Use Cases and Requirements for Energy Efficient Networking

https://datatracker.ietf.org/doc/draft-stephan-green-ucs-and-reqs/

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Template Proposal for the Use Cases

(by Carlos Jesús Bernardos)

Use case description

General description of the use case.

GREEN WG Specifics

(if there are no GREEN specific aspects, then it is not a UC to be documented)

For example, the use case involves components that can report on energy consumption and that might be reconfigured (on a local or global scale) to operate based on energy goals/limitations.

Requirements for GREEN WG

Examples (can be split into different categories to facilitate a summary at the end of the document):

- Granularity of measurements should be per component, per line, per port…
- Ability to switch on/off, put on sleep mode… components.
- Ability to reconfigure hardware mode based on power savings (e.g., reduce reliability or speed).
- Ability to operate globally (not constrained to just one device) based on power savings/goals (e.g., steer traffic using a different path that consumes less energy)

Use Case 2.1 - Incremental Application of the GREEN Framework

Description

Focuses on migrating legacy network devices to support energy efficiency.

Example: an old router, aims to optimize its circuits to reduce power consumption and contribute to energy efficiency.

GREEN WG Specifics

- Baseline Establishment: Set a reference point for typical energy usage.
- Component Migration: Transition hardware/software to support the GREEN framework.
- Network Level: Gradual implementation across the network.

Requirements for GREEN WG

- Discovery: Component granularity, e.g., per line-card, per-port.
- Observability: Access to power consumption data without additional instrumentation.
- Analysis: Common energy efficiency metrics for devices/components.
- Control & Management: Support for network-wide energy efficiency, including legacy devices.

Use Case 2.2 - Selective reduction of energy consumption in network parts proportional to traffic levels

Description

Typical traffic patterns show peaks and valleys that can be exploited to reduce the energy consumption in the network proportionally to the traffic delivered.

Reduction of energy consumption could be based on different mechanisms such as sleep modes of components or switching off capabilities

GREEN WG Specifics

- Models: definition of models for activating / deactivating advanced capabilities for energy efficiency

Requirements for GREEN WG

- Discovery: Component / module / device capabilities.
- Observability: energy / power consumption levels.
- Control & Management: models for energy efficiency control.

Use Case 2.3 - Reporting on Lifecycle Management

Out of Scope?

Description

Involves tracking "embedded carbon" related to manufacturing, transport, recyclability, and end-of-life impacts.

GREEN WG Specifics

- Carbon Reporting: Correlates operation locations with carbon factors.
- Energy Mix: Incorporates diverse energy sources into efficiency strategies.

Requirements for GREEN WG

- Data Collection: Embedded carbon data from vendor sources.
- ISO Compliance: Align with ISO 14040/44 standards.
- Energy Source Visibility: Track and report on energy source usage and backup power states.

Use Case 2.4: Real-time Energy Metering of Virtualized or Cloud-native Network Functions

Description

Facilitates precise real-time estimations of energy consumed by virtualized or cloud-native network functions.

GREEN WG Specifics

- Real-time monitoring: Continuous energy consumption monitoring for virtualized functions.
- Precision estimation: techniques for accurate energy use estimation.
- Cloud-native considerations: Adaptation to dynamic, scalable environments.

Requirements for GREEN WG

- Monitoring Infrastructure: Capable of real-time energy reporting.
- Integration: Seamless incorporation into network management systems.
- Accuracy: Ensure precise data for energy efficiency analysis.
- Scalability: Adapts to dynamic changes in cloud-native environments.

Use Case 2.5 - Indirect Energy Monitoring and Control

Does it cover PoE and Smart PDUs?

Description

Focuses on the necessity for devices to report on other entities within a network for effective energy management.

Addresses unique energy management needs distinct from typical network management functions.

GREEN WG Specifics

- Indirect Monitoring: Obtaining power values from other entities in the power distribution tree or external sources like databases and datasheets.
- Indirect Control: Requires communication with upstream entities to manage power supply, e.g., PDUs and PoE switches controlling power at sockets or ports.

Requirements for GREEN WG

- Communication Protocols: Facilitate indirect communication for monitoring and control.
- Instrumentation: Capability of measuring power at various distribution points.
- Energy Management Framework: Adapt the framework to indirectly address energy management methods.
- Standards Conformance: Align with standards specifying features for compliance, such as MIB module specifications.

Use Case 2.6 - Consideration of other domains for obtention of end-to-end metrics

Description

Connectivity of distinct technology domains is based on IETF technologies.

End-to-end energy efficiency metrics require to combine or compose the metrics per each of those domains

GREEN WG Specifics

- Metrics: definition of composable energy efficiency metrics, such as network slice energy efficiency.

Requirements for GREEN WG

- Observability: energy / power consumption levels.
- Analysis: generation of composable metrics.

Use Case 2.7 - Dynamic adjustment of network element throughput according to traffic levels in wireless transport network

Can be merged with 2.2 (proportionality use case)?

Description

Adjustment of radio link power based on the observed Traffic levels.

Control capabilities already defined in [ONF-MW][RFC8432] [mWT025]

GREEN WG Specifics

- Models: definition of models for activating / deactivating advanced capabilities for energy efficiency

Requirements for GREEN WG

- Discovery: Component / module / device capabilities.
- Observability: energy / power consumption levels.
- Control & Management: models for energy efficiency control.

Use Case 2.8 – Video streaming

Can be merged with 2.2 (proportionality use case)?

Description

Continuous growth in the number of simultaneous flows and higher bit rate per flow, dealing to a continuous upgrade of network devices.

High-capacity interfaces increase energy consumption.

Huge difference between peak and valley traffic patterns.

GREEN WG Specifics

- Models: definition of models for activating / deactivating advanced capabilities for energy efficiency
- Models: models for reporting energy usage (per stream)

Requirements for GREEN WG

- Discovery: Component / module / device capabilities.
- Observability: energy / power consumption levels.
- Control & Management: models for energy efficiency control.
- Metrics: reporting energy per flow (in this case, video stream)

UC1: WLAN Network Energy S

Can be merged with 2.5 (POE specific)

Description:

- In a WLAN network, The AP is usually powered by a PoE switch.
- AP nodes are network devices with the largest number and consuming most of energy. Therefore, the working status of the AP is the core of the energy saving solution.
- The working status of the AP can be break down into 3 modes as follows:
  - **PoE power-off mode**: In this mode, the PoE switch shuts down the port and stops supplying power to the AP. The AP does not consume power at all. When the AP wakes up, the port provides power again. In this mode, it usually takes a few minutes for the AP to recover.
  - **Hibernation mode**: Only low power consumption is used to protect key hardware such as the CPU, and other components are shut down.
  - **Low power consumption mode**: Compared with the hibernation mode, the low power consumption mode maintains a certain communication capability. For example, the AP retains only the 2.4 GHz band and disables other radio bands.
- In energ[illegible]er the surrounding energy saving APs are shut down, the Working AP automatically adjust t[illegible]reas[illegible] area at specific energy

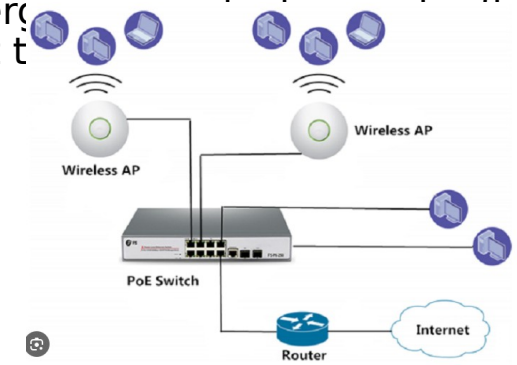


Figure 1 PoE Power off mode

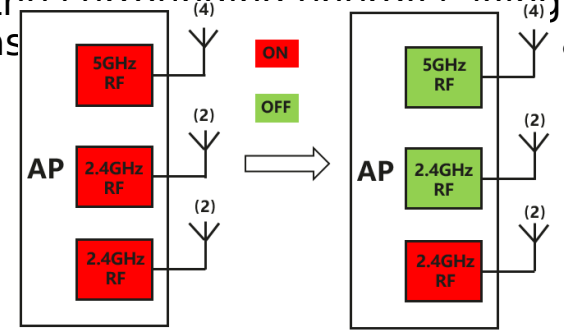
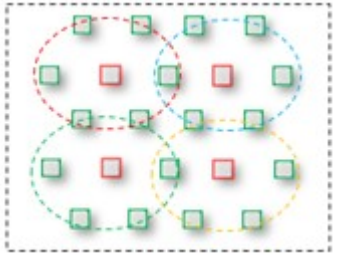


Figure 2 Low power consumption mode
RF shutdown for a single AP



Grouping area	Recommended energy saving period	Energy saving duration/hour
XED01-1	['01:00:00', '06:30:00']	5.5
XED01-2	['01:30:00', '06:30:00']	5
XED01-3	['01:30:00', '06:30:00']	5
XED01-4	['01:00:00', '06:30:00']	5.5
XED01-5	['01:30:00', '06:30:00']	5
XED01-6	['01:30:00', '07:30:00']	6

Figure 3 Wireless resource Management

GREEN WG Specific: Models: Control & Management, Dynamic energy saving, Scheduling

➢ Requirements of GREEN:

1. Ability to switch on or off to power the L2 network device at specific time period
2. Ability to reconfigure various different energy saving mode to adapt to network change
3. Ability to optimize wireless resource management to support dynamic energy saving

UC2: Fixed Network Energy Saving

Can be merged with 2.2

Description

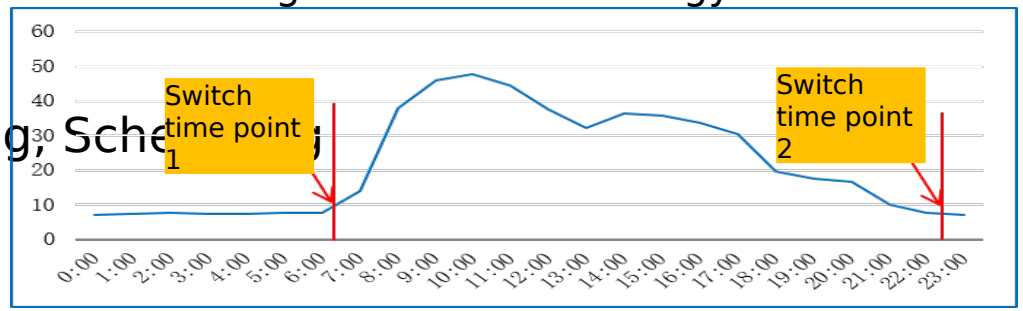
- Tidal Network: Traffic on the network has an obvious tidal period, including heavy-traffic periods and light-traffic periods:
  - The time duration of heavy traffic load and light traffic load are clearly distinguished,
  - The switching time between the heavy-traffic period and the light-traffic period is quite fixed and cyclic.
- **In a tidal network, some devices can be shut down or sleep during low-traffic periods to save energy.**
- In the metro or backbone network, the routers support various different speed interfaces, e.g., the gigabit level to 10GE/50GE, or 100G to 400G
  - Routers might choose to adjust speed of the interface based on network traffic load changes to save the energy.
- In addition, the routers can adjust the number of working network processor cores and clock frequency of chipsets and the number of SerDes buses based on network traffic load changes to save the energy.

GREEN WG specific:

- Requirements of GREEN:

1. Ability to shutdown devices during low traffic period
2. Ability to restart devices during high traffic period
3. Ability to adjust interface speed to adapt to network traffic change
4. Ability to adjust working component such as SerDes to adapt to network traffic change

Models: Control & Management, Dynamic energy saving, Scheduling



Resource usage of Routers in 24 hours (percentage)

UC3: Energy Efficiency Network Management

Description

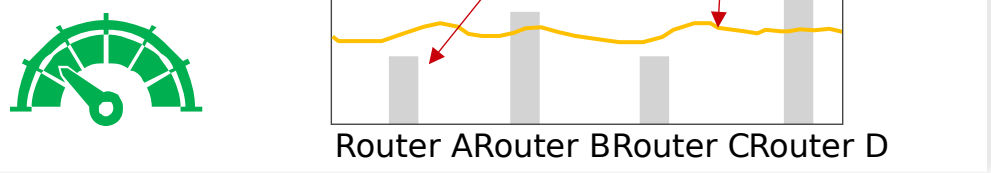
- Network level Energy Efficiency allow network operators not only see real time energy consumption in the network devices of large scale network, but also allow you see
  - which network devices enable energy saving, which devices not,which are legacy o
  - The total energy consumption changing trend over the time of the day, for all netw
  - Energy efficiency changing trend over the time of the day for the whole network.
- With the better observability to energy consumption statistics data and energy efficiency network operators can know which part of the network need to be adjusted or optimized b status change.

ITU/ETSI/ATIS
use case forcuses in run-time operations vs controled environment
- consider feedback from NGMN focus group:

(focus measurement data/ performance data):
sensor data per component
YANG model to access measurement data

GREEN WG Specific: Metrics: Definition of composite metric such as energy efficiency metrics, Data Collection: ility Di

Visualized Energy Efficiency



Energy Saving Evaluation

Energy Policy Management

Device	Energy saving switch
Router A	
Router B	
Router C	

➢ Requirements of GREEN:

1. Ability to provide observability to Network wide Energy Efficiency Statistics Data
2. Ability to provide observability to Network Wide Energy Consumption Statistics data.
3. Ability to discover energy saving capability for each device type