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Energy Aware Paradigm for Energy Efficient ICT: a Systemic Approach

Sergio Ricciardi, Davide Careglio, Germán Santos-Boada, Josep Solé-Pareta
Advanced Broadband Communication Center (CCABA), Universitat Politècnica de Catalunya (UPC), Barcelona, Spain
{sergior, careglio, german, pareta}@ac.upc.edu

Energy Aware Paradigm: the "EYE" on the future ICT

Energy consumption taken into account at all levels as **additional constraint**

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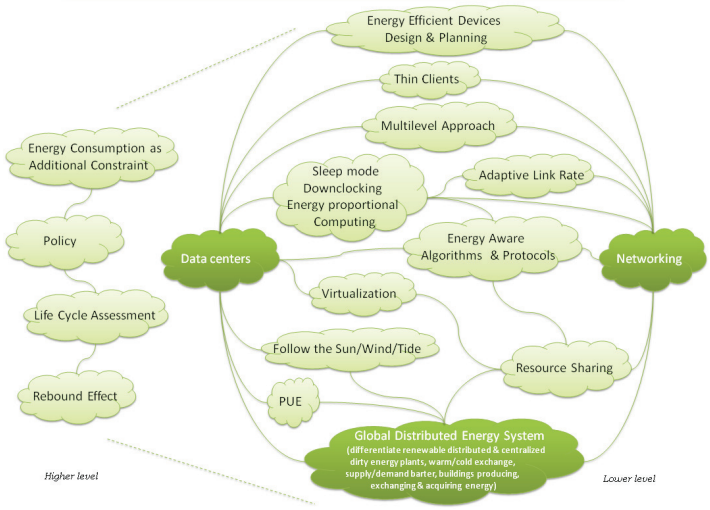
Policy should enforce a system approach that considers the **whole Life Cycle Assessment** in order to avoid the **Rebound effect**

⇓

Development & Implementation of the foreseen **energy-aware paradigm**



EYE = EnergY Efficiency

Energy aware paradigm

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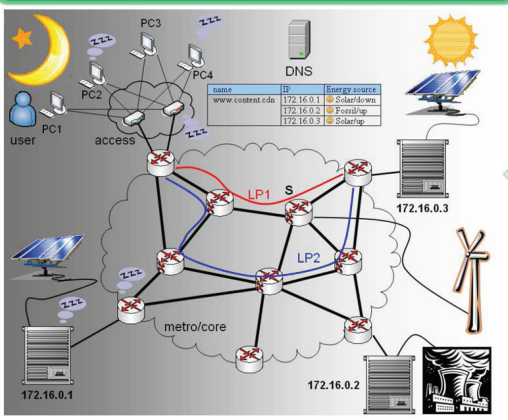
individual actions acting in **systemic fashion**

⇓

sustainable (*scalable*) society **growth and prosperity**

Networking model

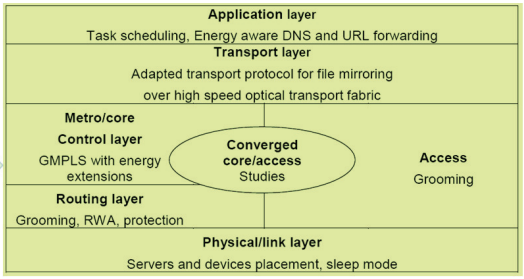


The **core network** is a **dynamically reconfigurable transparent network** and the access network is PON-based. The file servers 172.16.0.1, 172.16.0.2, 172.16.0.3 are part of the same **content delivery network** (CDN) and data is mirrored among them with high-speed data transfers through the **optical core** using static lightpaths (not represented here), established following a **planning stage**, including recommendations from an **energy analysis for optical networks**. On the access side planning, four PCs are connected to two access points (or two line cards of a single access point), such that one access point can go to **sleep mode** as soon as only two of the computers are turned off and require no network activity. Switch S is connected to a **wind turbine;** when wind stops, the corresponding router is set into the sleep mode and lightpath LP1 is dynamically rerouted into LP2 using an **energy aware control plane**, during the network operation stage. When a user (top-left corner) needs to download a file from the CDN, a query is made to a **green DNS server** that knows how the CDN servers that hold the desired file are powered up: server 127.16.0.1 is down because it is connected to a **solar panel** and the night has fallen; server 172.16.0.2 is using electricity generated by a **coal power plant**, while server 172.16.0.3 runs on clean energy and hence its IP address is returned by the DNS server.

Two types of energy plants: Green energy plants & fuel-based "dirty" plants ⇒ green distributed energetic system

Ecoplan STREP proposal, Energy-Constrained Optical Network Planning, FP7-ICT-2009-4

Multilevel Approach



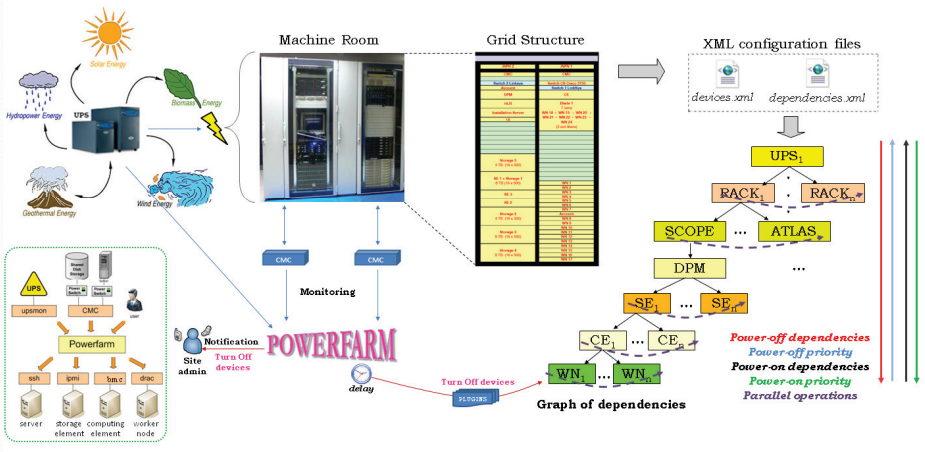
Green Layered Model of the Protocol Stack

Routing protocol extensions include:

- power-consumption information
- source of power (green or "dirty" energy sources)
- sleep mode on/off

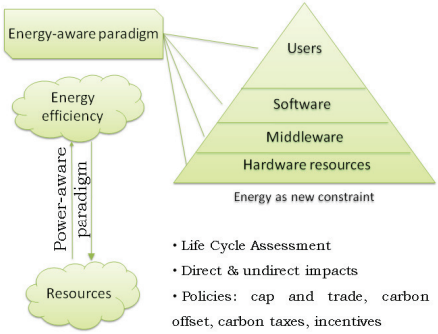
Data centers

Automatic enhanced sleep mode : Powerfarm[1] executes controlled shutdown respecting devices dependencies

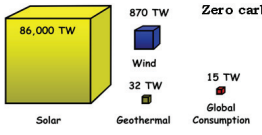


[1] Sergio Ricciardi, Alessandro Doria, Giampaolo Carlino, Salvatore Iengo, Leonardo Merola, Maria Carla Staffa, "Powerfarm: a power and emergency management thread-based software tool for the ATLAS Napoli Tier2", proceedings of Computing in High Energy Physics (CHEP) 21 - 27 March 2009, Prague, Czech Republic, Journal of Physics: Conference Series (JPCS), IOP Publishing

Systemic Approach



- Life Cycle Assessment
- Direct & undirect impacts
- Policies: cap and trade, carbon offset, carbon taxes, incentives



Zero carbon approach is **feasible!**