

Istituto di Tecnologie della Comunicazione, dell'Informazione e della Percezione

### Internet sustainability or Internet for sustainability: what really matters ?

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- How ICT could contribute to tackle climate change
- How ICT energy consumption could be lowered
- Yet another bubble ?





L.1400 covers definitions and general principles for the evaluation of ICT environmental impacts



Should quantify both environmental aspects.



Source: ITU-T Rec. L.1400 from Question 18/5 ITU-T SG5 WP3 ICT & © 2011 Scuola Superiore Sant'Anna **Climate Change** 

### Examples of using ICT to tackle climate change

- Using ICTs to monitor the global environment /ecosystem
- Using ICTs to address food security, water transportation and supply (e.g., use of Internet, to distribute information to farmers and consumers)
- Using ICTs to monitor deforestation and forest degradation (e.g., through satellite imaging)
- Waste management with smart ICT (e.g., websites for places to recycle ICT equipment)
- Using ICTs to increase energy supply efficiency and maximize the use of renewable sources (e.g., smart grid and amsrt infrastructure for electric vechicles)
- Using ICTs in education and to raise awareness on climate change (e.g., teleconference and teleteaching)



 Using ICTs in healthcare (e.g., telemedicine, remote health monitoring that remove the need for the patient to travel to the doctor's office and reduce 4 GHG emission) Energy Efficient Light Bulbs and Passive Optical Networks

#### Energy Efficient Light bulb Gigabit Ethernet (Compact fluorescent bulb®)ptical Network Unit (ONU)



~20 W (100 W traditional light bulb tungsten filament lamps) 6 hours/day → 120 Wh/day



~10 W 24 hours/day  $\rightarrow$ 240 Wh/day

Energy Consumption in Communications Networks





Source: C. Lange, D. Kosiankowski, R. Weidmann, and A. Gladisch, "Energy Efficiency in the Future Internet: A Survey of Existing Approaches and Trends in Energy-Aware Fixed Network Infrastructures", IEEE JSTQE, March/April, 2011

### Research Efforts in reducing communications networks energy consumption

- Physical approach
  - Lower consumption of device components
  - Lower consumption of utilized modulation formats for data tranmission
- MAC and Routing approaches
  - Adapt network utilization to traffic
  - Sleep mode
- Joint approaches
  - Upper layer approaches are boosted by improvements at the physical layer
  - Faster clock and data recovery to allow faster wake up after sleep
- Greentouch Consortium (led by Alcatel Lucent Bellabs)
  - Global Vision: "Dedicated to creating a sustainable Internet through innovation and collaboration — increasing ICT energy efficiency by a factor of 1000 to fundamentally transform global communications and data networks"

Power saving techniques in core networks Interfaces in sleep mode





Efforts from the standard bodies to reduce communications networks energy consumption

- Effort from the standards
  - ITU-T G.Sup45: XG-PON (G-PON, NG-PON1, NG-PON2)
  - IEEE 802.3az "Energy Efficient Ethernet"
  - European Codes of Conduct for ICT A European Action to Improve the Energy Efficiency of Information and Communication Technologies (http://re.jrc.ec.europa.eu/energyefficiency/html













#### • The More We Save, The More We Burn





Source: http://www.greglindsay.org/blog/2010/12/the\_jevons\_paradox\_the\_more\_we\_save\_the\_more\_we\_burn © 2011 Scuola Superiore Sant'Anna



- How much energy will we need to recycle/get rid of devices ?
  - Sensors
  - Solar panels
  - Etc.





- Exploit locality to minimize energy waste
- Distributed small producers for local consumers
- Producer federation





# ... something useful survived even the dot-com bubble !!!





### Thank you ! Questions ?

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#### Back-up





- L.1410 Environmental impact of ICT goods, networks and services
  - Covers negative and positive impacts of ICT
  - Expected mid-2011
- L.1420 Environmental impact of ICT in organisations
  - Includes 3 scopes of ISO 14064-1
  - Expected mid-2011
- L.1430 Environmental impact of ICT projects
- L.1440 Environmental impact of ICT in cities
- L.1450 Environmental impact of ICT in countries and group of countries



Energy Consumption by ICT and Carbon Footprint

 However the increased utilization of ICT would imply an increase in ICT energy consumption

|  | 2005  |           | 2020 BAU |         | 2020 ECO |         |
|--|-------|-----------|----------|---------|----------|---------|
|  | TWh/a | Mt CO2e   | TWh/a    | Mt CO2e | TWh/a    | Mt CO2e |
| Total ICT sector electricity use in EU 25    | 214.5 | 98.2839   | 409.7    | 187.725 | 288.2    | 132.053 |
| ICT sector without consumer electronics in   | 1186  | 5/1 2/125 | 2/15 1   | 112 205 | 185 2    | 84 8586 |
| Share of the ICT sector electricity use over | 110.0 | JH. JH2J  | 243.1    | 112.303 | 103,2    | 04.0300 |
| total EU-25 electricity use (%)              | 8     | 19        | 10.5     | 4.2     | 7.4      | 3       |
| Share of the ICT sector electricity use      |       |           |          |         |          |         |
| (without consumer electronics) over total E  |       |           |          |         |          |         |
| 25 electricity use (%)                       | 4.4   | 1.1       | 6.3      | 2.5     | 4.8      | 1.9     |



arbon Emission Factor (kg CO2e/kWh)=0.4582

Source: European Commission DG INFSO, "Final Report – Impacts of ICT on Energy Efficiency", Sep. 2008

BAU-scenario until 2020 – ICT sector total electricity use (EU-25)



ICT on Energy Efficiency", Sep. 2008

#### ECO-scenario until 2020 – ICT sector total electricity use (EU-25)



## Approaches for implementing energy efficiency in PONs



Source: L. Valcarenghi, D. Pham Van, P. Castoldi, "How to Save Energy in Passive Optical Networks", Invited paper, ICTON 2011

Source: Shing-Wa Wong, L. Valcarenghi, She-Hwa Yen, D.R. Campelo, S. Yamashita, L. Kazovsky, "Sleep Mode for Energy Saving PONs: Advantages and Drawbacks", GrennComm2, IEEE Globecom 2009 Workshops BEST PAPER AWARD

