Information and Communication Technologies (ICT)

The role of ICT in key sectors of the development of society. Standards in the field of ICT

Course Overview

- **The course provides** an overview of the **major conceptual** paradigms of **Information and Communication Technologies**, from their **theoretical foundations** to **practical implementation**

- <u>Topics will include</u>
  - **Architecture of Computer Systems**
  - **Operating systems** and **software**
  - **Network technologies** and **telecommunications**
  - **ICTs** in the **professional field**
  - **Perspective trends of ICTs**

Lecture 1

- **<u>Overview of Today's Lecture</u>**
  - Definition of ICT. The subject of ICT and its objectives
  - The role of ICT in key sectors of the development of society
  - Standards in the field of ICT
  - Internet of the future. Content technologies and information management
  - Cybersecurity.

What technologies?

- What do you understand by Information and Communication Technologies?

Defining ICTs

- Standard definitions:
  - **ICT** (<u>information and communications technology</u> - or <u>technologies</u>) is an umbrella term **that includes** <u>any communication device</u> or <u>application</u>,
  - **encompassing**: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and <u>distance learning</u>.
  - ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries.

(techtarget.com)

The role of ICT in key sectors of the development of society

- **Telecommunications**
- **ICT in Education**
- **ICT in Public Sector Management**
- **ICT in Health**
- **ICT in Agriculture and Food Security**

The role of ICT in key sectors of the development of society
Telecommunications

- **Telecommunication** is the transmission of signs, signals, messages, words, writings, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

- Telecommunication take place when the exchange of information between communication participants includes the use of technology. It is transmitted either electrically over physical media, such as cables, or via electromagnetic radiation

The role of ICT in key sectors of the development of society
ICT in Education

ICT can improve the efficiency and quality of education at all levels. Part of ICT's strategy to support its education policy principles is promoting "experimentation with, and **dissemination** of, innovative strategies and technologies in education." This involves developing appropriate e-applications to help of learning and teaching

propagation, spread, distribution

The role of ICT in key sectors of the development of society
ICT in Public Sector Management

E-government is the use of **ICT** to promote more efficient and cost-effective government, facilitate more convenient government services, allow greater **public** access to information, and make government more transparent and accountable to citizens

The role of ICT in key sectors of the development of society
ICT in Health

ICT can be a powerful tool for improving health and related services. ICTs projects are helping to improve dissemination of public health information, bridge the gap in consultation, diagnosis, and treatment between resource-rich and resource-poor hospitals, facilitate learning, enhance the ability to monitor diseases and other health issues, and make health administration more efficient

The role of ICT in key sectors of the development of society
ICT in Agriculture and Food Security

ICT efforts are raising agricultural productivity and the quality of life of farmers and the rural poor by improving information flows, communication, and access to reliable, up-to-date information. This enables strategic decision-making by farmers and prevents or mitigates losses caused by natural disasters

Standards in the ICT field

- Application and administration

- Scoping requirements

- Functional Performance Criteria

- Hardware

- Platforms and Applications

- Documentation and Support Services

You can find full information about standards ICT in here:
Information and Communication Technology (ICT) Standards and Guidelines (US)

https://www.access-board.gov/attachments/article/490/draft-rule.pdf

Development of ten standards for ICT field (Qazaqstan)

https://zerde.gov.kz/en/press/news/Development-of-ten-standards-for-ICT-field/#hcq=EQgCxvq

A new generation of components and systems

- ICT1 – 2016: Smart Cyber-Physical Systems

- ICT2 – 2016: Thin, Organic and Large Area Electronics

- ICT3 – 2016: SSI – Smart System Integration

- ICT4 – 2017: Smart Anything Everywhere Initiative

- ICT5 – 2017: Customized and low energy computing

- ICT6 – 2016: Cloud Computing

http://www.hermes-europe.net/files/horizon-2020/summary-ict-leit-2016-2017-and-challenges-vnov12a.pdf

12

Smart Cyber-Physical Systems

- The challenge is to design, programme and implement highly distributed and connected digital technologies that are embedded in a multitude of increasingly autonomous physical systems with various dynamics and satisfying multiple critical constraints including safety, security, power efficiency, high performance, size and cost.

CPS: Computing Perspective

- **Two types of computing systems**
  - Desktops, servers, PCs, and notebooks
  - Embedded
- **The next frontier**
  - Main frame computing (60's-70's)
    - Large computers to execute big data processing applications
  - Desktop computing & Internet (80's-90's)
    - One computer at every desk to do business/personal activities
  - **Embedded computing (21st Century)**
    - **"Invisible" part of the environment**
    - **Transformation of industry**

- **Number of microprocessor units per year**
  - Millions in desktops
  - Billions in embedded processors
- **Applications:**
  - Automotive Systems
    - Light and heavy automobiles, trucks, buses
  - Aerospace Systems
    - Airplanes, space systems
  - Consumer electronics
    - Mobile phones, office electronics, digital appliances
  - Health/Medical Equipment
    - Patient monitoring, MRI, infusion pumps, artificial organs
  - Industrial Automation
    - Supervisory Control and Data Acquisition (SCADA) systems for chemical and power plants
    - Manufacturing systems
  - Defense
    - Source of superiority in all weapon systems

Cyber-Physical Systems

14

CPS: Systems Perspective

Sectors	Opportunities	
Transportation	Aircraft that fly faster and further on less energy. Air traffic control systems that make more efficient use of airspace. Automobiles that are more capable and safer but use less energy.	
Defense	More capable defense systems; defense systems that make better use of networked fleets of autonomous vehicles.	
Energy and Industrial Automation	New and renewable energy sources. Homes, office, buildings and vehicles that are more energy efficient and cheaper to operate.	

Cyber-Physical Systems

CPS Definition

A CPS is a system in which:

- information processing and physical processes are so tightly integrated that it is not possible to identify whether behaviors are the result of computations, physical laws, or both working together

- where functionality and salient system characteristics are emerging through the interaction of physical and computational objects

Transformation of Industries: Health Care and Medicine

- **National Health Information Network, Electronic Patient Record initiative**
  - Medical records at any point of service
  - Hospital, OR, ICU, …, EMT?

- **Home care: monitoring and control**
  - Pulse oximeters (oxygen saturation), blood glucose monitors, infusion pumps (insulin), accelerometers (falling, immobility), wearable networks (gait analysis), …

- **Operating Room of the Future (Goldman)**
  - Closed loop monitoring and control; multiple treatment stations, plug and play devices; robotic microsurgery (remotely guided?)
  - System coordination challenge

- **Progress in bioinformatics: gene, protein expression; systems biology; disease dynamics, control mechanisms**

Transformation of Industries:
Electric Power Grid

- **Current picture:**
  - Equipment protection devices trip locally, reactively
  - Cascading failure: August (US/Canada) and October (Europe), 2003

- **Better future?**
  - Real-time cooperative control of protection devices
  - Or -- self-healing -- (re-)aggregate islands of stable bulk power (protection, market motives)
  - Ubiquitous green technologies
  - Issue: standard operational control concerns exhibit wide-area characteristics (bulk power stability and quality, flow control, fault isolation)
  - Context: market (timing?) behavior, power routing transactions, regulation

IT Layer

Images thanks to William H. Sanders, Bruce Krogh, and Marija Ilic

18
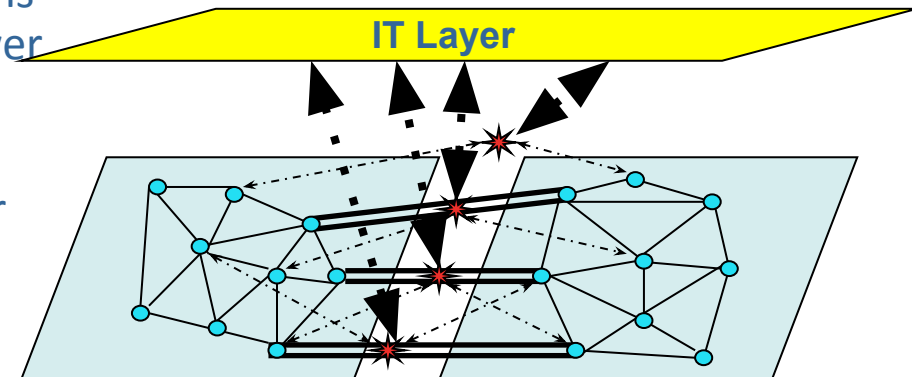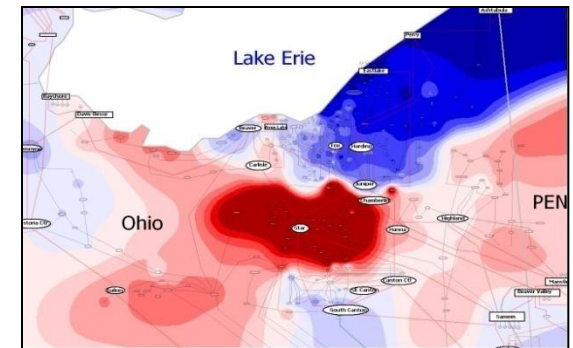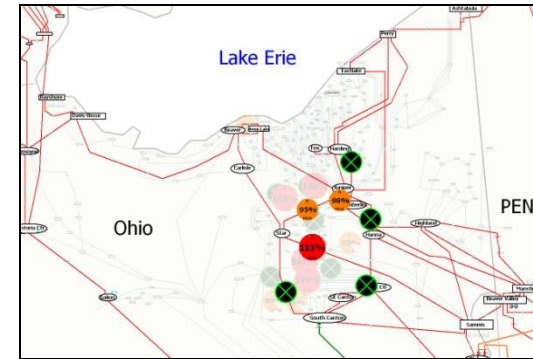
SSI – Smart System Integration

- The challenge is to be able to develop and manufacture smart objects and systems that closely integrate sensors, actuators, innovative MEMS, processing power, embedded memory and communication capabilities, all optimizing the use of supply power. This will require technology breakthroughs notably in integration, miniaturization with additional functionalities and mastering complexity.

Microelectromechanical systems

http://www.hermes-europe.net/files/horizon-2020/summary-ict-leit-2016-2017-and-challenges-vnov12a.pdf

Customized and low energy computing

- Information and Communication Technologies are becoming a core component of products in all market sectors.

- The trend towards "Smart Anything Everywhere" must be supported by innovations allowing a very significant reduction of the cost and complexity of software development for modern architectures, and of the energy footprint of computation and communication.

- Software development is the key challenge, because current programming tools do not fully support emerging system architectures.

http://www.hermes-europe.net/files/horizon-2020/summary-ict-leit-2016-2017-and-challenges-vnov12a.pdf
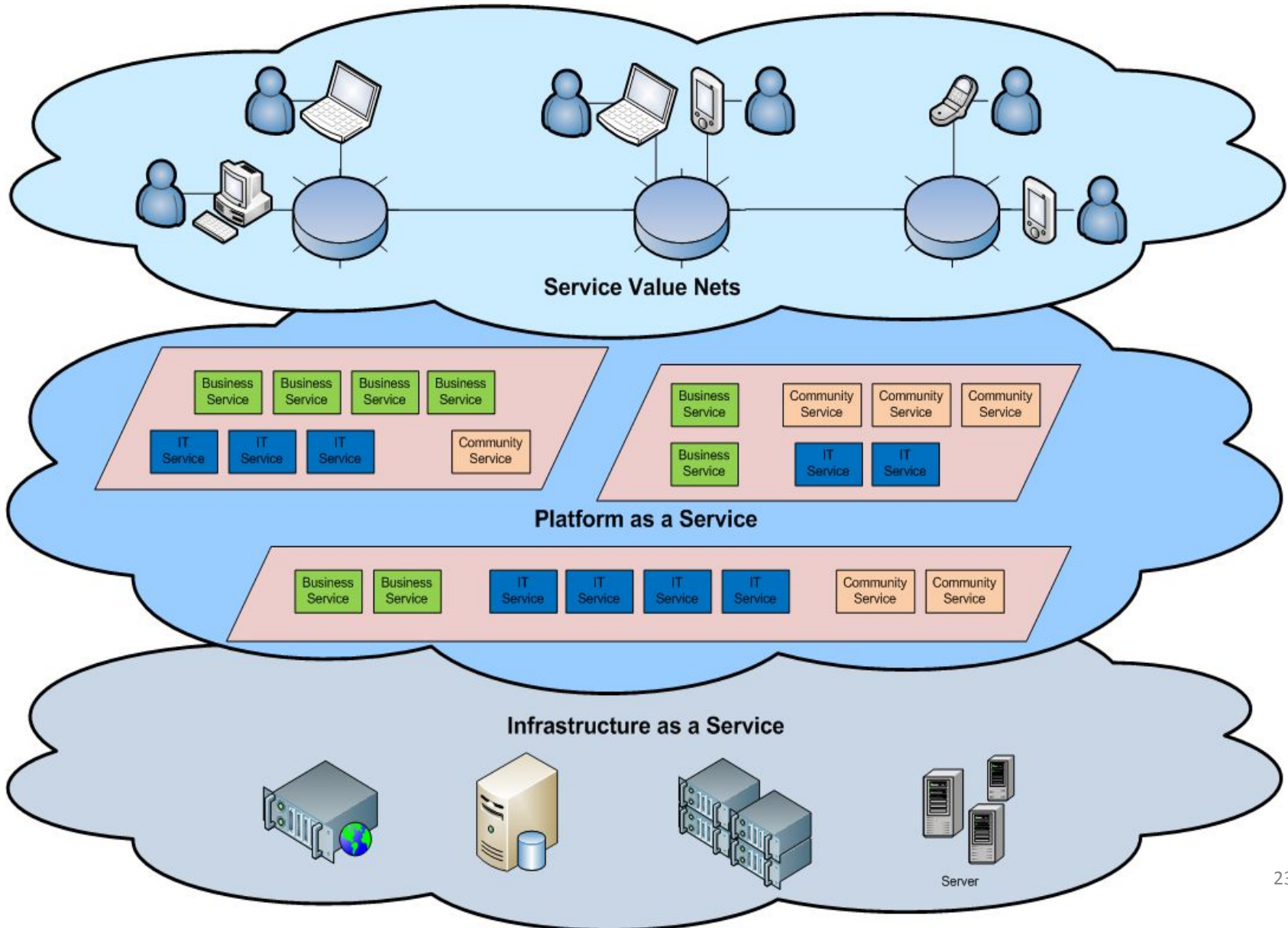
20

What is Cloud Computing?

- **Cloud Computing** is a general term used to describe a new class of network based computing that takes place over the Internet,
    - basically a step on from Utility Computing
    - a collection/group of integrated and networked hardware, software and Internet infrastructure (called a platform).
    - Using the Internet for communication and transport provides hardware, software and networking services to clients
- These platforms hide the complexity and details of the underlying infrastructure from users and applications by providing very simple graphical interface or API (Applications Programming Interface).

What is Cloud Computing?

- In addition, the platform provides on demand services, that are always on, anywhere, anytime and any place.

- Pay for use and as needed, elastic
  - scale up and down in capacity and functionalities

- The hardware and software services are available to
  - general public, enterprises, corporations and businesses markets

Cloud Architecture

Service Value Nets

Platform as a Service

- Business Service
- Business Service
- Business Service
- Business Service
- IT Service
- IT Service
- IT Service
- Community Service

- Business Service
- Community Service
- Community Service
- Community Service
- Business Service
- IT Service
- IT Service

- Business Service
- Business Service
- IT Service
- IT Service
- IT Service
- IT Service
- Community Service
- Community Service

Infrastructure as a Service

Server

Do you Use the Cloud?

The Cloud Requires

■An Internet connection

■An account - Created with a user name and a password

■Agree to Terms

Computer Storage

■Computers have internal or hard drive storage(C: Drive)

■CPU has a drive for storing programs, documents, pictures, videos, presentations, etc…
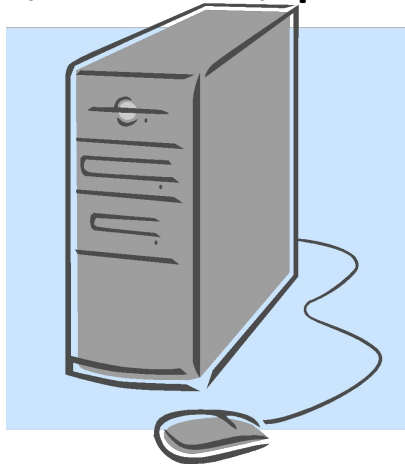
Standard Computer
Tower or Central
Processing Unit (CPU)

Inside the Computer

Internal Storage

■Content is stored on THAT computer

■To use content must return to THAT computer

■Cannot access this content from another device or computer

Programs

■Purchase programs

■Load to the computer

■Each computer would need the program loaded and stored on the internal drive

External Storage

- Allows your content to become mobile
- Save to the storage device
- Take device to any compatible computer
- Open and use content

CD/DVD

Thumb Drive

External Hard Drive

SD Card

Micro SD Card
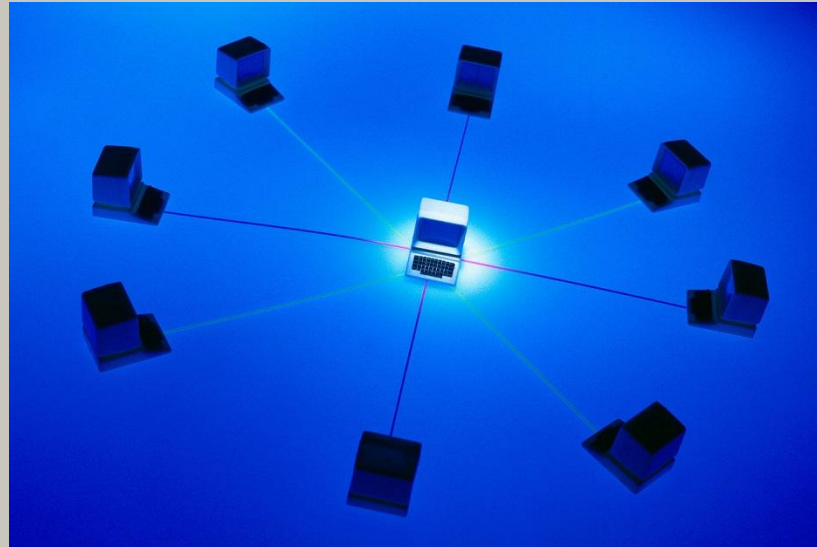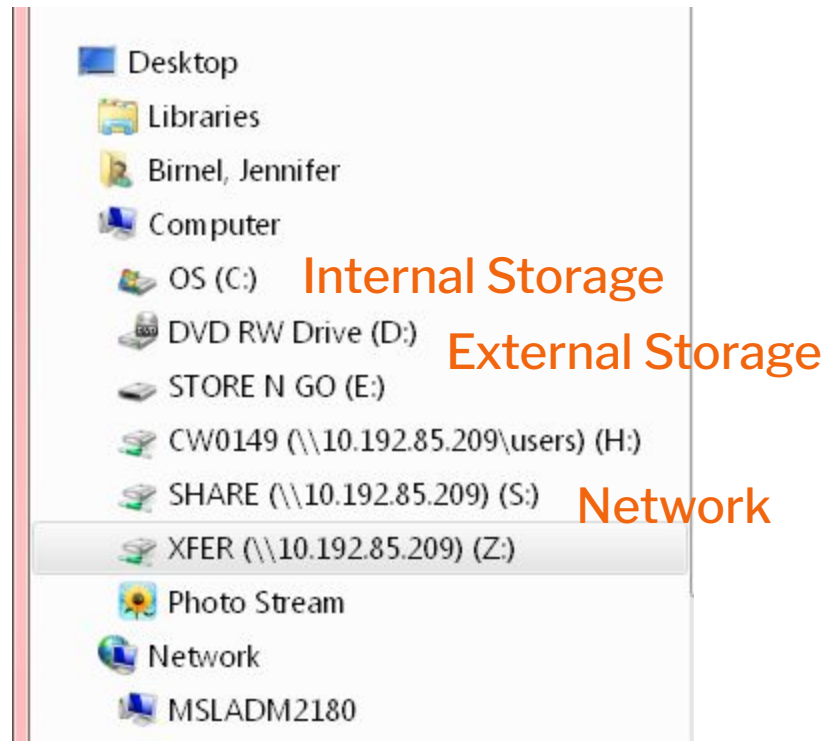
Networked Storage

■Multiple work stations talk to one unit that stores information and data.

■Data is not saved to the C: drive, but to a network drive

■Can retrieve the data stored to the network from any of the connected workstations

Saving documents

■When you do a "save as" on your computer, you choose where to save the material.

Desktop
Libraries
Birnel, Jennifer
Computer
OS (C:)   Internal Storage
DVD RW Drive (D:)   External Storage
STORE N GO (E:)
CW0149 (\\10.192.85.209\users) (H:)
SHARE (\\10.192.85.209) (S:)   Network
XFER (\\10.192.85.209) (Z:)
Photo Stream
Network
MSLADM2180

Cloud Storage

- Create an Account – User name and password
- Content lives with the account in the cloud
- Log onto any computer with Wi-Fi to find your content

Downloads for storage

■Download a cloud based app to a computer **you own**

■The app lives on your Computer

■Save files to the app

■When connected to the Internet it will sync with the cloud

■The Cloud can be accessed from any Internet connection

Save file as

■ Do "save as" to save a file to your computer and the cloud

■ The syncing folders makes data retrieval easier
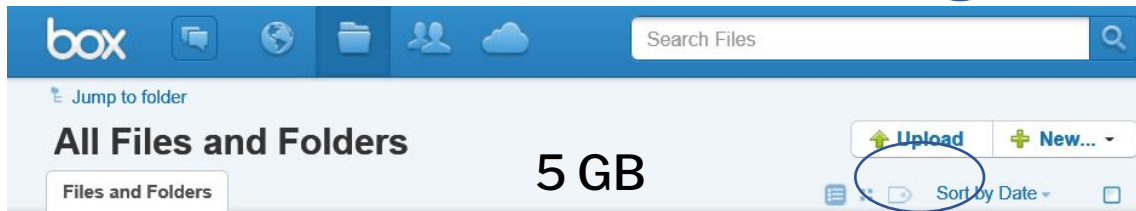
■ Box and DropBox require this download to work

Upload Documents

■Log-in to the online storage account

■Click upload a file

■Find the file on hard drive, network, or external storage

■Upload to cloud storage

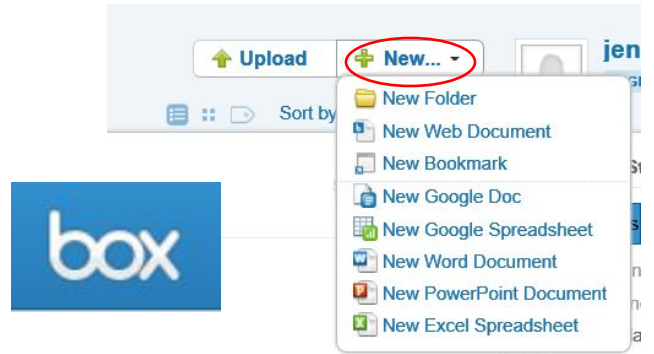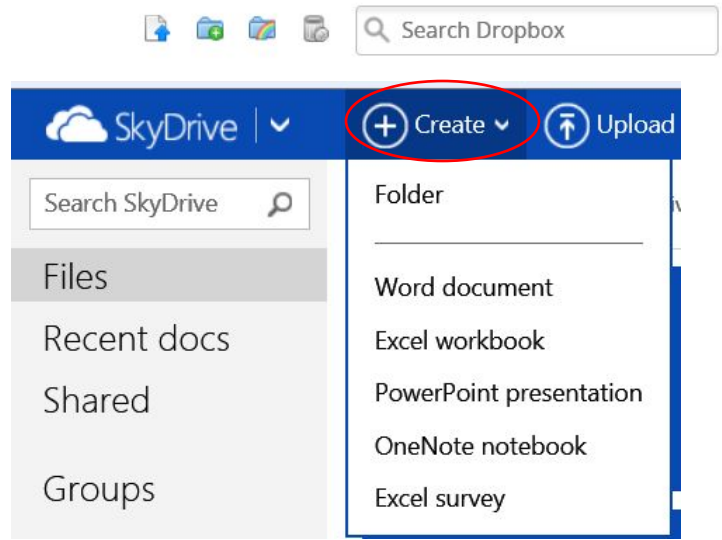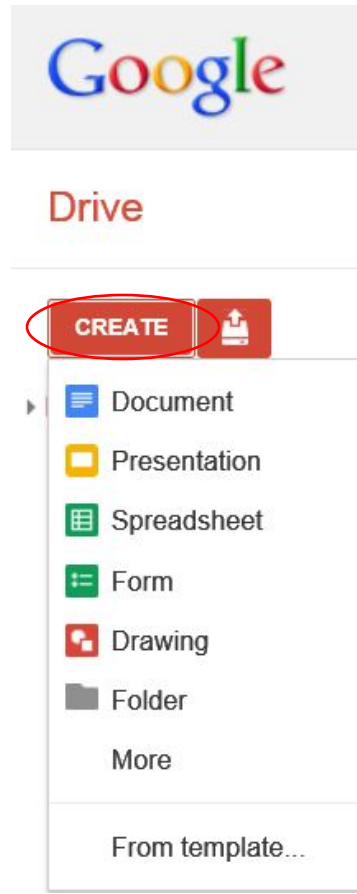# Document Creation

■Google Docs

■SkyDrive

■Box

Internet is required

■Creation is happening in the cloud

■Saving is going to the cloud

■To retrieve files, must return to the cloud

Other Software services

■Photo editing software

■Online banking apps

■Social media apps

■Communication

Programming

■ Group of instructions that directs a computer is called an **program**

■ **No computer can do anything without a program or Computer cannot do anything without a program**

■ A **programming language** is a formal computer language designed to communicate instructions to a machine, particularly a computer. Programming languages can be used to create programs to control the behavior of a machine or to express algorithms.

■ The person contributing the idea of the stored program was **John von Neumann**

■ The language that the computer can understand and execute is called **Machine language**

Programming

■ Programs designed to perform <u>specific tasks</u> is called known as **Application software**

■**Multiprogramming system** execute more jobs in the same time period

■**Device driver** type of **program** allows communication between a peripheral device, such as a mouse or printer, and the rest of the computer system

■**PASCAL is** <u>the computer program</u> language which is widely used in computer science and engineering and also in business

Programming

■ The process of writing computer instructions <u>in a programming language</u> is known as **Coding**

■A computer program consists of **Algorithms** written in computer's language

■**A computer program** that converts an entire program <u>into machine language </u>at one time is called a **compiler**

■**The purpose of an application program** is to meet specific user needs

■Programmed instructions to the computer is known as **code**

Programming

■ Personnel who design, program, operate and maintain computer equipment refers to **Peopleware**

■A step-by-step procedure used to solve a problem is called **Algorithm**

■A prewritten program that's sold to perform a common task is called an application **Package**

■A computer program that instructs other programs to perform a particular type of operation is **System software**

■A acronym for the organization that publishes programming language standard is **ANSI**

ICT in Industrial Leadership

1.   Components and systems
   - Smart embedded components and systems, micro-nano-bio systems, organic electronics, large area integration, systems of systems and complex system engineering

2.   Next generation computing
   - Processor and system architecture, interconnect and data localization technologies, cloud computing, parallel computing and simulation software

3.   Future Internet
   - Networks, software and services, cyber security, privacy and trust, wireless communication and all optical networks, immersive interactive multimedia and connected enterprise

ICT in Leadership

4. Content technologies and information management
   - Technologies for language, learning, interaction, digital preservation, content access and analytics; advanced data mining, machine learning, statistical analysis and visual computing

5. Advanced interfaces and robots
   - Service robotics, cognitive systems, advanced interfaces, smart spaces and sentient machines

6. Key Enabling Technologies: Micro- nano-electronics and photonics
   - Design, advanced processes, pilot lines for fabrication, related production technologies and demonstration actions to validate technology developments and innovative business models

Cybersecurity

- **Computer security**, also known as **cybersecurity** or **IT** **security**, is the protection of computer systems from the theft or damage to the hardware, software or the information on them, as well as from disruption (failure) or misdirection of the services they provide.

List of required textbooks and additional resources

Required Textbook:

- Brown G., Sargent B., and Watson D. Cambridge IGCSE ICT. - London: Hodder Education Group, 2015. -439 p. **[BW]**

- Williams, B. K. and Sawyer, S. Using information technology: A practical introduction to computers & communications.- New York: McGraw-Hil., - 8th ed. 2010. -563 p. **[WS]**

Alternative Textbook:

- Watson, D. and Williams, H. – Cambridge IGCSE Computer Science: Hodder Edu.; 3 ed. 2015.-278 p. **[W]**

Additional resources:

- Evans, V. Information technology. Books 1-3: English for specific purposes .- 5th impr.- Newbury: Express Publishing, 2014.- 40 p. **[E]**