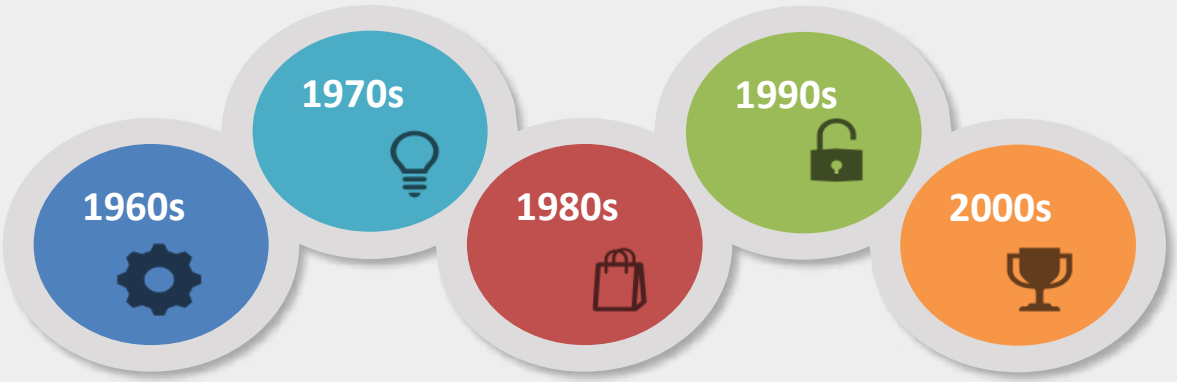




WHAT IS IT?

Communication networks are at the bedrock of our society. A communication network is a network of a group of devices comprising hardware and software connected together, whether in the same geographical location or globally to facilitate communication and information sharing. So you name it: ultra sound machines, cell phones, Internet communications, banking transactions, e-learning, border security, transport networks, satellite imaging and the list goes on, are all made possible only through communication networks. This modern society we live in cannot do without it.

Modern communication network consist of servers, clients, transmission media, data, operating systems, switches, routers, cables, printers and various peripheral devices extending communication between devices from local area network to globally covered networks.



In 1962, MIT computer scientist J.C.R. Licklider comes up with the idea for a global computer network.

In 1973, Robert Kahn and Vinton Cerf collaborate to develop a protocol for linking multiple networks together. This later becomes the Transmission Control Protocol/Internet Protocol (TCP/IP)

In 1981, Metcalfe's company 3Com announces Ethernet products for both computer workstations and personal computers; this allows for the establishment of local area networks (LANs)

CERN develop hypertext markup language (HTML) and the uniform resource locator (URL), giving birth to the first incarnation of the World Wide Web.

The rise and proliferation of Wi-Fi as well as mobile Internet devices like smartphones and, in 2005, the first-ever Internet cat video.

WHAT IS IT?

Networking Types and Structures

Networks can be wired or wireless with most networks being a mixture of both.

Wired vs Wireless Networks

Early (pre 2008) networks were predominately wired. Today however most networks will use a mixture of wired and wireless network.

Wired networks use Ethernet as the data link protocol. This is unlikely to change with the IoT, as IoT devices will be predominantly wireless.

Wired networks have the following advantages/disadvantages:

Advantages

- Ethernet ports are found on almost all laptops/PCs and netbooks even on those 8 years old.
- Wired networks are faster than Wireless. Data rates were periodically increased from the original 10 megabits per second, to 1 gigabyte per second. Most home networks use 10-100 Mbps.
- More secure than Wireless

Ethernet is a family of computer networking technologies commonly used in local area networks (LAN), metropolitan area networks (MAN) and wide area networks (WAN).

WHAT IS IT?

Disadvantages

- Need to Use cable which can be unsightly, difficult to run and expensive.
- Can't be used easily between buildings (planning etc).
- Note a new technology that uses mains cable overcomes many of these disadvantages. Powerline networking is common on home/small office networks
- Not supported on Mobile phones and tablets.

Wireless Networks – Advantages and Disadvantages

Wireless networks use Wi-fi as the data link protocol. However other wireless options are being developed for the IoT (Internet of Things). See Wireless networking Technologies for the IoT

Wireless Networks have the following advantages/disadvantages:

Advantages

- Generally easier to set up.
- Can be used both on home and public networks
- No cables required.
- Can be used with mobile phones and tablets.

Wireless Networks Disadvantages

- Generally Slower than wired networks.
- Limited by range.
- Open to eavesdropping.
- Not as secure depending on set up.

WHAT IS THIS FOR?

Networking Topologies and Layout

There are many different ways network nodes can be connected together. This isn't normally a consideration in small networks but has networks get larger it becomes more important. There are many different ways network nodes can be connected together.

Common connection technologies like Wi-Fi, Bluetooth etc are designed to work using a particular network topology. When designing networks and choosing connection protocols having an understanding of these topologies is important.

Common are: Bus, Ring, Mesh, Star, Hybrid

Early Ethernet networks used a bus structure, modern Ethernet networks and Wi-Fi Networks use a star bus (hybrid) structure.

Networking Topology- Physical vs Logical

How the nodes on a network communicate with each other can be very different to how they are physically interconnected. Most home and small office networks use a physical bus topology. Common logical typologies are Peer to Peer and Client Server. The web (WWW) is a client server network at the logical level.
In a peer to peer network all nodes are equal and any node can talk to any other node. No node has any special role. This was the original networking model of windows networking. (Windows for Workgroups).

WHAT IS THIS FOR?

Peer to Peer Networking Model

Advantages

- Easier to setup
- Not dependent on a single node
- More resilient
- Better distribution of network traffic
- No central administration required
- Less expensive hardware required

Disadvantages

- Less secure and more difficult to secure
- More difficult to administer
- More difficult to backup
- More difficult to locate information.

This was the original networking model used in early Windows networks (Windows for Workgroups)

A Modern example of Peer to Peer networking is BitTorrent.

Although this networking model isn't currently popular it could become more popular with the Internet of Things (IOT).

WHAT IS THIS FOR?

Client Server

In a Client Server network a server has a special role e.g file server, domain controller, web server etc. A client connects to a server to use the appropriate services.

This is the networking model used on the web and the Internet and on modern large Windows networks.

Advantages

- Easy to find resources as they are on a dedicated node i.e. A server
- Easy to secure
- Easy to administer
- Easy to backup

Disadvantages

- Servers are a single point of failure
- Expensive hardware required
- Network traffic get concentrated

A Modern example of Client Server networking is the Web. Facebook, Twitter, Google search and many other web services use this networking model.

WHAT IS THIS FOR?

Network Size

Networks vary considerably in size. The following are commonly used terms:

- PAN -Personal Area Network – Linking local devices e,g, PC to printer
- LAN – Local Area network- links devices in an office or offices
- MAN – Metropolitan Area network – links devices across multiple buildings like a campus
- WAN – Wide area network – links devices across a country/countries.

Networking Levels and Layers and Protocols

A protocol defines a set of rules that govern how computers talk to each other.

Ethernet and Wi-Fi are Data link protocols that are responsible for framing data on the media (cable or wireless).

Ethernet and Wi-Fi use a physical level address know as the MAC address which is 48 bits.

EUI 64 addresses are MAC addresses with 64 bits will replace MAC addresses on IPV6, 6LoWPAN, ZigBeeand other new network protocols.

You can divide networking into distinct levels or layers. Each level or layer is responsible for a particular function.

The OSI uses a 7 layer model and TCP/IP networks use a 4 layer model.

WHAT IS THIS FOR?

Because TCP/IP (TPC = Transmission Control Protocol, IP = Internet protocol) networks are the most common, the TCP/IP model is the most important one to understand. The levels are:

- Data link level – e.g. Ethernet, Wi-Fi
- Networking e.g. IP, – IPv4 Address classes and subnetting and IPv6 Explained for Beginners.
- Transport level e.g.TCP, UDP – See TCP vs UDP
- Application level – e.g. HTTP -See HTTP for beginners

Network Addressing

What is an IP Address?

Every device attached to a network, and the Internet has an IP address.

> An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication

There are two versions of IP, they are IPv4 and IPv6.

IPv4 has been in use since the start of the Internet, and is deployed across the Internet, and home/corporate networks.

IPv4 uses 32 bits for addressing, however due to the rapid growth of the Internet, all IPv4 addresses have been allocated (as of 2013).

WHAT IS THIS FOR?

Techniques like NAT (network Address Translation) have extended the life of IPv4 by allowing the use of private IP addresses inside networks.

However IPv4 will eventually be replaced by IPV6 which uses 128 bits for the address, and so can accommodate many more hosts (computers/devices)

The roll out of IPv6 across the Internet is happening slowly, and IPv4 will be with us for many years to come especially in home and small office networks.

As IP6 rolls out they will also be a need to operate with two addresses until migration is complete, and IP4 is discontinued.

IP addresses are logical addresses, and are assigned by a network administrator or can be auto assigned (using DHCP).

The important thing to note is that the IP address of a device isn't fixed.

Public and Private IP Addresses

Both IPv4 and IPV6 have both public and private address ranges.

The private addresses are used for home/business networks and the addresses aren't routeable on the Internet i.e. they don't travel across the Internet.

For IP4 the private addresses starts with 10.x.x.x or 192.168.x.x or 172.16.x.x

Public addresses are reachable from anywhere on the Internet and are routeable.

WHAT IS THIS FOR?

IP Address Assignment

Most modern networks use automatic IP address assignment via DHCP with manual assignment only being done in special cases.

For home networks the Internet router or hub usually provides DHCP services for the network.

For larger networks a dedicated DHCP server is normally used.

Most windows machines will auto assign their own address if they fail to find a DHCP server.

This can cause problems see troubleshooting Internet connections.

IP Addresses and Domain Names

Computers use numbers (IP addresses) but people use names as they are much easier to remember.

When you type in a domain name into your web browser the name is translated into an IP address by a DNS server usually located on the Internet.

WHAT IS THIS FOR?

TOP 8 NETWORK COMMUNICATION SKILLS FOR WORKERS

Figure 1. Top 5 Network Communication skills for workers
Source: self made

Computer network professionals manage the day-to-day operation of computer networks. Demand for these skilled information technology workers is expected to grow as more companies invest in newer, faster technology. A successful computer network professional will have a variety of skills they use to support an organization's computer systems, including:

WHAT IS THIS FOR?

Analytical skills

Learn to evaluate network and system performance and detect and monitor changes to computer systems.

Computer skills

Work with a variety of technologies, including local area networks, wide area networks, network segments, intranets, hardware and software. Administrators up-to-date in cloud computing and mobile technology will be especially in high-demand.

Communication skills

Provide IT support and communicate problems and solutions to administrators and less tech-savvy employees.

Problem-solving skills

Learn to quickly resolve problems that arise with computer networks.

Multitasking skills

Manage multiple problems and projects at once for an organization.

WHAT IS THIS FOR?

Researchers estimate that within two years from now, a whopping 20.4 billion Internet of Things (IoT) devices will be connected. This surge in the number of IoT devices in use will translate into a significant increase in the number of IoT jobs as well. Clearly, a job in IoT can pay well because of the rising demand, but candidates will require a combination of skills to ensure a promising IoT career.

Broad-based skills for an IoT career

1. Business intelligence
2. Data security
3. Application design
4. Mobile applications
5. IoT hardware
6. Networks
7. Sensors
8. Embedded chips
9. Cloud computing
10. Troubleshooting IoT

GOOD PRACTICES

Wearable Technology

Magoo Project

Magoo is a wearable device specifically designed for the visually impaired that is accessible, easy-to-use and fashionable in a way that it doesn't make the blind feel like they stand out negatively. This device provides two basic functions: obstacle detection and navigation assistance, both via haptic feedback

In obstacle detection, the user wears a necklace that contains an ultrasonic sensor, which provides vibration (haptic feedback) on the neck if the user is within 2 meters range of a barrier in front of them.

The second piece is an arm-length glove which houses the actuators and wifi component and features a beautiful, tactile design on the top. The user inputs his/her destination using a voice command and the integrated circuit on the glove commutes with the GPS to find the optimal route to this destination piece wise (every 0.1 miles) by finding a direction vector. The user can swing his/her arm to track the right direction. As the user's arm falls in the region of 'correct direction vector' (as indicated by GPS), the user gets a haptic feedback which points them in the right direction. This not only helps the blind in convenient navigation, but also prevents them from getting lost. .

GOOD PRACTICES

Best Practices of the University of Mary Washington (Google Glass)

The University of Mary Washington was part of the Google Glass Explorer Program. This program is now moving to its next phase of development.
Google Glass is a portable technology similar to your smartphone. It fits an eye-glass frame and has a camera mounted on the head and a screen placed over the right eye. To communicate with this mini laptop, you can use your voice using the command, ok glass or you can use touch. As with your smartphone, download applications that provide functionality to the device.

Glass in an Educational Setting:

Students:
First person perspective, record interactions, processes, role plays, public speaking activities, group work, problem solving strategies, tutorials, and field trips, head and body movements in sports. Take notes. Simple Google Searches. Augmented reality via QR Codes to view content (video, text, images). Real time language translation. Accessibility for visual, auditory, and physical handicaps.

GOOD PRACTICES

Teachers:

Document student learning during lecture, demonstrations, hands-on experiences activities, field trips in real time from teacher point of view. Record lessons from teacher perspective and combine with student perspective for a reflection. Tutorial lessons to help clarify misperceptions or answer student questions. Take notes. Receive questions from students during lectures. Poll students. View slide notes during presentation. Wear during intern evaluations or have intern wear and record from their point of view. Connect through Google Hangouts. Create content videos. Display student information to tailor lessons to students needs. Display various types of information for easy access. Send and receive messages.

General Uses:

Create video guides (first person tour in real time). Create documentaries to enhance storytelling. Capture everyday life. Connect with others through Google Hangout. Transfer content from Glass to Google+ computer for easy access. Personalized searches. Design and build Apps. Closed captioning.

The Internet of Things (IoT)

University of Wisconsin–Madison

At the IoT lab of this university researchers with the colaboration of industrial collaborators are developing many devices such as a digital home message center, a health monitoring bracalet or gadgets connected to bikes to warn about proximities to vehicles..

In this place students with great ideas can teaming up to advance their technology and business sense.

GOOD PRACTICES

IoT Lab

IoT Lab is a research platform exploring the potential of crowdsourcing and Internet of Things for multidisciplinary research with more end-user interactions. It gives the power to the crowd to be at the core of the research and innovation process. It gives you the power to change the world and the way we understand it.

IoT in Medical Education

This article describes IoTFlip or IoT Flipped Learning Platform that uses the IoT devices , IoT data and CBL (Case Based Learning) to create a platform based on flipped learning for medical education.

Some leading companies:

XILINX®

Google

INGENU simply genius

ARM

CISCO

IBM

BOSCH

R-Style Lab

BENEFITS FOR THE COMPANY

Setting up a computer network is a fast and reliable way of sharing information and resources within a business. It can help you make the most of your IT systems and equipment.

Main benefits of networks include:

File sharing
You can easily share data between different users, or access it remotely if you keep it on other connected devices.

Resource sharing
Using network-connected peripheral devices like printers, scanners and copiers, or sharing software between multiple users, saves money.

Sharing a single Internet connection
It is cost-efficient and can help protect your systems if you properly secure the network.

Increasing storage capacity
You can access files and multimedia, such as images and music, which you store remotely on other machines or network-attached storage devices.

Networking computers can also help you improve communication, so that:

- staff, suppliers and customers can share information and get in touch more easily
- your business can become more efficient - eg networked access to a common database can avoid the same data being keyed multiple times, saving time and preventing errors
- staff can deal with queries and deliver a better standard of service as a result of sharing customer data

BENEFITS FOR THE COMPANY

Cost benefits of computer networking

Storing information in one centralised database can also help you reduce costs and drive efficiency. For example:

Staff can deal with more customers in less time since they have shared access to customer and product databases

You can cut costs through sharing of peripherals and Internet access

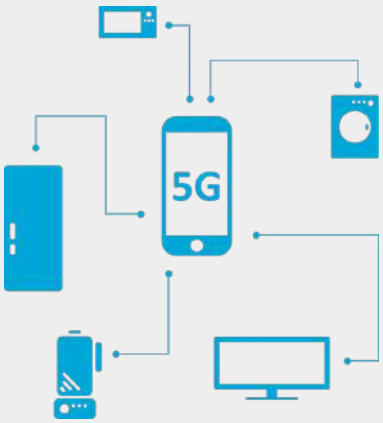
You can centralise network administration, meaning less IT support is required

You can reduce errors and improve consistency by having all staff work from a single source of information. This way, you can make standard versions of manuals and directories available to them, and back up data from a single point on a scheduled basis, ensuring consistency.

FUTURE APPLICATIONS

Securing the Communications Networks of Tomorrow

5G and other next-gen telecom technology are keeping IT and security managers on their toes. Learn what needs to be done to secure these new services.



Global IT is changing faster than ever with technologies such as 5G and Internet of Things (IoT) leading the way to increased speed and bandwidth, but also increased connectivity complexity. Through these ongoing changes and migrations to the next generation of telecommunications networks, communications service providers (CSPs) are dealing not only with new technology but also the security requirements that come with it.

Facing these challenges on the frontline are enterprise and provider IT and security managers, who will be charged respectively with overseeing the deployment and maintenance of new advanced networks and the related security issues.

Even though 5G may still seem several years from becoming ubiquitous, now is the time for IT managers, security managers, and their staff to learn about the issues and prepare themselves for what's coming.

FUTURE APPLICATIONS

Sharing the security responsibility

As the global IT ecosystem undergoes a rapid evolution, it will be critical for IT departments to have a strong understanding of the new network architecture, security implementation, and ultimately who will be responsible for what. Once 5G, and by extension its enabling services and technologies – such as IoT, IPv6, and machine-to-machine (M2M) – become the de facto standard within the communications landscape, operators and their IT departments and security managers will need to face, understand, and overcome a whole new set of security challenges that will be more complex than anything that's come before.

Some of the challenges that are specific to internal departments include:

Since IT departments at telcos will need to overcome these issues while running a 5G-enabled, and eventually a 5G-ready network, they will need help from a trusted partner that understands the network layer, the customer layer, and the security layer. This help must encompass proven expertise in various data types, such as customer data, transaction data, and network data, to ensure that sensitive information is compartmentalized and safe from a variety of threats. Good skills in security architecture can buttress effective security through a number of techniques, including segmentation.

FUTURE APPLICATIONS

Securing 5G networks becomes even more complex when network slicing, the ability to create multiple simultaneous mini-networks that operate under different sets of security and service requirements, enters the picture. This ability to invoke a 5G instance quickly for a specific period of time, in a specific place, will make security an even higher priority and that's much more of a challenge for IT and security managers, who will be the ones tasked with securing these various data types.

Their customers will turn to them in the event of a problem, and operators will be tasked with resolving any issues, which will require significant levels of knowledge and proficiency around security issues. For these reasons, most operators will not be able to go it alone successfully when it comes to overcoming the security hurdles of 5G and other shifts in communications networks. Rather, they will need to work with trusted partners that have the expertise, track record, and experience to ensure data integrity, customer privacy, and compliance with any mandates or orders. This approach can include:

FUTURE APPLICATIONS

Having these policies and framework in place is critical for vendors working with operators as they roll out next-generation networks, but in addition, there must exist the solid experience and knowledge to back it up.

Implementing an enhanced security plan

Operators need to ensure subscriber and other data is secure within the confines of their network as well as when data traverses public or private clouds. By implementing an enhanced security plan, operators can protect sensitive data, as well as the software and services used to store and process that data and to apply it to their needs.

This strategy would incorporate the principles of the shared model of responsibility outlined above and go further through alignment with industry security frameworks and standards in order to bring the highest levels of assurance to customers.

This strategic approach includes providing industry-leading secure services and solutions designed to ensure the confidentiality, integrity, and availability of our own data and our customers' data and systems, against the fast-evolving threats of cyber criminals, hackers and other forms of intrusion and disruption.

Security should never be an afterthought and teaming up with a partner that's serious about security and has been delivering a strong solution to its customers is critical for operators as they move into the world of 5G and beyond.

ADVANCED CONTENT

Transmission Efficiency (Data Communications and Networking)

One objective of a data communication network is to move the highest possible volume of accurate information through the network. The higher the volume, the greater the resulting network's efficiency and the lower the cost. Network efficiency is affected by characteristics of the circuits such as error rates and maximum transmission speed, as well as by the speed of transmitting and receiving equipment, the error-detection and control methodology, and the protocol used by the data link layer.

Each protocol we discussed uses some bits or bytes to delineate the start and end of each message and to control error. These bits and bytes are necessary for the transmission to occur, but they are not part of the message. They add no value to the user, but they count against the total number of bits that can be transmitted.

Each communication protocol has both information bits and overhead bits. Information bits are those used to convey the user's meaning. Overhead bits are used for purposes such as error checking and marking the start and end of characters and packets. A parity bit used for error checking is an overhead bit because it is not used to send the user's data; if you did not care about errors, the overhead error checking bit could be omitted and the users could still understand the message.

ADVANCED CONTENT

Transmission efficiency is defined as the total number of information bits (i.e., bits in the message sent by the user) divided by the total bits in transmission (i.e., information bits plus overhead bits). For example, let's calculate the transmission efficiency of asynchronous transmission. Assume we are using 7-bit ASCII. We have 1 bit for parity, plus 1 start bit and 1 stop bit. Therefore, there are 7 bits of information in each letter, but the total bits per letter is 10 (7 + 3). The efficiency of the asynchronous transmission system is 7 bits of information divided by 10 total bits, or 70 percent.

In other words, with asynchronous transmission, only 70 percent of the data rate is available for the user; 30 percent is used by the transmission protocol. If we have a communication circuit using a dial-up modem receiving 56 Kbps, the user sees an effective data rate (or throughput) of 39.2 Kbps. This is very inefficient.

We can improve efficiency by reducing the number of overhead bits in each message or by increasing the number of information bits. For example, if we remove the stop bits from asynchronous transmission, efficiency increases to 7/9, or 77.8 percent. The throughput of a dial-up modem at 56 Kbps would increase 43.6 Kbps, which is not great but is at least a little better.

ADVANCED CONTENT

The same basic formula can be used to calculate the efficiency of synchronous transmission. For example, suppose we are using SDLC. The number of information bits is calculated by determining how many information characters are in the message. If the message portion of the frame contains 100 information characters and we are using an 8-bit code, then there are 100 x 8 = 800 bits of information. The total number of bits is the 800 information bits plus the overhead bits that are inserted for delineation and error control. Figure 4.9 shows that SDLC has a beginning flag (8 bits), an address (8 bits), a control field (8 bits), a frame check sequence (assume we use a CRC-32 with 32 bits), and an ending flag (8 bits). This is a total of 64 overhead bits; thus, efficiency is 800/(800 + 64) = 92.6 percent. If the circuit provides a data rate of 56 Kbps, then the effective data rate available to the user is about 51.9 Kbps.

This example shows that synchronous networks usually are more efficient than asynchronous networks and some protocols are more efficient than others. The longer the message (1,000 characters as opposed to 100), the more efficient the protocol. For example, suppose the message in the SDLC example were 1,000 bytes. The efficiency here would be 99.2 percent, or 8,000/(8000 + 64), giving an effective data rate of about 55.6 Kbps.

The general rule is that the larger the message field, the more efficient the protocol. So why not have 10,000-byte or even 100,000-byte packets to really increase efficiency? The answer is that anytime a frame is received containing an error, the entire frame must be retransmitted. Thus, if an entire file is sent as one large packet (e.g., 100K) and 1 bit is received in error, all 100,000 bytes must be sent again. Clearly, this is a waste of capacity. Furthermore, the probability that a frame contains an error increases with the size of the frame; larger frames are more likely to contain errors than are smaller ones, simply due to the laws of probability.

ADVANCED CONTENT

Thus, in designing a protocol, there is a trade-off between large and small frames. Small frames are less efficient but are less likely to contain errors and cost less (in terms of circuit capacity) to retransmit if there is an error.

Throughput is the total number of information bits received per second, after taking into account the overhead bits and the need to retransmit frames containing errors. Generally speaking, small frames provide better throughput for circuits with more errors, whereas larger frames provide better throughput in less-error-prone networks. Fortunately, in most real networks, the curve shown in Figure 4.12 is very flat on top, meaning that there is a range of frame sizes that provide almost optimum performance. Frame sizes vary greatly among different networks, but the ideal frame size tends to be between 2,000 and 10,000 bytes.

What is IoT?

https://www.youtube.com/watch?v=LIhmzVL5bm8

IoT Tool kits

http://iotservicekit.com/

http://tilestoolkit.io/

EDUCATION

IoT security checklist:

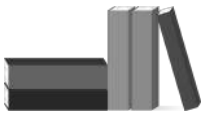
https://www.enisa.europa.eu/news/enisa-news/your-must-have-iot-security-checklist-enisas-online-tool-for-iot-and-smart-infrastructures-security

MOOCS:

- Introduction to Computer Networking - Standford University
- Fundamentals of Network Communication - Coursera
- Smart Device & Mobile Emerging Technologies - Coursera

EXTERNAL MANUALS FOR MORE INFORMATION:

- Networking Fundamentals - Cisco
- Network-based communication for Industrie 4.0 - Plattform Industrie 4.0
- Computer networking fundamentals - Study
- Communication Networks - Samson



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SELF APPRAISAL

- ★ After reading this text, do I have a clear idea of what Network Communication is?
- ★ What skills should I improve in my work?

- ★ Do I know the benefits that Network communication can bring to my company?
- ★ How could I detect any training need for my team?

INTRO 4.0

Cyber-Physical Systems

EuroProfis

edit value
apoio à gestão

@nced
ASOCIACIÓN NACIONAL DE CENTROS DE e-LEARNING Y DISTANCIA

bit schulungscenter
member of bit group

Co-funded by the
Erasmus+ Programme
of the European Union

Associate partner:
udima
UNIVERSIDAD A DISTANCIA DE MADRID

INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

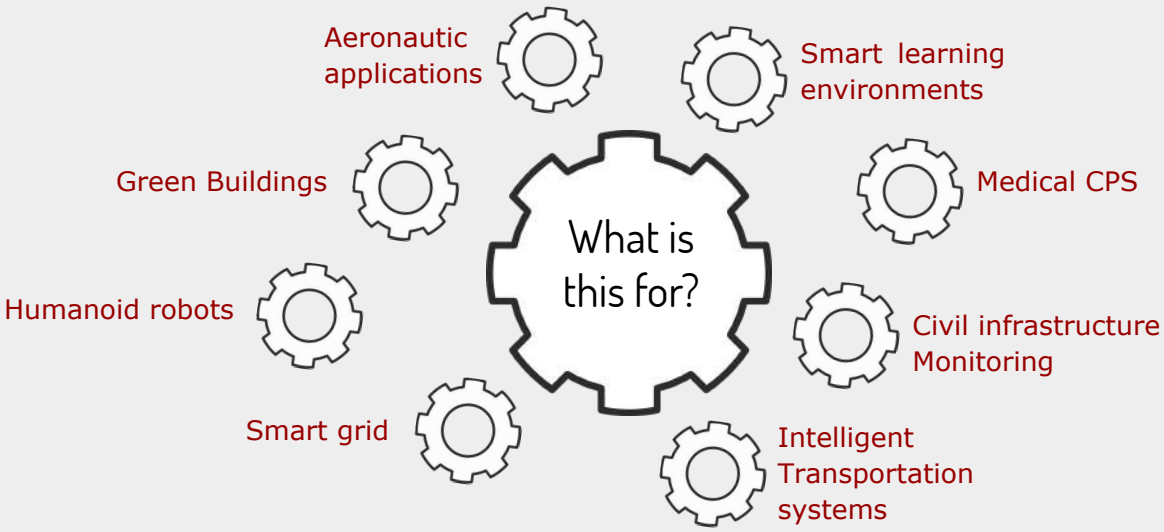
- Understand what is Cyber-Physical System and its applications.
- Identify the benefits derived from this technology.
- Know the potential of this technology and usage trends.

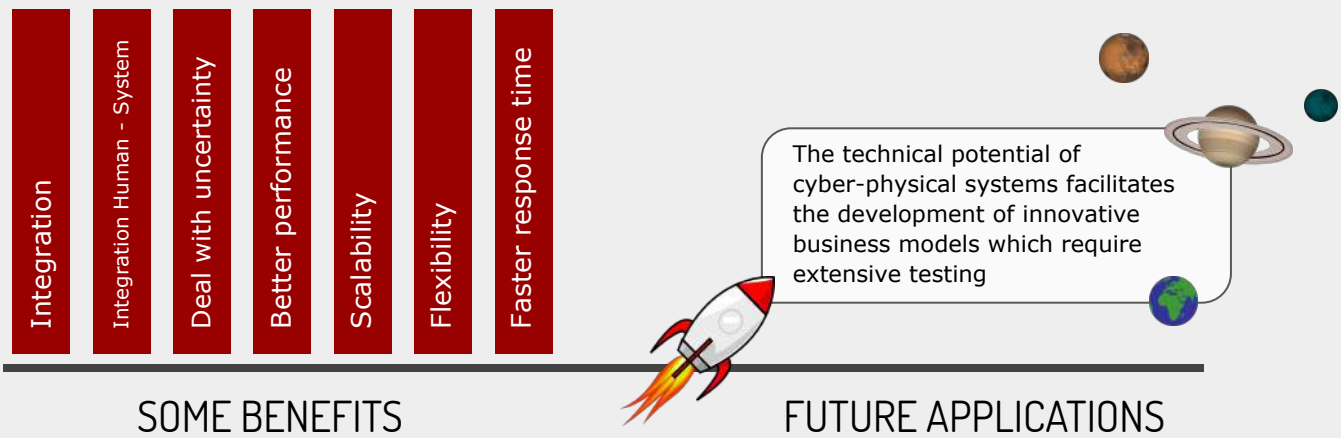
INTRODUCTION

Cyber-physical systems are key infrastructures for our modern society. They can improve the quality of life of citizens and the competitiveness of European industry.

Learning Objectives

- Understand what is Cyber-Physical System and its applications
- Identify the benefits derived from this technology
- Know the potential of this technology and usage trends





WHAT IS IT?

A **cyber-physical system (CPS)** is composed of a physical system and its corresponding cyber systems that are tightly fused at all scales and levels.

Many objects in our world are controlled by computers: cars, buildings, manufacturing machines or even musical instruments. In these cases, computers interact directly with the physical world. That is why we call them "cyber-physical systems" (CPS).

We interact with many complex objects and systems in our everyday life. Practically all of them are controlled by computers, which interact with the world not only through a touchscreen, but through direct actions performed in the physical world. The most common cyber-physical systems that we see everyday are modern cars, in which computers control not only the engine, but also the braking, the vehicle stability, and often support the driver in her tasks. Therefore we see clearly how actions controlled through computers have an impact in the real world.

Cyber-physical systems are also present in many other elements of our daily lives, such as energy networks, factories, automated warehouses as well as planes or trains. All these physically-entangled systems are of crucial importance for the quality of life of the citizens and for the European economy.

Cyber-physical systems are very complex, especially when several CPS need to be combined. That is the case for example in an airport or a large factory, where many machines have to work together to achieve a common goal. In this case, we speak about "cyber-physical systems of systems", or CPSoS.

WHAT IS IT?

Complex systems are difficult to build and to manage. If an application on your phone crashes the consequences are typically not very bad, but if the interface between two manufacturing machines breaks down, the production of a large manufacturing plant can be stopped. Even worse, in transport or medical systems, the physical safety of people can be jeopardized.

There are of course engineering techniques to manage this, but significant improvements are needed to manage the CPS of tomorrow, which will be even more sophisticated than today and very important both for our quality of life and for the competitiveness of European industry.

WHAT IS THIS FOR?

Applications of Cyber-Physical Systems:

Green Buildings:

Greenhouse effect is one of the major problems in today's world. The old buildings consume 70% of the electricity produced and generate the greenhouse gases which in turn increase greenhouse effect. By using the integrated Wireless Sensor Network, cognition manager and control systems we can achieve Zero Net Energy goal.

Smart grid:

Smart grid is an ecosystem which will rely on its basis on information acquisition assessment and decision making as well as management. In smart grid many traditional parts use Cyber Physical Systems. They are used in generation, transmission and distribution and also in customer side. In generation it will control the connection the network as well as the operational aspects in the electricity generation. CPS monitor the conditions and care for the stability of transmission and distribution networks that connect end-users to smart grid. It will provide two-way communication and control between power grid and consumers.

Medical CPS:

Wireless Sensor networks collect the diagnostic information, monitor the health and drug administration of patient's .The integration of computing and control mechanisms to the critical medical information communicated provides a fundamental prerequisite to high-confidence medical cyber-physical systems.

Intelligent Transportation systems:

Cyber Physical Systems provide a way to improve traffic system control performance. Road Traffic-control Cyber Physical System constructs an environment that exists in the natural geographical environment and manmade environment such as bridges across the sea or rivers, long and big tunnels ,high-risk sub-grade slope, urban elevated bridges and others. But also massive variety of vehicles, people and goods in the complex road environment. Intelligent Transportation System, can realize the traffic control by adding and installing a large amount of advanced electronic devices and information systems to the road traffic system, improving operational efficiency and safety level for the road traffic system Traffic control Cyber Physical Systems integrate these information into the transportation process, and operate through their coordination making the transportation more safe and efficient.

WHAT IS THIS FOR?

Humanoid robots:

Humanoid robots can be used for:

I. Taking care of the elderly people at home.
II. Scientific investigation of undersea environments, rainforest environments, space environments and critical infrastructure protection.
III. For personnel purpose.
IV. In agricultural fields.
V. Rescue operations in the event of emergencies and dangerous work environments.

Smart learning environments:

Cyber Physical Systems can be used in Smart learning environment. CPSs can used in the SLE to gather adequate information about the physical environments, convert measured data to information and knowledge, and eventually provide useful and prompt services for students, staffs and the university. Smart learning environment (SLE) will definitely transform the way people learn and work in universities.

Civil infrastructure Monitoring:

Today lot of civil engineers faces the problem stewardship of ageing of infrastructure like dams, bridges, buildings etc. Fiber optic sensors and Micro electrical and mechanical sensors and wireless communication technologies offer tremendous promise for accurate and continuous infrastructural monitoring.

Aeronautic applications:

Cyber-Physical Systems are used for Aeronautic applications such as flight test instrumentation, Pilot-crew communications, Structure Health Monitoring, In-flight tests, in flight entertainment Wireless Cabin, and flight landing.

WHAT IS THIS FOR?

5C architecture for implementation of Industry 4.0.

Industry 4.0 performances are shown with the tip of an iceberg. Therefore, some researchers are considering creating the structure to give a dissection of the Industry 4.0. '5C' architecture is an example for guiding the development of the Industry 4.0, depending on the Cyber-Physical system attributes. This architecture is divided into five levels, 'Connection Level', 'Conversion Level', 'Cyber Level', 'Cognition Level', and 'Configuration Level'.

		Main Attribute	Main Function
5	Configuration Level	Self-configure	Intelligent Production
4	Cognition Level	Early-aware	Predictive Maintenance
3	Cyber Level	Controllable	Automated System
2	Conversion Level	Informational	Information Discovery
1	Connection Level	Communicable	Hardware Connection

The **'Connection Level'** focuses on hardware development, which is accomplished by the sensor network and wireless communication, and the other four levels pay attention to the controlling system and software implementation. On the **'Conversion Level'**, the raw data is transformed into useful information by using data analysis technologies. The **'Cyber Level'** controls the entire network via the CPS. The **'Cognition Level'** and **'Configuration Level'** engage the artificial intelligence in the network, which are considered as future attributes of manufacturing. Manufacturing intelligence is also the main target of many researchers who are interested in Industry 4.0, which is represented by these two levels. Comparing the attributes of these two levels and the Industry 4.0, the 'Cognition Level' is considered as a lower level of Industry 4.0, and, the 'Configuration Level' tends to reveal upper levelled features of Industry 4.0 which are regarded as the accomplishment of the Industry 4.0.

WHAT IS THIS FOR?

Therefore, when these various types of the idea (future visions, research examples, and implementation architecture) are merged and summarized, under the Industry 4.0, several concepts of future manufacturing have been abstracted. These concepts are the main design principles of Industry 4.0, which sums up two main design principles: interoperability and consciousness. These two main design principles include many sub-concepts, the interoperability consists of digitalization, communication, standardization, flexibility, real-time responsibility, and customizability. The predictive maintenance, decision making, intelligent presentation, self aware, self-optimization and self-configuration comprise the consciousness.

The core idea of interoperability is integration, which is also the key point of IoT and CPS. There are three types of integration of Industry 4.0, horizontal integration, end-to-end integration, and vertical integration. These three types of integration represent three dimensions peer to peer, horizontal integration over the business value networks, end-to-end integration across the products chain, the vertical integration through the manufacturing system.

In addition, the other main design principle of the Industry 4.0 is consciousness. Basic on this concept, Industry 4.0 requires manufacturing to be intelligent, which discovers the knowledge, make the decisions and delivers the action independently and intelligently. These results are analysed from collecting raw data from the manufacturing networks by using cutting edge intelligent technologies. Moreover, these two main design principles are cooperative to achieve Industry 4.0. The interoperability set up several connected networks as the reliable environment of Industry 4.0, the consciousness offers the Industry 4.0 the essence with the artificial intelligent functions.

WHAT IS THIS FOR?

Cyber physical systems are hybrid networked cyber and engineered physical elements co-designed to create adaptive and predictive systems for enhanced performance.

Essential CPS characteristics:

- Cyber, engineered, and human elements as treated as integral components of a total system to create synergy and enable desired, emergent properties.
- Integration of deep physics-based and digital world models provides learning and predictive capabilities for decision support (e.g., diagnostics, prognostics) and autonomous function.
- Systems engineering-based open architectures and standards provide for modularity and composability for customization, systems of products, and complex or dynamic applications.
- Reciprocal feedback loops between computational and distributed sensing/actuation and monitoring/control elements enables adaptive multi-objective performance.
- Networked cyber components provide a basis for scalability, complexity management, and resilience.

For cyber-physical systems, consistent customer focus and, thus, user-friendliness and intuitive usability are the key to success.

GOOD PRACTICES

SmartSantander is a large-scale research project that spreads thousands of sensors around the city of Santander in Spain. Its purpose is to build a smart solution and improve various aspects of the city life, such as reducing traffic, reducing energy consumption, improving the quality of the environment, and encouraging citizens' participation. Also, the project hopes to share this environmental information and develop other useful applications. The research is also testing to see whether it is possible to reduce distances between theoretical designs of smart infrastructures and the adoption of practical applications in a real-world environment. The results of this test will help increase the spread of Internet of Things (IoT) and CPSs in real scenarios in the future.

Singapore, which was named as the world's smartest city for many years, is becoming a leading nation in implementing smart infrastructures and providing quality services. Singapore is one of the world's most important business centers, has one of the busiest ports, and is home to Asia's fifth largest airport. Singapore expects to create the first smart nation in the world to boost economic growth, to meet population needs, and to be an example for other nations. The insights of this smart nation are grouped as:

- Better policies to manage different contexts
- Development of novel business models and revenue streams that can strengthen the economic growth
- An increase in active citizens' participation towards the creation of quality services that can improve everyday life of the community

GOOD PRACTICES

WAYMO

It is the brand under which Google operates and has just launched its first hundred units by Chrysler with the Pacifica model, a car that can circulate without a driver, has the relevant licenses and has planned its first tests in real scenarios this month.

It has to be said that Google has already been in the autonomous car business for seven years and that it has been the first brand to complete a journey with a car without a driver. Since he turned in the development of the autonomous car has rolled more than one million kilometers.

Some leading companies:

FORTINET

FIREEYE

leidos

sparkcognition™

DARKTRACE

haystax

THETARAY

INTRINSIC ID

Echosec™

AVIRTEK
Smarter Cyber Resilience

BENEFITS FOR THE COMPANY

Integration

The integration of cloud and Wireless Sensor Networks is also an important part of Cyber Physical Systems. CPS provides network integration characteristics such as media access control techniques and their effects on system dynamics, middleware, and software that provide coordination over networks control over timing of network transactions, and fault tolerances.

Interaction between Human and System

Modeling and measuring situational awareness-human perception of the system and its environmental changes in parameters are critical for decision making.

BENEFITS FOR THE COMPANY

Dealing with uncertainty

Certainty is the process of providing proof that a design is valid and trustworthy. Cyber physical systems can be able to evolve and operate with new and unreliable environment.

Better System Performance

CPS is able to provide better performance in terms of feedback and automatic redesign with close interaction of sensors and cyber infrastructure.

Scalability

As a part of cloud computing CPS is able to provide the resources to users according to their requirements.

Flexibility

CPS can provide more facilities than WSN and Cloud Computing alone.

Faster response time

CPS will increase the fast response time and facilitate the early detection of failure, proper utilization of resources such as bandwidth.

"Intelligent" and networked objects (for example, using RFID technology) are mainly used in trade and logistics.

Cyber Physical Systems are Smart Systems that comprises of the merging and integration of Industry Control Systems, Critical Infrastructures, Internet of Things (IoT) and Embedded Systems.

FUTURE APPLICATIONS

For cyber-physical systems and smart cities to be successful, people need to think and act differently and get more involved in city life. Active communities that can aggregate the distributed knowledge of each individual and can complete synergistic actions to improve the city services are essential.

Technology today allows for distributed computing and crowdsourcing, sharing information among users, and building a collective intelligence. Collective intelligence is one of the keys for the success of CPSs and smart cities. Collective intelligence uses the crowdsensing for the cooperative monitoring of the urban environment. It also targets cooperative actuation of operations to perform tasks of general interest in an efficient way.

From the technical perspective, many hard challenges must still be solved, at least in an efficient and industrially applicable way. Some of the challenges are:

- **Data heterogeneity.** Data heterogeneity is a significant issue that can affect communication performance and the design of communication protocols. Systems need to be able to support a great number of different applications and devices.

- **Reliability.** CPSs are suitable to use in critical contexts like healthcare, infrastructure, transportation, and many others. Reliability and safety are basic requirements because of how actuators affect the environment. In fact, the impact of actuators can also be irreversible, and therefore the presence of unexpected behavior must be minimized. Moreover, the environment is not predictable so CPSs must continue to work under unexpected circumstances and adapt themselves in case of failures.

FUTURE APPLICATIONS

- **Data management.** It is necessary to store and analyze big data from different connected devices, process them, and show real-time results. Data can be managed by using offline or online stream processing in relation to the goals of the system. In particular with an online stream, information can change frequently with real-time conditions and are based on adaptive and continuous queries.

- **Privacy.** The challenge is to balance privacy concerns and personal data control, with the possibility to access data to provide better services. Because CPSs manage large amounts of data, including sensitive information like health, gender, religion, and many others, significant issues about data privacy are raised. CPSs require privacy policies in order to address privacy issues, thus a data anonymization management tool is required to have anonymized information before the system processes it.

- **Security.** CPSs must ensure security during communications because all actions among devices are coordinated in real time. As CPSs expand and increase interactions between physical and cyber systems, security problems affect more CPSs. Traditional security infrastructures are not enough to address the issue and new solutions must be found. Security issues are critical on new data and stored data that was collected for future use. Lastly, CPSs are based on heterogeneous applications and wireless communications, which often raise critical security issues.

- **Real-time.** CPSs manage large amounts of data that is derived from sensors. The computations need to work efficiently and be timely, because physical processes keep going independently from the results of the computations. To satisfy this requirement, CPSs must ensure that they have the bandwidth or system capacity needed to meet time-critical functions because failures on time of actions can cause permanent damages.

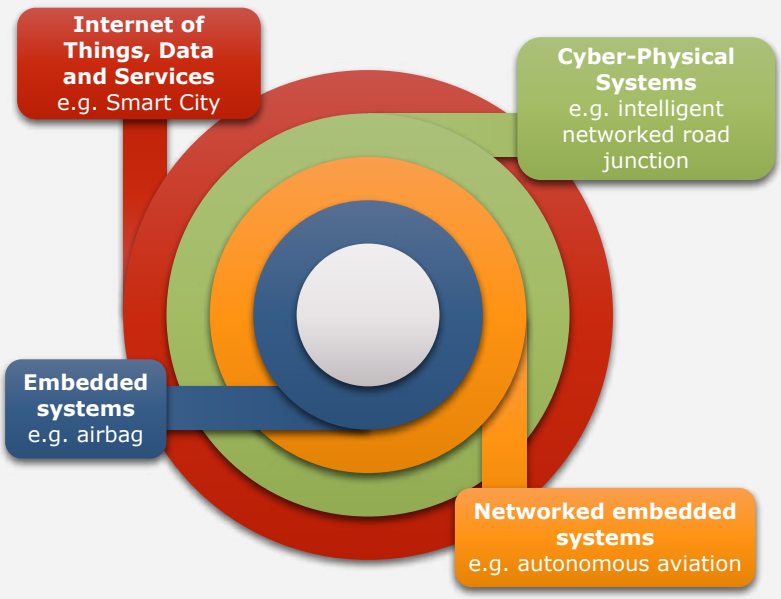
ADVANCED CONTENT

What is the difference between Cyber-Physical System and the Internet of Things?

The Internet of Things uses special sensors (e.g. cameras or RFID readers) to identify products and materials. Those products and materials contain special information about, for example, what should happen with them. This means that they can communicate with production or material flow systems and tell them what the next step in the manufacturing process should be. The technology thus removes any need for human involvement.

Cyber-physical systems are when the mechanical and electrical systems (e.g. sensors and communication tools) embedded in products and materials are networked using software components. The result is a complete merging of the virtual and physical worlds. Cyber-physical systems use shared knowledge and information from processes to independently control logistics and production systems. They are therefore the bridge that connects the Internet of Things with higher-level services – known as the Internet of Services.

In this virtual world, software providers, service providers, brokers and users collaborate to develop flexible applications that can be dynamically integrated with one another. If we are to achieve the goals of the fourth industrial revolution, scientists need to embrace both cyber-physical systems and the basic idea and technologies behind the Internet of Things.



ADVANCED CONTENT

Impact of Cyber-Physical Systems in cities:

Smart cities can be seen as wide-scale cyber-physical systems, with sensors monitoring cyber and physical indicators and with actuators dynamically changing the complex urban environment in some way. Governments, organizations, and technology industries are rising to the challenges of increased urbanization, working to improve urban life by offering improved efficiencies with energy utilizations or services, for example.

According to the *United Nations Population Prospects, 2014 Revision* report, the urban population of the world is growing rapidly, and it is continuing to increase. In 2014, 54% of the world's population resides in urban areas, and the coming decades will bring further profound changes to the size and spatial distribution of the global population. In 1950, 30% of the world's population was urban; by 2050, 66% of the world's population is projected to be urban.

ADVANCED CONTENT

Security of Cyber-Physical Systems:

To ensure cyber-physical systems are safe, we need to address two fundamental scientific challenges. First, we need to reason about the discrete and continuous at the same time. Fortunately, much progress in formal verification has been made in the past 20 years on this front. One approach is to model a cyber-physical system as a hybrid automaton, which is a finite state machine where each state's behavior is defined by a set of differential equations over continuous variables. Model checking technology can be applied to hybrid automata, making it feasible to prove properties about and find bugs in models of cyber-physical systems.

Another approach is to write logical formulas describing the behavior of a hybrid system and then use theorem proving technology to prove properties from the formulas. An example of an appropriate logic in which to write such formulas is differential dynamic logic, developed within the last decade along with rich tool support. Active research addresses the scalability of these techniques, since currently they support only tens of state variables, whereas an operational cyber-physical system typically has orders of magnitude more.

Second, cyber-physical systems operate under the presence of uncertainty. This uncertainty is due external conditions not under system control: Mother Nature, e.g., earthquakes, hurricanes and snowstorms; and The Human, acting mistakenly, surprisingly or maliciously.

This is an example of a self-organizing factory that is configured and fully organized and responds to changing requirements, and in which humans and machines collaborate perfectly.

https://youtu.be/wro3uoHR-ZY

EDUCATION

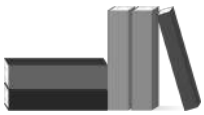
Because of the nature of CPSs, the study of CPS spans several different disciplines, such as software-hardware engineering, computations, control, communication, sensing and actuation. Results show that CPSs have been successfully deployed in smart grid and other "smart" applications.

MOOCS:

- Cyber-Physical Systems: Modeling and Simulation - Coursera
- Homeland Security & Cybersecurity Connection - Coursera
- Embedded Hardware and Operating Systems - Coursera
- Web Connectivity and Security in Embedded Systems - Coursera

EXTERNAL MANUALS FOR MORE INFORMATION:

- Guide to Cyber-Physical Systems Engineering
- Cyber–Physical System Security for the Electric Power Grid



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SELF APPRAISAL

- ★ After reading this text, do I have a clear idea of what Cyber-Physical System is?
- ★ How could I incorporate Cyber-Physical Systems technology in my company?

- ★ Could I say four applications of Cyber-Physical Systems?
- ★ Could I differentiate the Internet of Things and Cyber-Physical Systems?

INTRO 4.0

Modelado, Virtualización y simulación

EuroProfis

edit value
apoio à gestão

@nced
ASOCIACIÓN NACIONAL DE CENTROS DE e-LEARNING Y DISTANCIA

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Co-funded by the Erasmus+ Programme of the European Union

Associate partner:
udima
UNIVERSIDAD A DISTANCIA DE MADRID

INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

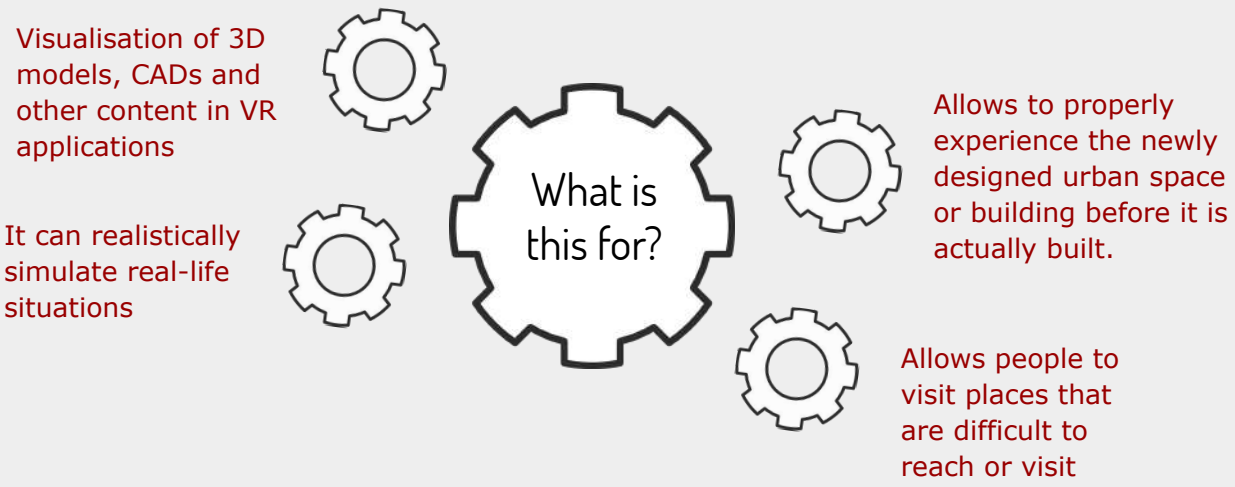
- Increase general knowledge Modelling, Virtualization and Simulation.
- Identify Virtualization benefits.
- Know the uses of simulation and Virtual Reality in society.
- Know the impact and trends of Virtual Reality

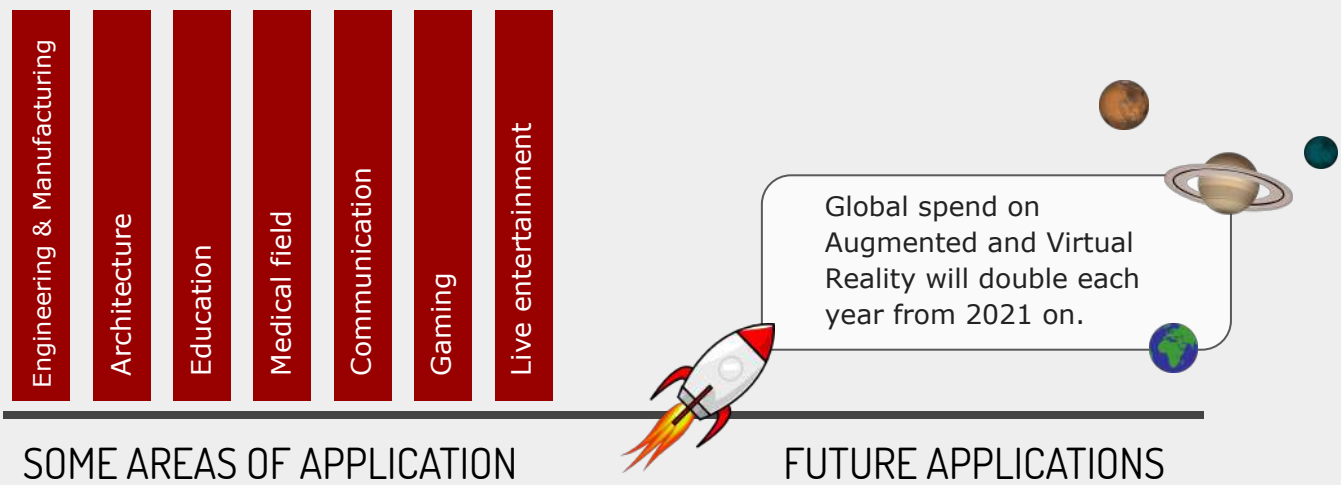
INTRODUCTION

Simulation modeling solves real-world problems safely and efficiently. It provides an important method of representation which is easily verified, communicated, and understood. Across industries and disciplines, simulation and virtualization provides valuable solutions by offering a clear view of different scenarios.

Learning Objectives

- Increase general knowledge Modelling, Virtualization and Simulation.
- Identify Virtualization benefits.
- Know the uses of simulation and Virtual Reality in society.
- Know the impact and trends of Virtual Reality





WHAT IS IT?

Modeling is anything that represents something else, usually on a smaller scale. Modeling is helpful because it allows you to take a good look at something that is too big or impractical to see otherwise.

Virtualization or **Virtual Reality (VR)** refers to computer-generated environments that simulate the physical presence of people and/or objects and realistic sensory experiences. VR has also spurred the evolution of 3D video technology, which uses dual imagery so that objects on the screen appear three dimensional and replicate real-world objects and places.

Simulation still has a clear the edge on the term Virtual Reality. Many aspects of the natural world can be transformed into mathematical models, and using simulation allows IT systems to mimic the outcomes that happen in the natural world.

Figure 1. 3D Simulation in Architecture.

WHAT IS IT?

Product development today is increasingly based on simulation and optimization of virtual products and processes. Mathematical models serve as digital twins of the real products and processes and are the basis for optimization and control of design and functionality. The models have to meet very different requirements: Deeply refined mathematical models are required to understand and simulate the true physical processes, while less refined models are the prerequisites to handle the complexity of control and optimization. To achieve best performance of mathematical modeling, simulation and optimization techniques (MSO), in particular in the industrial environment, it would be ideal to create a complete model hierarchy.

The current most favoured way in industrial applications to achieve such a model of hierarchy is to use a sufficiently fine parameterized model and then apply model order reduction (MOR) techniques to tune this fine level to the accuracy, complexity and computational speed needed in simulation and parameter optimization.

Although the mathematical models differ strongly in different applications and industrial sectors, there is a common framework via an appropriate representation of the physical model.

What is the difference between VR and AR?

Virtual Reality (VR) is described as a 3D environment in which a person can become immersed, using a dedicated headset, powered by a computer, game console or smartphone. The VR experience can be enhanced thanks to 3D audio sounds and by using haptic devices that use sensors to transfer body movement into the virtual space. **Augmented Reality (AR)** refers to a real-world environment enhanced with computer-generated information such as sound, video or graphics.

WHAT IS THIS FOR?

One of the great promises and at the same time one of the main focus areas in Industry 4.0 is the bridging of digital/cyber/virtual and physical worlds, hence the focus on cyber-physical systems.

Apart from the fact that this isn't just a technology issue *(nor is the Industry 4.0 vision as such)*, from the technological perspective one immediately thinks about the Internet of Things. However, Virtual Reality (VR) and augmented reality (AR) are certainly as important.

Virtual reality (VR) and augmented reality (AR) are used in several sectors and contexts, from consumer applications to manufacturers. Yet, it's in manufacturing that augmented reality offers great value in myriad applications, in combination with several other technologies as per usual.

The use of VR and AR in manufacturing and other industries for which the term Industry 4.0 gets used is not fiction. It happens as we speak and is poised to accelerate as the benefits become increasingly clear, offerings, hardware and applications mature and move to the next level and manufacturers increase their digital transformation efforts on the strategic and staged path towards the realization of Industry 4.0 and the digital transformation of manufacturing.

WHAT IS THIS FOR?

Although they are different, VR and AR share common processes and technologies, such as audio software and data processing. They also tend to concentrate in the same business and research worlds hence creating overlapping ecosystems.

- **VR** is used within a wide array of areas, ranging from the gaming industry and entertainment, to training and simulation, including training in the medical field. Other areas of application include education and culture, sports, live broadcasting, real estate, advertising, architecture, and arts. More areas of application are still to come.

- **AR** has an almost limitless range of uses in a wide variety of areas, be it commerce, technical applications, work processes or education. VR & AR serve both consumers and professional users that can be private and public.

Virtual Reality and augmented reality can play a role in the typical earlier stages where optimization and enhanced productivity (quantity, quality, speed, flexibility) are more important than later stages of innovation and genuine business transformation (which can of course be set out as Industry 4.0 goals at the start, more about that in 'Finding the value in Industry 4.0').

Just think about how simulation models and the use of augmented reality can speed up the entire production chain, in combination with the right data, starting from the use of AR and VR in virtual design. Or about the use of augmented reality in maintenance. And then there is of course the possibility to put a virtual layer, based on the right data and information, on top of the 'reality' in all sorts of factory and industry environments, using devices such as AR/VR glasses/viewers. The latter is probably the best known illustration of how de facto virtual or cyber and physical meet.

WHAT IS THIS FOR?

Application of AR/VR:

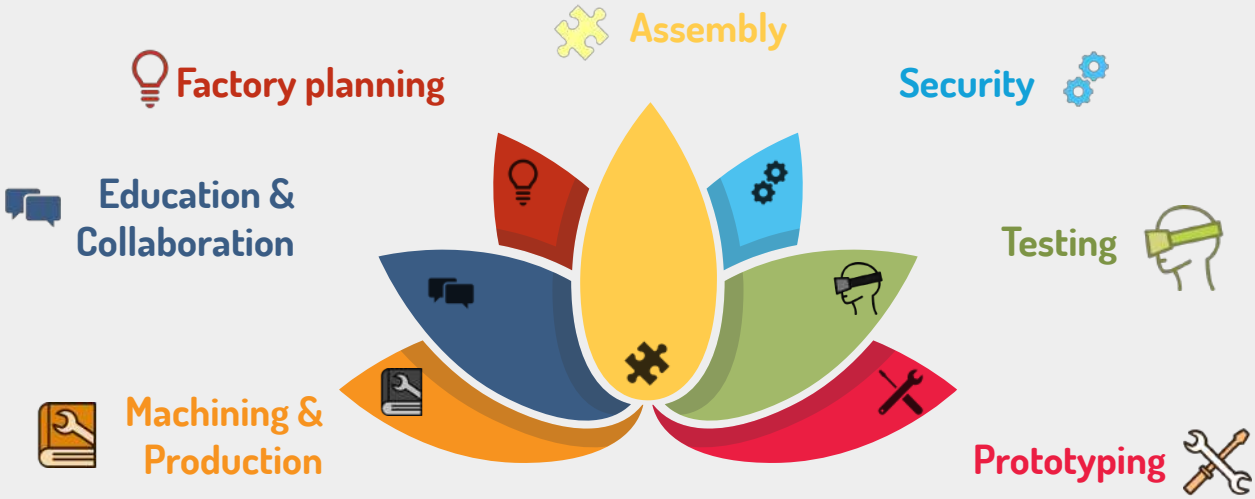


Figure 2. Use cases of AR and VR. Source: Self made

Tha application of AR/VR includes machining and production, education and collaboration, factory planning, assembly, security, testing and digital prototyping, to name a few. As we'll see showcasing and immersive *(key in AR/VR)* experiences on the customer side are important as well. So, marketers should also pay attention, certainly in the manufacturing of products where showcasing technological manufacturing expertise strengthens the perception of the technological wealth of both company and product. So, no, it is not a coincidence if many applications of AR/VR in manufacturing which get a lot of attention are in, for example, the automotive industry *(and certainly the luxury car brands)*.

In operations, you can certainly also imagine how, with the proper equipment and solutions *(from the worker's perspective as well of course, have you seen those first headsets?)* service people, factory staff and logistics staff can better perform their tasks if they have the information they need in front of their eyes and two of their main work instruments, on top of their brain, free: the left hand and the right hand. The result: smoother processes and flows.

WHAT IS THIS FOR?

Application of AR/VR:

ENGINEERING AND MANUFACTURING INDUSTRY

VR applications can be used for industrial purposes to improve product development processes, train staff and enhance communication. Driven by the needs of major European industries, VR applications are either developed in-house or are outsourced to VR/AR dedicated companies.

The visualisation of 3D models, CADs and other content in VR applications give the possibility for different people to access to them from any location, to analyse and interact with them in a virtual environment. This can improve the manufacturing process, firstly during the conception phase for the design and development of components or the final product, and secondly for the creation of prototypes and experimentation once the final product has been developed.

ARCHITECTURE, REAL ESTATE AND CONSTRUCTION

From streamlining the design process to facilitating property sales, Virtual Reality is revolutionising the construction, architecture, and real estate industries.

Not only does this eradicate the need for building physical mock-ups at each step of the process, but it also allows to properly experience the newly designed urban space or building before it is actually built. That way everyone involved has the opportunity to spot errors more easily and correct them more quickly. This drastically reduces the likelihood of an ill-designed finished product that does not fit well in its environment or does not suit the needs of those living in or using the space.

EDUCATION AND CULTURE

VR allows people to visit places that are difficult to reach or visit more spots virtually in a short period of time at lower cost. This can be for example used in education: pupils and students, or anyone interested in learning, can visit for example Jerusalem or a festival in ancient Rome in a 360-degree video. VR is capable of bringing knowledge closer to a student who wouldn’t be able to access it otherwise – for example due to disability or unavailability of quality education in her or his country.

MEDICAL FIELD

VR has great potential for health professionals and hospitals, ranging from trainings to better collaboration and mutual understanding.

In this way students and professionals in the medical sector have the opportunity to perform a realistic surgery on a virtual patient, test their knowledge and learn new methods and tips, without any risk for the patient. Another special element in VR trainings is that they can realistically simulate real-life situations by bringing together professionals or students from different disciplines and promoting cooperation.

WHAT IS THIS FOR?

AWARENESS-RAISING AND REPORTING

Many broadcasters and companies active in news and journalism, as well as organisations engaged in and/or furthering humanitarian efforts, are tapping into the unique potential of VR/AR technologies, in particular the empathy-inducing capabilities of VR. These can effectively educate and raise awareness about certain issues, and even elicit response and action among viewers. VR/AR can act as powerful tools for increasing compassion and influencing behaviour, tackling serious issues ranging from racism to climate change.

COMMUNICATION AND SOCIAL INTERACTION

VR has the potential to change the way we communicate and interact with each other. The added value of VR in comparison to other distance-based communication tools, is the interactivity and visualisation possibilities (data, documents, 3D models). In this respect, VR can offer new opportunities for efficient distant business meetings as well as fun social interactions.

ART AND STORYTELLING

VR does not only bring art to users' doorsteps, it is also a new form of expression and storytelling. VR film production possibilities are being explored in order to take full advantage of its potential to tell the stories in fresh and creative ways. Europe has a rich heritage and cultural diversity that have always been a great source of inspiration for film production and artistic expression, and this competitive advantage is also true for VR cinematic filmmaking.

COMMERCE AND BRANDED EXPERIENCES

The 'wow' factor of VR/AR technologies enables companies to engage with their customers in new and innovative ways, as the immersive nature of VR/AR tends to leave a lasting impression on existing and new audiences. At the same time, customers are able to undertake more interactive and enjoyable shopping experiences. Thus, not only can VR/AR help put brands on the map in customers' minds, but these technologies can also significantly increase and enhance e-commerce activity.

GAMING

The gaming industry has been one of the key drivers of consumer adoption of VR headsets and advancement in software development and content production. Creation of VR games is a field for highly skilled developers and requires skills in 3D design, animation and software programming, but also needs creativity and innovative ideas.

WHAT IS THIS FOR?

LIVE ENTERTAINMENT AND EXPERIENCES

VR/AR technologies are creating new experiences and ways of entertainment that are immersive and in real time. This means being able to experience sport matches, concerts and theatrical performances as if you are there, despite actuality being miles away.

With VR, however, fans may be ensured the best seats at every game. However, live streaming sports has certain requirements that VR has yet to fully meet. High definition TV already provides very good sports coverage, with an experienced director, a sharp picture, zoom as well as pause, rewind and replay - none of this is currently available with VR. Secondly, VR also creates mounds of data, making live-streaming with current broadband capacities difficult - 5G will therefore be very important.

OTHER AREAS OF VR & AR APPLICATION

Not all possible applications of VR technology have been further detailed above. This is mainly because they are either less visible or not yet fully developed even when they have a high future potential.

Potential also lies in big and complex data visualisation where extra dimension and virtual space can help capture flows in time and relations.

Figure 3. Virtual Reality examples.

WHAT IS THIS FOR?

Advantages and Disadvantages of using VR:

Positive implications	Negative implications
VR can be used to **save time and resources**. This technology is an asset because users in any industry can test its products without actually using raw material and increases the success rate of achieving their end goal.	Without the proper hardware it is **difficult to fully create the immersion and interactivity** necessary for a successful Virtual Reality system.
Trial time and resource waste can be greatly diminished, **vastly reducing the costs of development**.	Some people may experience cyber-sickness, or **feel nauseous because of the motion of the environment**.
Virtual reality can be used to test and practice delicate or important procedures.	**Psychological effects** the users may experience; one issue could be desensitization to aggressive actions. In terms of virtual reality gaming, being so fully immersed in a violent world, without any real world consequences, may lead people to behave more aggressively or callously towards real people.
Virtual Reality can enhance the daily lives of individuals. Not only can it improve gaming experiences, but it can also be used to encourage exercise by creating virtual worlds that demand movement while allowing people to forget that they are actually exercising.	**Cyber-addiction** may result from Virtual Reality technology since a tool that allows individuals to easily detach themselves from the real world may result in some people neglecting real life.
• *Gaming experiences* • *Virtual prototypes (ex: cars)* • *Training programs for military* • *Medical training (ex: surgical procedures and diagnosing)* • *Psychological therapy* • *Training astronauts, and many more*	• *Better tracking systems* • *Lag time* • *Overlooking basic laws of physics* • *Lack of acuity*

GOOD PRACTICES

VR companies are involved in three main core activities – R&D, manufacturing and content creation. European VR companies produce three main types of products: hardware, software and content. Many companies provide more than one of these product types at the same time. Companies are taking advantage of the VR research infrastructure and the skilled workers it produces.

Hardware manufacturing in Europe is mostly precision and niche technology. In the European context, companies involved in manufacturing also perform their own R&D activities, often in cooperation with European universities and research centres. When it comes to hardware for mass production, R&D is often done in Europe while the actual products are manufactured elsewhere. Interesting example of that is a joint initiative of **Starbreeze Studios (SE)** and **Acer (TW, Asia)** that resulted in the high-end headset StarVR.

Europe is a centre of R&D for both software and hardware and specialised applications. Interestingly, even non-European companies such as **Jaunt (USA)**, **Oculus (USA)** or **EON (USA)** often locate their R&D departments in Europe to benefit from the presence of high-skilled workforce. Some successful software and hi-tech companies such as **Unity (USA–DK)** or **Metaio (USA–DE)** kept their R&D in Europe but either relocated their business development and official headquarters to the USA or were acquired by big global brands such as Apple.

Content that can be either 360-degree videos or computer-generated images (CGI) is mostly associated with the creative processes of making video games, VR experiences and movies. Europe is strong in creative processes, with studios such as **Okio (FR)** providing independent movies and VR experiences. European broadcasters including the **BBC (UK)** and **ARTE (DE/FR)** are also involved in the VR content creation process. Some content studios would also build their own cameras to fit their needs.

GOOD PRACTICES

CycleSpex: Cycle and Spatial Context Experience Simulator (VR)

This research tool is being developed to answer knowledge and design questions about cycling. The advantage for planners and policy makers is to test possible design solutions ex-ante in a safe and controlled setting before the definite investment. The innovative experimental design facilitates the possibility of asking questions within the VR environment to large groups of respondents. This allowing us to collect valuable data about cycling behaviour, experience and performance.

Currently CycleSpex lines up multiple VR experiments to answer research questions on cycling experience related to road design, urban green, lighting, way-finding and underpasses/barriers in cities. Analyzing relationships between cyclists on the move and (designed) urban environment will lead to insights into which spatial factors contribute to a better cycling experience. Different urban environments might need a different set of spatial measures to ensure a cycling experience which will lead to a higher bicycle usage. The output from these VR experiments will be used to optimize the EU recommendations for Cycle Highways through the CHIPS project.

Training through simulation in the Lorraine Virtual Hospital

The Lorraine Virtual Hospital (HVL) provides students with health and sports simulation equipment and tools. Responding to the challenge of "never for the first time on a patient", the HVL is run by the Collegium-Santé of the University of Lorraine, which brings together the faculties of medicine, dentistry, pharmacy and sports sciences.

Figure 4. Lorraine Virtual Hospital. Source: https://ec.europa.eu/

GOOD PRACTICES

Some leading companies:

acer
JAUNT
OZO STUDIO
oculus
e·on
unity
metaio
BBC
arte
Google VR
NOKIA
UBISOFT
Capitola
VERTIGOGAMES
SOLIRAX
ZeroLight
THE FOUNDRY.

BENEFITS FOR THE COMPANY

AR and VR is far from omnipresent in all the mentioned and other use cases applications, even in high-tech industrial manufacturing.

In this stage virtual and augmented reality certainly aren't mainstream and you most likely will find them in (product) design, in virtual training programs and in the simulation of important scenarios and tests regarding key assets in factories and beyond. In other words: where the stakes are high and the value/risks are equally high.

Process manufacturing training, assembly and safety are by the way among the main use cases of VR and AR. However, across all industry use cases it's retail that takes the lead from a spending perspective with the 'retail showcasing' use case, as we'll cover next.

Showcasing also plays a role in manufacturing, among others in design and development and in customer-facing circumstances. In the end, someone needs to convince and sell. But this of course doesn't mean that VR and AR are just sales tools or gizmos, not in the consumer industry and most certainly not in Industry 4.0. A token of the increasing role of augmented reality in Industrial IoT is the growing support for it in several Industrial IoT platforms.

Time to look at some facts and findings about the usage of Virtual Reality and augmented reality in manufacturing and beyond with research data, predictions and trends, before looking at benefits, solutions and a few practical applications and cases.

KEY VR/AR applications in Industry 4.0:

- Product design
- Virtual training
- Simulations/tests with a focus on important assets, scenarios and security aspects.

BENEFITS FOR THE COMPANY

IDC's Tom Mainelli rightfully stated that "AR and VR headsets get most of the media attention right now, but the hardware is only as good as the software and services running on it".

In an Industry 4.0 context we can add that the use cases which will thrive are those generating the highest value, enabling to avoid risks, issues and downtime the most, optimizing the end-to-end manufacturing process and workflows in the best possible way, making productivity, satisfaction and making experiences of field engineers, factory workers, customers and stakeholders the most satisfactory – and immersive in ways that make sense. And that goes beyond just the technological dimensions and requires an individual business case – as always.

The infographic from the announcement of that semi-annual update below shows the predictions of IDC per AR/VR industry from a spending perspective for 2017, showing the 'place' of process manufacturing and discrete manufacturing in the bigger picture and isn't related to the forecasts mentioned for the next years.

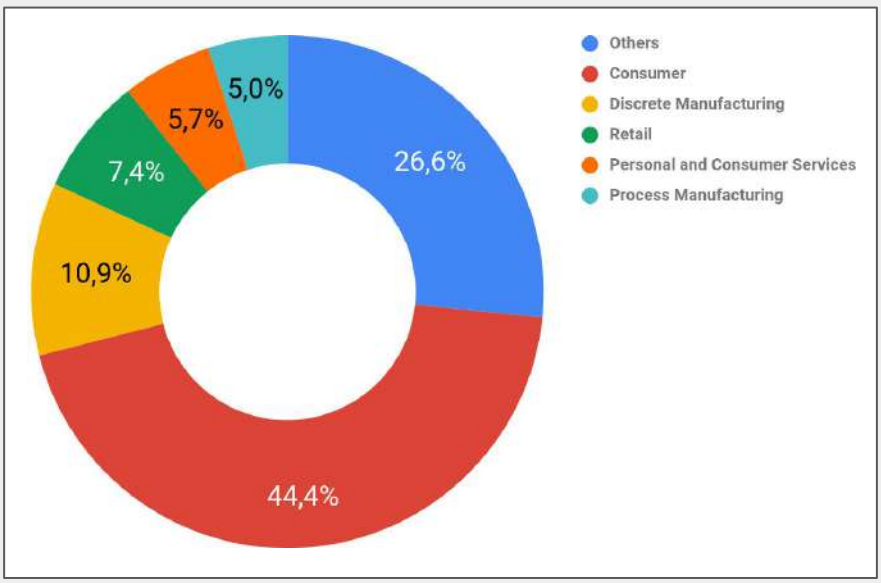


Figure 5. Source: IDC Worldwide Semiannual Augmented and Virtual Reality Spending Guide

BENEFITS FOR THE COMPANY

Companies that apply VR solutions and thus create the ecosystem demand are driving the adoption of VR technology. Sometimes they are an intermediate platform to the use of applications by consumers. In general demand can either come from:

Consumers that currently use VR mostly for entertainment (e.g. gaming) and shopping, but increasingly adopt VR apps for healthcare, commerce or education.

Professional users from the public sector such as ministries and governments who are particularly interested in VR trainings, the potential of VR rehab and psychological treatment, and the immersive value added for promotion of countries and regions.

Professional users from the private sector who demand VR to improve the internal production process, off er new value to their customers or implement a new media in building relations with customers.

Universities that advance (basic) research.

Some entities that demand VR & AR either **for internal processes** (e.g. Airbus (FR) or Jaguar Land Rover (UK)) **or to provide content for the public** (the BBC (UK) and ARTE (DE/FR)) develop VR internally but also hire external suppliers. Demand for VR is generated in a large number of domains, ranging from the manufacturing industry to consumer applications.

FUTURE APPLICATIONS

European companies in the European VR & AR ecosystem are mostly small and medium-sized enterprises. Together they employ over half of the total number of employees. The large companies are often established firms that come from manufacturing industries and deploy VR solutions for engineering. About half of these companies are at initial phases of product development, meaning that they are either in an R&D phase or at the very early stage of product launch, and they are not making any profits yet. The rest of the companies are already generating profits and/or have already launched their products.

Despite the many strengths of the VR and AR industry in Europe, there are certain issues that will need to be addressed in order for Europe to become a powerful player in the global VR and AR industry. Based on an extensive consultation with VR players in Europe, various challenges have been identified that have an impact on the growth of the European VR landscape. These include:

- A lack of risk funding as well as a pro-risk and experimentation mentality in general
- Weak links between research and the market
- A lack of cooperation across the different countries in Europe
- Current and expected needs for adequate infrastructure and resources

Figure 6. Four changes that have an impact on the growth of the European landscape.

FUTURE APPLICATIONS

AR and VR trends in Industry 4.0 and beyond:

The above mentioned main industry use cases of VR/AR for 2017 are part of some takeaways of IDC's August 2017 forecasts on the worldwide spending on augmented and Virtual Reality.

In that forecast IDC predicts that global spend on AR and VR will double each year through 2021, which is pretty impressive. However, given the broad scope of VR and AR use cases across several industries this obviously doesn't only fit in a context of manufacturing and Industry 4.0.

In each of the regions IDC looked at, the consumer segment is poised to be the largest in 2017. However, in the US and Western Europe, discrete manufacturing and process manufacturing already rank second in third.

In the US, process manufacturing and discrete manufacturing are predicted to take over the consumer segment in the forecast period, along with government, retail, construction, transportation and professional services. In Western Europe, discrete manufacturing, retail and process manufacturing are predicted to start growing fast by the end of the forecast *(until then the consumer segment remains largest)*.

By 2021, the majority of AR/VR spending will be for industrial maintenance

FUTURE APPLICATIONS

If we look at the key use cases for VR/AR we also see evolutions with a strong role for industrial use cases. In 2017 the three major VR/AR use cases from an investment perspective are respectively:

- **Retail showcasing**, accounting for a total investment of $442 million.
- **On-site assembly and safety**, worth a total spend of $362 million.
- **Process manufacturing training** as the number three with $309 million.

By the end of the forecast, however, the majority of spending will go to industrial maintenance with $5.2 billion and public infrastructure maintenance with $3.6 billion. And that, of course, brings us close to one of the key aspects of the Industrial Internet of Things, Industry 4.0 and so forth: maintenance, preventive and predictive. Industry 4.0 trends, drivers and spending evolutions, preventive and predictive maintenance are main priorities.

Again, the number of applications for VR/AR is very broad and manufacturing, transportation, logistics (Logistics 4.0) and other markets in today's current 4.0 scope are far from the only ones. Moreover, in some regions AR and VR predominantly will keep seeing investments in, among others, the consumer segment and retail. Education is often mentioned as well. In the APeJ region it's already the third most important 'sector' in 2017 according to the mentioned IDC research. The link with training in any given manufacturing context is quickly made.

Yet, it's clear that the usage and types of applications with VR/AR in manufacturing and related industries increase with a current focus on training and safety, to name just two, and an increasing focus on discrete manufacturing, process manufacturing and maintenance in the US and Western Europe.

FUTURE APPLICATIONS

While still too cumbersome and bulky, current VR interactive systems (think how they will be considered as funny in 50 years from now) will start delivering soon into single-user experiences. However, once the technology moves to a further step in the direction of usability, there are enormous unexploited opportunities in multi-user social interactions, for example in virtual collaboration and co-creation. The team experience is the next breakthrough with far-reaching market opportunities but also social implications. And this requires a combination of competences and technologies that can be referred to the Next Generation Internet:

- Hardware and software to provide more realistic and natural experiences, including a larger field of view, light field, panoptic capture, focus free, photo-realistic rendering, increased resolutions or frame rates.
- Research on social interactions to develop theories and technologies allowing an augmented human experience through technologies such as augmented reality, Virtual Reality or brain interface, to interact, work or entertain in groups, thus developing new ways of social interactions.
- Support the transfer of these technologies across different sectors (industrial manufacturing, automotive, data life cycle, consumer goods, healthcare, public services, design, entertainment, media, culture…).

Google Earth VR 'the next step to help the world to see the world.':

https://youtu.be/SCrkZOx5Q1M

Plunge into a Caribbean gem with National Geographic:

https://youtu.be/v64KOxKVLVg

ADVANCED CONTENT

Interestingly, VR & AR ecosystems are also closely related to the industry of artificial intelligence (AI). This advanced technology helps to create more realistic simulations in the virtual space, as well as independently acting avatars. AI is not a subject of this study, however it is important to be aware of the synergies amongst these three high-tech industries and their closely related ecosystems with a great importance of R&D and creativity.

As with many new technologies today, VR and AR are industries characterised by global value chains where activities, ranging from research and development (R&D) to hardware production and content creation, are spread out across the globe. A number of regions are of clear importance, including Europe, Asia and the USA.

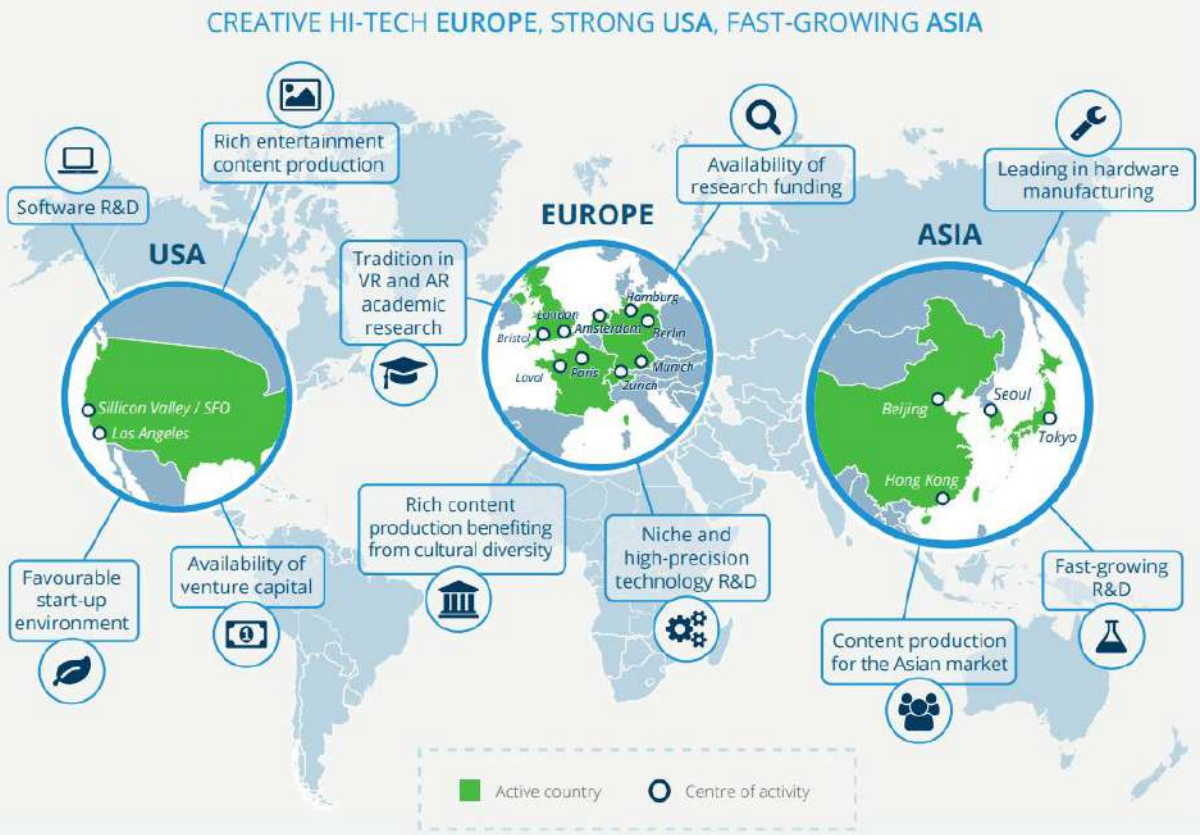


Figure 7. Source: Virtual Reality and its potential for Europe. Ecorys

ADVANCED CONTENT

What about Mixed Reality (MR)?

At the intersection of virtual and physical realities is an emerging environment known as mixed reality (MR), where digital and physical objects co-exist. This hybrid space integrates virtual technologies into the real world so that viewers cannot distinguish where one world begins and the other ends.

The virtual aspect of MR comes from the use of devices equipped with 3D viewing technology that seamlessly layers digital objects onto the real world.

Another major component of MR is the integration of augmented reality (AR), which is the layering of information over 3D space.

A key characteristic of AR is its ability to respond to user input, which confers significant potential for learning and assessment; learners can construct new understanding based on interactions with virtual objects that bring underlying data to life.

Holographic devices are also being used to create mixed reality environments, as their video displays project 3D images into a physical space. While lagging behind other virtual worlds, mixed reality is gradually making its way into the consumer market. In 2014, Michael Jackson was re-embodied in holographic form and debuted at the Billboard Music Awards, where his holograph performed on stage with live, choreographed dancers.

Tangible User Interfaces (TUI)
A TUI uses real physical objects to both represent and interact with computer-generated information
(Ishii & Ullmer, 2001)

Augmented Reality (AR)
AR 'adds' computer-generated information to the real world
(Azuma, et. al. 2001)

Augmented Virtuality (AV)
AV 'adds' real information to a computer-generated environment
(Regenbreach, et. al. 2004)

Virtual Reality (VR)
VR refers to completely computer-generated environments
(Ni, Schmidt, Staadt, Livingston, Ball & May, 2006; Burdea & Coffet, 2003)

ADVANCED CONTENT

VR technology in Education

As the technology improves, the ability to bring students into a single environment, even if they are from different schools, states, or countries, can help connect students to their larger world. This gives them the opportunity to learn from people they may otherwise never have met. A broader virtual world could expand their horizons and may promote more diverse collaboration in the future.While we are still only scratching the surface of what Virtual Reality can do in an educational environment, the potential exists for it to change education as we know it.

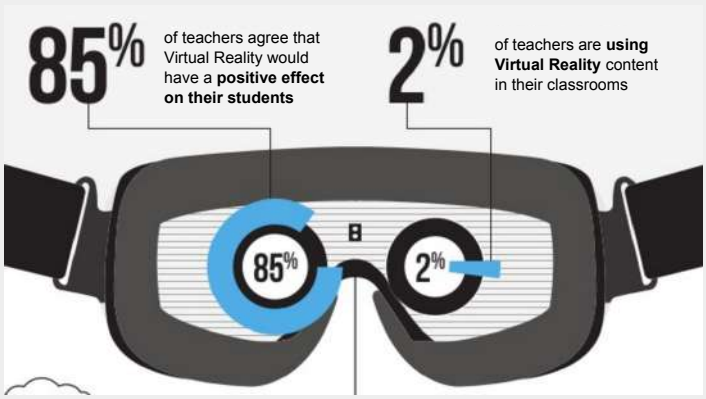


Figure 8. VR in the classrooms.
Source: https://www.vrmaster.co/teachers-ready-for-virtual-reality-education-infographic/

Researchers in science and medical fields are already making great use of immersive technology. Although augmented simulations and views inside the body are obviously great tools for learning, something as simple as experiencing the world from the perspective of an elderly patient with dementia can have an enormous lasting impact on a medical student's approach.

360 videos in Virtual Reality

https://bluehealth2020.eu/projects/360-virtual-reality/

Teacher ed programs turn to Virtual Reality

https://www.educationdive.com/news/teacher-ed-programs-turn-to-virtual-reality/511608/

ADVANCED CONTENT

SOME VIRTUAL REALITY TOOLS:

DESKTOP TOOLS

Unity 3D	Unity is by far one of the most ubiquitous of tools being used today for VR development.
Unreal Engine (UE4)	One of the main competitors of Unity 3D, Unreal Engine is also a gaming engine with VR integrations, an asset store, and great documentation.
3DS Max & Maya	These are Autodesk products for modeling, animation, lighting, and VFX. They don't have VR support by default but through pricey plugins instead.
Blender	It's free and open source software written in Python and is available for Windows, Mac, and Linux. There's a huge community of people devoted to this software and its use. Many websites provide tutorial videos, forums, and documentation.
SketchUp	Google's SketchUp is a basic modeling application with a very low learning curve that can get anyone up and running in a short amount of time. The tutorials on the website are excellent, not only teaching the basics of the software but also as introductory lessons to basic 3D modeling concepts.

WEB VR TOOLS

Three.js	This is a JavaScript library which works as a layer on top of WebGL. It has many helpers and abstractions that make working with WebGL much easier than the WebGL API alone.
A-Frame	This is a web framework built on top of Three.js and WebGL to build Virtual Reality experiences with HTML using an Entity-Component ecosystem. Works on Vive, Rift, desktop, and mobile platforms.
React VR	Promising to be the next big thing in WebVR, React VR promises rapid iteration and a syntax that is similar to A-Frame's but hinges on the benefits that React brings.
Vizor.io	Vizor is an interesting take on a WebVR editor in your browser built with NodeJS and Three.js. It's a visual programming environment for WebGL, WebVR and other HTML5 APIs.
JanusVR	Janus is more akin to a web browser for VR than a development tool. It's a platform and while the client is closed source and built in QT5, the server side component is open source and written in NodeJS.

EDUCATION

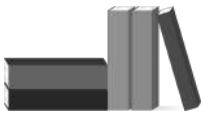
The use of Virtual Reality and cloud-based simulation engines promises to train automatons in real-world scenarios through simulated trial and error without endangering real people and real things. Developers will create VR simulations in the cloud rather than on a PC, able to run many simultaneous instances speeding the training of machine learning agents.

MOOCS:

- Introduction to Virtual Reality (Coursera)
- 3D Models for Virtual Reality (Coursera)
- 3D Interaction Design in Virtual Reality (Coursera)
- Making Your First Virtual Reality Game (Coursera)
- Using Virtual Scenarios to Create Effective Learning (FutureLearn)

EXTERNAL MANUALS FOR MORE INFORMATION:

- Virtual reality and its potential for Europe
- The VR Book: Human-Centered Design for Virtual Reality



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SELF APPRAISAL

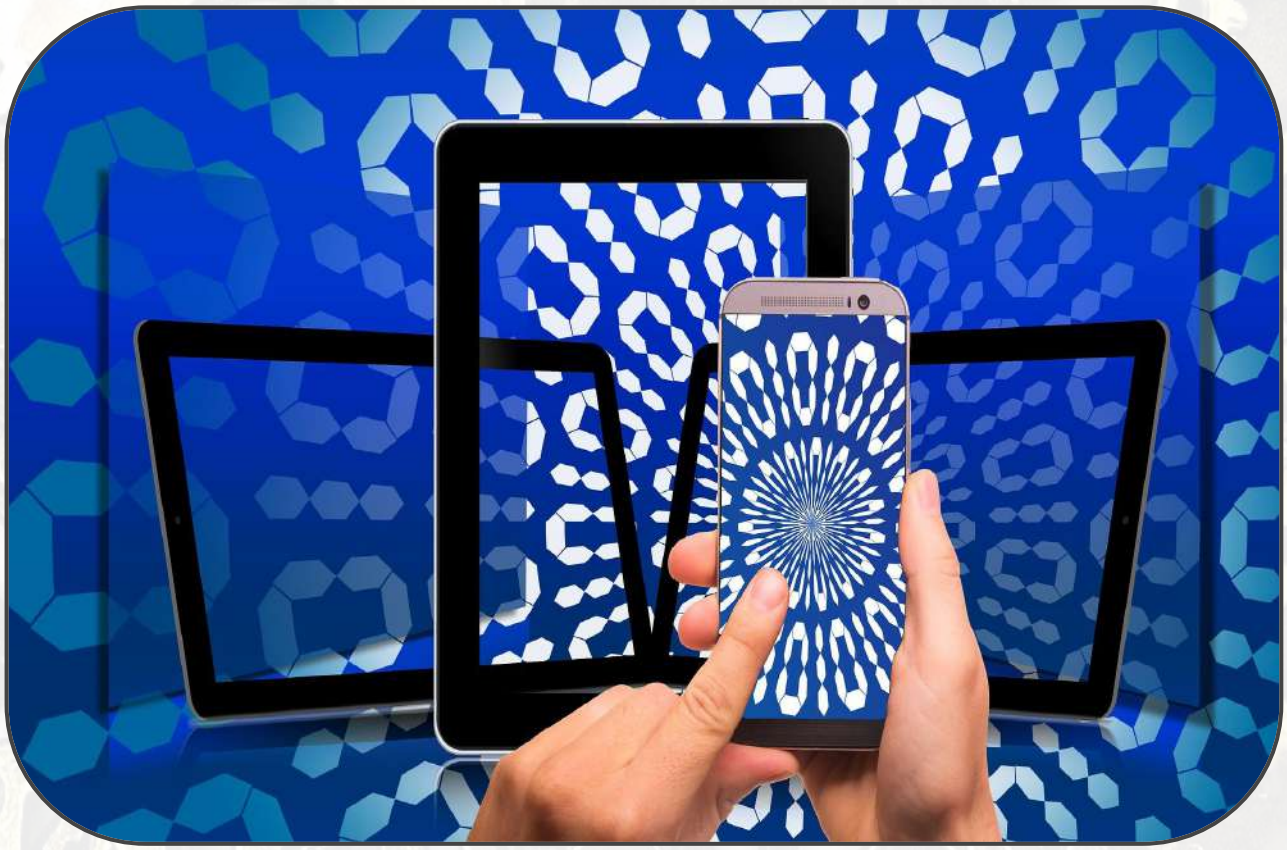
- ★ Could Virtual Reality have any application in my company?
- ★ What simulation could be useful in relation to the activity of my company?

- ★ Could I say four applications of simulation and Virtual Reality?
- ★ Could I now distinguish Virtual Reality (VR) and Augmented Reality (AR)?

INTRO 4.0

HCI

Human-Computer Interaction



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Erasmus+ Programme
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Associate partner:

udima
UNIVERSIDAD A DISTANCIA DE MADRID

INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

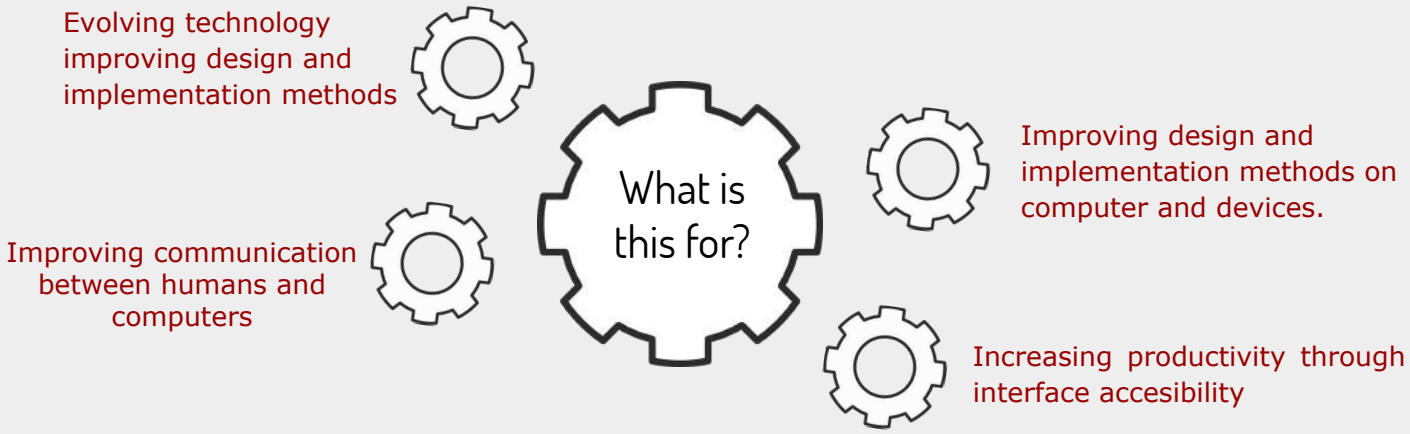
- Understand what is Human-Computer Interaction.
- Know how people and technology joins together thanks to HCI.
- Know the importance of design and implementation in HCI.
- Know about useful information about tools involving HCI.

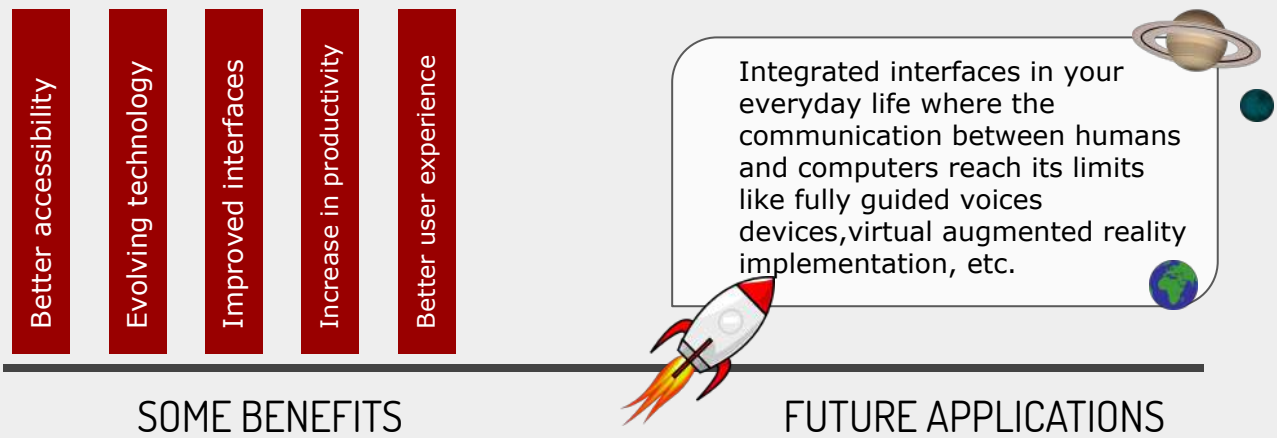
INTRODUCTION

HCI (Human Computer Interaction) Human-Computer Interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology and the interaction between humans (the users) and computers.

Learning Objectives

- Understand what is Human-Computer Interaction.
- Know how people and technology joins together thanks to HCI.
- Know the importance of design and implementation in HCI.
- Know about useful information about tools involving HCI.





WHAT IS IT?

HCI (human-computer interaction) is the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings.

As its name implies, HCI consists of three parts: the user, the computer itself, and the ways they work together.

User

By "user", we may mean an individual user and a group of users working together. An appreciation of the way people's sensory systems (sight, hearing, touch) relay information is vital. Also, different users form different conceptions or mental models about their interactions and have different ways of learning and keeping knowledge either and. In addition, cultural and national differences play a part.

Computer

When we talk about the computer, we're referring to any technology ranging from desktop computers, to large scale computer systems. For example, if we were discussing the design of a Website, then the Website itself would be referred to as "the computer". Devices such as mobile phones or VCRs (video cassette recorders) can also be considered to be “computers”.

Interaction

There are obvious differences between humans and machines. In spite of these, HCI attempts to ensure that they both get on with each other and interact successfully. In order to achieve a usable system, you need to apply what you know about humans and computers, and consult with likely users throughout the design process. In real systems, the schedule and the budget are important, and it is vital to find a balance between what would be ideal for the users and what is feasible in reality.

WHAT IS IT?

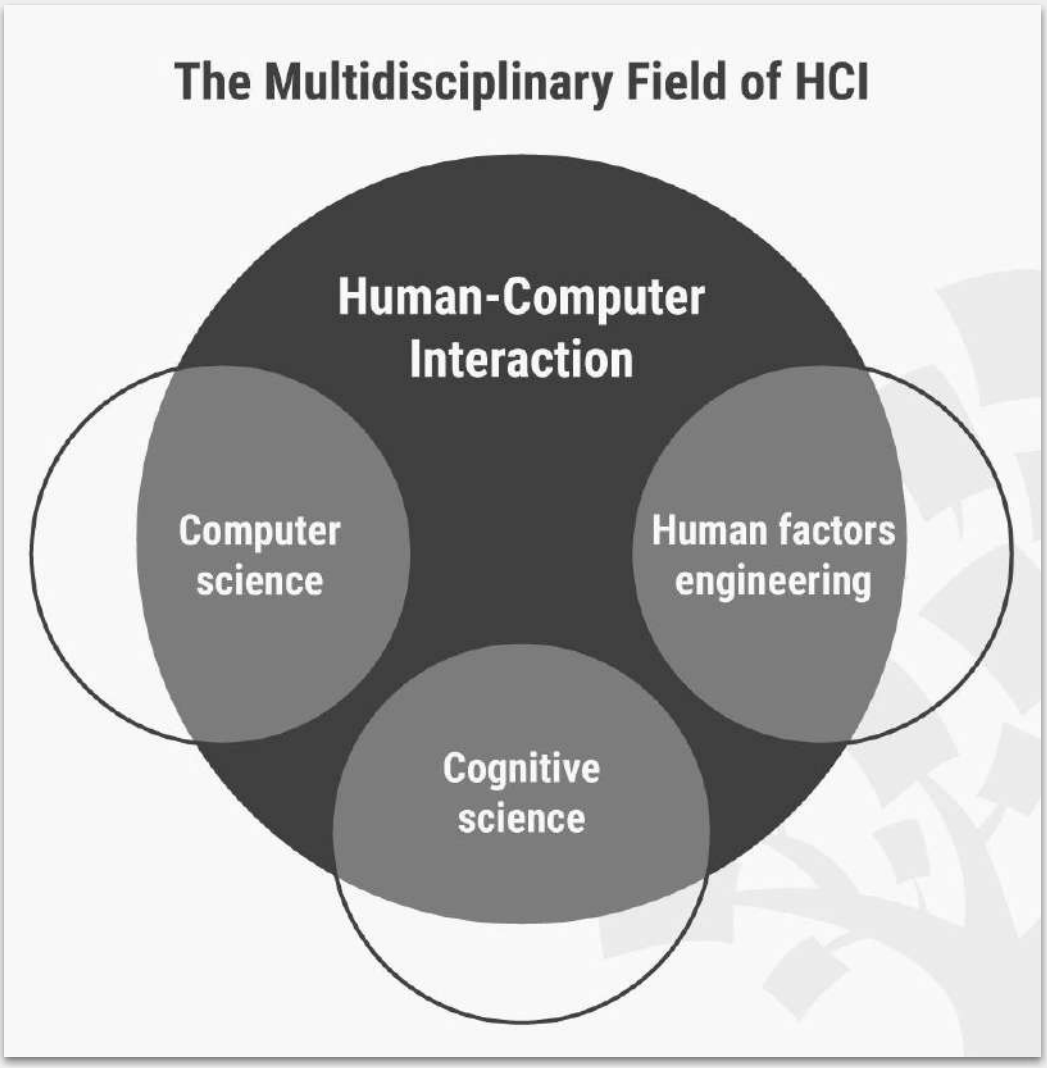


Figure 0. User interfaces in everyday devices. Source: www.interaction-design.org/

"…it no longer makes sense to regard HCI as a specialty of computer science; HCI has grown to be broader, larger and much more diverse than computer science itself. HCI expanded from its initial focus on individual and generic user behavior to include social and organizational computing, accessibility for the elderly, the cognitively and physically impaired, and for all people, and for the widest possible spectrum of human experiences and activities. It expanded from desktop office applications to include games, learning and education, commerce, health and medical applications, emergency planning and response, and systems to support collaboration and community. It expanded from early graphical user interfaces to include myriad interaction techniques and devices, multi-modal interactions, tool support for model-based user interface specification, and a host of emerging ubiquitous, handheld and context-aware interactions."

— John M. Carroll, author and a founder of the field of human-computer interaction.

WHAT IS THIS FOR?

HCI AND THE EVOLUTION OF TECHNOLOGIES

User Interface

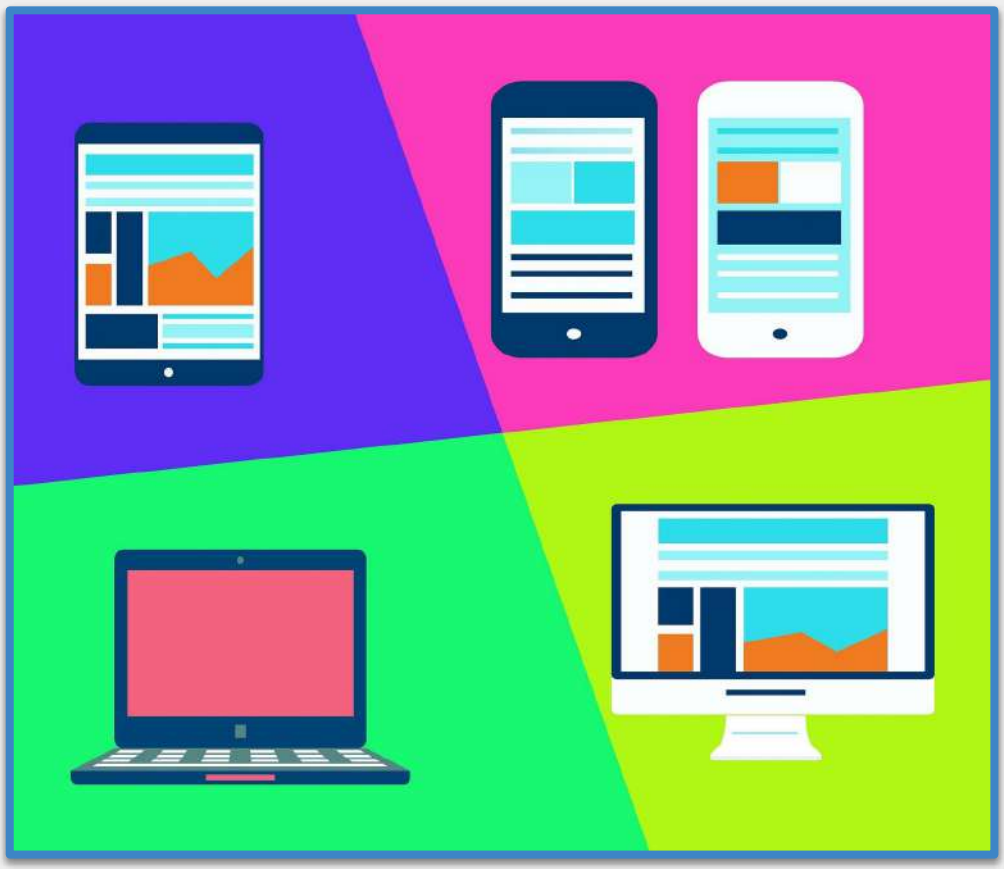


Figure 1. User interfaces in everyday devices. Source: medium.theuxblog.com

An interface sits **between you and technology**, and nearly every technology has one. Yet when we say the word interface, we inevitably think of the UI between a user and a computer, smartphone, tablet, or similar device. They can be physical devices such as keyboards, mice, touchscreens, and virtual objects such as screen icons and menus, voice-driven natural language assistants, gesture recognition devices, and more.

WHAT IS THIS FOR?

Interfaces are **intermediaries** that shield us from the underlying complexities of what we want to do from how the item needs to operate. In the computerized world, those complexities can be the underlying programs, operating systems, and networks. For example, when AOL, Prodigy, and CompuServe were popular, they all tried to shield us from some of the underlying intricacies through their GUI (Graphic User Interface). Nowadays, Firefox, Edge, Safari, and Chrome browsers have user interfaces that hide the underlying HTML, style sheets, and scripts. Web and app designers strive to create user interfaces that prevent us from making mistakes, improve productivity, ensure smooth operations, and shield us from inefficient, confusing or unusable products and systems.

Figure 2. Interface. Source: www.pixabay.com

They employ **design and implementation techniques that fall under the scope of Human-Computer Interaction**. Many of the standards governing this field of study are contained in ISO 9241 "Ergonomics of human-system interaction". The benefits of a good UI are tangible and measurable. In the business world, good interfaces lead to higher morale and job satisfaction, and lower training costs and staff turnover, all leading to lower operational costs.

WHAT IS THIS FOR?

From a user's perspective, **the UI is a gateway into their computer** and represents easy access to the intricacies of its underlying hardware, software, and networking. For example, when you enter an elevator, its interface works with elevator logic to close the door, get you to your floor at an acceptable speed, process multiple floor requests, adjust the floor indicator, open the door, and dispatch the car to waiting passengers.

Important elements in an user interface

Clear

A UI needs to be easy to use and obvious. For example, present the user with a sorted list if it is appropriate.

Concise

Clarity is important, but it should not be overly wordy.

Familiar

People learn new concepts based on ones they already know.

Responsive

User feedback is key. Rapidly acknowledging a GUI screen press.

Consistent

Visual interfaces in a series of screens should have the same "look and feel." For example, Microsoft Word, Excel and PowerPoint have a similar appearance.

Attractive

Users may need to use the interface daily, so it should be nice-looking.

WHAT IS THIS FOR?

Efficient

Users should interact with complex applications in the simplest way possible. For example, parse their "first" and "last" name instead of using two fields.

Forgiving

If the UI can't prevent a user error, it should allow the user to correct it.

When hardware, software, and the way we interact with computers are constantly evolving then HCI remains relevant for UI designers and engineers alike who want to investigate the "Why" behind the "How" of the interfaces they design. **The answer to that "Why?" will almost always be: To make interfaces "easy to learn, and easy to use"** an early mantra of HCI.

WHAT IS THIS FOR?

Augmented Reality

Augmented reality is **enhancing the view of reality** by supplementing virtual objects using technology.

Figure 3. Augmented Reality example. Source: forbes.com

Augmented reality is **enhancing the view of reality** by supplementing virtual objects using technology. Using AR technology the environment around a person can become much more **interactive and digital**. Apart from sense of sight **AR applies to all senses**, such as hearing, smell, and touch.

Various types of hardware components are required for the functioning of augmented reality: processors, sensors, display and input devices. Smartphones or tablets often use camera, GPS and other sensors.

Figure 4. Augmented Reality example. Source: phys.org

WHAT IS THIS FOR?

Augmented reality takes a real world scene with the help of camera on device and superimposes images, videos or sounds on the real world scene. AR works in two ways, first based on positioning of markers which is identified by the software on the device and then the content hidden in the marker is displayed and second way is to identify the location of device through GPS and displays the content according to the field of view of the device.

Systems in future that will allow human computer interaction will require technology to **interpret human gestures and movements** including complexity of motions like joint movements. New systems that can mimic human brain and systems that are capable of deep learning have been developed by researchers .These systems can even understand endless complexities of joint angles.

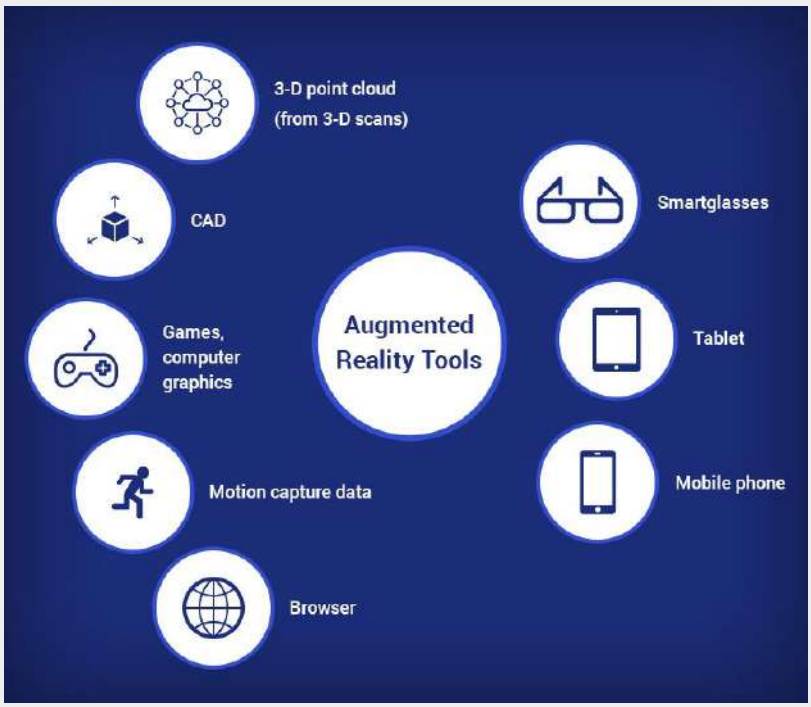


Figure 5. Augmented Reality tools. Source: mobixed.com

Augmented Reality is emerging as one of the most powerful technologies in the field of computer science. It has added a new dimension in the world of computing. With its capability of superimposition it has been contributing to entertainment, education, medical sciences, commercial, sports, military etc. With the rapid development of Human Computer Interaction and its ability to interpret three dimensional human gestures, it will lead Augmented Reality to an exceptional level.

WHAT IS THIS FOR?

Social Computing

Social computing involves **the digital systems that support online social interaction**. Some online interactions are obviously social – exchanging email with a family member, sharing photos with friends, instant messaging with coworkers. These interactions are prototypically social because they are about communicating with people we know. But other sorts of online activity also count as social – creating a web page, bidding for something on eBay™, following someone on Twitter™, making an edit to Wikipedia. These actions may not involve people we know, and may not lead to interactions, but nevertheless they are social because we do them with other people in mind: the belief that we have an audience – even if it is composed of strangers we will never meet – shapes what we do, how we do it, and why we do it.

Figure 6. Social Computing Media. Source: posachaidonut.wordpress.com

Thus when we speak of social computing we are concerned with **how digital systems go about supporting the social interaction** that is fundamental to how we live, work and play.

They do this by providing communication mechanisms through which we can interact by talking and sharing information with one another, and by capturing, processing and displaying traces of our online actions and interactions that then serve as grist for further interaction.

WHAT IS THIS FOR?

Social Computing examples

Blogs, (derived from Web logs) are the most visible of the social computing initiatives. Started in late '90s, they have come to take the world of journalism by storm, and have extended their presence into several other domains as well. Blogs may be thought of as online journals, which may be published by an individual or a small group, through the Web interface, and focused either on a single topic or a variety of topics reflecting interests of the authors.

Wikipedia is an online open source encyclopedia built by aggregating so-called wikis, which are tools (or instances) of collaborative authoring of tagged hypertext content, with version control and user feedback features built in. Wikis allow several users to contribute their knowledge so that a structured hypertext article on a topic can build itself from grassroots. The quality control derives from user feedback, and version control allows undoing changes and reverting when necessary. Wikis are popularly used as knowledge sharing tools and for collaborative authoring in teams.

Skype, the peer-to-peer, Internet-based voice and video communication service, represents social cooperation in bandwidth usage subverting traditional telephony; millions of users on the edge collaborate to share their bandwidth and realize service quality that is competitive with circuit-switched expensive lines, and thus undermine the usage-based pricing model of traditional telephony.

LinkedIn is a social network for business professionals rapidly gained popularity. In essence, it takes "networking" online; allowing professionals to create their profiles, and invite their professional contacts to be part of their "network." Networks grow rapidly, and users help each other by "endorsing" them and by various referrals and testimonials, as well as by providing access to the networks of each.

GOOD PRACTICES

Over the past decade, the research community has made major inroads in building common HCI design patterns, resulting in a lingua franca for UI design. These patterns are increasingly important for designers as a **vehicle for mediating between HCI and other software engineering practices**, but there is still some room for improving them to maximize their utility to designers. Today's software applications introduce challenges that also call for HCI patterns capable of organizing the interaction on modern interfaces— for example, mobile platforms.

Usability functionalities are one of the best ways to tackle routine user tasks—some examples include letting users undo an action, informing them about an action's progress, enabling them to cancel a command in progress, or letting them set their own preference. However, much of this functionality goes beyond UI design: providing an undo functionality has more implications than just displaying an undo button in the UI.

Therefore, integrating usability functionalities into a software application is not straightforward. In our work, we've developed the following related best practices:

- The development team must gather information related to the usability functionalities suitable for the **target software application based on user interactivity**, the complexity of the required usability functionality, and the tradeoff between usability and any other quality attributes.

- Developers must integrate such usability functionalities into **the artifacts used in the application to describe the system's functional requirements, use cases, user stories, or any other artifact used for that aim.**

GOOD PRACTICES

- Usability functionalities imply **specific responsibilities that the software system must address**. Responsibilities for the abort functionality, for example, must include recording information to recover the system status prior to the cancelable command's execution, stopping the active command, or freeing allocated resources.

- Developers **must map all of these responsibilities to different components of the design models**—for example, to particular classes in class diagrams—which also need to be allocated to the respective layer or subsystem in the architecture according to the main architectural style.

- Finally, developers must **test usability functionalities like any other software requirement**. These practices are clear indicators of usability's impact on software design. Developers must carefully deal with usability functionalities during software construction to deploy them properly.

Beyond UI design and usability components engineering, an important issue for developers wrestling with usability is how to deal with **current and future user experiences**—that is, how users will apply, perceive, and learn the software, as well as how it will evolve and adapt to users' changing expectations.

HCI practitioners advocate a user centered design (UCD) approach, which includes a set of activities for building interactive systems with user involvement in all development stages. According to this model, if a UCD process is identified as being necessary, developers must determine who is to use the product and for what purpose, in addition to what other requirements a successful product must fulfill. Developers also need to evaluate design alternatives, create design solutions, and evaluate their usability with real users.

GOOD PRACTICES

The notion of design as it is defined in user-centered approaches refers to UI design or interaction design, not to software design as conceived from a software architecture perspective. Therefore, developers must integrate this UCD process into a particular software development process to build systems with the required quality attributes, including usability.

An important challenge in this integration is how to manage the design loop generated by the continuously evolving, ambiguous, and unclear user experience during the software development process. HCI techniques such as user observation, focus groups, or even social networks can help elicit proper user needs, paper prototyping or storyboarding can drive development and heuristic evaluations, and usability testing can help develop software applications that are more focused on real users. But an organizational change is necessary to align the software process with the design loops needed to properly address the user experience. This involves tackling the following issues:

- **Different HCI techniques require different expertise, resources, and user availability**. Laboratory usability testing and video recording are two HCI techniques proposed for assessing usability, for example, but they require applying an entire physical infrastructure. HCI experts must select the best techniques for each project based on its own idiosyncrasies.

- **Integrating UCD activities into particular software development processes** with their own particularities will produce differing results. In an agile project, for example, usability questionnaires might be replaced by a thinking aloud protocol to assess the software product's usability after each iteration.

GOOD PRACTICES

- **Developers must integrate HCI techniques incrementally and logically into a software engineering process**. We advocate the use of HCI techniques first for gathering user needs and expectations, then for designing the respective interaction, and, finally, for evaluating the resulting system's usability. It's inefficient to apply usability testing at the end of the development project without applying any other HCI technique during requirements engineering or UI design.

HCI practice	Description	Examples	Project phase	Person in charge	Benefits
HCI interface patterns	Patterns used to capture best practices for solving particular user-interface design scenarios	Color-coded divisions, titled sections, scrolling menu, icon menu, shopping carts, small groups of related things, chart or graph, map of navigable spaces, thumbnail, collapsible panels	At any time, but preferably during interface design.	The UI designer or the programmer, if no UI designer participates in the development team	Improve system interface appearance and navigation; improve access to system functionalities (such as menus)
Usability functionalities	Usability requirements that ease the use of any software system and facilitate daily user tasks	Undo/cancel commands, predict a task duration, aggregate commands, check for errors, present system state, provide good help, minimize user recovery work due to systems errors	During requirements elicitation to capture the usability functionalities as any other requirement.	The requirements analyst must be conscious about the need to incorporate usability functionalities in the system; the project manager must estimate the cost and resources needed	Enrich user interaction capabilities with new usability functionalities that the user is not aware of a priori
User centered design	Approach for building interactive systems that explicitly involves the user through all development stages; particular HCI techniques contribute to this aim	Focus groups, card sorting, scenarios of use, thinking aloud, heuristic evaluation, Wizard of Oz prototyping, expert evaluation, participatory evaluation, laboratory testing, surveys	At project startup because it affects the entire software development process	Whole organization must be involved to adapt the traditional software development process to take into account user-centered needs and HCI techniques	Helps capture user interaction with the system; reduces the level of user rejection of the software product

GOOD PRACTICES

HUMANISING AUTONOMY

We were founded on the premise of enabling a safer, more human-centered implementation of autonomous technology, and called ourselves Humanising Autonomy because that was what we wanted to do. We started the company because we realised that our position on urban mobility was not being reflected by the automotive industry's view of automated vehicles in the cities of today and tomorrow. We want to see cities where mobility systems — private vehicles, ridesharing fleets, public transportation — take into account the vulnerable road users outside the vehicle, not just focus on the interior experience. The pedestrians, cyclists, and other users of the road should be able to interact with these vehicles — and the vehicles will need to understand this nuanced communication to be able to safely and efficiently navigate complex urban environments. We discovered an opportunity to create something truly necessary, but in our view underserved by current technology, and started developing our own AI-powered technology that is able to predict the full range of pedestrian and vulnerable road user behaviour in real time for the safer, and more trustworthy mobility systems that we have in our minds.

Some leading companies:

CTRL-labs ORBAI tobii

TRIFACTA emteq

Furhat Robotics

BENEFITS FOR THE COMPANY

The Benefits of Converged Infrastructure

- The infrastructure deploys faster than traditional data centers, particularly for cloud environments.

- HCI is easier to manage since it includes a software interface. **IT admin can keep a pulse on monitoring and troubleshooting actions by using the HCI software**.

- **HCI lowers operating and capital costs** since it relies on commodity hardware such as a white box or x86 platforms. In addition, "converged systems also provide a single resource pool for applications that make them easier to share thus improving utilization efficiency."

- HCI is more flexible, scalable, and **easy to maneuver**.

- Cisco points out that HCI "enables companies to gain the benefits of on-demand infrastructure for data-centric workloads **without placing resources in public clouds.**"

- HCI is readily **accessible** to purchase.

- HCI is capable of **increased data protection**. HCI is designed to effectively deal with this data protection problem since it already comes with included comprehensive backup and recovery capabilities allowing to meet even the strictest RTO (recovery time objective) and RPO (recovery point objective) requirements.

- HCI can operate as a virtual machine (VM) since it includes a hypervisor.

FUTURE APPLICATIONS

Intelligent and Adaptive HCI

Although the devices used by majority of public are still some kind of plain command/action setups using not very sophisticated physical apparatus, the flow of research is **directed to design of intelligent and adaptive interfaces**. The exact theoretical definition of the concept of intelligence or being smart is not known or at least not publicly agreeable. However, one can define these concepts by the apparent growth and improvement in functionality and usability of new devices in market. As mentioned before, it is **economically and technologically crucial to make HCI designs that provide easier, more pleasurable and satisfying experience for the users**. To realize this goal, the interfaces are getting more natural to use every day.

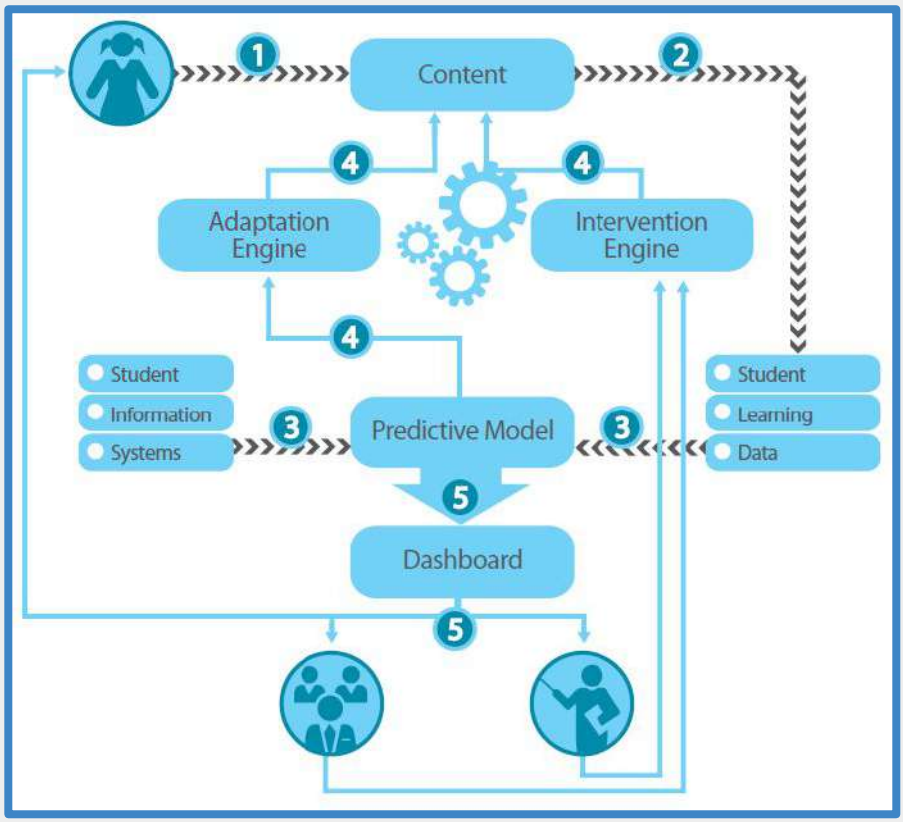


Figure 7. Adaptive learning process. source: www.dreambox.com

Evolution of interfaces in note-taking tools is a good example. First there were typewriters, then keyboards and now touch screen tablet PCs that you can write on using your own handwriting and they recognize it change it to text and if not already made, tools that transcript whatever you say automatically so you do not need to write at all. One important factor in new generation of interfaces is to differentiate between using intelligence in the making of the interface (Intelligent HCI) or in the way that the interface interacts with users (Adaptive HCI).

FUTURE APPLICATIONS

Intelligent HCI designs are interfaces that incorporate at least some kind of intelligence in perception from and/or response to users. A few examples are speech enabled interfaces that use natural language to interact with user and devices that visually track user's movements or gaze and respond accordingly. Adaptive HCI designs, on the other hand, may not use intelligence in the creation of interface but use it in the way they continue to interact with users. An adaptive HCI might be a website using regular GUI for selling various products. This website would be adaptive -to some extent- if it has the ability to recognize the user and keeps a memory of his searches and purchases and intelligently search, find, and suggest products on sale that it thinks user might need. Most of these kinds of adaptation are the ones that deal with cognitive and affective levels of user activity.

Another example that uses both intelligent and adaptive interface is a PDA (Personal Digital Assistant) or a tablet PC that has the handwriting recognition ability and it can adapt to the handwriting of the logged in user so to improve its performance by remembering the corrections that the user made to the recognised text.

Finally, another factor to be considered about intelligent interfaces is that most non-intelligent HCI design are passive in nature i.e. they only respond whenever invoked by user while ultimate intelligent and adaptive interfaces tend to be active interfaces. The example is smart billboards or advertisements that present themselves according to users' taste. In the next section, combination of different methods of HCI and how it could help towards making intelligent adaptive natural interfaces is discussed.

FUTURE APPLICATIONS

Ubiquitous Computing and Ambient Intelligence

The latest research in HCI field is unmistakably ubiquitous computing (Ubicomp). The term which often used interchangeably by ambient intelligence and pervasive computing, refers to the ultimate methods of human-computer interaction that is **the deletion of a desktop and embedding of the computer in the environment** so that it becomes invisible to humans while surrounding them everywhere hence the term ambient.

The idea of ubiquitous computing was first introduced by Mark Weiser during his tenure as chief technologist at Computer Science Lab in Xerox PARC in 1998. His idea was t**o embed computers everywhere in the environment and everyday objects so that people could interact with many computers at the same time while they are invisible to them and wirelessly communicating with each other.**

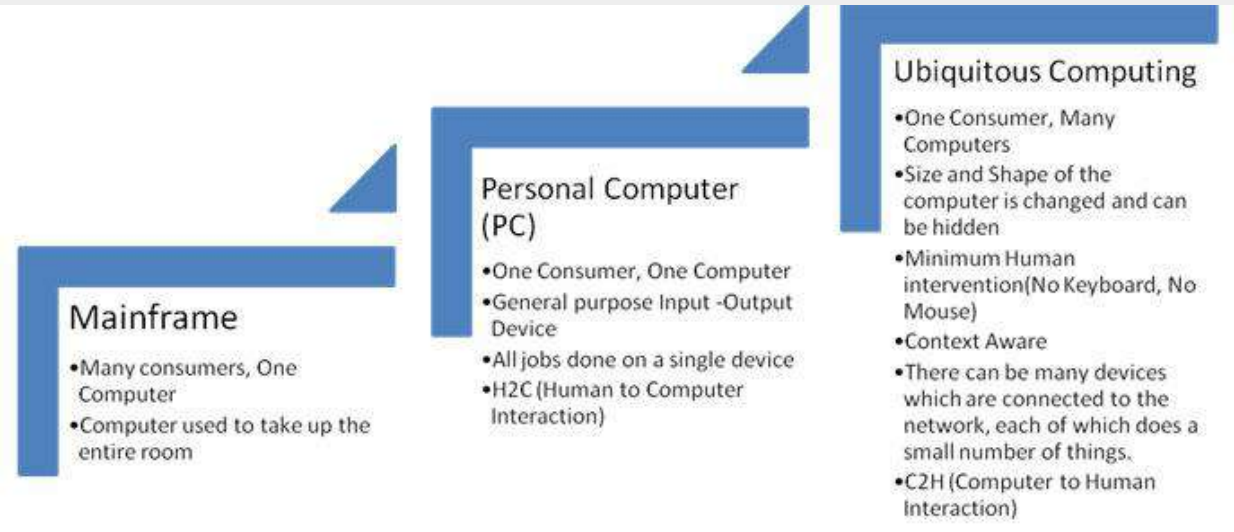


Figure 8. Computing waves. Source: www.thbs.com

Ubicomp has also been named the Third Wave of computing. The First Wave was the mainframe era, many people one computer. Then it was the Second Wave, one person one computer which was called PC era and now Ubicomp introduces many computers one person era.

FUTURE APPLICATIONS

Visual-Based HCI

The visual based human computer interaction is probably the most widespread area in HCI research. Considering the extent of applications and variety of open problems and approaches, researchers tried to tackle different aspects of human **responses which can be recognized as a visual signal**.

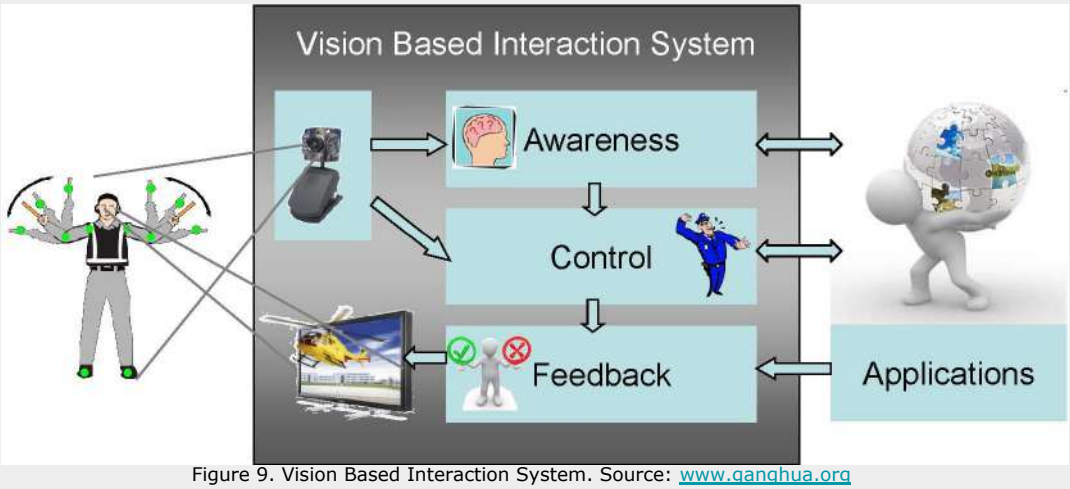


Figure 9. Vision Based Interaction System. Source: www.ganghua.org

While the goal of each area differs due to applications, a general conception of each area can be concluded. Facial expression analysis generally deals with recognition of emotions visually. Body movement tracking and gesture recognition are usually the main focus of this area and can have different purposes but they are mostly used for direct interaction of human and computer in a command and action scenario. Gaze detection is mostly an indirect form of interaction between user and machine which is mostly used for better understanding of user's attention, intent or focus in context-sensitive situations.

The exception is eye tracking systems for helping disabilities in which eye tracking plays a main role in command and action scenario, e.g. pointer movement, blinking for clicking. It is notable that some researchers tried to assist or even replace other types of interactions (audio-, sensor-based) with visual approaches. For example, lip reading or lip movement tracking is known to be used as an influential aid for speech recognition error correction.

FUTURE APPLICATIONS

Audio-Based HCI

The audio based interaction between a computer and a human is another important area of HCI systems. This area **deals with information acquired by different audio signals**. While the nature of audio signals may not be as variable as visual signals but the information gathered from audio signals can be more trustable, helpful, and is some cases unique providers of information.

Historically, speech recognition and speaker recognition have been the main focus of researchers. Recent endeavors to integrate human emotions in intelligent human computer interaction initiated the efforts in analysis of emotions in audio signals. Other than the tone and pitch of speech data, typical human auditory signs such as sigh, gasp, and etc helped emotion analysis for designing more intelligent HCI system. Music generation and interaction is a very new area in HCI with applications in art industry which is studied in both audio- and visual-based HCI systems.

Figure 10. Audio based HCI Speech recognition. Source: www.medium.com

ADVANCED CONTENT

Multimodal HCI Systems

The term multimodal refers to combination of multiple modalities. In MMHCI systems, these modalities mostly refer to **the ways that the system responds to the inputs**, i.e. communication channels. The definition of these channels is inherited from **human types of communication which are basically his senses: Sight, Hearing, Touch, Smell, and Taste.** The possibilities for interaction with a machine include but are not limited to these types.

Therefore, a multimodal interface acts as a facilitator of human-computer interaction via two or more modes of input that go beyond the traditional keyboard and mouse. The exact number of supported input modes, their types and the way in which they work together may vary widely from one multimodal system to another. Multimodal interfaces incorporate different combinations of speech, gesture, gaze, facial expressions and other non-conventional modes of input. One of the most commonly supported combinations of input methods is that of gesture and speech. Although **an ideal multimodal HCI system should contain a combination of single modalities that interact correlatively, the practical boundaries and open problems in each modality oppose limitations on the fusion of different modalities**. In spite of all progress made in MMHCI, in most of existing multimodal systems, the modalities are still treated separately and only at the end, results of different modalities are combined together.

ADVANCED CONTENT

The reason is that the open problems in each area are yet to be perfected meaning that there is still work to be done to acquire a reliable tool for each sub-area. Moreover, roles of different modalities and their share in interplay are not scientifically known. "Yet, people convey multimodal communicative signals in a complementary and redundant manner. Therefore, **in order to accomplish a human-like multimodal analysis of multiple input signals acquired by different sensors, the signals cannot be considered mutually independently and cannot be combined in a context-free manner at the end of the intended analysis but, on the contrary, the input data should be processed in a joint feature space and according to a context-dependent model**. In practice, however, besides the problems of context sensing and developing context dependent models for combining multisensory information, one should cope with the size of the required joint feature space. Problems include large dimensionality, differing feature formats, and time-alignment."

An interesting aspect of multimodality is the collaboration of different modalities to assist the recognitions. For example, lip movement tracking (visual-based) can help speech recognition methods (audio-based) and speech recognition methods (audio-based) can assist command acquisition in gesture recognition (visual-based). The next section shows some of application of intelligent multimodal systems.

ADVANCED CONTENT

A classic example of a multimodal system is the "Put That There" demonstration system. **This system allowed one to move an object into a new location on a map on the screen by saying "put that there" while pointing to the object itself then pointing to the desired destination**. Multimodal interfaces have been used in a number of applications including mapbased simulations, such as the aforementioned system; information kiosks, such as AT&T's MATCHKiosk and biometric authentication systems.

Multimodal interfaces can offer a number of advantages over traditional interfaces. For one thing, **they can offer a more natural and user-friendly experience**. For instance, in a real-estate system called Real Hunter, one can point with a finger to a house of interest and speak to make queries about that particular house. Using a pointing gesture to select an object and using speech to make queries about it illustrates the type of natural experience multimodal interfaces offer to their users. Another key strength of multimodal interfaces is their ability to provide redundancy to accommodate different people and different circumstances. For instance, MATCHKiosk **allows one to use speech or handwriting to specify the type of business to search for on a map. Thus, in a noisy setting, one may provide input through handwriting rather than speech.**

Few other examples of applications of multimodal systems are: Smart Video Conferencing, Intelligent Homes/Offices, Driver Monitoring, Intelligent Games, E-Commerce, Helping People with Disabilities.

ADVANCED CONTENT

Multimodal HCI Systems Applications

People with disabilities

One good application of multimodal systems is **to address and assist people with disabilities (as persons with hands disabilities), which need other kinds of interfaces than ordinary people.** In such systems, users with disabilities can perform work on the PC by interacting with the machine using voice and head movements. Two modalities are then used: speech and head movements. Both modalities are active continuously. The head position indicates the coordinates of the cursor in current time moment on the screen. Speech, on the other hand, provides the needed information about the meaning of the action that must be performed with an object selected by the cursor.

Synchronization between the two modalities is performed by calculating the cursor position at the beginning of speech detection. This is mainly due to the fact that during the process of pronouncing the complete sentence, the cursor location can be moved by moving the head, and then the cursor can be pointing to other graphical object; moreover the command which must be fulfilled is appeared in the brain of a human in a short time before beginning of phrase input.

In spite of some decreasing of operation speed, **the multimodal assertive system allows working with computer without using standard mouse and keyboard.** Hence, such system can be successfully used for hands-free PC control for users with disabilities of their hands.

Emotion Recognition

As we move towards a world in which computers are more and more ubiquitous, **it will become more essential that machines perceive and interpret all clues**, implicit and explicit, that we may provide them regarding our intentions. **A natural human-computer interaction cannot be based solely on explicitly stated commands**. Computers will have to detect the various behavioural signals based on which to infer one's emotional state. This is a significant piece of the puzzle that one has to put together to predict accurately one's intentions and future behaviour.

People are able to make prediction about one's emotional state based on their observations about one's face, body, and voice. Studies show that if one had access to only one of these modalities, the face modality would produce the best predictions.

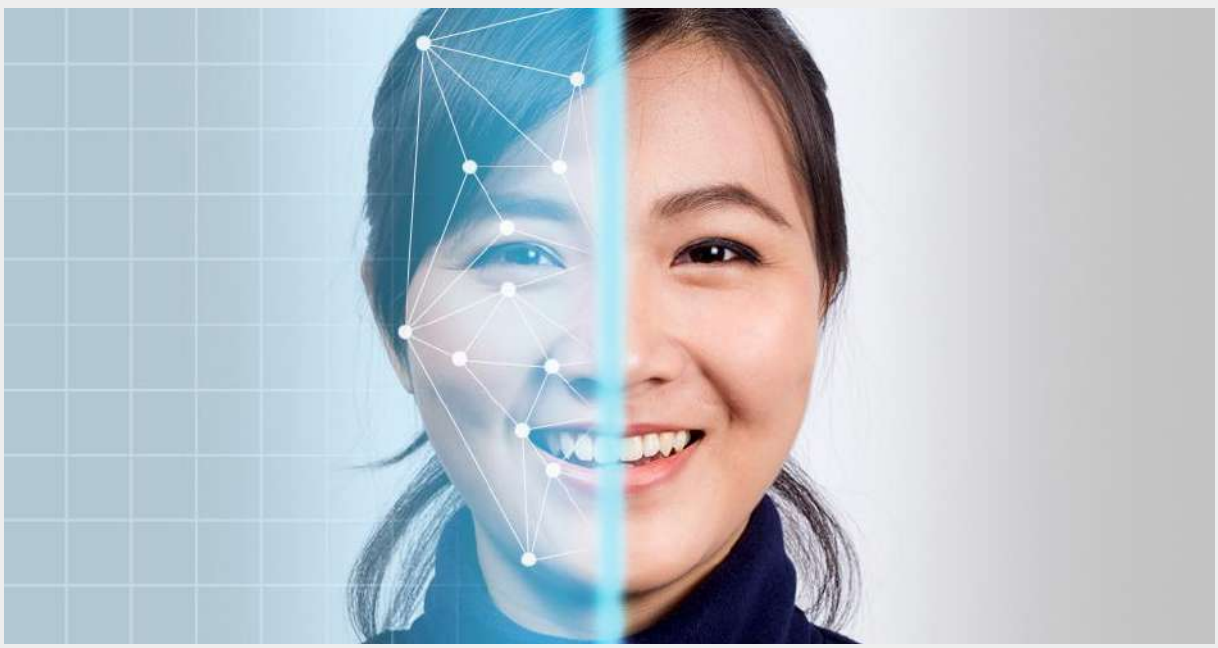


Figure 11. Facial based recognition. Source: www.acart.com

ADVANCED CONTENT

However, this accuracy can be improved by 35% when human judges are given access to both face and body modalities together. This suggests that affect recognition, which has for the most part focused on facial expressions, **can greatly benefit from multimodal fusion techniques**.

One of the few works that has attempted to integrate more than one modality for affect recognition is in which facial features and body posture features are combined to produce an indicator of one's frustration. Another work that integrated face and body modalities is in which the authors showed that, similar to humans, machine classification of emotion is better when based upon face and body data, rather than either modality alone. The authors attempted to fuse facial and voice data for affect recognition. Once again, remaining consistent with human judges, machine classification of emotion as neutral, sad, angry, or happy was most accurate when the facial and vocal data is combined.

They recorded the four emotions: "sadness, anger, happiness, and neutral state". The detailed facial motions were captured in conjunctions with simultaneous speech recordings. **Deducted experiments showed that the performance of the facial recognition based system overcame the one based on acoustic information only.** Results also show that an appropriate fusion of both modalities gave measurable improvements.

Results show that the emotion recognition system based on acoustic information only give an overall performance of 70.9%, compared to an overall performance of 85% for a recognition system based on facial expressions. This is, in fact, due to the fact that the cheek areas give important information for emotion classification.

On the other hand, for the bimodal system based on fusing the facial recognition and acoustic information, the overall performance of this classifier was 89.1%.

ADVANCED CONTENT

Different input modalities are suitable for expressing different messages. For instance, speech provides an easy and natural mechanism for expressing a query about a selected object or requesting that the object initiate a given operation. However, speech may not be ideal for tasks, such as the selection of a particular region on the screen or defining out a particular path. These types of tasks are better accommodated by hand or pen gestures. However, making queries about a given region and selecting that region are all typical tasks that should be accommodate by a map-based interface. Thus, **the natural conclusion is that map-based interfaces can greatly improve the user experience by supporting multiple modes of input, especially speech and gestures**.

Quickset is one of the more widely known and older map-based applications that make use of speech and pen gesture input. Quickset is a military-training application that allows users to use one of the two modalities or both simultaneously to express a full command. For instance, users may simply draw out with a pen a predefined symbol for platoons at a given location on the map to create a new platoon in that location. Alternatively, users could use speech to specify their intent on creating a new platoon and could specify vocally the coordinates in which to place the platoon. Lastly, users could express vocally their intent on making a new platoon while making a pointing gesture with a pen to specify the location of the new platoon.

A more recent multimodal map-based application is Real Hunter. It is a real-estate interface that expects users to select objects or regions with touch input while making queries using speech. For instance, the user can ask “How much is this?” while pointing to a house on the map.

ADVANCED CONTENT

Tour guides are another type of map-based applications that have shown great potential to benefit from multimodal interfaces. One such example is MATCHKiosk, the interactive city guide. In a similar fashion to Quickset, MATCHKiosk allows one to express certain queries using speech only, such as "Find me Indian restaurants in Washington."; using pen input only by circling a region and writing out "restaurants"; using bimodal input by saying "Indian restaurants in this area" and drawing out a circle around Alexandria. These examples illustrate MATCHKiosk's incorporation of handwriting recognition that can frequently substitute for speech input. **Although speech may be the more natural option for a user, given the imperfectness of speech, especially in noisy environments, having handwriting as a backup can reduce user frustration**.

Human-Robot Interface

Similar to some map-based interfaces, human-robot interfaces usually have to provide mechanisms for pointing to particular locations and for expressing operation-initiating requests. As discussed earlier, the former type of interaction is well accommodated by gestures, whereas the latter is better accommodate by speech. Thus, the human-robot interface built by the Naval Research Laboratory (NRL) should come as no surprise. NRL's interface allows users to point to a location while saying "Go over there". Additionally, it allows users to use a PDA screen as a third possible avenue of interaction, which could be resorted to when speech or hand gesture recognition is failing. Another multimodal human-robot interface is the one built by Interactive System Laboratories (ISL), **which allows use of speech to request the robot to do something while gestures could be used to point to objects that are referred to by the speech.** One such example is to ask the robot, "switch on the light" while pointing to the light. Additionally, in ISL's interface, **the system may ask for clarification from the user when unsure about the input**. For instance, in case that no hand gesture is recognized that is pointing to a light, the system may ask the user: "Which light?"

ADVANCED CONTENT

Medicine

By the early 1980s, surgeons were beginning to reach their limits based on traditional methods alone. The human hand was unfeasible for many tasks and greater magnification and smaller tools were needed. **Higher precision was required to localize and manipulate within small and sensitive parts of the human body**. Digital robotic neuro-surgery has come as a leading solution to these limitations and emerged fast due to the vast improvements in engineering, computer technology and neuroimaging techniques. Robotics surgery was introduced into the surgical area.

State University of Aerospace Instrumentation, University of Karlsruhe (Germany) and Harvard Medical School (USA) has been working on developing man-machine interfaces, adaptive robots and multi-agent technologies intended for neuro-surgery.

The neuro-surgical robot consists of the following main components: An arm, feedback vision sensors, controllers, a localization system and a data processing centre. Sensors provide the surgeon with feedbacks from the surgical site with real-time imaging, where the latter one updates the controller with new instructions for the robot by using the computer interface and some joysticks.

Neuro-surgical robotics provide the ability to perform surgeries on a much smaller scale with much higher accuracy and precision, giving access to small corridors which is completely important when a brain surgery is involved.

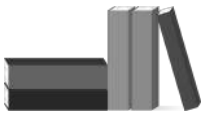
EDUCATION

MOOCS:

- Human-Centered Design: an Introduction
- UX Design: From Concept to Prototype
- Understanding User Needs
- Visual Elements of User Interface Design
- UX Design Fundamentals

EXTERNAL MANUALS FOR MORE INFORMATION:

- Human-Computer Interaction Fundamentals
- The evolution of Human-Computer Interaction
- A Missing Link in the Evolution of Human-Computer Interaction



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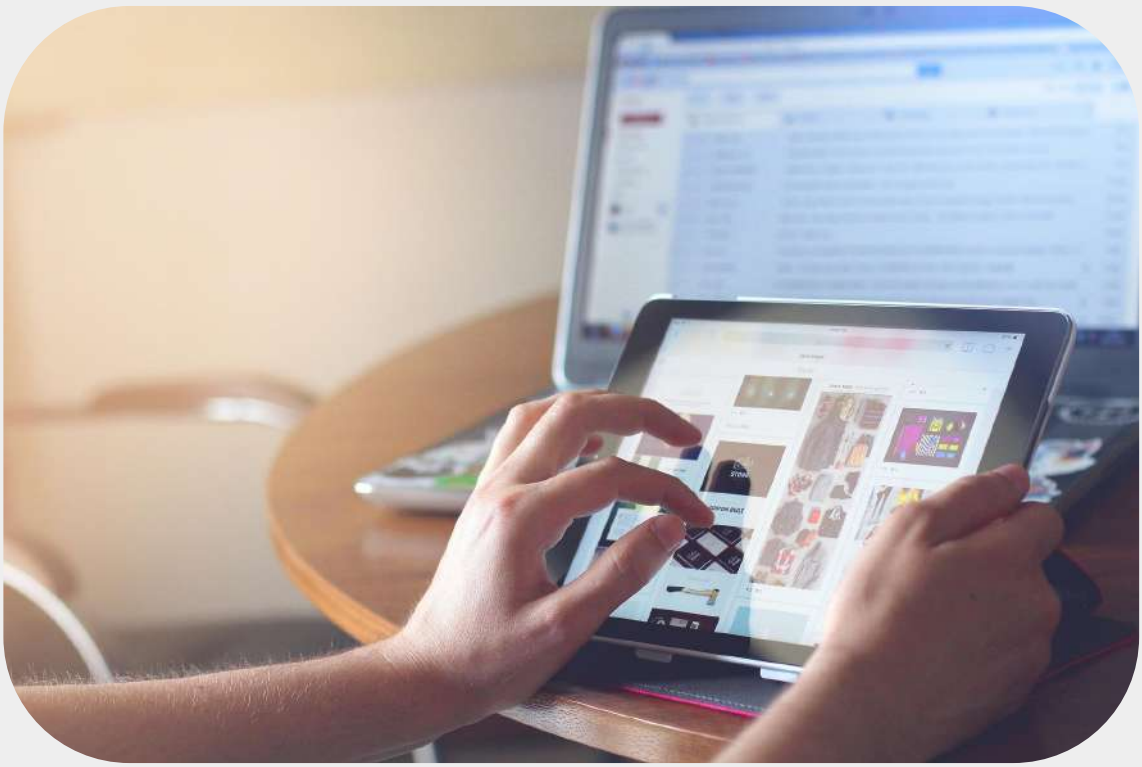
SELF APPRAISAL

- After reading this text have I a clear idea of what Human-Computer Interaction is?
- What tools am I used to?

- Do I know the benefits that Human-Computer Interaction can bring to my company?
- Can I recognize the advantages and disadvantages of its implementation for my company?



INTRO 4.0

ICT

Information and Communication Technologies

EuroProfis

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INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

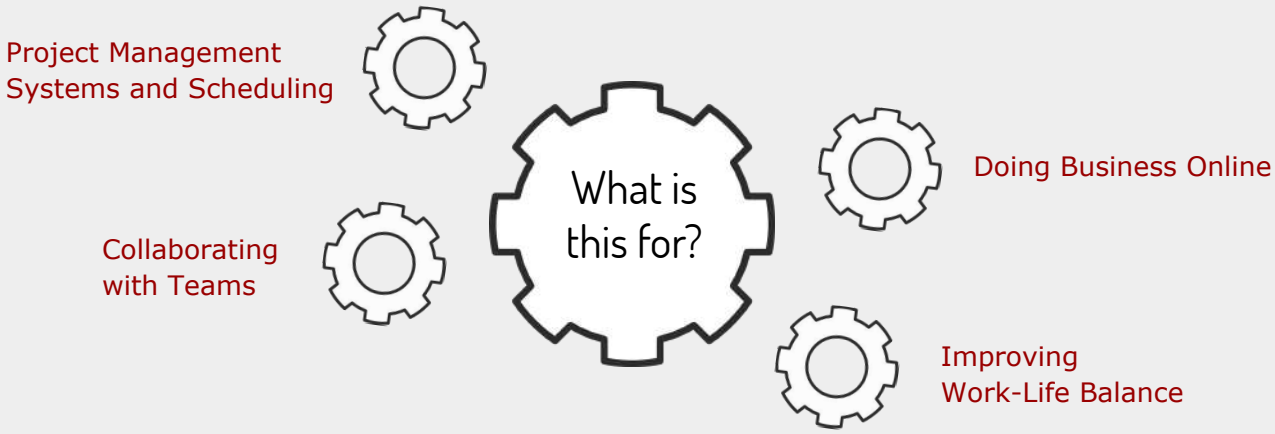
- Understand ICT as an integral factor of society at home, work and leisure.
- Identify the most valued skills for workers.
- Recognize ICT benefits for companies.

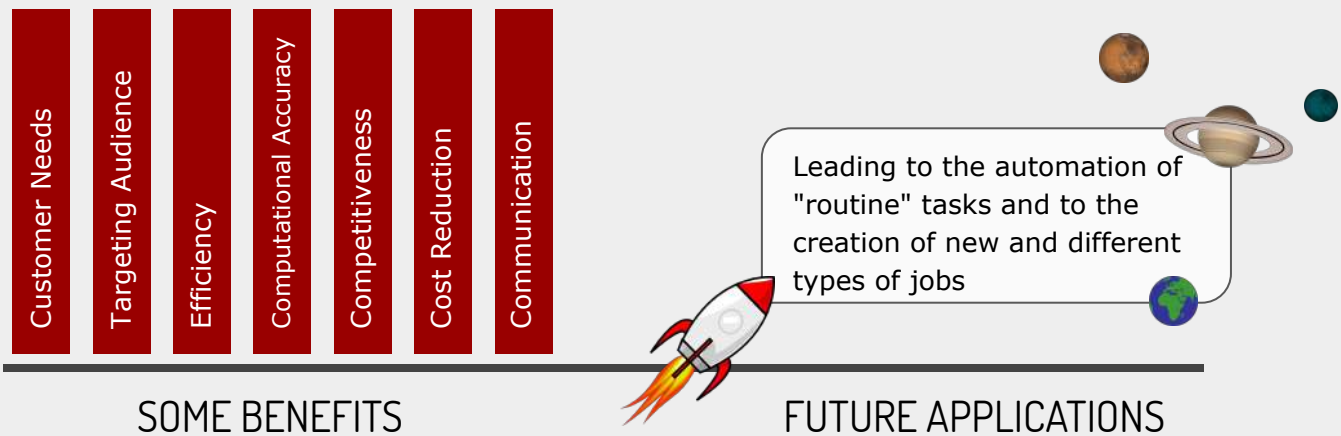
INTRODUCTION

ICT (Information and Communication Technologies) is the integration of information processing, computing and communication technologies.

Learning Objectives

- Understand ICT as an integral factor of society at home, work and leisure
- Identify the most valued skills for workers
- Recognize ICT benefits for companies





WHAT IS IT?

ICT (information and communication technologies) refers to the technology technological tools or mediums that aid transfer of information to handle telecommunications, broadcast media, intelligent building management systems, audiovisual processing and transmission systems, and network-based control and monitoring functions. It is the integration of information processing, computing and communication technologies. Digitalization and the application of ICT allows the integration of all systems throughout the supply and value chains and enables data aggregation on all levels.

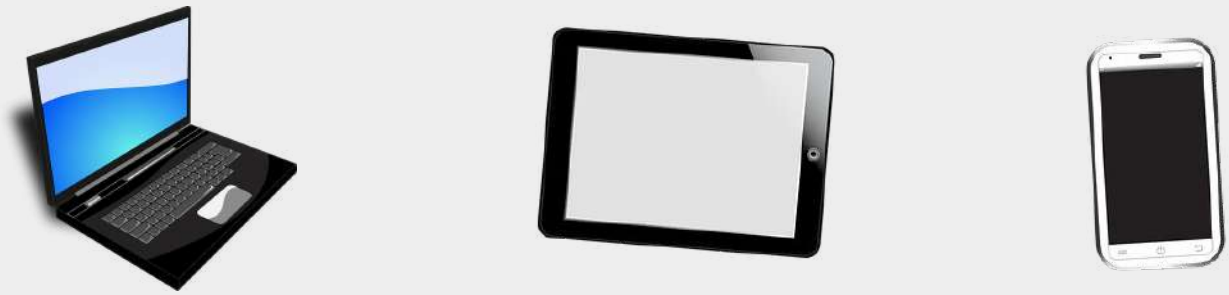


Figure 1. Some electronic devices for digital communication (laptop, tablet and smartphone)

ICT covers **any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form** and is concerned with these products. Importantly, it is also concerned with the way these different uses can work with each other. Information is digitized and the corresponding systems inside and across companies are integrated at all stages of both product creation and use lifecycles.

THE WORLD WAR II

Alliance of the military and industry in the development of electronics, computers, and information theory

1950s

Four generations of computers have evolved. Each generation reflected a change to hardware of decreased size but increased capabilities to control computer operations.

TODAY

Challenges, such as sensor technology for continuous health monitoring, cyber-physical systems for the industrial Internet, 3D-printing, smart-grids for energy supply, tracking and tracing solutions for mobility.

WHAT IS IT?

The diffusion of Information and Communication Technologies (ICT) across all economic sectors is placing new demands on workers' skills. The changing skill set is both expanding employment opportunities and imposing new demands on disadvantaged groups. In today's job market, basic ICT skills are considered essential for people entering the workforce and for those trying to get a better job.

A nation's economic well-being depends "on both the effective use of ICT for businesses and industrial processes and on the knowledge, competencies, and skills of current and new employees" (European Commission, 2004, p. 2). ICT skills are not only required for jobs in the information technology (IT) sector. The demand for them cuts across sectors and job types.

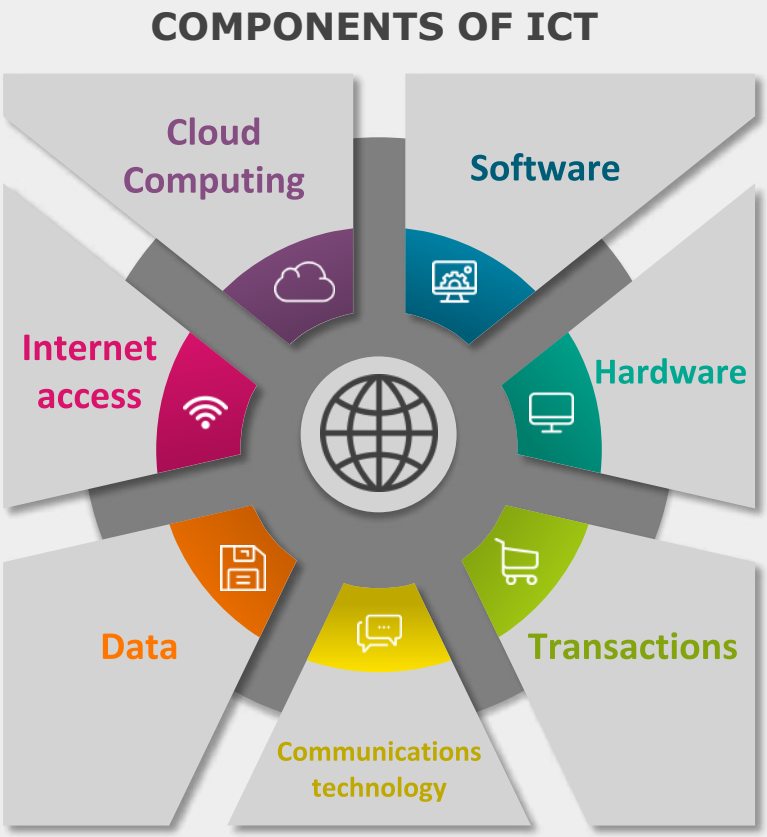


Figure 2. Components of ICT
Source: self made

WHAT IS THIS FOR?

How can ICT help?

Collaborating with Teams

Team collaboration software and apps have changed the way many businesses operate. Companies no longer need to save multiple versions of documents and spreadsheets, and email them to each other in order to get feedback from their colleagues. With online authoring tools such as Google Docs, businesses can enable multiple team members to work on and review documents simultaneously, saving time.

Improving Work-Life Balance

While technology can cause employees to be overworked, it also enables many people to maintain a work-life balance. Improved network connectivity allows employees to work from home. Many organizations have full or partial remote offices, while others have policies where their teams can work remotely in cases of bad weather or outside appointments. This saves many employees from spending time commuting.

Doing Business Online

For many small businesses, technology has opened up a new market online. While many companies still serve customers in person, many organizations have online stores. E-commerce allows small businesses to reach wider audiences that are outside of their geographical area, which can be particularly useful for small niche offerings.

Conducting business online isn’t limited to making sales. Technology enables businesses to give prospects the option to book business consultations and service appointments through calendar tools integrated with their websites. This gives website visitors the flexibility to book on their own schedule, rather than having to make a phone call during business hours.

Project Management Systems and Scheduling

Another use of technology in business is the implementation of project management systems for collaboration among employees. Workers no longer need to be in the same building or sit in a lengthy meeting to share their ideas. Whether they're at the corporate headquarters or working from home, individuals can create task lists, assign work, upload content, set appointments and track progress all in one online application.

WHAT IS THIS FOR?

Definition of e-Skills:

We can distinguished between three categories of e-skills:

ICT practitioner skills: the capabilities required for researching, developing, designing, strategic planning, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and servicing ICT systems.

ICT user skills: the capabilities required for the effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work. User skills cover the use of common software tools and of specialised tools supporting business functions within industry. At the general level, they cover "digital literacy": the skills required for the confident and critical use of ICT for work, leisure, learning and communication.

E-Leadership skills: these cover a range of skills, attributes and attitudes related to: knowledge of the capabilities and limitations of software systems and information systems in use; ability to quickly assess new capabilities of existing systems and the relevance of offers of software and web services emerging on the market; ability to describe prototype solutions; understanding of the fundamentals of alignment of business and IT functions in an organisation.

WHAT IS THIS FOR?

TOP 8 ICT SKILLS FOR WORKERS

Figure 3. Top 8 ICT skills for workers
Source: self made

Email: Being able to effectively and successfully communicate via email is critical to any job. You will need to send emails to colleagues, employers, clients, vendors, and so on. Companies expect their employees to write professional and well-written emails, as well as respond promptly to messages received in their inboxes.

Online Research: Almost every job requires at least some online research. Whether you are looking up new lesson plans in a subject or checking out the latest news on your company's competitor, you need to be able to sift through all the information online to find what you need. This involves basic online information management skills.

WHAT IS THIS FOR?

Social Media: Some jobs require you to use social media. For example, many people working in marketing tend to manage or update a company's social media presence. Even if this is not a critical part of your job, employers increasingly look for employees with basic social media literacy. The more you know about the benefits of and limits to social media, the more you can begin to use that media in valuable ways at work.

Online Collaboration: Online collaboration is a broad category that refers to any means of sharing information with your coworkers (or supervisors, or clients) online. This includes adding a meeting to a shared online calendar, providing feedback on a document through a web-based document application, and holding an online video conference with colleagues.

Spreadsheets: From researchers to administrative assistants to K-12 teachers, almost everyone now needs to be able to develop and manage data using spreadsheets. Furthermore, they have to be able to analyze that data and recognize trends and patterns. Fluency in programs like Microsoft Excel is critical in today's job market.

Desktop Publishing: Desktop publishing involves the creation of a variety of print materials using a computer. These might include fliers, brochures, newsletters, and other materials that include graphics. Because you can create so many materials using desktop publishing, almost any job requires some basic skills in this field. While people with a creative, artistic eye might be particularly good at desktop publishing, anyone can get better with practice.

Smartphones and Tablets: Many employers require that their employees use smartphones and tablets; they might even issue particular phones to employees or state that workers must have be accessible by email during certain hours. For these reasons, it is important to know how to use a smartphone.

WHAT IS THIS FOR?

Word Processing: In this day and age, it is pretty much understood that all job candidates must know how to use word processing technology. Job candidates need to be able to produce written documents (including business letters, meeting minutes, and more) using a computer processor such as Microsoft Word. Candidates also need to be able to type quickly and accurately.

Most valued skills:

1. Teamwork
2. Customer oriented
3. Commitment to learning
4. Problem solving
5. Negotiation skills
6. Empathy
7. Assertiveness
8. Empowerment

WHAT IS THIS FOR?

Potential implications of ICT on employment:

	Positive implications	Negative implications
Job availability	• New jobs likely to be created to design, build, and repair new technology, particularly robots. • New business models and industries are being created that could lead to both direct and indirect job creation (e.g. sharing economy).	• A significant number of jobs are likely to be made redundant, including predictable, routine tasks but increasingly some higher cognitive tasks. • New industries are expected to be less labour intensive or provide less reliable employment, thus reducing net job creation.
Job access	Jobs may become more accessible for certain groups, such as women and people with disabilities, by overcoming social, cultural, and physical barriers to work. Technologies could make the means of production more accessible to small-scale producers.	Lower-skilled and less educated groups could face particular challenges in filling new higher-skilled roles if efforts are not made to help them grow with the required skills.
Job quality	• Factory spaces may become cleaner and safer, and some of the most difficult and dangerous tasks may be mechanised. • Repetitive motion injuries may be reduced, and sensors and other tools may be used to monitor health and air quality. • Productivity gains, if passed on to workers, could drive higher wages. • Technology can augment human skills, enabling workers to extend their own capabilities and learn new skills, providing more mobility.	• More part-time work and contractor work could mean less access to formal employer benefits and weakened job security. • Downward pressure on wages as a result of competition with 'cheap' machine capital could lead to income loss. • Reduction of available low-skill jobs could reduce negotiating power of workers in remaining low-skill positions.

GOOD PRACTICES

Promoting ICT (Information and Communication Technologies) uptake as an innovative business solution for SMEs (Small-Medium Enterprises) a key factor for success: software and intangibles combined with adequate investments in hardware and high-speed connectivity are essential to improve the business of microenterprises and SMEs.

Microsoft Office Tools are the most widely used software in business and the office environments. Having the right skills and knowledge is essential if you want to keep up to date with the skills demanded by many employers to progress in your career. Whatever your level Sparsholt Business Training offer a wide range of ICT courses designed to train you in all aspects of Microsoft Office, and the individual programmes it contains such as Excel, PowerPoint and Microsoft Word.

GOOD PRACTICES

FAB LAB

Fabrication labs (or FabLabs) represent prototype environments for promoting innovations and inventions in the fields of modern digital technologies, ICT and IoT applications.

They help increase creative literacy, which means that people can use new high-tech tools. They are dedicated to creators, students, researchers, and entrepreneurs who want to express their creativity in the form of development of innovative products with high benefit. In addition to the basic tools found in classical workshops, FabLabs have modern equipment such as 3D printers, CNC milling machines, and laser cutters.

Modernly furnished rooms represent only the first step; mentors that help creators overcome problems on their way and through education involve inexperienced creators in the FabLab form the second step. The third step represents the linking of creators to groups that encourage the formation of ideas and mutual motivation to stay on this difficult journey. Networks of related laboratories, exchanging knowledge flows, and equipment forms the fourth step, which also opens up important opportunities for linking with the industry and financing the projects in the early stages of product development. FabLabs enable industry, and especially small and medium-sized enterprises, to test their ideas before entering the path of digitization.

Some leading companies:

DELL motorola HAWKERS IBM ERICSSON TOSHIBA

FUJITSU General Electric SIEMENS

SONY Microsoft Hewlett Packard Enterprise HITACHI

BENEFITS FOR THE COMPANY

Meeting Customer Needs

Customer service is paramount for both big and small businesses today, and the customer experience often begins when a prospect reaches a company website. Web chat software can help small businesses reach out to prospects in an automated but personal way. When businesses are able to offer help and answer questions through a chat solution, prospects may be able to make the purchasing decision sooner.

Targeting Audience Segments Effectively

Businesses can use online search engines such as Google and social media channels such as Facebook to target various segments of their audience with highly tailored ads and content.

Make Your Business More Efficient

You can schedule sales calls and appointments, track employee time, and perform many tedious tasks that once took hours in only minutes.

Ensure Computational Accuracy

Accounting programs like QuickBooks allow you to accurately keep inventory, make and record sales, manage and pay bills, and handle payroll. Consider the time and cost once required to compile financial information. Now, your books can be regularly maintained in a software program and your financial statements can be generated in moments.

Be Competitive In the Marketplace

Use digital marketing to promote your company and online sales tools to sell across the street and across the globe. Embrace Customer Relationship Management (CRM) systems that allow you to track what your customers do and like. Wouldn’t it be great if you could target the right customer at the right time in the consumer journey so they turn to you instead of a competitor? You can with technology.

Communicate More Effectively

Whether you instant message or use Slack with a co-worker across the hall or Skype with clients across the ocean, technology has made connecting in real time easier than ever. Follow up that voice or FaceTime call with an email to recap and clarify. Connect on LinkedIn to network interoffice and interindustry. Use Facebook, Instagram and Twitter to communicate directly with your customers. Create and promote your brand and get your message directly to the consumer.

BENEFITS FOR THE COMPANY

Benefits to Communication

Rapid communications can help increase productivity, allow for better business decision-making and ease a company's expansion into new territories or countries. IT equipment can be used to send business status reports to executives, to update employees on critical business projects and to connect with business partners and customers.

Improved Workplace Efficiency

Streamlined workflow systems, shared storage and collaborative work spaces can increase efficiency in a business and allow employees to process a greater level of work in a shorter period of time. Information technology systems can be used to automate routine tasks, to make data analysis easier and to store data in a manner that can easily be retrieved for future use.

Competitive Advantage over Rivals

Companies using a first-movers strategy can use information technology to create new products, distance their products from the existing market or enhance their customer services. Companies that follow a low-cost product strategy can look to information technology solutions to reduce their costs through increased productivity and reduced need for employee overhead.

Cost Reduction and Economic Efficiencies

Using IT infrastructure, redundant tasks can be centralized at one location. For example, a large company could centralize their payroll function at one location to lower employee costs.

Economic efficiencies can also be realized by migrating high-cost functions into an online environment. Companies can offer email support for customers that may have a lower cost than a live customer support call. Cost savings could also be found through outsourcing opportunities, remote work options and lower-cost communication options.

Automated Voice Systems Provide Service

Automated voice response systems are another way to provide customer service while allowing employees to stay focused on other tasks. Instead of a "live person," the automated system handles the call and either directs the customer to the appropriate individual or retrieves data and communicates the basic information requested by the caller. Similarly computer "bots" handle online requests for information through live chats.

BENEFITS FOR THE COMPANY

Artificial Intelligence Engages in Marketing

Artificial Intelligence (AI) systems are being used to predict and influence future sales based on consumer preferences. Knowledge of customer preferences in real time can assist marketing departments in determining where to spend their money by tracking trends more closely and adapting promotional and sales efforts. The streaming entertainment industry, for example, suggests additional programming based on shows already being watched. "Because you watched this ... you might enjoy this."

Easy Collaboration with Remote Workers

The gig or freelance industry has also grown dramatically because of technological advancements that allow talented workers to be hired and perform remotely for an organization. Needs can be posted online and workers hired, sometimes within hours. Freelancers can collaborate with managers and employees through project management platforms, without any one-on-one interaction.

In business strategy, these reasons lead to a constant search for ideas and a rapid process of innovation:

Interdisciplinary cooperation to foster innovations	Adaptability to the rapid innovation cycles	Good IT skills and competences
New business thinking	Bursting with creativity	Empowering people to innovate
Creating and applying knowledge	Applying innovation to address global and social challenges	Enhancing the governance and measurement of innovation policies

Figure 4. Reasons lead to a constant search for ideas.
Source: Self made

FUTURE APPLICATIONS

The first ICT-Leadership in Enabling and Industrial Technologies (LEIT) Work Programme provides a balanced response to the main challenges faced by Europe in the field: firstly, the need to maintain a strong expertise in key technology value chains; secondly, the necessity to move quicker from research excellence to the market.

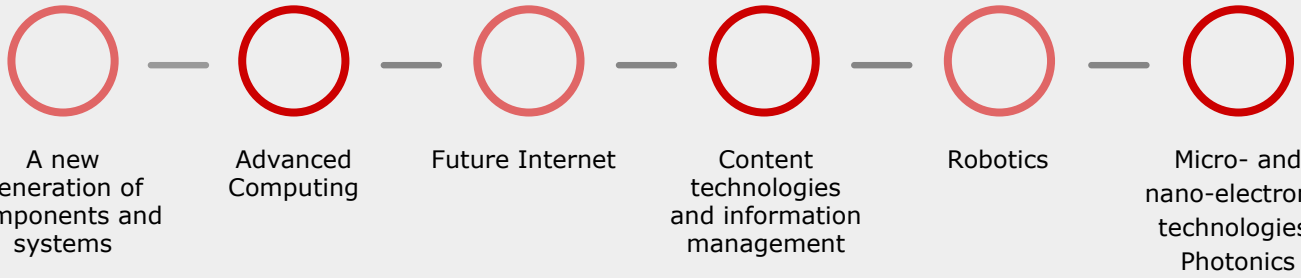


Figure 5. Six main activity lines of technology
Source: Self made

The full potential for improving ICT in Europe remains yet to be discovered and this is why the European Commission is developing policy and supporting research to make learners fit for 21st century life and work.

The spread of digital is having a massive impact on the labour market and the type of skills needed in the economy and society.

FUTURE APPLICATIONS

Digital technologies, systems and processes are having a massive impact on the labour market and the type of skills needed in the economy and society:

- Changing the structure of employment, leading to the automation of "routine" tasks and to the creation of new and different types of jobs.
- Leading to the need for more skilled ICT professionals in all sectors of the economy.
- Leading to the need for digital skills for nearly all jobs where ICT complements existing tasks. Careers such as engineering, accountancy, nursing, medicine, art, architecture, and many more require increasing levels of digital skills.
- Changing the way we learn by fostering online communities, by enabling personalised learning experiences, by supporting the development of soft skills such as problem solving, collaboration and creativity, and by making learning fun.
- Connecting job seekers and employers in new innovative ways.
- Causing every citizen to need least basic digital skills in order to live, work, learn and participate in the modern society.

FUTURE APPLICATIONS

ICT combines a strong support to industrial roadmaps with new mechanisms to encourage disruptive innovation. The former will reinforce medium to long term commitment to industrial strategies and provide continuity and stability. The latter will offer flexibility and openness and will help develop dynamic eco-systems in which innovators can operate. Both strands will require the involvement of new actors, on one hand to exploit and leverage new technologies and on the other to initiate and drive change.

The six main activity lines that have been identified are:

1. A new generation of components and systems
2. Advanced Computing
3. Future Internet
4. Content technologies and information management
5. Robotics
6. Micro- and nano-electronic technologies, Photonics

EIC SME Instrument

The SME Instrument is part of the European Innovation Council (EIC) pilot that supports top class innovators, entrepreneurs and small companies with funding opportunities and acceleration services. The main focus of the SME Instrument is on market-creating innovations that shape new markets and generate jobs, growth and higher standards of living

In addition, the Work Programme features several cross-cutting topics addressing cyber-security, Internet of Things and research on a Human-centric Digital Age. All activities are complemented with support to innovation and take-up, international cooperation and a dedicated action for SMEs to propose bottom-up innovative ideas, using the SME instrument.

FUTURE APPLICATIONS

Summary of predictions of the **ICT trends for 2019**:

1. Your app is your brand - digital displaces physical in the connected, software-centric customer experience

Today, over one-third of shoppers use smartphone apps to browse, research or compare prices before they buy. Almost every organisation already has a digital presence and a digital entrance and apps have become the new 'shop front'. As a result, customers will develop a perception of brand through a digital experience instead of the touch-and-feel experience of bricks and mortar stores and service centres. The app and the brand will become one. The experience delivered by apps will therefore be critical to business and raises the priority level of software development, operation and automation in terms of speed to market, cost, reliability and risk.

2. From mobile-first to AI-first - connected augmented intelligence

If the trebling of global investment into AI is any indicator, expectations are extraordinarily high. Business focus has shifted from customer connectivity (mobile-first) to what the connectivity can enable and the behaviour it can measure (AI-first). However, 'artificial general intelligence' (i.e. multi-skilled and human-like) is still decades away and when compared to other living beings, we are 'at the worm stage'. On the other hand, 'connected augmented intelligence', intelligence that assists human decision-making, is here now. For example, connected, human-driven, intelligent vehicles are in widespread operation today, whereas autonomous vehicles are only in limited deployment.

AI is advancing rapidly across areas such as sensory systems, predictive analytics, image analysis, speech recognition and machine learning. AI commoditization through plug-and-play solutions will accelerate as leading technology providers, notably Google (e.g. Google Assistant, TensorFlow), Microsoft (e.g. Cortana, Azure Machine Learning) and Amazon (e.g. Alexa, SageMaker), make new announcements almost weekly. Surprisingly, business adoption is lagging but this is not expected to last long.

FUTURE APPLICATIONS

3. Infrastructure as code - connected intuitive infrastructure

Despite retail outlets struggling, shopping is as popular as ever. The in-person shopper experience is making way for digital and software is dominating design and deployment of shopping malls as well as almost all physical infrastructure, from buildings and transportation to IT itself. Connected intuitive infrastructure enables sensing, analysis and action that leverages a combination of networking and AI. IT infrastructure is shifting from a system of physical boxes to just one or a few software entities and operated as code. This transition began a few years ago in the data centre/cloud and in several telecommunications networks. It is now expected to take hold in the WAN and access networks.

2019 will be the 'year of SD-WAN' with an expected 37 percent compound annual growth rate. Hardware will undergo its own transformation with massive advancements such as 7nm chips, 3D chip stacking, optical-photonic integration and a new generation of AI-specific silicon. Despite an unsteady start, confidence in IoT is high. It is an integral part of connected intuitive infrastructure, with an expected economic impact of $11 trillion by 2025.

4. Tech reality bites - economic dislocation

Existing challenges such as unemployment (through automation), unemployability (which is worse), cyber risk, fake news, algorithmic accountability and digital distraction will be more obvious and acute. New challenges are also emerging. Power is shifting from government into the hands of a small number of powerful multi-national technology organisations based in the US or China. Trust in institutions is at an historic low. Government intervention for law enforcement (encryption), national security, data protection, ethical AI (AI-to-human and AI-to-AI), data/algorithm bias and copyright will escalate alongside new regulation. The shortage of women in technology is a priority especially as demand for technology-based jobs grows at the expense of other traditional, manual types of work.

FUTURE APPLICATIONS

5. Expanding to Cloud - telemetry, policy and AI are key

Even public cloud providers now understand that it may take longer, if ever, to expand to public cloud. This realisation has impacted expectations such as timing and investment and market dynamics, such as supply-side technology relationships (e.g. Cisco with Google, Microsoft and Amazon). Nevertheless, cloud continues to disrupt IT innovation, consumption and the industry itself. Cloud capabilities such as serverless computing, edge computing, containers, microservices and AI toolkits provide compelling options for rapid, cost-effective development and deployment of modern software and applications. Expanding to cloud will require a sharper focus on telemetry, policy and AI to manage, secure, orchestrate and automate operations.

6. Cyber defence is a system and culture, not a product - perimeters shift closer to the entities they protect

It is estimated that there are more than 120 million new variants of malware every year and that the cost of cyber-crime is now in the trillions. Nation-state attacks are being called out by governments under attack and state actors are being arrested. Anyone still buying discrete appliances to combat cyber-attack will fall behind - defence is a system and a culture, not a product. It is complex and remediation can be costly if not, devastating. Re-architecting cyber security will gather pace. Zero trust networking with a security posture of default deny, will be the first step to continuous risk/trust assessment. The hype around “perimeter-less” networks is misguided as there will actually be an increase, not a decrease, in the number of demarcation boundaries of trust.

Small-to-medium businesses (SMBs) that thought they were not worth attacking will need to think again. SMBs by definition, have fewer resources and therefore represent a large number of small ‘soft’ targets. They will therefore require a solid approach to threat intelligence and management.

FUTURE APPLICATIONS

7. Faster and wider - 5G and nano satellites

Anticipation and expectation of 5G is probably higher than any other new technology in history. Governments believe 5G will affect national security and economic performance in decades to come and several mobile operators are literally betting their businesses on it. While it promises higher speed and other benefits such as lower latency, 5G raises many questions around its commercial value proposition against existing options including 4G/LTE and Wi-Fi variants. 5G is also headed for a collision course with fixed-line broadband threatening its business case.

2019 will be a year of marketing (and politics) and figuring out the use-cases and business case. Full-scale deployment will follow, probably slightly delayed. At the same time, satellite will step back onto centre stage for two important reasons – coverage and cost. Massive cost reductions through efficiencies in rocket launch and re-use as well as technology advancement, promise to enable a new generation of nano-satellites to belatedly and cost-effectively connect some of the most remote places on earth.

8. The value of data - now to control and monetise

Amidst so much change, one thing we can predict with certainty – production and demand for data will continue to soar. Global IP traffic will grow three-fold to 2022 and mobile data will grow seven-fold. Economies are transitioning from human-scale to machine-scale, which means that more decisions are being made by machines, and that machines and AI will thirst for more data. The value of data is clearer than ever, as machines with the right data help us make smarter, quicker decisions.

Traditional organisations like banks and telecommunication operators are acutely aware that they have stimulated data production and consumption while someone else has been taking advantage of it at their expense. The challenge is how to control and monetise it. As data becomes more personalised, it generates numerous opportunities as well as challenges for consumers, businesses and governments. Tension will rise between government and consumers and we can expect more regulation not less.

FUTURE APPLICATIONS

9. Decentralised Web and the Internet of Blockchains – Web 3.0 and distributed trust

In less than a decade, the World Economic Forum expects that 10 percent of global Gross Domestic Product (GDP) will be stored on blockchain. However, in 2018, crypto-currencies such as Bitcoin that use blockchain, have been in turbulence, turning the curious into sceptics and in some cases, disbelievers. But we should not to be side-tracked by crypto-currencies. Blockchain itself is a serious, secure, distributed ledger and digital cryptographic platform. Venture capital and other investment is consistently growing. Blockchain offers distinct value to supply chains – trust enshrined in decentralised crypto-algorithms. Its credentialing capability is more secure and robust than alternatives, it is open source, collectively owned, decentralised and neutral – critical ingredients for Web 3.0 and the 'decentralised Web' (DWEB). While it has massive scope, we can expect initial use cases based on permissioned access (i.e. private) blockchain. The huge disruption to business models will push out public blockchain deployment by at least 3-5 years.

10. Anywhere, anytime, any mode transport as-a-service – connected and autonomous vehicles

The vehicle industry is a beacon for how technology can transform an entire sector and impact adjacent ones too. Although autonomous vehicles (AV) seem to attract the most attention, other transitions within the industry are taking hold and impacting consumers much sooner. Electric vehicles (EV) are more of a given now than a bold vision and although it will take some years, the move to EV is certain. Connectivity technology will undergo a disruptive, winner-take-most battle between the well-known and universally supported Dedicated Short-Range Communications (DSRC) technology and the relative newcomer (and incompatible), cellular vehicle-to-everything (C-V2X) alternative. Vehicle ownership will decline as the shift towards shared platforms and Mobility-as-a-Service (MAs) accelerate. These platforms are spawning new forms of transport including electric bikes and scooters.

You can also watch the Top 10 ICT Trends video here:

https://youtu.be/dzRovkW7qbM

ADVANCED CONTENT

The **ICT innovation vouchers' scheme** is a useful instrument to include in strategies for innovation and growth implemented at local and regional levels. It enables regional and national authorities to facilitate SMEs' access to digital know-how and technology by giving them the incentive to connect with ICT knowledge and service providers. The aim is to encourage the use of new ICT-based business models.

The objectives of implementing ICT innovation vouchers in EU regions are: to improve the competitiveness of microenterprises and SMEs by developing new products, processes and businesses; and to stimulate demand for a large range of innovative ICT-related services – notably e-commerce including cross-border online sales – and thus contribute to reaching the Digital Agenda for Europe's priorities.

What is an ICT innovation voucher?

It's a small credit line dedicated to micro, small and medium-sized enterprises (SMEs) to help them innovate their existing business through ICT uptake.

The voucher will be funded through the EU Structural Funds (ERDF). Implementing body delivers vouchers to SMEs who buy ICT services from local providers.

Who are the beneficiaries ?

- Microenterprises and SMEs
- ICT knowledge/service provider

What are the services offered under the ICT innovation voucher?

1. "From No-web to Low-web" for SMEs seeking a presence on the web and/or with low ICT knowledge.
2. "From Low-web to Medium-web": SMEs that want innovate by using the web and other ICT tools to expand their production/sales processes.
3. "From Medium-web to High-web": SMEs pushing ICT innovation to its limits.

ADVANCED CONTENT

Standardisation is the process by which specifications are set. The majority of ICT specifications help ensure that devices, systems and services retain the ability to connect and interoperate with each other, boosting innovation, and keeping ICT markets open and competitive. A specification is a document that outlines the agreed properties for a particular product, service, or procedure. In ICT, specifications are primarily used to maximise interoperability – the ability for systems to work together –, which is essential to ensure that markets remain open. This allows consumers to have the widest choice of products possible and gives manufacturers the benefit of economies of scale.

Figure 6. ICT Standards. Source: https://ec.europa.eu/digital-single-market/en/standards-digitising-european-industry

The Commission's initiative on standards is proposing two lines of action:

- to focus resources by concentrating standard setting in a set of core technologies will be the building blocks of tomorrows' technologies - 5G, IoT, Cloud, Cybersecurity and Data Technologies. These are increasingly part of the traditional industry strengths in Europe – e.g. connected cars, eHealth, smart energy:
- to propose a series of measures to ensure R&D results are better linked to new standards, as well as for improved collaboration between standard-setting organisations in Europe and internationally.

The results of today's plan will ensure that European standards are in place quickly enough to allow future devices to connect smoothly across the Digital Single Market.

ADVANCED CONTENT

Innovation procurement can deliver solutions to challenges of public interest and ICT can play a major role in this.

How public procurers and suppliers have implemented innovation procurement

http://eafip.eu/resources/videos/

The eafip Toolkit provides support to policy makers in designing PCP and PPI strategies, and to procurers and their legal departments in implementing such procurements

http://eafip.eu/toolkit/

- Public Procurement of Innovative solutions (PPI) is used when challenges can be addressed by innovative solutions that are nearly or already in small quantity in the market and don't need new Research & Development (R&D).

- Pre-Commercial Procurement (PCP) can be used when there are no near-to-the-market solutions yet and new R&D is needed. PCP can then compare the pros and cons of alternative competing solutions approaches. This will in turn enable to de-risk the most promising innovations step-by-step via solution design, prototyping, development and first product testing.

The ICT innovation strategy under Horizon 2020 focuses on ensuring that the rapid changes occurring in ICT technology develop into tangible benefits for European citizens.

PPI happens when the public sector uses its purchasing power to act as early adopter of innovative solutions which are not yet available on large scale commercial basis.

PCP is an approach to public procurement of research and development

ADVANCED CONTENT

SOME ICT TECHNOLOGY TOOLS:

CLOUD STORAGE	Dropbox	Multiplatform file hosting service in the cloud. Free up to 2 Gb
	Gsuite	Multiplatform file hosting service in the cloud. Free up to 15 Gb
	One Drive	Multiplatform file hosting service in the cloud. Free up to 5 Gb
	ICloud	Multiplatform file hosting service in the cloud. Free up to 5 Gb
PROJECT MANAGEMENT	Basecamp	Task management for everyday users. Small to mid-sized companies
	Evernote	Project collaboration, scheduling and task management functionalities within a suite.
	Asana	Team collaboration. Small to mid-sized companies
	Trello	Collaborative brainstorming. Small to mid-sized companies
COMMUNICATION	Skype	Voice/video chat and 1-to-1 presentations at a specific time
	Blackboard	Structured teaching sessions, external access without login, interaction beyond text/chat
	Hangouts	Voice/video chat, utilising existing Google circles/groups

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

EDUCATION

The prototype of an online landscape, self-assessment tool and web portal is offered to stakeholders interested in its further development and enhancement, with a view to creating a fully-fledged service in the job placement, recruitment, e-skills development and certification market.

Self-assessment tool:

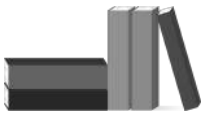
http://www.e-competence-quality.com/

MOOCS:

- Information and Communication Technology (ICT) Accessibility (edX) - Coursera
- Technical Support Fundamentals - Coursera
- System Administration and IT Infrastructure Services - Coursera
- Digital Transformations - Coursera

EXTERNAL MANUALS FOR MORE INFORMATION:

- PANORAMA. ICT practitioner skills and training: automotive industry
- Towards European e-Skills Quality Labels for ICT Industry Training and Certifications
- SMEs Going Digital - A Blueprint for ICT Innovation Vouchers



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SELF APPRAISAL

- ★ After reading this text, do I have a clear idea of what ICT is?
- ★ What skills should I improve in my work?

- ★ Do I know the benefits that ICT can bring to my company?
- ★ How could I detect any training need for my team?

INTRO 4.0

BIG DATA

EuroProfis

edit value
apoio à gestão

@nced
ASOCIACIÓN NACIONAL DE CENTROS DE e-LEARNING Y DISTANCIA

bit schulungscenter
member of bit group

Co-funded by the
Erasmus+ Programme
of the European Union

Associate partner:
udima
UNIVERSIDAD A DISTANCIA DE MADRID

INTRODUCTION TO THE INDUSTRIAL REVOLUTION 4.0

These didactical materials, which have been developed in the framework of the European project 'Industry 4.0 - INTRO 4.0', funded by the European Commission aims to come up with an overview of what has been done in the European Industry in terms of Industry 4.0.

The content of these didactical materials provides the most relevant and useful information on Industry 4.0 to a target group that includes: adults, educators (VET & Higher Education), teachers, trainers, coaches, employers, employees, the general public, and suppliers of innovative solutions.

This information is rooted within the report 'Current Status Of The Industry 4.0' and the report 'Summary Report of the expert interviews/questionnaires and the specific research on the field of manufacturing companies", both developed by the partners of this project.

INDEX

THIS CONTENT MAY BE OF GREATER INTEREST TO THE COMPANIES

THIS CONTENT MAY BE OF GREATER INTEREST TO THE GENERAL PUBLIC

LEARNING OBJECTIVES

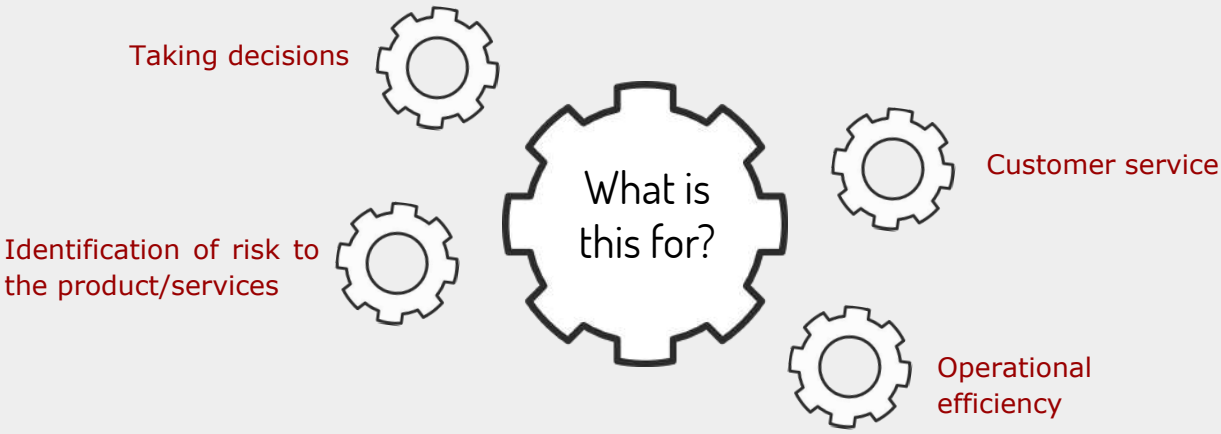
- Understand Big Data.
- Identify Big Data opportunities.
- Recognize and improve most value skills.
- Monitor organizational challenges and good practices.
- Increase company resources and benefits.
- Perform useful strategies.
- Set practical uses.
- Provide useful information about courses and certificates

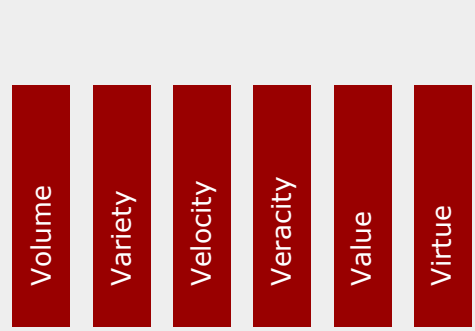
INTRODUCTION

Big Data refers to large amounts of data produced very quickly by a high number of diverse sources.

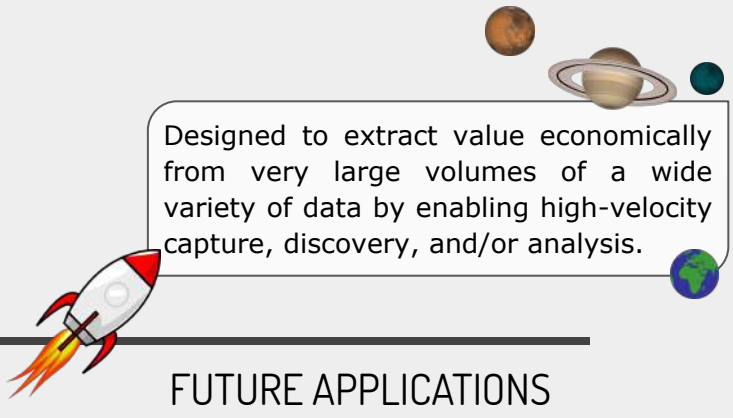
Learning Objectives

- Understand Big Data
- Identify Big Data opportunities
- Recognize and improve most value skills
- Monitor organizational challenges and good practices
- Increase company resources and benefits
- Perform useful strategies
- Set practical uses
- Provide useful information about courses and certificates





6 Vs of Big Data



FUTURE APPLICATIONS

WHAT IS IT?

Across society, from health to agriculture and transport, from energy to climate change and security, practitioners in every discipline recognise the potential of the enormous amounts of data being created every day. The challenge is to capture, manage and process that information to derive meaningful results and make a difference to people's lives. Data can either be created by people or generated by machines, such as sensors gathering climate information, satellite imagery, digital pictures and videos, purchase transaction records, GPS signals, etc. It covers many sectors, from healthcare to transport and energy, communications and retail.

Figure 1. Big Data uses. Source: www.edureka.com

Generating value at the different stages of the data value chain will be at the centre of the future knowledge economy. Good use of data can also bring opportunities to more traditional sectors such as transport, health or manufacturing.

WHAT IS IT?

- Transform service industries by generating a wide range of innovative information products and services
- Increase the productivity of all sectors of the economy through improved business intelligence
- Better address many of the challenges that face our societies
- Improve research and speed up innovation
- Achieve cost reductions through more personalised services
- Increase efficiency in the public sector
- Digitising European Industry

Figure 2. Predictive analytics. Source: www.dreamstime.com

XV-XIX

- The Emergence of Statistics
- First recorded experiment in statistical data analysis.
- The Hollerith Tabulating Machine used punch cards reducing 10 years' work to three months

XX

- The Early Days of Modern Data Storage
- The Beginnings of Business Intelligence
- The Start of Large Data Centers
- The Emergence of the Internet

XXI

- Early Ideas of Big Data
- "Internet of Things"
- Web 2.0 Increases Data Volumes
- Today's Use of the Term 'Big Data' Emerges
- Final Thought

WHAT IS THIS FOR?

Big Data presents great opportunities as they help us develop new creative products and services, for example apps on mobile phones or business intelligence products for companies. It can boost growth and jobs in Europe, but also improve the quality of life of Europeans.

Healthcare

Enhancing diagnosis and treatment while preserving privacy, Big Data offers solutions for improved efficiency in healthcare information processing which in turn creates value for businesses, public sector and citizens. The analysis of large clinical datasets can result in the optimisation of the clinical and cost effectiveness of new drugs and treatments and patients can benefit from more timely and appropriate care. Data interoperability is of utmost importance since the data is derived from diverse and heterogeneous sources such as bio-signal streams, health records, genomics and clinical lab tests. Privacy-preserving technologies aim at providing access to health data for patients, healthcare professionals and clinical researchers in a uniform way and in an anonymized and aggregated form to develop better prevention or treatment options.

Data Markets

Information technology has driven, directly or indirectly, much of Europe’s economic growth during the last decades as the role of data transitioned from the support of business decisions to becoming a good in itself. An open approach towards data value creation has become critical in the new networked economy, with Europe well placed to nurture this new revolution.

Transport: fewer accidents and traffic jams

The transport sector can clearly benefit from Big Data collected through sensors, GPS data and social media in particular. A smart use of Big Data supports governments in optimising multimodal transport and managing traffic flows, making our cities smarter. Citizens and companies can save time through the use of route planning support systems.

WHAT IS THIS FOR?

Environment: reduced energy consumption

The Big Data revolution brings about novel ways of understanding and addressing environmental challenges. A better use of globally available national and local datasets helps scientists in their research and enables policy-makers to make informed and evidence-based decisions related to natural disasters like flooding, to fight against climate change and reduce costs. Smart cities also host data centres adapting the power consumption of public buildings to the availability of renewable energy and other useful indicators. At the same time, our mobiles devices become smarter by integrating analytical tools to reduce our energy consumption and save money.

Open Data

Open Data refers to the information collected, produced or paid for by the public bodies and made freely available for re-use for any purpose. Public sector information is information held by the public sector. The Directive on the re-use of public sector information provides a common legal framework for a European market for government-held data. It is built around the key pillars of the internal market: free flow of data, transparency and fair competition.

Agriculture: safer food and increased productivity

A smart use of Big Data in agriculture can increase productivity, food security and farmer incomes at the same time. Through an intelligent and widespread use of data coming from sensors and Earth observations such as the open data from the Copernicus Programme the ways we are farming today can be changed entirely for the better. This can lead to a more efficient use of natural resources (including water or sunlight) in our farming practices. With advanced technologies farmers can have access to data in real time on how their farm machinery is working as well as to historic weather patterns, topography and crop performance.

Industrial impact / Big Data access technologies / Research

Maximally exploiting available data is increasingly critical to industrial competitiveness. Accessing the relevant data is becoming progressively difficult due to the explosion in the size and complexity of data sets. Maximally exploiting data requires flexible access and engineers need to explore the data in ways not supported by current applications. Engineers spend up to 80% of their time on data access problems. Apart from the enormous direct cost, freeing up expert time would lead to even greater value creation through deeper analysis and improved decision making.

WHAT IS THIS FOR?

TOP 8 BIG DATA SKILLS FOR WORKERS

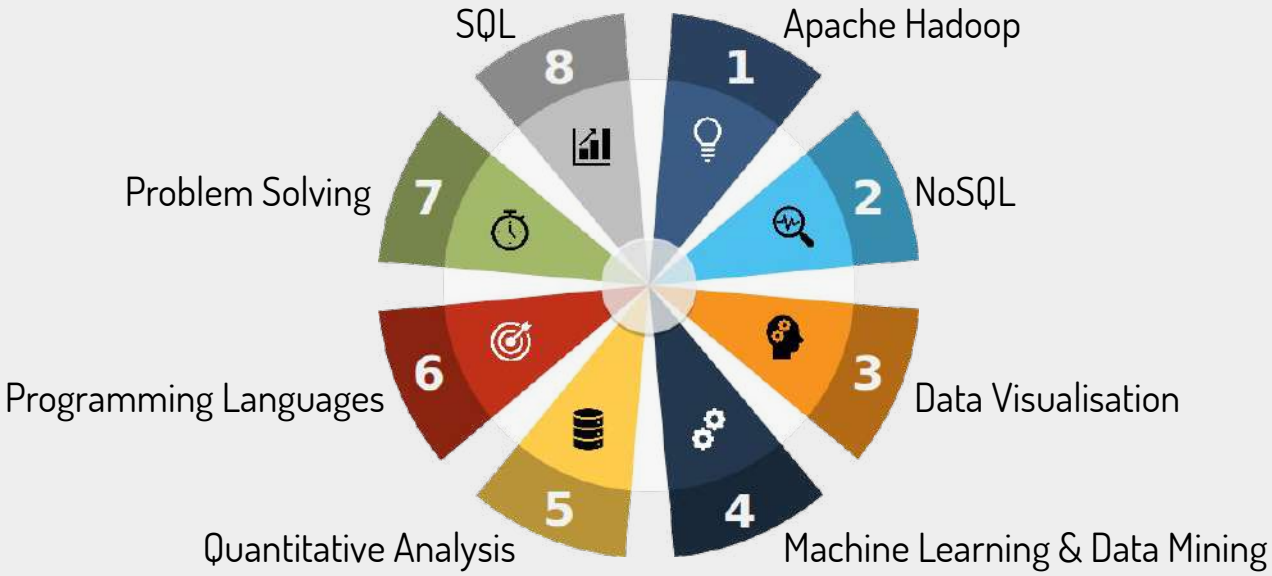


Figure 3. Top 8 Big Data skills for workers.
Source: Self made

Apache Hadoop: Hadoop is an open-source, a Java-based programming framework that continues the processing of large data sets in a distributed computing environment. It runs few applications on distributed systems with thousands of nodes involving petabytes of information. It has a distributed file system, called Hadoop Distributed File System or HDFS, which enables fast data transfer among the nodes. A modern implementation of Hadoop now features an ecosystem of related projects that provide a rich set of big data services:

- Apache Spark is a distributed processing engine that performs high performance, in-memory processing of large data sets.
- Apache Hive provides built-in data warehousing capabilities to the Hadoop system using a SQL-like access methods for querying data and analytics.
- Apache HBase is a scalable, distributed NoSQL wide column database built on top of HDFS.
- Apache Zeppelin is a web-based, multi-purpose notebook that enables interactive data processing including ingestion, exploration, visualization, and collaboration features for Hadoop and Spark.

WHAT IS THIS FOR?

NoSQL: The NoSQL databases including Couchbase, MongoDB, etc. are replacing the traditional SQL databases like DB2, Oracle, etc. These distributed NoSQL databases help in meeting the Big Data storage and access needs. This complements the expertise of Hadoop with its data crunching ability. The professionals with NoSQL expertise can find opportunities everywhere.

Data Visualisation: The data visualization tools like QlikView, Tableau can help in understanding the analysis performed by the analytics tools. The complex Big Data technologies and processes carried out are tough to grasp, and this is where the role of professionals come into the picture. A professional well versed with data visualization tools can get a chance to grow in their career with big organizations.

Machine Learning & Data Mining: Data mining and Machine Learning are the two hot fields of Big Data. Though the landscape of Big Data is vast, these two make an important contribution to the field. The professionals that can use machine learning for carrying out predictive and prescriptive analysis are scarce. These fields can help in developing recommendation, classification and personalization systems. The professionals with the knowledge of data mining and machine learning are heavily paid as well.

Quantitative Analysis: Quantitative and Statistical analysis is a significant part of Big Data as it is all about numbers. The background in statistics and mathematics helps a lot. The knowledge of tools like SAS, SPSS, R, etc. help in adding to your skills as well. Hence, the industry required professionals with the quantitative background in large numbers.

Programming Languages: Certain general-purpose programming languages can help you a great deal in gaining a competitive edge over others. These programming languages include Java, Python, C, Scala, etc. Even the programmers with experience in data analytics are in great demand.

WHAT IS THIS FOR?

Problem Solving: Even if you carry the knowledge of all tools and technologies in the Big Data field, the ability of problem-solving and creativity will help you to perform your tasks well. Implementation of Big Data techniques for efficient solutions will require both these qualities in a professional.

SQL: SQL is the data centered language that works as a base for the Big Data era. The knowledge of Structured Query Language will essentially be an added advantage to the programmers while working on Big Data technologies like NoSQL. It is also an important part of the Hadoop Scala warehouses.

Most valued skills:

1. Teamwork
2. Business acumen
3. Intellectual curiosity
4. Problem solving
5. Communication skills

Not all applications of Big Data technologies are for analysis of data. Some are used for deploying Web sites for social media or gaming applications, and others are used for large content stores that provide information access to massive amounts of documents. Examples include:

Analytics (e.g., data mining, multi-dimensional analysis, data visualization)

Operations (e.g., running a Web site, processing online orders)

Information access (e.g., search-based access to information, normalization, and access across content and data sources)

WHAT IS THIS FOR?

Improving your Big Data skills you will be able to...

Figure 4. Capabilities when improving Big Data skills. Source: Self made

WHAT IS THIS FOR?

How to Develop Your Big Data Skills?

Data Visualisation and Analytical Skills

Big Data tools essentially carry out data analysis to derive important insights from the large datasets. Being familiar with the business domain can help you to understand the data for which the analysis is conducted.

The data professionals shall have an ability to interpret the data by visualizing it. This needs a specific science and mathematics edge to understand the complex data with creativity and imagination. Learning the analytics tools can help you to develop your data visualization and analytics skills.

Programming Ability

The ability to code and conduct statistical and quantitative analysis is a significant requirement in Big Data market. The background in mathematics will help greatly. Knowledge of Object-Oriented Languages and the fundamental knowledge of data structures and algorithms can go a long way. It is important to be familiar with sorting algorithms, data types, etc.

Familiarity with Technologies

It is important for a Big Data professional to be familiar with a range of tools and technologies that the industry uses. The number of tools you can work with, the better it is. These tools help in performing research analysis and reaching conclusions.

These technologies include SPSS, Excel, SQL, SAS, R, MatLab, Python, Linux, Hadoop, Scala, etc. There are many open source technologies written in other languages giving an edge to the technical experts. The demand for people with both statistical and programming skills is even higher.

Hands on experience and developing yourself

Intenta obtener experiencia práctica con las herramientas de Big Data que estás aprendiendo. Dado que la tecnología cambia muy rápidamente, estudiar algunos cursos puede ayudar significativamente. La interacción con las bases de datos puede ayudar a comprender mejor las herramientas de datos. El aprendizaje automático y la minería de datos pueden ayudarte a obtener una mejor experiencia en herramientas Big Data. Puedes buscar cursos en línea para aprender más sobre estas tecnologías.

GOOD PRACTICES

Today, almost any interaction made over the Internet or through the consumption of goods and services is being tracked, stored, and used in targeted ways. This has led to the notion of Big Data massive amounts of data that reflect the behavior and actions of various people. Data scientists and data collection platforms are now able to computationally organize petabytes and exabytes of data so that it is easy to analyze and identify patterns that may have otherwise gone undetected.

Big Data technologies are being deployed in support of processes within commercial, nonprofit, or government organizations. The challenges and problems organizations face are not Big Data challenges but rather business or organizational challenges that are impacted by Big Data. Big Data technology deployment cases can be found across business processes such as:

- Customer relationship management (sales, marketing, customer service, etc.)
- Supply chain and operations
- Administration (focused on finance and accounting, human resources, legal, etc.)
- Research and development
- Information technology management
- Risk management

GOOD PRACTICES

BBVA

The history of BBVA is the history of the many different people who have been a part of the more than one hundred financial institutions that have joined our corporate endeavor since it originated in the mid-19th Century. During the economic development of the 1960s until now , BBVA has expanded, acquiring other banks and creating a solvent financial group. Prestigious financial publications recognized the efficiency of BBVA's integration, naming it the best bank in the world (Forbes) and in Spain (The Banker) and in the year 2000, the best bank in Latin America (Forbes) and the best bank in Europe (Lafferty) in 2001.

Corporate responsibility is at the core of its business model. BBVA fosters financial education and inclusion, and supports scientific research and culture. It operates with the highest integrity, a long-term vision and applies the best practices. They really believe the knowledge derived from financial data can transform the banking industry. Thus, they implement and use the most advanced analytics and artificial intelligence to offer the best digital interaction with the customer. The challenge, and more accurately the opportunity, comes not from the gathering and storing, but rather from how insight is derived from that data – how it is put to good use, and it's an area where BBVA is gaining recognition as a leader and expert in the field,transforming Big Data into financial intelligence for large institutions as well as smaller companies and individuals that in the past had not access to such advantages.

Some leading companies:

vmware ESXi, Microsoft, IBM, Google, Hewlett Packard Enterprise, ORACLE, SAP, alteryx, TERADATA, cogito, amazon web services, splunk>, DELL EMC

BENEFITS FOR THE COMPANY

Big Data Management solutions:

- Provide companies the ability to add a variety of data from hundreds of different sources in real time. This means that you can increase the client's commitment since you can have more effective interactions with them and better marketing proposals, which ultimately lead the company to achieve a longer and more profitable relationship with the client.
- Eliminate data niches, so that organizations can obtain a unique view of the customers that include countless descriptive, calculated and industry-specific metrics that allow for the construction of a detailed record of the behavior of each client. These profiles provide organizations with a global understanding of their clients through in-depth knowledge of the client and its operations.
- Provide organizations with complete customers' profiles, which allows for more personalized customer experiences at each point where contact is made throughout the entire journey of the company.
- Your organization can address the data it needs to obtain actionable information and increase the value of the entire relationship with the client. Apps developed by a smartphone app development company can be used to sustain a good relationship with your clients.

The reality is that as data volumes continue to increase, its promise for companies also appears to exponentially grow. This allows companies to convert raw data into relevant projections, predictions, and trends with accuracy.

Big Data is Timely: 60 percent of each work day, knowledge workers spend it trying to find and manage the data. Big Data can provide timely reports immediately.

Big Data is Accessible: Half of the senior executives indicate that access to correct data is often difficult.

Big Data is Holistic: The information is currently stored in silos within many organizations. Marketing data, for example, can be found in web analytics, mobile analysis, social analysis, CRM systems, A/B testing tools, email marketing systems, and many other sites each with its focus on its silo.

BENEFITS FOR THE COMPANY

Big Data is Reliable: Things as simple as securing the correct contact data of customers through the review of multiple systems can save thousands of Dollars in incorrectly sent communications.

Big Data is Relevant: 43 percent of companies are not satisfied with the ability of their tools to filter irrelevant data.

Big Data is Safe: A breach of data security costs hundreds of dollars per customer.

Big Data is Precise: Businesses have difficulty with multiple versions of the fact based on the supply of their info. Combining multiple reliable sources, businesses can create accurate correct of intelligence.

Big Data is Usable: Many companies make bad decisions due to obsolete or bad data. Big Data can ensure that the data is usable without fear of mistakes.

Advantages

- Better decision-making
- Increased productivity
- Reduce costs
- Improved customer service

- Increased revenue
- Increased agility
- Greater innovation
- Faster speed to market
- Fraud detection

Disadvantages

- Need for talent
- Address data quality issues
- Need for cultural change
- Compliance with regulations

- Cybersecurity risks
- Technology changes
- Hardware needs
- Difficulty integrating legacy systems

Figure 5. Advantages and Disadvantages of Big Data.
Source: Self made

FUTURE APPLICATIONS

The importance of Big Data does not revolve around how much data a company has but how a company utilizes the collected data. Every company uses data in its own way; the more efficiently a company uses its data, the more potential it has to grow. The company can take data from any source and analyze it to find answers.

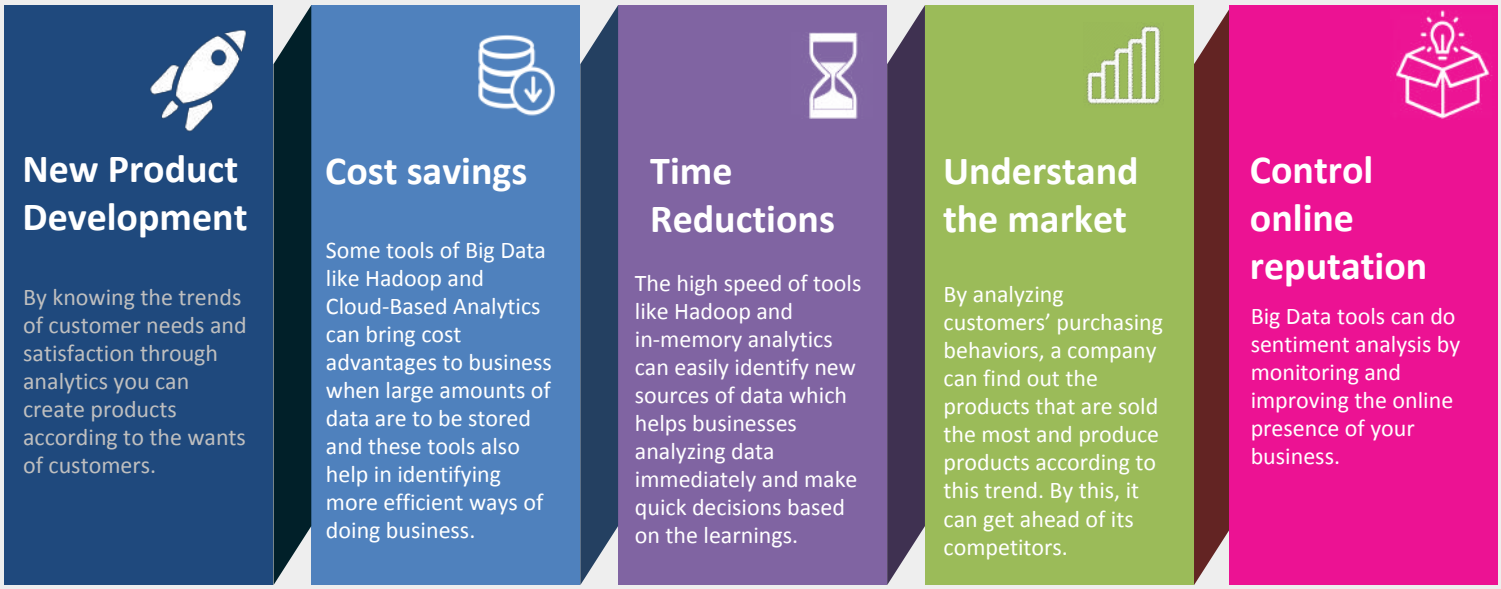


Figure 8. Benefits of Big Data for companies. Source: Self made

The use of Big Data is becoming common these days by the companies to outperform their peers. In most industries, existing competitors and new entrants alike will use the strategies resulting from the analyzed data to compete, innovate and capture value.

Big Data helps the organizations to create new growth opportunities and entirely new categories of companies that can combine and analyze industry data. These companies have ample information about the products and services, buyers and suppliers, consumer preferences that can be captured and analyzed.

FUTURE APPLICATIONS

Practical Uses of Big Data:

Different industries are using Big Data in different ways. In our list, we have compiled the uses of Big Data and what industries are using them.

Location Tracking: Logistic companies have been using location analytics to track and report orders for quite some time. With Big Data in the picture, it is now possible to track the condition of the good in transit and estimate the losses. It is now possible to gather real-time data about traffic and weather conditions and define routes for transportation. This will help logistic companies to mitigate risks in transport, improve speed and reliability in delivery.

Precision Medicine: With Big Data, hospitals can improve the level of patient care they provide. 24x7 monitoring can be provided to intensive care patients without the need of direct supervision. On top of that, the efficiency of medication can be improved by analyzing the past records of the patients and the medicines provided to them. The need for guesswork can be significantly reduced. In the case of certain biopharmaceuticals, there are many variables that impact the final product. For example, while manufacturing insulin intense care needs to be taken to ensure the product of desired quality. By analyzing all the factors impacting the final drug Big Data analysis can point out key factors that might result in incompetence in production.

FUTURE APPLICATIONS

Fraud Detection & Handling: Banking and finance sector is using Big Data to predict and prevent cyber crimes, card fraud detection, archival of audit trails, etc. By analyzing the past data of their customers and the data on previous brute force attacks banks can predict future attempts. Not just Big Data helps in predicting cyber crimes but it also helps in handling issues related to miss transactions and failures in net banking. It can even predict possible spikes on servers so that banks can manage transactions accordingly. The Securities Exchange Commission (SEC) is using Big Data to monitor financial markets for possible illegal trades and suspicious activities. The SEC is using network analytics and natural language processors to identify possible frauds in the financial markets.

Advertising: Advertisers are one of the biggest players in Big Data. Be it Facebook, Google, Twitter or any other online giant, all keep a track of the user behavior and transactions. These internet giants provide a great deal of data about people to the advertisers so that they can run targeted campaigns. Take Facebook, for example, here you can target people based on buying intent, website visits, interests, job role, demographics and what not. All this data is collected by Facebook algorithms using Big Data analysis techniques. The same goes for Google, when you target people based on clicks you will get different results and when you create a campaign for leads that you will get different results. All this is made possible using Big Data.

Entertainment & Media: It is focused on targeting people with the right content at the right time. Based on your past views and your behavior online you will be shown different recommendations. This technique is popularly used by Netflix and Youtube to increase engagement and drive more revenues. This will allow in better revenue from ads and will provide a more engaging user experience.

FUTURE APPLICATIONS

TRENDS:

❖ Rapidly Growing IoT Networks

It is becoming quite common that our smartphones are being used to control our home appliances, thanks to the technology called the Internet of Things (IoT). With smart devices such as Google Assistant and Microsoft Cortana trending in homes to automate specific tasks, the growing IoT craze is drawing companies to invest in the technology's development.More organizations will jump on the opportunity in providing better IoT solutions. This will lead to more ways to collect vast amounts of data, and along with it the means to manage and analyze it. The industry response is to push for more new devices that are more capable of collecting, analyzing and processing data.

INTERNET OF THINGS (IOT)

The Internet of Things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

❖ Accessible Artificial Intelligence

Artificial intelligence is now more commonly utilized to help both big and small companies improve their business processes. AI programs can now execute tasks that make it faster and more precise than humans, cutting down errors along the way and improving the overall flow. This allows humans to focus better on more critical tasks and further enhance the quality of service.The good news is everybody can have access to pre-built machines that run AI applications to address the growing demand, which levels the playing field for companies in the same industry. Individual organizations may gain an advantage if they find the most efficient way to integrate this into their business process.

FUTURE APPLICATIONS

❖ The Rise of Predictive Analytics

Big Data analytics has always been a key strategy for businesses to have a competitive edge and achieve their goals. They use the necessary analytics tools to process Big Data and determine the reasons why certain events happen. Now, predictive analysis through Big Data can help predict what may occur in the future. There is no doubt this kind of strategy is highly effective in helping analyze gathered information to predict consumer behavior. This allows companies to determine the measures they have to take by knowing a customer's next action before they even do it. Analytics can also provide more context on data to help understand the reasons behind them.

❖ Dark Data Migration to the Cloud

Information that is yet to be transformed into digital format is called dark data, and it is a huge reservoir that is currently untapped. These analog databases are expected to be digitized and migrated to the cloud, so they can be used for predictive analytics that benefits businesses.

❖ Chief Data Officers Will Have Bigger Roles

Now that Big Data is increasingly becoming an essential part of executing business strategies, chief data officers are adopting a more critical role in their organization. They are expected to take a more active position in steering the company towards the right direction. This trend opens doors for data marketers who are looking for career growth.

FUTURE APPLICATIONS

❖ Quantum Computing

Getting to analyze and interpret massive amounts of data can take a lot of time with the current technology we are using. If only we can crunch billions of data at once in just a few minutes, we can cut processing time immensely, giving companies the opportunity to make timely decisions to achieve more desired results. This huge undertaking can only be possible through quantum computing. Despite being in its infancy, experiments are currently being carried out on quantum computers in an effort to help in practical and theoretical research across different industries. Pretty soon, large tech companies such as Google, IBM, and Microsoft will start testing quantum computers to integrate them into their business processes.

❖ Smarter and Tighter Cybersecurity

Organizations have grown paranoid over the past scandals that involved hacking and system breaches. This has prompted them to focus on strengthening information confidentiality. IoT is also being a cause for concern with all the data being collected; cybersecurity is an issue. To address this perpetually impending threat, Big Data companies pitch in to help organizations use data analytics as a tool to predict and detect cybersecurity threats. Big Data can be integrated into a cybersecurity strategy through security log data where it can be used to provide information about past threats. This can help companies prevent and mitigate the impact of future hacks and data breaches.

FUTURE APPLICATIONS

❖ Open Source Solutions

There are many public data solutions available, such as open source software, that have been making considerable improvements to speed up data processing. They now have features that allow access and response to data in real time. For this reason, they are expected to flourish and will be in high demand from 2019. There is no doubt open source software is cheaper, in that it can help your business cut operations costs.However, there are some downsides that you need to know if you are willing to give them a shot.

❖ Edge Computing

Edge computing is set to leave the cloud in the dust when it comes to processing data. It delivers a better performance since there is less data flowing in and out of the network, with less cloud computing costs. The company can also benefit from storage and infrastructure costs if they choose to delete unnecessary data collected from IoT. Additionally, edge computing can speed up data analysis, giving companies ample time to react.

❖ Smarter Chatbots

Powered by smarter AI, chatbots are now being deployed by companies to handle customer queries to deliver more personalized interactions while eliminating the need for actual human personnel. Big Data has a lot to do with delivering a more pleasant customer experience as bots process large amounts of data to provide relevant answers based on the entered keywords by customers in their queries. During interactions, they are also able to collect and analyze information about customers from conversations. This process can help marketers develop a more streamlined strategy to achieve better conversions.

ADVANCED CONTENT

The vast collections of information available on the web and in the cloud could help prevent the next financial crisis, or even tell you exactly when your bus is due. The key lies in giving everything (whether it's a person, business or product) a unique identifier.

The EU data market has been analysed in the past years by several studies and reports. Despite of this growing bottom-line market, there are some barriers:

- Europe has been slow to adopt data technologies compared to the US.
- Data skills gap.
- Standardization. Increasing complexity and variety on standards can slow innovation.
- Privacy and data protection. A reliable legal framework, like GDPR, is complex but can guarantee success of the companies.
- Reaching all sorts of SMEs and start-ups. Companies emerging from entrepreneurial ecosystems like accelerators or incubators are usually not so linked to EU initiatives.

Data Market Services is born to overcome the barriers of data-based SMEs and start-ups in Europe in data skills, entrepreneurial opportunities, legal issues and standardization, thanks to the provision of free support services for them.

ADVANCED CONTENT

To learn Big Data, it is important to get some hands-on experience apart from the theoretical knowledge. Organisations looking for data analysts and data scientists often prefer the talent with special Big Data certifications in the field. The candidates can gain an edge over others by having certain certifications on their resume.

There are some important, helpful certifications in building a career in Big Data:

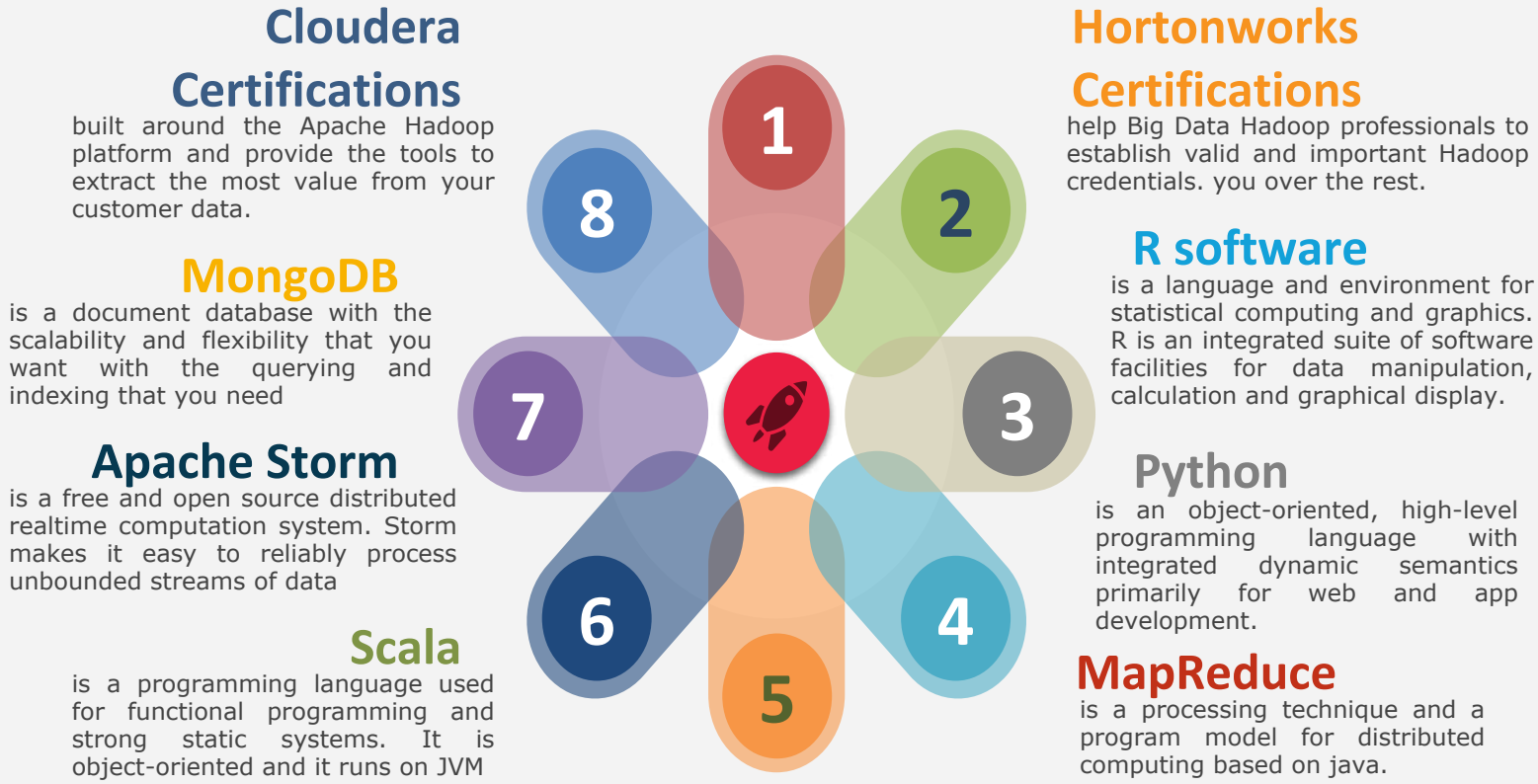


Figure 9. Certifications in building a career in Big Data.
Source: Self made

ADVANCED CONTENT

Creating a strategy

1 **Identify What You Want:**

Your end goal has the biggest impact on the shape of your overall strategy. You need to decide whether you want to increase the efficiency of customer reps, improve operational efficiency, increase revenues, provide better customer experience or improve marketing. The goal you have should be precise, certain and direct. Any strategy with just the sole purpose of exploring possibilities is likely to end up in confusion. Based on your goal you can choose a methodology, hire employees and select the right sources of data. So create SMART (Specific, Measurable, Attainable, Relevant and Timely) goals and make plans accordingly.

2 **Leverage a Proven Big Data Strategy:**

There are 4 proven ways to create a working Big Data strategy. Based on your end goal and availability of data you can choose either of the below Big Data strategies to attain successful results:

A. Performance Management: It involves using transactional data like customer purchase history, turnover and inventory levels to make decisions relating to store management and operational supremacy. This data is available within the organization and gives insights into subjects relating to short term decision making and long term planning. It works well with companies with large historical databases that can be leveraged without much pain. It can also help with better customer segmentation and targeting.

ADVANCED CONTENT

B. Data Exploration: This approach makes heavy use of data mining and research to find solutions and correlations that are not easily discoverable with in-house data. Currently, it is used by companies focusing on robust inbound marketing to generate insight on prospects behavior on the website. It helps you identify new segments of data and bring out insights regarding customer's behavior and preferences.

C. Social Analytics: Social analytics measures the non-transactional data on various social mediums and review sites like Facebook, Twitter and Google+. It is based on the analysis of conversations and reviews that come up on these platforms. It brings out three primary analytics viz. awareness, engagement, and word-of-mouth. In-stream data analysis techniques like sentiment analysis prove very effective in these cases. It gives insights on the brand identity and customer's opinions on new offerings and services. The social analysis also proves effective in predicting spikes in demand for certain products.

D. Decision Science: Decision science refers to the experiments and analysis on non-transactional data, such as consumer-generated content, ideas, and reviews. Decision science is more about exploring possibilities than measuring known objectives. Unlike social analysis, that is based on engagement analytics, decision science focuses on hypothesis testing and ideation process. This involves extensive use of text and sentiment analysis to understand customer's opinions about new services and schemes.

ADVANCED CONTENT

3 Identify Infrastructural Changes:

To leverage Big Data particularly historical databases you might need to create many infrastructural changes in the company. If the old company data was stored in traditional formats it might not facilitate the running of complex algorithms and analysis. Moreover, different departments may need integration to collect and streamline data to put it to more usable format. Integration between different departments is key to bringing and implementing changes at scale. If your existing infrastructure is not interlinked properly then you will need to prepare for big changes.

4 Establish Talent Pool:

Human Resources is one of the most critical aspects of creating a Big Data strategy. Your Big Data team must have statisticians to make sense out of data, business analysts to communicate insights to the decision makers and key decision makers themselves who are capable to lead the team. Without a proper team, the discussions on Big Data may revolve around jargons that are not clear to either of the teams. A proper language needs to created to facilitate discussions between the business leaders and the technical team. If this is not done properly then no side will be able to understand the insights and the entire execution will end up with regrets and blame games.

ADVANCED CONTENT

5 Obsess Over Customer Satisfaction:

The key use of Big Data is to generate insights that can help companies serve their customers in a better way. Customer oriented marketing is the new way of approaching the market and making revenues. At the end of the day, you need to communicate to your customer that you are there to solve a problem and not just to make money. Big Data provides such insights into the customer mind set that can be used to improve and even alter the current marketing practices. Another thing you need to focus on is to create a fine line between data gathering and privacy abuse. Your customers should not feel like they are spied.

6 Ensure Usability:

Many times it happens that the insights created by the statisticians are beyond comprehension for staff. The data, analytics, and insights that are collected by the analysts needs to be communicated precisely to the implementation team. The information should be comprehended and represented in a way that its value is identified by people who are not from a statistical background. This can be done by using graphical representation and by communicating direct instructions to the teams involved.

7 Be Agile:

This goes without saying. While implementing disruptive technologies many hurdles might come up that no one initially thought about. You need to adjust your budget, people, and ideologies based on the circumstances and insights you gather. It is best to start with a high-level plan and make changes as the need be. You might come up with an action plan that is nowhere close to the initial idea but it will be worth the toil.

ADVANCED CONTENT

SOME BIG DATA TOOLS:

FusionCharts Suite XT

Interactive charts for reports, dashboards, analytics, monitors, and surveys.

QlikView

Software for business intelligence & data visualization. You can analyze data and use your data discoveries to support decision making.

Tibco Spotfire

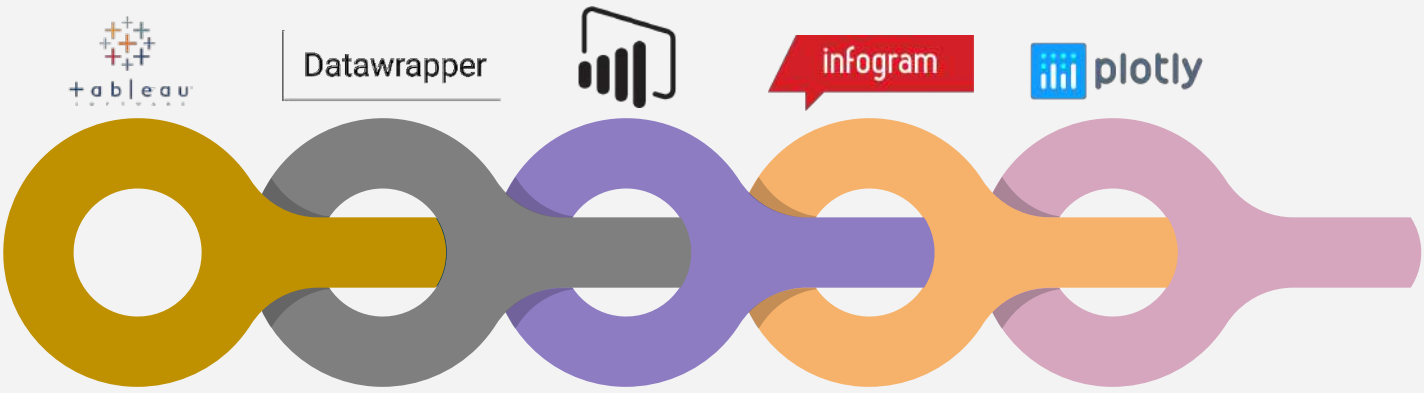
Is a very powerful data visualization tool that allows users to access and combine data in a single analysis. It gives you a quick insight into your data.

Watson Analytics

Is a smart data analysis and visualization service on the cloud that helps just about anyone quickly discover patterns and meanings in their data.

Sisense

It is a platform that gives analytic builders the tools to simplify complex data and provide insights to everyone.



Tableau

You can create interactive and flexible dashboards making use of custom filters and its drag and drop functions.

Datawrapper

Is an easy to use tool for creating visualizations like infographics, maps, data tables and responsive charts like line, bar, stacked bar, donut, etc.

Microsoft Power BI

Is a business analytical tool which makes it easy for businessmen to visually analyze their data and form strategies based on it.

Infogram

It makes accessing data easy by letting you edit the data in the editor and connect to your desirable cloud service.

Plot.ly

Has a graphical user interface for importing and analyzing data into a grid and using stats tools.

Figure 10. Some Big Data tools. Source: Self made

EDUCATION

Test your knowledge of Big Data tools in the cloud with this quiz:

Self-assessment tool:

https://searchcloudcomputing.techtarget.com/quiz/Test-your-knowledge-of-big-data-cloud-services

Degrees/Masters

- MSIT: BUSINESS INTELLIGENCE & DATA ANALYTICS (BIDA) - Carnegie Mellon University's Heinz College
- M.S. in Statistics: Data Science - Stanford University
- Big Data, Strategic Decisions: Analysis to Action - Stanford Graduate School of Business
- Master of Science in Data Science – ETH Zurich

MOOCs

- Big Data Analysis: Hive, Spark SQL, DataFrames and GraphFrames -Coursera
- Big Data Applications: Machine Learning at Scale -Coursera
- Managing Big Data with MySQL - Coursera
- Intro to Machine Learning - Udacity

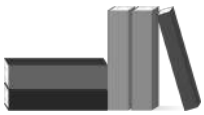
EDUCATION

External manuals & tutorials for more information

- Data Analytics Made Accessible, by A. Maheshwari
- Lean Analytics: Use Data to Build a Better Startup Faster, by A. Croll and B. Yoskovitz
- Big Data and Hadoop Tutorial - Intellipaat
- Introduction to Machine Learning
- Introduction to Data Science
- Big Data Quick Exploratory Self-Assessment Guide

Certifications

- Cloudera Certified Professional
- Intellipaat Big Data Hadoop Certification
- Microsoft's MCSE : Data Management and Analytics
- Hortonworks Hadoop Certification



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SELF APPRAISAL

- After having read this text do I have a clear idea of what Big Data is?
- What tools am I used to?

- Do I know the benefits that Big Data can bring to my company?
- Can I recognize the advantages and disadvantages of its implementation for my company?