Green Computing

CDSP

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Ciclo de vida

Huella de carbono

- La huella de carbono se conoce como «la totalidad de gases de efecto invernadero (GEI) emitidos por efecto directo o indirecto de un individuo, organización, evento o producto».

Algunas calculadoras Online

- https://footprint.wwf.org.uk/questionnaire

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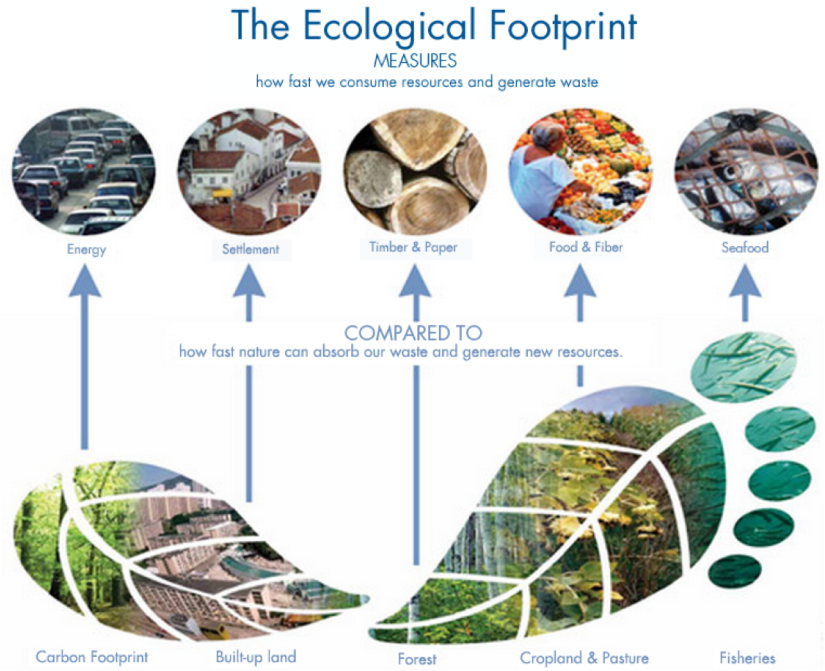
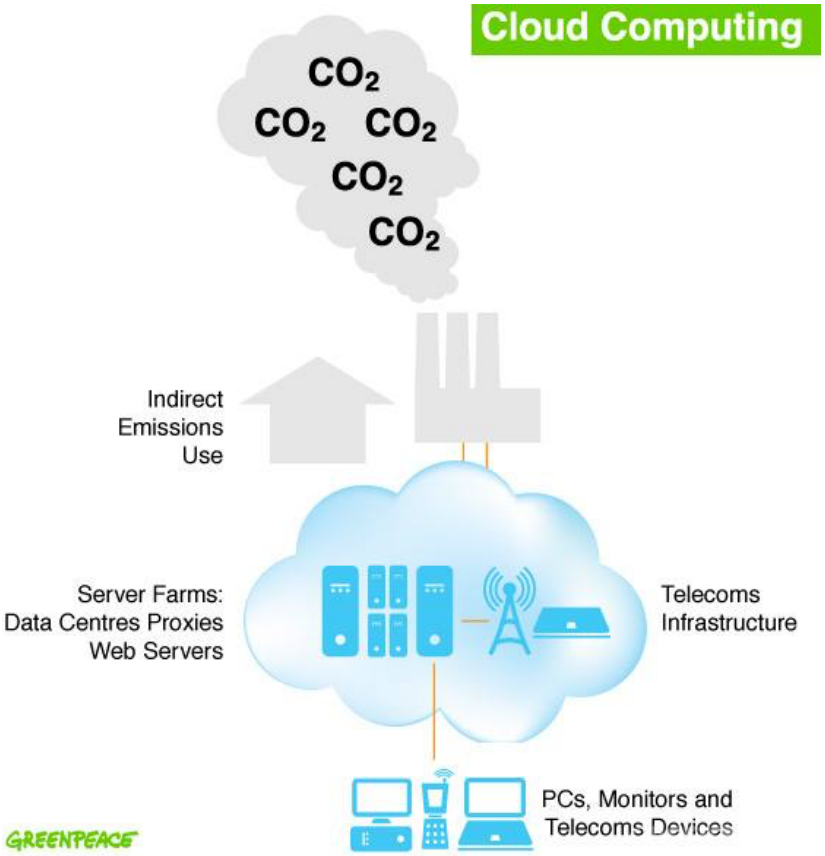
Huella ecológica

- Se mide en el terreno capaz de absorber el CO2 producido por el proceso industrial



Impact in telecomunications - Cloud computing



Pathway towards Greening

1. Green Use: Intelligent use of energy and information systems.

2. Green Disposal: Reduction of waste, reuse and refurbishment of hardware and recycling of out of use peripherals and other items.

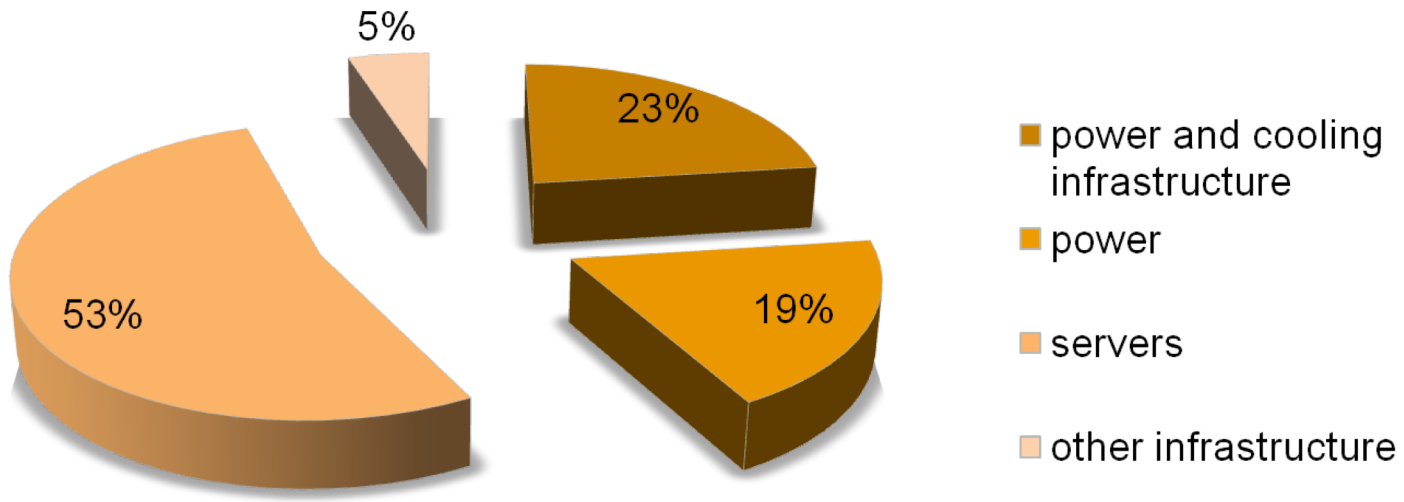
3. Green Design: Efficient design of data centres and workstations.

4. Green Manufacture: Informed purchasing of components, peripherals and equipments manufactured with the environment in mind.

Green Computing

- Why
  - computer energy is often wasteful
    - leaving the computer on when not in use (CPU and fan consume power, screen savers consume power)
  - printing is often wasteful
    - how many of you print out your emails or meeting agendas
    - printing out partial drafts
    - for a “paperless” society, we tend to use *more* paper today than before computer-prevalence
  - pollution
    - manufacturing techniques
    - packaging
    - disposal of computers and components
  - toxicity
    - as we will see, there are toxic chemicals used in the manufacturing of computers and components which can enter the food chain and water!

Energy distribution in the data centre [1]



Current State OF Energy Efficiency In ICT Infrastructure

- Energy-efficient hardware
- Energy-aware scheduling in multiprocessor and grid systems
- Power minimization in clusters of servers
- Power minimization in wireless and wired networks

Manufacturing

- Microchip fabrication has over 400 distinct steps which involve 4 general phases

Process	Description
Layering	Application of a thin layer of desired material, usually silicon or aluminum
Oxidation	Changes a semi-conducting silicon layer into a insulating silicon dioxide layer
Patterning	Carving of a dense, maze-like set of furrows into a layer
Etching	Use of solvents or particle bombardment to alter the layer patterns

- Throughout, the process requires a great deal of ultra-pure water and the chips are bathed in chemical solvents

Component	Fossil Fuels (kg)	Chemicals (kg)	Water (kg)
Computer Chips	94	7.1	310
Printed Circuit Boards	14	14	780
CRT monitors	31.5	0.49	450
LCD monitors	226	3.7	1290

Toward Energy Efficient Cloud Computing

- Energy-aware data centre
- Energy savings in networks and protocols
- The effect of Internet applications

Chemical Elements Used: Mercury

- Mercury is used in
  - batteries, switches, housing, printed circuit boards
  - mercury is found in medical equipment, data transmission equipment, telecommunications equipment and cell phones as well
  - if is estimated that 22% of the yearly use of mercury is in electrical and electronic equipment
    - although a small amount of mercury is used, it is used in nearly all computer construction amounting to 400,000 pounds of mercury used between 1997 and 2004
- The problem
  - mercury spreads out in water transforming into methylated mercury which easily accumulates in living organisms
  - it enters the food chain through fish that swim in polluted waters
  - methylated mercury can cause chronic brain damage

Chemical Elements Found in Computers and Components

- Elements in bulk: lead, tin, copper, silicon, carbon, iron and aluminum
- Elements in small amounts: cadmium and mercury
- Elements in trace amounts:
  - germanium, gallium, barium, nickel, tantalum, indium, vanadium, terbium, beryllium, gold, europium, titanium, ruthenium, cobalt, palladium, manganese, silver, antimony, bismuth, selenium, niobium, yttrium, rhodium, platinum, arsenic, lithium, boron, americium
- List of examples of devices containing these elements
  - almost all electronics contain lead & tin (as solder) and copper (as wire & PCB tracks), though the use of lead-free solder is now spreading rapidly
  - lead: solder, CRT monitors (Lead in glass), Lead-acid battery

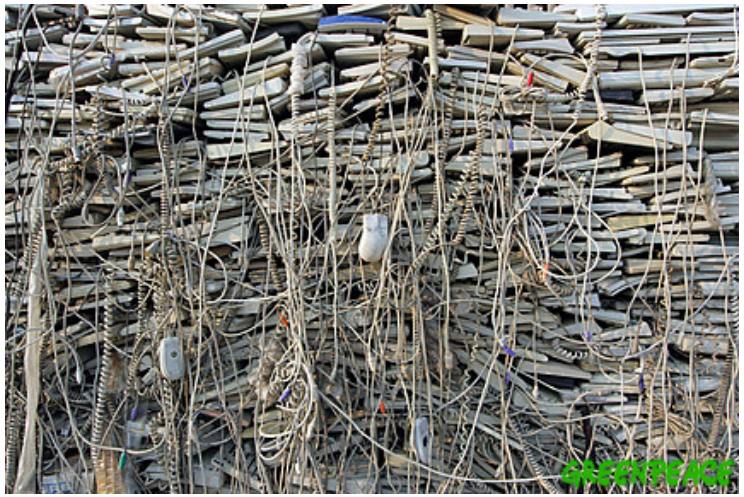
List Continued

- List of examples of devices containing these elements
  - tin: solder
  - copper: copper wire, printed circuit board tracks
  - aluminum: nearly all electronic goods using more than a few watts of power
  - iron: steel chassis, cases & fixings
  - silicon: glass, transistors, ICs, Printed circuit boards.
  - nickel & cadmium: nickel-cadmium rechargeable batteries
  - lithium: lithium-ion battery
  - zinc: plating for steel parts
  - gold: connector plating, primarily in computer equipment
  - mercury: fluorescent tubes (numerous applications), tilt switches (pinball games, mechanical doorbells)
  - sulphur: lead-acid battery
  - carbon: steel, plastics, resistors

Disposal

- Consider that the average computer lifespan is about 2 years (cell phones < 2 years)
  - 10 years ago, the lifespan of a computer was 5 years
  - between 1997 and 2004, it is estimated that 315 million computers became obsolete (and were discarded, donated, or recycled)
- 183 million computers were sold in 2004 (674 million cell phones!)
- New users in China (178 million by 2010) and India (80 million by 2010) will require the creation of new computers
- Disposal of these devices constituted 20-50 million tons per year (about 5% of the total waste of the planet)
  - this waste is called e-waste
  - where are we going to put all of it?

Land Fills



- Europe has outlawed using landfills for computer components
  - the US and Europe export a lot of e-waste to Asian landfills (especially China even though China has outlawed the importing of e-waste)
  - in addition, incineration of computer components leads to air pollution and airborne toxins