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Functional entities for enabling per service eco-data reporting
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Abstract

This document provides an architectural mapping between the Exigence intra-domain functional architecture and the IETF GREEN Framework for Energy Efficiency Management. The purpose is to harmonize Exigence' s service-centric energy attribution and green orchestration functions with the multi-layered monitoring, control and API-exposed energy management architecture defined in the GREEN reference model.

This document identifies a number of functional components enabling a service-centric energy attribution for the network domain, and describes their mapping to the IETF GREEN framework for energy efficiency management, including interfaces and energy-object concepts. Such functional components allow the realization of green orchestration capabilities with multi-layered monitoring, control and API-exposed energy management.

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1. Introduction

The IETF GREEN Framework [I-D.belmq-green-framework] defines an extensible, device-to-system architecture for representing, measuring, aggregating and controlling energy information across devices, controllers, and network-wide systems.

In order to collect the energy consumption associated to a given service, different functional blocks can be considered as part of such framework, making possible the creation of an end-to-end energy-reporting overlay collectng and reporting the data through a Reporting Function (RF). This architecture provides energy attribution at the service-function level through a consistent functional pipeline: service discovery, resource allocation, energy measurement, attribution, and, if necessary, green orchestration.

This document propose detailed extensions on top of the GREEN framework for such purpose.

2. Terminology

Key terms from the GREEN framework, including Energy Object, Energy Management System (EnMS), Power Interface, and Relationship types (Power Source, Metering, Aggregation), follow [I-D.belmq-green-framework].

3. Overview of the IETF GREEN Reference Model

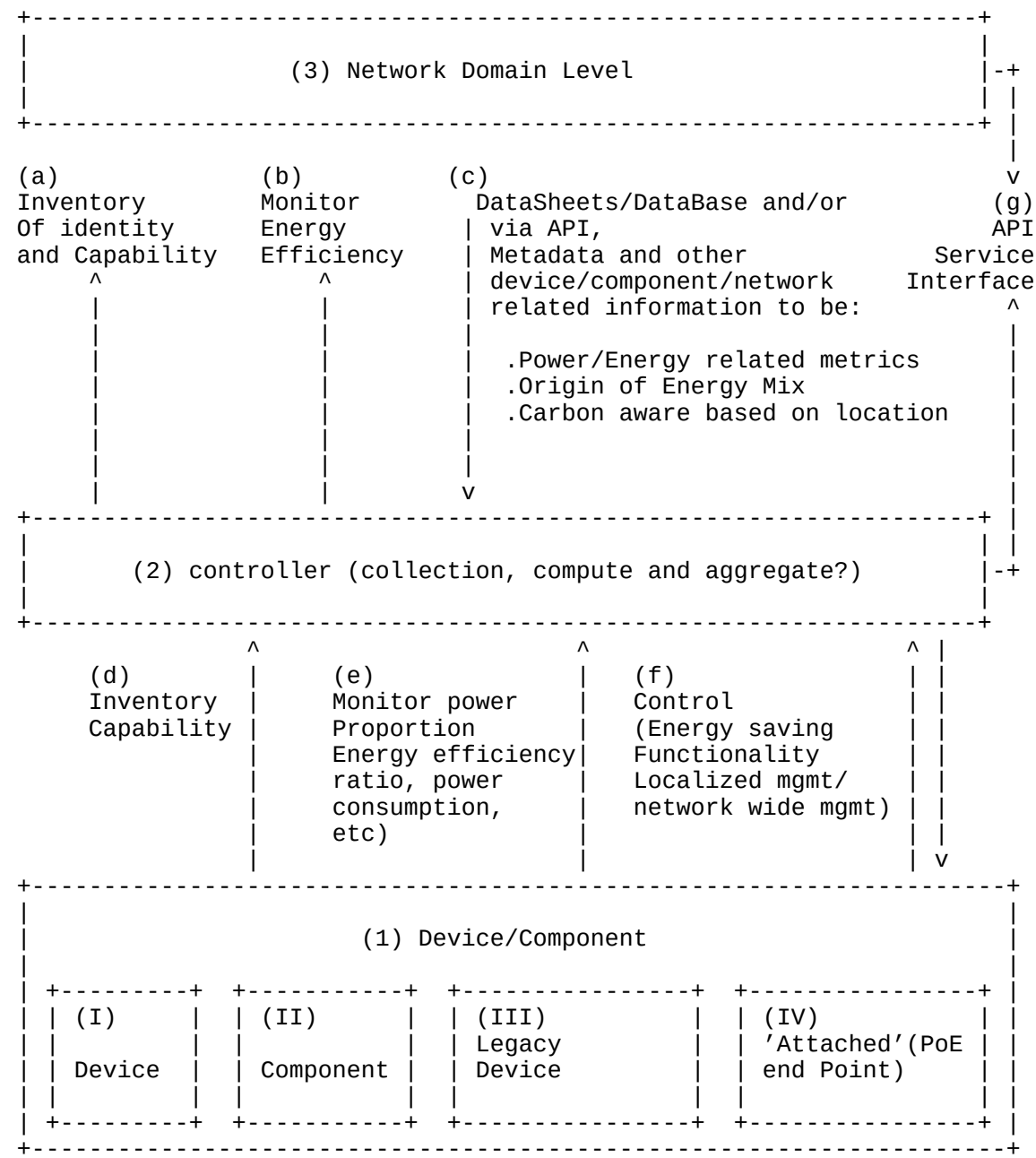
The GREEN Framework [I-D.belmq-green-framework] organizes energy-management functionality into three levels:

* Device & Component Level: Energy Objects, physical meters, PoE endpoints, legacy devices, and the energy topology relations among them.

* Controller / EnMS Level: Aggregation, computation, and policy-driven control; supports centralized, distributed, or hierarchical layouts.

* Network Domain Level: Inventories, data repositories, analytics platforms, and service APIs (e.g., PETRA).

The framework is graphically described as follows.


(3) Network Domain Level
(a)
Inventory
Of identity
and Capability
(b)
Monitor
Energy
Efficiency
(c)
DataSheets/DataBase and/or
via API,
Metadata and other
device/component/network
related information to be:
.Power/Energy related metrics
.Origin of Energy Mix
.Carbon aware based on location
(g)
API
Service
Interface
(2) controller (collection, compute and aggregate?)
(d)
Inventory
Capability
(e)
Monitor power
Proportion
Energy efficiency
ratio, power
consumption,
etc)
(f)
Control
(Energy saving
Functionality
Localized mgmt/
network wide mgmt)
(1) Device/Component
(I)
Device
(II)
Component
(III)
Legacy
Device
(IV)
'Attached'(PoE
end Point)

Interfaces (ag) define how discovery, monitoring, metrics, control, and higher-level service APIs interact across levels. The description of such interfaces is provided in [I-D.belmq-green-framework].

4. Overview of the Functional Blocks

Distinct functions can be considered to collectively enable energy measurement, attribution, optimization, incentives and service-variant orchestration. Altogether define a functional blueprint applicable to any network domain. Such a blueprint contains three planes, i.e. User, Control, and Management planes, that can be mapped onto the general IETF GREEN Framework.

The functional blocks are:

* Service Energy Information Function (SEIF): this function is responsible for attributing resource-level energy measurements to service-level energy consumption. It produces the service-oriented energy information consumed by the Reporting Function.

* Resource Energy Measurement Function (REMF): this function measures the energy consumption (and carbon information, when available) of any resource in the network domain, providing the raw energy telemetry used by higher-level functions.

* Resource Allocation Function (RAF): this function tracks which resources are allocated to which service, maintaining mappings so that energy usage can later be attributed correctly.

* Service Directory Function (SDF): this function maintains the list of active services and maps each service identifier to the service instances running in the domain

* Orchestration and Optimization Function (O2F): this orchestration function optimizes and manages service placement and lifecycle from an energy-aware perspective. It could include capabilities such as optimal placement, service lifecycle, incentives, etc.

* Reporting Function (RF): this function is in charge of consolidating the eco-data information and reporting it by means such as APIs (for instance, [I-D.petra-green-api] or [I-D.amalj-sustain-shape]).

5. Mapping of Functions to the GREEN Framework

Next sub-sections describe a potential mapping of functions to GREEN framework levels.

5.1. Device & Component Level

GREEN defines Energy Objects, meters, PoE endpoints, components, and their topological relations (source, metering, aggregation). The Resource Energy Measurement Function (REMF) corresponds precisely to the acquisition of energy measurements from such Energy Objects and exposes the resource-level consumption that Service Energy Information Function (SEIF) later attributes.

As result, the following mapping can apply:

* GREEN Energy Objects → network domain resources

* GREEN Metering Interfaces → REMF measurement sources

* Physical or virtual meters → REMF telemetry ingestion points

5.2. Controller Level

The GREEN Controller Level aggregates metrics, correlates contextual information, and executes energy-aware control policies.

GREEN Controller Function	Functional Block
Energy Aggregation and Metrics Processing	SEIF (service-level attribution from REMF + RAF)
Inventory and Resource Mapping	RAF (mapping SF→resource) + SDF
Energy-Aware Control	O2F (left for further study in future versions)

The Service Energy Information Function (SEIF) specifically associate the metrics of relevance for the service of interest.

5.3. Network-Domain Level

The GREEN Network Domain Level includes repositories and domain-wide inventories. All the eco-data information which cannot be automatically retrieved from the network or the devices can be gathered from here, such as values reported in datasheets, consumption models (e.g., dependent on the network or device load), etc.

5.4. Reporting Function

The Reporting Function (RF) aligns with the GREEN Service API mechanism when responding to service-energy queries, similar to PETRA's [I-D.petra-green-api] [I-D.amalj-sustain-shape] aggregated, service-pathrelevant reporting. The RF exposes ecodata reports as domain-level exported information consumable by higher-layer orchestrators. This is also where PETRA-compatible energy views may be offered for inter-domain composition.

6. Mapping of Process Flows and Interfaces

The interfaces defined in the IETF GREEN Framework can be mapped to the propsoed funcitonal blocks as follows:

* GREEN Discovery Interfaces (a,d): SDF and RAF consume resource and service inventories from the domain

* Monitoring Interfaces (b,e): REMF streams energy measurements consistent with GREEN's monitoring and accuracy model (push-based, hierarchical inheritance, accuracy classifications).

* Metrics Interfaces (c): SEIF transforms RAW metrics from REMF into service-level ones using RAF mappings—analogous to GREEN's derived metrics and efficiency computations.

* Control Interface (f): An Optimization Function can executes lifecycle, energy-variant optimization, and domain reallocation—aligned with GREEN's energy-saving control interface. This optimization function is left for further analysis in future versions of this document.

* Service API Interface (g): The RF exposes ecodata for inter-domain or multi-layer energy composition, conceptually similar to PETRA's recursive API-exposed energy reporting.

7. Handling Double Counting

In order to allow per-service eco-data reporting it is necessary to rely on service-instance identifiers and ecodata merging rules to avoid double counting across domains. The IETF GREEN Framework defines metering and power-source relationships to prevent aggregation of identical values from upstream/downstream Energy Objects.

In consequence, it is necessary to combine the per-service tagging approach with the proposed IETF GREEN relationship modelling to ensure correct aggregation across layers and domains.

This combined approach is left for further work in future versions of this document.

8. Security Considerations

Security considerations adhere the IETF GREEN Framework focus on protecting power-state control, integrity of telemetry, confidentiality of measurement data, and authentication for all control and monitoring interfaces.

More detailed analysis will be provided in future versions of the document.

9. IANA Considerations

This document makes no IANA requests.

10. Informative References

[I-D.amalj-sustain-shape]
Snchez, A. G., Rodriguez-Natal, A., Contreras, L. M., Palmero, M. P., and J. Lindblad, "Sustainability holistic API for Path Energy Evaluation (SHAPE)", Work in Progress, Internet-Draft, draft-amalj-sustain-shape-01, 27 February 2026, <https://datatracker.ietf.org/doc/html/draft-amalj-sustain-shape-01>.

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Rodriguez-Natal, A., Contreras, L. M., Palmero, M. P., Lindblad, J., and A. G. Snchez, "Path Energy Traffic Ratio API (PETRA)", Work in Progress, Internet-Draft, draft-petra-green-api-02, 20 October 2025, <https://datatracker.ietf.org/doc/html/draft-petra-green-api-02>.

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