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WORKSHOP ON ENVIRONMENTAL IMPACT ASSESSMENT AND ENERGY EFFICIENCY

DES/EE-0030 - Green Abstraction Layer (GAL)

Power Management Capabilities of the Future Energy Telecommunication Fixed Network Nodes

7-8 October 2013, ETSI Athens, Greece

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GAL Rationale

- The energy efficiency issue is assuming ever-greater importance in most industrial sectors and research fields.
- An effective way to reduce this energy consumption (see the ECONET project results) is to insert and exploit consumption modulation and standby techniques in the devices
  - These mechanisms should operate at the hardware level because the energy is used by the HW..
  - But Control Planes usually operates by considering logical/virtual entities without being aware of the hardware details, and so about the actual consumption.
- **The GAL allows to map the hardware level management of energy consumption in the various network devices offering a simple and uniform interface to the control plane and by**
  - **making explicit the trade-off between consumption and network performance;**
  - **mapping the consumption of hardware blocks with virtual/logical network resources;**
  - **Hiding the details/complexity of internal power modulation mechanisms**

GAL story: from ECONET project to the standardization arena

- October 2010 – December 2013
  One of the main target of the **ECONET Project** (It dedicates an entire Work Package to the GAL).
- Paris, France – 25/27 September 2012
  ECONET Project with support of its partners Ericsson, Telecom Italia, Alcatel-Lucent, GRNET and CNIT proposed to the TC-EE the creation of a new Working Item (WI) for the standardization of the Green Abstraction Layer (GAL).
- Paris, France – 25/27 September 2012
  The WI has been officially approved by the TC-EE
- Sofia Antipolis, France – 27/28 June 2013
  The WI released an early draft of the standard which was approved by the TC-EE
- 2-7 October2013
  A stable draft version has been released by the TC-EE and submitted for remote consensus

What is the GAL (Green Abstraction Layer) ?

Standard interface aimed at exchanging power-aware data between data- and control-planes of a same network device or group of devices.

Extend and re-engineer the ACPI (Advanced Configuration and Power Interface) standard for general purpose computing systems, and adapt it to architectures, functionalities and paradigms of network devices, and especially of their data-plane components.

Device internal interface

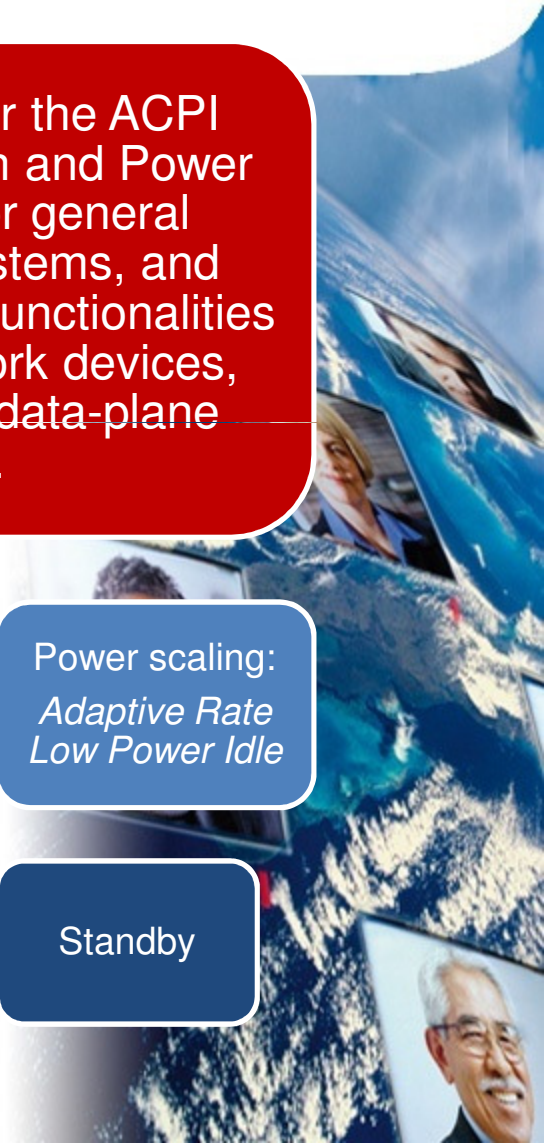
Control-plane processes implements signalling protocols to make more network nodes agree on a certain configuration.

Not behave as a network signaling protocol

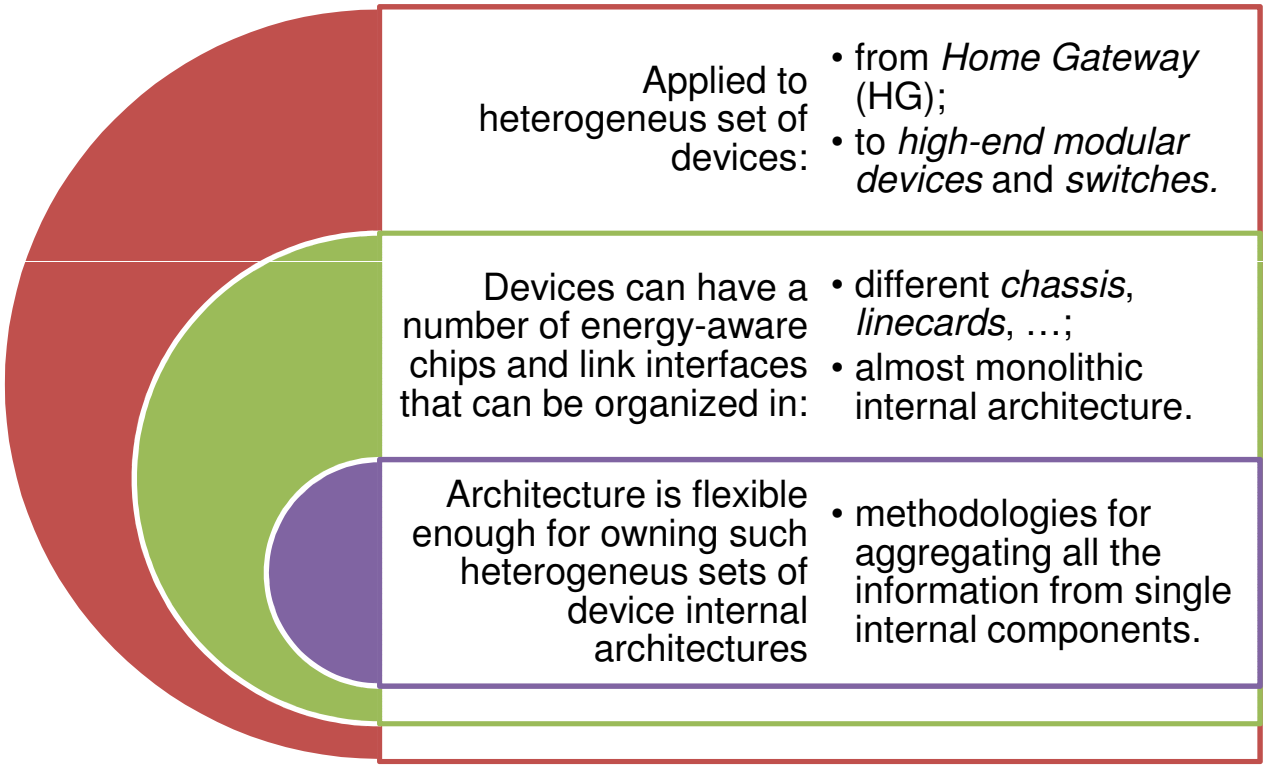
green capabilities explicitly considered

Power scaling:
Adaptive Rate
Low Power Idle

Standby



GAL Background



Applied to heterogeneus set of devices:	• from *Home Gateway* (HG); • to *high-end modular devices* and *switches.*
Devices can have a number of energy-aware chips and link interfaces that can be organized in:	• different *chassis*, *linecards*, …; • almost monolithic internal architecture.
Architecture is flexible enough for owning such heterogeneus sets of device internal architectures	• methodologies for aggregating all the information from single internal components.

GAL Structure

It should be used by three main sets of control plane processes:

LCPs

Local Control Policies

- optimize the configuration at the device level;
- to achieve the desired trade-off between energy consumption and network performance, according to the incoming traffic load.

NCP

Network Control Policies

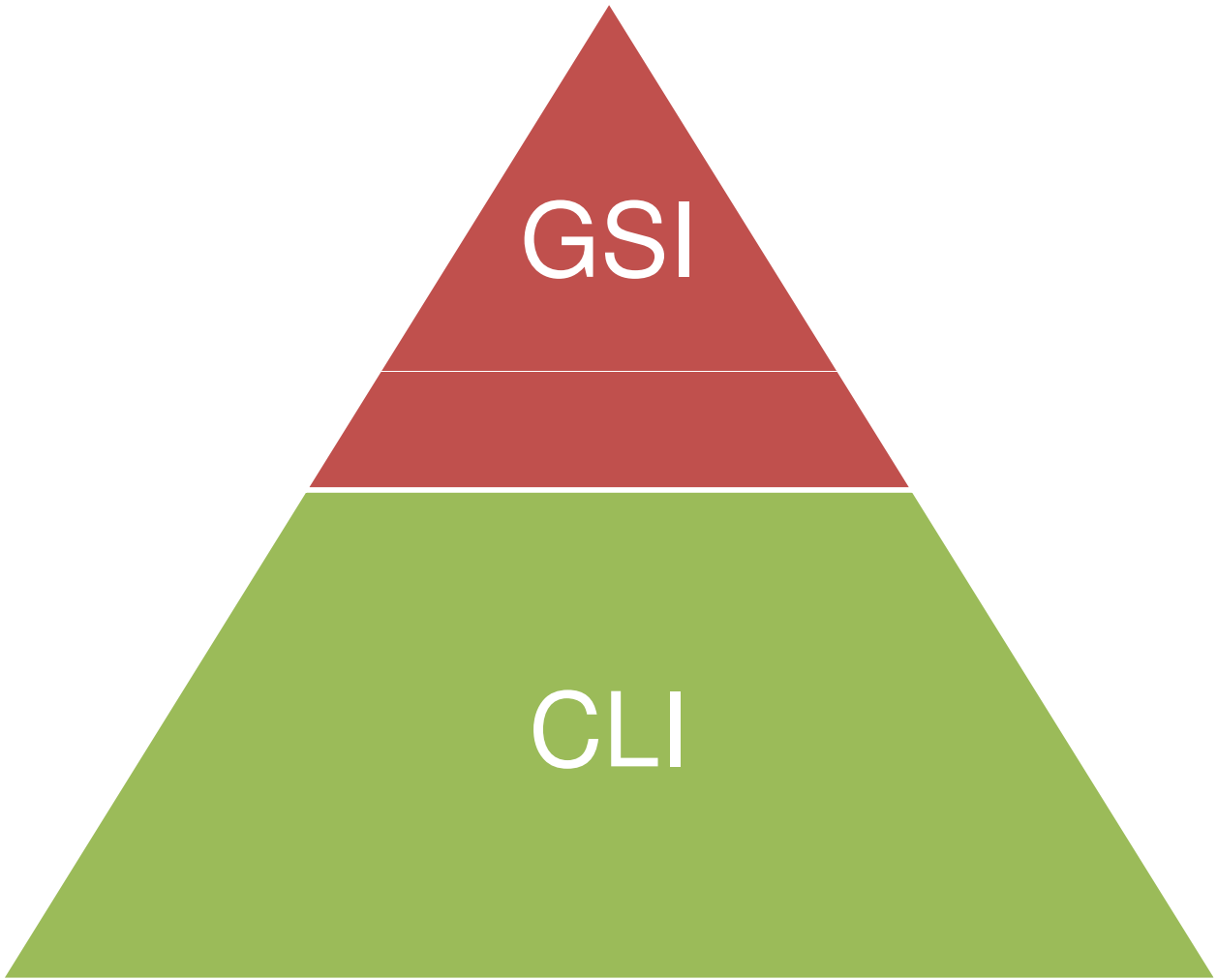
- to autonomously control and optimize the behavior of a network (set of devices);
- typical examples of this kind of processes are traffic engineering, routing and signaling algorithms/protocols (e.g. OSPF-TE/RSVP-TE) with "*green*" extensions.

OAM

Monitoring and Operation Administration & Management

- for the operator to control and optimize the behavior of a network (as in network management systems with "*green*" capabilities).

GAL Structure



GAL Structure

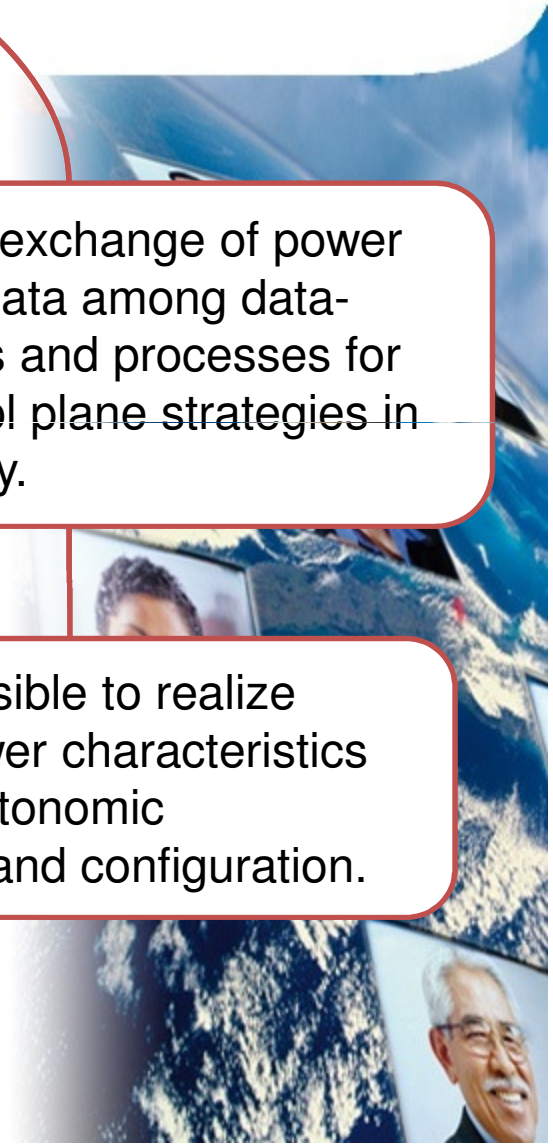
Green Standard Interface

GSI

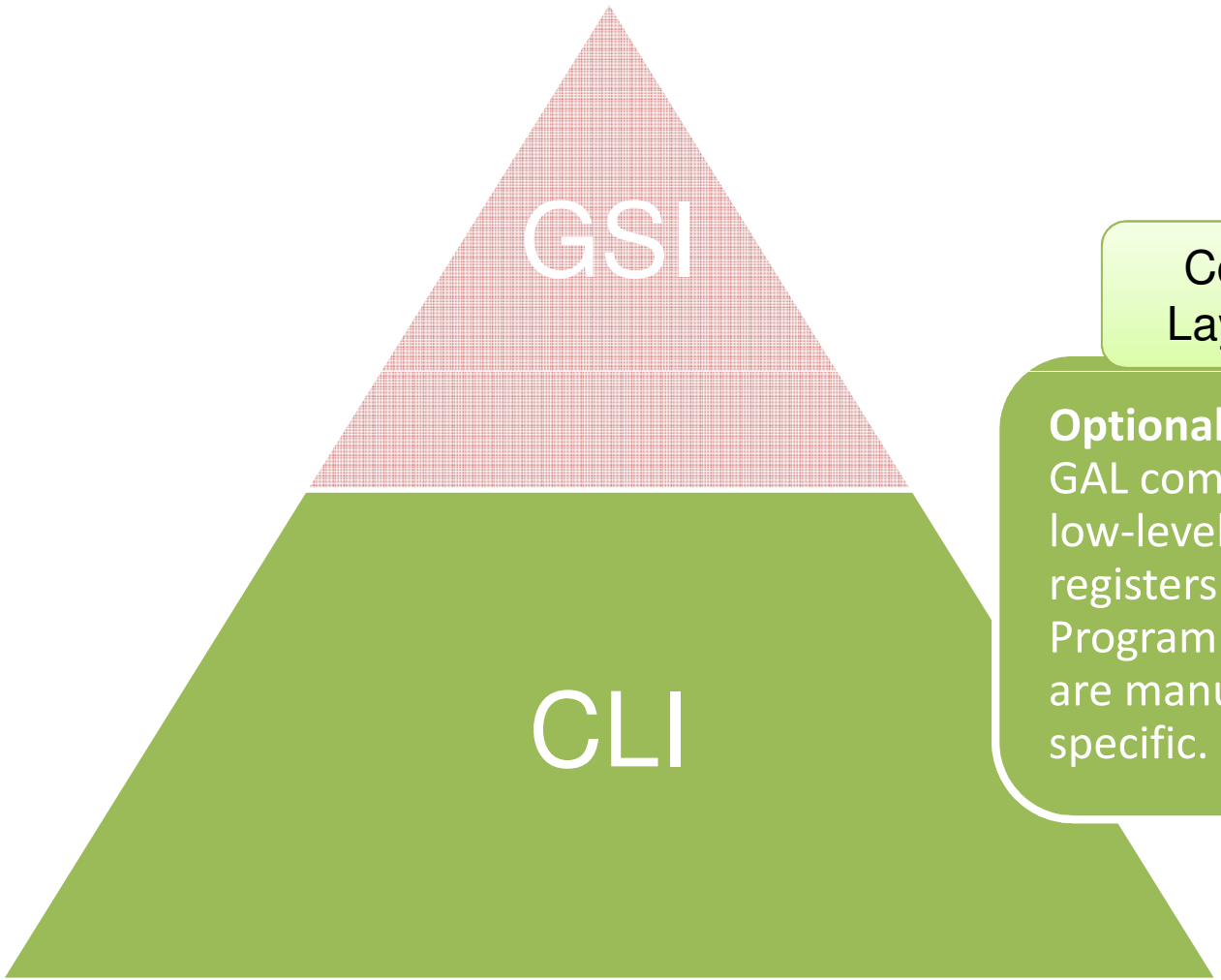
It supports the exchange of power management data among data-plane elements and processes for realizing control plane strategies in a simplified way.

It provides the command set necessary to setup the power management and monitoring of a wide set of energy-aware resources and network devices.

It makes possible to realize resource power characteristics discovery, autonomic provisioning and configuration.

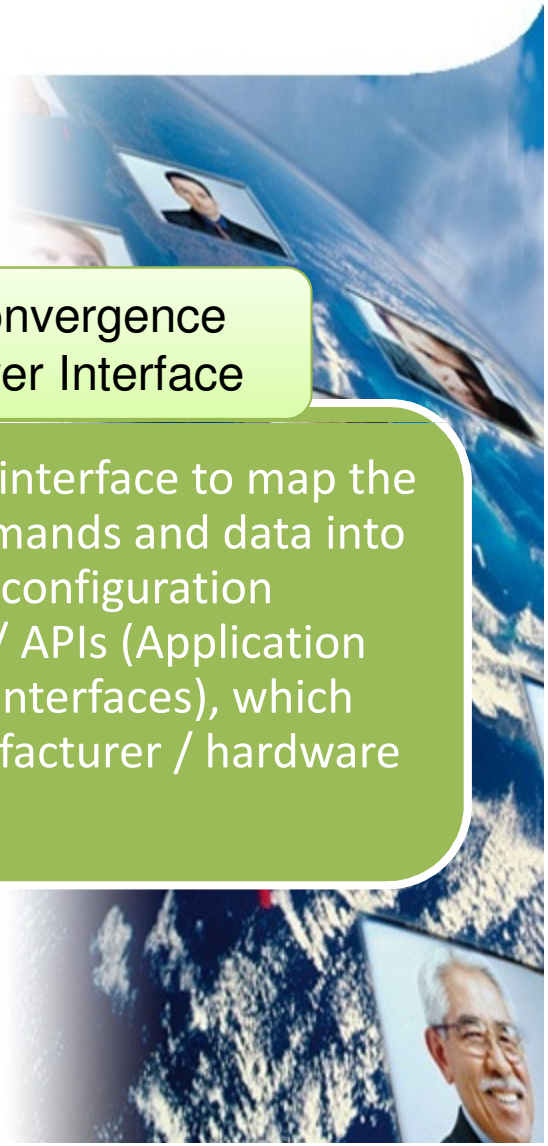


GAL Structure

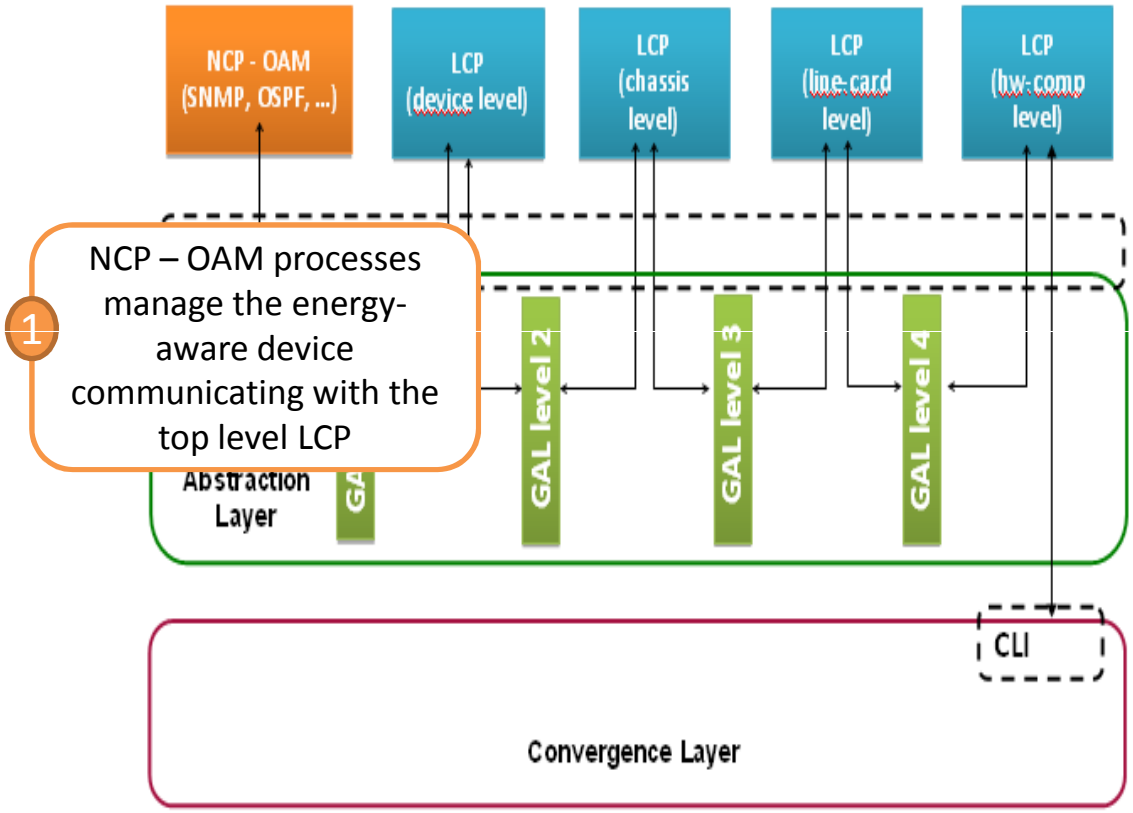


Convergence Layer Interface

Optional interface to map the GAL commands and data into low-level configuration registers / APIs (Application Program Interfaces), which are manufacturer / hardware specific.



GAL Structure



1 NCP – OAM processes manage the energy-aware device communicating with the top level LCP

2 The different levels are instances of the same simple interface

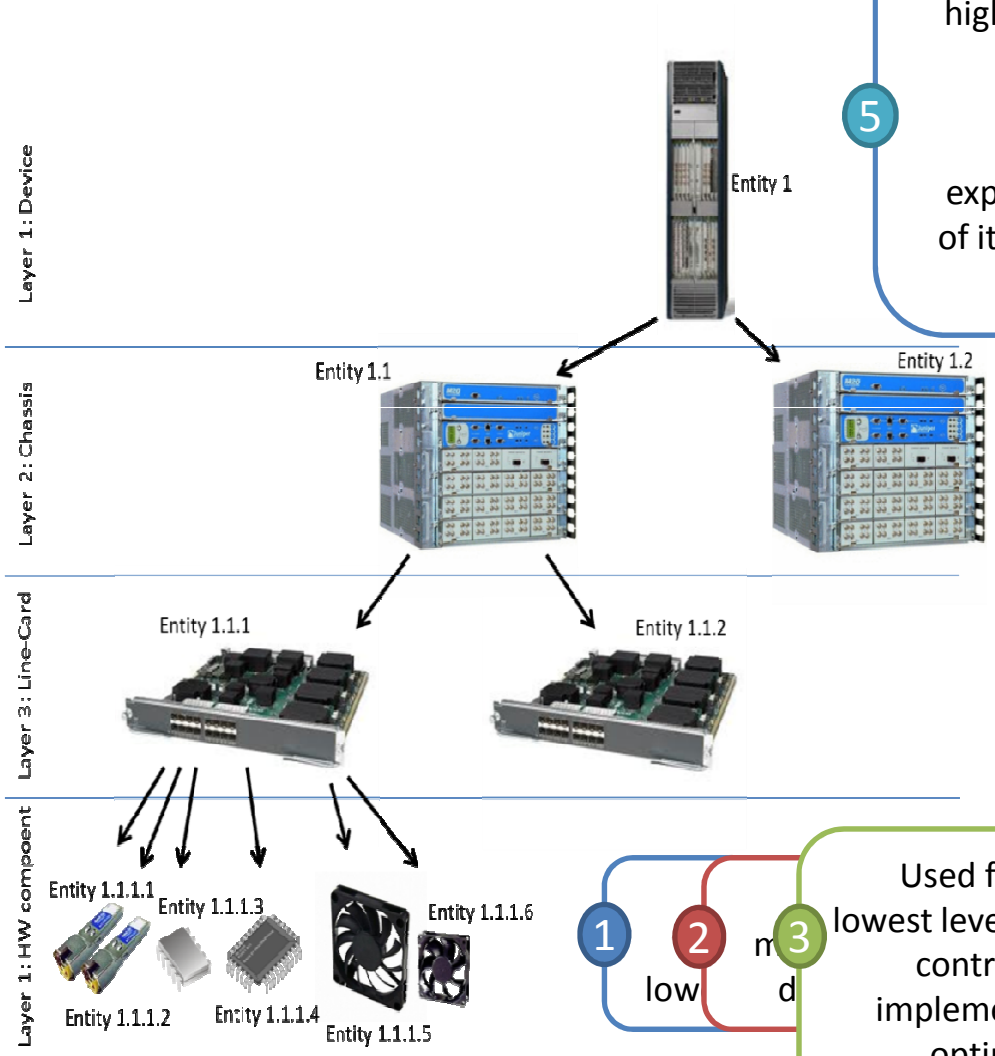
3 The hierarchy degree depends on the device

4 Only the low level LCPs interact with the CLI

GSI: Green Standard Interface

CLI: Convergence Layer Interface

GAL Hierarchical Structure



5 At the device level, the highest LCP orchestrates the high-level configuration of the device, and needs to expose a simplified view of it to network signaling protocols.

4 ...iated levels (e.g., at line-card, or at chassis ones), new LCPs needed to orchestrate the settings and the operating behaviors of underlying entities, and to expose a synthetic and aggregate set of operating characteristics and available configurations (of the line-card, or of the chassis) to higher levels.

1 2 3 low m d Used for i... lowest level entity with some control-plane processes implementing HW-specific optimization strategies

GAL & EASes

- The GAL synthetizes the data related to power management settings by means of *Energy-Aware States* (EASes), they :
  - are a way to control the energy configuration of energy-aware entities (i.e., an entity that provides some power scaling and/or standby capabilities);
  - represents a *stable* configuration of the entity, which is obtainable through the use of power scaling or standby capabilities;
  - must be associated to parameters indicating energy consumption, availability of functionalities, network performance levels;
  - define a complete set of associated parameters (with a mandatory sub-set and an optional one).
- Each entity is supposed to have the ability of effectively working in one or more EASes
  - entities with more than one EAS are "*energy controllable*".
- EASes are modeled as **a couple of energy-aware Primitive sub-States (PsS)** related to the configuration of Power Scaling and Standby mechanisms

EAS Definition

S_k is the *k*-th PsS related to the Standby techniques

- S_0 is the active state
- in S_k with $k > 0$ the entity is sleeping
- in S_K the device is completely off

EAS Definition

P_j is the *j*-th PsS related to the Power Scaling techniques

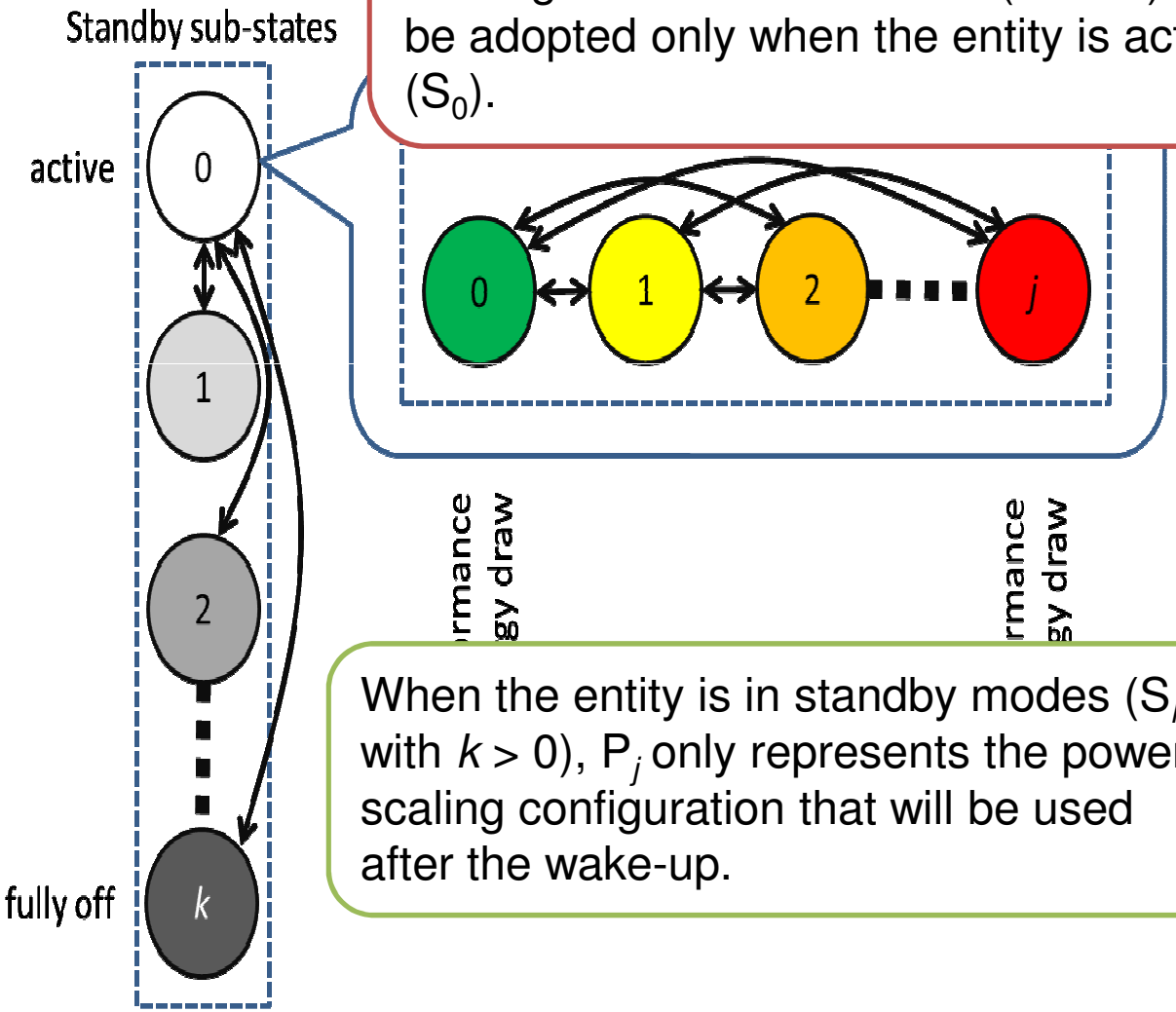
P_0 is the PsS for the highest device network performance (it also consumes the highest power)

with $j > 0$, P_j is the PsS for the intermediate level where the entity is in reduced performance level while still being

P_J is the PsS with the lowest performance level for the device while still being active (it consumes the lowest power for the device in active state)

EAS Definition

Given the exclusive use of power scaling and standby capabilities, the *j* Power Scaling Primitive sub-States (P-PsS) can be adopted only when the entity is active (S_0).



When the entity is in standby modes (S_k with $k > 0$), P_j only represents the power scaling configuration that will be used after the wake-up.

Conclusions

- GAL allows you to extract complex heterogeneous hardware implementations of the various network devices
  - Different energy profiles for each device associated with specific performance
- Control Plane can **balance the trade-off between performance and energy consumption** of the network/devices ***without having to deal*** *with* the energy management on individual parts.

End Presentation

CURRENT SCHEDULE

Discussion on Stable Draft

ETSI Workshop, Naples, end of October 2013.

Final Draft

Deadline: 15th December 2013

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Thank you!