INNOVATION

Green Technology
ในระบบสายสื่อสัญญาณ ICT

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Why Green ICT, IT, or Computing?

- 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!
- 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

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

Manufacturing

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

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

Chemical Elements Used: Lead

- used in soldering of printed circuit boards and other components
  - also used in glass for CRTs
- It is estimated that between 1997 and 2004, 1.2 billion tons of lead was used in computer components
- The problem:
  - lead can cause damage to the central and peripheral nervous systems, blood system, kidneys, endocrine system and cause negative effects on child brain development
  - lead accumulates in the environment and has toxic effects on plants, animals and microorganisms
  - electronics contribute 40% of the total amount of lead found in landfills and can make its way from landfills into the water supplies

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
- 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

Other Chemical Elements

- Cadmium is used in resistors for chips, infrared detectors and in semiconductors (plus older CRTs)
  - estimated that between 1997 and 2004, 2 million pounds of cadmium was used in computer components
- The problem:
  - cadmium is classified as toxic, these compounds accumulate in the human body, particularly the kidneys
  - cadmium is absorbed through respiration and also food intake
  - cadmium has a half life of 30 years so that cadmium can poison a human body slowly through the human's life
- Hexavalent Chromium (Chromium VI) is used to treat steel plates (an anti-corrosive) and it is estimated that between 1997 and 2004, 1.2 million pounds were used in computer components
  - if you've seen Erin Brokovich, you know that this can lead to cancer and a number of other medical problems

Plastics

- Plastics are found throughout the computer, largely from casings but also internally to hold components together
  - 4 billion pounds of plastic were used to build computers and components between 1997 and 2004
- One specific form of plastics used is polyvinyl chloride (PVC) which is used in cabling and housings
  - PVC is difficult to recycle and the production and burning of PVC generates dioxins and furans
- The plastics in computers are often treated with flame retardant chemicals, particularly brominated flame retardant
  - these chemicals can act as endocrine disrupters and increase risk of several forms of cancer
  - they have been found entering the food chain

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

Green Label: RoHS

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

Other Solutions

- Reuse: donate your computer components to people who may not have or have lesser quality computers
  - inner city schools, churches, libraries, third world countries. This however leads to the older computers being dumped but there is probably no way around this as eventually the older computers would be discarded anyway
- Refurbish: rather than discarding your computer when the next generation is released, just get a new CPU and memory chips – upgrade rather than replace
  - while you will still be discarded some components, you will retain most of the computer system (e.g., monitor, the system unit housing, cables)
- Are there adequate incentives to do either of the above? Do computer companies encourage refurbishing/upgrading?

One More Solution: Recycling

- If companies can recycle the plastics and other components, this can greatly reduce waste and toxins
  - however, the hazardous materials in e-waste can harm the recycle workers if they are not properly protected
  - in undeveloped countries, a lot of the recycling chores are left up to unprotected children!
- Developed countries now have facilities for recycling e-waste
  - however, in Europe, the plastics are discarded instead of recycled because the flame retardant chemicals are too toxic to work with
- To resolve these problems, the computer manufacturers must start using recyclable chemicals

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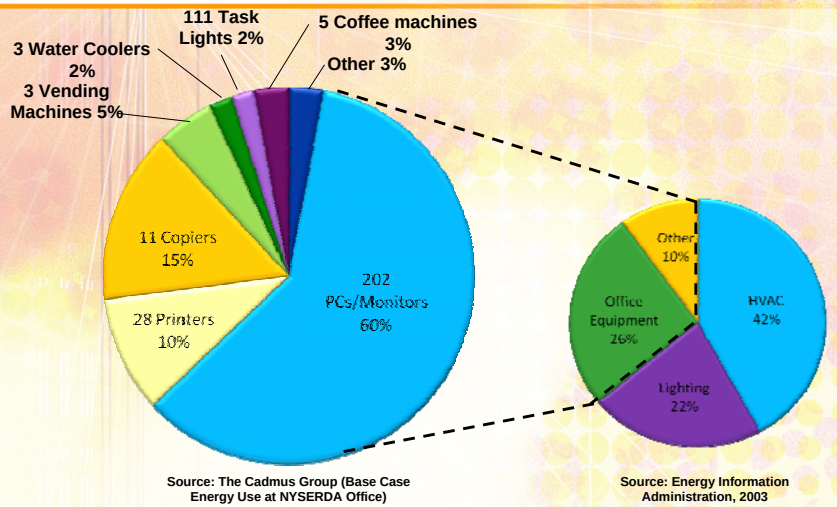
Why Power Management? Plug Load in Commercial Buildings: Mostly PCs



Source: The Cadmus Group (Base Case Energy Use at NYSERDA Office)

Source: Energy Information Administration, 2003

Server Specification - Highlights

- Requirements:
  - Power supply efficiency targets that scale with size
  - Maximum idle power consumption levels set by category
  - Server must have the ability to measure and report its power, temperature, and processor utilization
  - Each server must have its own Power & Performance Data Sheet
  - Blade servers will be covered soon - Timing depends ability to determine approach for Idle measurement
- Timeline
  - Tier 1 effective on May 1, 2009 and will be in place 12 to 24 months
  - Preliminary Draft of Tier 2 specification currently open for stakeholder comment

Server Specification – Savings

- Standard computer servers can consume between 1,200 to 8,600 kWh/Y.
- Energy Star qualified servers could save as much as 1,000 kWh per server/Y.

=

All US Servers = ES Energy cost savings about $800M

1 million vehicles

Energy Star Data Center Storage Specification

Objectives

- Widespread adoption of strategies to improve energy efficiency
- Assist purchasers in identifying identify the most energy efficient solutions
- Provide tools and information to designers and mangers
- Currently collecting data.
- Draft 1 expected February, 2010.

Federal Case Study: AF Specifies ES and Implements Power Management

- Air Force's new procurement and power management guidelines for computers and monitors across one-half million computers save $15 million annually.
- Implemented purchase of ES computers and monitors through:
  - Sending out periodic notices regarding purchasing policy
  - Revising buying standards twice per year for the Quarterly Enterprise Buy (QEB) to ensure low prices without sacrificing performance
  - Each of the Major Commands' CIO is represented on governing committee which ensures each base enforces the purchasing policy
- After working with ENERGY STAR to evaluate options, using MSFT Group Policy activate power management and Task Scheduler utility to accommodate night-time updates.

ES Buildings Specification for Data Centers

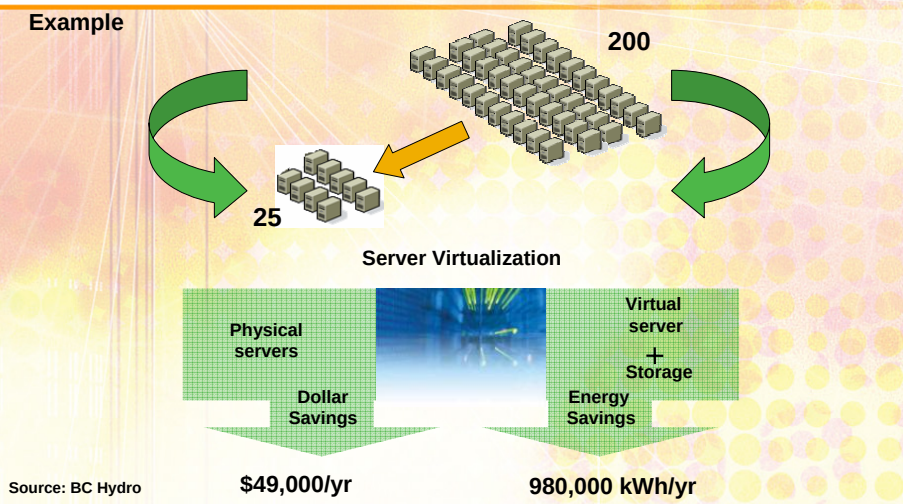
- Develop a useful rating for industry
  - Can be available for use as soon as possible
  - Based on items that are commonly measured and tracked
- Apply to stand-alone data centers and data centers housed within office or other buildings
- Assess performance at the building level to explain how a building performs, not why it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ES building plaque to data centers with a rating of 75 or higher (performance in the top quartile) as determined by Portfolio Manager tool

Example Best Practice: Virtualization

- A software implementation of a computer that executes programs like a real computer

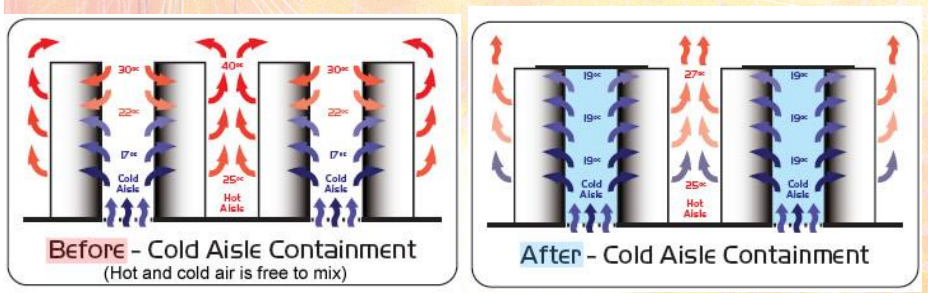
Source: VMWare.com

Virtualizing Servers Can Cut Energy & Capital Costs



Source: BC Hydro

Example Best Practice: Cold Aisle Containment



Cold aisle containment can reduce fan energy by 20–25%, plus ~20% savings on the chiller side

Sources: Keyzone Computer Products, Ltd., LBNL

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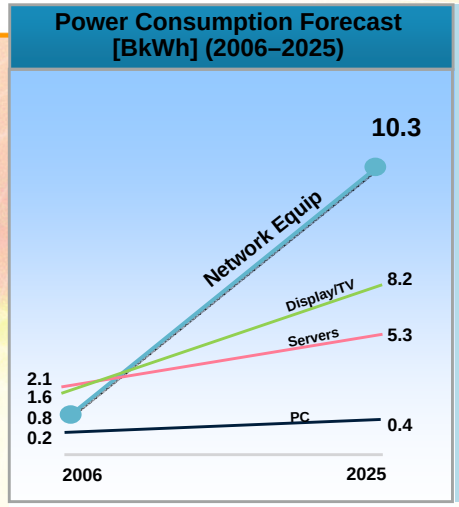
Why care about energy efficiency?



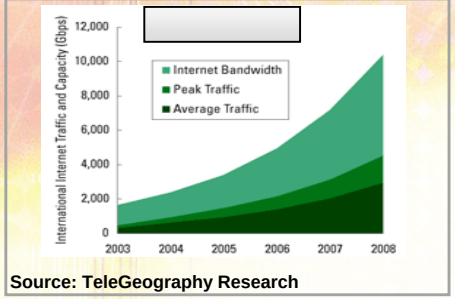
- **Electricity costs rose 88% in US since 2003**
  (Source: US EIA official government stats)
- **Energy is a non-trivial OPEX item**
- **Worldwide legislation changes and public support for energy efficiency and climate control**
  - California: Reduce CO_2 by 80 % in 2050
  - European Union: Reduce CO_2 by 20% by 2020
  - UK: Reduce CO_2 by 20% by 2010
  - Japan: Reduce CO_2 to 6% below 1990 level by 2010

Source: IDC 2007

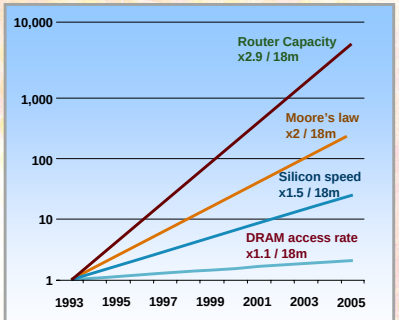
Growth, Growth, Growth!

Traffic—Mean annual growth 1.88 times

International Internet Traffic Forecast



Source: TeleGeography Research

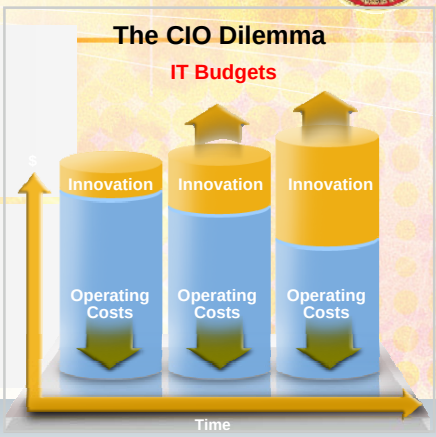


Source: N. McKeown, Stanford University (Modified)

- System requirements grow faster than silicon and cooling technology
- Pushing the limits
  - Total system power
  - Individual device power
  - Cooling infrastructure

2008 CIO priorities

- Business priorities
  - Service customers
  - Improve business process
  - Create new business strategies
  - Cut costs
- IT priorities
  - Deploy strategic applications
  - Expand infrastructure
  - Improve security/continuity
  - Implement flexible architecture



Stay in the game

Change the rules and win the game

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How to establish meaningful energy metrics to measure networking consumption

Compare
- "Like" feature sets and applications

Configure
- Systems comparably

Consider
- All elements

Example
Energy Consumption Rating ECR

ECR = Ef/Tf

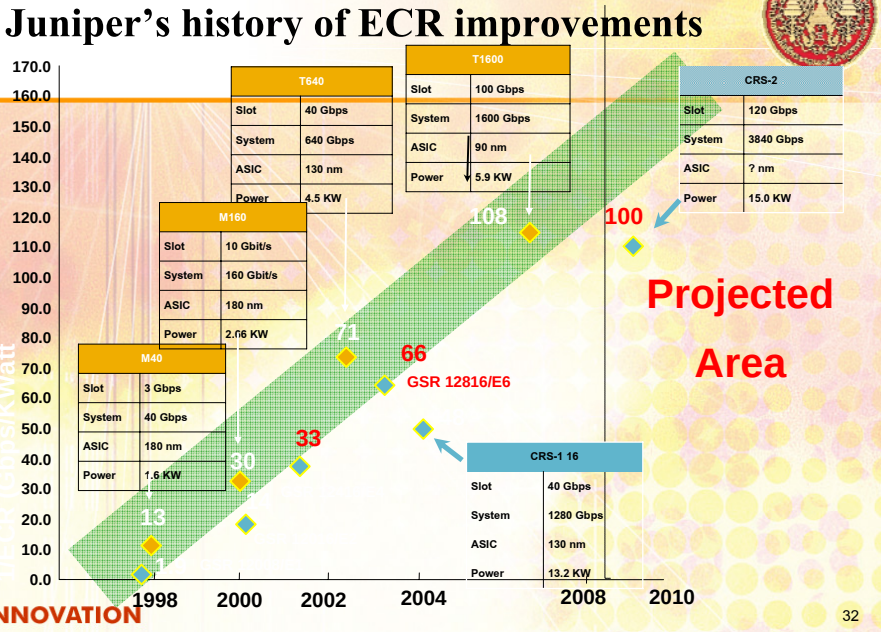
(expressed in Watts per Gbps)

Where:
Ef = energy consumption (Watts) measured during running test
Tf = maximum throughput (Gbps) achieved in the measurement

Ultimate Goal to Consider Entire Product Lifecycle

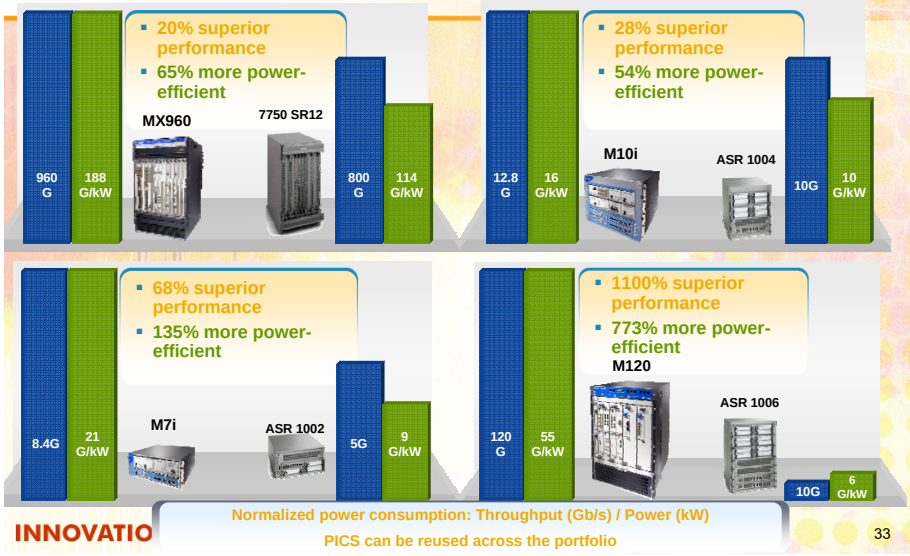
Juniper's history of ECR improvements

Full Load



INNOVATION

The Juniper advantage in the medium/large WAN (M-series)



The Juniper advantage in the Data Center (EX and SRX)

Typical Configuration

- 3000 servers, dual 1GbE attached
- Fully redundant design
- 125Gbps firewall
- 10GE uplink from access and in core

	Juniper	Cisco	Savings $$
Total List Price	$4.6M	$9.6M	Up to 52.1% CAPEX
Power	372,169 kW*hr/yr	666,758 kW*hr/yr	Up to 44.2% power
Rack Space	210 RU	450 RU	Up to 55.3% space
Operating Systems (time to manage)	JUNOS	IOS	Up to 25% OPEX

Juniper Solution

- EX 4200 top-of-rack (2/rack)
- EX 8208 in core
- 2 SRX 5800

Cisco Solution

- Cat 4948 top-of-rack (2/rack)
- Cat 6500 in aggregation and core
- 46 FWSM

Source: publicly available data sheets, price lists, Lake Partner study

D-Link 24-Port 10/100/1000 Mbps Rack-mount Switch

24 Gigabit Ethernet ports
48 Gbps switching capacity
Desktop or rack-mountable design
Non-blocking architecture

- **Benefits of Green Ethernet technology:**
- Reduces power consumption & creates less heat
- Extended product life
- Reduces operating costs

D-Link 5-Port 10/100/1000 Mbps Desktop Switch

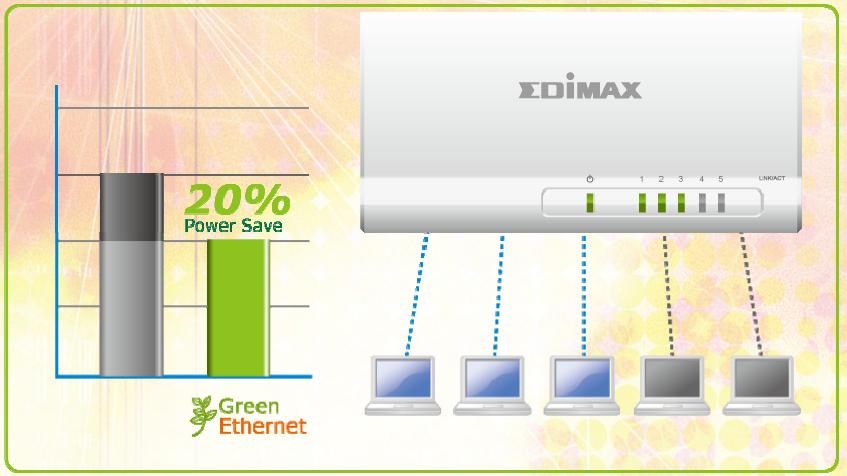
5 Gigabit Ethernet ports
10 Gbps switching capacity
Desktop or wall-mount design
Non-blocking architecture

- **Benefits of Green Ethernet technology:**
- Reduces power consumption & creates less heat
- Extended product life
- Reduces operating costs

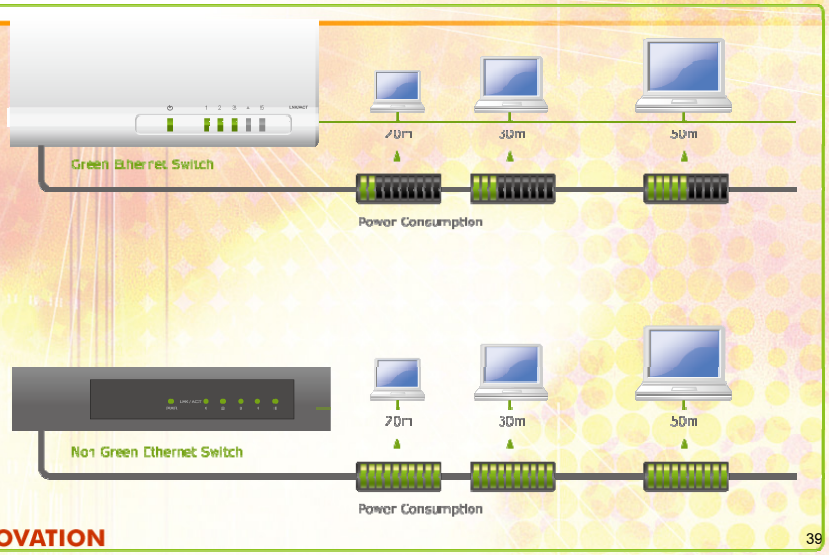
Savings by cable length

- The Green Ethernet switches have the ability to analyze the length of any Ethernet cable connected to them for adjustment of power usage accordingly. Shorter lengths require less power.
- In SOHO deployments, standard cable length is less than 20 m.
- For a traditional switch, power consumption remains constant even when the ports are not in use. In a standard workday scenario where PCs are used for 10 hours a day and powered off 14 hours a day, and connected to the switch using 20 meter cables, D-Link's Green Ethernet can save up to **27%** power used for each system.

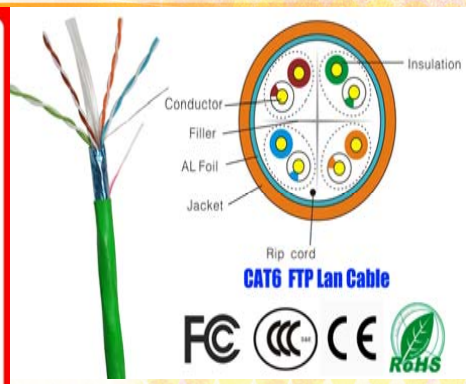
EDiMax Green Ethernet Technology



Green Ethernet Technology



Green Cables



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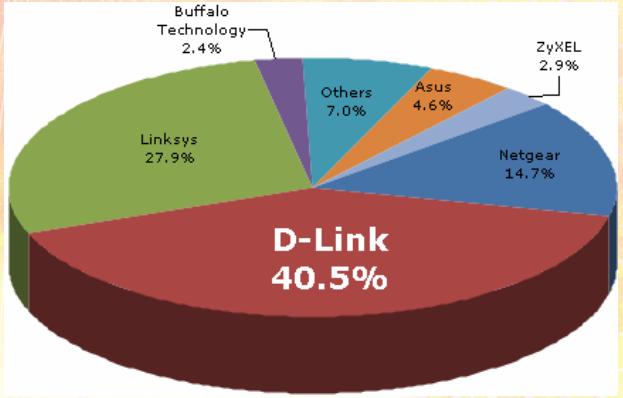
Small Enterprise WLAN

No.1 in Small Enterprise WLAN, WorldWide, 2008



Wireless LAN Stand-Alone Access Points:
Small Enterprise Market, Unit Shipments (K), Worldwide, 2008 by Gartner Research

D-Link Features Roadmap

11n Business Access Point

- Meeting the market trend of **GREEN**.
  - Phase in the most efficiency power adapter and state-of-the-art design
  - Reducing the power consumption during off-duty period by adding the "Wireless Schedule" feature.
  - Work with PoE Switch to be powered on/off.

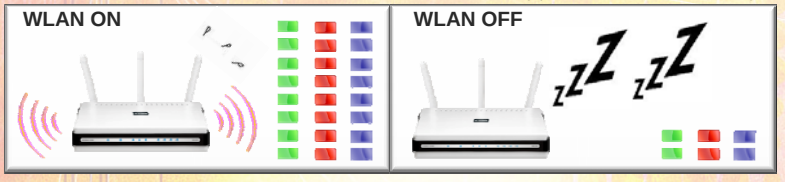
*: Available by 2H in 2009

D-Link Features Roadmap

11n Wireless Router

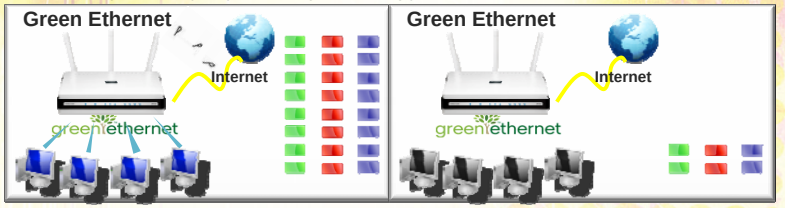
Green Wi-Fi: WLAN Scheduler

WLAN Scheduler turn down WLAN with software scheduler to saving power and enhance security.



Green Ethernet

D-Link's Green Ethernet implements special power-saving features that automatically detect link status and cable length and adjust power usage accordingly.



Other Green WiFi Product & Project

GO GREEN
Green Ethernet Technology

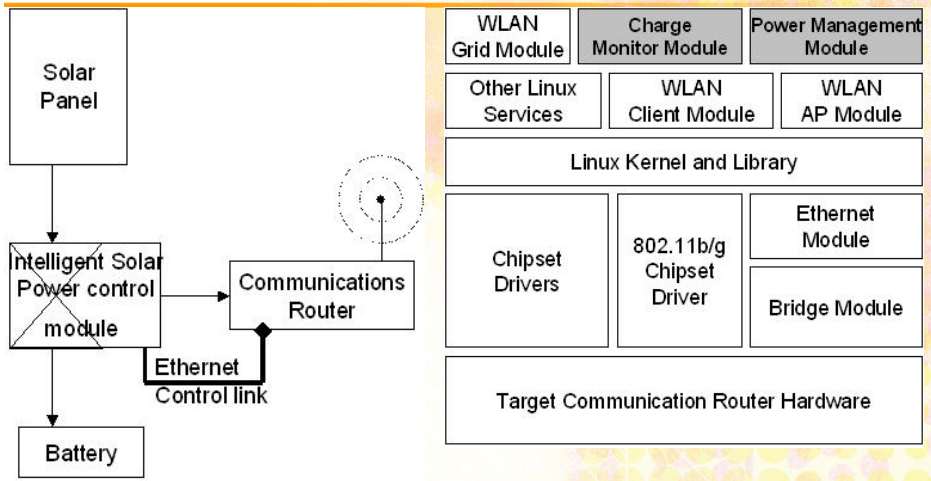
Green WiFi

When Disaster Strikes, Power Paramount

Functional Considerations:

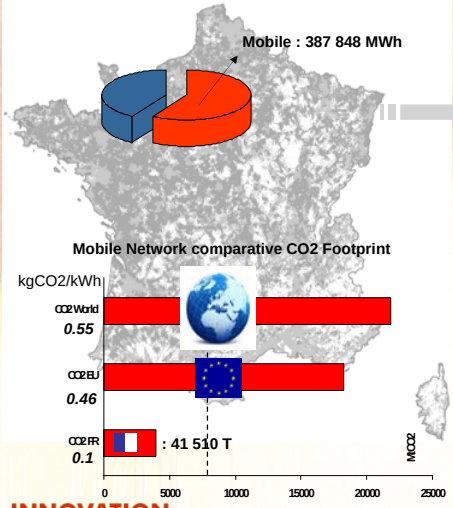
- Engineering
- Cost
- Design

Green WiFi

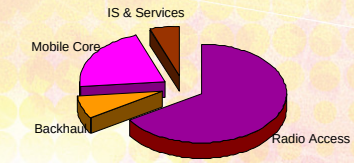


Mobile Network Key figures 2008

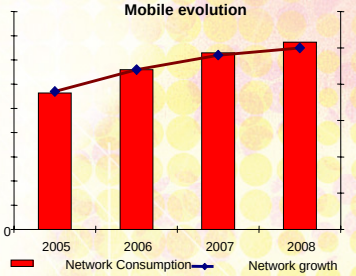
Fixed + Mobile global consumption



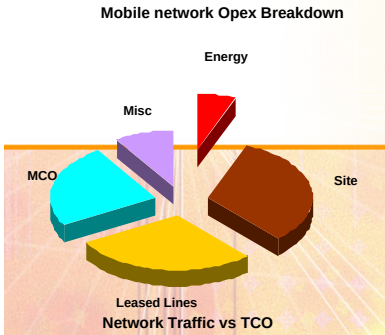
Mobile consumption breakdown 2008

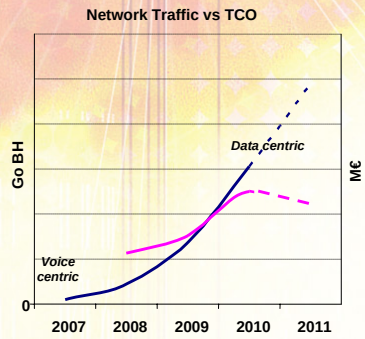


Mobile evolution



Green Cellular Network





- **High energy efficiency** across the network is required to enable a **sustainable growth** in terms of Total Cost of Ownership and CO2 footprint :
- High capacity growth triggered by mobile data demand
- Separating capacity from cost is for a sustainable growth
- Energy bills account for 6% of SFR's Infrastructure Opex
- Consumption is sensitive to capacity growth and may raise Opex and CO2 footprint without Energy Efficiency.
- Energy efficiency is achieved through a set of structural network evolution (IP convergence) and introduction of efficiency specific features

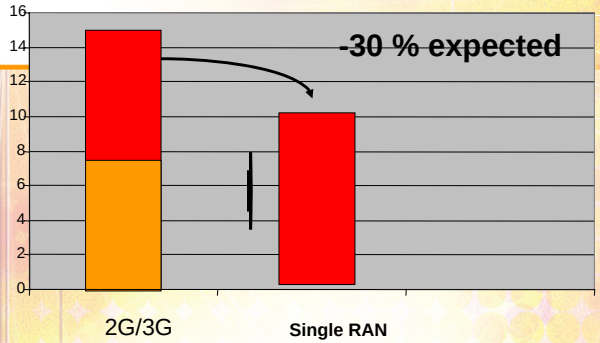
Energy Efficiency in the RAN (Radio Access Network)

RAN ecosystem characteristics :

- Several technologies (2G, 3G/HSPA,…LTE) to handle,
- Thousands of nodes required to address a national coverage,
- Dramatic traffic growth forecasted combined with higher data peak-rate
- Stringent QoS requirement

- New generation of BTS/ Node B improves energy efficiency :
  - Higher Efficiency Power Amplifier : from 10% to 40 %
  - PA installed closer to the antennas
  - Reduction of the dB loss on the RF cable to the antennas.
  - Easier installation and lower power requirement (expected 20% gain)
  - Reduced Site consumption thanks to the lower cooling requirement (enables free cooling or natural heat dissipation)

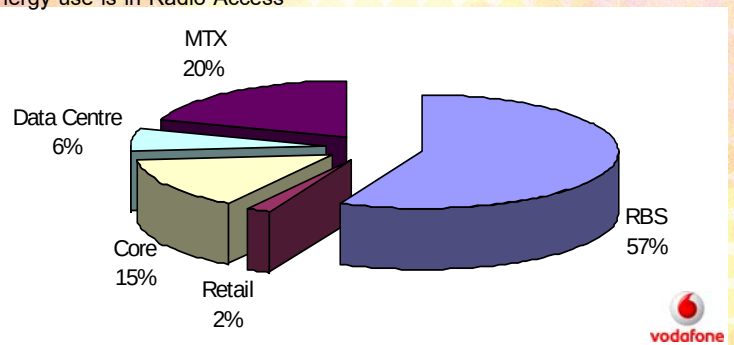
Energy Efficiency in the RAN



- Standardisation of UMTS 900 MHz :
  - Delivers a better reach than the 1.8 and 2.1GHz band
  - Enables a national coverage with lower amount of sites
  - Allows 2G/3G Single RAN application
- Single RAN solution collapses the 2G/3G network and reduces the amount of network element
  - Common control and PA serve several 2G TX and 3G carrier

Why Green Radio? – An operator view

- Vodafone UK is an average load of 50MW
- Energy costs money and Vodafone has pledged to reduce CO_2 emissions by 50% by 2020
- 57% of energy use is in Radio Access



Green Radio Scenarios

1. Developed World
   - Developed Infrastructure
   - Saturated Markets
   - Quality of Service Key
   - Drive to reduce costs
2. Emerging Markets
   - Less Established Infrastructure
   - Rapidly expanding Markets
   - Large Geographical Areas
   - Power consumption a major issue

Green Radio Objectives

- April 2008 workshop and following discussion identified two key targets:
  1. *To identify the best radio **techniques** across all layers of the protocol stack that collectively address the aspiration of achieving 100x power reduction.*
  2. *To identify a green network **architecture** - a low power wireless network & backhaul that still provides good QoS*

Mobile VCE industrial members

Alcatel·Lucent, BAE SYSTEMS, BBC, BT, FUJITSU, HUAWEI, 3, KT, NEC, Nokia Siemens Networks, NORTEL, PHILIPS, SAMSUNG ELECTRONICS, orange, THALES, TOSHIBA, Turner, vodafone, University of Bristol, Kings College London, Royal Holloway University of London, University of Strathclyde, University of Southampton, University of Surrey

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- ทำไมต้อง Green IT หรือ Green ICT?
- Green Manufacturing of ICT Equipment
- การใช้พลังงานของอุปกรณ์ด้าน ICT
- ระบบเครือข่าย (Green ICT Network)
  - อุปกรณ์เครือข่าย
  - สายสื่อสัญญาณ (Media)
    - เครือข่ายมีสาย (Wired Network)
    - เครือข่ายไร้สาย (Wireless Network)
  - **อุปกรณ์ปลายทาง: Computer, Monitor, Printer, etc.**
- สรุป (Conclusion)

Energy Use of PCs

- CPU uses 120 Watts and CRT uses 150 Watts
  - 8 hours of usage, 5 days a week = 562 KWatts
    - if the computer is left on all the time without proper power saver modes, this can lead to 1,600 KWatts
  - for a large institution, say a university of 40,000 students and faculty, the power bill for just computers can come to $2 million / year
- Energy use comes from
  - electrical current to run the CPU, motherboard, memory
  - running the fan and spinning the disk(s)
  - monitor (CRTs consume more power than any other computer component)
  - especially laser printers

Reducing Energy Consumption

- Turn off the computer when not in use, even if just for an hour
- Turn off the monitor when not in use (as opposed to running a screen saver)
- Use power saver mode
  - in power saver mode, the top item is not necessary, but screen savers use as much electricity as any normal processing, and the screen saver is not necessary on a flat panel display
- Use hardware/software with the Energy Star label
  - Energy Star is a "seal of approval" by the Energy Star organization of the government (the EPA)
- Don't print unless necessary and you are ready
- Use LCDs instead of CRTs as they are more power efficient

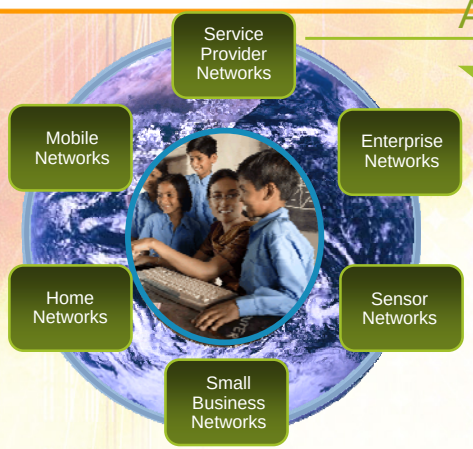
Components: Hard Drive

Components: Power Supply (AC to DC)

สรุป (Conclusion)

Make Every Connection …

A Greener Connection



MONITOR
MANAGE
REDUCE

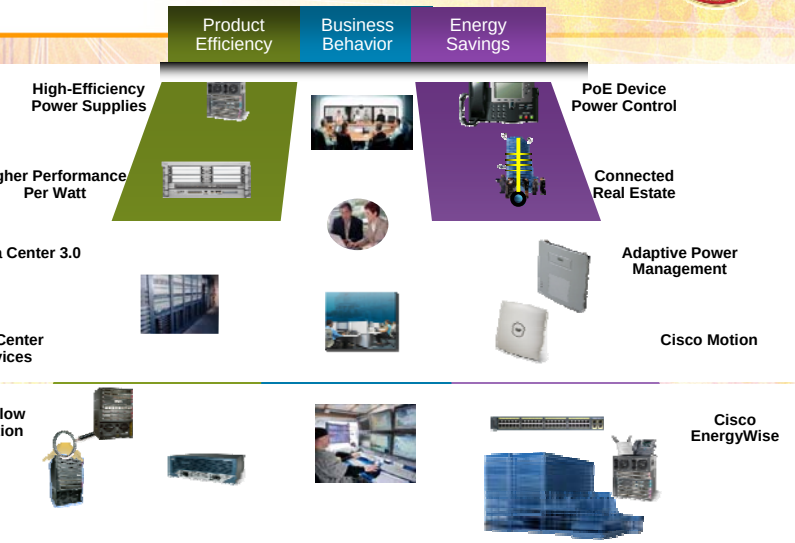
Traffic flows in cities
Electricity use in offices
Appliances in homes

Sustainable Business Practices

Collaborating across organizations to build new models for dealing with environmental issues, for Cisco and our customers

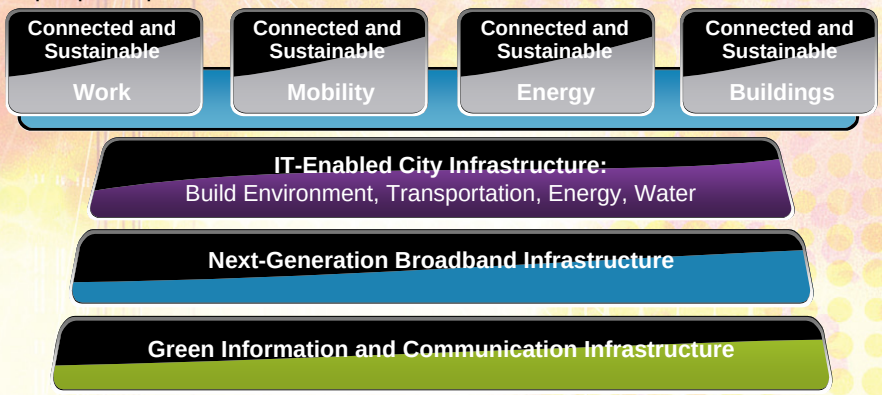
Operations	Products	Solutions	Employees & Advocacy
25% GhG Reduction by 2012 EPA Green Power Partner of Year	SA Set Top Boxes Cisco Unified Coms Manager Data Centers	Connected Urban Development (CUD) Connected Real Estate EnergyWise Technology	Eco-board Green Blog Global Earth Day Environmental Organizations (EDF, WRI, Climate Group, GreenGrid, etc.) SDOs (ITU, ATIS, ETSI, IEEE, GeSI, etc.)

Continuum of Greener IT Innovations

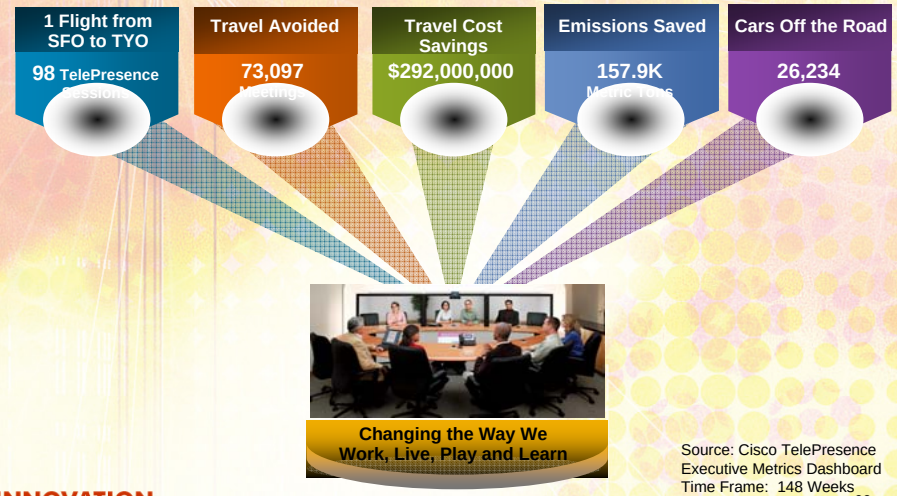


Sustainable Solutions: Intelligent Urbanization

An urban communications infrastructure that makes the flow of information, knowledge, people, and traffic more efficient, in turn dramatically enhancing how people experience life in and around cities.



Sustainable Solutions: TelePresence



Source: Cisco TelePresence Executive Metrics Dashboard
Time Frame: 148 Weeks