Green Computing

Mutlu Dogus Yildirim
SONY ISC
15.12.2009

Introduction

- A rise of two degrees centigrade in global temperatures...
- ...is the threshold for catastrophic climate change, which will expose millions to drought, hunger and flooding.
- ...is "very unlikely" to be avoided!

"Some" Consequences (Sooner than you think)

- **Asia:** 1 billion people will suffer water shortages!

rica: 350-600 million people will suffer water shortages!

America: Water shortages, coastal flooding, extreme weather

s, forest fires, flash floods, new diseases etc.

Australia: Between 3000-5000 heat-related deaths a year, water shortages etc.

UNITED NATIONS CLIMATE CHANGE CONFERENCE – COPENHAGEN (DEC 7 – DEC 18 2009)

Green Computing?

- Refers to environmentally sustainable computing or IT
- It is "the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems effectively & efficiently”.
- Green IT also strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities.

Math I

- An average CO2 emission of a car ~= 200 g / km
  - Assume that you drive 10000 km / year= 2.000.000 gr CO2 / year = **2000** kg / year
- A single Dell PowerEdge M600 blade server consumes an average of 383.75 W when idle and 454.39 W under stress. It also produces **3500** kg CO2 / year.
- **1 Dell server ~= 2 car (!!!)**

Math II

- A typical desktop computer uses about 65 to 250 watts.
  - Let’s say 1/3 of a Dell server
  - Let’s say we use it 8 hours / day
- Desktop computer produces about 500 kg CO_2 / year
- **~= Driving car for 1700 km!**

(By The Way)

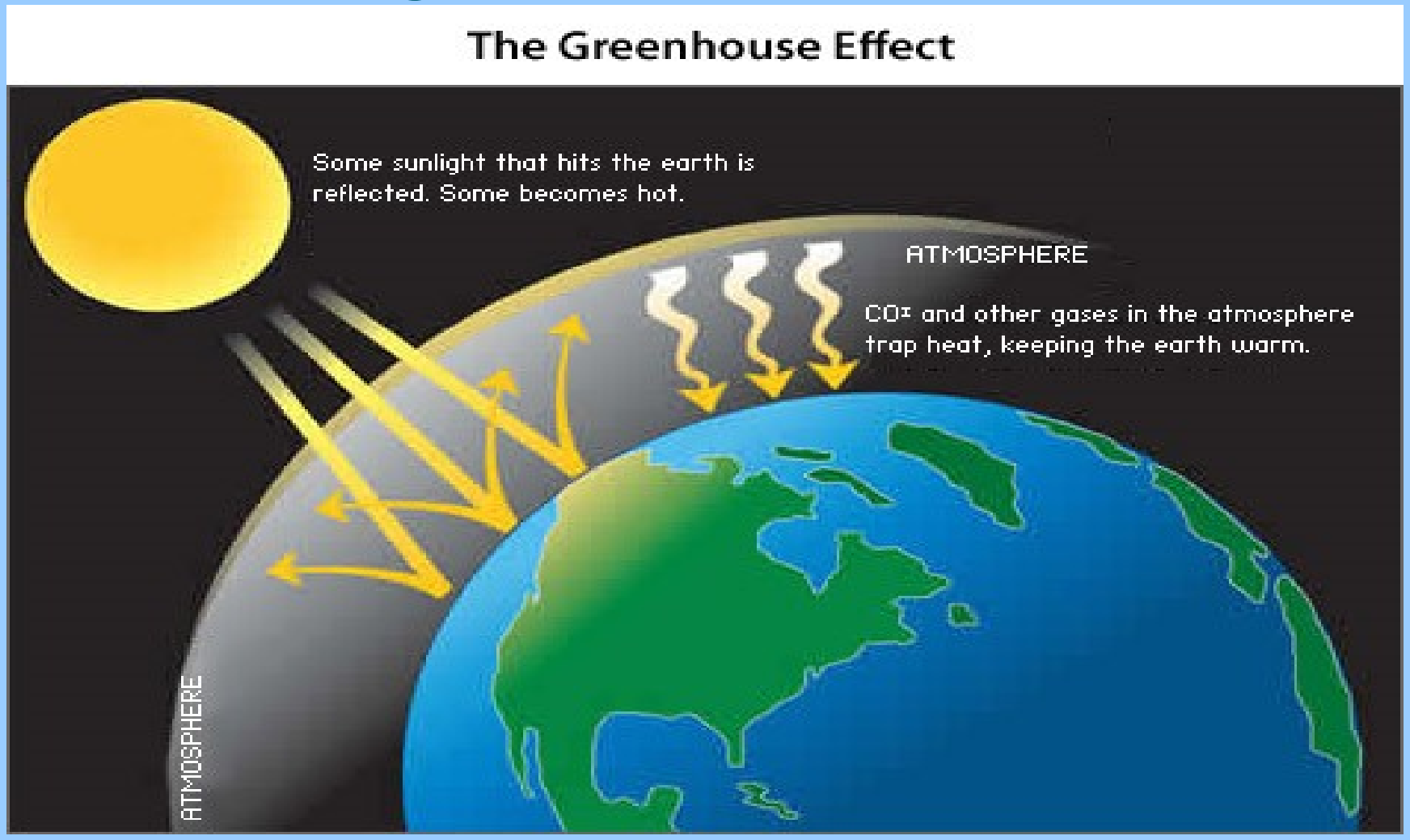
watts up?	Desktop (Windows XP)	Desktop (Ubuntu 7.10)	Laptop (Windows XP)
Run 1 Appr. Watts / Hr	165.6	150.0	24
Run 2 Appr. Watts / Hr	165.6	148.8	24
Run 3 Appr. Watts / Hr	166.8	148.8	25.2
Average Appr. Watts / Hr	166	149.2	24.4

Use Laptop!

Math III

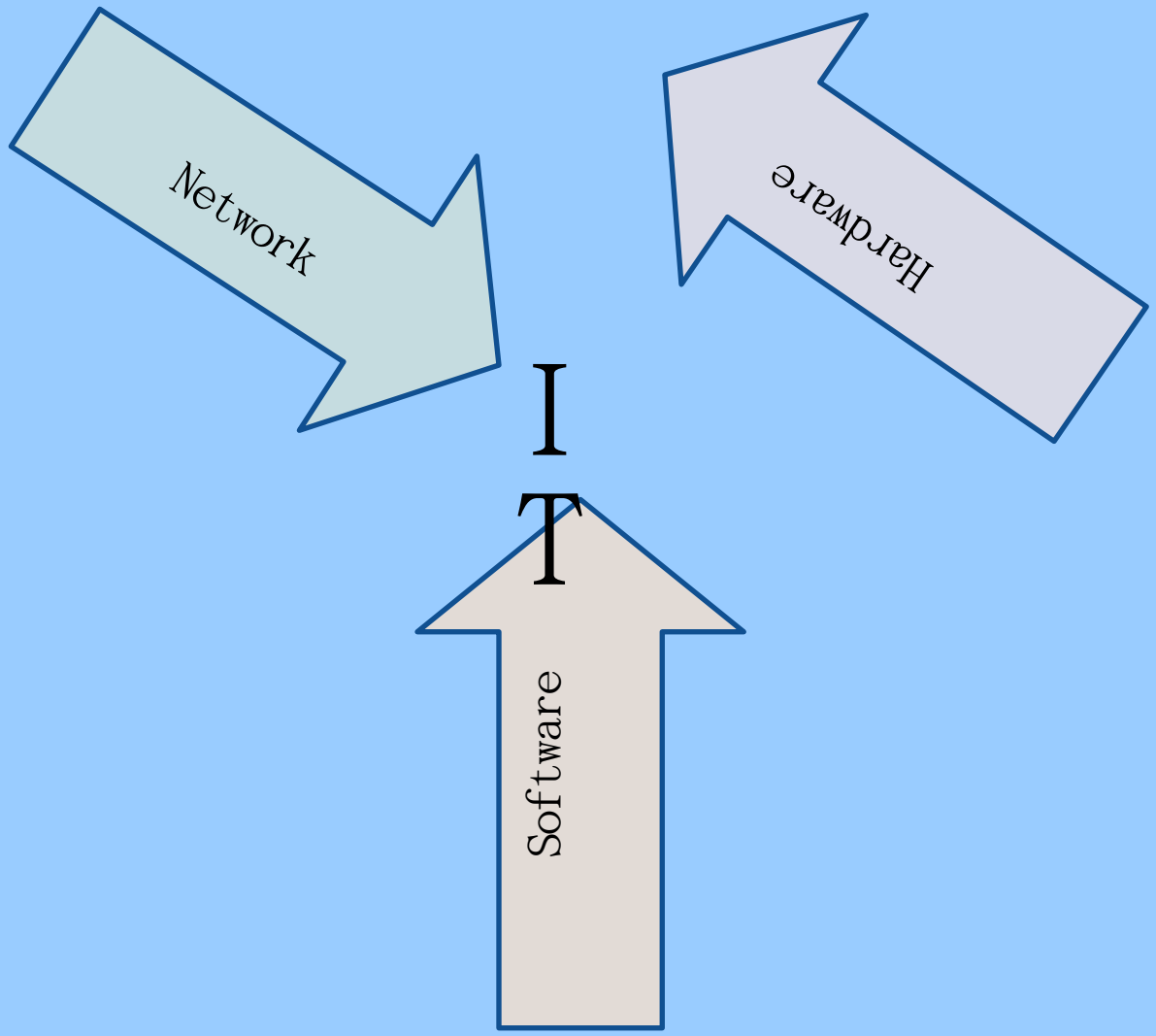
- Google claims; “An average query produces roughly 0.2 gr of CO2”
- Google.com served **7,5 billion** searches on July 2008
  - ~= **1.500 ton** CO2 on July 2008 !
  - ~= **18.000** ton CO2 on 2008!
  - ~= **90.000.000 km** travelling by car (equator = 40.075 km)
- Youtube: **1.2 billion** video streams / **day**
  - Yearly CO2 emission ~= **ERROR**
  -

What's wrong with CO2?



More CO2 in atmosphere means warmer world!

IT Components



Network

-
- Topology (Ring, Star etc.)
- Network Device (Repeater, Hub etc.)
- Cable (Coaxical, Fiber Optic etc.)
- Protocol (HTTP, FTP etc.)
- Infrastructure
- ...
-
- Choose the most efficient element
-

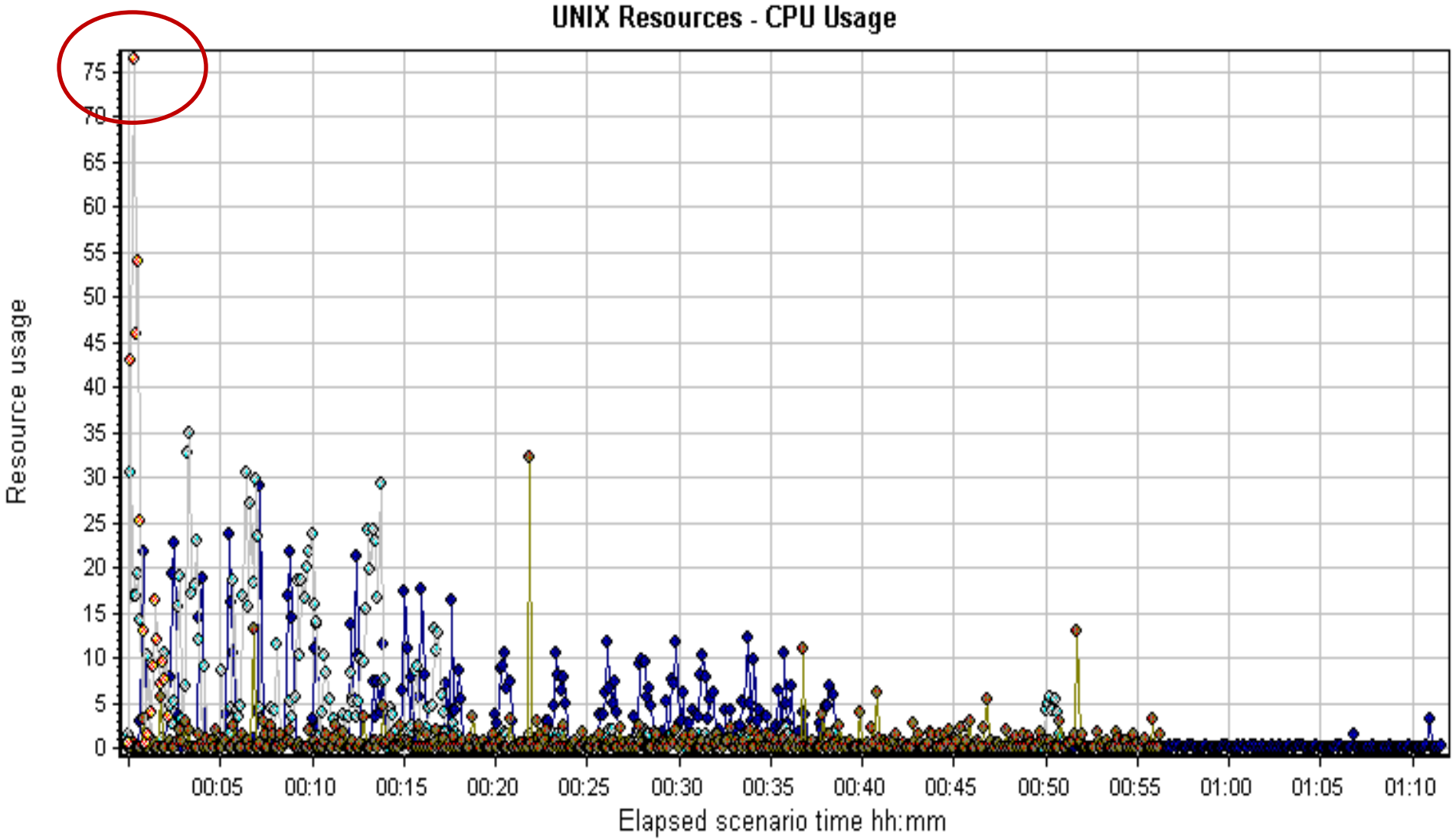
Hardware

- Computer Components
  - CPU
  - Video Card
  - Battery
  - ...
- Virtualization
  - Cloud computing
- Data Center *
- Recycling

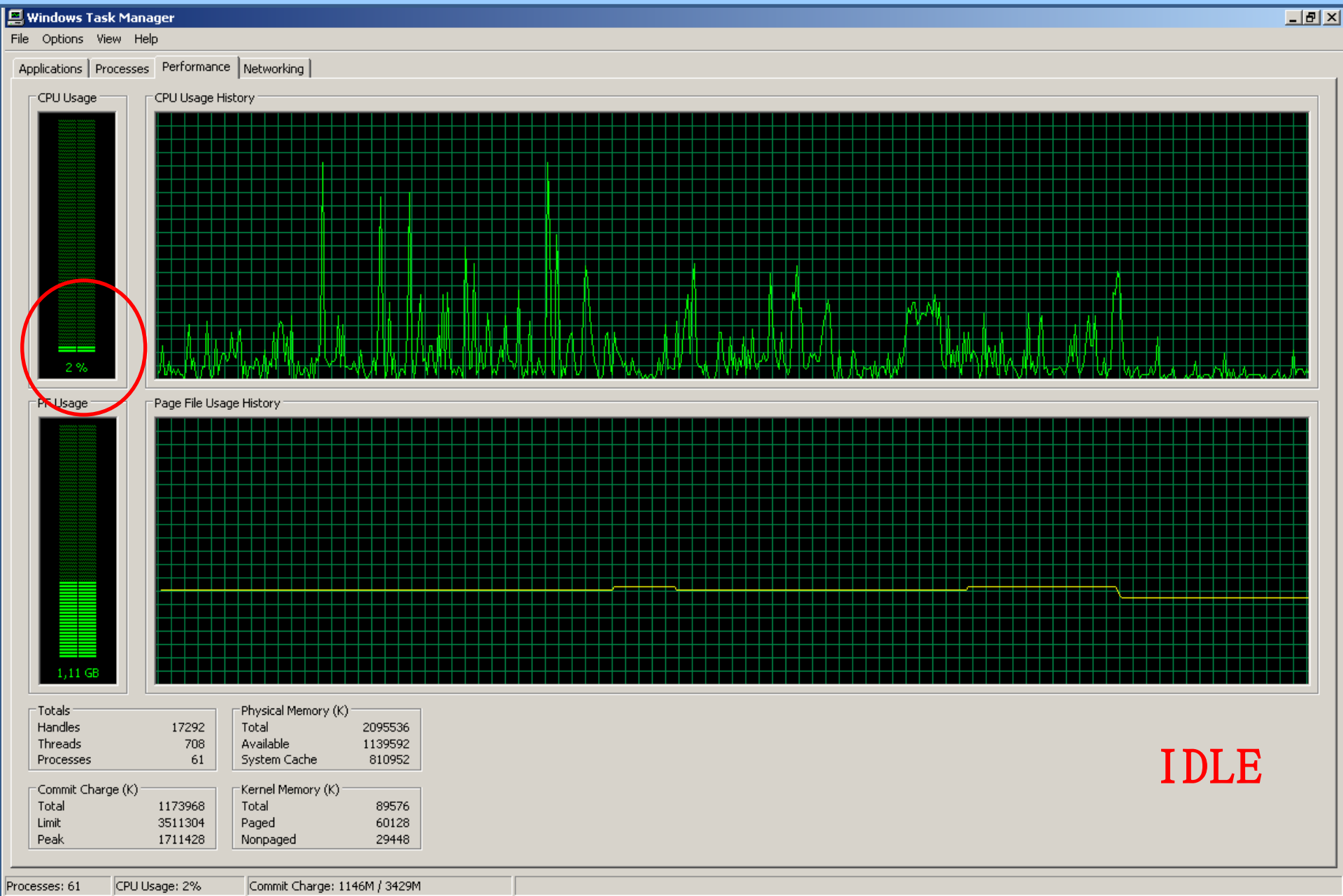
Data Centers

- One of the fastest growing energy consumers.
  - Critical computational systems (servers, storage, …)
  - Cooling systems
  - Power conversion such as power distribution units (PDU)
  - Hoteling (everything else: lighting, and so on).
- Governments have begun discussing hard limits on how much energy data centers can consume!

Software - Server

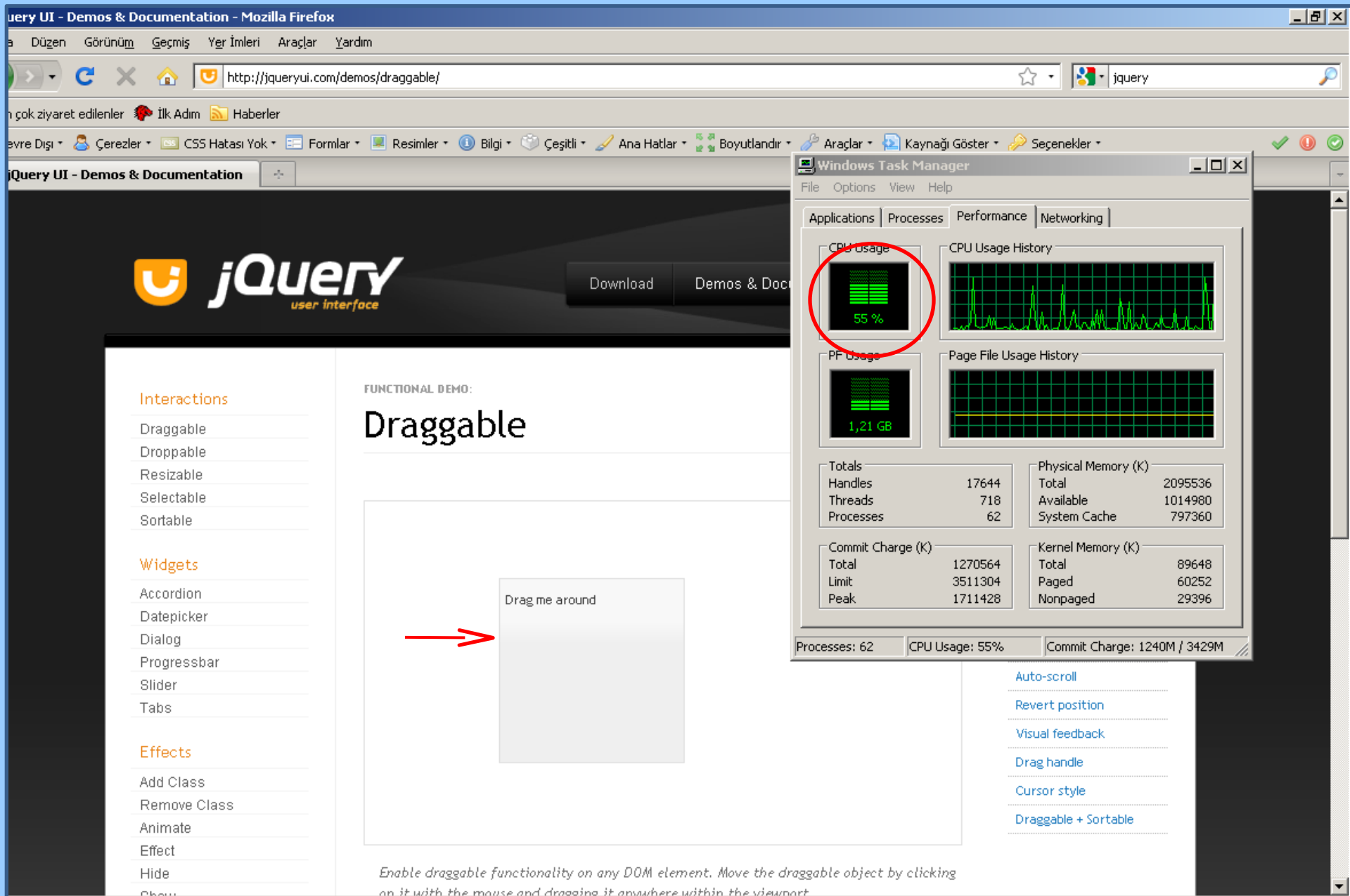


Software - Client

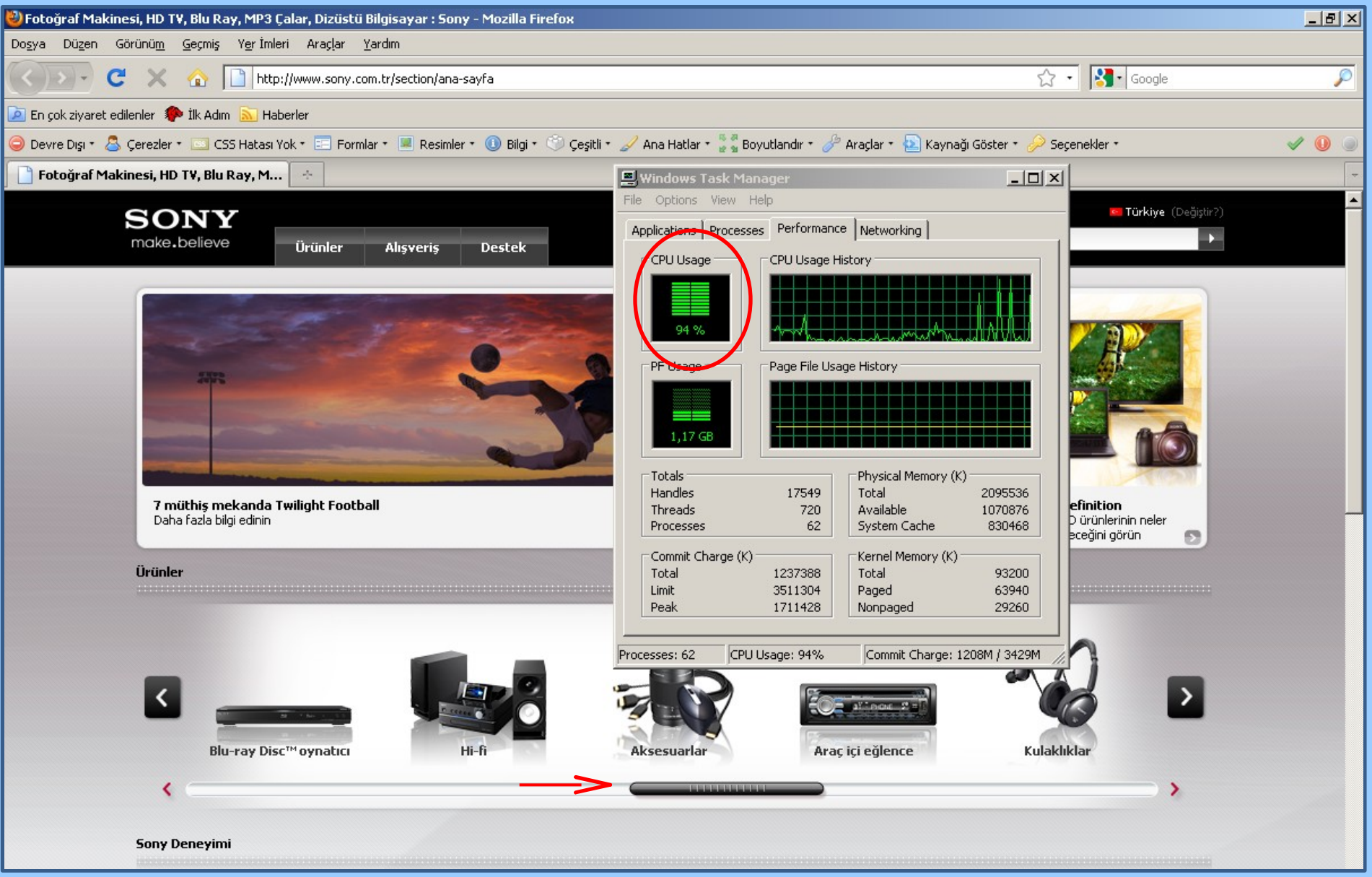


IDLE

Software - Client

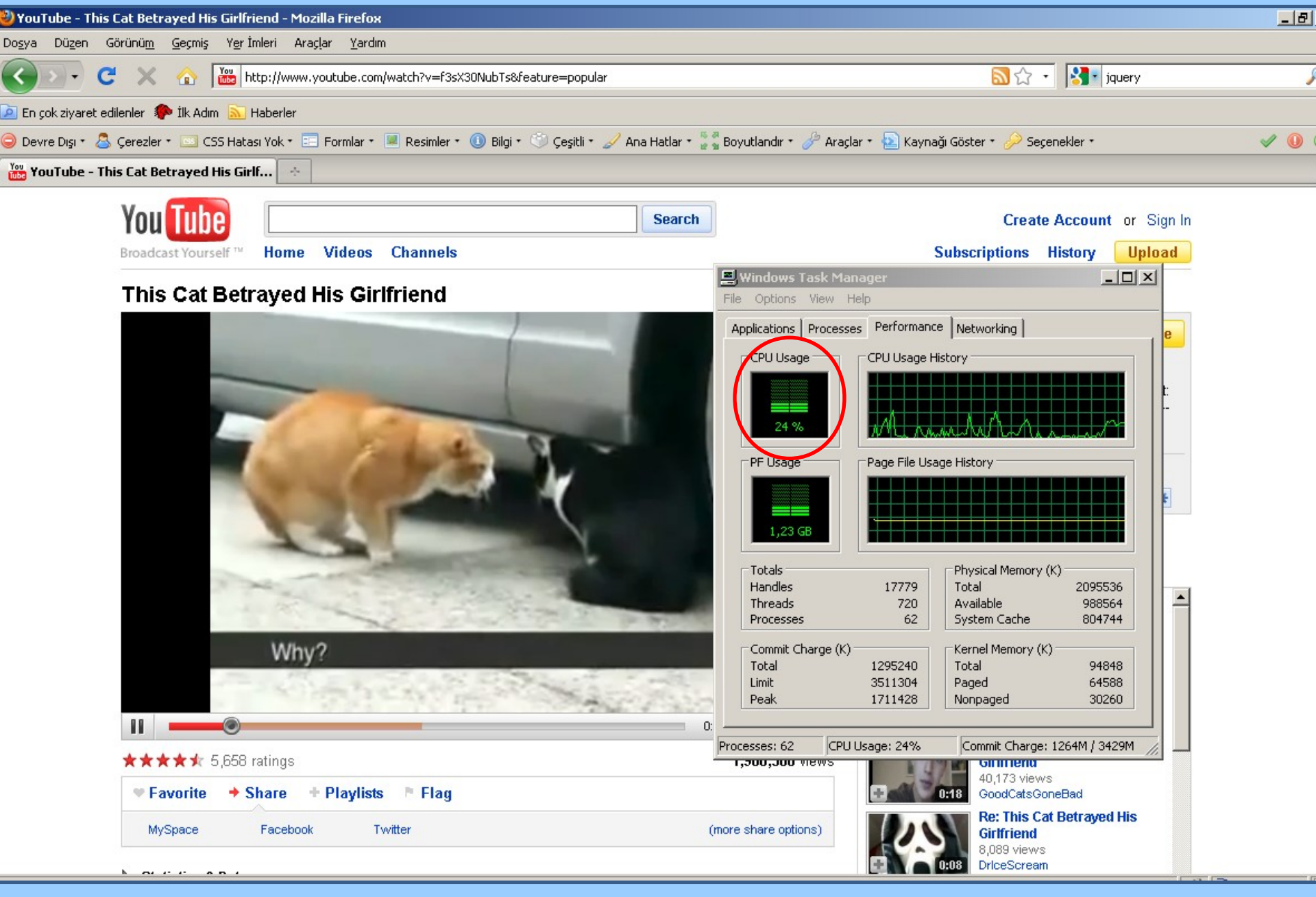


Software - Client

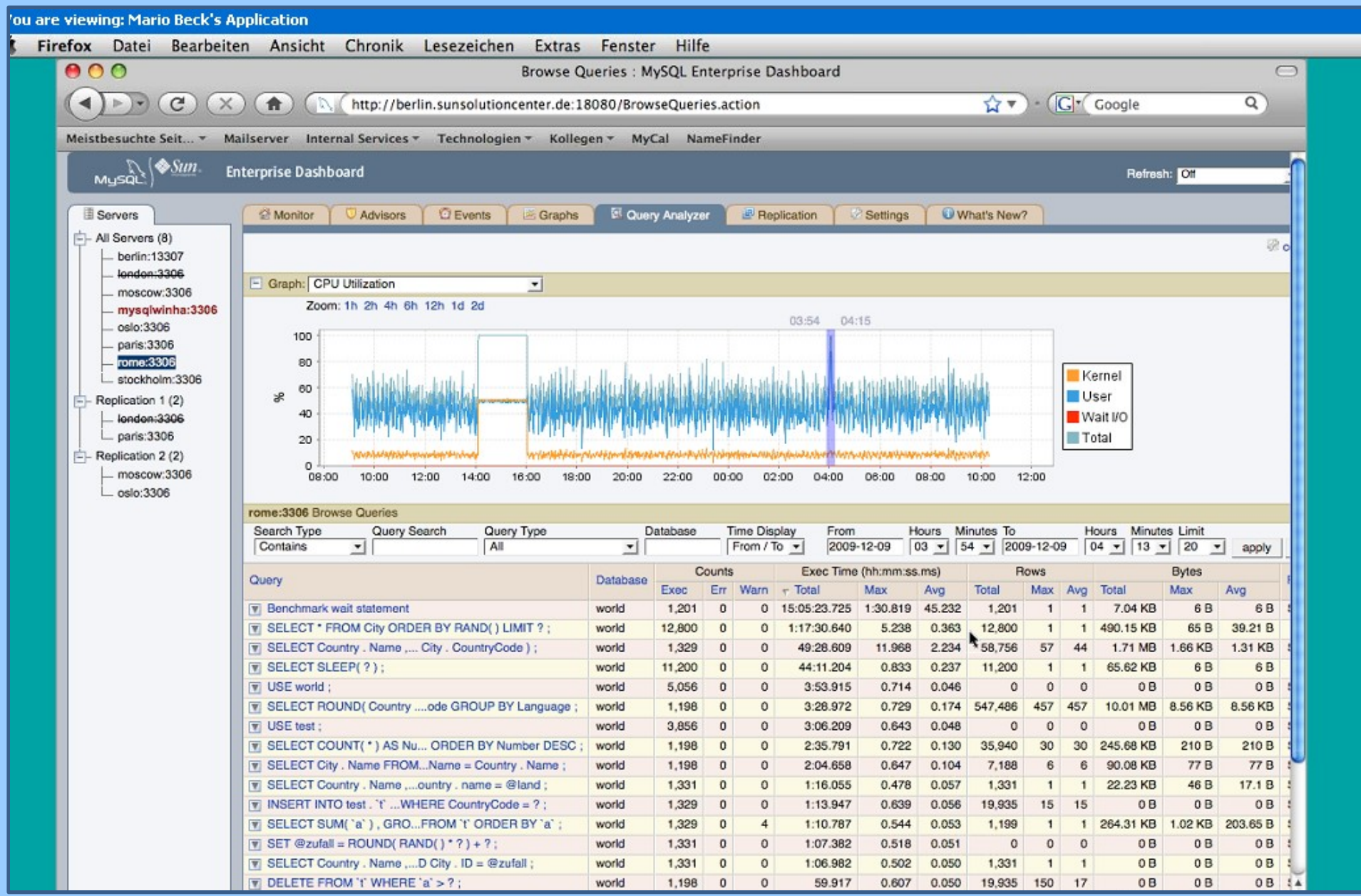


- What if ODW could reduce CPU usage %10 both on client and server side?
  - (Multiply it by hits per day!)
  - What if SONY could claim a greener website?

Software - Client



What about database?



What can we do?

- Business analysts
  - Minimize gold-plating
  - Minimize assumptions
  - Think green!
- Architects
  - Follow “green patterns”*
  - Reduce architectural complexity
  - 3rd party component? Are you sure?
  - Think green!

GREEN OBJECT ORIENTED PROGRAMMING (GOOP)

- Optimize your code
  - Dan Pritchett (eBay), estimates that inefficient programming techniques may increase eBay's energy consumption by 25-30%.
- Think "better" algorithms
- Use less resources
  - focus especially on CPU usage
- Yes, a simple "if statement" can kill the planet*
- Think green!

An innocent IF statement...

- We performed a load test to a simple web page (10 min., 100 threads) 2 times
- Then added below lines to same page and run the same test 2 times again

```
if(true){
//
}
```

- The CPU usage was higher on both last tests!

Green Patterns

.

.

- (Try to) forget Moore’s Law
- Use JIT (Just In Time) Approach
  - Allocate it when you need it
- What is required? When is required?

.

.

.

Green Patterns

-
- Use guesswork based on past experience
- Don’t be risk-averse (much)
  - Bad: “Let’s use 3 replica servers, if the other 2 crashes, the last one can save us”
  - Worse: “Let’s use 4 replica servers, if the other 3 crashes, the last one can save us”
  - Balance recovery and robustness solutions with environmental objectives
- Measure everything

.

EUP = Energy Usage Profile

Component	Idle Power Usage	Average Power Usage	Maximum Power Usage
Server 1	383.75	454.39	600 (Estimated)
CPU	40.8		130
HDD	14.35		17
DIMM1	3		3
DIMM2	3		3
Video	18.3		25.6
Network Card	4.95		4.95
CD/DVD	2		18

EUP

- Create EUP for hardware
  - Can be obtained from manufacturers' Web sites and Web sites that perform independent hardware research.
- Create EUP for app.
  - Build a set of load tests that reflect both the average and peak loads for your application.
  - What is high priority in terms of performance improvement may not always be high priority for energy usage reduction.
- Create EUP for OP
  - Disable unnecessary services
  - Virtualization

Green Computing:

-
-
- Saves World!
- Saves Money!
- Saves Your Family
- Saves YOU!

Resources & further reading

- http://msdn.microsoft.com/en-us/library/dd393307.aspx
- http://www.infoq.com/news/2008/12/Architecture-Green-Computing
- http://www.oricane.se/start/maximizing-the-efficiency-of-software-products-link.html
- http://www.thegreengrid.org/
- http://www.energyefficiencynews.com/policy/i/1576/
- http://earth2tech.com/2007/10/13/your-bad-code-is-killing-my-planet/
- http://msdn.microsoft.com/en-us/library/dd393312.aspx
- http://msdn.microsoft.com/en-us/library/dd393310.aspx
- http://msdn.microsoft.com/en-us/library/dd393308.aspx
- http://www.technewsworld.com/story/Sustainability-Software-Part-1-Its-Easy-Being-Green-68770.html
- http://www.energysmart.com.au/sedatoolbox/esm1.asp
- http://michaelbluejay.com/electricity/computers.html
- http://www.environmentalleader.com/2008/02/05/top-10-reasons-to-green-it/
- http://en.wikipedia.org/wiki/Green_computing
- http://timeforchange.org/what-is-a-carbon-footprint-definition
- http://shipsoftwareontime.com/2007/12/24/rules-for-being-a-green-software-engineer/
- http://www.theregister.co.uk/2007/07/21/green_software_possibility/
- http://blog.technoetic.com/2007/03/25/green-software/
- http://www.examiner.com/x-12791-SF-Green-Careers-Examiner~y2009m8d5-What-is-green-software-design
-

Resources & further reading

- http://www.techcrunch.com/2009/06/09/youtube-video-streams-top-1-billionday/
- http://en.wikipedia.org/wiki/Triple_bottom_line
- http://www.energyrating.gov.au/library/pubs/200905-data-centre-efficiency.pdf
- http://www.energyefficiencynews.com/policy/i/1576/
- http://www.google.com/corporate/green/datacenters/
- http://www.nrel.gov/docs/fy04osti/33905.pdf
- http://news.bbc.co.uk/2/hi/europe/6409741.stm
- http://msdn.microsoft.com/en-us/library/dd393312.aspx
- http://forgood.yahoo.com/go_green/
- http://www.ibm.com/ibm/green/index.shtml
- http://www.hp.com/hpinfo/newsroom/feature_stories/2007/07-360_greenup.html
- www.**dell**.com/earth
- http://googleblog.blogspot.com/2009/01/powering-google-search.html
- http://www.technewsworld.com/story/Harvard-Prof-Sets-Record-Straight-on-Internet-Carbon-Study-65794.html
- http://www.computer.org/portal/web/csdl/abs/html/mags/it/2008/01/mit2008010012.htm#mit20080100121
- http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf
- http://www.greenpeace.org/usa/campaigns/global-warming-and-energy/science/co2-emissions
- www.foe.co.uk/resource/briefings/**driving_up_co2_emissions**.pdf
- http://www.independent.co.uk/environment/climate-change/too-late-to-avoid-global-warming-say-scientists-402800.html

THANK YOU

Mutlu Dogus Yildirim
dogus.yildirim@eu.sony.com