



ENERGY STAR Small Network Equipment Draft Specification Framework Document October 2009

Please send comments to Networking@energystar.gov
no later than **November 16, 2009**

Introduction

The US EPA ENERGY STAR program is increasingly focused on products described as miscellaneous energy users – products that are responsible for an ever-growing slice of the home electricity budget. Small Network Equipment (SNE) like modems and routers present an opportunity for reducing national household energy use due to the large installed base of products and their always-on status. Nearly 20 million SNE devices were shipped in 2008¹ as demand for broadband services continues to drive sales. Related products currently covered by the ENERGY STAR program are set-top boxes, digital to analog converter boxes, computers, and a wide range of office equipment; in addition, numerous SNE devices are presently recognized by the ENERGY STAR program indirectly through use of ENERGY STAR external power supplies (EPS). EPA intends to investigate energy saving opportunities across the full spectrum of network equipment, so an effort to develop a specification for Large Network Equipment will be considered separately in the coming year.

This Draft Specification Framework document serves to launch the ENERGY STAR specification development process for SNE. The Framework is intended to outline EPA's initial assessment of the product category and describe ways in which the ENERGY STAR program may be structured. Included in this document are EPA's initial thoughts on definitions, eligible products, possible test protocols, and structures for efficiency requirements. After each section is a set of questions designed to facilitate discussion with stakeholders and further EPA's understanding of this product category.

Stakeholders are encouraged to provide feedback on the concepts and definitions presented in this document. Communication between EPA and industry stakeholders is critical to the success of the ENERGY STAR program, especially in this early stage of the specification development process. To that end, EPA will host a **web meeting on November 19, 2009** (access details to be forwarded separately). Any and all creative suggestions for improvements to the basic ENERGY STAR approach outlined in this document will be considered for inclusion in subsequent draft and final specifications. ENERGY STAR representatives are available for additional technical discussions with interested parties at any time during the specification development process. Please send a message to networking@energystar.gov or to Una Song, at song.una@epa.gov to arrange a meeting.

Definitions

- a) **Purpose:** Establish a set of definitions to explicitly describe which products are intended to be covered by the specification and to clearly differentiate Small Network Equipment products from other ENERGY STAR product categories. Definitions are used to describe classes and sub-classes of products, operational modes, key components, etc. Note that

¹ Infonetics: *Quarterly Worldwide and Regional Market Share, Size, and Forecasts: 1Q09*. 2008 North American combined shipments of ASDL/VSDL modems, gateways, and IADs, and Cable modems and gateways.

a product may not be qualified as ENERGY STAR under more than one specification – manufacturers must select the product category that best describes the product they wish to qualify.

b) Preliminary Approach: EPA prefers to make use of existing definitions that are generally accepted by industry. In cases where industry accepted definitions are not available or appropriate, EPA will work with stakeholders to develop acceptable definitions.

c) Preliminary List of Definitions:

- **Equipment:** A generic term for a group or groups of devices within a product category.
- **Device:** A term used to describe a single product within a product category.
- **Network Equipment:** A device whose primary function is to pass Internet Protocol traffic among various network interfaces / ports.
 - i. **Small Network Equipment (SNE):** Network Equipment that is neither rack-mounted nor intended for use in standard equipment racks. SNE covered by this specification is limited to devices meeting the following criteria:
 1. Designed for stationary operation;
 2. Contains no more than nine wired network ports;
 3. Meets the definition of one or more of the *Product Types* defined below.
 - ii. **Large Network Equipment:** Network Equipment that is rack-mounted, intended for use in standard equipment racks, or contains more than nine ports for wired network. Large Network Equipment includes devices that are typically used in offices, data centers, and telecom facilities.

Note: The proposed scope of the Small Network Equipment (SNE) specification covers devices meeting the SNE definition. The general Network Equipment category also covers Large Network Equipment as found in enterprises and communications facilities. The definition above is provided as a reference.

- **Product Types:**
 - i. **Wired Router:** A network device that determines the optimal path along which network traffic should be forwarded. Routers forward packets from one network to another based on network layer information. Wired Routers with Wi-Fi capability as a primary function are either *Access Points* or *Integrated Home Access Devices*.
 - ii. **Wired Switch:** A network device that filters, forwards, and floods frames based on the destination address of each frame. The switch operates at the data link layer of the OSI model. Wired Switches with Wi-Fi capability as a primary function are either *Access Points* or *Integrated Home Access Devices*.

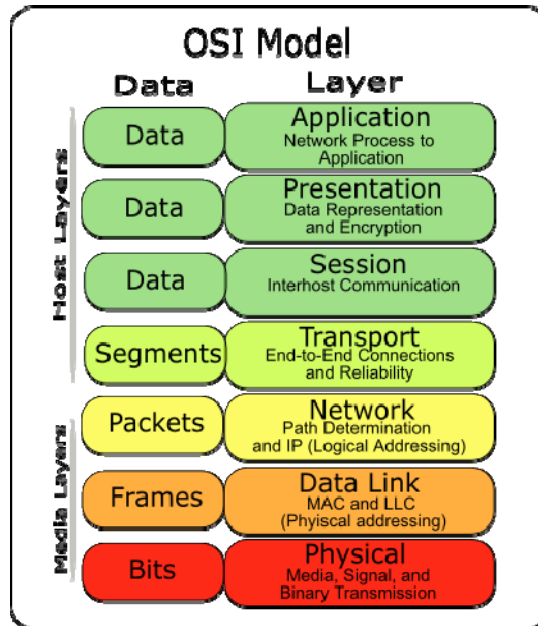


Figure 1 - OSI Model²

- iii. **Access Point:** A device that provides IEEE 802.11 (Wi-Fi) connectivity.
 - iv. **Broadband Modem:** A device that transmits and receives digitally-modulated analog signals over a wired network.
 - v. **End Point Device:** A device that functions as either an originator or destination for network traffic passed through Network Equipment. Examples of end point devices include computers, servers, set-top boxes, IP-capable televisions, etc. An end point device is not network equipment.
 - vi. **Integrated Home Access Device (IHAD):** A network device that includes the capability of a *Broadband Modem*, a *Wired Router*, and/or *Wireless Router*. IHADs may be referred to as *Gateways*.
 - vii. **Wi-Fi Extender:** A network device that functions to increase the coverage area of a Wi-Fi network by linking to other Wi-Fi devices using only the wireless link. These devices may alternately be classified as *Wi-Fi Repeaters*.
 - viii. **Optical Network Termination Device (ONT):** A device that converts signals between copper (wired) or wireless connections and an optical fiber connection. ONTs are available in either desktop or building-mounted versions with different connectivity options.
- **Operational Modes:** The modes defined below are intended to address the range of expected functional states for products covered in this specification.
 - i. **On Mode:** The product is connected to a mains power source, has been activated and is providing one or more primary functions. The common terms “active”, “in-use” and “normal operation” also describe this mode.
 - ii. **Sleep Mode:** The product is connected to a mains power source, is not providing a primary function, and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time (the common term “standby” may also describe this mode):

² www.cs.brandeis.edu/~rshaull/cs33b/osi-model.png

1. To facilitate the activation of other modes (including activation or deactivation of On mode) by remote switch (including remote control), internal sensor, timer;
 2. Continuous function: information or status displays including clocks;
 3. Continuous function: sensor-based functions.
- iii. **Off Mode:** The product is connected to a mains power source and is not providing any On Mode or Sleep Mode functions, and where the mode may persist for an indefinite time. An indicator that only shows the user that the product is in the off position is included within the classification of an Off Mode.
 - iv. **APD (Auto Power Down):** The capability to automatically switch a device from On mode to Sleep mode after (1) the device has ceased performance of all primary functions, and (2) a specified period of time has elapsed without active network traffic passing through the device.

Note: The definitions above for operational modes were developed to be consistent with other areas of the ENERGY STAR program. EPA's goal for the SNE program is to identify savings opportunities across all modes of operation. EPA's initial focus will include investigating opportunities for power management and low power modes. EPA will consider comments on revisions to these definitions to ensure that included modes best describe the expected operation of SNE.

An alternative set of definitions exists in the European Union's *Code of Conduct on Energy Consumption of Broadband Equipment, Version 3*. EPA intends to further consider this set of definitions to ensure the most cohesive set is incorporated into the SNE specification.

- **Other Definitions:**

- i. **SOHO:** Small Office / Home Office.
- ii. **External Power Supply (EPS):** A component contained in a separate physical enclosure from the SNE device designed to convert line voltage AC input into lower voltage AC or DC output(s) for the purpose of powering the SNE product. An EPS must connect to the SNE product via a removable or hard-wired male/female electrical connection, cable, cord or other wiring.
- iii. **Energy Efficient Ethernet (EEE):** A technology which enables reduced power consumption of Ethernet interfaces during times of low data throughput. To be specified by *IEEE 802.3az*.
- iv. **Power over Ethernet (PoE):** A technology which enables transfer of electrical power, along with data, to network end point devices through an Ethernet cable. Currently specified by *IEEE 802.3af* and *IEEE 802.3at*.
- v. **Cable, Satellite, and Telecom Service Provider ("Service Provider"):** An entity that provides content to subscribers with whom it has an ongoing contractual relationship, such as, but not limited to, a lease or rental arrangement.
- vi. **Manufacturing Partner:** An entity that manufactures, or markets OEM-manufactured, SNE for sale to either end customers or Service Providers.

Note: The definitions above for *Service Provider* and *Manufacturing Partner* are intended to delineate the two expected categories of ENERGY STAR partners for the SNE program. The *Service Provider* definition is based on a similar element of the ENERGY STAR Set-top Box (STB) program.

d) Discussion Questions:

- a. Are there alternate definitions for small network equipment that should be reviewed and considered by EPA?
- b. Are definitions of operational modes clear and applicable in general to the SNE market? Are there types of low power modes that currently exist which are relevant, and can be defined and included?

Eligible Product Types

a) Purpose: Identify specific product categories to be covered by the specification based on the agreed upon definitions included in this document. Clearly defined product types are particularly important as ENERGY STAR requirements may be tailored to specific product types or product functions. It is also important to identify product types that are not eligible for ENERGY STAR qualification for reasons such as use of proprietary technologies, limited availability of data, lack of differentiation with regards to product efficiency, or presence in niche markets.

b) Preliminary Approach: EPA is considering a tiered approach for the SNE specification. The tiered requirements system has been used in other ENERGY STAR programs for home and office electronics products. Under this tiered approach, a first set of requirements (*Tier 1*) is developed to address products that are established on the market, have measurable energy savings, and may be subject to industry standards or test procedures that can be leveraged by the ENERGY STAR program.

At this time, EPA is considering the following types of SNE for inclusion in Tier 1:

- Wired Router
- Wired Switch
- Access Point
- Broadband Modem (DSL and Cable)
- ONT Device
- IHAD (DSL and Cable)

Note: In addition to the product categories above, EPA is considering ways to address the efficiency of IP Telephony products. To foster further discussion toward potential inclusion of IP Telephony in this or an alternative ENERGY STAR specification in the future, EPA is open to comments on this market and efficiency of the products it includes.

Typically, Tier 2 requirements are also set forth as part of the Tier 1 specification, with the intent of providing manufacturers with advance notice regarding forthcoming efficiency requirements.

c) Network Ecosystem: EPA intends to evaluate protocols and best practices developed in the SNE program for widespread application across ENERGY STAR electronics and

IT programs. Further, EPA believes that SNE can be used to monitor and manage the energy consumption of connected PCs and other end point devices (related research has been carried out at the University of South Florida).^{3,4} There are also opportunities for network equipment to enable significant energy savings in connected PCs and other devices through full network connectivity as identified in the ENERGY STAR Computer specification. EPA intends to engage in a dialogue with stakeholders on these and other “ecosystem” efficiency opportunities that ENERGY STAR may be able to facilitate in the market.

d) Implementation Timing: As a new ENERGY STAR product category, the Tier 1 SNE specification would go into effect immediately upon finalization. An effective date for Tier 2 requirements will also be established at that time. Possible requirements for these tiers are discussed at greater length in the Energy Efficiency Requirements and Testing section below.

e) Questions for Discussion:

- a. Are there any SNE products missing from the list of products under consideration for Tier 1? If so, are there existing efficiency features or methods that could be promoted by ENERGY STAR now or in the future?
- b. Are there any product development trends in the SNE market that may have an impact on power consumption or proper categorization of devices?
- c. Is supply of PoE an expected technology in the SNE market? Are more devices that support supplying PoE expected in the future? How should test procedures accommodate SNE powered over PoE? Should PoE mid-span devices be considered to be network equipment or external power supplies?
- d. For devices with Ethernet, the Energy Efficient Ethernet effort was identified as a technology that could save energy both in the SNE and attached end point devices. Are there analogous technologies available for other wired or wireless network protocols?
- e. EPA believes that “power management” features could enable off-hours power-down scheduling and provide end-users a better understanding of network usage and power consumption over time. What are some strategies that can be promoted by ENERGY STAR to improve power management and data availability?
- f. EPA is aware of the growth potential in ONT devices as direct fiber connections to the home become more prevalent. What does EPA need to know about the types of products that provide this service and how they perform from an energy perspective?
- g. While IP Telephony fits the definition of a network end point device, it is possible for some IP telephones to function as a wired router or switch for a connected PC? Do IP Telephony devices share characteristics with other SNE devices identified in this document? What features or technologies exist to promote energy efficiency in IP Telephony?

Energy Efficiency Features and Test Procedures

a) Purpose: Once it is determined which products will be included in the ENERGY STAR specification, the next step will be to define metrics for energy-efficient performance. Metrics may address the efficiency of key components or features (e.g., power supplies),

³ http://www.csee.usf.edu/~christen/energy/lcn08_2_proceedings.pdf

⁴ <http://www.ietf.org/proceedings/75/slides/opsawg-4.pdf>

operational modes, and/or whole-system energy efficiency. Efficiency metrics are ideally supported by generally-accepted test procedures. EPA will evaluate the need to develop unique requirements for segments of the market based on data showing the energy impact of key product functions.

The efficiency metric(s) will ultimately be used to determine ENERGY STAR qualification. The ENERGY STAR program strives to set requirements so the top product performers available in the market at the time the specification becomes effective will be able to qualify.

- b) Preliminary Approach:** EPA recognizes the trend towards convergence in features and capabilities as devices become more highly functional over time. Such convergence (and diversity) provides ample opportunity to highlight features that promote better energy efficiency. To reflect the impact of these features, a preliminary approach would include evaluation of SNE by setting a power limit base with a structured set of power allowances over these limits based on the power needed to provide supplemental functions. Such an approach would ensure that SNE were designed to operate as efficiently as possible without prohibiting the inclusion of beneficial product features.

This approach has been used in the past in the ENERGY STAR program. As an example, Version 4.0 of the ENERGY STAR Computer program was based on an assessment of system power in various modes of operation. In addition to this system metric evaluating base power consumption, power supply efficiency requirements and Wake on LAN (WOL) functionality were required as specific features. Power supplies were required to meet ENERGY STAR requirements for the EPS product category, while WOL implementation was required based on intended use of the computer. For WOL, a small additional power allowance was given based on performance data provided to EPA.

- c) Preliminary Energy Efficiency Features Under Consideration:** This section includes a list of energy efficiency features that will be reviewed during development of the SNE specification. Next to each feature is a brief note describing the feature or EPA's initial considerations on the feature.

- **Ethernet**

- Product supports 802.3az (Energy Efficient Ethernet):** EPA remains committed to encouraging network ecosystem efficiency improvements. The *IEEE 802.3az* standard is nearing completion and EPA intends to support the uptake of compatible components and technology by including this provision for Small Network Equipment.
- Automatic unused port power-down:** System detects and disables power to disconnected Ethernet ports.
- Adaptive port power based on cable length:** Stakeholders informed EPA of a feature that allowed the SNE product to modify the power delivered to a specific port based on the length of the cable connected to the port. This feature "right-sizes" power consumption to provide the necessary signal strength.
- Ability to enable/disable PoE:** Implementation options could include either the ability to schedule PoE downtime or adaptively sense that no end point device requiring power was connected.

- **Wireless**
 - i. **TBD:** EPA seeks feedback from stakeholders on relevant efficiency methods or standards for wireless networking. EPA received feedback from a stakeholder who noted that some access point devices supporting multiple protocols operated several Wi-Fi radios simultaneously, while others managed power based on end point device requirements.
- **External Power Supply**
 - i. **ENERGY STAR Version 2.0 External Power Supply:** EPA intends to include efficient power supply requirements in the SNE program. EPS requirements are a core requirement in numerous ENERGY STAR electronics programs and SNE has been present in the End-Use Products with Qualified EPSs (EUP) program since early in that program's implementation. Below is the requirement as it might appear in an SNE specification.
 1. *External Power Supplies sold with ENERGY STAR SNE must be ENERGY STAR qualified or meet the no-load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for Single Voltage External AC-AC and AC-DC Power Supplies, Version 2.0. The ENERGY STAR specification and qualified product list can be found at www.energystar.gov/powersupplies.*
- **System Power Management**
 - i. **Device APD:** EPA believes that many SNE usage scenarios require continuous network connectivity where "inactive" power modes are not relevant. However, EPA does intend to recognize devices that consume less power when used at low levels of throughput.

To support usage scenarios where extended periods of inactivity are expected (e.g. home use while occupants are away from the premises), options include firmware scheduling capability to power down based on user preferences (with a local or web interface), or timed "sleep" requirements.

Finally, EPA will consider requirements for sleep or hard off switches to allow devices to be easily powered down, though stakeholders noted that simple on/off switches were not often used by consumers when made available.

- ii. **Smart Monitoring features (TBD):** EPA seeks comments on strategies for displaying usage information to help inform end-users of opportunities to power down end point devices during periods of inactivity.

d) Efficient Operation Requirements: EPA intends to develop an energy performance metric that reasonably scales with available connectivity features. EPA is aware of proposed and existing efficiency metrics for network equipment which evaluate power consumption scaled with connectivity.

As noted in *Section B*, EPA intends to begin developing a system of base power allowances for the product types covered by the SNE specification, plus power allowances for additional capabilities (similar to the ENERGY STAR Imaging Equipment specification). To achieve these goals, a test procedure may need to be developed or adopted for use in the program. Discussion of related test procedures is included in *Section E*, below.

- **Base Power Allowance:**

- i. **Description:** EPA intends to develop typical power consumption levels by using the weighted average power consumption of the equipment over different throughput conditions. This method has been proposed in industry energy efficiency network equipment test procedures (see *ATIS and ECR* in Section B), and the resulting power measurement is intended to encourage low power consumption at low utilization while still providing high throughput.
- ii. **Expected Data/Information Needs:**
 1. List of expected throughput conditions (e.g. unconnected, connected with minimal traffic, etc.);
 2. List of settings and configuration factors to specify in testing process;
 3. Device power in each throughput condition.

- **Additional Power Allowances:**

- i. **Description:** To develop technology-appropriate adders and ensure base allowances are truly representative of base functionality, EPA will identify and collect data on the power impact of additive capabilities in SNE. A list of potential capabilities is listed below (this list is not intended to be comprehensive and only adders supported by sufficient data to justify a power allowance will be considered):
 1. Wired interface type;
 2. Wireless technology or standard;
 3. Maximum device throughput;
 4. Data interface(s) (e.g. phone or USB);
 5. Packet filtering.
- ii. **Expected Data/Information Needs:**
 1. List of candidate features beyond base functionality requiring power allowances;
 2. Data supporting creation of an allowance.

Note: The approach described above was developed based on anticipated levels of scalability, feature sets, and available power modes in Small Network Equipment. All of these factors likely differ in the other types of network equipment not covered by this specification. A future effort dedicated to these other areas of the network equipment market would be developed independently to arrive at metrics most suitable to the category.

- e) **Test Procedures and Reference Standards:** EPA anticipates the need to develop a test procedure for SNE that would be applicable to all products covered by the program. EPA strives to make use of existing test procedures whenever possible and is open to

suggestions from stakeholders. The following test standards have been identified as candidates for use:

- *Ministry of Economy, Trade and Industry (METI)*. In Top Runner documentation, METI presents a detailed test methodology for small routers and L2 switches that evaluates transmission efficiency. Energy consumption efficiency is evaluated in units of Watts/bit/second.
- *EU Code of Conduct on Energy Consumption of Broadband Equipment*. Appendix B of the CoC defines Low Power and On-State conditions for the products covered by the regulations.
- *IEC 62301*. Addresses measurement of standby power for household electrical appliances. The test voltage and power analyzer requirements from IEC62301 are often cited by the ENERGY STAR program.
- *ATIS-0600015 (Draft)*. Addresses measurement of typical power consumption of network equipment using a weighted power approach. This procedure is intended for large, enterprise-class network equipment and would not be directly applicable to SNE, though potentially useful as a resource.
- *ECR Network and Telecom Equipment Energy and Performance Assessment Test Procedure and Measurement Methodology (Draft)*. Addresses measurement of typical power consumption of network equipment using a weighted power approach. This procedure is intended for large, enterprise-class network equipment and would not be directly applicable to SNE, though potentially useful as a resource. The procedure has additional sections on measuring static energy savings for low power modes.

f) Questions for Discussion

- a. Are there additional industry-standard test procedures that EPA should consider during development of this specification?
- b. Stakeholders commented to EPA that the expected duty cycle of SNE primarily consists of “idle” with very short periods of active use and short (if any) periods in low power modes. Are there any comprehensive studies of SNE usage patterns that should be considered by EPA?
- c. Are there any concerns/support for features included in the preliminary list? Are there additional features EPA should be aware of that represent energy saving opportunities?