Framework for Energy Efficiency Management

draft-belmq-green-framework-06

GREEN WG Meeting – Nov 3rd 2025

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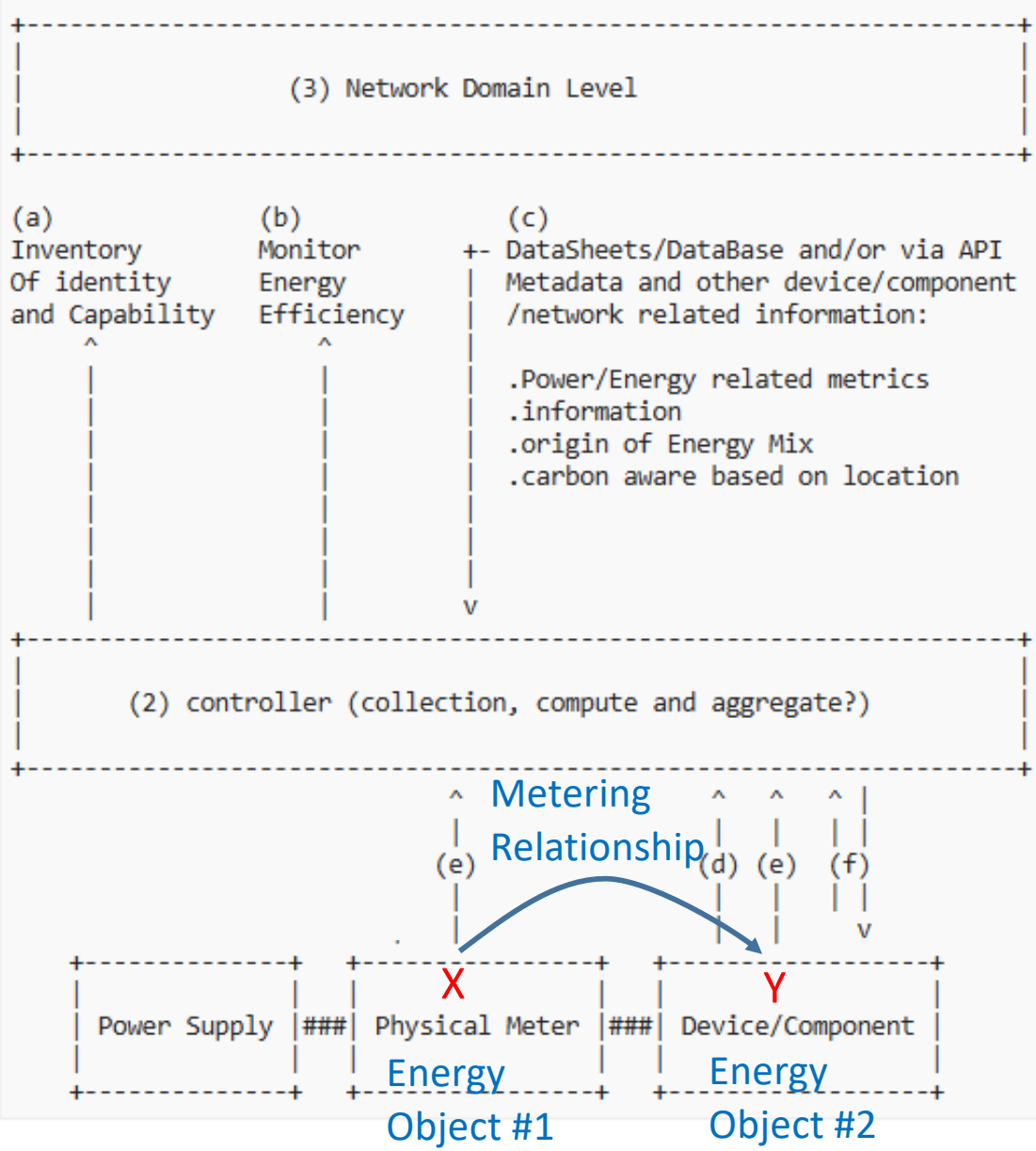
Example: Physical Meter with Newer Device

From the previous meetings



NOTE: "###" is used to denote a transfer of energy.
"- >" is used to denote a transfer of information.

ISSUE: double counting!

- Where to measure?
  - X or Y
  - The physical meter Energy Object or the device/component Energy Object?
- What if the controller can query both? => double-counting issue?
- The controller MUST NOT calculate the sum of all Power Interfaces
- The controller (or Network Domain Level) must know & report that the physical meter measures on the behalf of the device/component, based on (a)
- Conclusion: « Controller must know which for which Energy Object(s) it measures power or energy. This is the Metering Relationship"

Example: Power over Ethernet

From the previous meetings

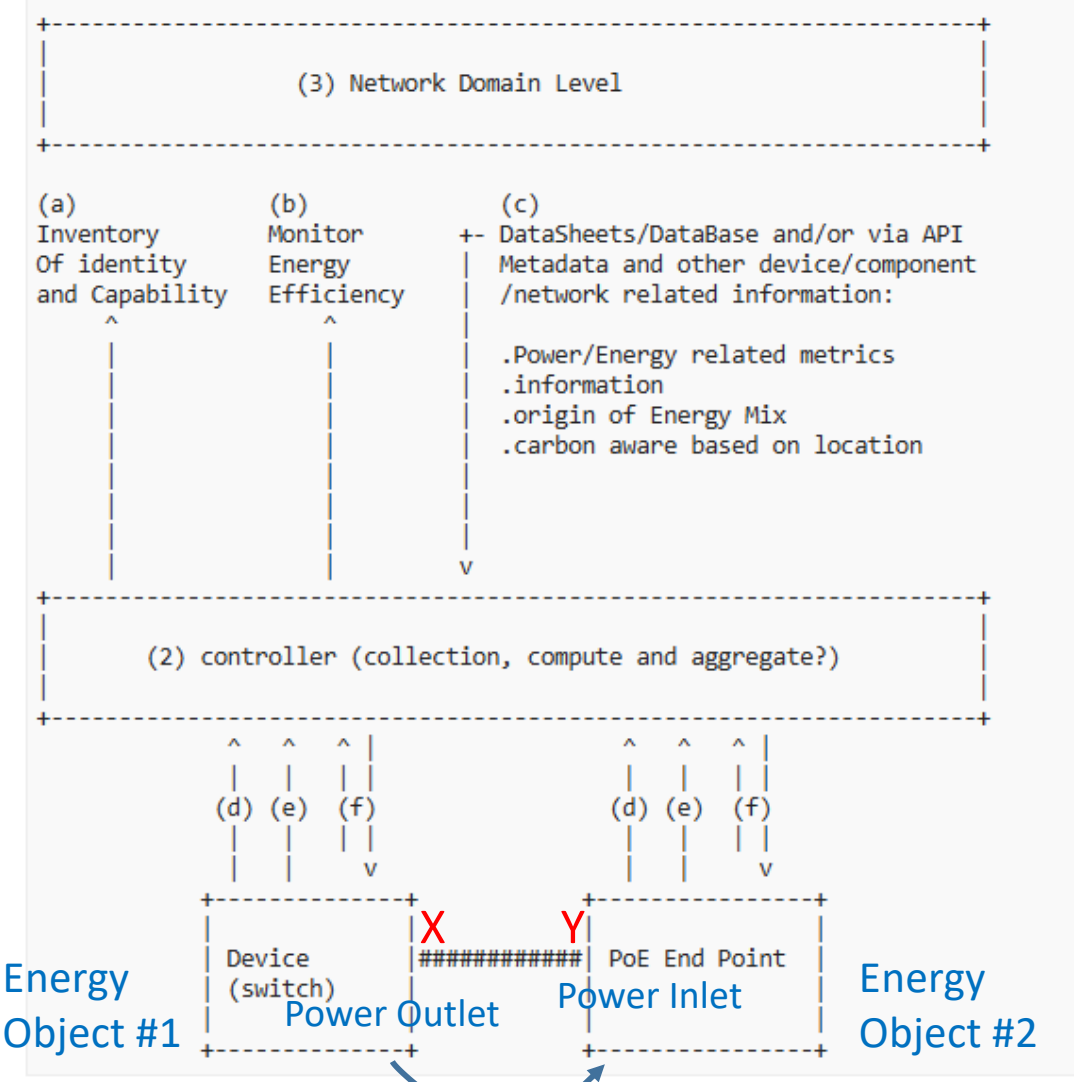


Figure 3: Reference Model Example: Power over Ethernet

Power Source Relationship

```
NOTE: "###" is used to denote a transfer of energy.
      "- >" is used to denote a transfer of information.
```

ISSUE: controller double counting?

- Same issue as before
- Power Outlet vs Power Inlet

ISSUE #2: who controls what?

- In this case, the PoE port on the switch controls the PoE End Point
- We might have two ways to control the PoE End Point:
  - Power on switch port
  - Power State on the PoE End Point (ex: low energy mode)
- To control the PoE End Point, the controller must know the Power Source Relationship between the two Energy Objects.

These are key differences with typical networking frameworks

GREEN Framework Highlights

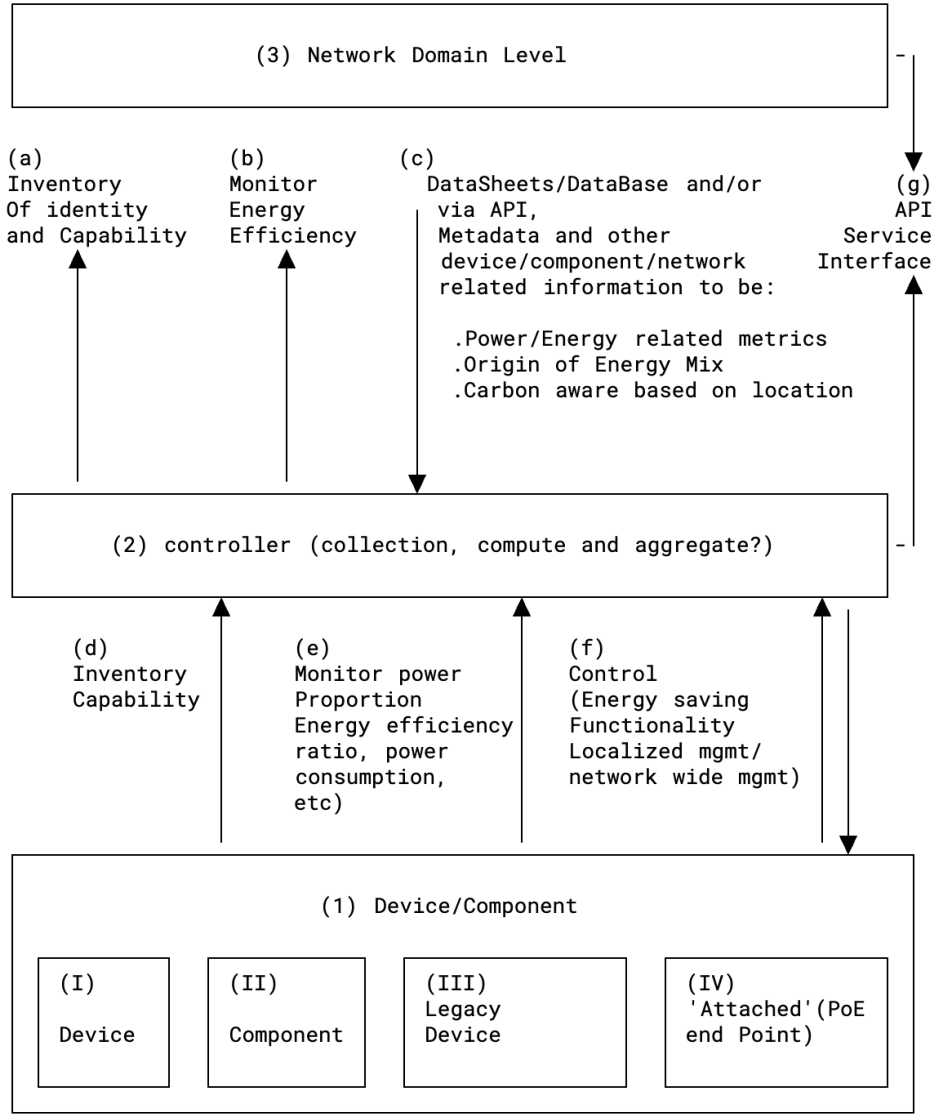


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Figure 1: GREEN Reference Model

- Defines how networks consume, produce, and manage energy, not just how they operate.
- Introduces explicit relationships — Metering, Source, and Aggregation — for end-to-end traceability.
- Enables both monitoring and control, supporting energy-aware automation.

What's New?

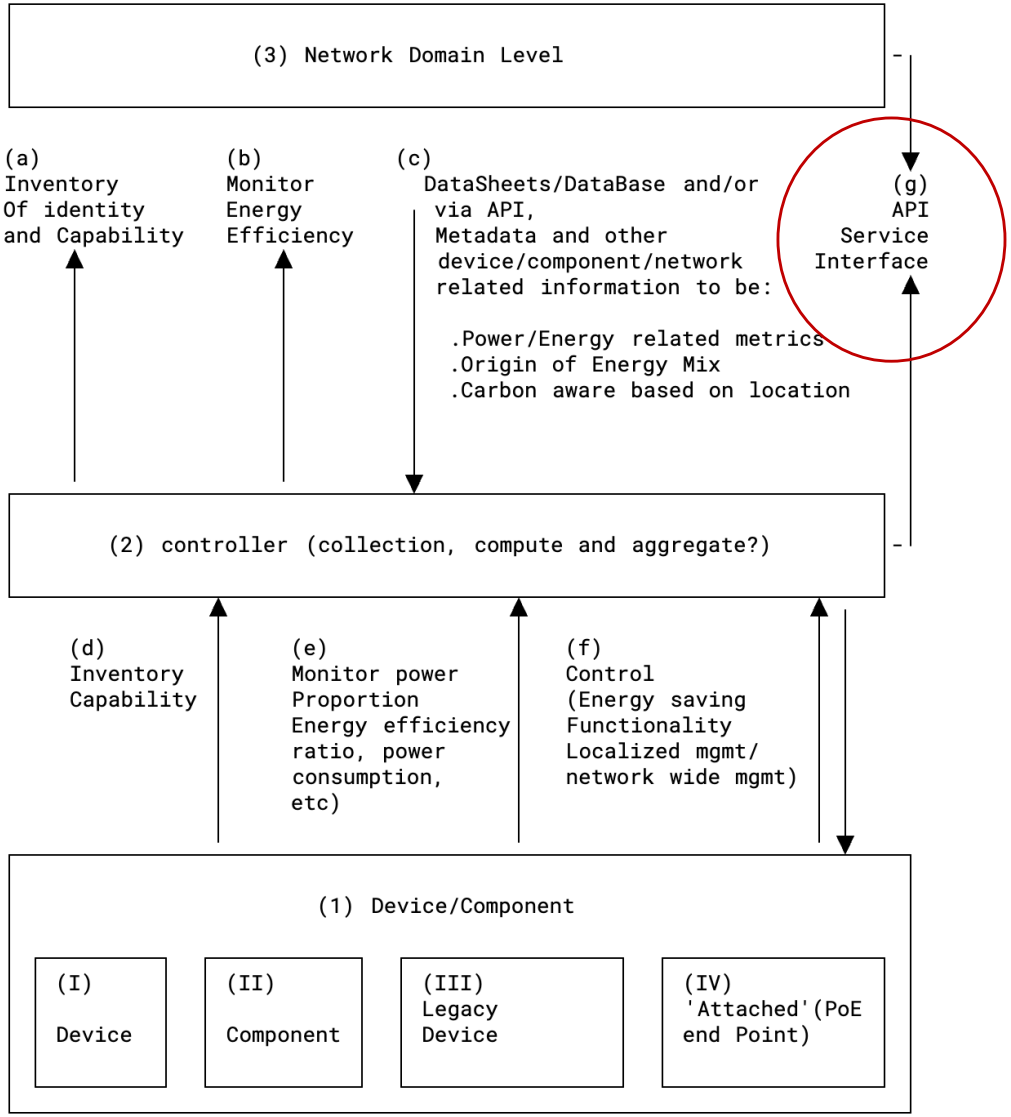

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Figure 1: GREEN Reference Model

(g) API Service Interface: enables access for service consumption,
enabling data retrieval , control, and integration through API, e.g., [PetraApi].

Note: nice drawings will arrive with the next draft revision. Thanks Marisol

GREEN Framework & Data Model Alignment: Concepts

- Power Interface
- Power Outlet vs Power Inlet
- Power State (Series)
  => YANG identity
- The Metering, Power Source, and Aggregation relationships
  ⇒ YANG identity
- AND some power YANG leaf, to start with? Why is it difficult? See RFC 7460
  Note: charter created on 2024-10-04

```
eoPower OBJECT-TYPE
    SYNTAX          Integer32
    UNITS          "watts"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
       "This object indicates the power measured for the Energy
       Object.  For alternating current, this value is obtained
       as an average over fixed number of AC cycles.  This value
       is specified in SI units of watts with the magnitude of
       watts (milliwatts, kilowatts, etc.) indicated separately
       in eoPowerUnitMultiplier.  The accuracy of the measurement
       is specified in eoPowerAccuracy.  The direction of power
       flow is indicated by the sign on eoPower.  If the Energy
       Object is consuming power, the eoPower value will be
       positive.  If the Energy Object is producing power, the
       eoPower value will be negative.

       The eoPower MUST be less than or equal to the maximum
       power that can be consumed at the Power State specified
       by eoPowerState.

       The eoPowerMeasurementCaliber object specifies how the
       usage value reported by eoPower was obtained.  The eoPower
       value must report 0 if the eoPowerMeasurementCaliber is
       'unavailable'.  For devices that cannot measure or
       report power, this option can be used."
    ::= { eoPowerEntry 1 }
```

```
EoPowerEntry ::= SEQUENCE {
    eoPower                     Integer32,
    eoPowerNameplate            Unsigned32,
    eoPowerUnitMultiplier       UnitMultiplier,
    eoPowerAccuracy             Integer32,
    eoPowerMeasurementCaliber   INTEGER,
    eoPowerCurrentType          INTEGER,
    eoPowerMeasurementLocal     TruthValue,
    eoPowerAdminState           PowerStateSet,
    eoPowerOperState            PowerStateSet,
    eoPowerStateEnterReason     OwnerString
  }
```

GREEN Framework & Data Model Alignment: Source Id

```
container sources {
  description
    "Container for defining data sources for this job.";

  list source {
    key id;
    description
      "List of sources for this green data collection job.";
    // Source connection and auth info elsewhere!

    leaf id {
      type source-id;
      description
        "ID of the data source.";
    }
    leaf-list mechanisms {
      type leafref {
        path "../../../mechanisms/mechanism/name";
      }
      description
        "Reference to the collection mechanism to be used.";
    }
  }
}
```

- Is this something we want to described in the framework? Absolutely!
- The Metering, Power Source, and Aggregation relationships need those unique Id/source Ids
- But we are waiting for the modeling efforts
- Solve in the MIB world with ENTITY-MIB-v4, RFC6933; why not reuse the same concept?

```
entPhysicalUUID OBJECT-TYPE
    SYNTAX      UUIDorZero
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains identification information
            about the physical entity.  The object contains a
            Universally Unique Identifier, the syntax of this object
            must conform to RFC 4122, Section 4.1.

            A zero-length octet string is returned if no UUID
            information is known."

    REFERENCE
            "RFC 4122, A Universally Unique IDentifier (UUID) URN
            Namespace, Section 4.1, July 2005."
```

GREEN Framework & Data Model Alignment: Provenance - Open Issue

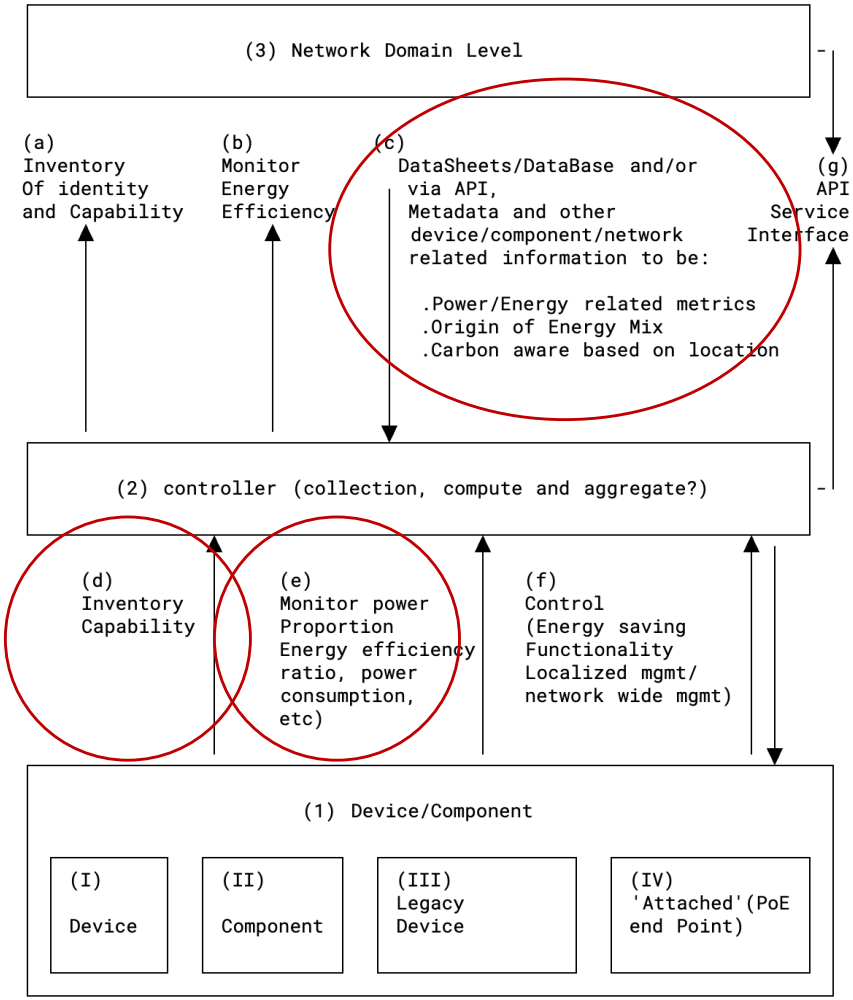

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Figure 1: GREEN Reference Model

- How to provide and verify the provenance of (YANG) data, so it is possible to verify the origin and integrity of a dataset
  - YANG, sure
  - But also not YANG: datasheets
- See draft-ietf-opsawg-yang-provenance: 4 ways, which one to promote here

4.1. Including a Provenance Leaf in a YANG Element

4.2. Including a Provenance Signature in YANG-Push Notifications

4.3. Including Provenance as Metadata in YANG Instance Data

4.4. Including Provenance in YANG Annotations

GREEN Framework Open Issues

Discovering Capabilities

- Automate detection of power-saving features.
- Identify device-specific limits (transition time, duty cycle).

Understanding Device Capabilities

- Support multiple power-state sets per Energy Object.
- Clearly define power states in a machine-readable format.

Mapping Intents to Settings

- Translate high-level energy goals into concrete configurations.
- Standardize the mapping method across systems.

https://author-tools.ietf.org/iddiff?url1=draft-belmq-green-framework-04&url2=draft-belmq-green-framework-05&difftype=--html

GREEN Framework Open Issues (Cont.)

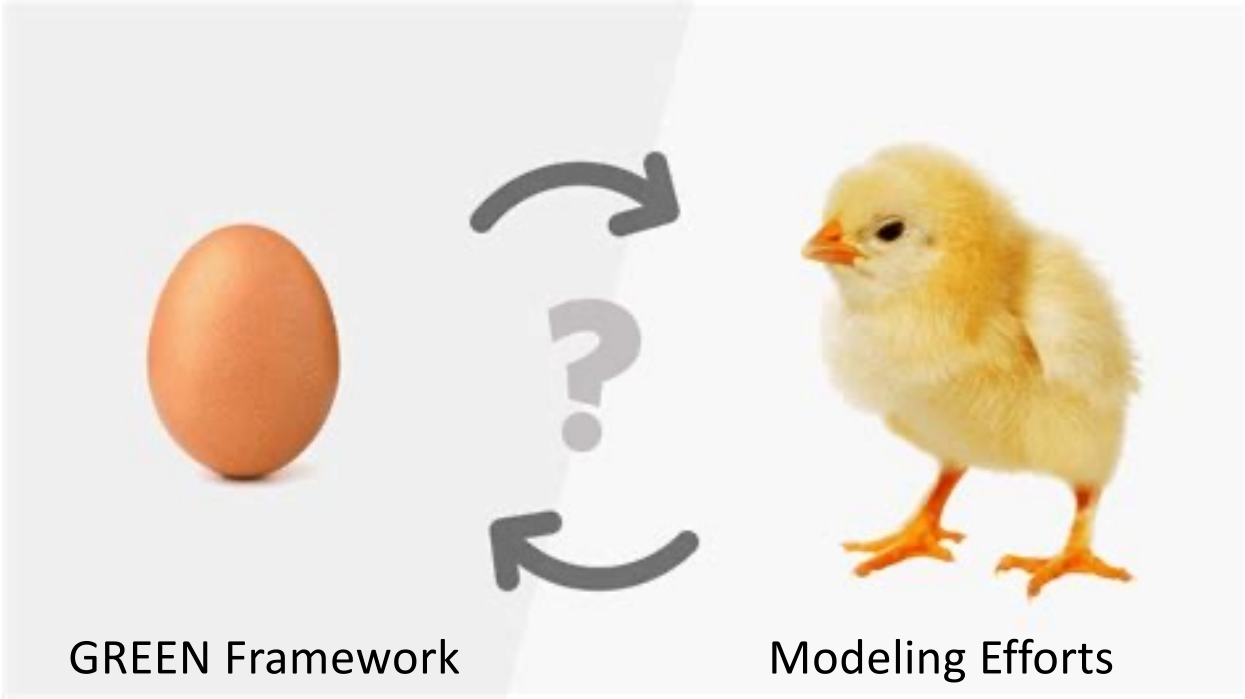
Handling Transitions & Ensuring Safety

- Account for transition times and safe operating limits.
- Standardize data models for transition frequency/speed limits.
- Measurement accuracy.
- SLAs covering performance and safety.

East-West Energy Metrics

- Standardize models for energy-efficient East-West interconnects.

Observation & Conclusion

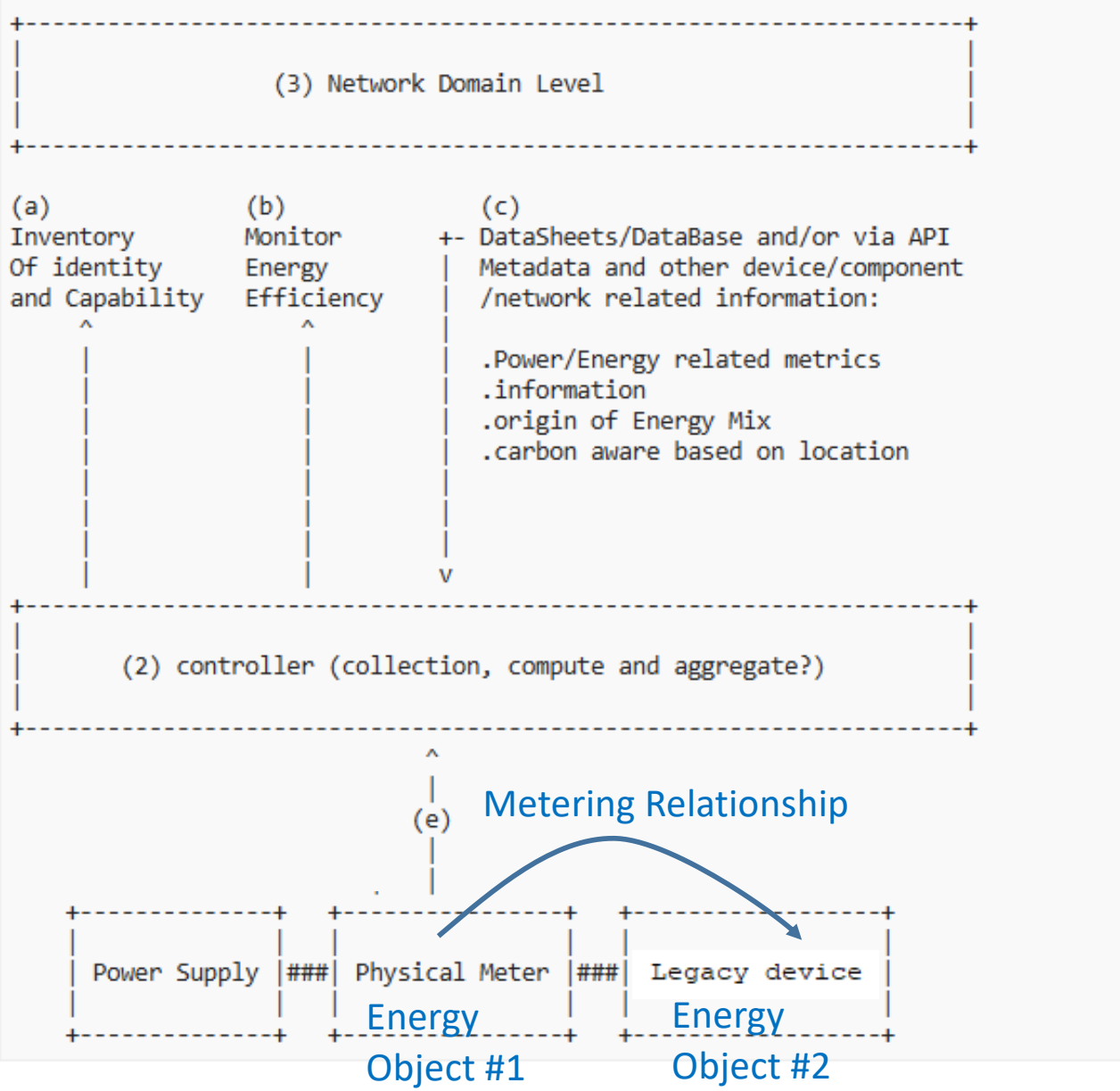


- We are losing time and energy ☺, while waiting for each other
- Requesting WG adoption
  - Both are required anyway
  - Need to work in parallel

BACKUP

Example: Physical Meter with Legacy Device

From the previous interim



NOTE: "###" is used to denote a transfer of energy.
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- With legacy devices, the controller (or Network Domain Level) must know & report that the physical meter measures on the behalf of this legacy device.
- In other words, it must know & report that the Energy Object 1 reports on behalf of Energy Object 2
- Conclusion: « Controller must know which for which Energy Object(s) it measures power or energy. This is the Metering Relationship"
- No LLDP over energy distribution => so a manual process

Example: Smart PDU

Hackathon

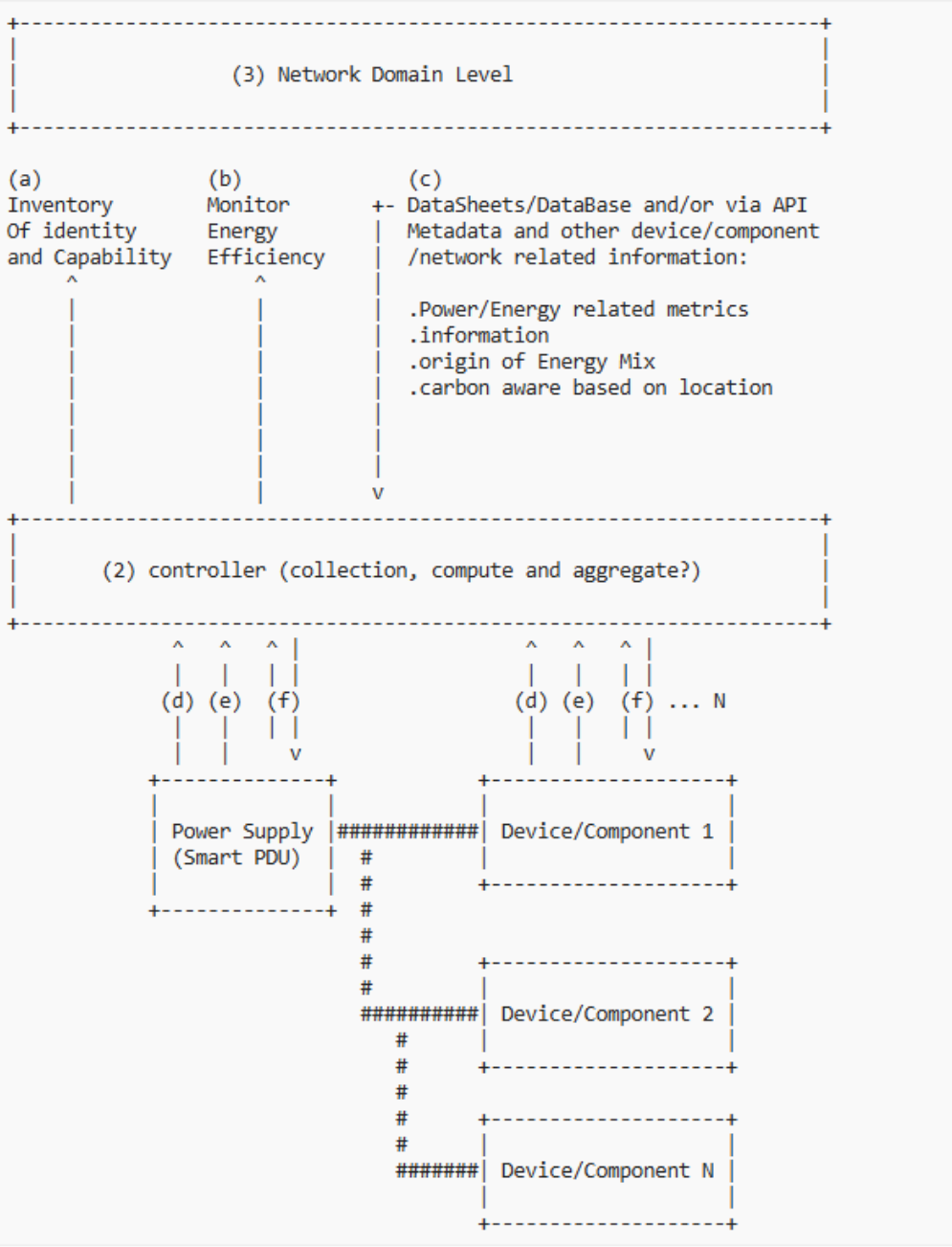

Figure 5: Reference Model Example: Single Power Supply with Multiple Devices

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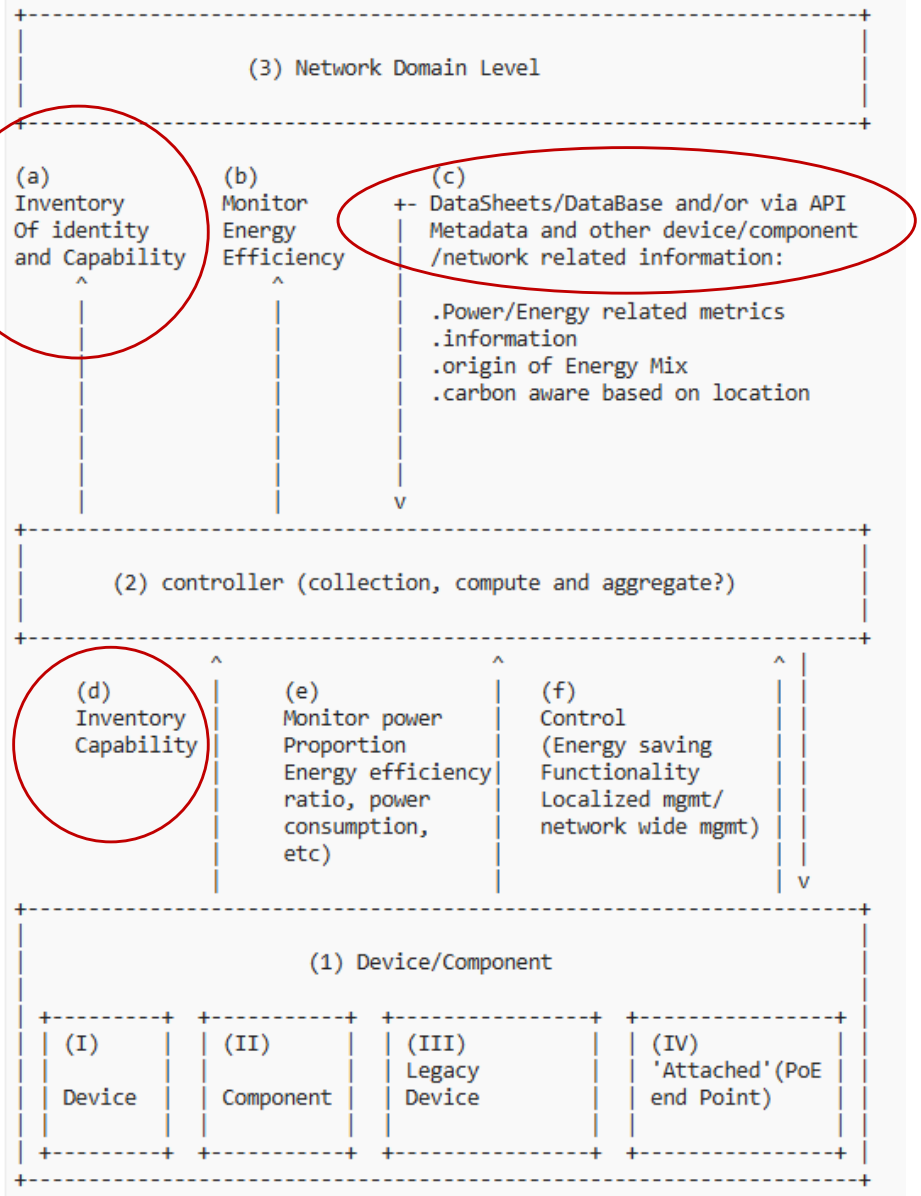
GREEN Reference Model

From the previous interim



Conclusion:

- Next to the physical topology, we need the power source & control topologies
- Inventory Capabilities include metering and power source relationships
- From which interface(s) (a), (c), and/or (d)… to be discussed in the framework document (might vary depending on the lifetime)

In version 4

Open Issues

- Discovering Capabilities
  - Enable automatic detection of power-saving features
  - Allow controllers to easily discover device-specific limits like transition time and duty cycle
- Understanding Capabilities
  - Explore if Energy Objects can support multiple sets of power states.
  - Make power states clearly described and understandable.
  - Represent these capabilities in a machine-readable format.
- Mapping Intents to Device Settings
  - Develop ways to translate high-level energy goals (like “save energy at low utilization”) into actual device configurations.
  - Create a standard method to describe this mapping across systems.
- Handling Transitions and Ensuring Safetly

- How to link the component to the Hardware YANG, IVY, SIMAP?

Big question: Should we focus first on monitoring, as well as discovering capabilities, as opposed to controller configuration?

From the previous interim, as presented by the chairs

Modelling Questions

1. **What level of dependence do/should models have on Framework?**
2. **What layers of models do we need, device, network, service, inventory, topology?**
3. **How much granularity in power control? (e.g., power states vs on/off)**
4. **Should control relate to intent or actual power usage?**
5. **How generic should the model be for components? (e.g., linecards vs optics, vs forwarding planes)**
6. **How to model power reported for other devices?**
7. **How does the data get aggregated together?**
8. **Accuracy of the data?**
9. **Time intervals for data reporting?**