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IEEE **COMMUNICATIONS SOCIETY**

ECO net

low Energy COnsumption NETworks

SEVENTH FRAMEWORK PROGRAMME

National Inter-University Consortium for Telecommunications

cnit

Department of Communications, Computer and Systems Science – University of Genoa, Italy

dist

Telecommunication Networks and Telematics Laboratory

TNT

Energy Efficient Networking: The ECONET Project (low Energy COnsumption NETworks)

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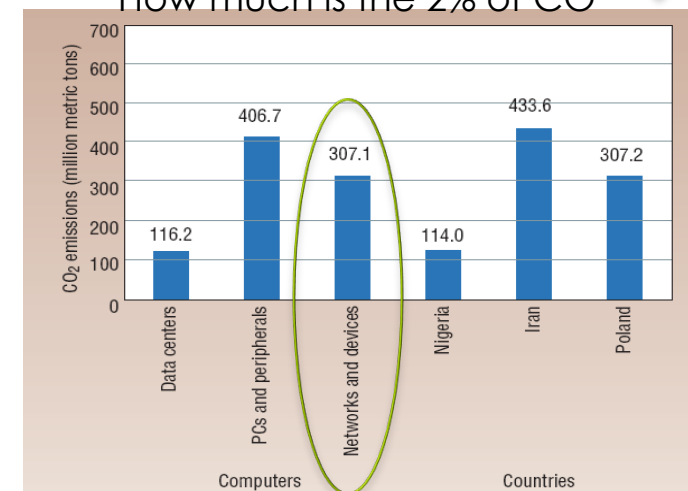# Where did the idea of ECONET stem from?
…Driving forces

- There are two main motivations that drive the quest for "green" ICT:
  - the environmental one, which is related to the reduction of wastes, in order to impact on CO_2 emission;
  - the economical one, which stems from the reduction of operating costs (OPEX) of ICT services.

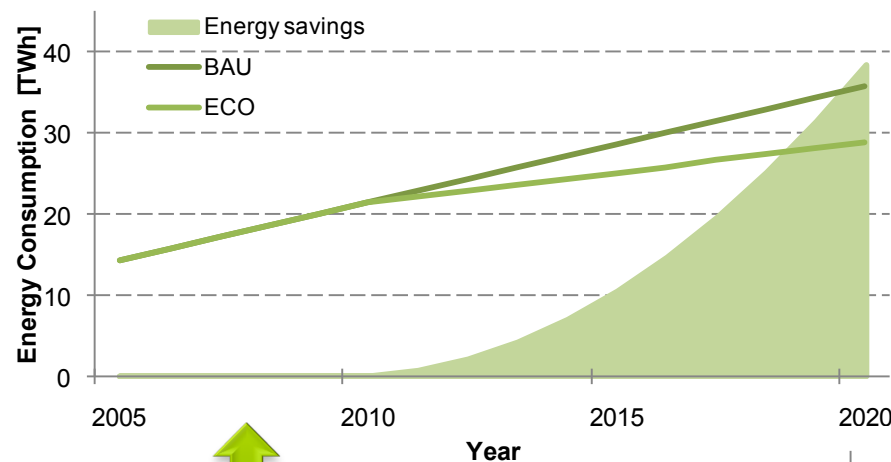### How much is the 2% of CO_2

Gartner Group, Inc. (2007)

"The global information and communications technology (ICT) industry accounts for approximately 2 percent of global carbon dioxide (CO_2) emissions, a figure equivalent to aviation."

Note that the ICT sector raises much faster than aviation

Chart: CO_2 emissions (million metric tons)
- Data centers: 116.2
- PCs and peripherals: 406.7
- Networks and devices: 307.1
- Nigeria: 114.0
- Iran: 433.6
- Poland: 307.2

Computers | Countries

Where did the idea of ECONET stem from?

...Potential saving

OPEX estimation related to energy costs for the European telcos' network infrastructures in the "Business-As-Usual" (BAU) and in the Eco sustainable (ECO) scenarios, and cumulative savings between the two scenarios.

Source: R. Bolla, R. Bruschi, F. Davoli, F. Cucchietti, "Energy Efficiency in the Future Internet: A Survey of Existing Approaches and Trends in Energy-Aware Fixed Network Infrastructures," IEEE Communications Surveys & Tutorials, vol. 13, no. 2, pp. 223-244, 2nd Qr. 2011.
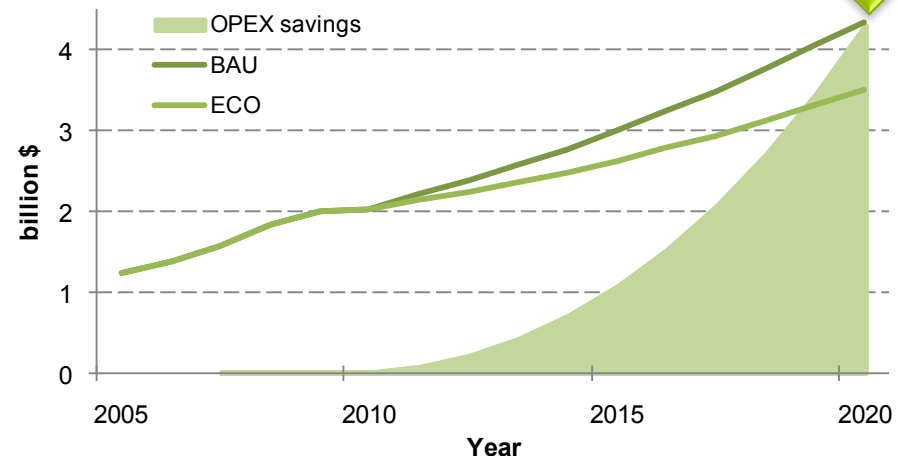
Energy consumption estimation for the European telcos' network infrastructures in the "Business-As-Usual" (BAU) and in the Eco sustainable (ECO) scenarios, and cumulative energy savings between the two scenarios.
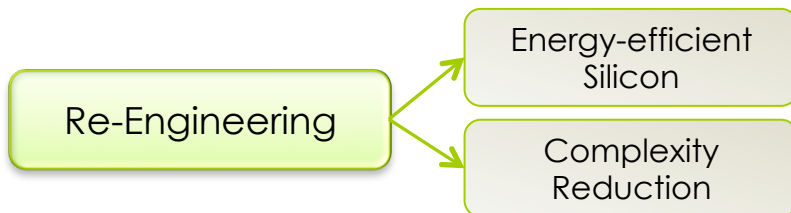
Source: European Commission DG INFSO report
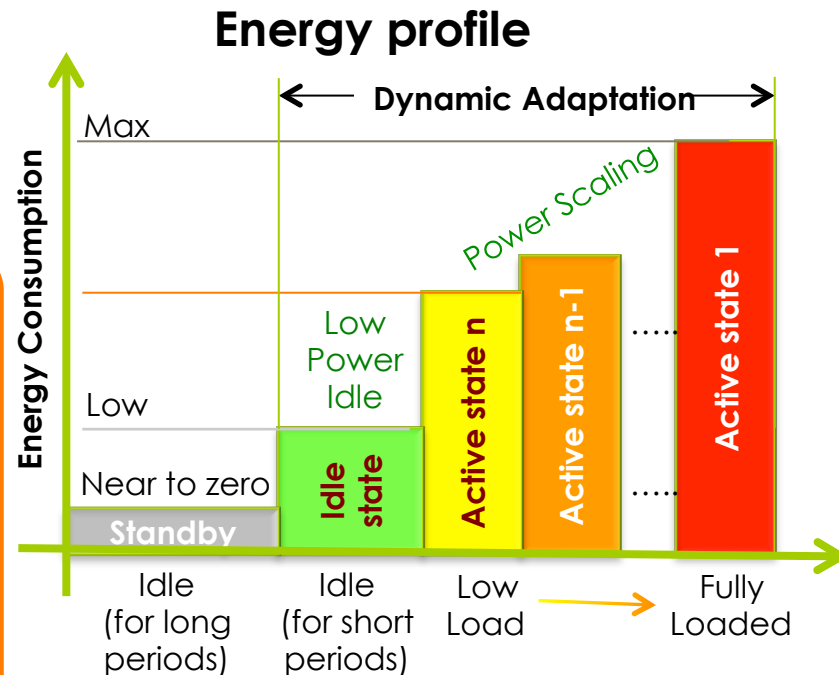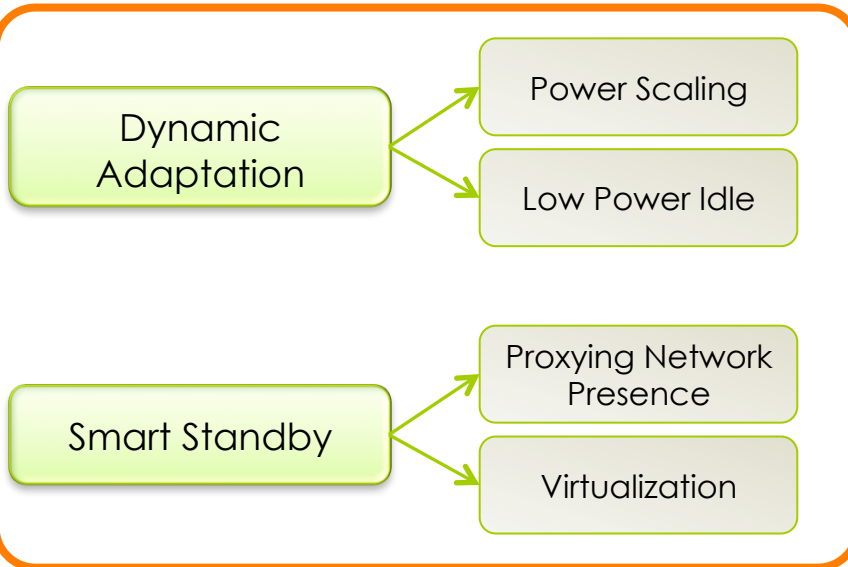
Where did the idea of ECONET stem from?

…How to cope with this

- Today's (and especially future) network infrastructures are characterized by:
  - **Design capable to deal with strong requests and constraints** in terms of resources and performance (large loads, very low delay, high availability, ….)
  - **Services characterized by high variability of load and resource requests** along time (burstiness, rush hours, …)
- The current feasible solution:
  - **Smart power management**: energy consumption should follow the dynamics of the service requests.
  - **Flexibility in resource usage**: virtualization to obtain an aggressive sharing of physical resources.

Possible Approaches

Re-Engineering
→ Energy-efficient Silicon
→ Complexity Reduction

Power management

Dynamic Adaptation
→ Power Scaling
→ Low Power Idle

Smart Standby
→ Proxying Network Presence
→ Virtualization

Energy profile

Dynamic Adaptation

Energy Consumption

Max

Power Scaling

Low

Near to zero

Power Scaling

Low Power Idle

Standby

Idle state

Active state n

Active state n-1 ......

Active state 1

Idle (for long periods) — Idle (for short periods) — Low Load → Fully Loaded

ECO net

low Energy COnsumption NETworks

Project data at a glance	
Project Type	FP7 Integrated project
Project coordinator	Prof. Raffaele Bolla (CNIT, c/o University of Genoa)
Project duration	October 2010 – September 2013 (36 months)
Consortium	15 partners from 8 countries and 2 American University associated
Project budget	10.5 M€ (6.2 M€ from EU)
Resources	1168 PM (33 full time persons for three years)
Website	http://www.econet-project.eu

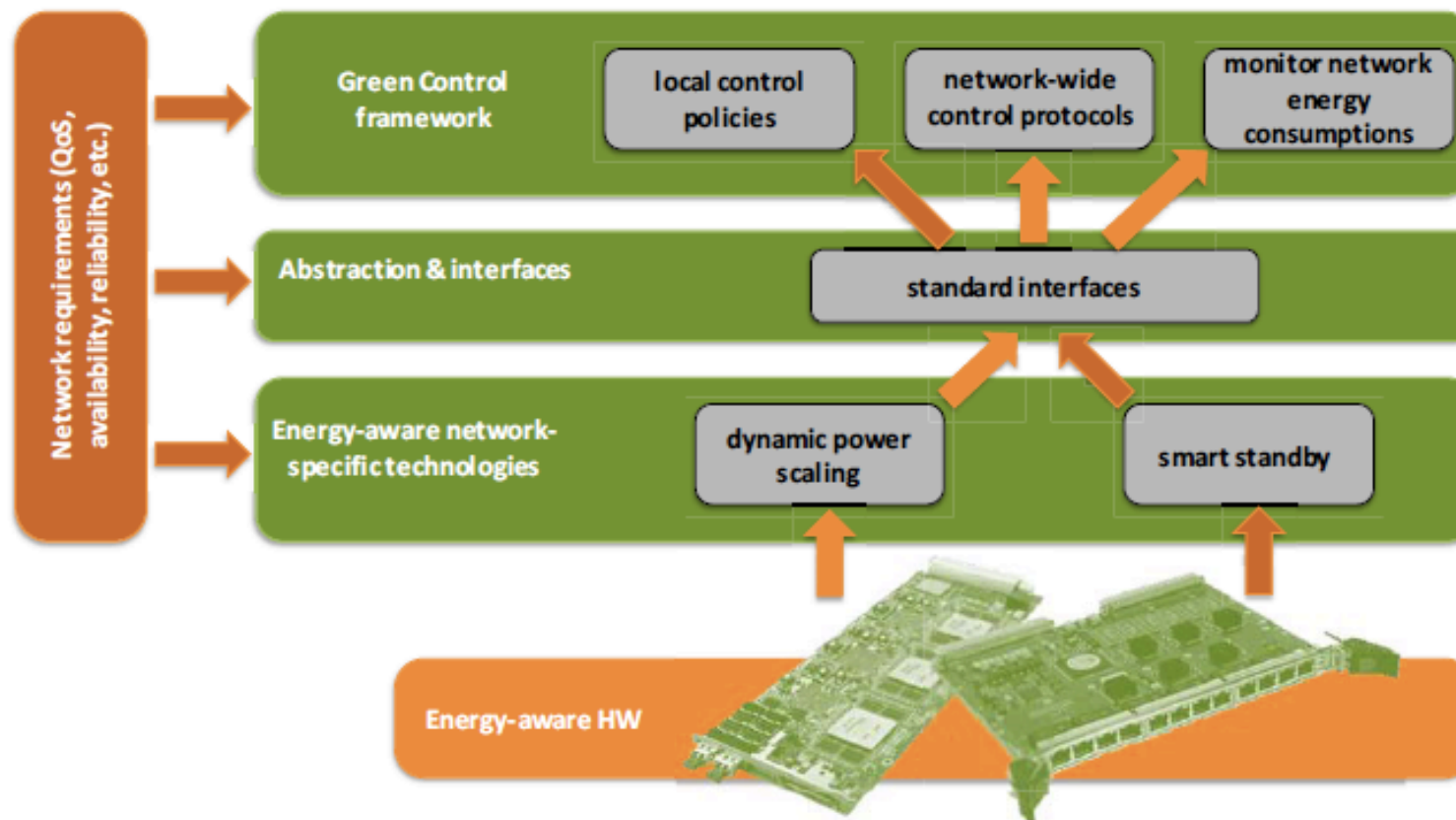| Participant organisation name	Short name	Country	
Consorzio Nazionale Interuniversitario per le Telecomunicazioni – UdR at DIST University of Genoa (Coordinator)	CNIT	Italy	
Mellanox Technologies	MLX	Israel	
Alcatel Lucent	ALU	Italy	
Lantiq	LQDE	Germany	
Ericsson Telecomunicazioni S.p.A.	TEI	Italy	
Telecom Italia	TELIT	Italy	
Greek Research & Technology Network	GRNET	Greece	
Research and Academic Computer Network	NASK	Poland	
Dublin City University	DCU	Ireland	
VTT Technical Research Centre	VTT	Finland	
Warsaw University of Technology	WUT	Poland	
NetVisor	NVR	Hungary	
Ethernity	ETY	Israel	
LightComm	LGT	Italy	
InfoCom	INFO	Italy	
Portland State University	PSU	USA	
University of South Florida	USF	USA	

Motivations

- Increasing the energy efficiency and the sustainable growth of our world is a global process where Telecommunications technologies (and the ICTs in general) play a key role.

- But to obtain optimum results the process should involve the "two faces of the same coin":

  - **Green ICT** – reducing the carbon footprint of ICT

  - **ICT for Green** – using ICT for reducing third party-wastes.

- ECONET is dealing with the first aspect

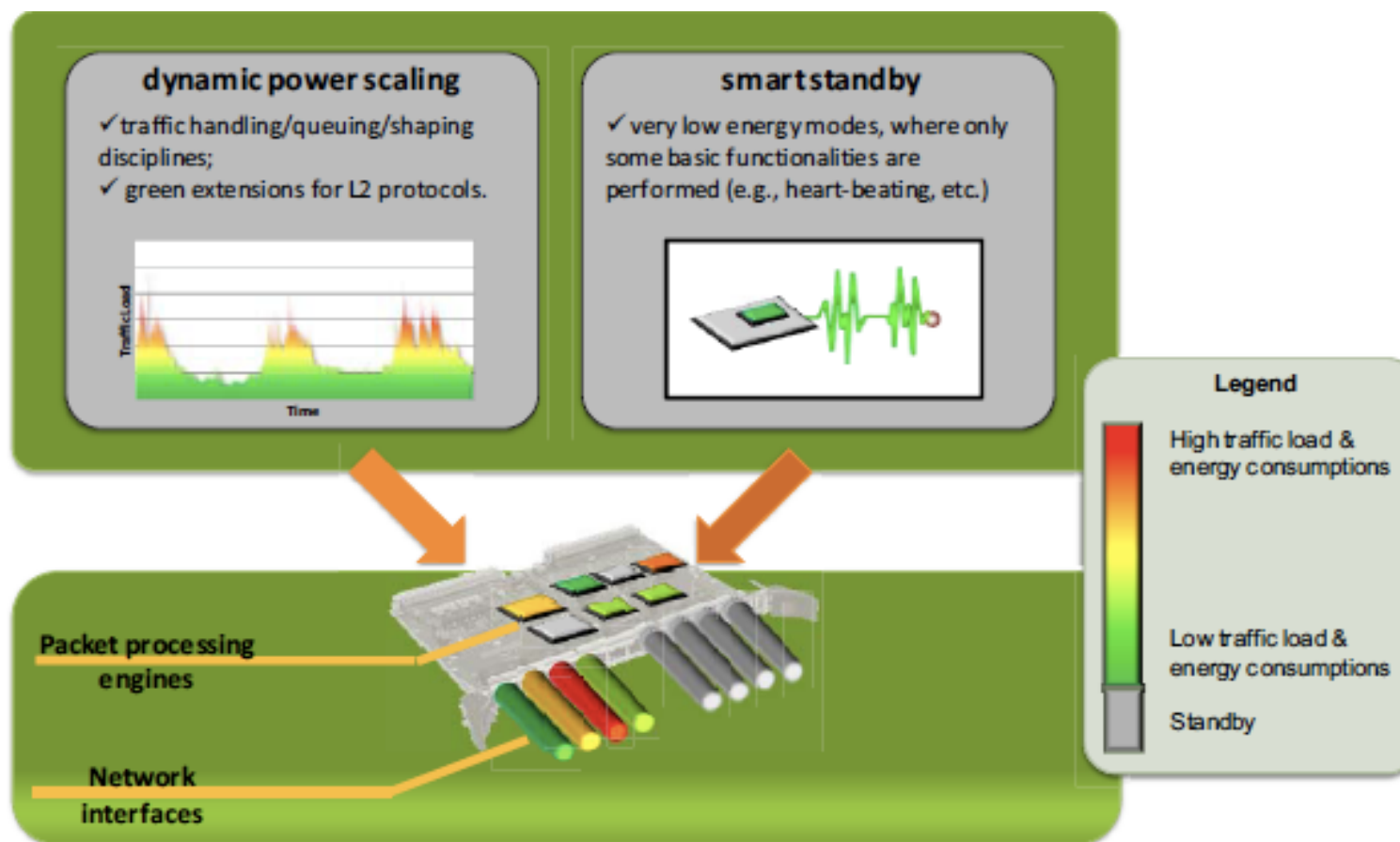 - **Focused on short and medium term exploitation**

Main objectives

- The ECONET project aims at studying and introducing **adaptive technologies (standby and performance scaling) that allow saving energy when a network device or part of it is not used in wire-line networks**.
  - **Access/home** -> standby when users are not "connected"; idle/performance scaling when users are "connected"
  - **Core/metro** -> standby for redundant and unused HW; idle/performance scaling for active HW
- The **final objective is to obtain an average consumption reduction of 50-80%**
- **The ambition is to produce a feasible and concrete solution exploitable within very few years to improve the behaviour of the current equipment and architectures.**
- This goal is also pursued by
  - promoting bridging actions between the Research/Academia and the **Standardization arena** to guarantee early and effective adoption of the new energy efficient techniques.
  - exploiting clustering activities with other projects running on the same green subject
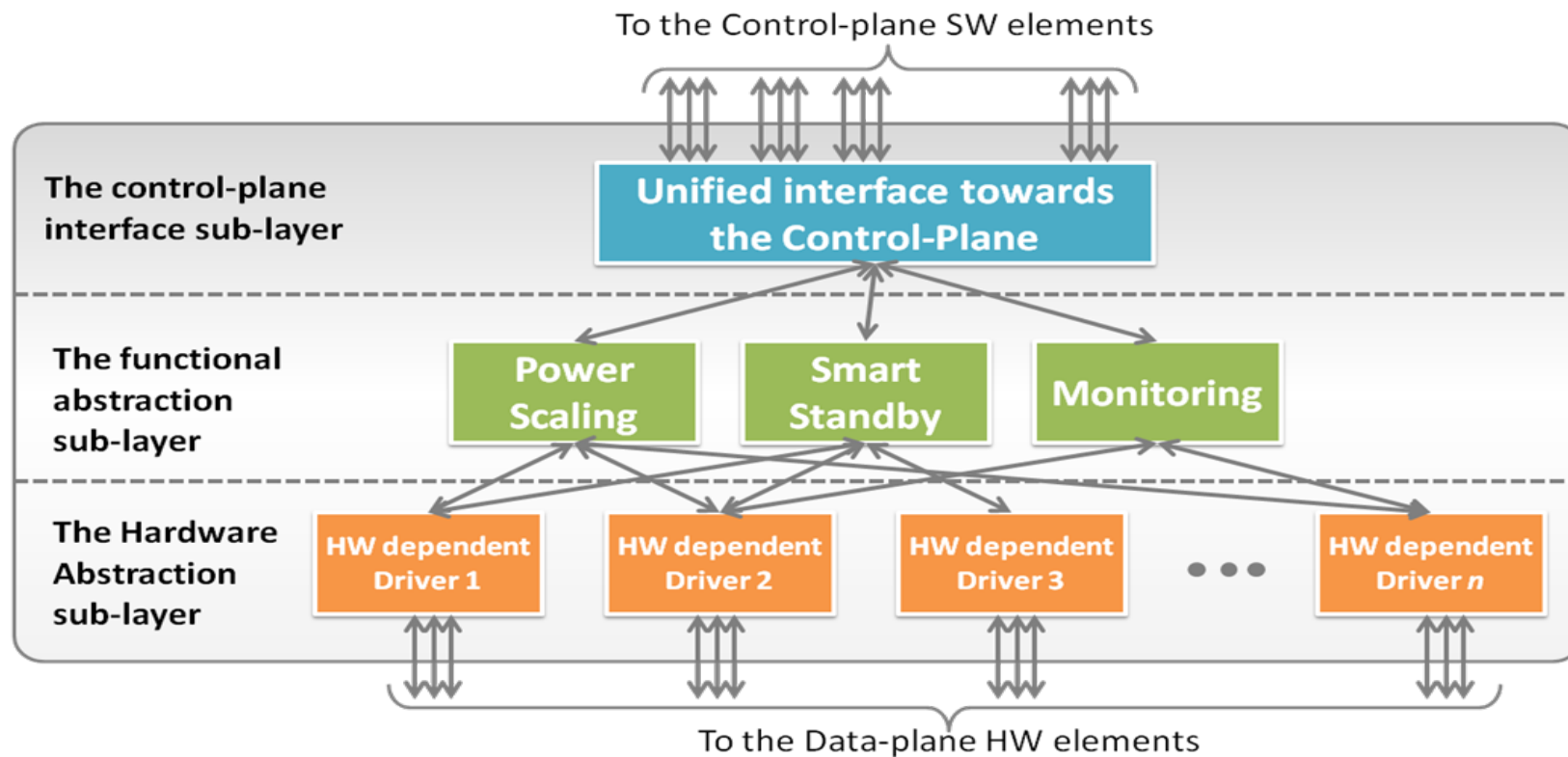
The project approach

The project approach
Energy aware specific technologies

dynamic power scaling

✓ traffic handling/queuing/shaping disciplines;
✓ green extensions for L2 protocols.

smart standby

✓ very low energy modes, where only some basic functionalities are performed (e.g., heart-beating, etc.)

Packet processing engines

Network interfaces

Legend

High traffic load & energy consumptions

Low traffic load & energy consumptions

Standby

The project approach
Green Abstraction Layer

To the Control-plane SW elements

The control-plane interface sub-layer	**Unified interface towards the Control-Plane**
The functional abstraction sub-layer	**Power Scaling** **Smart Standby** **Monitoring**
The Hardware Abstraction sub-layer	**HW dependent Driver 1** **HW dependent Driver 2** **HW dependent Driver 3** • • • **HW dependent Driver n**

To the Data-plane HW elements

The project approach
Green Control Framework

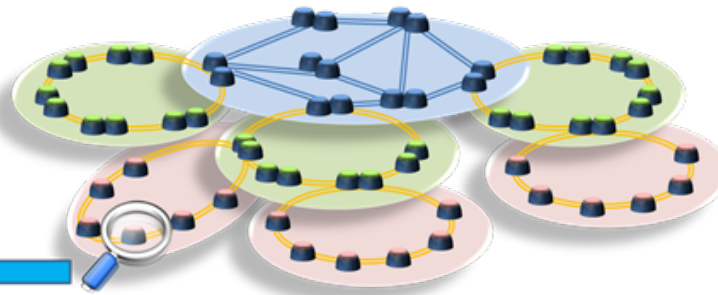Autonomic and short-term on-line optimizations

Routing & Traffic Engineering

Given:
- The traffic matrix
- Service requirements
- The energy-aware capabilities of network nodes and links

Dinamically move the traffic flows among network nodes in order to minimize the overall network consumption

Local Optimization Policies

Given:
- the actual traffic workload from input links
- Local service requirements

dinamically find the best energy-aware configuration

Operator-driven long-term off-line optimizations

Network-wide Monitoring

Given the history of measurements regarding:
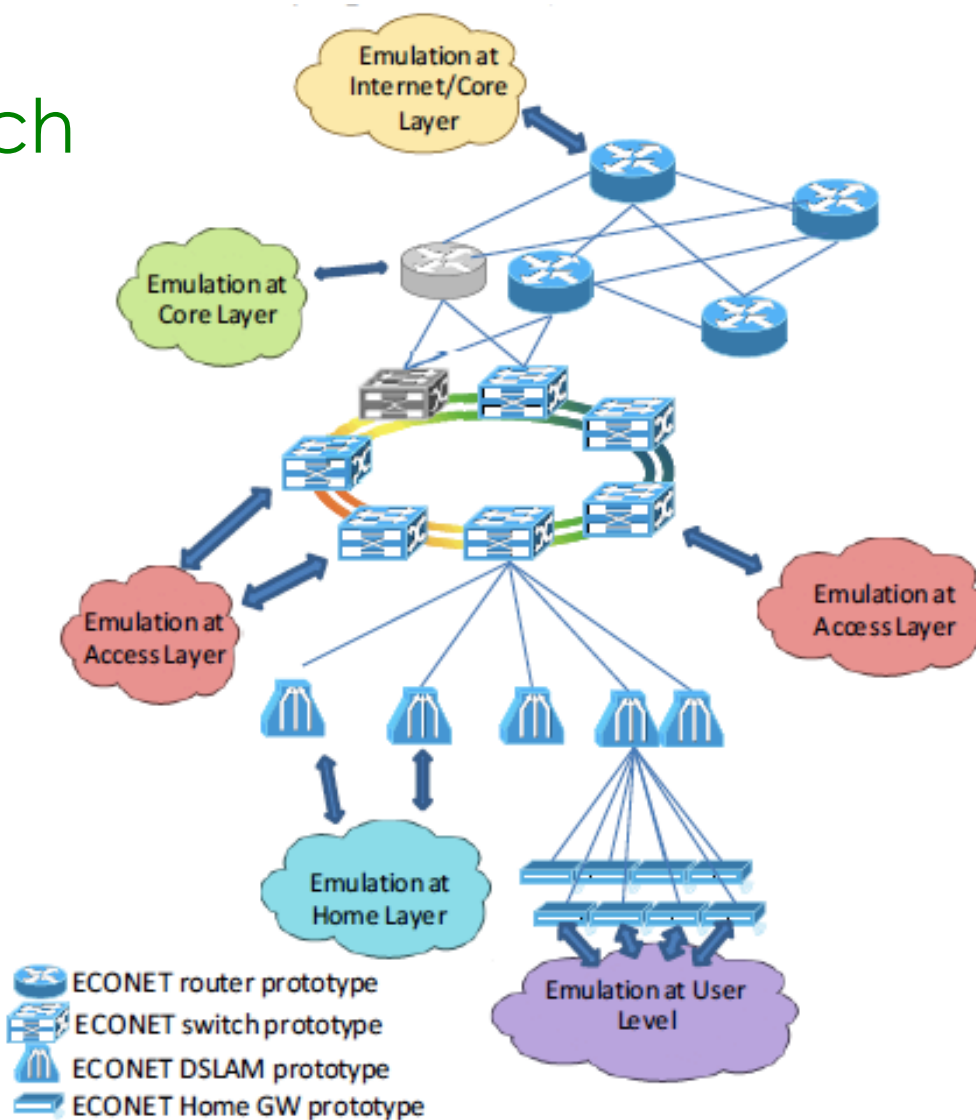- network performance
- energy consumption

The operator can explicitly plan and/or reconfigure the settings of:
- single device
- Traffic engineering and routing.

The Network Operations Center (NOC)

ECONET Test Bench @ TELIT Test Plant

- ECONET router prototype
- ECONET switch prototype
- ECONET DSLAM prototype
- ECONET Home GW prototype

Thanks for your attention